Treatment and disinfection of secondary treated sewage through filtration and anodic oxidation; a sustainable approach

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Waste Water

- Waste water is a type of water unfit for any further use.
- Generated by domestic sewage, industrial effluent
- Contributes to the contamination of water resources
- Putting threat to water quality

Status of sewage treatment in India

- Sewage treatment systems exist only in major cities
- The majority of towns and cities have limited sewage treatment services.
- Situation is challenging in smaller towns
- Need to enhance the treatment capacity

Quality of Secondary treated sewage

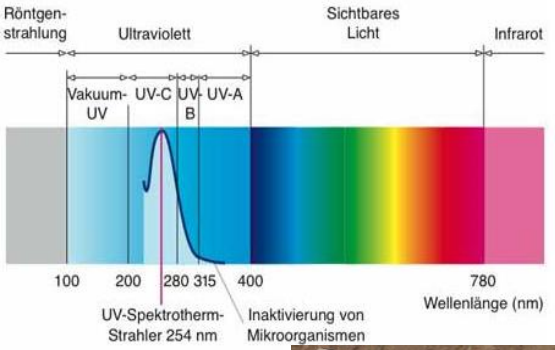
- The common secondary treated sewage is not safe for reuse
- May contains bacteria, viruses, protozoans, helminthes
- May pose threat to the environment
- Needs further treatment or disinfection

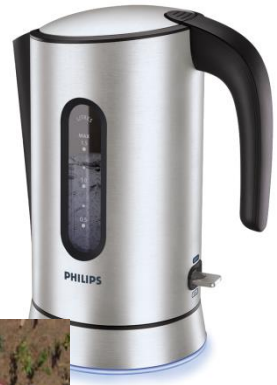
Disinfection Methods

Chemical Methods
- Chlorine
- Chlordioxine
- Ozonation

  → All of them increase oxidizing conditions in water

Physical Methods
- UV Radiation
- Filtration
- Boiling





Disinfection of treated sewage by in situ chlorination

- Disinfection of treated effluent was performed at IGNTU
- Done by a combined system of gravel bed and electrolytic disinfection system
- Chlorine is produced by oxidation of dissolved chloride
- No external addition of Chlorine

Safeguarding Water resources in India with Green and Sustainable technologies" – SWINGS

- Present study was carried out under the international collaborative research project "SWINGS" financially supported under Department of Science and Technology (DST), Govt. Of India & European Union (EU) Collaborative Program

