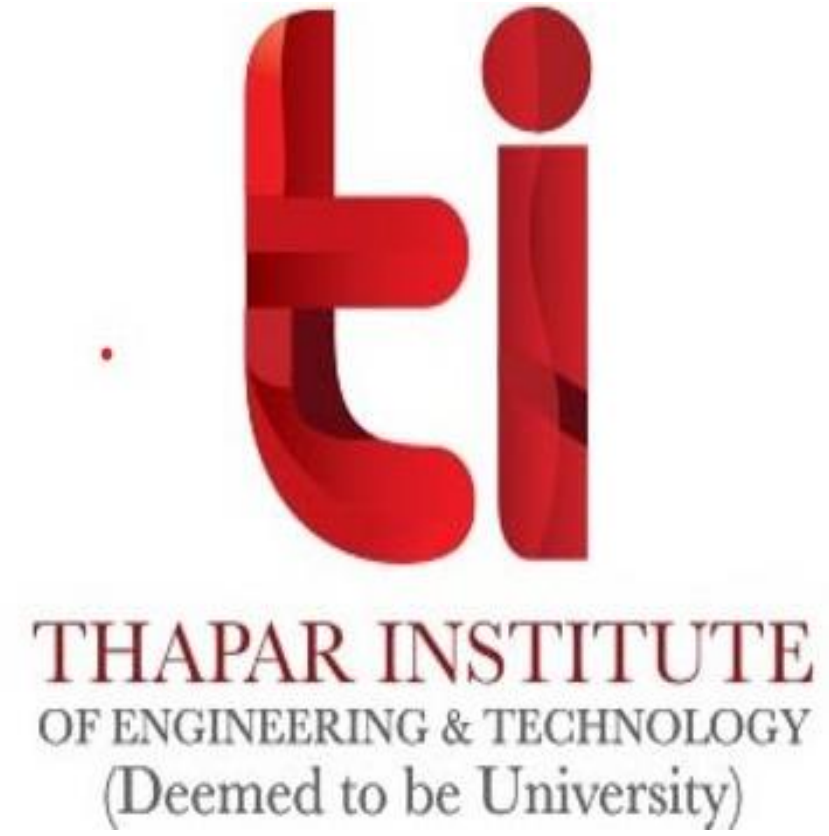
A Practical Activity Report
For
Technologies
For
Sustainable Development-UEN004
3rd Year



THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY, (DEEMED TO BE UNIVERSITY), PATIALA, PUNJAB

Submitted To:

Dr. Anoop Verma

Submitted by:

