EPS

Public Seminar/ Workshop

" An approo
securin

Ecological Purification System
for Safe Drinking Water

- Application of Natural Process -

Eco-friendly technique to make artificial spring water

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Prof. Emeritus of Shinshu University, Japan


August 2018

16:15-17:00

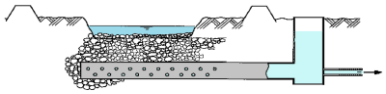
Challenges and Perspective for the future, Q & A

# EPS -Use of Natural Process -**Chemical Free** : **Gentle for small organisms**

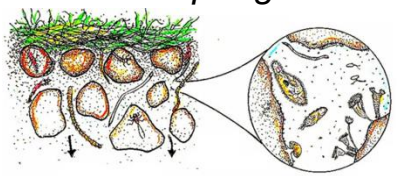
*Surface stream water*

*Reservoir*

*Clean spring water*



*Subsurface water*

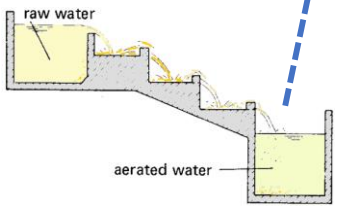




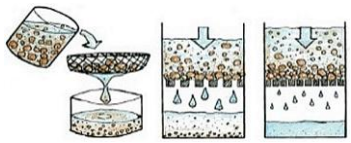

*Borehole*

*Aeration*

*Tubewell*

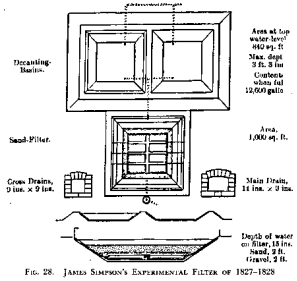



*Smart Treatment System to make artificial spring water by Eco-friendly technique.*



Mechanical filtration

Slow filtration by fine sand



1829 London UK

2-3m/d (10cm/h)

Slow sand filter

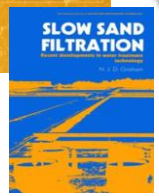
English standard filter rate 4.8m/d (20cm/h)

1910 Rapid sand filter, USA

Turbidity⇒coagulant +chlorination

1974 Tri-halo methane ⇒cancer risk, USA

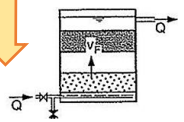
1974 SSF manual from WHO


1988 ①SSF conference, London, UK

1991 ②SSF conference, New Hampshire, USA

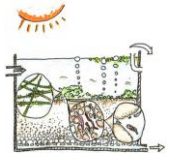
1993 Large outbreak by cryptosporidium, USA



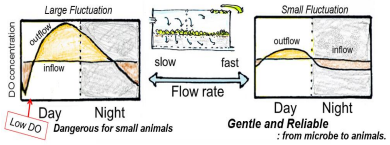
1994 Refocus to SSF by AWWA

1996 ③SSF conference, London, UK

1980-1996 Chemical free Up-flow Roughing Filter for turbid water



1994-'96




2006④ SSF conference, Mulheim, Germany

2014⑤ SSF conference, Nagoya, Japan

Present Thames filter rate 9.6m/d (40cm/h)

Importance of the ecological point was recognized at the SSF conference.

