EXPERIENCIAS, DIFICULTADES Y VENTAJAS EN EL ESTABLECIMIENTO DE HUMEDALES CONSTRUIDOS EN PAÍSES EN VIAS DE DESARROLLO.

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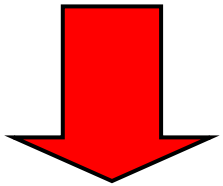
Google

TRATAMIENTOS DE AGUAS EN PAISES EN VIA DE DESARROLLO

En Malaysia 89 de las 91 plantas de tratamiento de aguas residuales convencionales no funcionan o producen efluentes que no cumplen las normas .

Situación similar en India, Tailandia, México, Colombia, Perú, Vietnam, etc.



Sistemas altamente tecnificados instalados en países en vías de desarrollo tienen alta probabilidad de fallar.

Y FALLAN! ....

No hay alcantarillados adecuados

Aguas residuales diluidas

Operarios no calificados

Falta de recursos económicos y humanos

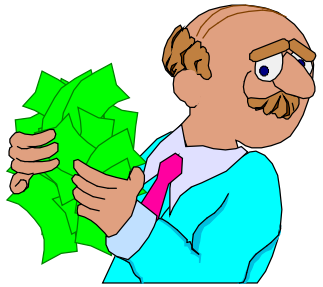
Descuido en rutinas de operación y mantenimiento

Prioridades políticas locales.

PLANTA DE TRATAMENTO DE LA CIUDAD DE .....

INFRAESTRUCTURA UTIL

Caracteristicas para la selección de soluciones



Construcción y mantenimiento a costos asequibles

Tratamientos basados en procesos naturales

Soluciones in-situ y descentralizadas

Bajos costos de construcción

Bajos costos de operación y mantenimiento

Poca exigencia de mantenimiento.

Sistemas de tratamiento que cumplan con las exigencias de descarga

Sistemas que ofrezcan potencial para recuperar recursos (agua, biomasa, energía).

Humedales en países en vías desarrollo (tropicales subtropicales?)

Como diseñarlos?

Se carece de información básica!

- Bases de datos?
- Constantes cinéticas?
- Plantas?
- Materiales?
- Modelos numéricos

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Como construirlos

Materiales adecuados

Capacidad constructiva

Tecnicas constructivas

Diseños adecuados

Control de calidad

COMO CONSTRUIRLOS

Firmas y constructores sin experiencia suficiente

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ARIAS Y BRIX

Diferencias culturales

- Distancia en el poder
- Incertidumbre
- Género
- Individualismo
- Planeación a largo plazo
- Manejos económicos .....

Ventajas

Receptividad

Innovación

Reacciones cinéticas diferentes

Materiales innovadores

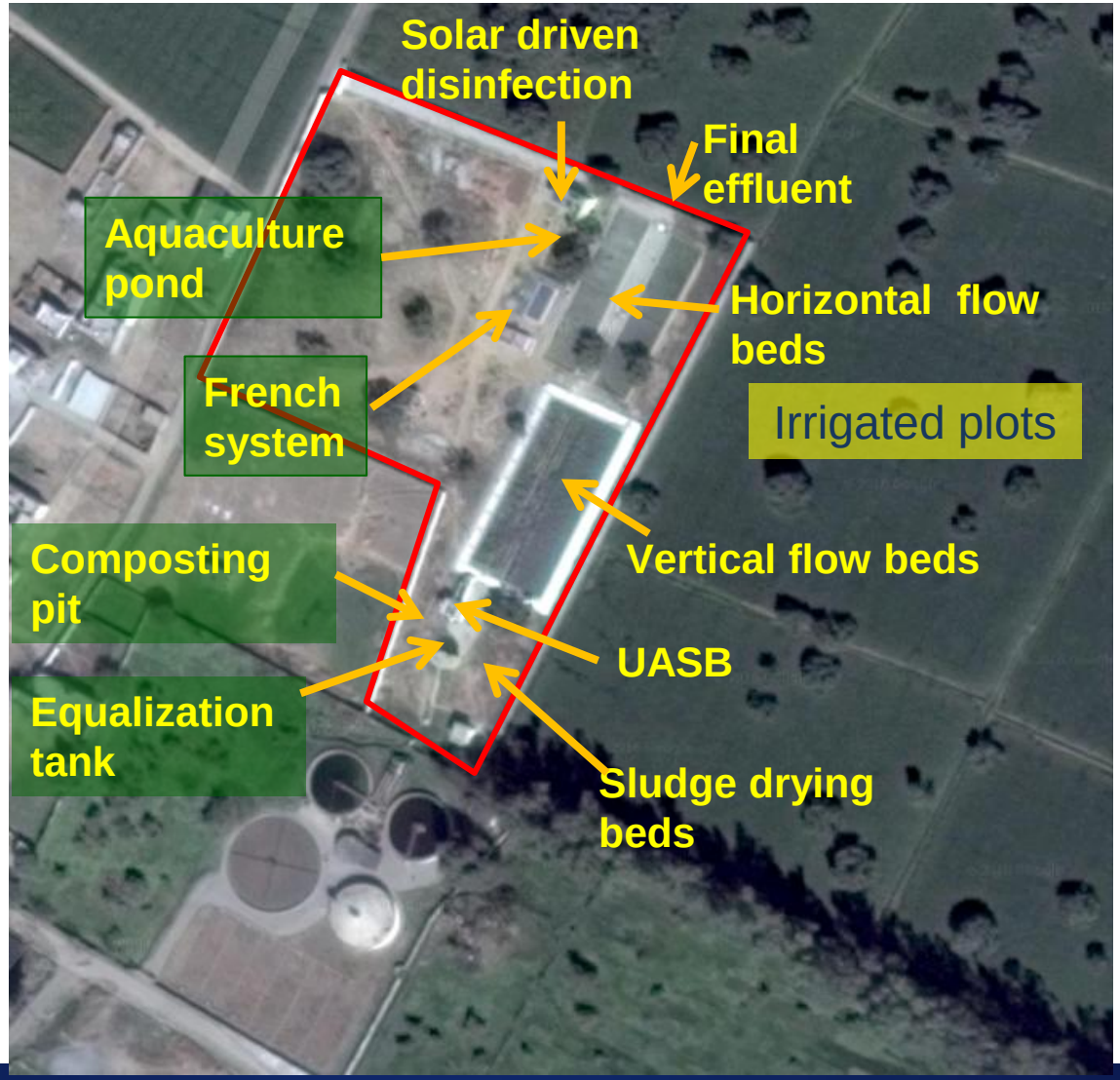
Prácticas locales

Kalyani University, (KLY, Kalyani)

Aligarh Muslim University, (AMU, Aligarh)

Indira Gandhi National Tribal University, (IGNTU, Amarkantak)

AMU AD-CW pilot plant construction



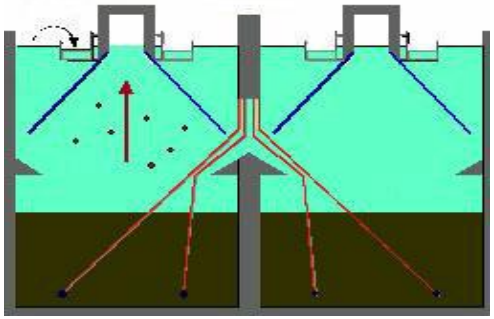
Primary treatment (Anaerobic digestion)

→

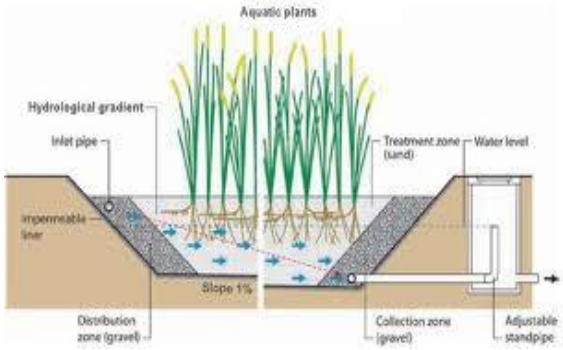
Secondary treatment (Constructed wetlands)

→

Solar-driven disinfection

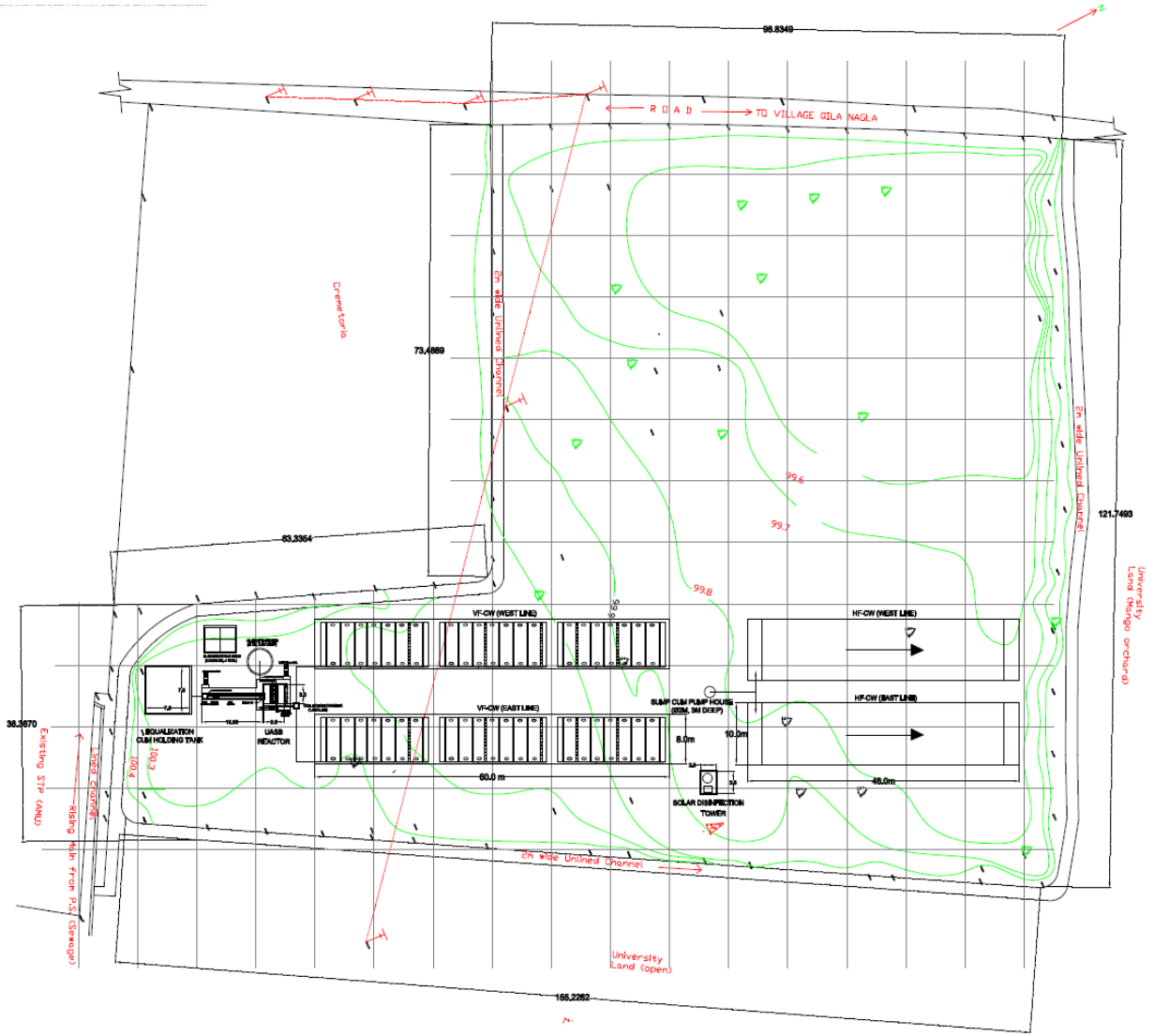


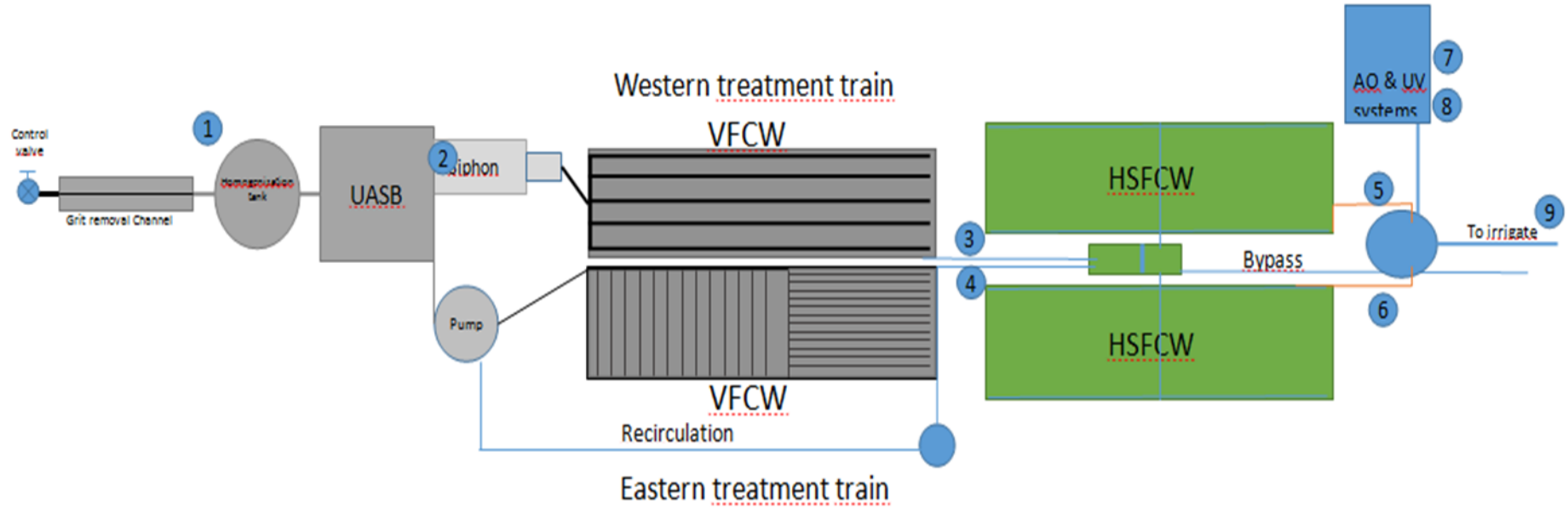
UASB System

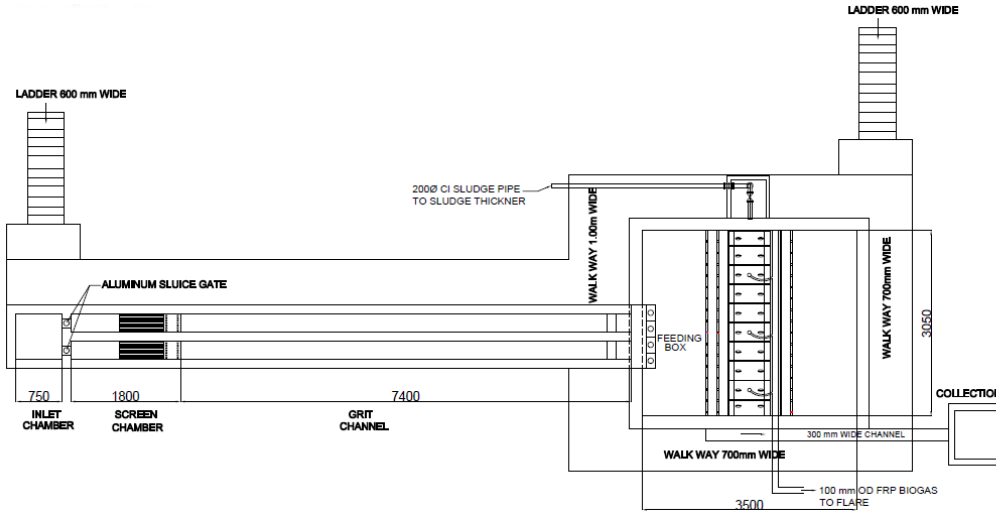


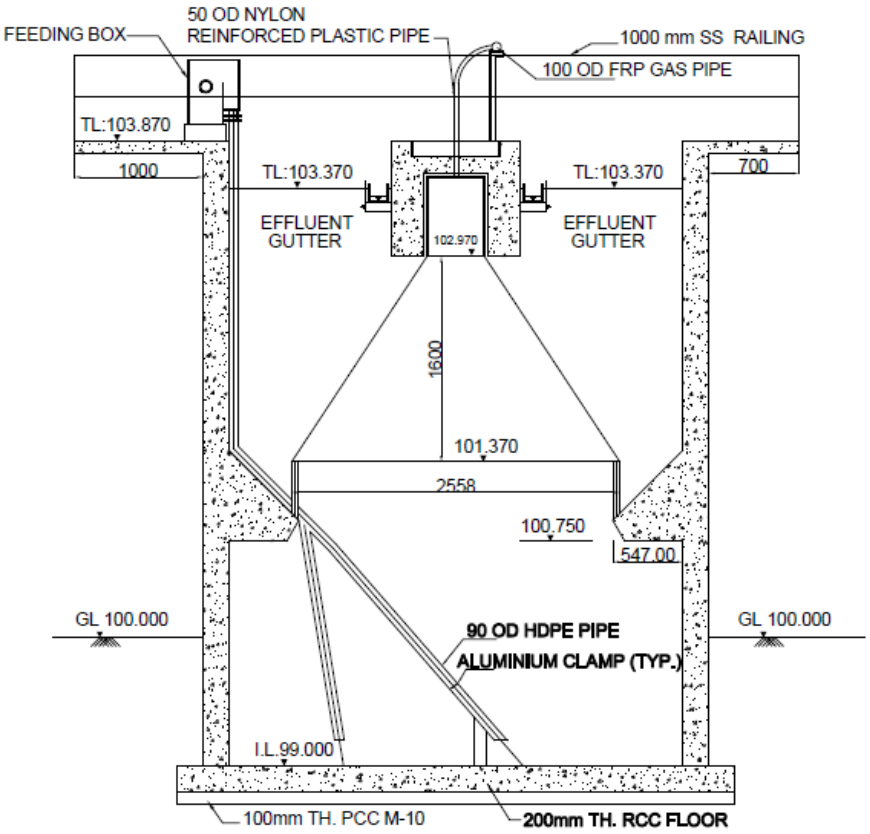
Vertical Flow and Horizontal Flow Sub-Surface CWs