Varun Malhotra-101715175-3rdyear-ENC

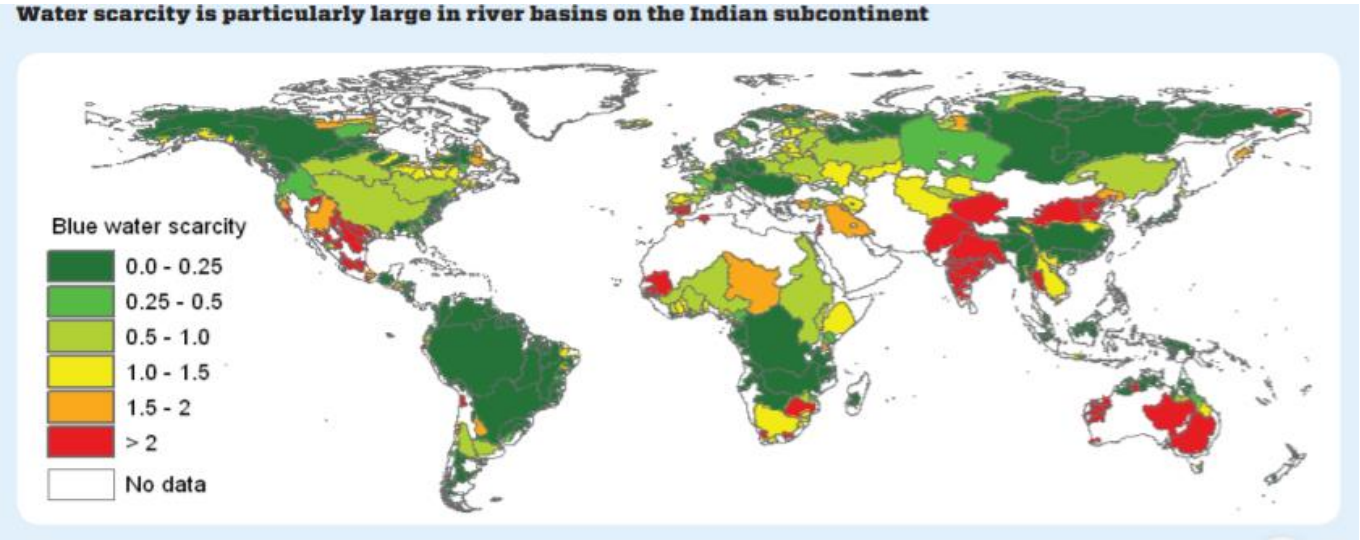
Vishu Chikara - 101715177-3rdyear-ENC

Introduction

"Necessity is mother of invention"

In the present world the growing energy crisis has led to design of new buildings that are energy efficient.If we think of conserving the energy little by little even it can makes a lot. We know water and electricity both are blessing former of nature and later of science.Its impossible to sustain life without water. It is used in every activity of day whether from waking up with a glass of water to getting ready for office, from making breakfast to making dinner, from agriculture to industrial almost in every field.

Due to population explosion there is surge increase in demand of water but due to modern industries water sources are getting unfit for utilisation. The careless use leading to scarcity of water in various areas. According to research of "Water Foot Print Network" water footprint in India is not sustainable. In too many places groundwater is overexploited and river flows depleted



(Source: An article by AY Hoekstra)

Sustainable development as coined by the Brundtland Commission in the document **"Our Common Future"** state as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (UN, 1987).Water is at the core of sustainable development and very crucial for socio-economic development, healthy ecosystems and for human survival itself. Water is a finite and irreplaceable resource and only renewable if well managed. More than 1.7 billion people live in river basins where depletion through use exceeds natural recharge, a trend that will see two-thirds of the world's population living in water-stressed countries by 2025.

Although there are various treatment available to treat this water but they all are at industrial scale but on individual basis how we can conserve water. Do conserving on individual basis will make a difference? This paper will deal with the fact that a slight change in design can conserve a lot of water as well as electricity thus conserving your own earning.

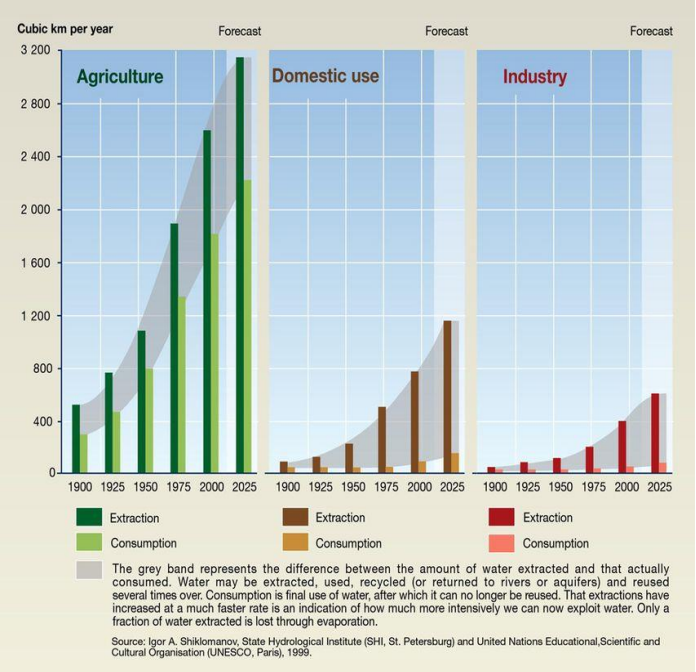
Objective:

- Water conservation
- Electricity conservation
- Saving your earnings

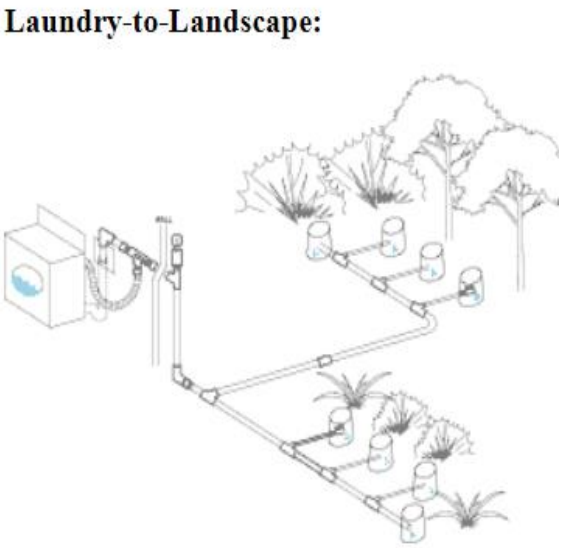
Literature Review:

- **The Grey Water**

It is estimated that between 8% and 10% of worldwide water is used for household purposes(*source: World Water Assessment Programme*).The water coming for home consumption is divided as only 10% is used for food preparation and drinking purposes and 25% is for laundry and household cleaning and rest 65% goes for sanitation and bathing/showering purposes.



(Source: herox.com article)



Laundry-to-landscape system. Image credit: CleanWaterComponents

(Source :greywateraction.org)

Grey water is term coined for water that is less contaminated and can be reused without any specific chemical treatment. The water from bathroom sinks, shower tubs and washing machine can be reuse for irrigation purposes. It is not allowed to mix with sewerage thus reducing pollution of local water bodies. Moreover its design is simple and no complex structure are required to implement this

Commercial example of grey water system are

- **Margot and Harold Schiff Residences- Mercy Housing**: Greywater from showers and sinks is filtered, disinfected, and used to flush toilets in all 96 units.

- **Quayside Village gray water Demonstration Project**: A co-housing unit in British Columbia uses greywater for toilet flushing. They have gone through several types of filtering methods as there were maintenance issues.

Some implementation of grey water system in India:

- JS Jainarayan High School, Kanpur
- Air Force Administrative College, Coimbatore
- Nerul Sector-9, Navi Mumbai

Source:jalsevak.co

- **The Reflow**

(Source: greenwatersolution4u.com)

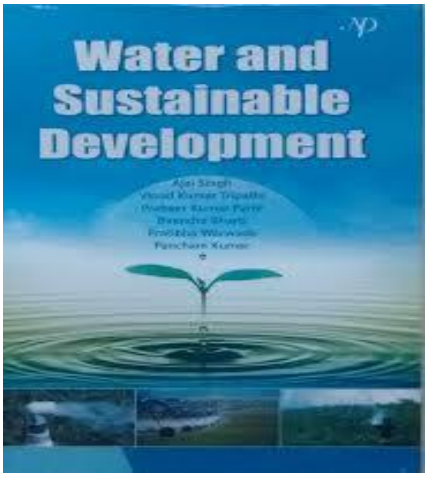
Reflow G2R2 is implementing grey water recycling system. It is invented by Green Water Solution(Vancouver).It allow recycling of 35% of water of our household consumption that is used in bathing and convert it into flush water. It is decentralized and does not require renovation or plumbing in existing bathroom thus causing one third of conventional grey system go for and can save up to 30% of the average household freshwater consumption reducing expenses.

The existing system are too costly for reusing grey water to flush toilets and conserving freshwater thus saving utility bills. There is no need of pipe retrofits, walls renovation or change in social habits. Its viable in conserving life providing resource. It also reduce the pressure on municipal sewage sparing water system and local ecology. In places like California, which is suffering from severe droughts, an installed ReFlow could come in handy to help citizens deal with the crisis at home.

The final prototype features a pump that can accommodate varying sizes of bathroom pipes, a three-dimensional water filter element that removes lint and hair, and a disinfection unit that removes pathogens. Other features include a towel warmer, running lights, and functional cabinets and shelf space, all of which ensure that it fits right into the bathroom environment.

Problem statement:

Today we live in world were natural resources are depleting on an exponential scale. One of this life providing resource is fresh water.As discussed earlier 10% of worldwide water is used for household purposes. The water coming for home consumption is divided as only 10% is used for food preparation and drinking purposes and 25% is for laundry and household cleaning and rest 65% goes for sanitation and bathing/showering purposes. In India the electricity we used is basically generated from coal only. Thermal production is main source of electricity in India which intake coal which is a non-renewable resources and depleting at a high rate too. Besides this India too is country of skyscraper excluding rural areas there is flat system in urban areas which require pumping of water to water tank situated at top of the roofs which is expensive as it deplete energy resources. So is there any sustainable approach to deal with this depletion?



