Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology
(Deemed to be University Estd. u/s 3 of UGC Act, 1956)

# Water Consumption per person

Water used in the university, including hostels, is taken from mains supply such as extraction from Rivers, Lakes, or Aquifers (Deep bore wells).

**Table 1 - Details of Aquifers / Deep Bore Well Extraction**

| S. No. | Location of Bore wells | Depth in feet | Pump Capacity | Run Time / day | Extraction per day* (LPD) |
|---|---|---|---|---|---|
| 1 | Vel Tech Campus | | | | |
| | 1) B6 -Rear | 250 | 5 HP | 5 hours | 60,000 |
| | 2) B 33 - Beside | 500 | 5 HP | 5 hours | 60,000 |
| | 3) B 29 - Opposite | 500 | 7.5 HP | 5 hours | 90,000 |
| 2 | Ladies Hostel | | | | |
| | i)Bus Depot Opposite | 500 | 7.5 HP | 5 hours | 90,000 |
| | ii)Front Gate | 500 | 7.5 HP | 5 hours | 90,000 |
| 3 | B3, Balaji Hostel | 250 | 5 HP | 10 hours | 1,20,000 |
| | National Hostel -Rear | 250 | 5 HP | 10 Hours | 1,20,000 |
| | Mango Garden-3No. | 250 | 5HP | 10 Hours | 3,60,000 |
| 4 | Media & Law Campus-3No. | 250 | 5 HP | 6 hours | 2,16,000 |
| 5 | Prince Hostel | | | | |
| | Vel Tech Junction 2 No. | 500 | 5 HP | 10 hours | 2,40,000 |
| | Labour Shed | 500 | 5 HP | 10 hours | 1,20,000 |
| | Canteen block | 250 | 5 HP | 10 hours | 1,20,000 |
| | Besides Concrete Road | 500 | 7.5 HP | 10 hours | 1,80,000 |
| 6 | Leaders Hostel | | | | |
| | A – Block | 500 | 5 HP | 10 hours | 1,20,000 |
| | Work Shop | 250 | 5 HP | 6 hours | 1,08,000 |
| 7 | Vel Vinayaga Hostel 3 No. | 250 | 5 HP | 6 hours | 1,08,000 |
| 8 | International Guest House IGH | 150 | 1 HP | 4 hours | 45,000 |
| | **Total Quantity Extracted** | | | | ***22,47,000*** |
| | **Deducting 15% of wastage, Net Quantity** | | | | ***19,09,950*** |

* Subjected to Change as per Monsoon.

**Table 2 – Water Consumption per Person**

| S.No. | Source | Total No. (Students, Faculty & Staff) | Academic Year | Total Quantity |
|---|---|---|---|---|
| 1 | Aquifers / Deep bore well | 11633 | 2020-2021 | 564722 $m^3$/ Year |
| 1a | RO- Drinking water | | | 1744950 LPD |
| 2 | Aquifers / Deep bore well | 12057 | 2021-2022 | 660120 $m^3$/ Year |
| 2a | RO -Drinking water | | | 1808550 LPD |

LPD – Liter per Day

**Raw Groundwater Quality**

**Fig- 1. a. The above photos depict the source of Aquifers from Prince Hostel**

Water collected from the deep bore well for supply to Vel Tech (deemed to be a University) and its hostel facility is depicted below.