Food chain

Mislead by the name of SSF

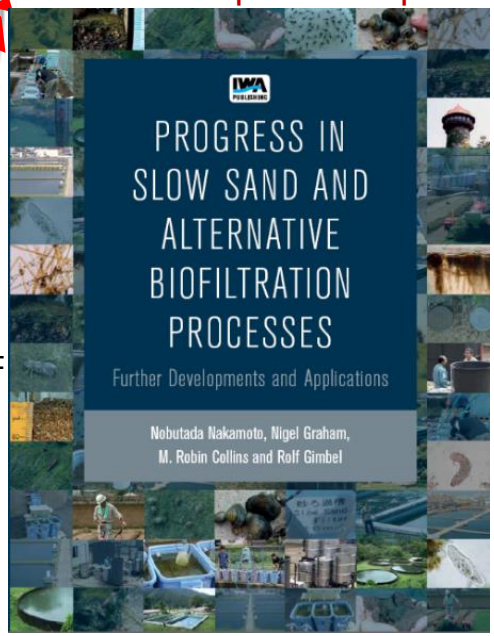
Gentle for every organisms

Vertical flow

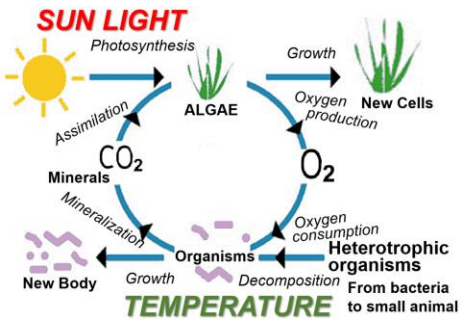
1984 ～

2003 Ecological Purification System

New concept from Japan

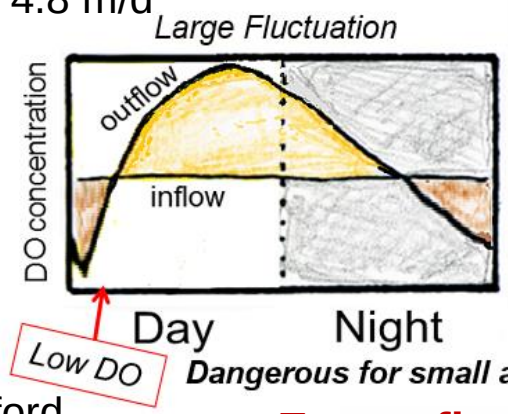



Ecological Purification System: from Japan to the world