AO


98.8349
R O A D
TO VILLAGE GILA NAGLA
Crematoria
6m wide Unlined Channel
73.4889
6m wide Unlined Channel
121.7493
83.3354
99.6
99.7
99.8
University Land (Mango orchard)
VF-CW (WEST LINE)
HF-CW (WEST LINE)
VF-CW (EAST LINE)
HF-CW (EAST LINE)
SUMP CUM PUMP HOUSE (02M, 3M DEEP)
EQUALISATION CUM HOLDING TANK
UASB REACTOR
SOLAR DISINFECTION TOWER
8.0m
10.0m
60.0 m
40.0m
38.3670
Existing STP (MW)
Lined Channel
Rising Main from P.S (Sewage)
6m wide Unlined Channel
University Land (open)
155.2282

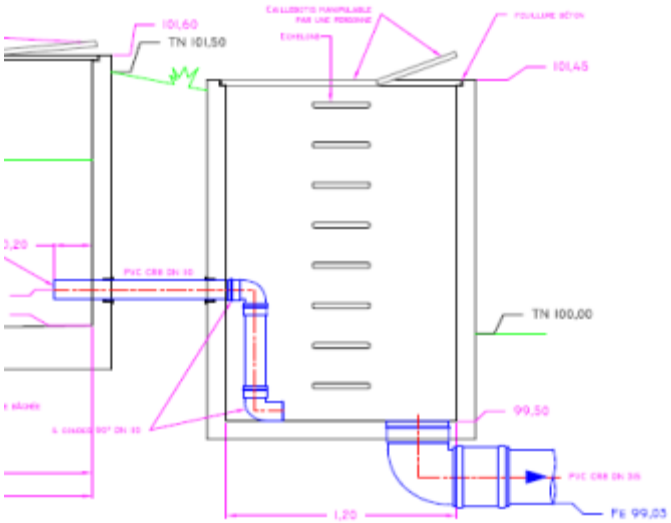

Control valve
1
Grit removal Channel
UASB
2
Siphon
Western treatment train
VFCW
Pump
VFCW
Recirculation
Eastern treatment train
HSFCW
HSFCW
Bypass
3
4
5
6
AO & UV
systems
7
8
9
To irrigate





Design parameters for UASB

Dimensions (length/width/depth)	3.54/ 3.04/ 4.87	m
Volume	51.13	m^3
Sludge Bed Concentration	65 - 75	Kg TSS/m^3
Upflow Velocity at Avg. Flow	0.52-0.54	m/h
Min. hydraulic retention time (HRT)	7.0	hrs.
SRT at design temp.	35-40	days
VSS destruction in Reactor	50	%


101,60
TN 101,50
101,45
TN 100,00
99,50
1,20
FE 99,03

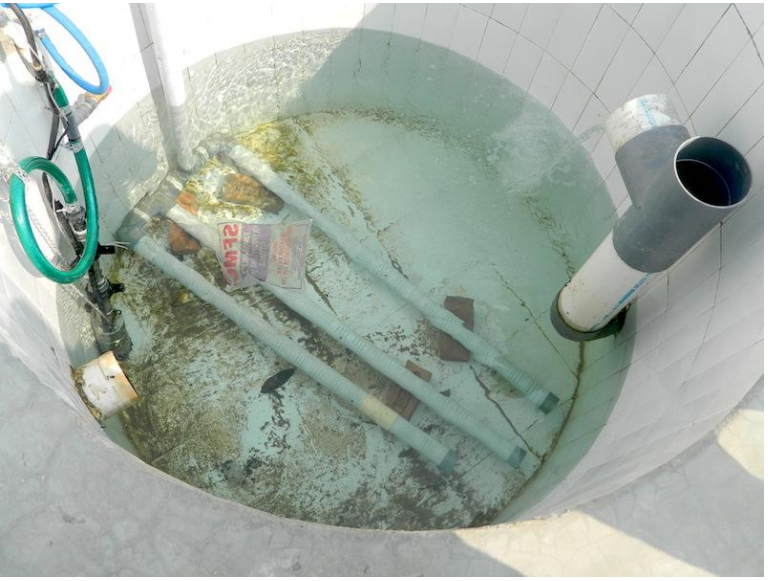
AMU AD-CW: West and East VFCWs construction

AMU AD-CW: West and East VFCWs construction

AMU AD-CW: West and East VFCWs construction

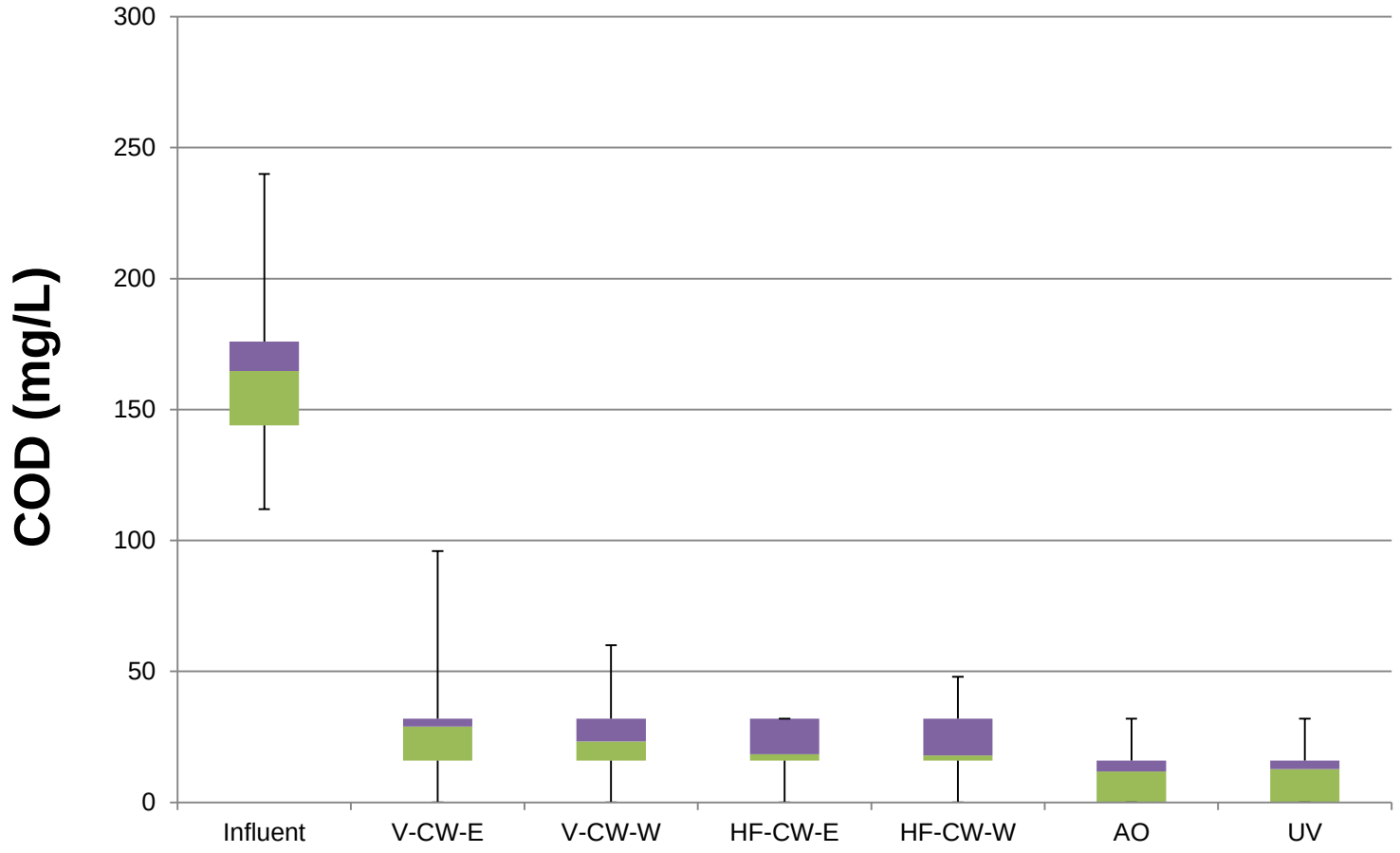
AMU AD-CW: West and East HFCWs construction

