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Designing and Installation of two Groundwater Recharging Wells at UET Taxila

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ABSTRACT

Shortage of water and the depletion of groundwater reserves are serious challenges in Pakistan. As a result, solutions including groundwater recharge and other forms of sustainable groundwater management are being considered. Water quality, aquifer characteristics, and the feasibility of refilling were just a few of the hydrogeological factors that were carefully examined in this study. Well-construction methods were also dissected for this study. All aspects of the well's construction were considered. The study's findings highlight the importance of selecting a proper location for replenishing groundwater wells. In addition, different recharge strategies, including basins for infiltration and injection wells, were evaluated to find the most appropriate method for the site. It also investigated how the replenishment of groundwater wells could affect the ecosystem. Mitigation measures, such as proper sealing of the well casing and monitoring of water quality parameters, were recommended to minimize potential risks and ensure the sustainability of the recharge operation. Taxila, a Hilly area of Pakistan, poses unique challenges for groundwater management and sustainability. The water table is lower as compared to other areas. In response to diminishing groundwater resources and increasing water stress, this research project aimed to design and install two groundwater recharging wells in the Taxila area. The study's primary objectives were to assess the effectiveness of these wells in recharging groundwater, evaluate their environmental impact, and provide insights into their potential for sustainable water resource management in hilly regions. The research involved comprehensive site selection, hydrogeological investigations, and the design and construction of two recharge wells. Detailed monitoring and data collection were carried out before, during, and after the installation of these wells to evaluate their impact on groundwater levels and quality.

KEYWORDS: Groundwater replenishment, Recharging well, Water quality, SDGs

1 INTRODUCTION

Water is an essential element to sustain all life. Globally, one-third of the freshwater resources on earth are found in groundwater[1]. However, the global over-exploitation of surface water resources has put enormous pressure on terrestrial resources, leading to their depletion in many parts of the world[2]. There has been a lot of pressure put on both the quantity and quality of

Pakistan's water resources due to the country's fast population growth, urbanization, and unsustainable freshwater-use practices both in rural & modern areas[3]. Water pollution from declining water quality causes an increase in waterborne illnesses and their harmful impact on human health[4].

Rainwater is a fresh source for groundwater recharging wells (GWRW), and a proactive approach to deal with urban flooding[5]. The project primarily consists of surface rainwater harvesting to cope with stormwater in Taxila. The key objective of this research is to reuse rainwater for groundwater recharge and other several activities such as preventing rainwater discharge in municipal drains and devising and developing a policy for rainwater harvesting at the University of Engineering and Technology (UET), Taxila.

To the best of our knowledge, this is the first project of rainwater harvesting to cope with stormwater in Taxila which will be helpful for policymakers and water stewardship managers who are working on groundwater replenishment. The designing and workflow methodology for groundwater recharging well are comprised of (i) site visits to select suitable catchment areas (ii) pointing out the ponding sites during the peak (Monsoon) season (iii) data analysis for groundwater quality and rainwater quality monitoring (iv) Estimation for potential rainwater harvesting at Library top and multipurpose Hall top (v) pre-installation measures for the design of recharge well (vi) post-installation measures for recharge.

2 METHODOLOGY

Before adopting a suitable methodology for groundwater recharging wells, the past data of the groundwater table in Taxila were collected to check the current groundwater table. Firstly, suitable catchment areas have been selected for groundwater recharging well through several site visits. Then we performed the data analysis for groundwater quality, rainwater, and hydrological studies to check the feasibility of groundwater recharge Wells. After that, we designed and installed the filtration assembly recharged the well according to the designed dimension, and then checked and evaluated the performance of groundwater recharge wells by monitoring the well.

2.1 Site Selection within the premises of UET Taxila

A general survey was conducted in UET Taxila to select a suitable catchment area for the installation of a ground water recharge well. Those areas were selected, where the accumulation of rainwater is in excessive amounts. Various field visits have been made after every rainfall to identify the potential areas for groundwater recharging wells. After detailed site visits and meeting two areas were selected, one is near the library of the university and the other one is near the multipurpose hall.