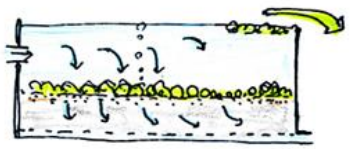



Ashford Common WTP, Thames Water, London

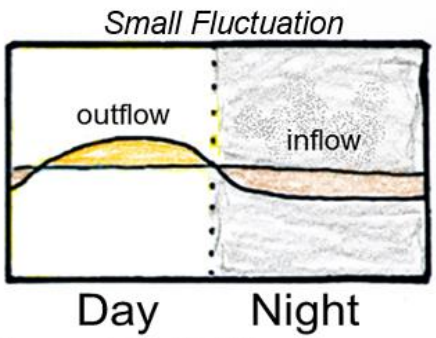
4.8 m/d




Dangerous for small animals




9.6 m/d




**Gentle and Reliable**

***: from microbe to animals.***

**Faster flow rate :**

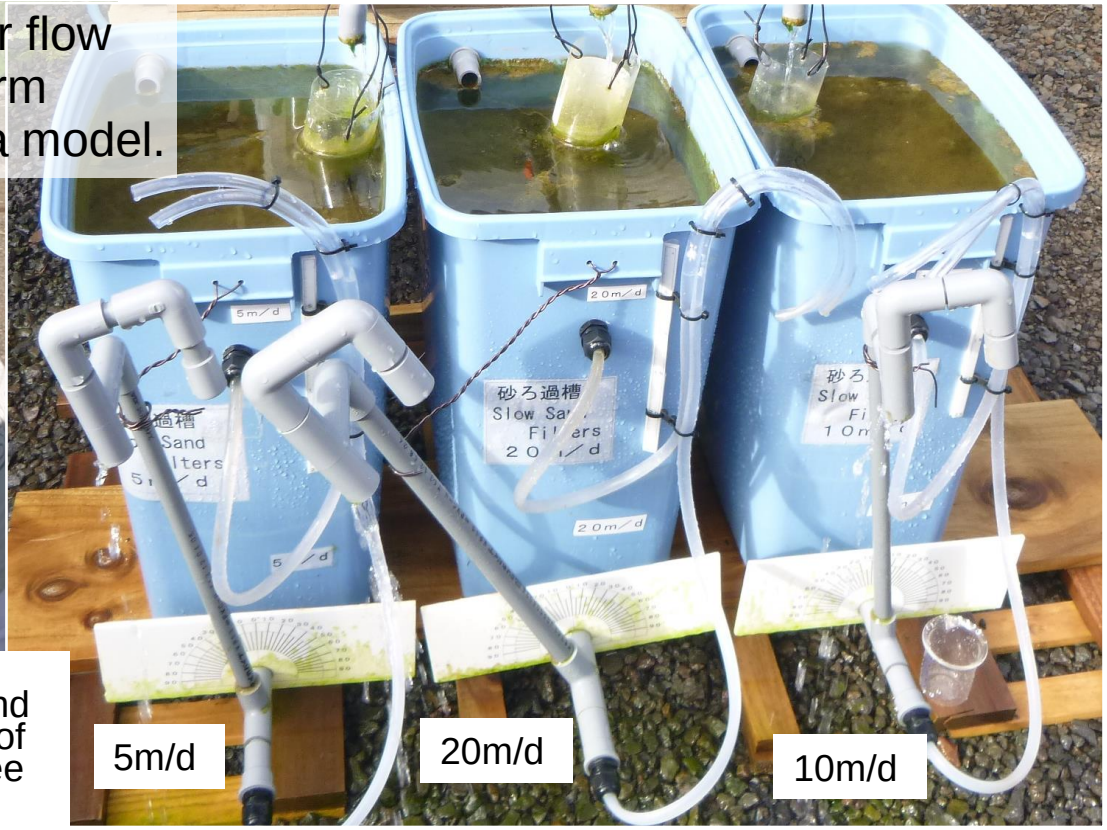
Gentle for small organisms: keep aerobic condition