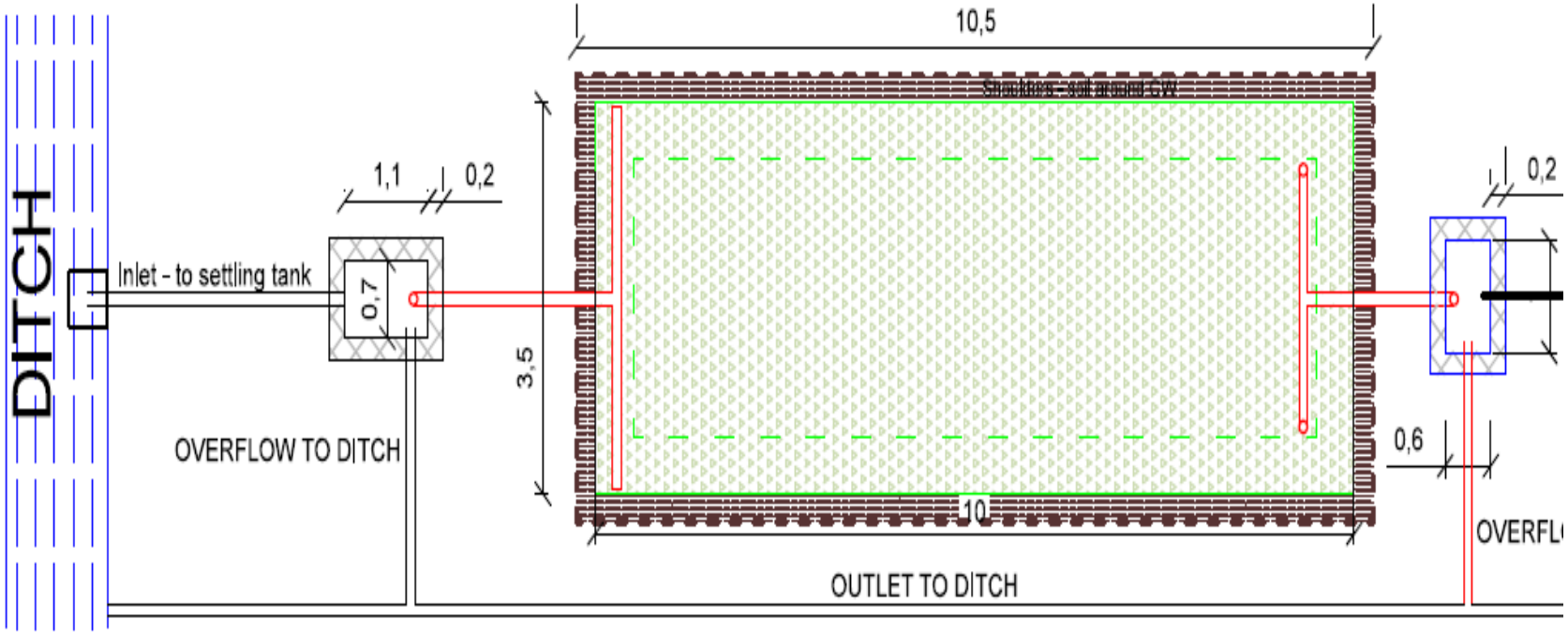
Pilot Plant at IGNTU campus

- At IGNTU solar driven disinfection system was proposed

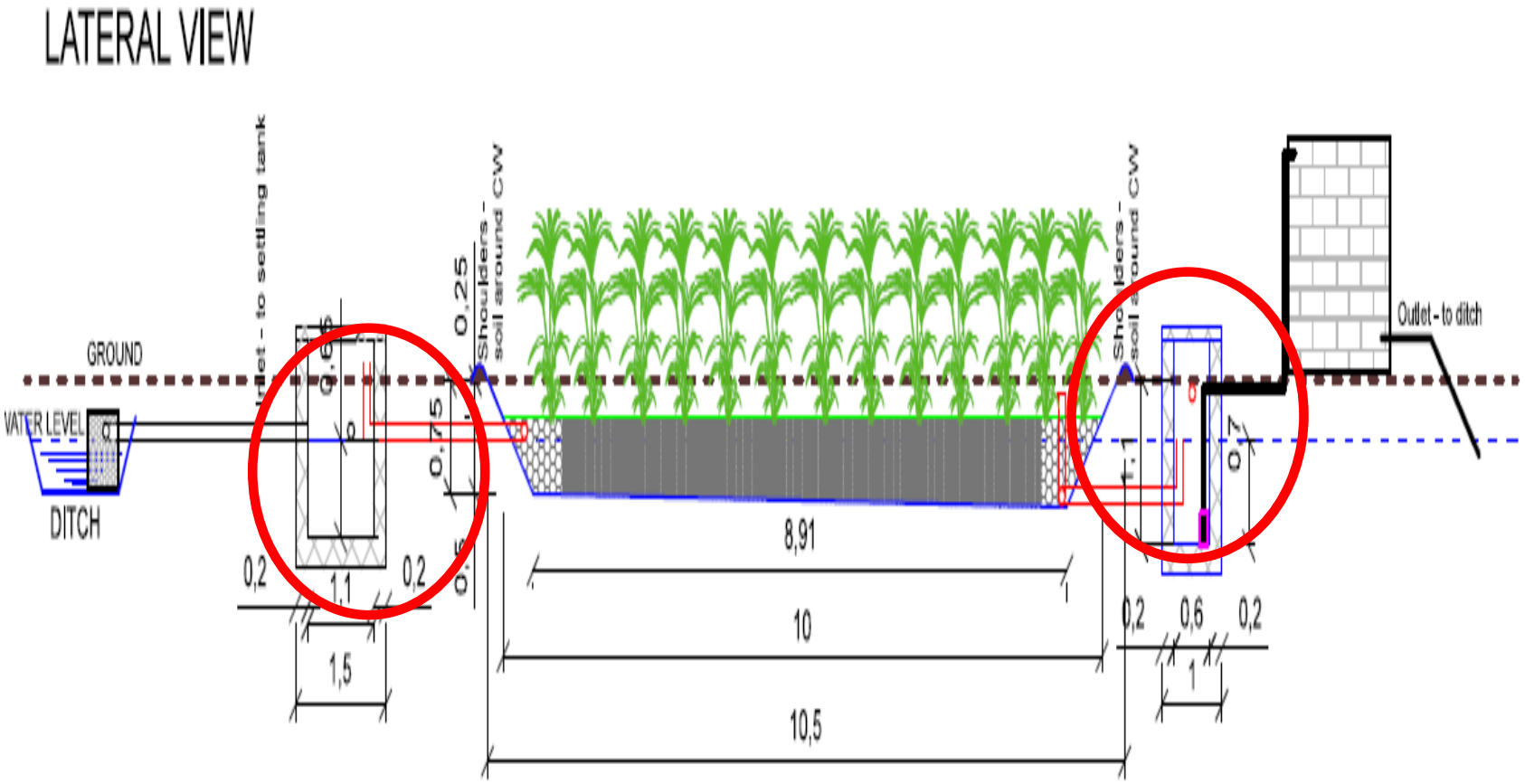
Site for Pilot plant

- Quality of sewage was not stabilized
- Varying due to several reason
- To stabilize the quality, a gravel bed filter was constructed, to filter treated sewage

Gravel bed at IGNTU: Complete setting



Wetland system at IGNTU



Construction of Gravel bed

Dimension	
Length	10 m
Width	3.5 m
Gravel Depth	0.5 – 0.6 m

Cont..

Gravel media

Gravel	Properties
Coarse gravel	600 ft^3, 16 – 32 mm 30 INR/ft^3
Fine gravel	180 ft^3, 10 – 16 mm 32 INR/ft^3

Filling of Gravel

Inlet chamber: (Chamber Volume: ~1 m^3

Gravel bed and plantation

Wetland vegetation IGNTU

Disinfection unit

Filtration Cylinder AO chamber and control unit Pilot plant building

Disinfection plant at IGNTU

- Unit: solar AO (anodic oxidation)-system
- Design and construction by AUTARCON/IGNTU
- Solar AO disinfection systems named as Su Me Wa disinfection system developed by AUTARCON -GERMANY

