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“Sustainable Watershed Management” – A Smart Way to Preserve Water

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ABSTRACT: At the rate in which Indian population is increasing, it is said that India will surely replace China from its number 1 position of most densely populated country of the world after 2030. These will lead to high rate of consumption of most valuable natural resource “Water” resulting in augmenting of pressures on the permitted freshwater resources. Ancient method of damming river and transporting water to urban area has its own issues of eternal troubles of social and political. In order to conserve & meet the daily demand of water requirement & increase ground water table, Watershed management is one of the best method fulfilling these requirements.

In future, everyday about 10,000 persons including Students, Staff – Members will come to KJEI Campus. In this campus, the intensity of rainfall is moderate, but there is no exact method use for storing this rainwater, so because of this summer season the campus needs to get water from outside sources like water tankers. The technical aspect of this paper is watershed management which collected from rooftop all buildings of KJEI Campus, all area of KJEI campus & surrounding hills of KJEI campus which is considered to be catchment area. First of all, we require following data to be collected to progress the imitation of our paper area is to be calculated, and the storage capacity with suitable design is to be considered. Volume of storage has to be calculated with suitable design is to be considered. Volume of storage has to be calculated with the most appropriate method of estimation. Locations of storage on the basis of hydrological analysis & Geographic Information System analysis is to be define in the campus.

KEYWORDS: Indian Population, natural resources, KJEI campus, Watershed Management, rooftop, Catchment Area, Hydrological Analysis, Geographic Information.

I. INTRODUCTION

Watershed Management means the process of creating & implementing plans, programs & project to sustain & enhance watershed functions that affect the plant, animal & human communities within watershed management boundary. Watershed management is not so much about managing & mitigating human environmental interaction. Because human activity includes actions by government, municipalities, industries & landowners, watershed management must be cooperatives efforts. Effective watershed management can be prevent community water shortages, poor water quality, flooding & erosion. The expense of undertaking watershed management far less than the cost of future remediation. These are various points includes in watershed management & discuss briefly such as concept of augmenting groundwater reservoir.

Human activities on land have a direct & cumulative impact on water and other natural resources within a watershed. Upstream activities influence river flows and water quality downstream. Channelizing rivers, removing riparian

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vegetation along watercourses, paving recharge areas, filling in wetlands & consuming groundwater at rates faster than it can be replenished can have severe & in some cases, irreversible effects on natural systems. These effects in turn usually impair water quality, degrade aquatic & terrestrial habitat, contribute to a loss of biodiversity, contaminate underground aquifers & increase risks of flooding & erosion damage.

At the heart of watershed management is the underlying philosophy that “**Everything is connected to everything else**”. Watershed components are interrelated & interdependent, like the links of a chain or the spokes of a wheel. Damage to any one watershed component runs of damage to all. The health of upstream components directly determines the health and function of areas downstream. If the headwaters of Duffins Creek & Carruthers Creek are healthy, areas downstream will benefit. If the headwaters of DuffinsCreek & Camuthers Creek Watersheds are well managed then lakeOntario and the St Lawrence River Basin will benefit.

II.LITERATURE REVIEW

1] **Mr. Pandurang D. Jankar & Dr. Mrs.Sushma. S. Kulkarni** carried out “ **A Case Study of Watershed Management For Madgyal Village**”: It started that in the madgyal some measures have been adopted to recharge the ground water resources, but it has been found that these measures don’t work with full capacity in some cases. In the madgyal watershed area, Demand for water for agriculture & drinking purpose is increasing rapidly depleting water resources coupled with overpopulation. Efforts are made to divert large amount of rainwater to recharge ground water resources.

Conclusion: By disucssion with local peoples & technical experts, they collected information about past & present situation of water & water demand . They also collected information from social mapping, GIS survey including contour map, natural stream map &water delineation map. They designed bunds for the water storage.

2] **Mr. Suhas P. Wani & Kaushal K. Garg** worked on “ **WATERSHED MANAGEMENT CONCEPT & PRINCIPLES**” and concluded that, watershed is not only simply the hydrological unit but also socio-political-ecological entity which plays crucial role in determining food, social & economical security & provides life support services to rural people. The criteria for selecting watershed size also depends on the objectives of the development & terrain slope. A large watershed size also depends on the objectives of the development & terrain slope. A large watershed management can be achieved in Plain valley areas or where forest or pasture development is the main objective.