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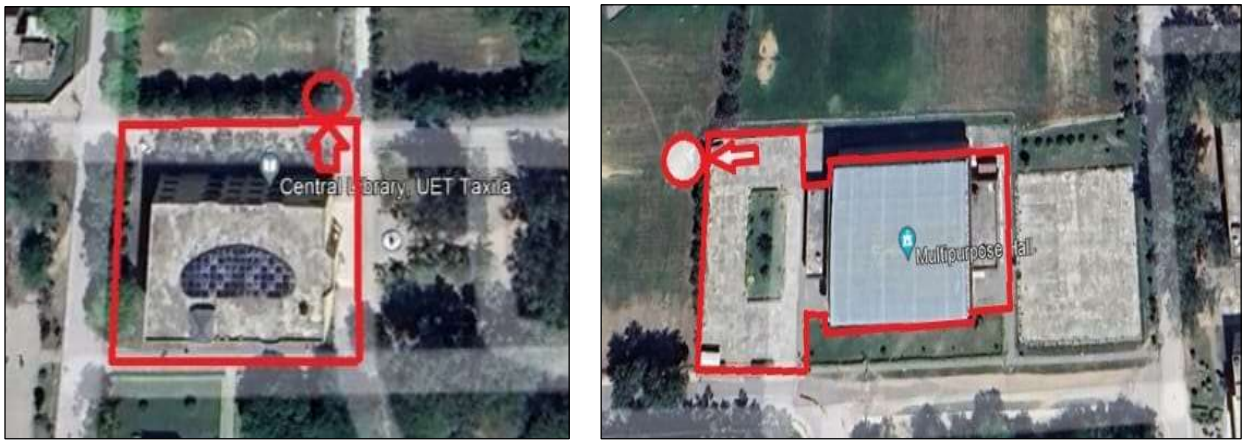

Figure 1: Selected sites for GWRW (Left; Library Site, right; MPH Hall)

2.2 Design and Construction

To design the groundwater recharge well system, including well depth, diameter, screen placement, and filter materials. Mobilize drilling equipment and personnel to the site. The depth of the borehole of the recharge well is 80 ft down and the monitoring well depth is 150ft down. The technique used for drilling is rotary drilling.

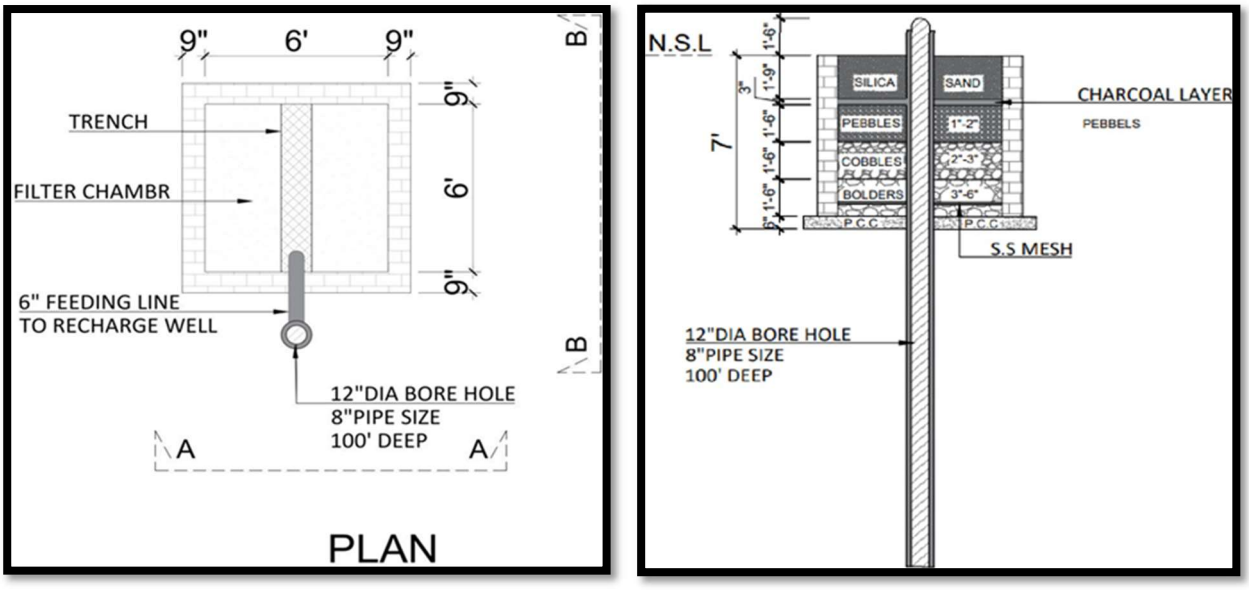

Figure 2: Left (Plan of Recharge Well), Right (Filter Media)

2.3 Analysis and Monitoring:

Pumping tests have been conducted to assess the well's performance, including water yield and drawdown. We analyzed the groundwater quality before filter media and after placing the filter media. A monitoring program during the rainfall and after the rainfall has been done to monitor water levels, water quality, and overall system performance.