AMU AD-CW: Planting of the beds and final effluent

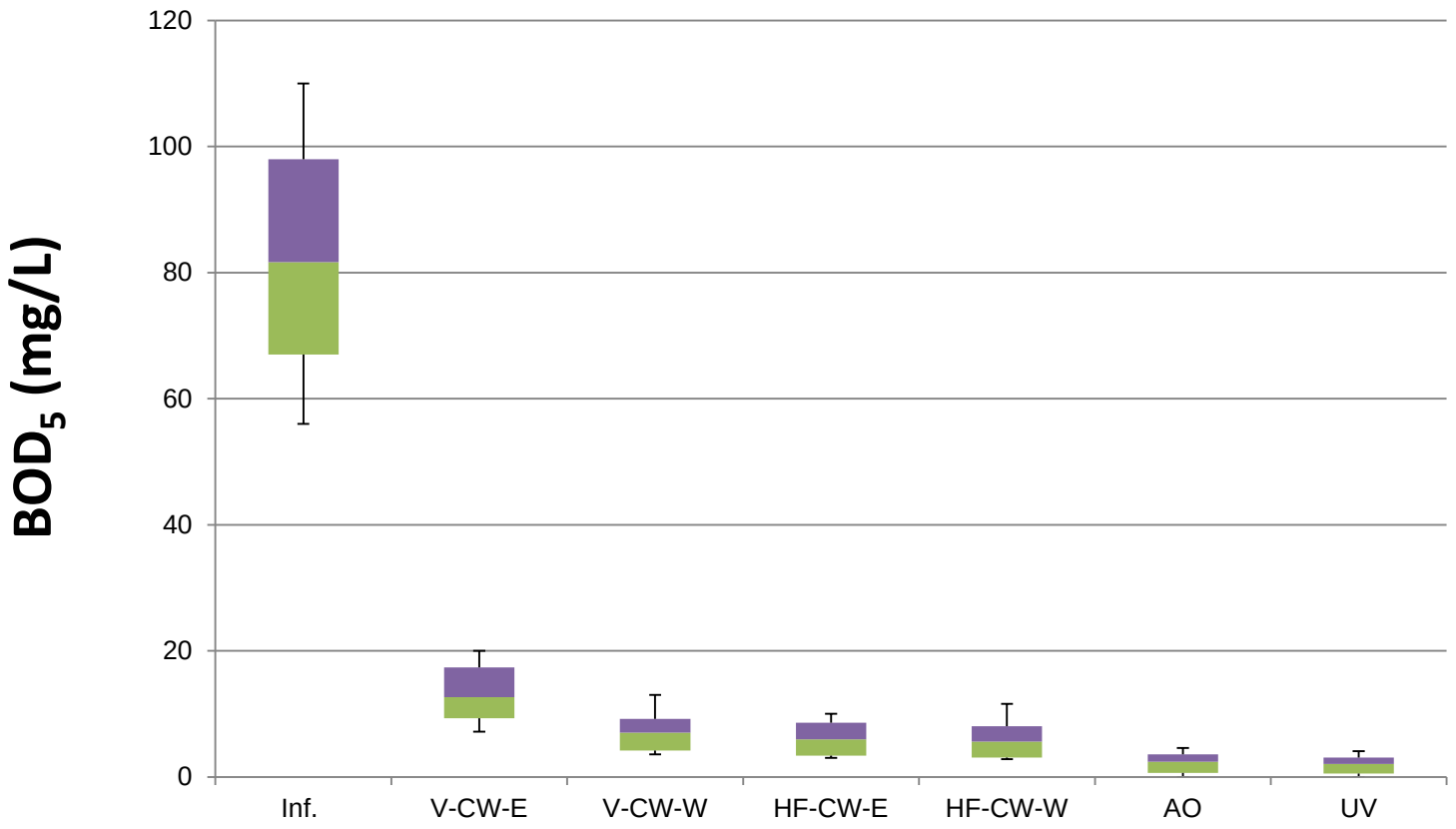


Solar-driven disinfection systems

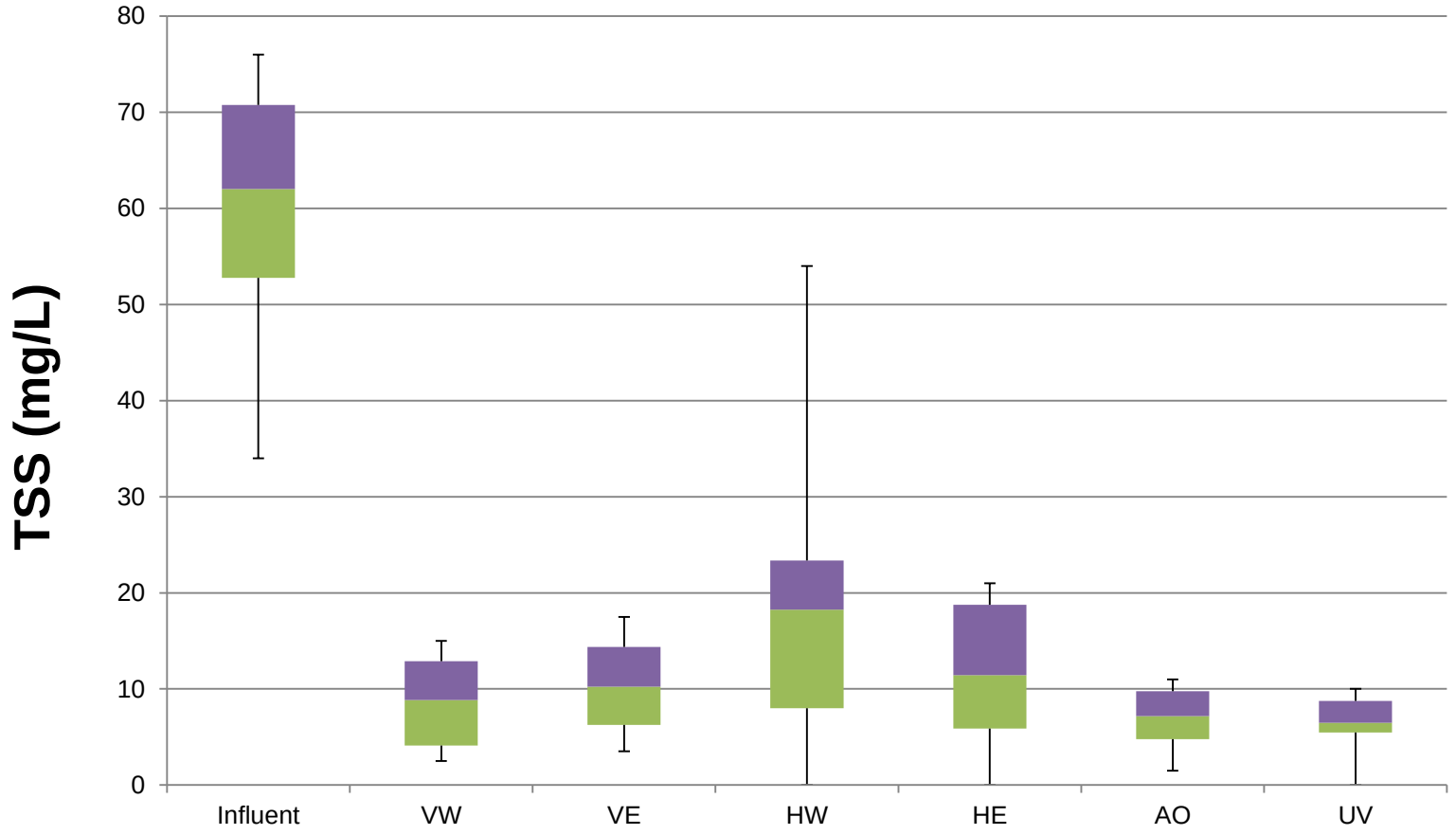
AMU AD-CW - steady state condition



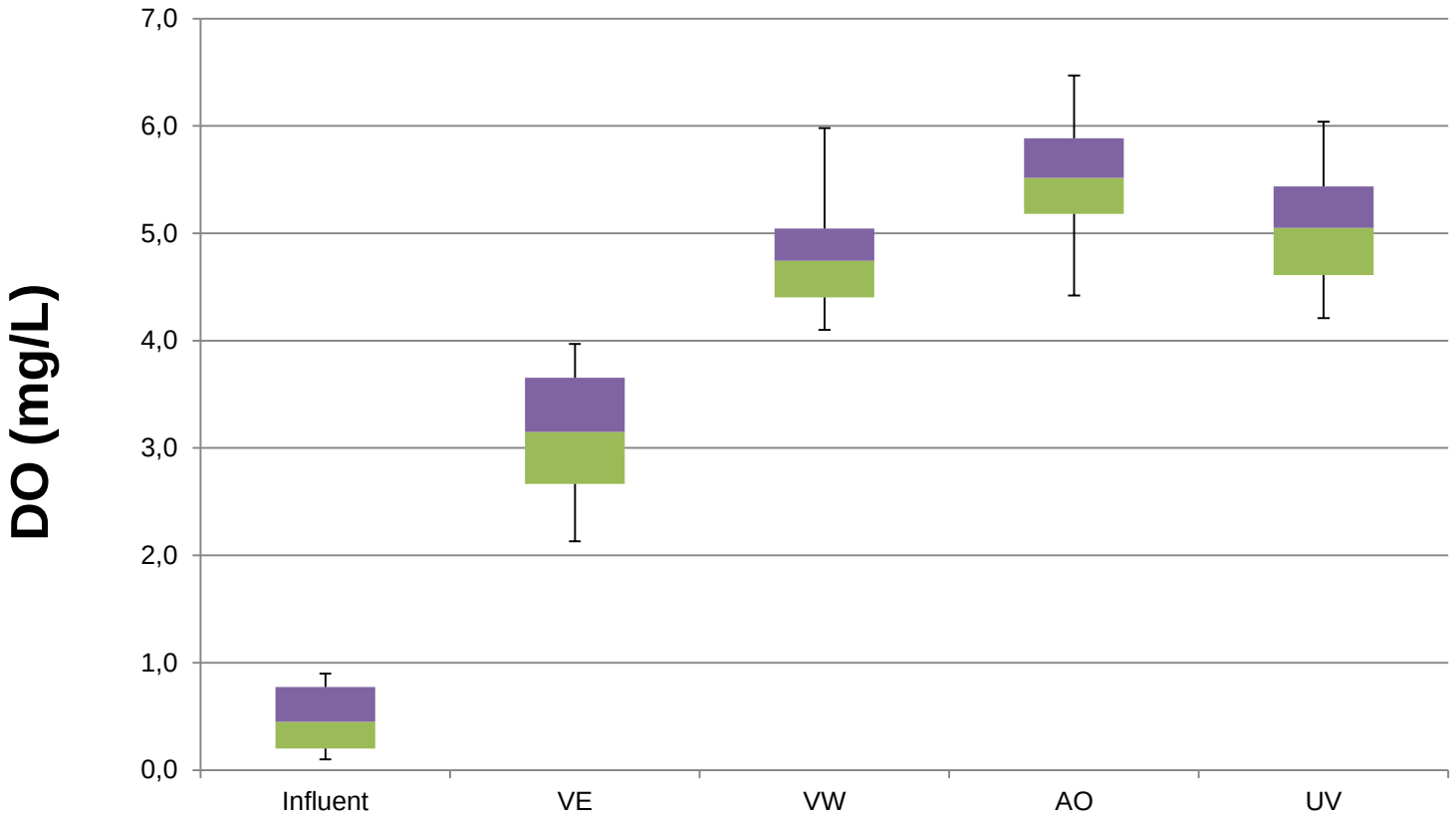
AMU AD-CW - steady state condition



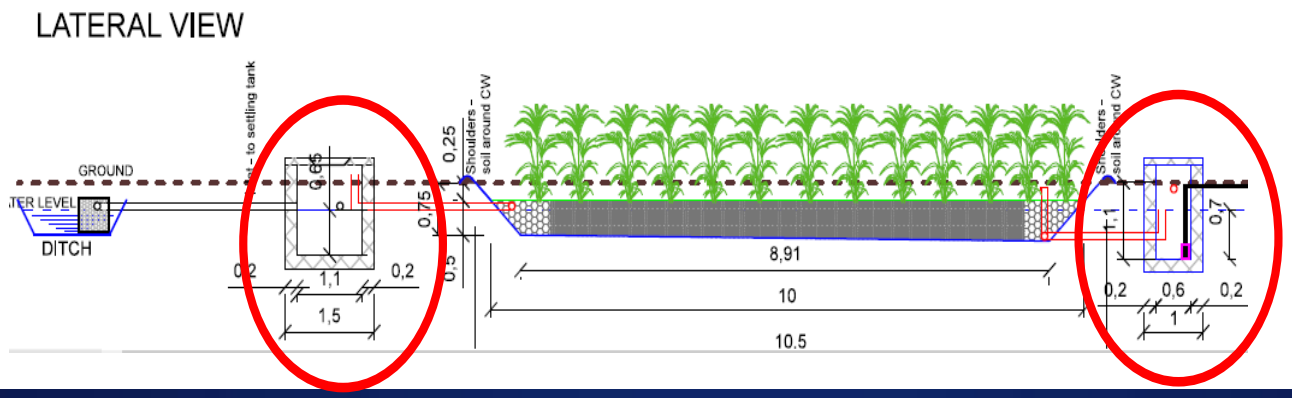
AMU AD-CW - steady state condition



AMU AD-CW - steady state condition



Effluent polishing gravel bed → Solar driven disinfection



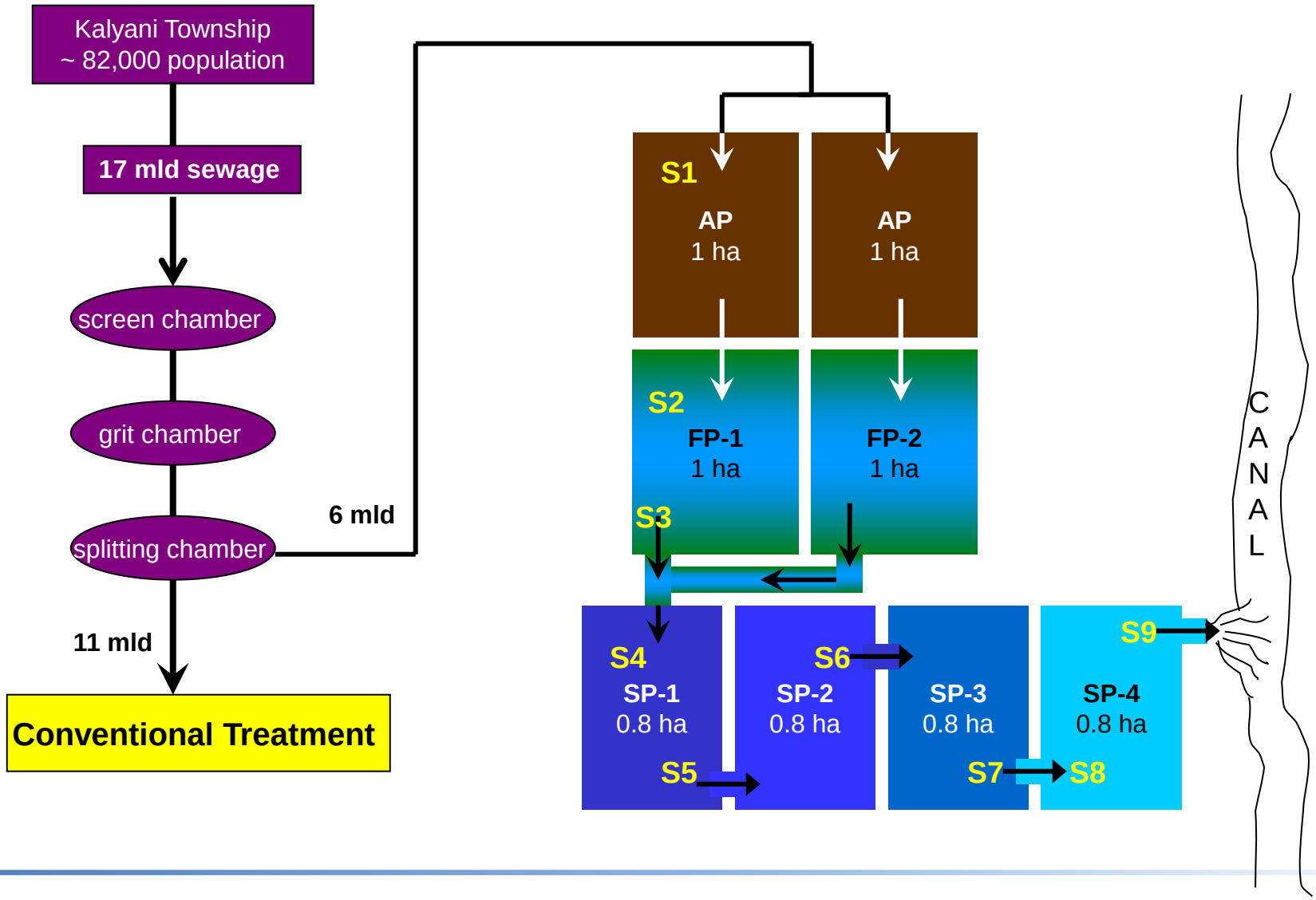
KALYANI site

Background Objectives

Disinfection by:

1. Natural Filtration Systems
    a. Bank Filtration
    b. Soil Aquifer Treatment
2. Chemical Free Solar Driven Disinfection Systems
    a. Solar AO
    b. Solar UV
3. Determine overall treatment performance for safe reuse of treated wastewater