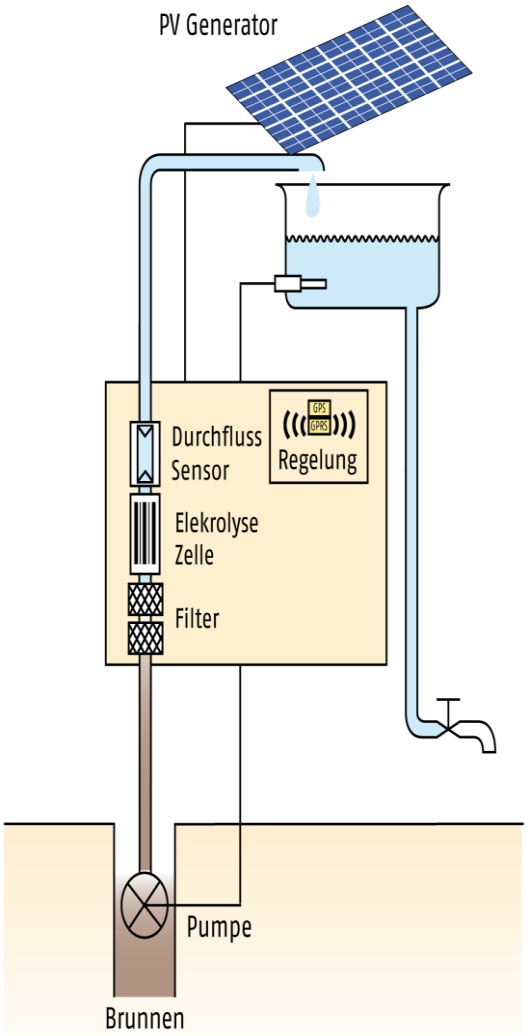
Su-Me-Wa System

Highly efficient utilization of solar energy

Direct disinfectant production

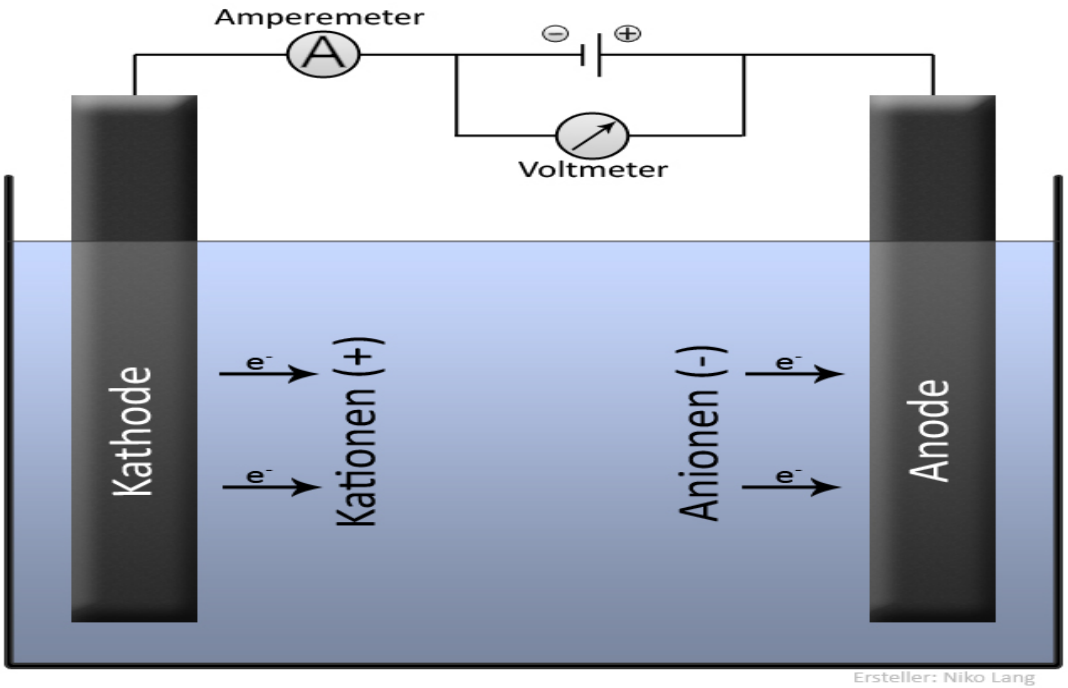
Residual disinfection

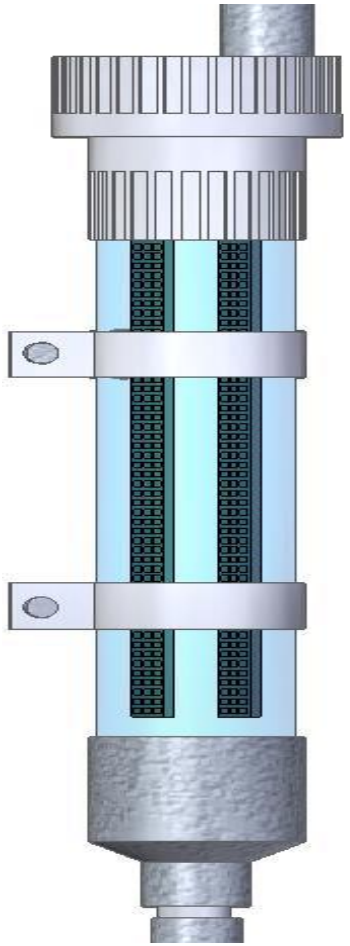
“Online” control of water quality



Chlorine production with anodic oxidation

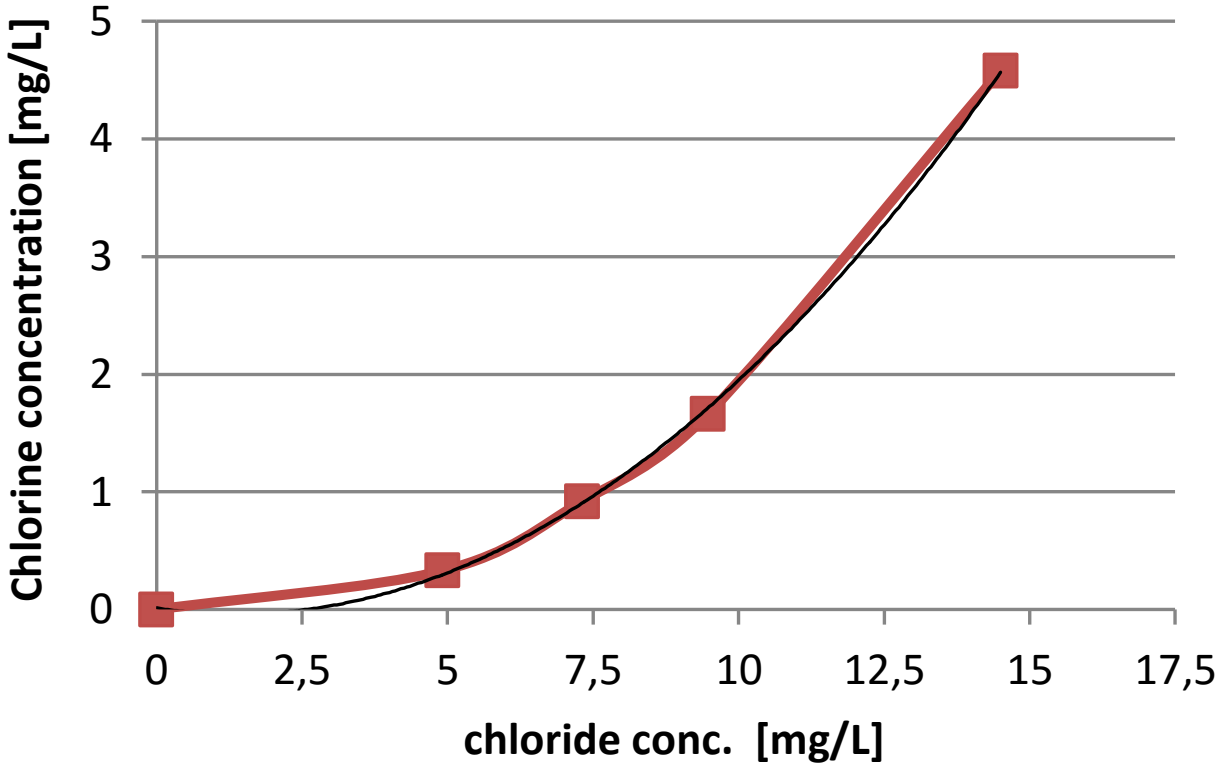
Reaction in water $Cl_2 + H_2O \leftrightarrow HOCl + H_3O^+ + Cl^-$