Solution:

"You mustn't throw them away

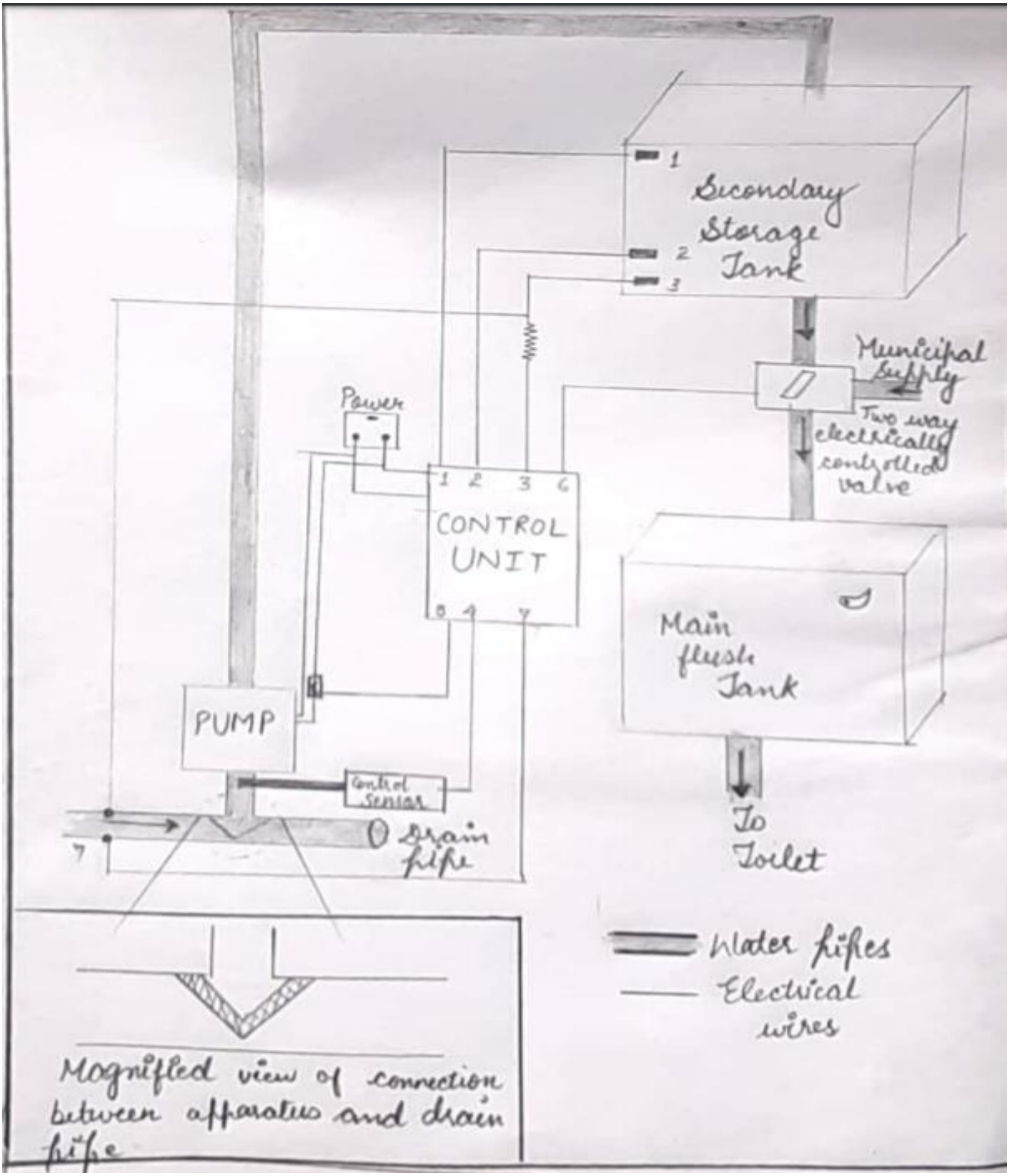
Let me have them"