Kalyani wastewater treatment system



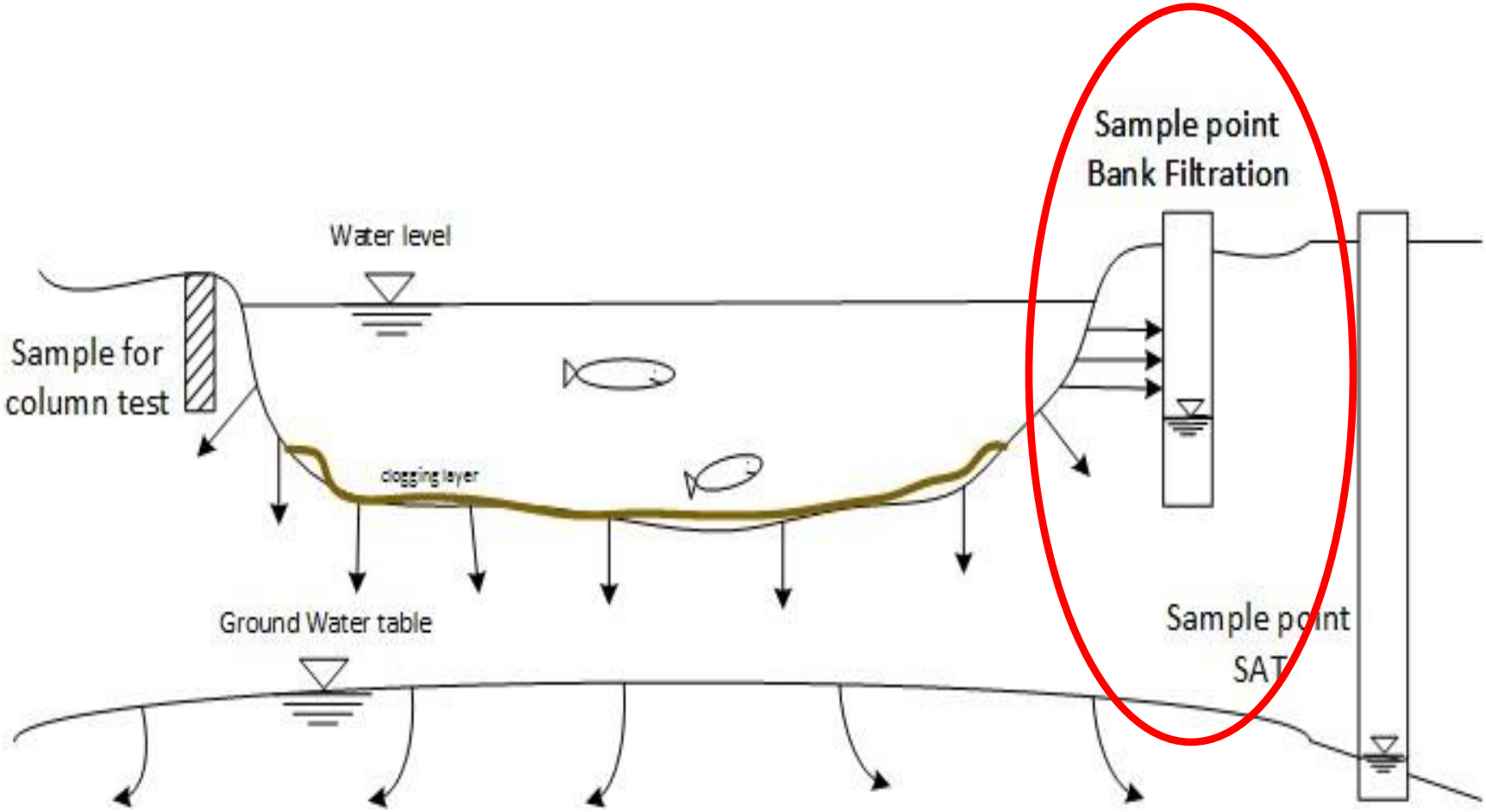
Kalyani University Site

Maturation Ponds at Kalyani Site

Kalyani Wastewater Stabilization Ponds

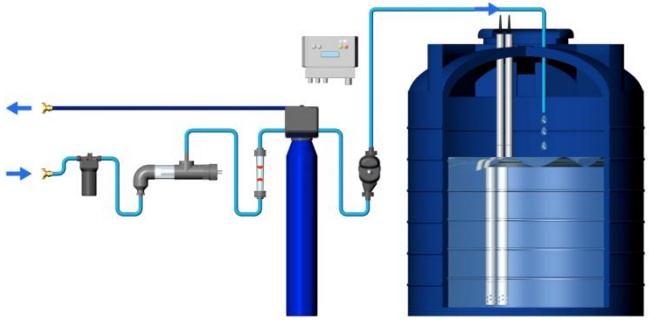
Bank Filtration

- River bank filtration commonly applied for drinking water treatment

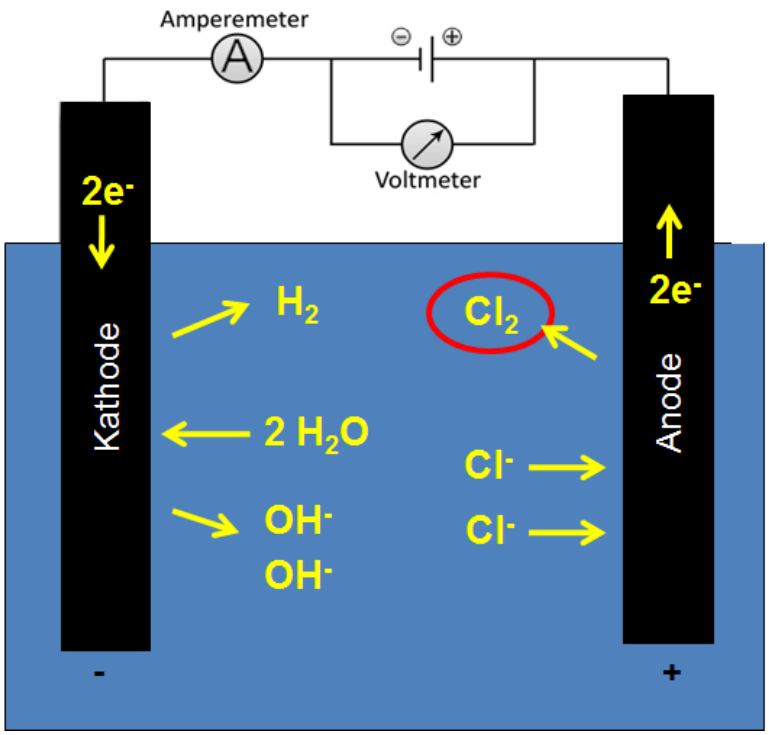


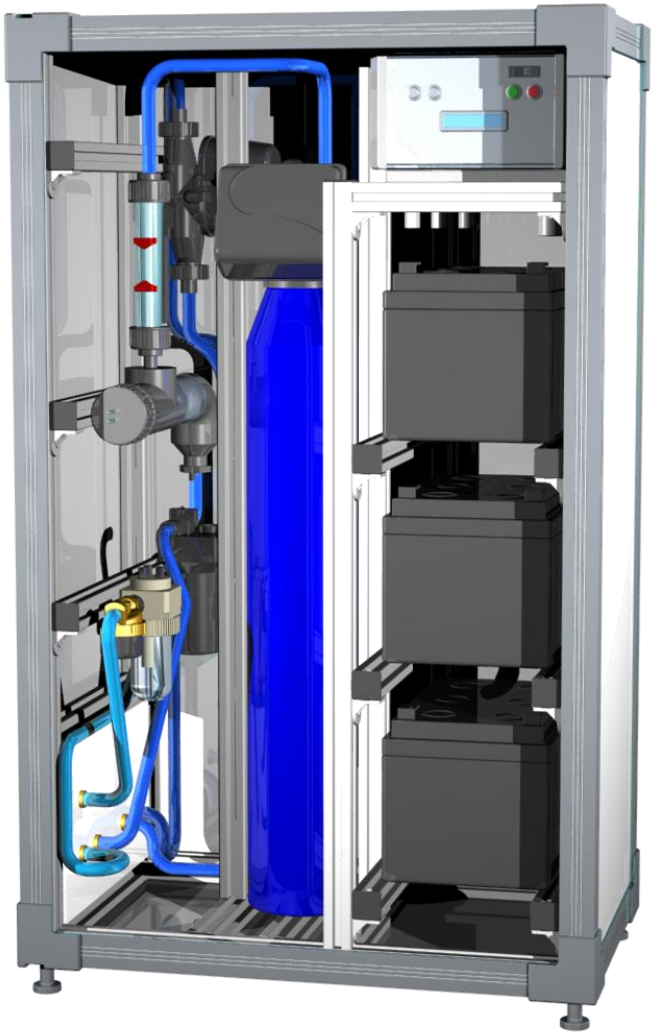
Solar AO System

- AO – Anodic Oxidation
- Up to 20 m³/d
- Solar pumping
- Prefiltration with automatic backwash
- Online water quality control by ORP
- Chlorine production 0,3 – 10 mg/L



Chlorine production with solar Anodic Oxidation (AO)





$Cl_2 + H_2O \leftrightarrow HOCl + H_3O^+ + Cl^-$

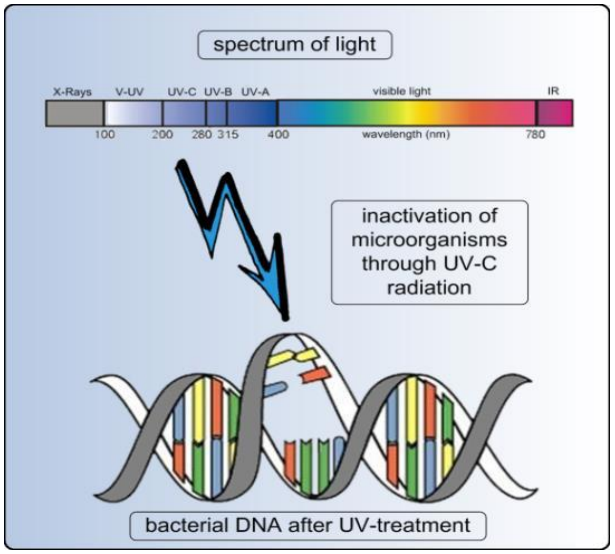
- Natural mineral content of water is sufficient
- Reliable disinfection without any chemicals

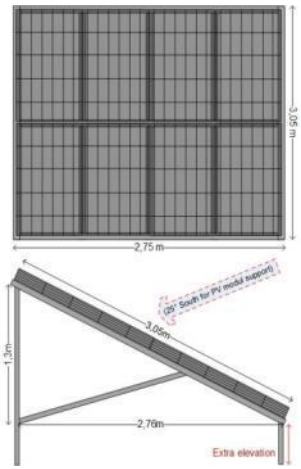
Technologies SolarSpring – SolarUV

10 m³/day SolarUV (AMU)

3 m³/day SolarUV (Kalyani)

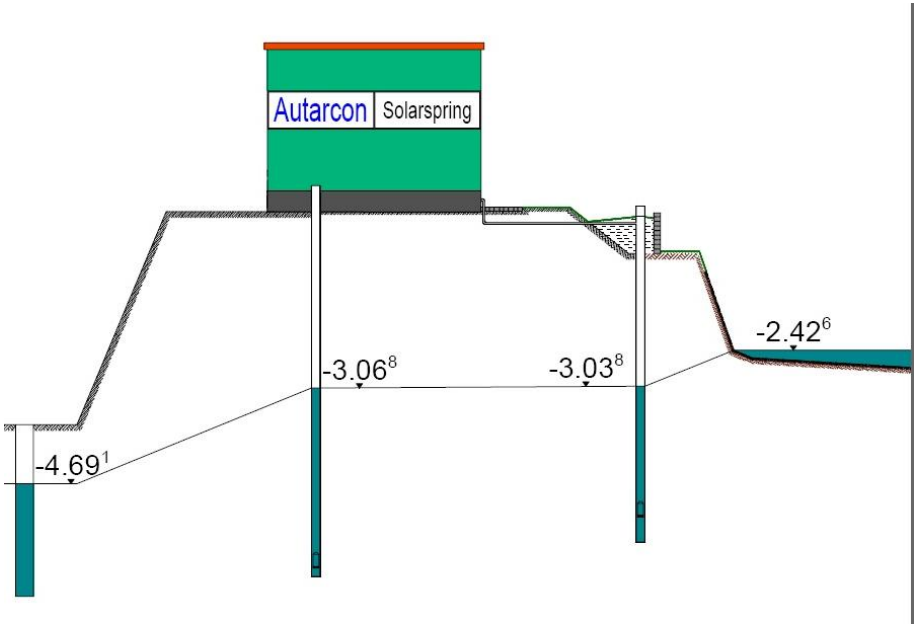
- Power supply – 800 Wp
- Pre-filtration with automated back flush function + cartridge filter
- Disinfection quality monitoring by UV sensors
- Water storage disinfection by UV
- Data acquisition and remote access system for quality control and improved maintenance





Hydro-geological survey

- Drilling of sampling wells
- Determination of water tables
- Establishment of hydrogeological triangle



Hydrogeological survey

- Identification of Soil profile and filtration properties

Drilling of BF Wells

Site Construction

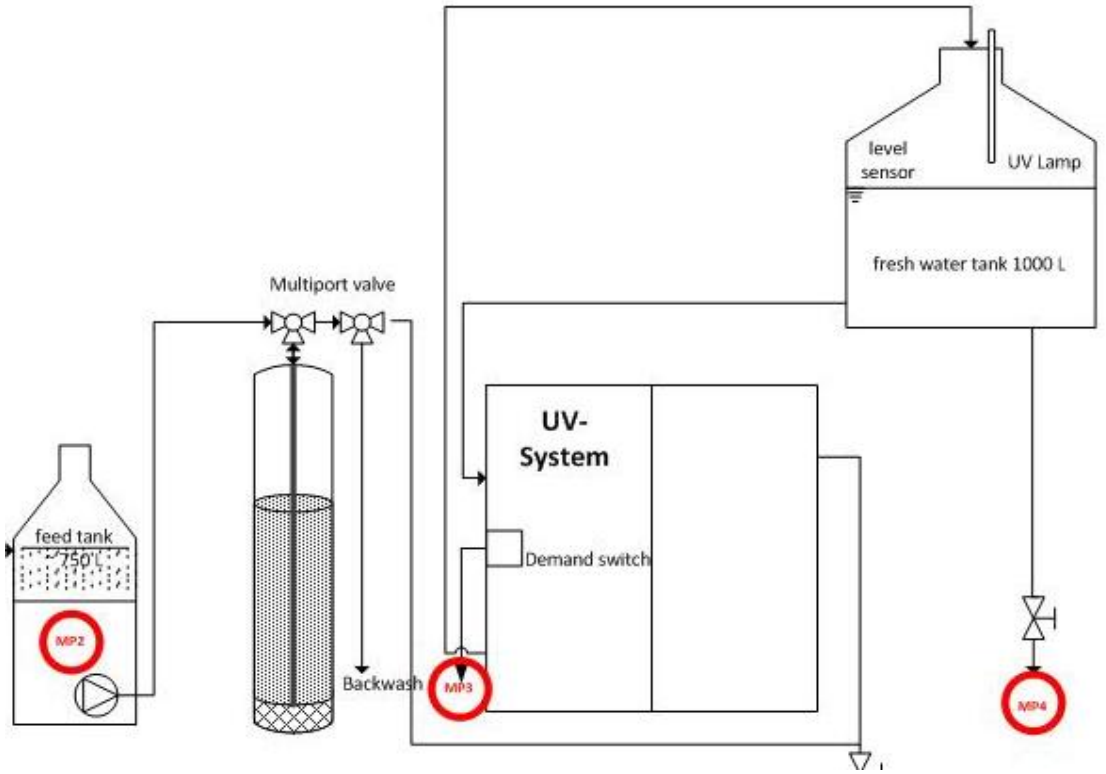
- Construction of solar disinfection system building

Installation of Solar Driven Disinfection Systems

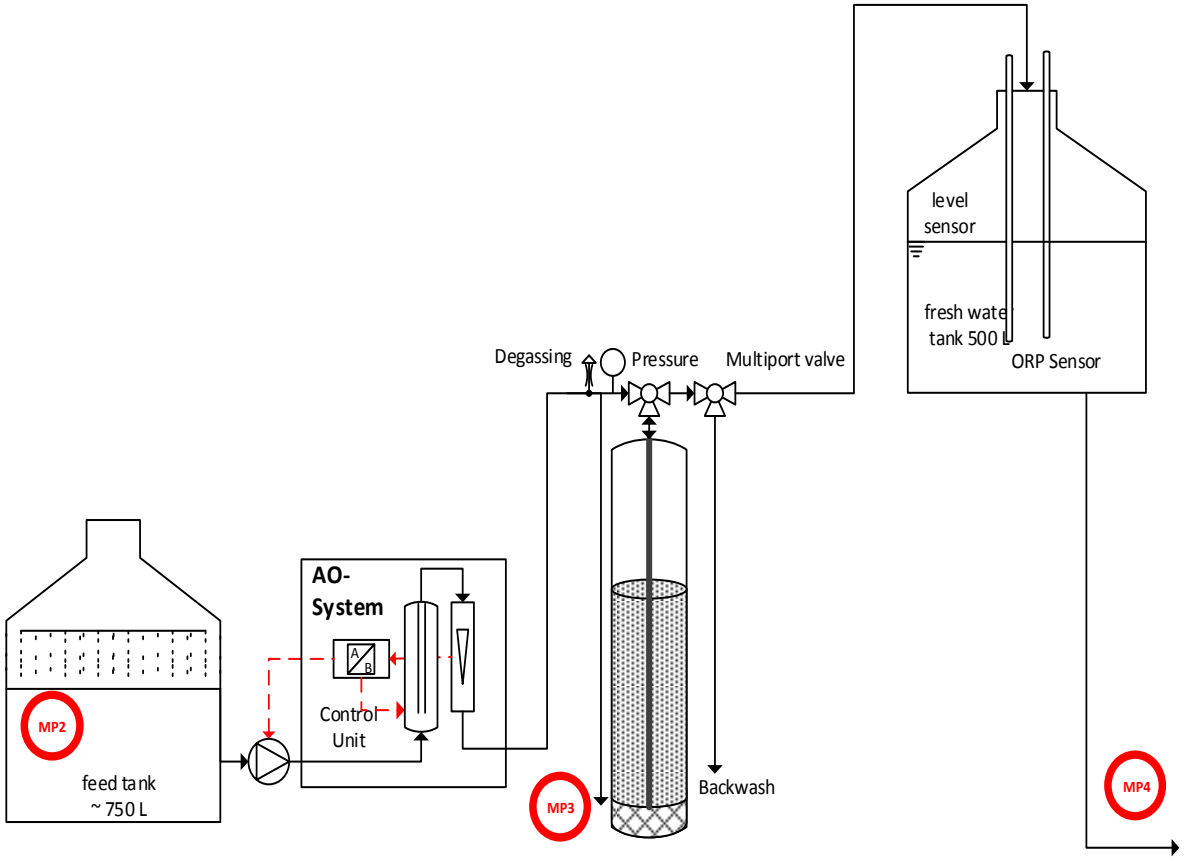
Installation of Solar Driven Disinfection Systems