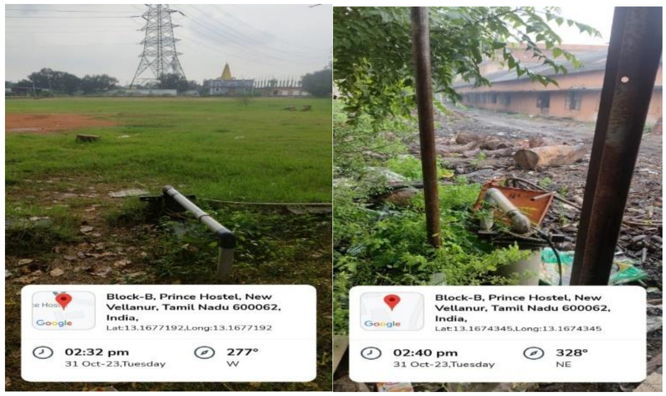


**Fig- 1b. The above photos depict the source of Aquifers from Prince Hostel**

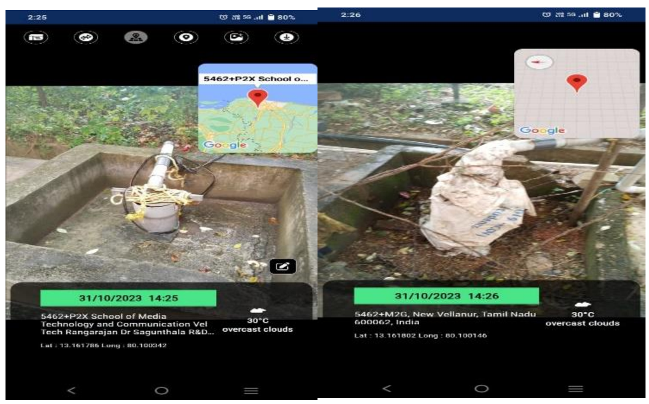


**Fig- 2a. Aquifers extraction from Law Campus to Vel Tech Campus**


**Fig- 2b. Aquifers extraction from Law Campus to Vel Tech Campus**


**Fig- 3 Aquifers extraction for B-3 Hostels**


**Fig- 4a. Aquifers Extraction Available within the Vel Tech Campus**

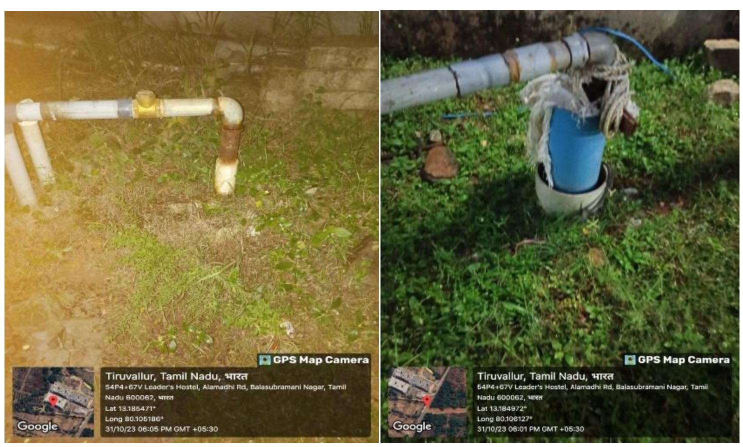


**Fig- 4b. Aquifers Extraction Available within for Leaders Hostel**

**Groundwater Quality Analysis**

Analysis of the collected groundwater samples was done by the procedures suggested in the Standard Analytical Procedure Manual for water samples, which is based on 'Standard Methods for the Examination of Water and Wastewater' 19th edition, APHA. To know the suitability of groundwater for drinking purposes, various physicochemical parameters like pH, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), calcium (Ca), magnesium (Mg), sodium (Na), chloride ($Cl_2$), nitrate ($NO_3$), sulphate ($SO_4$), carbonate ($CO_3$), Bicarbonate ($HCO_3$), Fluoride (F) and Total alkalinity as $CaCO_3$ were analyzed and finally, compared all physicochemical parameters with BIS drinking water quality and determined water quality indices to suit groundwater for drinking purpose. The standard ranges of the Water Quality Index are presented in the table below.

**The Standard Ranges of WQI**

| WQI Value | Water Quality |
|---|---|
| <50 | Excellent |
| 50-100 | Good |
| 100-200 | Poor |
| 200-300 | Very Poor |
| >300 | Not fit for drinking |

**Acceptable Limit**

The Acceptable limit-based Water quality index is calculated and presented in the table below.

| Parameters | Standard Acceptable Values (si) | Observed values (Ci) | Weight Factor (wi) | Relative Weight Factor (Wi) | Quality Rating (qi) | Water quality Sub index (Si) |
|---|---|---|---|---|---|---|
| pH | 7 | 6.32 | 5.00 | 0.12 | 90.00 | 9.61 |
| Calcium (Ca) | 75 | 32.45 | 2.00 | 0.05 | 42.67 | 1.83 |
| Magnesium (Mg) | 30 | 17.00 | 1.00 | 0.02 | 56.67 | 1.20 |

| Parameters | Standard Acceptable Values (si) | Observed values (Ci) | Weight Factor (wi) | Relative Weight Factor (Wi) | Quality Rating (qi) | Water quality Sub index (Si) |
|---|---|---|---|---|---|---|
| Sodium (Na) | 200 | 60.00 | 4.00 | 0.09 | 30.00 | 2.55 |
| Potassium (K) | 10 | 0.00 | 2.00 | 0.04 | 0.00 | 0.00 |
| Bicarbonate (HCO3) | 200 | 128.00 | 2.00 | 0.04 | 64.00 | 2.72 |
| Sulphate (SO4) | 200 | 30.00 | 5.00 | 0.11 | 15.00 | 1.60 |
| Chloride (Cl) | 250 | 85.00 | 4.00 | 0.09 | 34.00 | 2.86 |
| Nitrate (NO3) | 45 | 7.00 | 4.00 | 0.09 | 15.56 | 1.32 |
| Fluoride (F) | 1.5 | 0.45 | 2.00 | 0.04 | 30.00 | 1.23 |
| Total dissolved solids (TDS) | 500 | 295.00 | 5.00 | 0.11 | 59.00 | 6.24 |
| Total hardness as CaCO3 | 200 | 150.00 | 5.00 | 0.11 | 75.00 | 7.98 |
| Total alkalinity as CaCO3 | 200 | 105.00 | 4.00 | 0.09 | 52.50 | 4.45 |
| | | | **45.00** | | | **43.52** |