Conclusion: They studied on history of watershed development programs in India. We got information about delineation of watershed, we also came to know about components of watershed management. They focused on various approaches in watershed management.

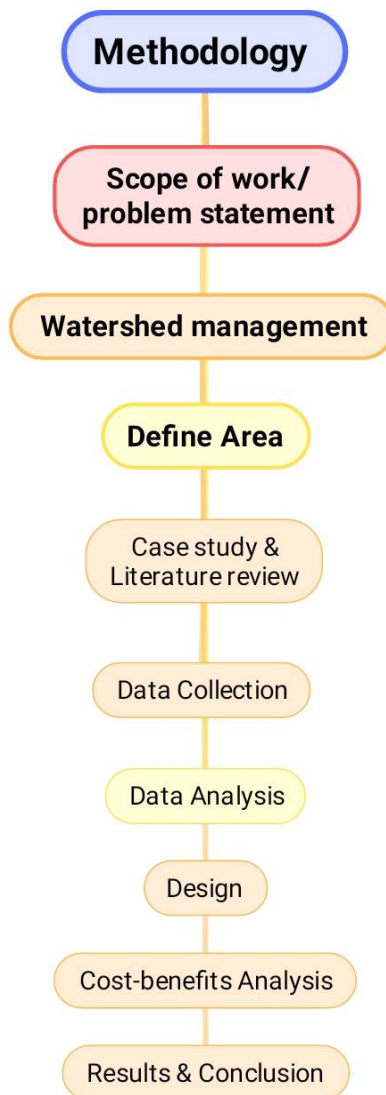
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III. METHODOLOGY



Quality of Water: 1] Water being a good carrier for disease germs, should be well treated so as to avoid the dangerous water born disease. Therefore, impure water should be treated into pure water, which is potable one.
2] The treated water controls the various water born disease & makes it possible to safe guard the health of the people & reduce costly repairs of various machines & also raises the standard of living of the community.
3] The water supplied to consumers should be pure.
4] The term pure dose not means that it should be physically or chemically pure, but it should be potable. Domestic water should be free from impurities & bacteria.

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| Sr. No | Parameter | Limits | Remarks |
|--------|-----------------|------------|--|
| 1. | Colour | 5 | May be extended up to 50 if toxic substances are suspected. |
| 2. | Turbidity | 10 | May be relaxed up to 25 in the absence of alternate |
| 3. | pH | 6.5 to 8.5 | May be relaxed up to 9.2 in the absence |
| 4. | Total Hardness | 300 | May be extended up to 600 |
| 5. | Calcium as Ca | 75 | May be extended up to 200 |
| 6. | Magnesium as Mg | 30 | May be extended up to 300 |
| 7. | Copper as Cu | 0.05 | May be relaxed up to 1.5 |
| 8. | Iron | 0.3 | May be extended up to 1 |
| 9. | Manganese | 0.1 | May be extended up to 0.5 |
| 10. | Chlorides | 250 | May be extended up to 1000 |
| 11. | Sulphates | 150 | May be extended up to 400 |
| 12. | Nitrates | 45 | No relaxation |
| 13. | Fluorides | 0.6 to 1.2 | If limit is below 0.6 water should be rejected. Limit is extended to 1.5 |
| 14. | Phenols | 0.001 | May be relaxed up to 0.002 |
| 15. | Mercury | 0.001 | No Relaxation. |
| 16. | Cadmium | 0.01 | No Relaxation. |
| 17. | Arsenic | 0.05 | No Relaxation. |

Methods for Calculation of Runoff:

A] Analytical Method –

1] Hydrological Analysis. - As 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 soil sample (L). In other words, here H/L represents the head loss or hydraulic gradient (I), K is the Coefficient of Permeability. Hence $Q = K.I.A$. Similarly based on the above principle the water harvesting potential of catchment area can be calculated.