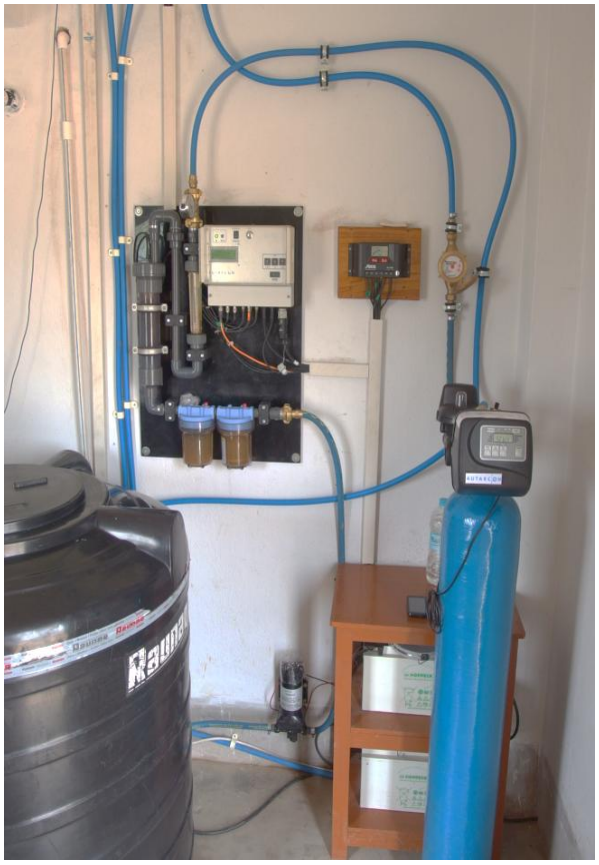
Finalized BF Site

Solar UV system



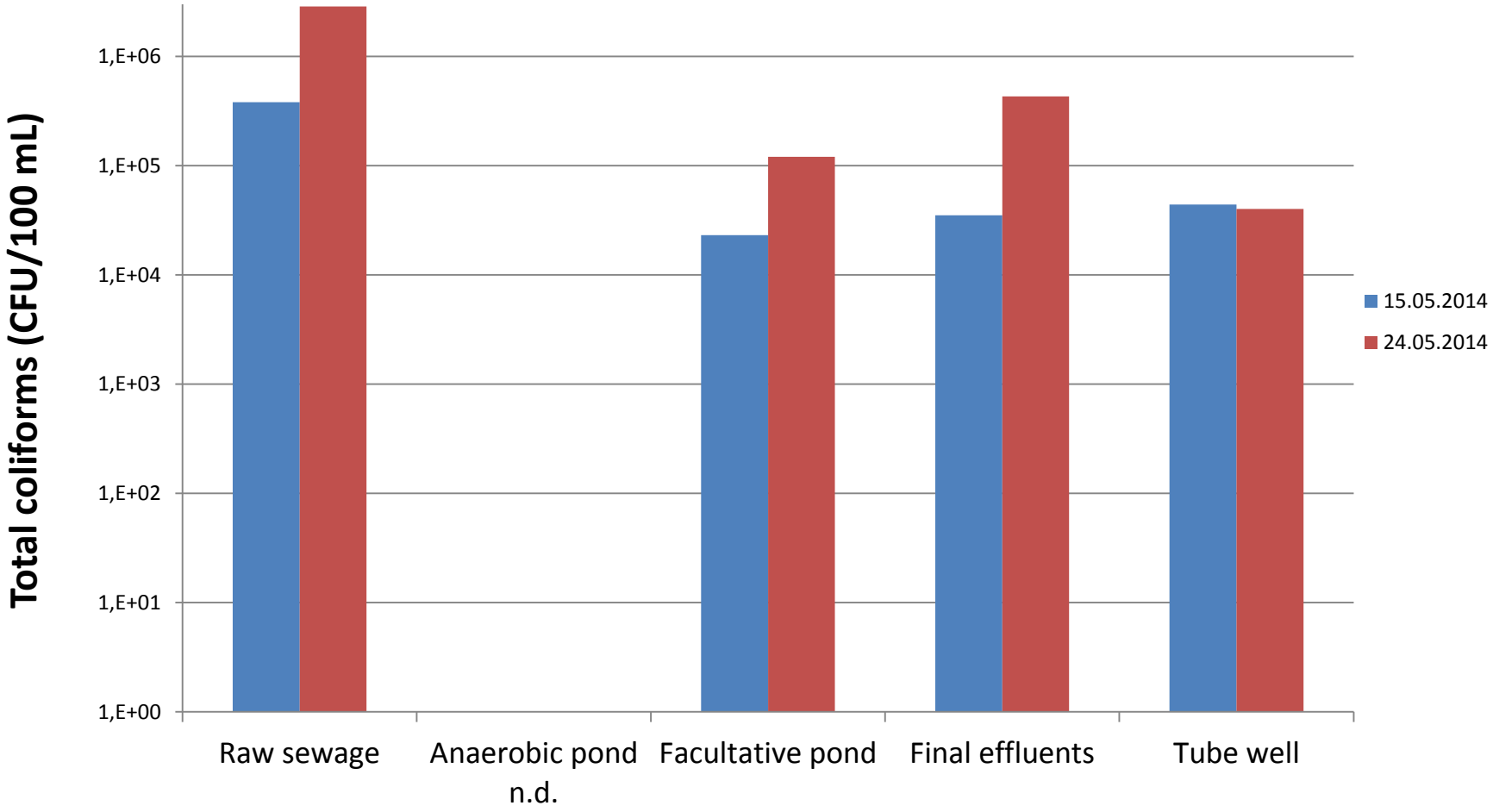
Solar AO System





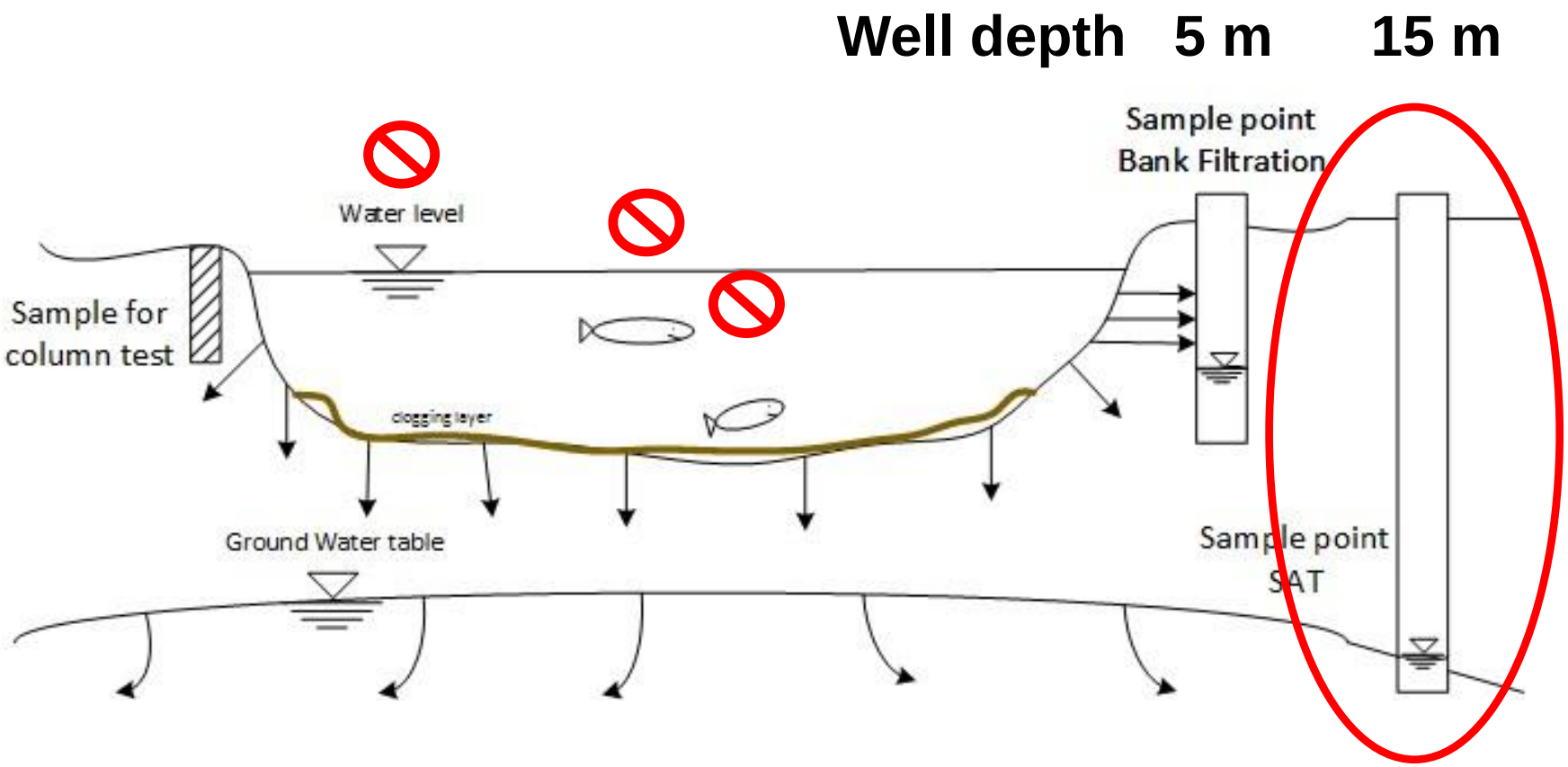
Solar driven disinfection systems

First measurements of Total Coliforms - KALYANI

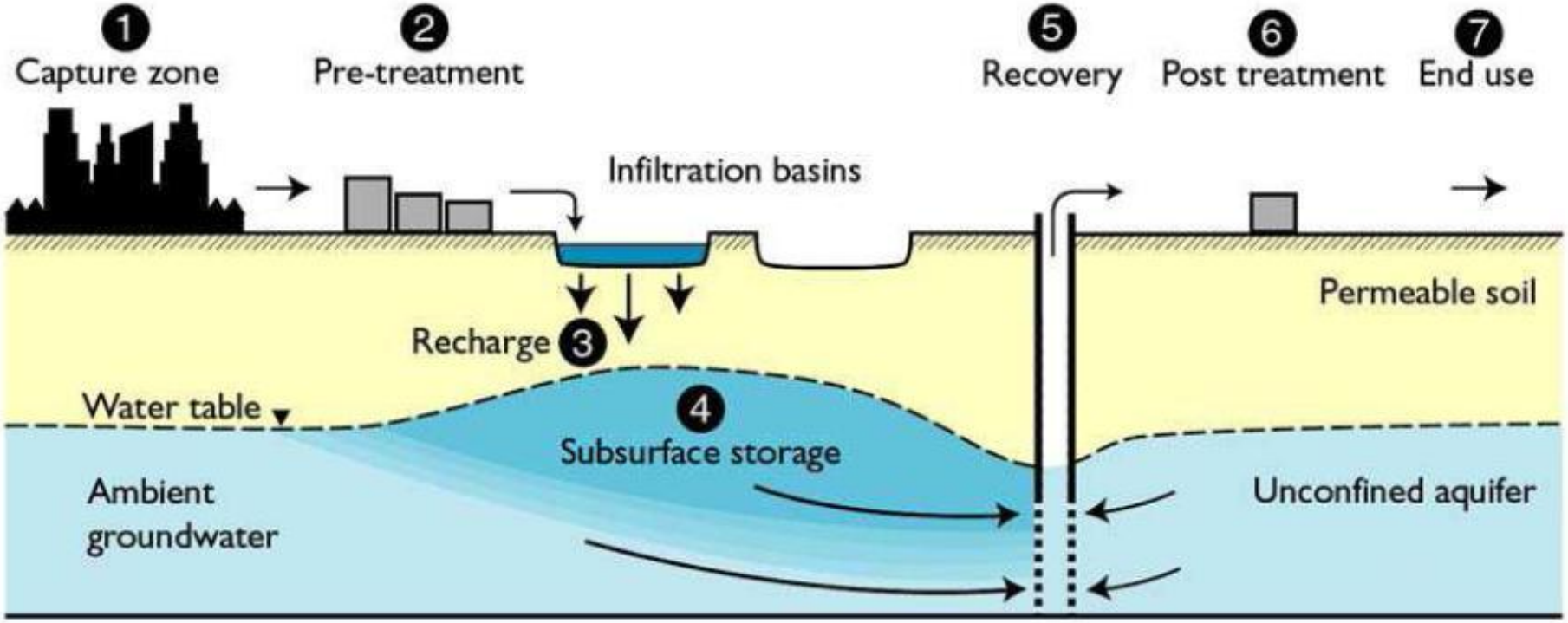


Refurbishment of Ponds

Soil aquifer treatment (SAT) - 2015 (intermittently)

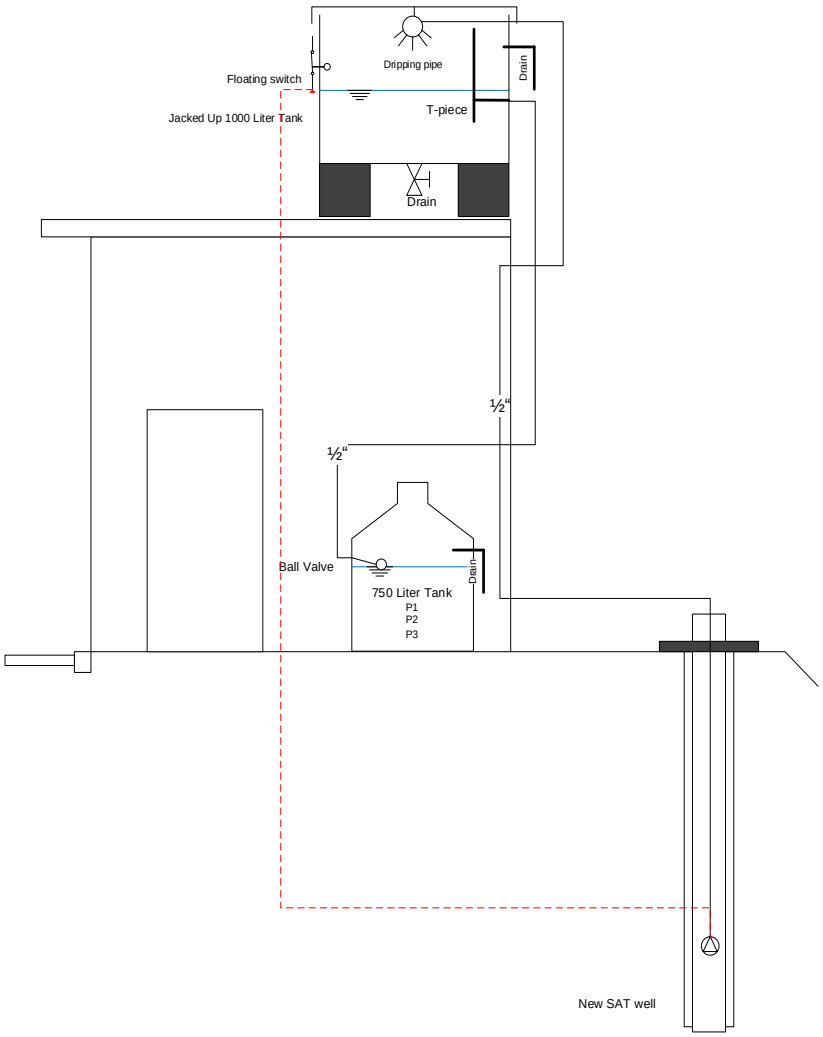


Soil Aquifer Treatment

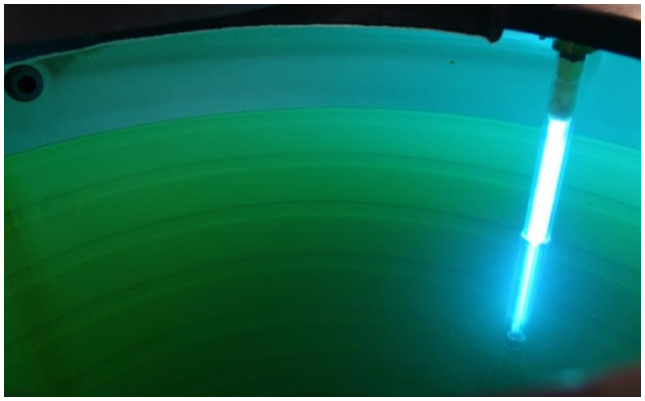


Schematic view of the soil aquifer treatment process (Miotlinski et al., 2010).