**Permissible Limit**

The Permissible Limit-based Water Quality Index is calculated and presented in the table below.

| Parameters | Standard Permissible Values (si) | Observed values (Ci) | Weight Factor (wi) | Relative Weight Factor (Wi) | Quality Rating (qi) | Water quality Sub index (Si) |
|---|---|---|---|---|---|---|
| pH | 7 | 6.30 | 5.00 | 0.11 | 90.00 | 9.57 |
| Calcium (Ca) | 200 | 32.00 | 2.00 | 0.04 | 16.00 | 0.68 |
| Magnesium (Mg) | 100 | 17.00 | 1.00 | 0.02 | 17.00 | 0.36 |
| Sodium (Na) | 200 | 60.00 | 4.00 | 0.09 | 30.00 | 2.55 |
| Potassium (K) | 10 | 0.00 | 2.00 | 0.04 | 0.00 | 0.00 |

| Parameters | Standard Permissible Values (si) | Observed values (Ci) | Weight Factor (wi) | Relative Weight Factor (Wi) | Quality Rating (qi) | Water quality Sub index (Si) |
|---|---|---|---|---|---|---|
| Bicarbonate ($HCO_3$) | 200 | 128.00 | 2.00 | 0.04 | 64.00 | 2.72 |
| Sulphate ($SO_4$) | 400 | 30.00 | 5.00 | 0.11 | 7.50 | 0.80 |
| Chloride (Cl) | 1000 | 85.00 | 4.00 | 0.09 | 8.50 | 0.70 |
| Nitrate ($NO_3$) | 45 | 7.00 | 4.00 | 0.09 | 15.56 | 1.32 |
| Fluoride (F) | 1.5 | 0.45 | 2.00 | 0.04 | 30.00 | 1.28 |
| Total dissolved solids (TDS) | 2000 | 295.00 | 5.00 | 0.11 | 14.75 | 1.53 |
| Total hardness as $CaCO_3$ | 600 | 150.00 | 5.00 | 0.11 | 25.00 | 2.62 |
| Total alkalinity as $CaCO_3$ | 600 | 105.00 | 4.00 | 0.09 | 17.50 | 1.49 |
| | | | 45.00 | | | 25.65 |

**Remarks**

Acceptable Limit calculation indicated that the water is excellent, and Permissible Limit calculation suggested that the water is excellent. Though it is good quality water, the water is allowed to reverse the Osmosis process and then supplied to students for drinking.

**Treated Reverse Osmosis Water Quality**

| Parameters | Acceptable Limit | Permissible Limit | Treated Water Quality |
|---|---|---|---|
| pH | 7 | 7 | 6.90 |
| Calcium (Ca) | 75 | 200 | 11.0 |
| Magnesium (Mg) | 30 | 100 | 2.0 |
| Sodium (Na) | 200 | 200 | 8.0 |
| Potassium (K) | 10 | 10 | 0 |

| Parameters | Acceptable Limit | Permissible Limit | Treated Water Quality |
|---|---|---|---|
| Bicarbonate ($HCO_3$) | 200 | 200 | 45.0 |
| Sulphate ($SO_4$) | 200 | 400 | 6.0 |
| Chloride (Cl) | 250 | 1000 | 8.0 |
| Nitrate ($NO_3$) | 45 | 45 | 0.5 |
| Fluoride (F) | 1.5 | 1.5 | 0.03 |
| Total dissolved solids (TDS) | 500 | 2000 | 72.0 |
| Total hardness as $CaCO_3$ | 200 | 600 | 48.0 |
| Total alkalinity as $CaCO_3$ | 200 | 600 | 18.0 |
| **WQI** | | | **18.17 (AL)** |
| | | | **13.96 (PL)** |

**Remarks**

Acceptable Limit calculation indicated that the water is excellent, and Permissible Limit calculation suggested that the water is excellent. Hence, it is supplied to students for drinking purposes.