A quote by Diane Samuels pointing towards concept of reusing and not wasting. The main idea is waste of any can be raw for another and this quote is enough to solve above problem

The idea for the implementation of this project also goes the same way. We will use a device which would be able to differentiate between moderate and bad quality of drain water from the floor of bathroom or bathtub. From here we will extract the the moderately contaminated water and use it in toilet flush. This idea is different from similar existing idea as it use a good blend of fresh supply and waste water and hence will overcome the existing problem of foul smell (which is due to killing of bio decomposers by soap and detergents).Our solution basically focus on less investment and more profit and conservation that's why we are focussing on conservation rather than water treatment as there are already plenty of ideas for water treatment. We just giving a new design approach that can be follow up by middle class people too.

The idea can be materialized by the use of the circuit below.

Design:


1
Secondary Storage Tank
2
3
Municipal Supply
Two way electrically controlled valve
Power
1 2 3 6
CONTROL UNIT
8 4 7
Main flush Tank
PUMP
Control Sensor
Drain pipe
7
To Toilet
Water pipes
Electrical wires
Magnified view of connection between apparatus and drain pipe

Working:

- A dedicated controller is used
- Terminal 3 serves as power supply to the controller as it is connected to 5 Volt supply
- The control sensor will detect level of impurity
- Terminal 1 and 3 will give the information about secondary storage tank
- Terminal 5 serves as activation signal for pump
- Terminal 6 is connected to a valve in secondary and main flush tank

When anyone takes the bath the 7 terminal will be connected with terminal 3.Control sensor will act like a TDS meter and will check water impurity level and if water level crosses the threshold a signal will be sent to controller that water can be used for filling up secondary tank. Now a signal from secondary tank via terminal 1 and 3 will be sent to controller telling the level of water in tank if it is full then action is aborted if not then a signal is sent to controller. Controller on receiving desired signal will switch on terminal 5 thus activating relay switch and pump will start operating. Controller will keep checking input signal from secondary tank and when the signal aborted from secondary tank that means tank is full no more water can be added thus pump will be turned off by switching down the relay.

Valve in secondary and main flush tank is also electrically controlled via terminal 6 and when main flush tank is empty controller will check status of secondary storage tank and if found empty the main flush tank will be connected to municipal water supply line else it will be connected to secondary storage tank .

The connection between drain Pipe and the pump is made up of filter grill which does not touch the bottom of the pipe so that thick garbage should not penetrate to the pump thus making this water appropriate to the levels of grey water and even better than that.

Algorithm of control unit:

The computer algorithm to implement above prototype is divided into two part-

Declare that hold all variable literals and constants

Algo that hold the logic to implement our solution

Declare

```
Input Tank_full;                    //signal control unit when to turn process off
Input tank_not_empty;
constant  s=1;
input control;          //check for water quality and respond accordingly
output relay;           //switch pump to on/of mode
output valve;           //change between main supply and secondary tank
input main;             //check for drain supply
```

Algo

```
If(main=1 && control=1)
        {
            if(tank_full =0)
              Set relay=1;
              }
If(tank_not_empty=1)
            set valve=1;
else
            set valve=0;
```

Calculation:

First ground water is pumped up. According to Hindustan time in 2018 the level of groundwater was 750ft deep i.e 228.6meter from ground level.

So energy required for pumping 10litre of water to ground level is as follow

Energy = mass*gravity*height

We know 1lites of water=1kg and assuming g approximately=10

E=10*10*228.6 J

E=22860 J

E=0.00635KWH 1KWH=3.6MJ

Taking standard cost of electricity as ₹10/KWH

Cost to pump 10 litre of water to ground level =63paise

Now we need to pump water from ground to hostel tank

Energy = mass*gravity*height

E=10*10*30

E=3000J

E=0.00083KWH 1KWH=3.6MJ

Cost to pump 10 litre of water from ground level to Hostel tank=10*0.00083

Cost=0.8paise/10L

Now cost of water to pump from hostel tanks to washroom = cost of pumping from underground to ground + cost of pumping from ground level to hostel tank

Total cost = 63.8paise per 10L

Now by implementing our solution we can reuse at least 10L of water

We are using at least 10L of used water (bathing) by pumping it to height of 1.5metres where an extra storage tank will hold this water

Energy to pump this 10L of water to tank is

E=mass*gravity*height

E=10*1.5*10 1L water=1kg

E=150J=0.0004KWH

Cost = 0.0004*10 =0.4paise

Now this device will work for 24*7 which will cost

Device is working at 3W DC adapter

Thus consuming energy per day=3*24

=0.072KWH

Cost according to standard rates=0.072*10

=₹0.72 for 24hours

The washroom in which we are setting up our solution is going to be used by 4 people. Assuming 1 bath per person per day. Thus there will be 4 baths and 40L of water can be reused.