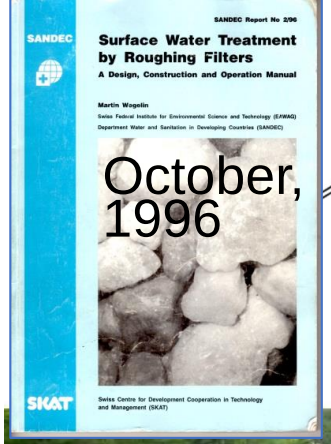
We confirmed that faster flow rate is acceptable in warm region in Samoa using a model.




No SS load

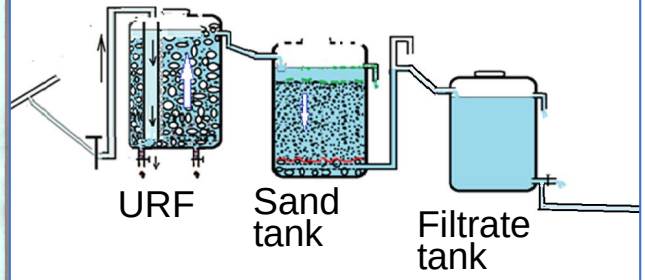
Filtrate is delicious and safe water of Bacteria free water.

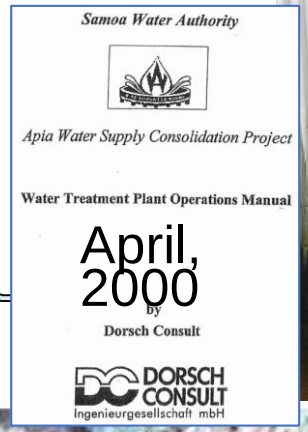





October, 1996

## Fiji EPS for village

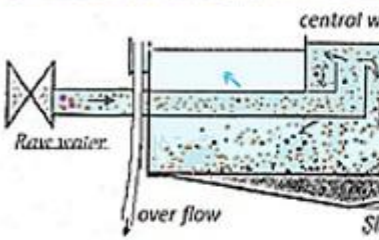


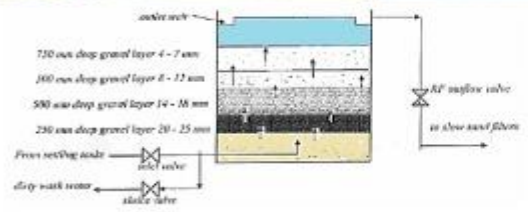


Diameter 17.8 m
Area 248.8 m2
2 settling tanks
Detention time: 3.3 hrs


1984-'87



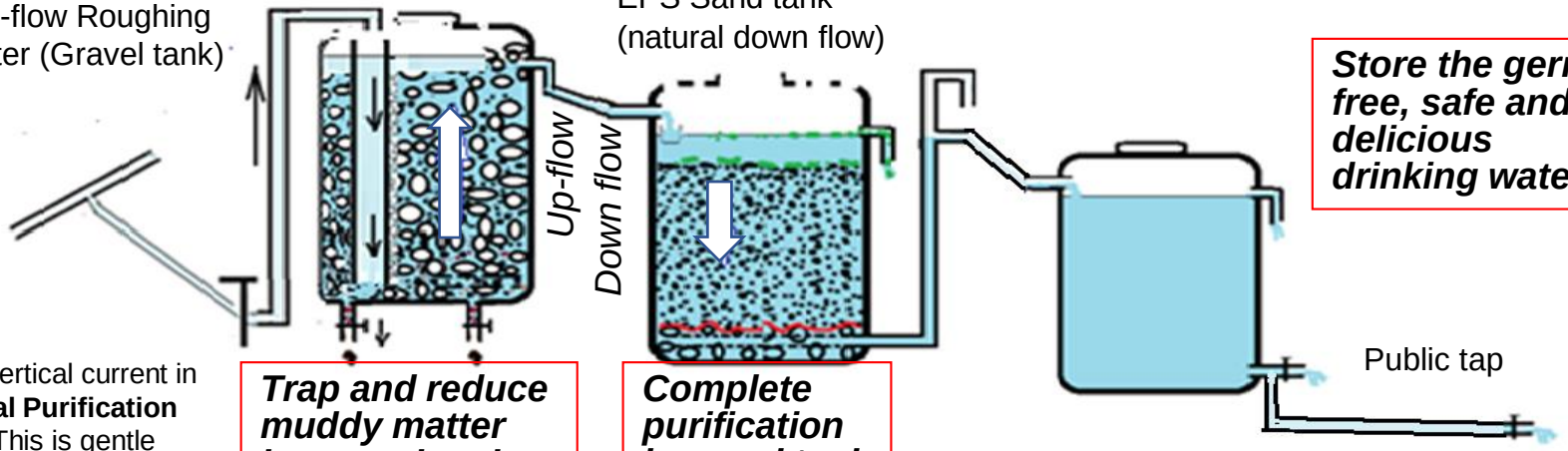

Diameter 28 m
Area 616 m2 5 Filters
**Design rate: 3m/d**




Diameter 11.2 m
Area 98.5 m2
4 URFs
Flow rate: 1m/h

Up-flow Roughing Filter (Gravel tank)

EPS Sand tank (natural down flow)




***Store the germ free, safe and delicious drinking water***

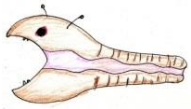
Public tap

There is vertical current in **Ecological Purification System**. This is gentle system for small organisms where sand does not move.

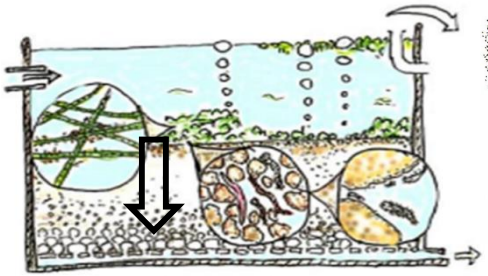
***Trap and reduce muddy matter by gravel tank***

***Complete purification by sand tank***

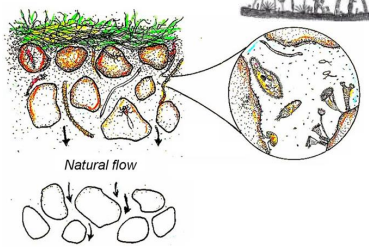
*Small animals on the surface of rocks collect turbid matters.*