**Utilization of Ground Water Reservoirs**

**Study Area**

Thiruvallur district, a newly formed district bifurcated from the erstwhile Chengalpattu district (on 1st January 1997), is located in the northeast part of Tamil Nadu. North Latitude between 12°15' and 13°15'. East Longitude between 79°15' and 80°20' The district is surrounded by the Kancheepuram district in the South and the Vellore district in the West—Bay of Bengal in the East and Andhra Pradesh State in the North. The district is spread over an area of about 3422 sq. km. An insight into the early history of this region shows that the region was ruled by kingdoms such as the Pallavas, the Golkondas, the

Mughals, the French, the Dutch and the British.

Avadi is coming under Thiruvallur district, a suburb of Chennai located at a latitude of 13.1067°N and a longitude of 80.0970°E in the Thiruvallur district of Tamil Nadu, India. It is a municipal corporation in the Chennai Metropolitan Area and the 15th municipal corporation in Tamil Nadu. Our Institution, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, is situated at a latitude of 13°10’34.28’’N and a longitude of 80°5’53.81’’E near Avadi, bounded by surrounding villages like Morai, Vellanur etc. The nearest airport is Chennai, and the nearest railway station is Avadi.

Avadi is a selection-grade municipality situated at a distance of 24 km from Chennai. The town serves as a transit point between Chennai and Arakkonam station and is surrounded by places of industrial and heritage interest. Ambattur, an industrial center, is on the eastern side, while Thiruverkadu and Thiruninravur surround the town on the southern and western sides. Its total coverage is 65 sq. km divided into 48 wards. The town has a population of 2.16 lakhs per the 2001 census, with a population density of 3331 persons per sq. km.

**Soils**

The area's soil has been classified into i) Red soil, ii) Black soil, iii) Alluvial soil, and iv) Colluvial soil. The major part is covered by Red soil of red sandy/clay loam type. Ferruginous red soils are also seen in places. Black soils are deep to very deep and generally occur in the western part of the depressions adjacent to hilly areas. Alluvial soils occur along the river courses and the eastern part of the coastal areas. Sandy coastal alluvium (arenaceous soil) is seen all along the sea coast as a narrow belt.

**Ground Water ScenarioHydrogeology**

Both porous and fissured formations underlie the district. I constitute the important aquifer systems in the district) unconsolidated and semi-consolidated formations, and ii) weathered fissured and fractured crystalline rocks. The porous formations in the district include sandstones and clays of Jurassic age (Upper Gondwana), marine sediments of Cretaceous age, Sandstones of Tertiary age and Recent alluvial formations. As the Gondwana formations are well-compacted and poorly jointed, groundwater movement in these formations is mostly restricted to shallow levels. Ground water occurs under phreatic to semi-confined conditions in the inter-granular pore spaces in sands and sandstones, bedding planes, and thin fractures in shales.

**Ground Water Quality in Thiruvallur District**

Groundwater in phreatic aquifers in the Thiruvallur district, in general, is colorless, odorless and slightly alkaline.

It is observed that the groundwater is suitable for drinking and domestic uses for all the constituents except hardness and nitrate.

**Analysis of Water Samples**

Groundwater samples were collected during the year AY 2021- 2022 in September from ten bore wells. The depth of the bore wells varies from 150 to 500 feet. Groundwater samples were analyzed in our Laboratory, and the test was carried out at Air Aqua Labs India Private Limited, located at Thirumullaivoyal, Chennai. The following parameters were analyzed in both of the above locations.

**pH – Value of Water**

pH is an expression of hydrogen ion concentration in water. Specifically, pH is the negative logarithm of hydrogen ion ($H^+$) concentration (mop/L) in an aqueous solution:

The term indicates the basicity or acidity of a solution on a scale of 0 to 14, with pH 7 being neutral. As the concentration of $H^+$ ions in solution increases, acidity increases, and pH gets lower, below 7 (see Figure 1). When pH is above 7, the solution is basic.

Because pH is a logarithmic function, one unit change in pH (e.g., 7 to 6) indicates a 10x change in H+ concentration in that solution. However, what is measured is hydrogen ion activity, not concentration.

Note that although basic solutions are alkaline, “basicity” and “alkalinity” are not the same thing. Basicity refers to the ratio of hydrogen and hydroxyl (OH-) ions in **solution and is** directly related to pH. Alkalinity is related to the acid-neutralizing capacity (ANC) of a solution.

pH affects most chemical and biological processes in water. It is one of the most important environmental factors limiting species distributions in aquatic habitats. Different species flourish within different ranges of pH, with the optimal for most aquatic organisms falling between pH 6.5-8. U.S. EPA water quality criteria for pH in freshwater suggest a range of 6.5 to 9.