2] Rationing Method (RM): The Rationing method (RM) distributes the stored rainwater to target public in such a way that the rainwater tank is able to serve water requirement to maximum period of time. This can be done by limiting the amount of use of water demand per person. The factors consider in this method are a) Catchment Area, b) Impermeability factor & c) Intensity of rainfall. Formula: $Q = K.I.A > R_i$ where K= factor taken as 1/360, A= Catchment Area in hectare, R_i = Rainfall Intensity in mm/hr.

3] Rapid Depletion Method (RDM): In Rapid Depletion Method, there is no restriction on the use of harvested Rainwater by consumer. Consumer is allowed to use the preserved rain water up to their maximum requirement, resulting in less number of days of utilization of preserved water. The rainwater tank is considered the only source of water for the consumer, and alternate source of water has to be till next rains, if it turns dries.

B] By Runoff Formulae & Tables-

1] Runoff Coefficient: $R = K * P$ where K= Runoff Coefficient, P= Rainfall, R= Runoff.

2] Strange's Tables: Strange gave tables and curves for runoff resulting from rainfall in the plain of south India. Strange's table is based on daily rainfall & three types of catchment (Dry, Wet, Damp)

3] Lacy's Formula: $R = P / (304.8f / 1 + P * S)$ Where, S= Catchment Factor, F= Monsoon duration factor.

Methods for Cost Analysis:

Using Revit Software – Built for Building Information Modeling (BIM), Autodesk Revit Software combines features for architectural design, MEP & Structural Engineering & Construction in a single comprehensive application. The 2016 release Continues to support user productivity with improved Revit Software Performance & usability

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enhancements. New Features includes MEP fabrication detailing within Revit, improved structure reinforcement detailing & improved workflows specific to steel connection design & detailing. In our Project, by using revit software developing models of earthen reservoir including design data such as size of reservoir, Capacity of required water demand etc.

IV. DATA COLLECTION SURVEY

Preliminary Survey:

We defined catchment area, carried out contour survey by using prismatic level, we determined ridge line, and we studied soil condition of the campus. We define slopes from analysis of contour survey. Found out reduce level of hilly area of KJEI Campus.

Rainfall Data Collection: The rainfall data of KJEI Campus is given below in tabular form

| Months | Avg. Annual Rainfall in mm | Rainy Days |
|-----------|----------------------------|------------|
| January | 1.7 | 0.2 |
| February | 1.5 | 0.1 |
| March | 0.6 | 0.1 |
| April | 9.8 | 0.9 |
| May | 30.0 | 2.2 |
| June | 171.4 | 9.6 |
| July | 171.0 | 12.2 |
| August | 139.5 | 9.8 |
| September | 141.7 | 7.9 |
| October | 85.8 | 4.7 |
| November | 21.5 | 1.2 |
| December | 7.4 | 0.4 |
| TOTAL | 781.9 | 49.4 |

Calculation Survey of Population in Campus: The Calculation of Population of campus is given below in tabular form

| Types of Buildings | Population (Nos.) | Water Req. BLD |
|--------------------|-------------------|----------------|
| T.C.O.E.R | 2060 | 82400 |
| K.J.E.I.M.R | 2560 | 102400 |
| T.A.E | 1120 | 44800 |
| ARCHITECTURE | 0075 | 3000 |
| POLYTECHNIC | 0135 | 5400 |
| SCHOOL | 0110 | 4400 |
| JR.COLLEGE | 0380 | 15200 |
| CANTEEN | - | 5000 |
| CANTEEN | - | 3000 |
| HOSTEL | 0250 | 31030 |
| TOTAL | 6605 | 296630li/day. |

Quantity of water required for Institute= **0.296MLD.**

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V. ANALYSIS & DESIGN

Determination of Catchment Area: The KJEI Campus surface area is nothing but the catchment area which receives rainfall. Catchment area of KJEI campus is measured. This measurement was done by available AutoCAD drawings.

Total Catchment Area = 1.5km²

Determination of water demand & Capacity: The campus population includes no of staff, no of students was collected from account department of each college.

Total population of KJEI Campus = 6605

Calculations:

Per Capita Demand of Water= $Q / (P \times 365)$ lit/capita/day.