3 RESULTS AND DISCUSSION

Two samples of groundwater have been collected by monitoring Well to check the effectiveness and efficiency of recharge well.

Table 1: Post-installation Groundwater Quality Analysis

Post-installation Groundwater Analysis					
Sr.no	**Parameters**	**Unit**	**6/5/2023**	**2/6/2023**	**15/7/2023**
1	**pH**	-	7.7	7.69	7.53
2	**Turbidity**	NTU	4.3	4.8	4.1
3	**TDS**	mg/l	289	322	280
4	**TSS**	mg/l	131	119	109
5	**Alkalinity**	ml	155	179	169
6	**Hardness**	mg/l	410	483	425
7	**Calcium hardness**	mg/l	189	212	203
8	**Magnesium hardness**	mg/l	12.33	17.5	15.78
9	**Sulphate**	mg/l	7.8	11.2	19.22
10	**chloride**	mg/l	20.3	25	31
11	**Nitrate**	mg/l	11.2	17	9.46
12	**Nitrite**	mg/l	0.33	0.49	0.37

3.1. CALCULATION FOR TOTAL RECHARGE

Table 2: Rainfall data collected for Library site

1	Annual rainfall intensity	1336mm
2	No. of days of project up to now	72 days
3	Total area	1000 m^2
4	Runoff coefficient for rooftop	0.9
5	Runoff coefficient for open area	0.6

$$\text{Annualainfall intensity} = \frac{1336\text{mm}}{\text{Annum}}$$
$$\frac{1336}{1000} = 1.34\text{m}^3$$
$$\text{No. of das of projectpto till now} = 72\text{ays}$$
$$\text{llpto till now} = \frac{\text{rainfall intensity}}{\text{days in year}}$$
$$=> \frac{1.34}{365} = \frac{0.0037}{\text{day}}$$
$$= 0.0037 \times 72 \text{ days}$$
$$= 0.264$$

Now,

$$\text{rooftop flow} = \text{area} \times \text{runoff coefficient} \times \text{rainfall intensity}$$
$$= 1100 \times 0.9 \times 0.264$$
$$= 261\text{m}^3$$

To calculate open-area flow, we used the following formula:

$$\text{open area flow} = \text{square meter} \times \text{runoff coefficient} \times \text{total rainfall}$$
$$= 1000 \times 0.6 \times 0.264$$
$$158.4\text{m}^3$$
$$\text{total availible supply} = 261 + 158.4$$
$$= 419.4\text{m}^3$$
$$\text{total recharge capicity} = \text{vol capture} \times \text{evaporation} \times \text{withdrawl}$$
$$=> 419.4 \times 10\% = 41.94$$
$$= 419.4 - 41.94 = 377.46$$
$$\text{total recharge} = \frac{377.46\text{m}^3}{72\text{days}}$$

4 CONCLUSION AND RECOMMENDATIONS

This research emphasizes the importance of integrated water resource management strategies, combining groundwater recharging wells with rainwater harvesting, watershed management, and water conservation initiatives. Such integrated approaches can significantly improve water availability, especially in regions facing water scarcity and stressed groundwater reserves.

This research also underlines the necessity for continuous monitoring, data collection, and adaptive management of groundwater recharging wells. Long-term assessments of their performance and periodic revisions of strategies are crucial to adapt to changing environmental conditions and emerging challenges.

It is recommended for further studies that focus on the waste handling of filter media in recharging well.

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6 REFERENCES

1. Gleeson, T., et al., Global groundwater sustainability, resources, and systems in the Anthropocene. Annual review of earth and planetary sciences, 2020. **48**: p. 431-463.
2. Wada, Y., et al., Global depletion of groundwater resources. Geophysical research letters, 2010. **37**(20).
3. Tariq, M.A.U.R., et al., An engineering perspective of water sharing issues in Pakistan. Water, 2020. **12**(2): p. 477.
4. Rehman, H., et al., Impact of construction method and ground composition on headrace tunnel stability in the Neelum–Jhelum Hydroelectric Project: A case study review from Pakistan. Applied Sciences, 2021. **11**(4): p. 1655.
5. Arshad, M. and R.N. Oad, Water Resources and Irrigation Network of Pakistan. Applied Irrigation Engineering. University of Agriculture, Faisalabad, 2017: p. 5-7.