Fluctuating pH or sustained pH outside this range physiologically stresses many species and can result in decreased reproduction, decreased growth, disease or death. This can ultimately lead to reduced biological diversity in streams.

pH measures the intensity of acidity or alkalinity and the hydrogen ion concentration in water. pH value below 4 produces a sour taste and a higher value above gives an alkaline taste. The pH of the water samples varied between 7.15 and 7.50. All the groundwater samples were found within the limit (6.5–8.5) prescribed by WHO (2005) and IS 10500:2012).

**Electrical Conductivity and Total Dissolved Solids**

According to Walton (1970), the term electrical conductivity denotes the characteristics of a medium to the passage of electricity. It is a function of temperature, type of ions present and concentration of various ions. Generally, groundwater tends to have higher EC than surface water due to high dissolved salts. EC ranged from 337 µS/cm to 1180µS/cm. TDS in the groundwater samples went from 236 mg/L to 773mg/L.

**Total Hardness**

Hardness in water is due to the presence of dissolved salts of calcium and magnesium. It is unfit for drinking, bathing, and washing, and it also forms scales in boilers. Hence, estimating the amount of hardness-producing substances in the water sample is necessary. Once it is estimated, the amount of chemicals required for water treatment can be calculated. The estimation of hardness is based on complex metric titration. The hardness of water is determined by titrating with a standard solution of ethylene diamine tetra acetic acid (EDTA), a complexing agent. Since EDTA is insoluble in water, the disodium salt of EDTA is taken for this experiment. EDTA can form four or six coordination bonds with a metal ion. Two types of hardness are present in water: temporary and permanent. Temporary hardness is due to bicarbonates of calcium and magnesium ions. It can be easily removed by boiling. Permanent hardness is due to chlorides and sulphates of calcium and magnesium ions. This type of hardness cannot be removed by boiling. The Total hardness in the study area varies between 150 mg/L to 245 mg/L for groundwater samples.

**Calcium and Magnesium**

Calcium and magnesium ions present in groundwater are mainly derived from the leaching of limestone's, dolomites, gypsum and anhydrite, whereas the calcium ion is also derived from the cation exchange process. The calcium concentration in groundwater ranges from 21 to 169 mg/L.

$$(Ca.Mg)\ CO_3 + H_2CO_3 \rightarrow 2HCO^{-}_3 + Ca^{2+} + Mg^{2+}$$

Magnesium salts are more soluble than calcium; however, their lower abundance in rocks than calcium makes them less available for weathering reactions. The content of $Mg^{2+}$ in groundwater ranges from 9 to 31 mg/L.

**Iron**

The presence of iron in groundwater is a direct result of its natural existence in underground rock formations and precipitation water that infiltrates through these formations. As the water moves through the rocks, some of the iron dissolves and accumulates in aquifers, serving as a groundwater source. Iron content in groundwater ranges from 0.05 to 0.10 mg/L.

**Turbidity**

Turbidity measures water clarity in streams, rivers, lakes, and oceans. Turbidity describes the amount of light scattered or blocked by suspended particles in a water sample. Clearwater has low turbidity, and cloudy or murky water has a higher turbidity level. Turbidity is caused by soil particles, organic matter, metals, or similar matter suspended in the water column.

Suppose a large amount of suspended matter such as clay, silt, or some other finely divided organic materials is present in water. In that case, it will appear muddy, cloudy, or turbid. The turbidity depends upon the finesse and concentration of particles present in water. Although these are not harmful to health, they should be removed or reduced for aesthetic and psychological reasons.

Since people do not like turbid water, the turbidity of raw water must be measured and then reduced by treatment to permissible values to make it almost invisible to the naked eye. The turbidity content in groundwater was less than one, which falls below the detectable limit.

**Colour and Odour**

Most customers judge the quality of drinking water by taste and odour. If the customer is satisfied with these qualities, it is assumed the water is safe to drink. Many harmful contaminants in water cannot be detected due to taste or smell, and many contaminants found in drinking water that have a detectable taste or odour are not harmful. Taste and odour problems can be found in surface water and groundwater. Surface water or groundwater may become contaminated by pollutants such as gasoline, industrial solvents or various volatile organics. The content of odour in groundwater was well below the detectable limit.

**Per Capita Water Usage (Ground Water) Response**

The reflection of the response from each was the botheration of hardness parameter that was reflected in their daily water usage cycle. Consideration was given, reflected in the ground realities with establishing the Reverse Osmosis plant.

**Capacity of The Reverse Osmosis Plant**

The total intake of raw groundwater feed to the plant is 6,756,000 liter per day, which will be subjected to the assigned treatment as mentioned, and it diverges into two channels. One channel will transmit the treated water of a capacity of 33,78,000 liter, and the other will carry and transmit the rejected water of 3378,000 liter.