*Small organisms live on the surface area of sand and stone.*

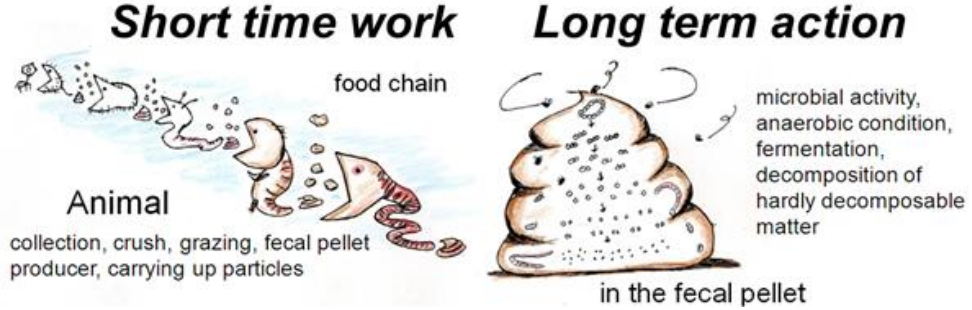


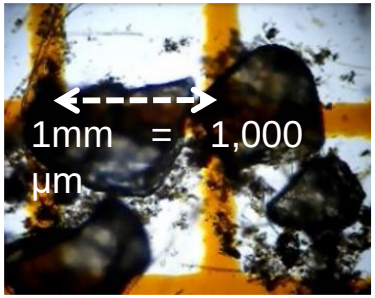
Germ free safe water to drink




*Food comes from the top. Microscopic organisms collect any germ cells.*

*Trap and collection time of particle by small organisms is very short. Passing time of food in body is also very short.*

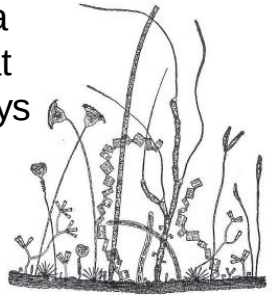


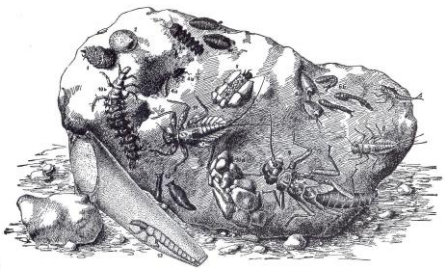



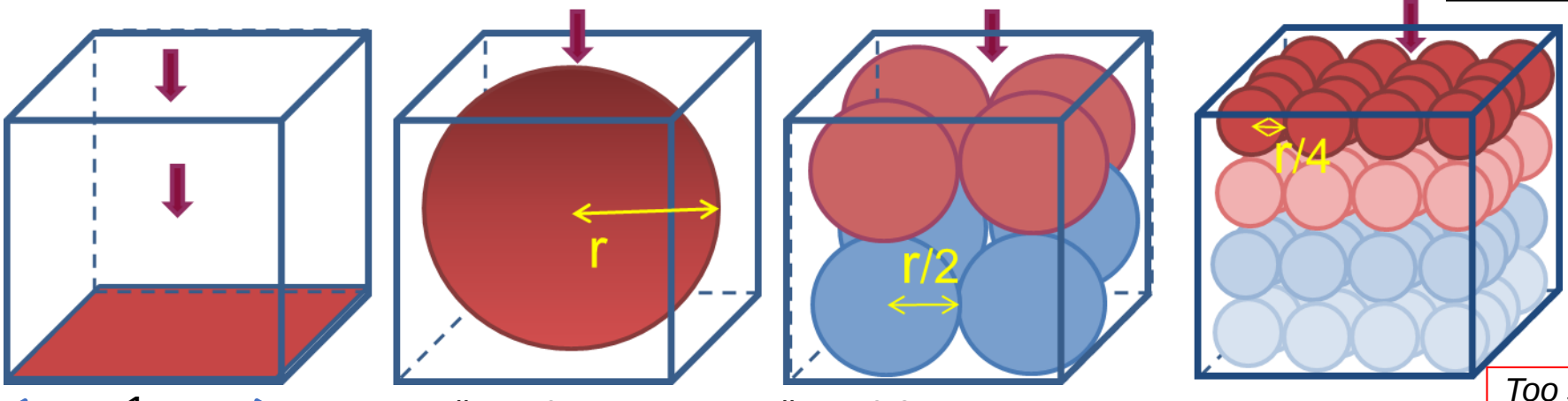

*Food chain by small animals is the key for purification system.*

*Healthy and hungry condition of animals are important to collect any particles under gentle condition.*

Most of small organisms live on the surface of substrata (sand particle) under slow current condition. They live at the top of sand layer where food comes. They are always waiting for food. They are hungry.