Chlorine production with Anodic Oxidation

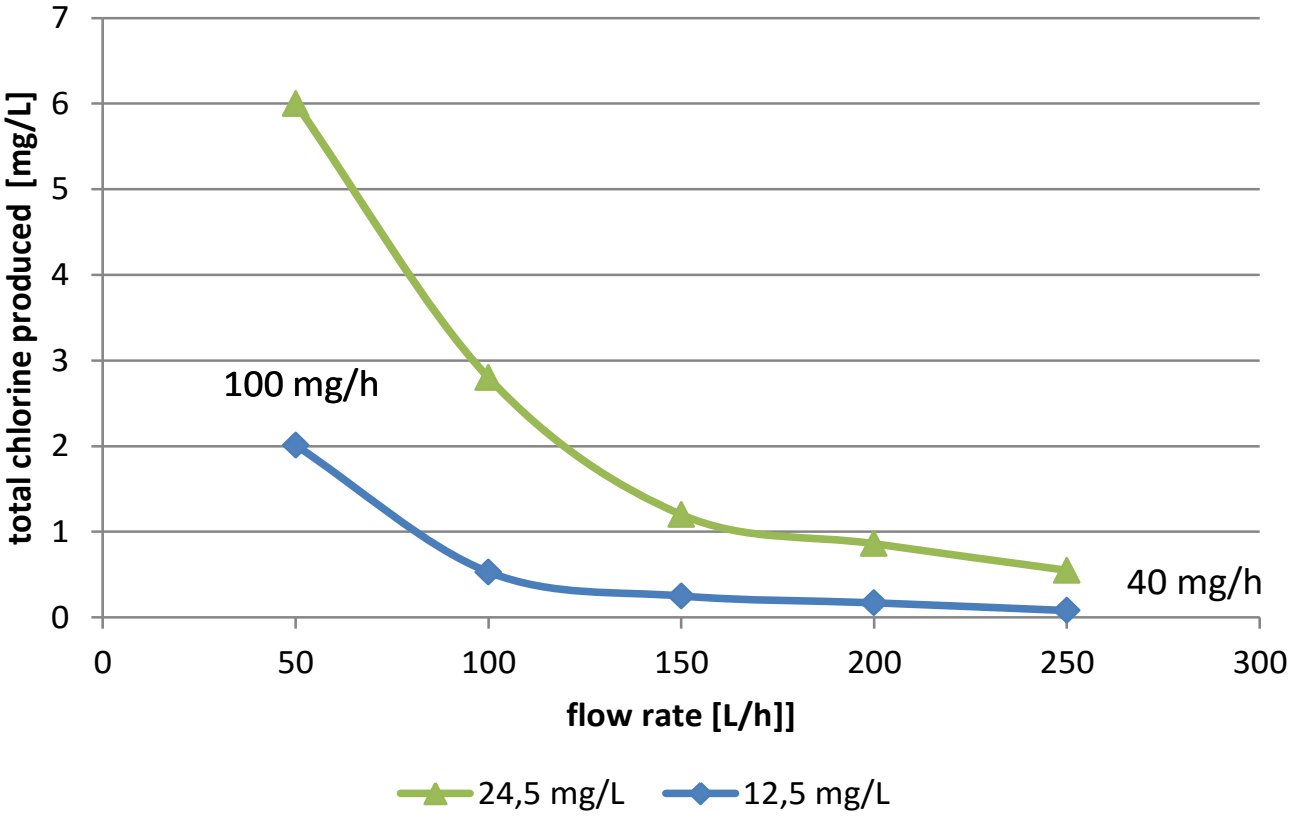
Cell Material: Titanium coated with mixed oxides of platinum metals (Ir and Ru)



At 30 L/h and 12 V

Chlorine production with Anodic Oxidation

Influence of residence time in electrolytic cell on chlorine production



Quality of Sewage at IGNTU

Parameter	Raw Sewage	Sec. Treated Sewage
pH	7.86	8.3
temp	29	29.8
Conductivity [µS/cm]	1405-2250	700-1420
TDS mg/l	702-1124	330-709
Chloride mg/l	56-115	40-71
BOD mg/l	150-240	30-80
COD mg/l	178-300	55-122

Results

Parameters	Inlet Chamber	Chamber After Gravel bed	After Zeolith Filter	After AO Treatment
temp °C	21.7	20.8	21.6	22.9
pH	8.3	8.55	8.83	8.2
DO mg/l	3	3.8	5.6	11
Acidity mg/l	90	56	4	6
Alkalinity mg/l	66	182	190	172
Hardness mg/l	106	70	117	34
ORP	210	230	388	431
conductivity	1312	738	760	732
TDS mg/l	656	376	380	367
BOD	48	26	18	10