Regarding the rejected water utility, it has found its importance and footprint in the sector of floor washing and toilet flushing (closet).

As per IS 1172-1993, the water requirements of Individual Institutions in line with colleges (Residential/Educational type) is ***135 -150 liter per capita per day***. Here, 5 liter is meant for cooking and 5 liter for drinking purposes. The treated RO water has been utilised for drinking and cooking, which comes to the total daily requirement of 1,20,570 liter /per. Regarding the population of students and staff members, there are 9871 and 2186 numbers; hence, it comes to 12,057 numbers. Therefore, to meet the requirements of students and staff members, we are maintaining 24 liter per capita per day (12 liter for drinking and 12 liter for cooking, which includes wastage), which comes to the gross requirement of approximately 2,90,000 liter.

**Unit Operations – Process Description Macro Filter**

The Macro Filter allows the water to travel through its unique 4-layer media and, in the process, removes turbidity, suspended solids, colour, and odour and gives the water crystal clarity.

**UV Disinfection Plant**

UV Sterilizers are built on the property of UV Radiation at 2540 Angstrom units, capable of destroying bacteria, algae, and fungi. These units are built with high-efficiency UV lamps surrounded by quartz glass sleeves to isolate the bulbs from direct water contact. The sleeves also ensure a very high transmission of UV energy with lesser losses. Removing biological contaminants is an essential pre-treatment to avoid bio-fouling of membranes in the RO system. This is a safer alternative to chlorination systems in small plants.

**Reverse Osmosis Plant**

Reverse Osmosis is a reliable treatment method for reducing the total dissolved solids in the water, thus bringing the water quality to drinking standards and is the most advanced liquid filtration. In the reverse osmosis process, water is passed under pressure through a semipermeable membrane having a pore dia of 0.0001 m, which is smaller than bacteria µm to 1 µm) and virus (0.02 µm to 0.04 µm), thereby ensuring effective filtration (99%), so that even such fine impurities cannot escape thro' the membrane. This membrane is made of thin, multi-layered, high-quality polyamide sheets. The design of the RO PLANT is primarily based on two factors. TDS content in the feed water and the recovery/reject ratio. In the separation process, purified water permeates the membrane and is collected separately, while the reject water containing concentrated dissolved and suspended solids is discharged to the drain. The feed water flows continuously across the membrane, and the rejected solids get into the backflow and are sent to the reject port. This process continues without clogging the membrane. Measured dosing of antiscalant chemicals is done to avoid fouling of the membrane. RO process is very effective in removing chemical contaminants like Chlorides, Nitrates, Fluorides, Lead, Copper, Mercury, Sulfates, Calcium, and Magnesium, as well as physical and microbiological impurities.

**Anti Scalant Chemical**

Liquid anticalin is highly effective in controlling scale precipitates and reduces particulate fouling within membrane separation systems. Proper dosing of antiscalant chemicals helps maintain cleaner membrane surfaces and provides longer run times with extended membrane life, reducing operating and capital costs. Proper choice of antiscalant chemicals and the right quantity of dosing is vital for the smooth running of Reverse osmosis systems.

**Ground Water Recharge – A Second Life**

Water scarcity is a serious problem throughout the world for both urban & rural communities. Urbanization, industrial development & increase in agricultural fields & production have resulted in overexploitation of groundwater & surface water resources and resultant deterioration in water quality. Due to unbalanced rainfall, conventional water sources, namely wells, rivers, reservoirs, etc., are inadequate to fulfil water demand. While the rainwater harvesting system investigates a new water source. The present study aims to use rainwater, thus taking close to the concept of nature conservation. This study analyses the rainwater harvesting (RWH) system as an alternative water source at the Vel

Tech campus. The expected outcome is developing a rainwater harvesting system for a catchment area of the campus (1,90,000 square feet), including a parking area, workshop area, and all the department blocks and hostel blocks. The result shows that the present RWH system has storage

**40,30,762 liter/year** and construction cost of Rs.9 Lakh, respectively, reasonably well compared to conventional water sources. The developed system satisfies the social requirements and can be implemented in rural areas by considering almost all the technical aspects.

Recharge of the groundwater table is a gradual process; we cannot suddenly increase the groundwater table after constructing recharge structures by constructing any type of recharge structure, and we can give our contribution to aquifer recharge. This will help to rejuvenate the depleting groundwater resources. Also, it helps save the little rainwater that used to drain away for many years. Thus, it is concluded that implementing the RWH system at the Vel Tech campus would result in the best approach to dealing with the present water scarcity scenario and storing huge quantities of 40,30,762 liter in a year on the college campus.