1

Bottom surface area

***1***

radius = 0.5
Surface area
= 4 x π x r x r

***= 3.14***

*Surface area of a ball is 3.14 times than flat area.*

radius = 0.25
Surface area of one ball
= 0.785
8 balls in box = ***6.28***
Total area of top 4 balls

***= 3.14***

radius= 0.125
One ball area
= 0.196
64 balls in box =***12.56***
Total area of top 16 balls

***= 3.14***

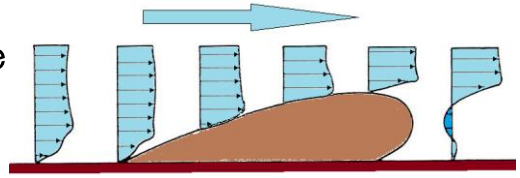
*Too small particle becomes a flat surface.*

*Total surface area of top layer of balls is always same of 3.14 times than flat area. Smaller ball makes larger area.*

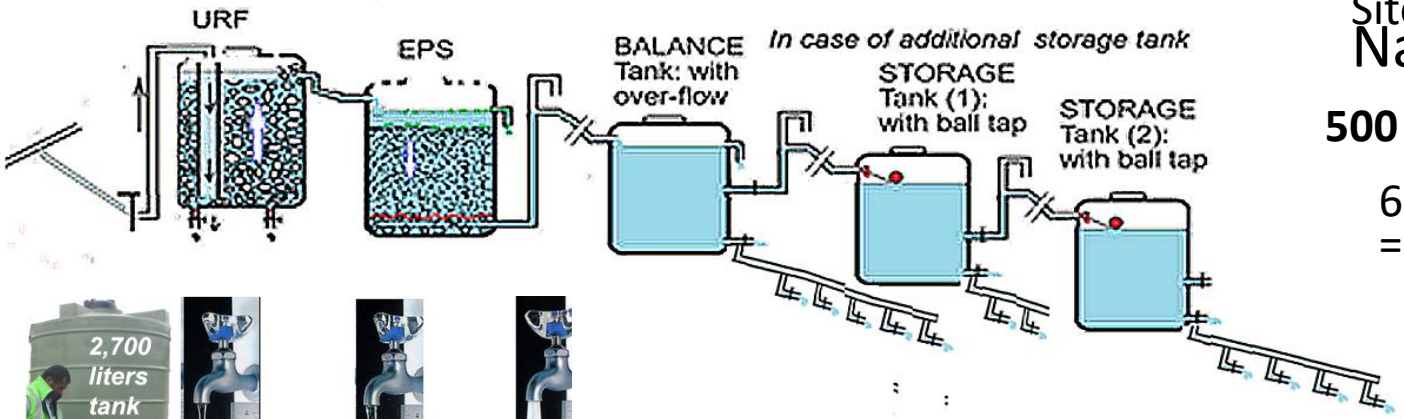
*And, total volume of balls is always same of 52 % ( porosity : 48%) in a box.*

*Filter resistance increases toward smaller size of particle.*

Viscosity : temperature



| EPS capacity of 2,700 liters tank | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| radius（r）=0.7m、（π x r x r）=1.54m2 | | | | | | | | | |
| flow rate | | | filtrate | | | Available persons | | | remarks |
| m/d | cm/h | m3/d | liter/d | liter/h | liter/min | 2 liter/d | 6 liter/d | 100 liter/d | |
| 2 | 8 | 3.1 | 3,080 | 128 | 2.1 | 1,540 | 513 | 31 | Original flow rate in UK, 1829 |
| 5 | 20 | 7.4 | 7,392 | 308 | 5.1 | 3,696 | 1,232 | 74 | English standard rate |
| 10 | 42 | 15.4 | 15,400 | 642 | 10.7 | 7,700 | 2,567 | 154 | Present Thames Water rate |
| 15 | 63 | 23.1 | 23,100 | 963 | 16.0 | 11,550 | 3,850 | 231 | Possible rate in warm region |
| 20 | 83 | 30.8 | 30.800 | 1.283 | 21.4 | 15.400 | 5.133 | 308 | Possible rate in warm region |