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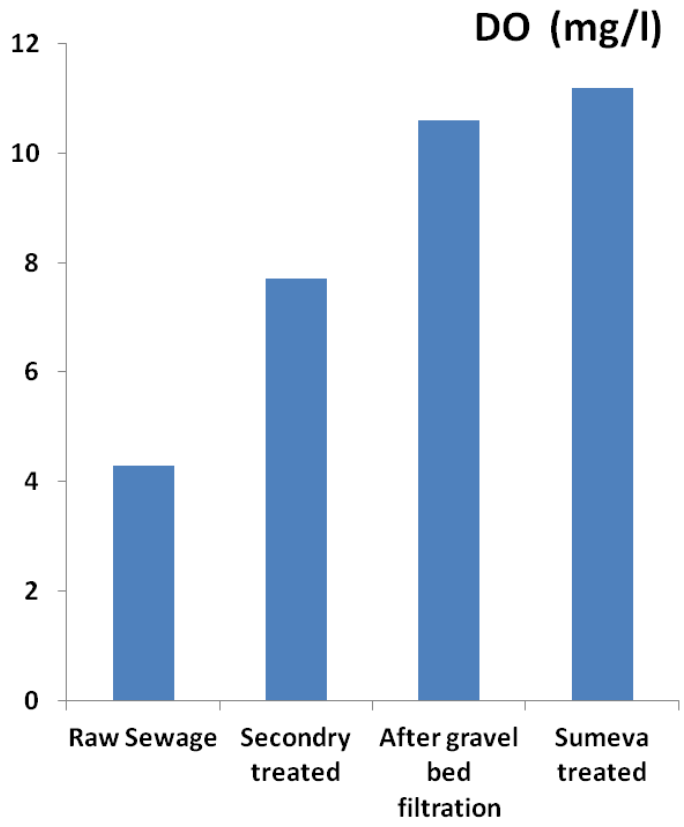
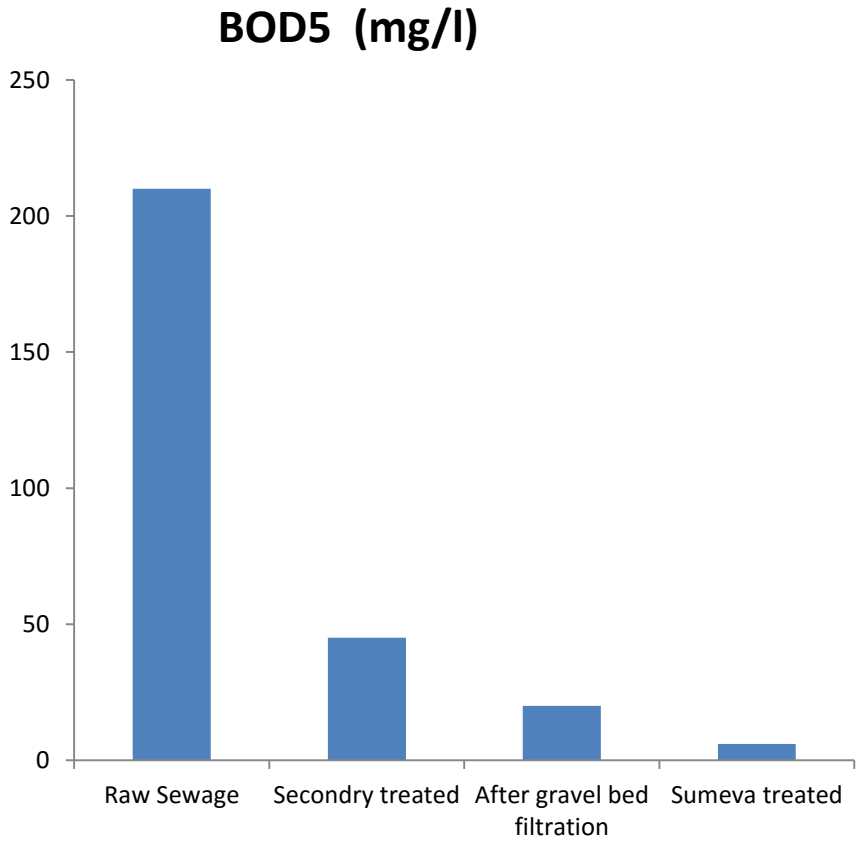
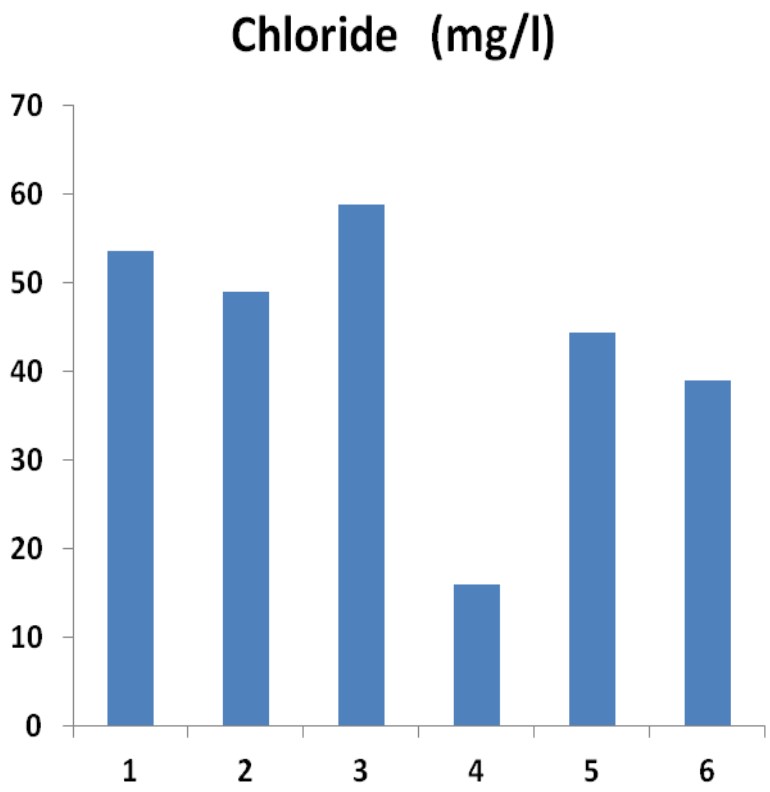
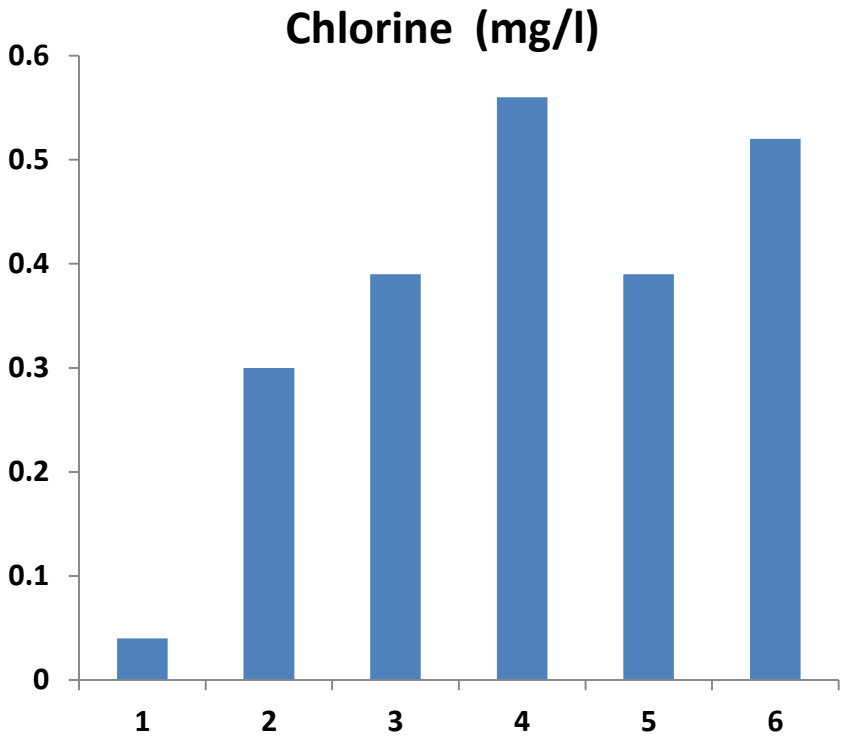

DO (mg/l)
12
10
8
6
4
2
0
Raw Sewage
Secondry treated
After gravel bed filtration
Sumeva treated


BOD5 (mg/l)
250
200
150
100
50
0
Raw Sewage
Secondry treated
After gravel bed filtration
Sumeva treated