So, **device functional cost** =0.72/4

=₹0.18 per 10L

=18p per 10L

Fixed Cost:

- 1 storage tank(10L) =₹300
- 1 control unit(dedicated/Arduino)= ₹300
- 1 relay switch=₹10
- 1 electrically controlled 2 way valve=₹40
- 1 pump(18W)= ₹200
- 1 control sensor(Modified TDS meter)= ₹350

- Pipe Network and wires=₹800

Total cost of hardware =₹2200

Operational Cost for device for 10L water=device standby cost+pumping cost

=18p+0.4p

=18.4p

Break Even point:

Let breakeven point is reached after x baths

2000+0.184x=0.638x *all values are in ₹*

x=4405 baths

In a day we are considering 4 baths so

Total number of days = 4405/4

=1101 days =3 years

So it will take 3 years to get profit from our investment

Profit in hostel M in 5 year (3 year to recover cost) is as follows:

After 3 year span we will save for each bath=63.8p-18.4p =45.4p

Total baths in one washroom=4, Washroom per floor in hostel M=5, Total floors=8, Total blocks=4

Total washroom in hostel M=5*8*4 =160

Total baths per day=640

Total baths for 5 year (that are giving profit) =640*(days in 5 year – days in 3 years)

= 640*(1825-1095)

= 467200

Total savings From Hostel M =467200*0.454

=**₹212108**

If our solution in implemented in whole thapar i.e every residential washroom is installed with our system then:

Total profit of thapar in 5 year=4000*(days in 5 year – days in 3 years)*0.454

=4000*730*0.454

= ₹1325680

Total water saved=total baths in one day*total no of days*water saved in every bath

=4000*730*10L

=29200000L = 29200KL

CONCLUSION:

S.No	Feature	Cost
1.	TOTAL WATER PUMPING COST FROM GROUND TO HOSTEL WATER TANK	63.8p per 10L
2.	DEVICE FUNCTIONAL COST	18p per 10L
3.	FIXED COST(HARDWARE)	₹2000
4.	DEVICE OPERATIONAL COST	18.4p per 10L
5.	TOTAL 5 YEAR PROFIT(HOSTEL M)	₹212108
6.	TOTAL 5 YEAR PROFIT(WHOLE CAMPUS)	₹1325680

Outcome &Benefits:

- This project aims at conserving 10L of water with every bath
- Installation of apparatus in hostel M generates a net profit of ₹212108 in electricity bill in a tenure of 5 years. This project will conserve total 4672000L of ground water from Hostel M only
- Ours idea insures sustainability as it is improving sanitation facilities keeping in check the groundwater level which is a matter of concern in cities like Patiala
- Expansion of project to university level will save a total of ₹1325680 and 29200KL of water in first five year with covering the cost of operation and installation
- In 10 year quantity of conserved water by our college will be able to quench thirst of 100 people for **74years** thus covering whole life time
- In 10 year cost of electricity conserved by our college will be ₹46398800

Note: Due to unavailability of real data of the pumps used by the college to pump water, Ideal energy consumption and limited resources due to Lockdown the actual calculations may differ. Actual figure of capital used by the college to bring 10ltr of water to toilet would be more hence will generate more profit per bath in comparison to what we have calculated.

Literature References:

i. https://greywateraction.org/commercial-scale-greywater-systems/
ii. https://www.un.org/waterforlifedecade/water_and_sustainable_development.shtml
iii. https://newatlas.com/re-flow-grey-water-recycle/37104/
iv. https://timesofindia.indiatimes.com/city/ludhiana/patiala-stares-at-crisis-as-groundwater-level-dips/articleshow/64474887.cms
v. http://www.hms.biz/upload/117E_CirisBorehole.pdf