The wastewater generated from the Vel Tech premises is treated with sewage treatment units to match the treated water quality with the BIS inland surface water discharge and Tamil Nadu Pollution Control Board standards.

The treated wastewater is stored in the two-percolation pond of 14.3 Crore liter each. Part of the treated wastewater is used for gardening, and the remaining quantity of treated wastewater is stored in the percolation pond. The generated treated wastewater is not quantified in earlier stages; now, it is quantified as 20 lakh liter per day. Further, it is estimated that the treated wastewater of 9 lakh liter is used for gardening, 7 lakh liter is used for crop cultivation, and the remaining 7 lakh liter is stored in the percolation pond daily. As a result, there is a significant increase in the groundwater table by 1.29, 1.20, 1.35 and 1.46 m, respectively, for winter, pre-monsoon, monsoon and post-monsoon seasons in the year 2022- 2023 and the combined increase in groundwater table by 1.91, 1.79, 2.02 and 2.18 m respectively for winter, pre-monsoon, monsoon and post-monsoon season in the year 2022- 2023.

The rainwater from the rooftop of each building is collected through the drainage channel and discharged on land, which is not quantified in an early stage. In a later stage, it is quantified as 2.7 lakh liter per annum. The collected rainwater is being sent through the soak pit arrangements for groundwater recharge, and thereby, the groundwater table level increases significantly along with treated wastewater by 1.37 and 1.48 m, respectively, for winter, pre-monsoon, monsoon and post-monsoon seasons in the year 2022-2023 and the combined increase in groundwater table along with treated.

Wastewater by 2.02 and 2.18 m, respectively, for winter, pre-monsoon, monsoon and post-monsoon seasons in the year 2022- 2023.

Due to the utilization of 16 lakh liter of treated wastewater per day for gardening and cultivation of crops, the Vel Tech Institutions saved electrical energy to Rs. 1,236/- per day and Rs. 5,12,534/- per annum. Further, due to the utilization of 7 lakh liter of rainwater per annum through a rooftop rainwater harvesting system, Vel Tech Institutions saved electrical energy of Rs. 650/- per day.

According to the Tamil Nadu Groundwater (Development and Management) Act, 2003, the Vel Tech institutions have implemented three techniques viz.,

a. Wastewater treatment by sewage treatment,
b. Groundwater recharge by percolation pond and
c. Rooftop rainwater harvesting techniques for groundwater recharge.

1. The wastewater generated from the Vel Tech premises is treated with sewage treatment units. The treated wastewater generated from Vel Tech premises is quantified as 17 lakh liter per day. The treated wastewater of 6 lakh liter is used for gardening, 7 lakh liter is used for crop cultivation, and the remaining lakh liter is stored in the percolation pond per day.

2. The rainwater from the rooftop of each building is collected through the drainage channel by rooftop water harvesting techniques, and it is quantified as 3.4 lakh liter per annum. Further, the collected rainwater is sent through soak pit arrangements for groundwater recharge.

## I. Creation of Irrigation Potential in the Last One Year

The wastewater generated in the Vel Tech institutions is about 25 lakh liter daily, and the same is treated with the help of sewage treatment units in such a way that the treated water quality is matched with the BIS inland surface water discharge and Tamil Nadu Pollution Control Board standards. The treated wastewater is stored in the two percolation ponds with a capacity of 12.6 crore liter each. These two ponds are used to store treated wastewater for gardening and growing crops so that the daily bore well extractions of groundwater of approximately 10 lakh liter are reduced. The remaining 16 lakh liter of treated wastewater in the percolation pond is used for recharging the groundwater, which increases the groundwater level in and around Vel Tech premises.

The groundwater extraction is obtained by running a 5 hp submersible motor pump. The electrical power consumption for drawing one lakh liter of water from one bore well is 12.5 units of electricity (5 hours running time). There are 10 such bore wells which supply water of 10 lakh liter per day and consume 132.5 units of electricity. The cost of one unit of electrical power consumption is Rs. 10/-; therefore, the cost of electrical power consumption for 130.5 units per day is Rs. 1435/- and annually, Rs. 5,13,227/-.

Due to the utilization of rainwater for groundwater recharge, groundwater extraction from bore wells is reduced to 3.6 lakh liter per annum. The corresponding electrical power consumption for taking 2.4 lakh liter from the bore well is 25 units. The cost of electrical consumption of 27 units per annum is therefore Rs. 270/-.

Thus, annual savings in electricity by Vel Tech Institutions is to the extent of Rs.4,93,543/-, which indirectly contributes to the growth of the National Economy by saving energy.