SAT well and aeration

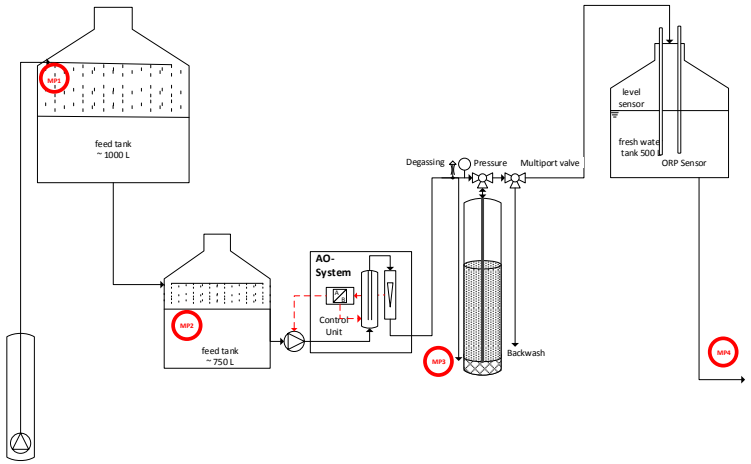


First results

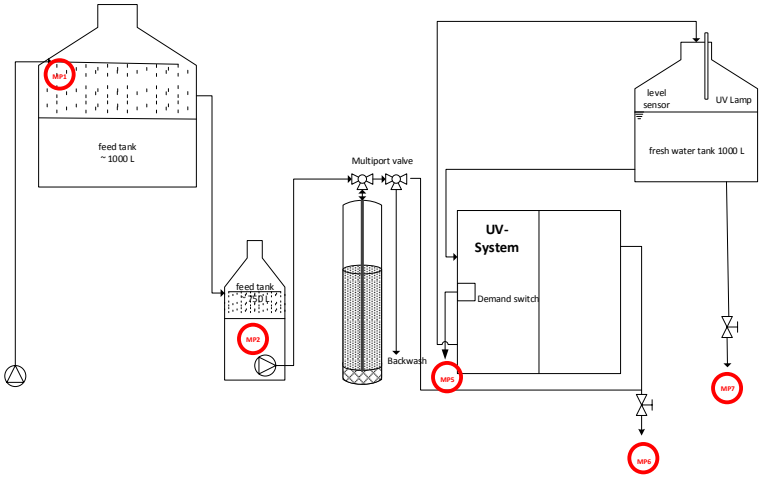


Sampling Plan Kalyani Site

Solar AO System



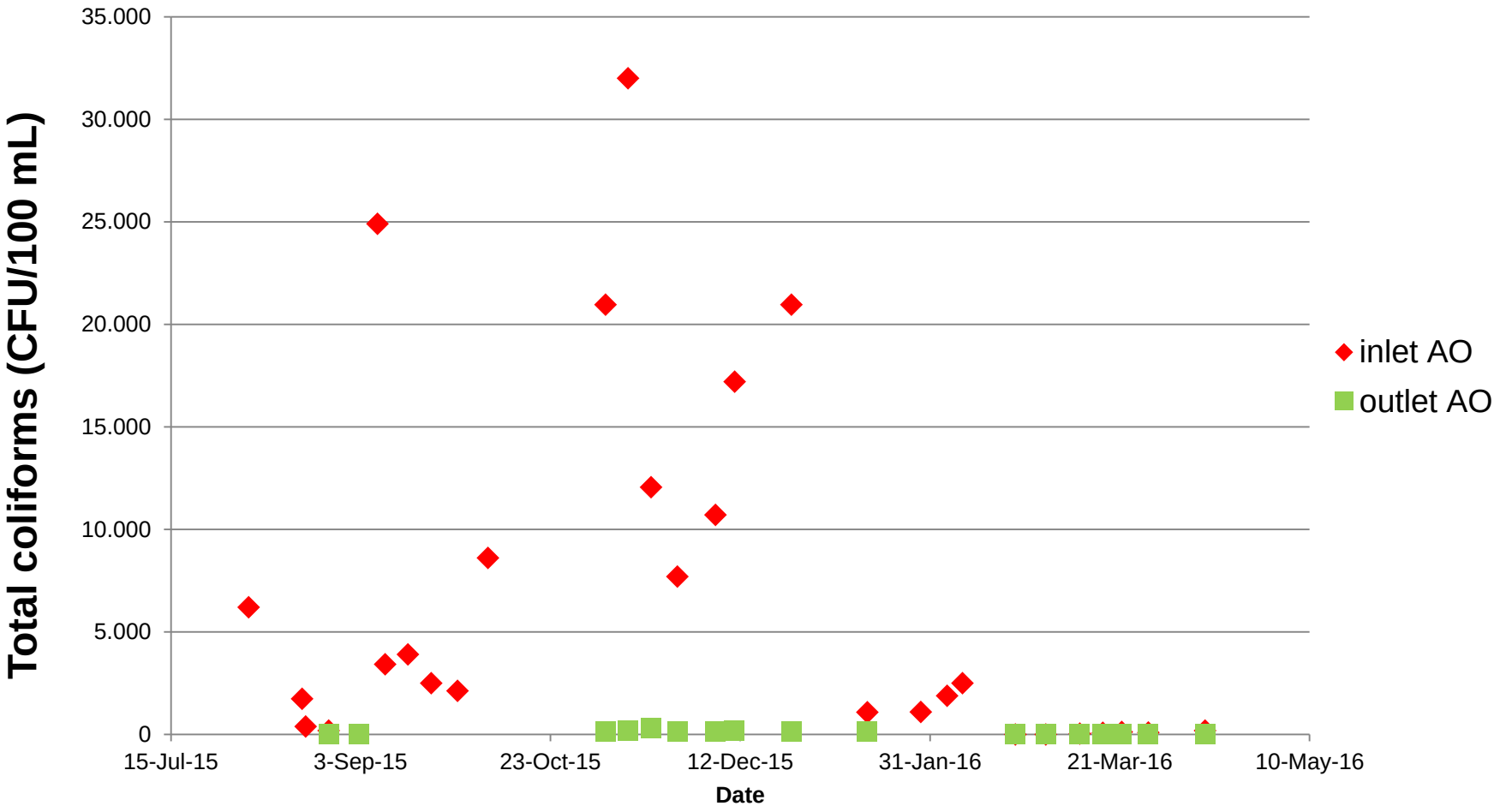
Solar UV System



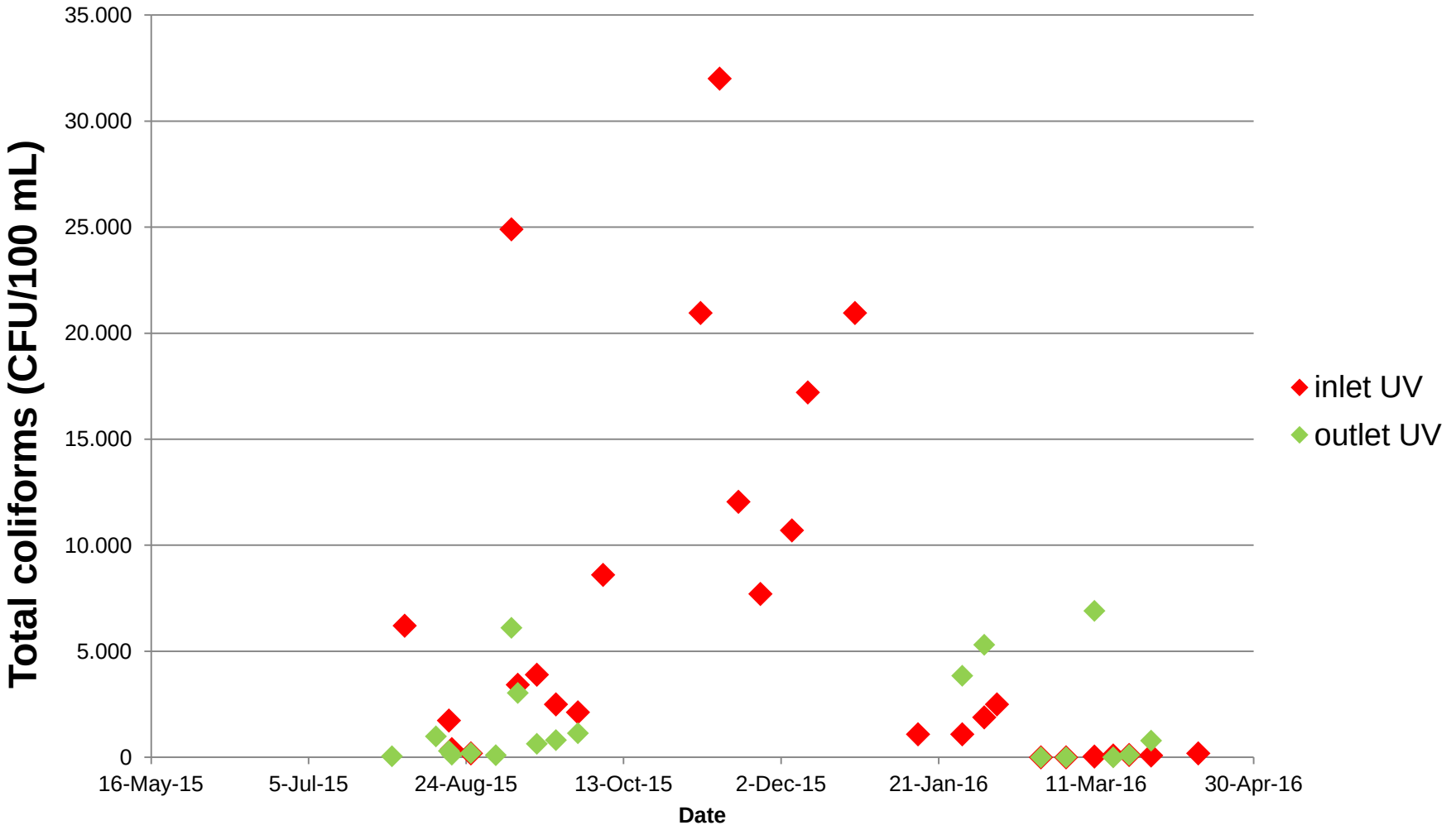
Parameters	Times per month
Turbidity, TDS	8
EC, pH, DO, ORP, Temp	8
Hardness	4
Iron	8
Manganese	8
Chloride	1
Chlorine (only AO)	8
Nitrogen, Nitrate, Nitrate, Ammonia	4
Phosphorous	4
COD, BOD	4
E.Coli and total coliform	4