Chloride and chlorine in final treated water





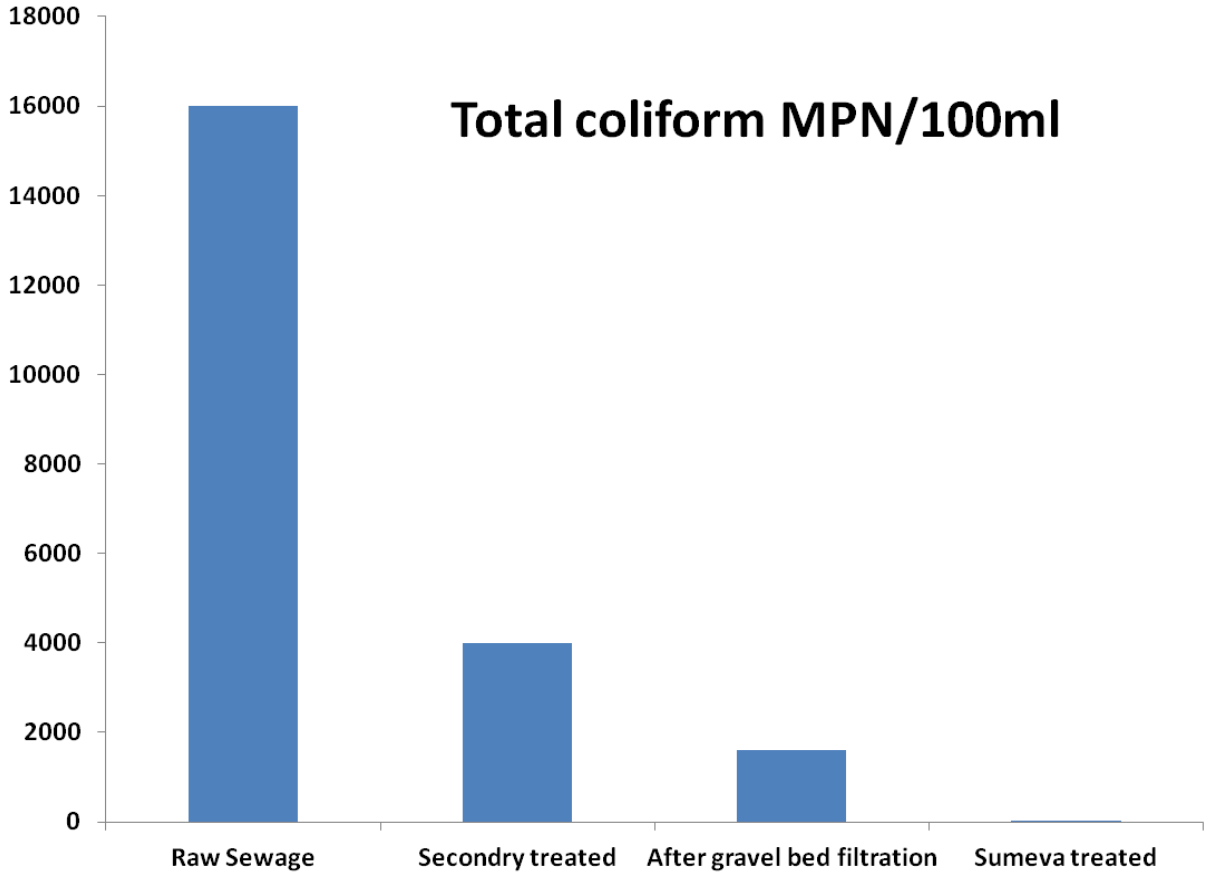
Pathogen Analysis

Pathogen	**Method**
Coliform	MPN membrane filtration plate count
Pseudomonas	MPN membrane filtration plate count
Cryptosporidium & *Giardia*	Immuno fluorescence assay Polymerase chain reaction

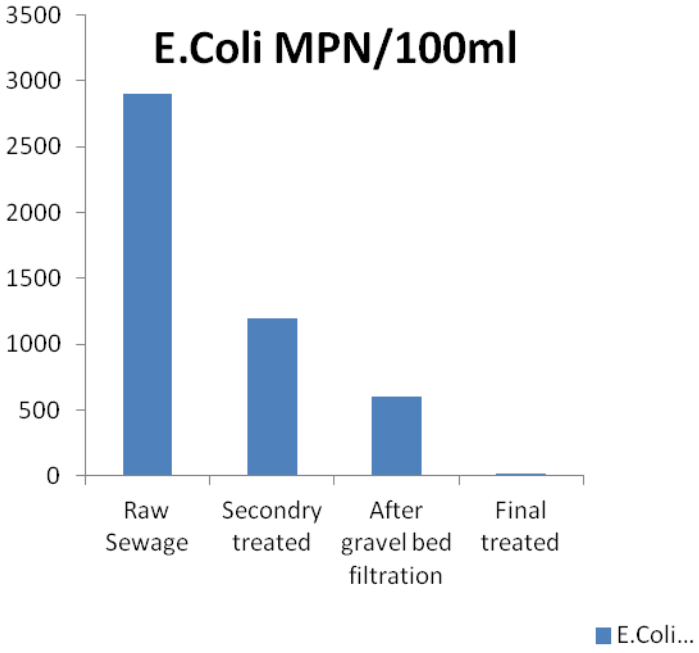
Disinfection of Coliforms

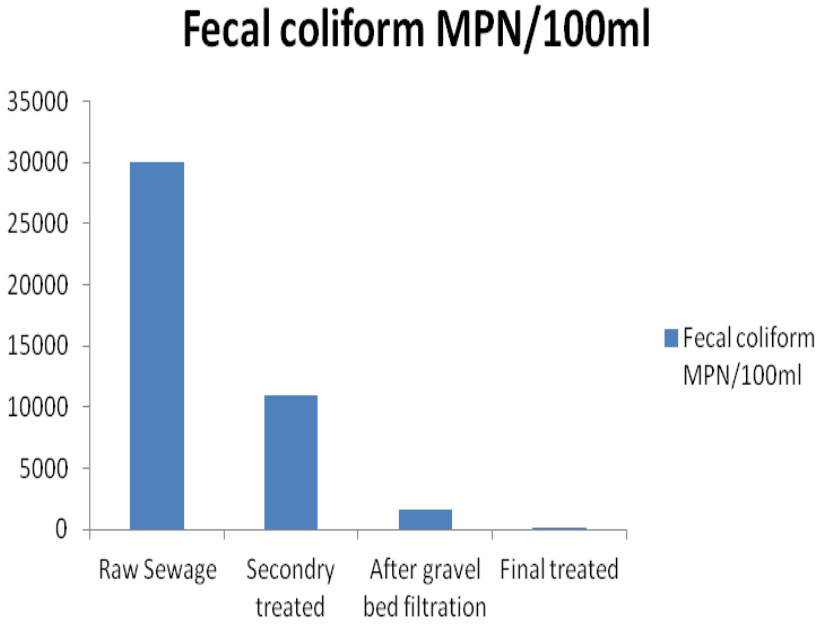
Pathogen	Method	Raw Sewage	Secondary Treated Sewage	Final Treated
Total Coliform	**MPN**	**$16x10^6$/100 ml**	**30000**	**ND**
Fecal Coliform	**MPN**	**30000**	**11000**	**ND**
E. Coli	**MPN**	**2900**	**1200**	**ND**