## II. Creation of Groundwater Recharge Structure and gradation of GroundwaterLevel

The major benefits of groundwater include municipal water supply, agricultural and landscape irrigation, and industrial water supply. Groundwater recharge is incidentally achieved in irrigation and stored water via percolation and infiltration ponds.

**Advantages of Groundwater Recharge:**

1. The cost of artificial recharge may be less than that of equivalent surface water reservoirs.
2. The aquifer serves as an eventual natural distribution system and may reduce the need for transmission pipelines or canals for surface water.
3. Including groundwater recharge in a wastewater reuse project may provide psychological benefits due to the transition between reclaimed municipal wastewater and groundwater.

**Techniques of groundwater recharge**

Two types of groundwater recharge are commonly used with reclaimed wastewater: surface spreading or percolation and direct aquifer injection.

**Surface Spreading or Percolation**

Groundwater recharge by surface spreading is the simplest, oldest, and most widely applied method of artificial recharge. In surface spreading, recharge water, such as treated municipal wastewater, percolates from spreading basins of the unsaturated soil and ground (vadose) zone. Infiltration basins are the most common methods of recharging because they allow efficient use of space and require only simple maintenance. Infiltration rates are generally the highest where soil and vegetation are undisturbed.

**Direct Injection of a Groundwater Aquifer**

Direct subsurface recharge is achieved when water is placed directly into an aquifer. Indirect injection, highly treated reclaimed water is pumped directly into the groundwater zone, usually into a well-confined aquifer. Groundwater recharges by direct injection are practised in the following instances: (a) where groundwater is deep or where the topography or existing land use makes surface spreading impractical or too expensive, and (b) when a direct injection is particularly effective in creating freshwater barriers in coastal aquifers against the intrusion of saltwater.

**Groundwater Recharge at Vel Tech Institutions**

The wastewater collected from the Vel Tech Institutions and the Vel Tech Hostels is treated with sewage treatment plants. The wastewater is treated to the specification of inland surface water discharge standards mentioned by "BIS and the Tamil Nadu Pollution Control Board". The treated wastewater is stored in the two percolation ponds for groundwater recharge.

Sample location points are shown in Figure 1 and Figure 2, respectively.

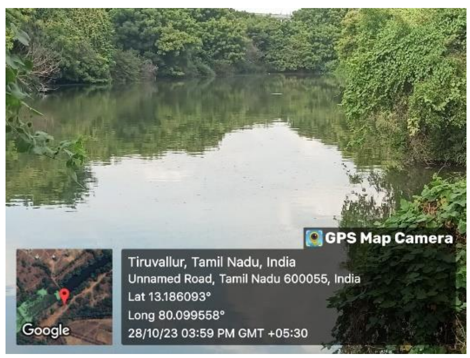


**Fig- 5. Percolation Pond 1 at B3 Hostel (one of the Gent's hostels)**

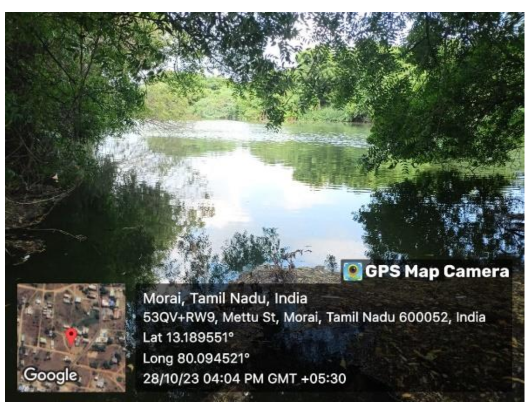


**Fig- 6. Percolation Pond 2 at B3 Hostels**

### III. Percentage Reduction in the Gap between Irrigation Potential Created andIrrigation Potential Utilized

Initially, there were no structures to store rainwater and treated wastewater for developing irrigation potential. Later, rooftop rainwater harvesting structures, including soak pits and percolation ponds, were created to enhance the irrigation potential. The percentage utilisation of treated wastewater for gardening and irrigation is 50 % daily, and groundwater recharge is 50 % daily. The spilt up of utilisation is for gardening (4 lakh liter) and crop cultivation (5 lakh liter). Thereby, there is a reduction in bore well extraction of groundwater, and the utilisation of treated wastewater for gardening and crop cultivation results in the percentage of the gap between irrigation potential created and irrigation potential utilised.

Thus, Vel Tech Institutions are saving electrical energy to the extent of Rs. 1,752/- per day through the effective use of treated wastewater and Rs. 360/- per annum through rainwater harvesting, thereby contributing to nation-building.