In total 8 Sampling Points

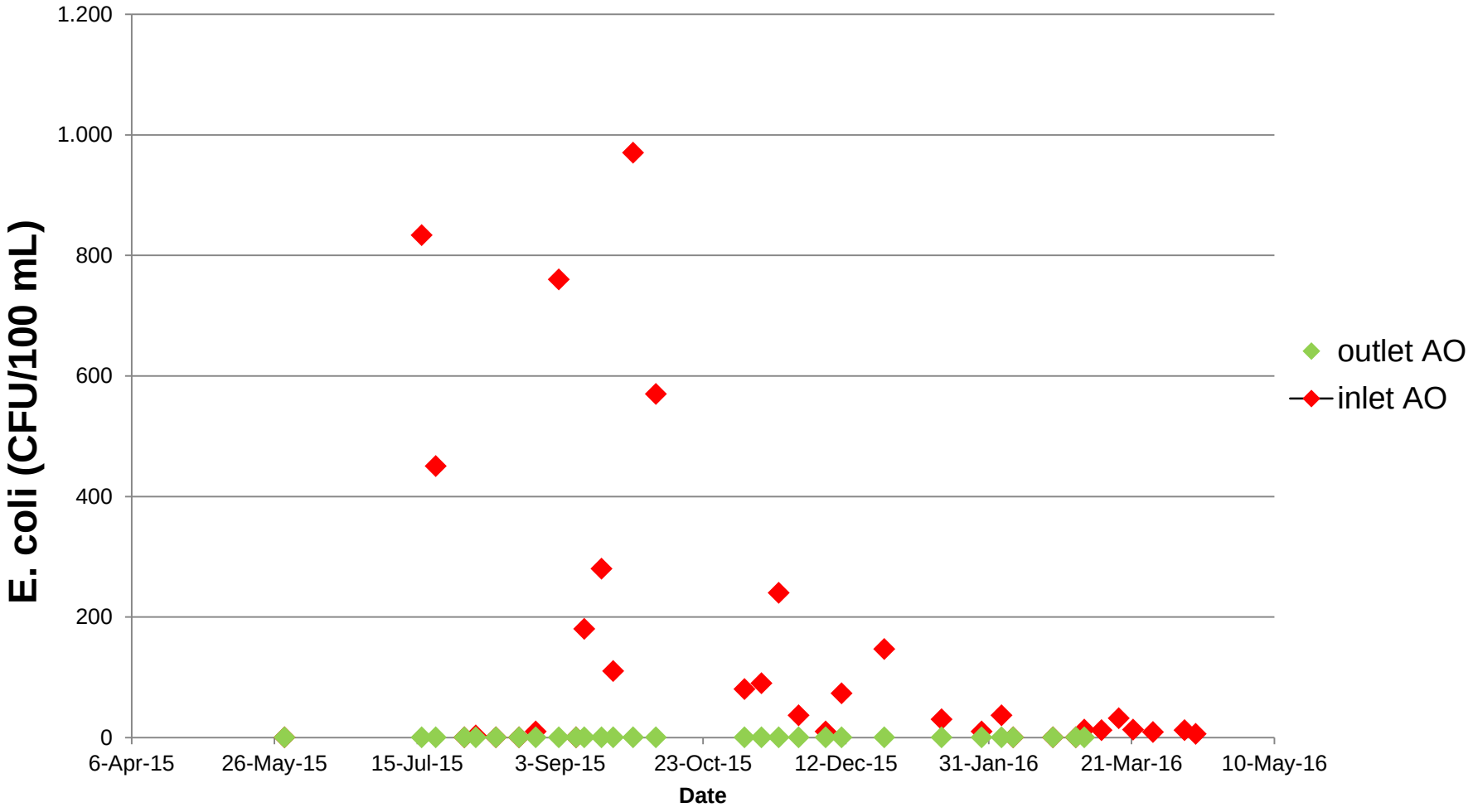
Total Coliform removal AO System



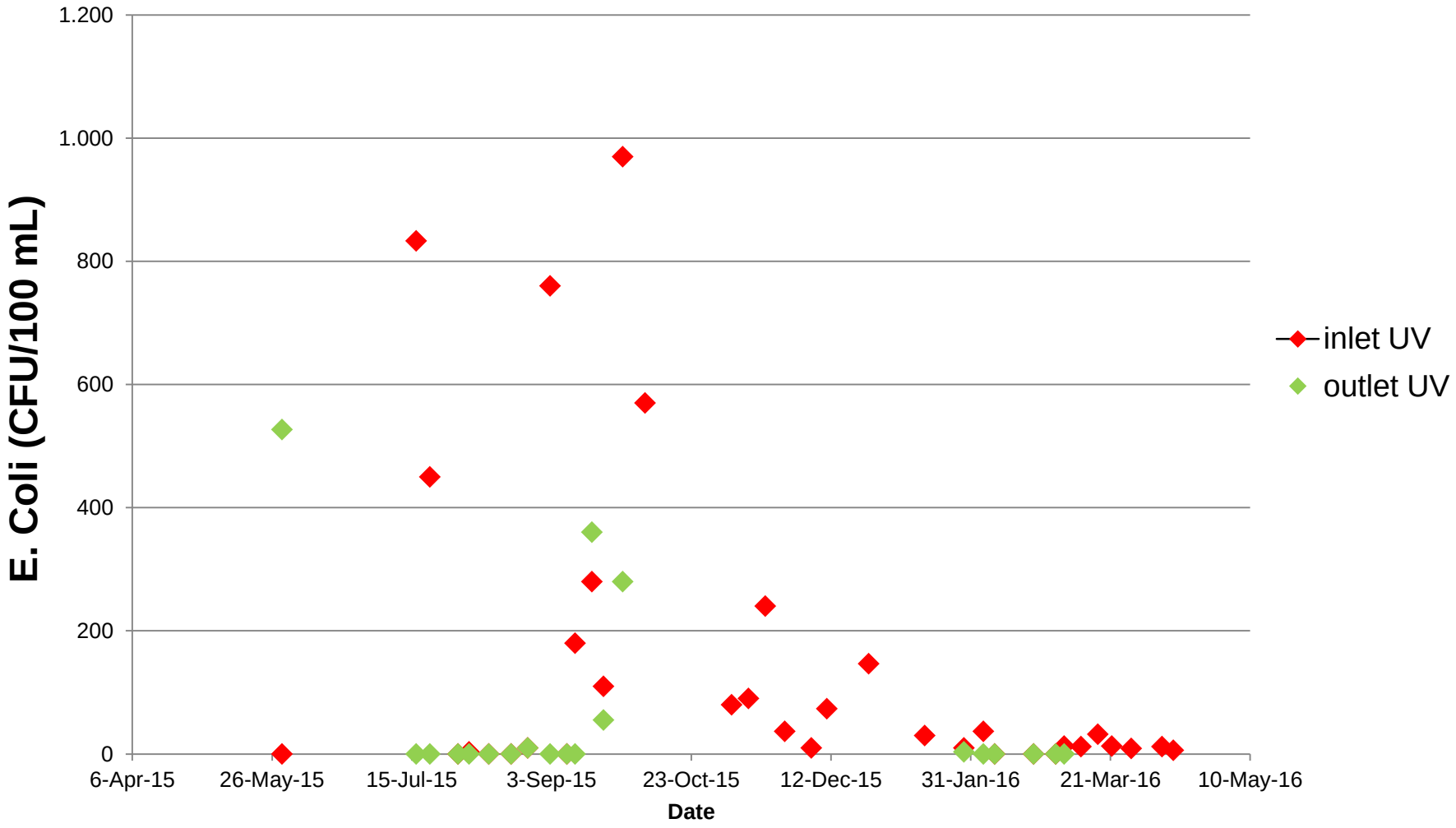
Total Coliform removal UV System



E.coli removal AO System



E.coli removal UV System



Comparison AO and UV System

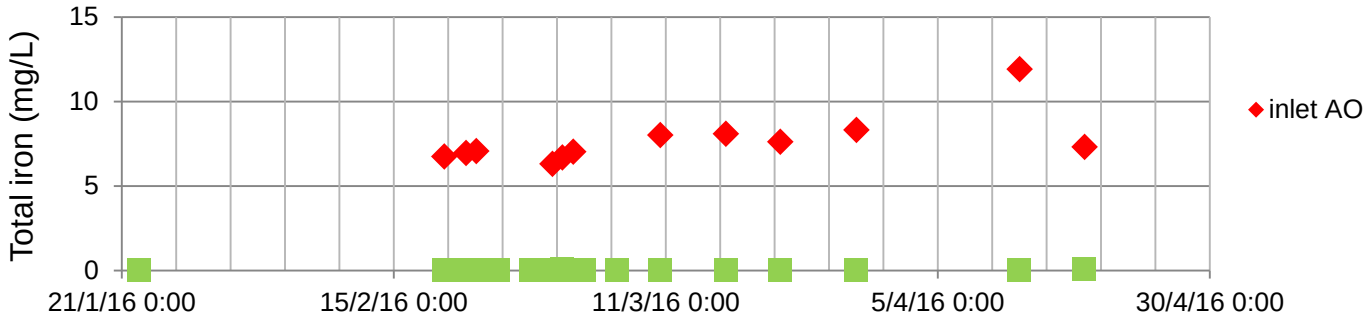
Total coliforms

Parameter	Inlet (well)	Outlet AO	Outlet UV (extra)
Mean (CFU/100mL)	6.3^{+3}	7.2^{+1}	2.0^{3}
SD (CFU/100mL)	8.6^{+3}	8.9^{+1}	3.1^{3}
Min (CFU/100mL)	0	0	1
Max (CFU/100mL)	3.2^{+4}	2.9^{+2}	1.1^{4}
N	29	18	18
% removal		99%	69%
log removal		1.9	0.5

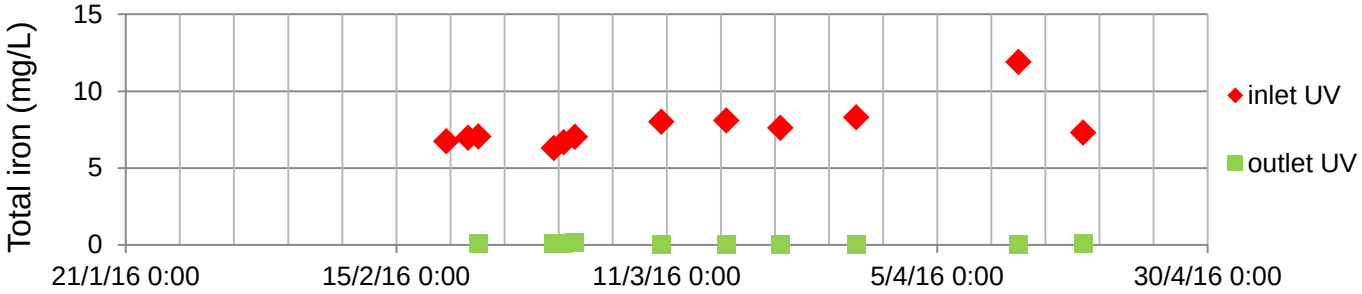
E.coli

Parameter	Inlet (well)	Outlet AO	Outlet UV (extra)
Mean (CFU/100mL)	1.4^{+2}	0	3.5^{+1}
SD (CFU/100mL)	2.5^{+2}	0	5.9^{+1}
Min (CFU/100mL)	0	0	0
Max (CFU/100mL)	9.7^{+2}	0	2.0^{+2}
n	35	25	3.5^{+1}
% removal		100%	75 %
log removal		2.2	0.6

Total iron removal



Solar AO System



Solar UV System

Parameter	Inlet (well)	Outlet AO	Outlet UV
Mean (mg/L)	7.7	0.02	0.04
SD (mg/L)	1.4	0.03	0.03
Min (mg/L)	6.3	0.01	0.01
Max (mg/L)	11.9	0.10	0.11
n	12	18	10
% removal		99.7%	99.5%

Treatment Performance

Turbidity

Parameter	Inlet (well)	Outlet AO	Outlet UV
Mean (NTU)	72.1	0.4	3
SD (NTU)	13.8	0.1	2
Min (NTU)	51.3	0.2	1
Max (NTU)	98.3	0.5	8
N	19.0	7	12
% removal		99%	96%

TSS

Parameter	Inlet (well)	Outlet AO	Outlet UV
Mean (mg/L)	0.32	0.12	0.12
SD (mg/L)	0.17	0.10	0.09
Min (mg/L)	0.03	0.01	0.03
Max (mg/L)	0.66	0.34	0.30
n	14	14	7
% removal		64%	63%

Treatment Performance

Ammonium nitrogen

Parameter	Inlet (well)	Outlet AO	Outlet UV
Mean (mg/L)	17.37	11.79	14.17
SD (mg/L)	7.28	6.68	8.61
Min (mg/L)	4.12	0.73	2.66
Max (mg/L)	55	45.7	50
N	38	38	25
% removal		32%	18%

Orthophosphate phosphorus

Parameter	Inlet (well)	Outlet AO	Outlet UV
Mean (mg/L)	0.90	0.10	0.41
SD (mg/L)	0.58	0.14	0.30
Min (mg/L)	0.14	<LOD	<LOD
Max (mg/L)	2.80	0.83	0.92
n	33	33	19
% removal		89%	54%

Potential reuse applications

[1][SCHEDULE – VI]
(See rule 3A)

GENERAL STANDARDS FOR DISCHARGE OF ENVIRONMENTAL POLLUTANTS PART-A : EFFLUENTS

S. No.	Parameter	Standards			
		Inland surface water	Public Sewers	Land for irrigation	Marine coastal areas
1	2	3			
		(a)	(b)	(c)	(d)
1.	Colour and odour	See 6 of Annexure-I	--	See 6 of Annexure -I	See 6 of Annexure-I
2.	Suspended solids mg/l, Max.	100	600	200	(a) For process waste water- 100 (b) For cooling water effluent 10 percent above total suspended matter of influent.
3.	Particulate size of suspended solids	Shall pass 850 micron IS Sieve	--	--	(a) Floatable solids, max. 3 mm. (b) Settleable solids, max. 850 microns.
[2]4.	***	*	--	***	--
5.	pH Value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
6.	Temperature	shall not exceed 5°C above the receiving water temperature	--	--	shall not exceed 5°C above the receiving water temperature

1 Schedule VI inserted by Rule 2(d) of the Environment (Protection) Second Amendment Rules, 1993 notified vide G.S.R. 422(E) dated 19.05.1993, published in the Gazette No. 174 dated 19.05.1993.

2 Omitted by Rule 2(d)(i) of the Environment (Protection) Third Amendment Rules, 1993 vide Notification No.G.S.R.801(E), dated 31.12.1993.

Results at Kalyani

- Good disinfection performance
- Sufficient for agricultural reuse
- Robust and reliable operation of systems
- Development of marketable products in India
- New future research topics
  - Arsenic removal
  - Ammonium removal
  - Performing bank filtration

IGNTU site

Objectives at IGNTU site

- To provide sustainable sanitation by producing an effluent of sufficient quality to be reused in landscape and agriculture irrigation, industrial processes and other uses for humans

IGNTU - two Sites

Lalpur Village

- A solar powered anodic oxidation system installed in the village of Lalpur
- A small infrastructure (with basic laboratory equipment) were built for the system, solar panels and water storage tank.
- An adequate water quality control sensor setting and online monitoring unit were tested, evaluated and optimized.
- From the tank, the water was distributed to the village people using simple tap points

IGNTU Campus

- The quality of treated sewage vary to great extent
- To maintain the quality of treated sewage a gravel bed of 10.5 m X 3.5m was constructed
- The treated sewage is pre-filtered through this bed
- Followed by Zeolite media filtration and disinfection through internally produced chlorine

IGNTU – Field Survey

Parameter	**Location 1** Borehole at Staff Quarter IGNTU	**Location 2** borehole girls hostel IGNTU	**Location 3** Village Bijauri Deep Well 1	**Location 4** Bijauri Hand dug well (old man)	**Location 5** Pamara Iron well	**Location 6** Lalpur
Temperature [°C]	27,4	27,3	29,5	25,5	25,9	27,1
pH	6,89	6,62	8,1	7,53	6,89	7,9
Conductivity [µS/cm]	301	318	342	245	296	301
Total Fe [mg/L]	0,14	< 0,02	0,04	0,12	10,1	< 0,02
Manganese [mg/L]					0,22	< 0,01
Chloride [mg/L]	5,4	5,2	33,5	25,5	20,5	59
Depth	200-300	200 - 300	~ 300	16	n.d.	180

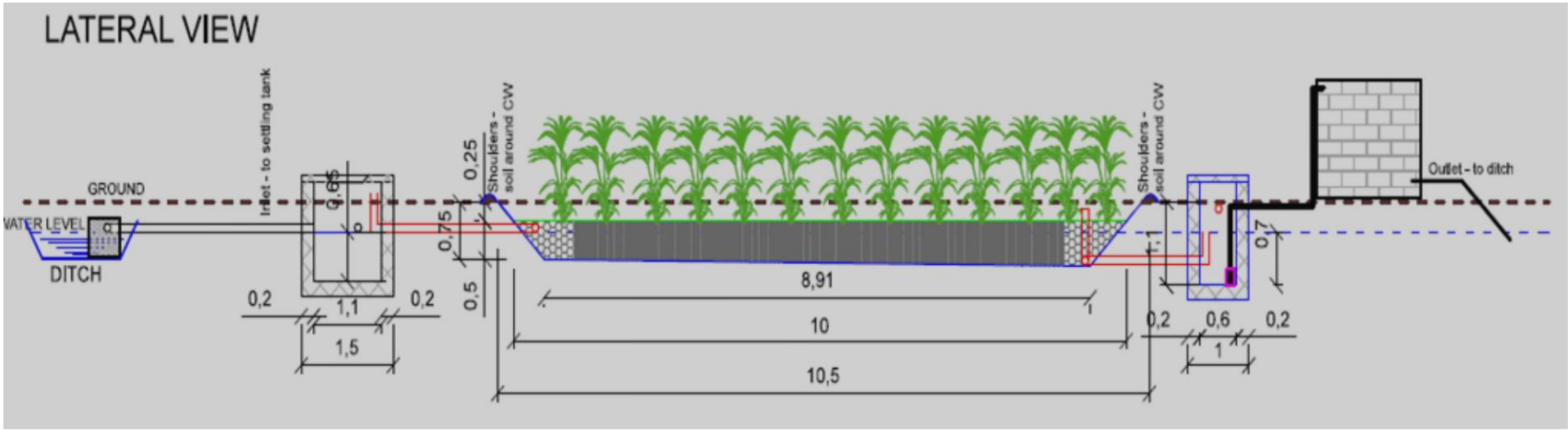
Lalpur: Construction of solar driven water station

- Water tower and small lab (9 m^2) construction at Lalpur village
- Drilling 90 m deep well constructed for submersible solar pump

Construction of solar driven water supply station

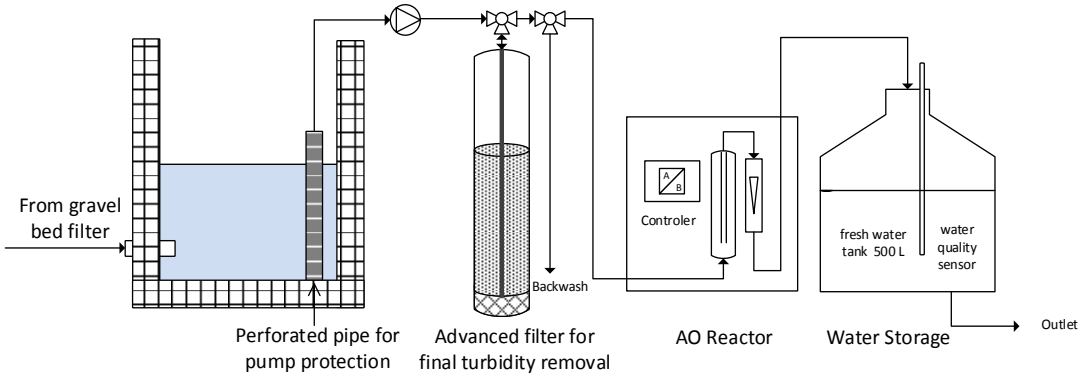
- AO system installation:
  - solar panels
  - battery bank
  - pipeline connections
  - pre filtration
  - AO unit implementation
- Water distribution into the village