Total Water Demand per Day= **296630.**

Demand of water per year = $296630 \times 365 = 108.27 \times 10^3$ Cu.M

Determination of Runoff: The Formula for calculation or runoff produced is given below

Volume of Water Received (m³) = Area of Catchment (m²) x Amount of Rainfall (M)

$$= (1.5 \times 10^6) \times 0.750$$

$$= \mathbf{1125 \times 10^3 \text{ Cu.M}}$$

Design of Percolation Tank: A study was planned to design a percolation pit to harvest rain water and recharge ground water aquifers so as to improve or maintain the ground water quality of well located in our campus. K.J Campus receives torrential rains during monsoon season but now days, good quality water is rare available.

Current dimensions of percolation tank which is available in our college campus, = (20 x 20 x 15) = **6000Cu.M**

But the current demand of water in our campus is more than capacity of percolation tank already available in campus.

We have modified the current percolation tank available near K.J College building. The design data is as follows

Total water Demand: 296630 lit/Day

Total water demand per year= $296630 \times 365 = 108.270 \times 10^3 \text{ Cu.M}$

Total required water demand including evaporation losses and other losses = $108270 + 32481 = 140751 \text{ Cu.M}$

We assumed that the depth of tank is 20m,

Therefore, $108270/20 = 5413.5$ per sq.m

$A^2 = 5413.5$ therefore $A = 75\text{m}$ where $A =$ length or width of tank.

Therefore dimensions of tank is **75 x 75 x 20m.** but it is not satisfied as per demand, so we again modified the design of tank. We assumed the depth of tank as 20m therefore we took dimensions of percolation tank as **85 x 85x 20m** which is satisfied as per need.

VI. RESULT

Dimension of Tank & Cost of Construction:

| Sr. No | Description | Volume m ³ | Rate / unit m ³ | Cost |
|--------|-------------------------|-----------------------|----------------------------|-------------|
| 1. | Excavation in hard soil | 144500 | 200 | 28900000.00 |

Cost of Excavation.

| Sr. No | Description | Volume | Rate / unit (Brass) | Cost |
|--------|---|---|---------------------|-------------|
| 1. | Salable Murum assume the depth of 15m | 108375 m ³ in brass = 38295.053 | 500 | 19147527.00 |

Estimation of Percolation Tank

The initial cost of excavated percolation tank was Rs 28900000.00

Salable cost of excavated soil is about Rs 1,91,47,527.00

Total Estimated Cost of Percolation Tank is = initial cost – salable cost

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= 2,89,00,000.00 – 1,91,47,527.00
= Rs 97,52,473.00

Consider 5% maintenance cost every year = Rs 4,87,623.00.

Cost analysis of Water Tankers: Cost per water tank = Rs 1000.00

No of water tanks required per day = 20 (March to june)

Total cost of tankers = 20x1000x120 days = Rs 24,00,000.00

| No of Years | Cost of Water Tankers | Cost of Percolation Tank |
|-------------|-----------------------|--------------------------|
| One Year | Rs 24,00,000.00 | 97,52,473.00 |
| Two Year | Rs 48,00,000.00 | 1,02,40,096.00 |
| Third Year | Rs 72,00,000.00 | 1,07,27,719.00 |
| Fourth Year | Rs 98,00,000.00 | 1,12,15,342.00 |
| Five Year | Rs 1,22,000.00 | 1,17,02,965.00 |

VII. CONCLUSION

This project dealt with all aspect of improving the water scarcity problem in the K.J.E.I Campus by implementing ancient old technique of watershed management. From above analysis, it was concluded that a huge amount of water got collected from the K.J.E.I Campus and surrounding hills. This percolation tank should have to built for the storage of 1404751 m³of water. Hence this tank has huge capacity of getting rainwater and on proper storage, this tank can supply almost throughout the year for about 6605 consumer having a consuming rate of 40lit/day as calculated by rational depletion method.

Hence it was finally concluded that implementation of WATERSHED MANAGEMENT OF KJEI CAMPUS will be the best approach to fight with present and future water related problems from financial as well as optimum utilization of land resources.

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