Pathogen removal



Fecal coliform & *E.coli* count





Conclusion

- Complete removal of almost all the pollutants including bacteria

- Economical, cost-effective and sustainable system

- Very simple but highly effective, no skilled man power is needed

Conti…

- No electricity or other type of energy is needed its natural system, best for rural and remote areas with power crisis
- Treated water can be used for irrigation, aquaculture, other application
- Highly applicable at village/community level

Vegetables grown from treated water

Acknowledgement

- Department of Science and Technology (DST), Govt. Of India & European Union (EU) Collaborative Program for water technology

- VC & Registrar, Indira Gandhi National Tribal University Amarkantak, MP

Thank You

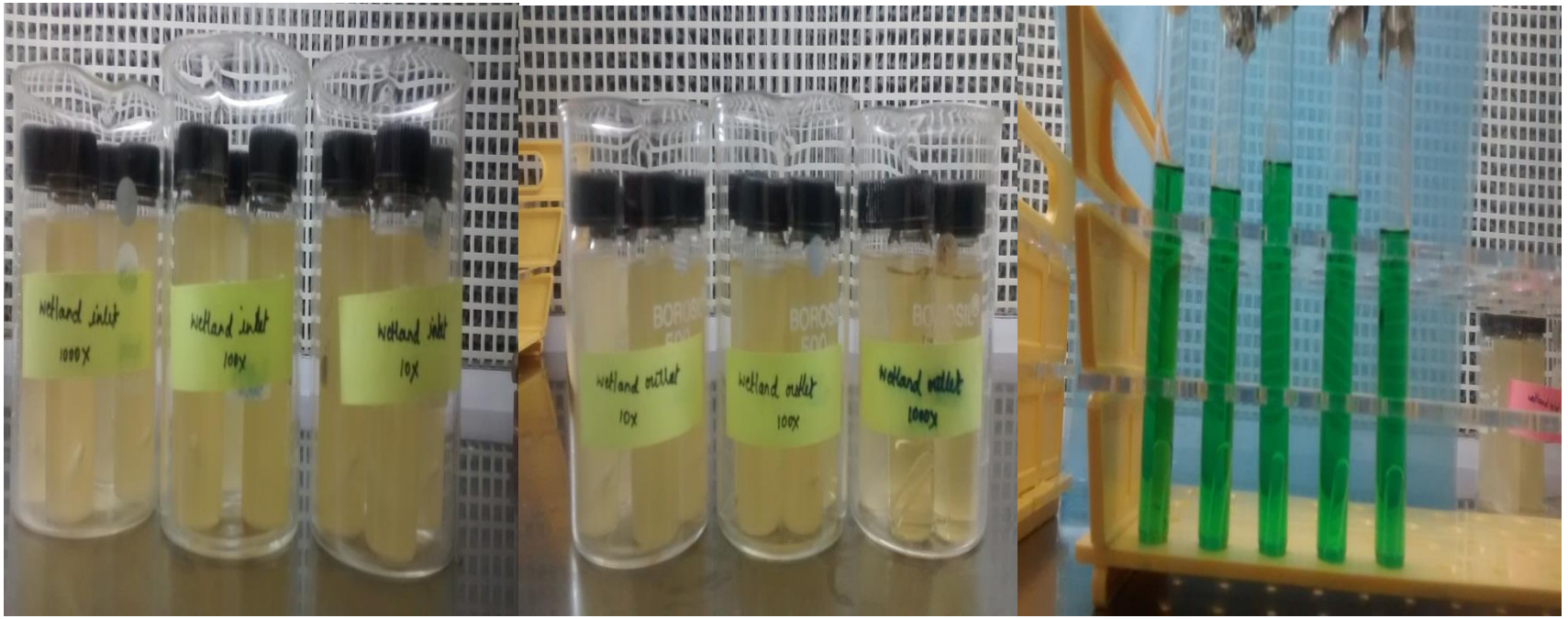
MOST PROBABLE NUMBER (MPN) METHOD FOR COLIFORMS

- Presumptive *coliform* Count
- Confirmatory *coliform* count
- *Fecal coliform* count
- *E. Coli* count

Total Coliforms, Fecal coliforms & E. Coli

- Preparation of media
- Dilution of sample (10x 100x , 1000x)
- Inoculation of tubes containing Durham tubes
- Incubate tubes at 35±0.5 °C for 24-48 hours
- Tubes with acid/gas production indicate confirmative coliform count
- Calculation of MPN value from MPN table.

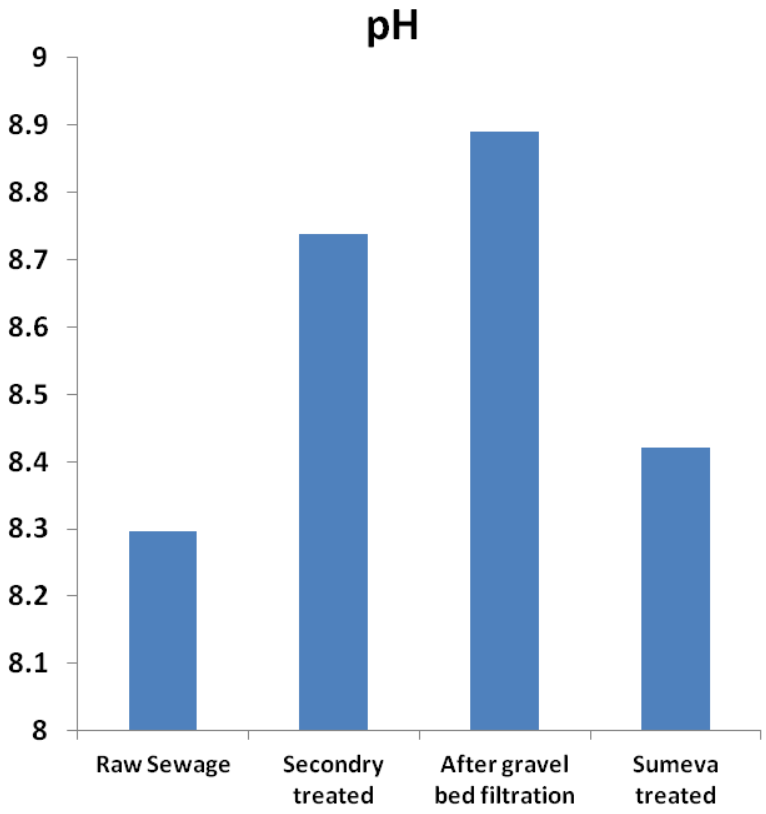
Positive tubes for presumptive, confirmatory coliform count