Campus Unit for STP effluent disinfection



Construction of Planted Gravel Bed Filter

Installation of solar driven disinfection system



Inlet chamber

Planted Gravel Bed

Reuse of treated water for irrigation

Reuse of treated water for irrigation

Campus irrigation

Seedlings field

Performance Evaluation

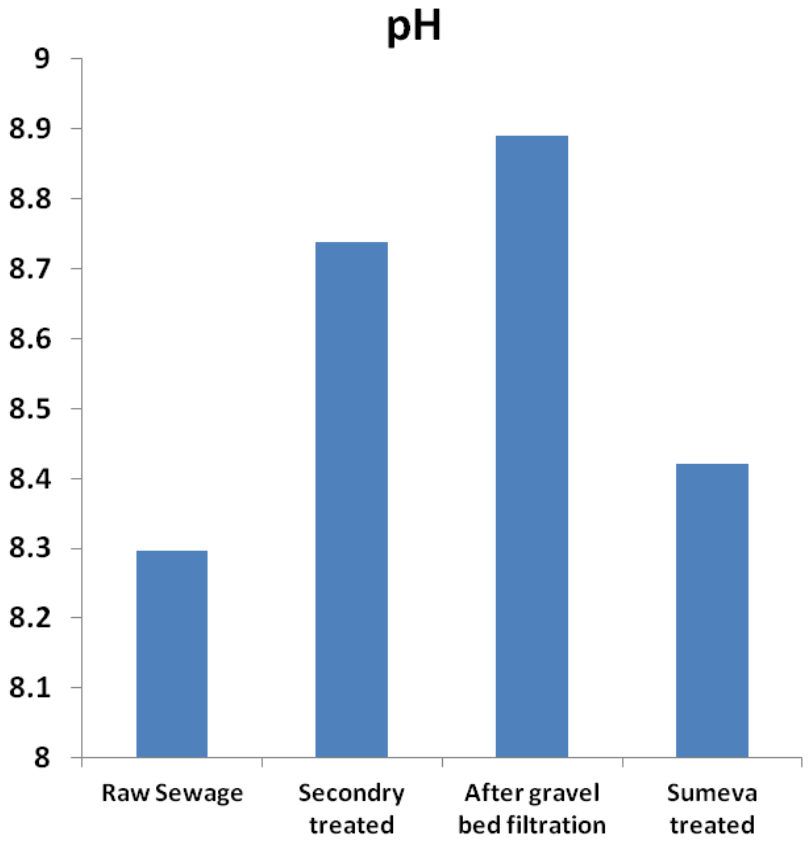
Parameters currently analyzed

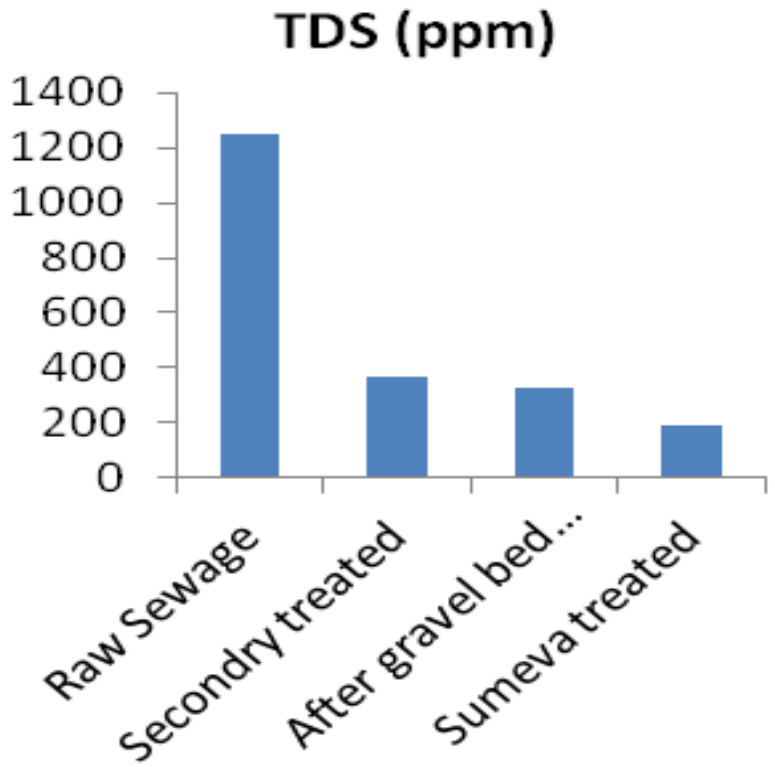
S. No.	Parameter		Parameter
1	**pH**	13	**BOD_5 (mg/L)**
2	**Temperature (°C)**	14	**COD (mg/L)**
3	**Conductivity (µs/cm)**	15	**Total coliforms (MPN/100mL)**
4	**TDS (mg/L)**	16	**Fecal coliforms (MPN/100mL)**
5	**ORP (mV)**	17	***E. Coli* (MPN/100mL)**
6	**Alkalinity (mg/L)**	18	***Enterococcus fecalis***
7	**Acidity (mg/L)**	19	**Clostridium**
8	**Hardness (mg/L)**	20	**Salmonella**
9	**Calcium (mg/L)**	21	**Enterococcus**
10	**Magnesium (mg/L)**	22	***Clostridium perfringens***
11	**DO (mg/L)**	*23*	***Pseudomonas aeurogenosa***
12	**Nitrate**	*24*	**Orthophosphate**

Results at IGNTU site

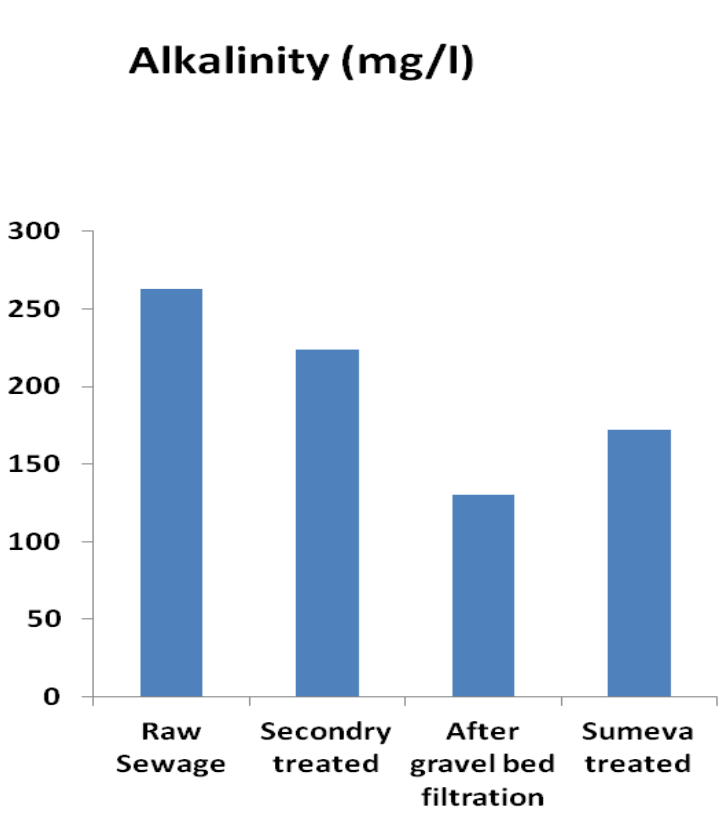
Parameters	Inlet Chamber	After Gravel Bed	After zeolite filter	After AO Treatment
temp ^{o}C	21.7	20.8	21.6	22.9
pH	8.3	8.55	8.83	8.2
DO (mg/L)	3	3.8	5.6	11
Acidity (mg/L)	90	56	4	6
Alkalinity (mg/L)	66	182	190	172
Hardness (mg/L)	106	70	417	34
ORP (mV)	210	230	388	431
EC (uS/cm)	1312	738	760	732
TDS (mg/L)	656	376	380	367
BOD_5 (mg/L)	48	26	18	10

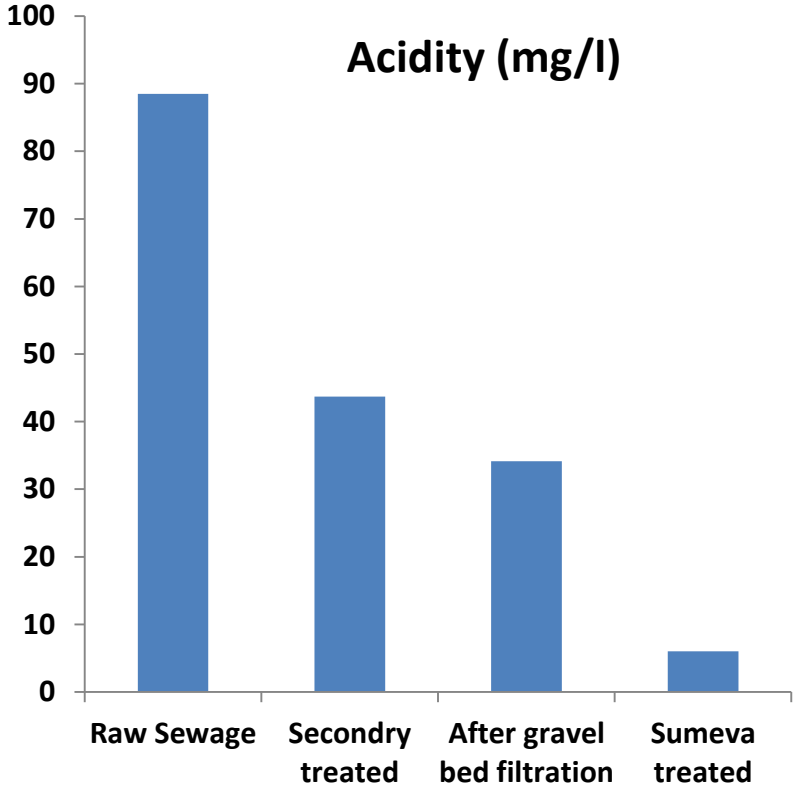
Water quality during disinfection



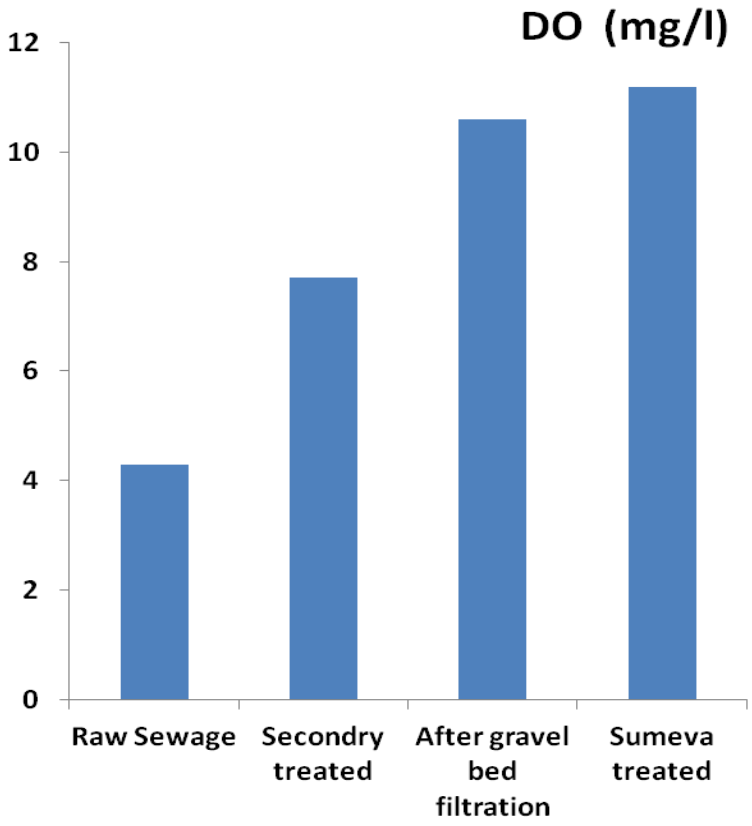


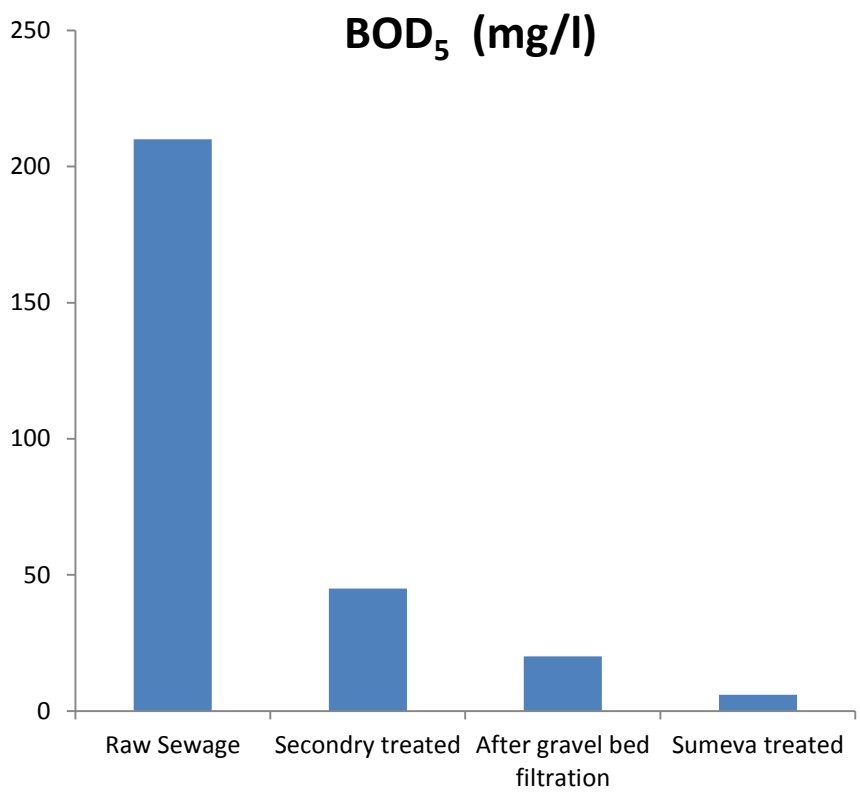
Water quality during disinfection



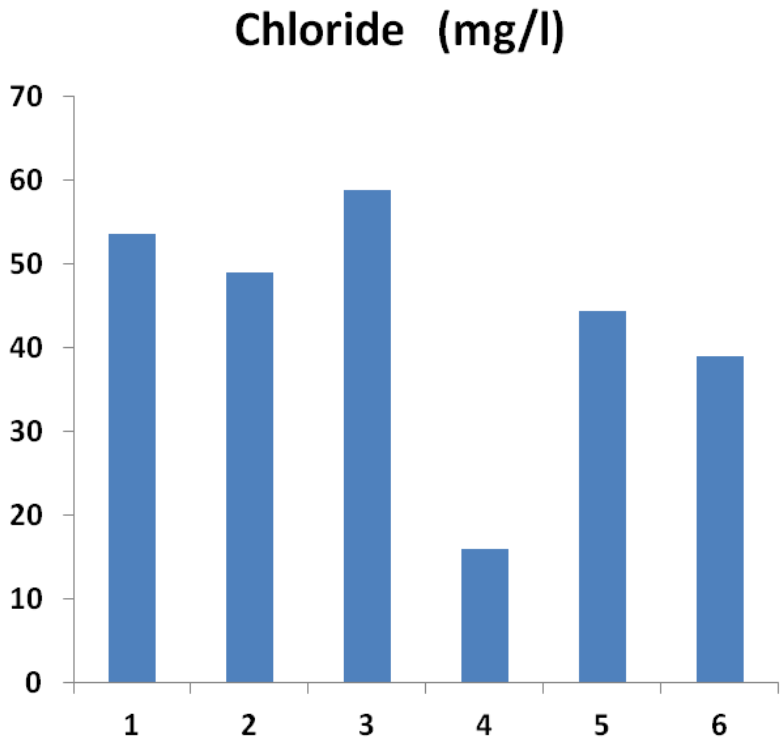


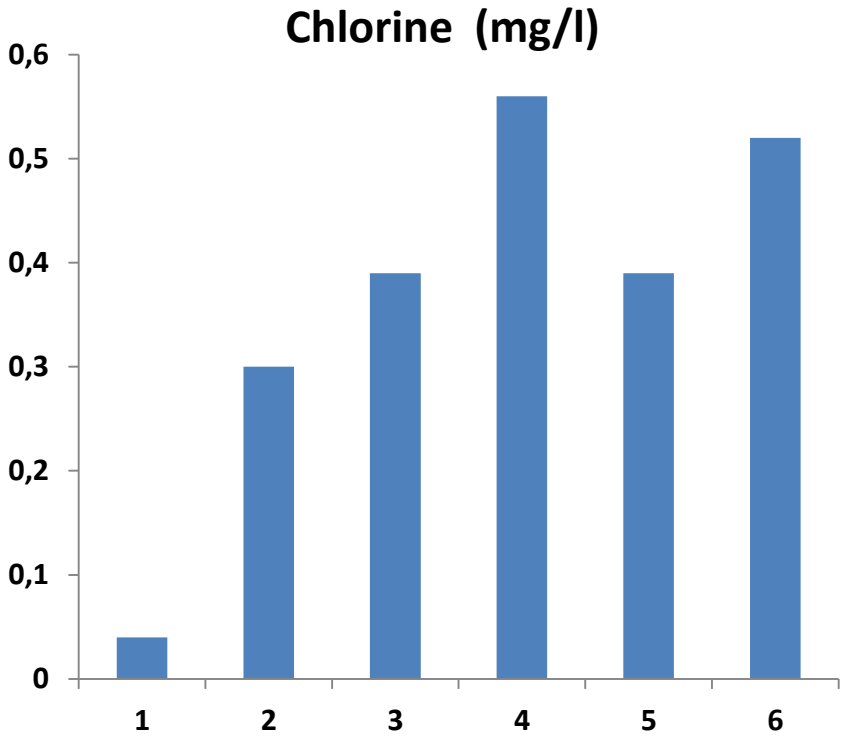
Water quality during disinfection





Chloride and residual chlorine in final treated water





Muchas gracias por su atención