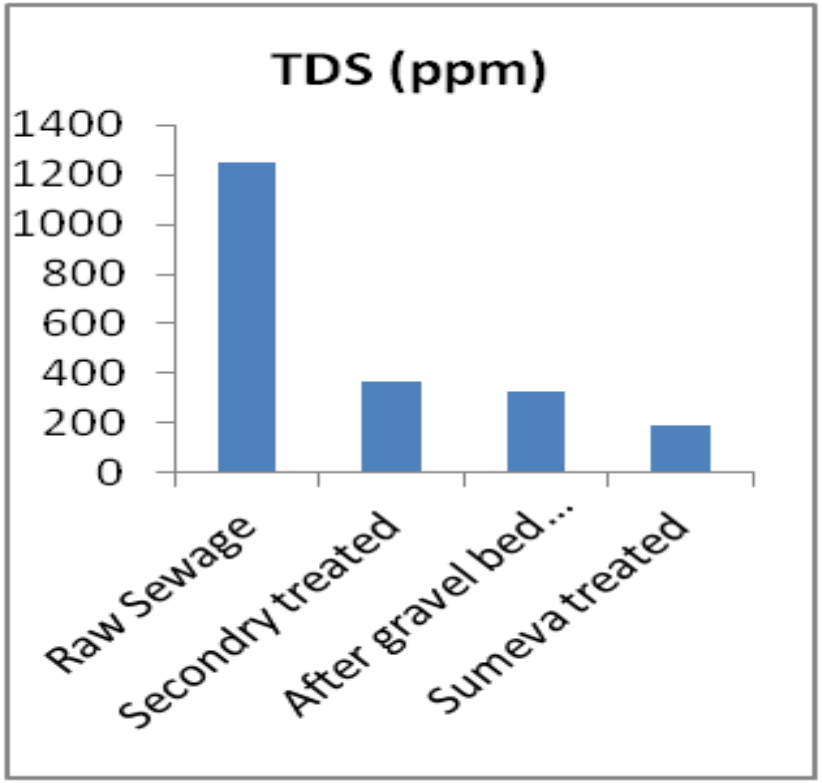


Disinfection systems and sustainable pathogen monitoring

- The main objective: to develop low-cost, sustainable disinfection methods
- Disinfection system is installed and running in IGNTU

Water quality during disinfection





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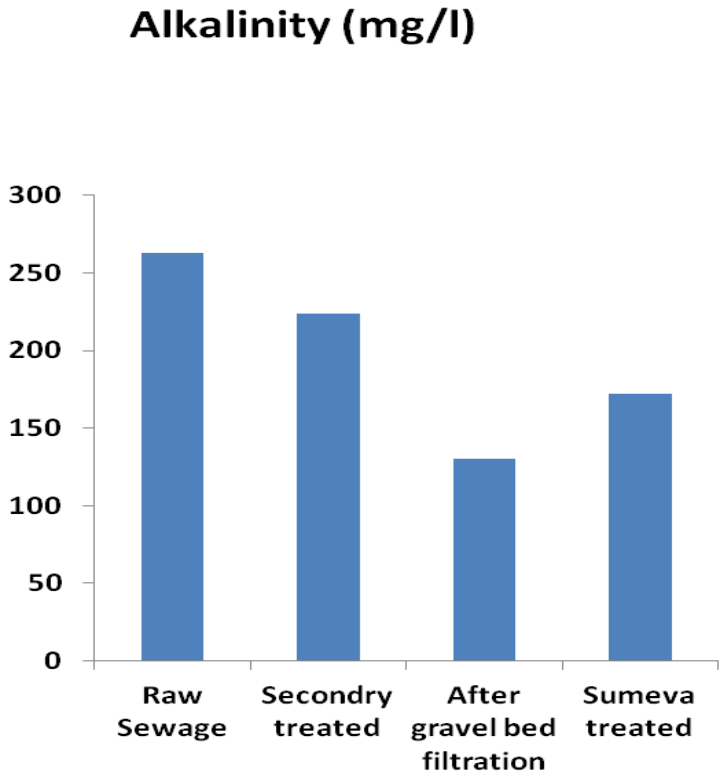
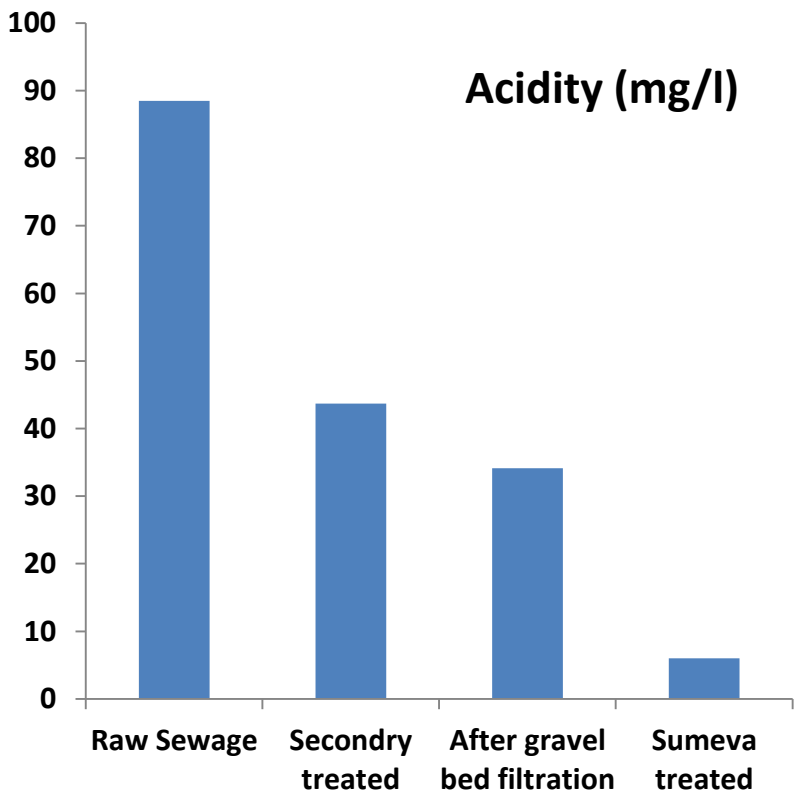

Alkalinity (mg/l)
300
250
200
150
100
50
0
Raw Sewage
Secondry treated
After gravel bed filtration
Sumeva treated


Acidity (mg/l)
100
90
80
70
60
50
40
30
20
10
0
Raw Sewage
Secondry treated
After gravel bed filtration
Sumeva treated

Treatment Process

Component of System	**Treatment**
Settling Chamber 1	Physical/ Settling of solids
Gravel bed	Removal of degradable compounds/ filtration
Settling chamber 2	Settling/o
Pumping to Zeolite filter	Physical adsorption/ filtration
Passing to Anodic oxidation chamber	Disinfection by chlorine