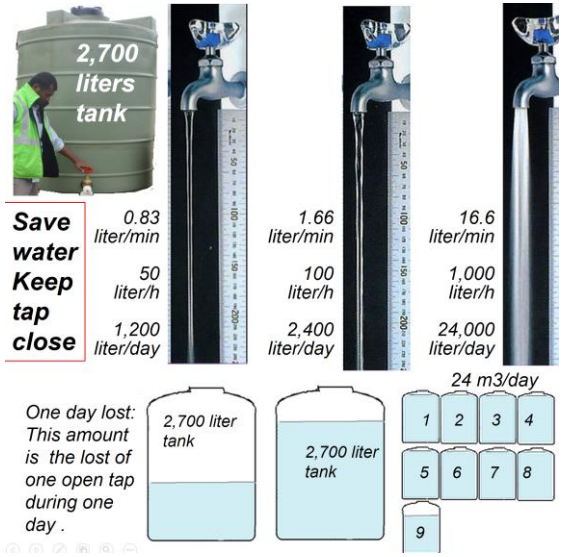



Sites visit on 22/08/18

Naivucini

**500 persons 120 houses**

6 liters x 500 persons
= 3,000 liters



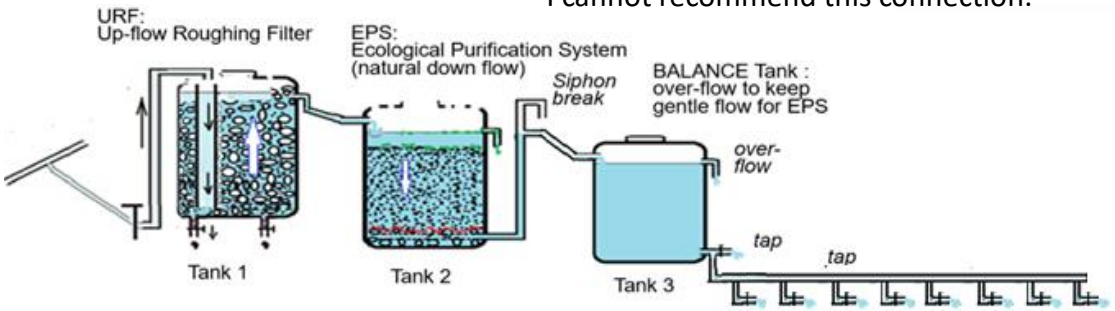

We can supply every taps of 120 houses by EPS water, if there is no leakage.

Comment on more use of EPS water in a village

**There is non-detected leak, therefore we have to install EPS pipe with may public taps in a small village.**

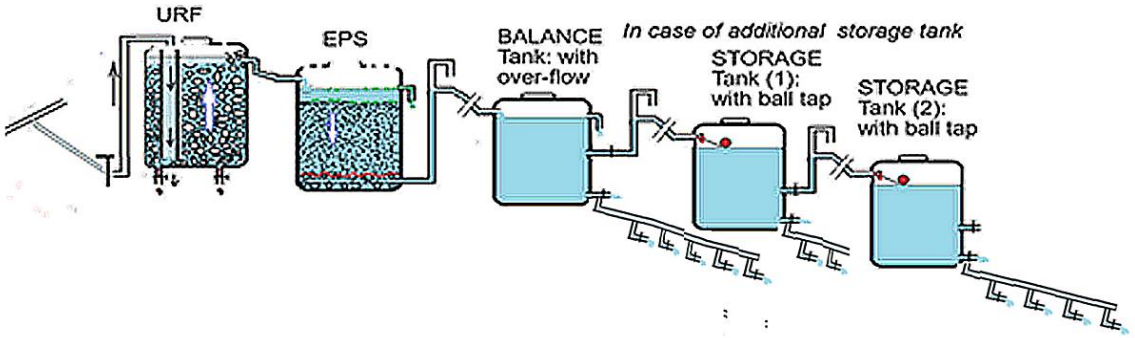
## Up to 200 persons in a village

If there is no leak problem, we may connect to present distribution pipe in case of a small village. But this is risky. I cannot recommend this connection.



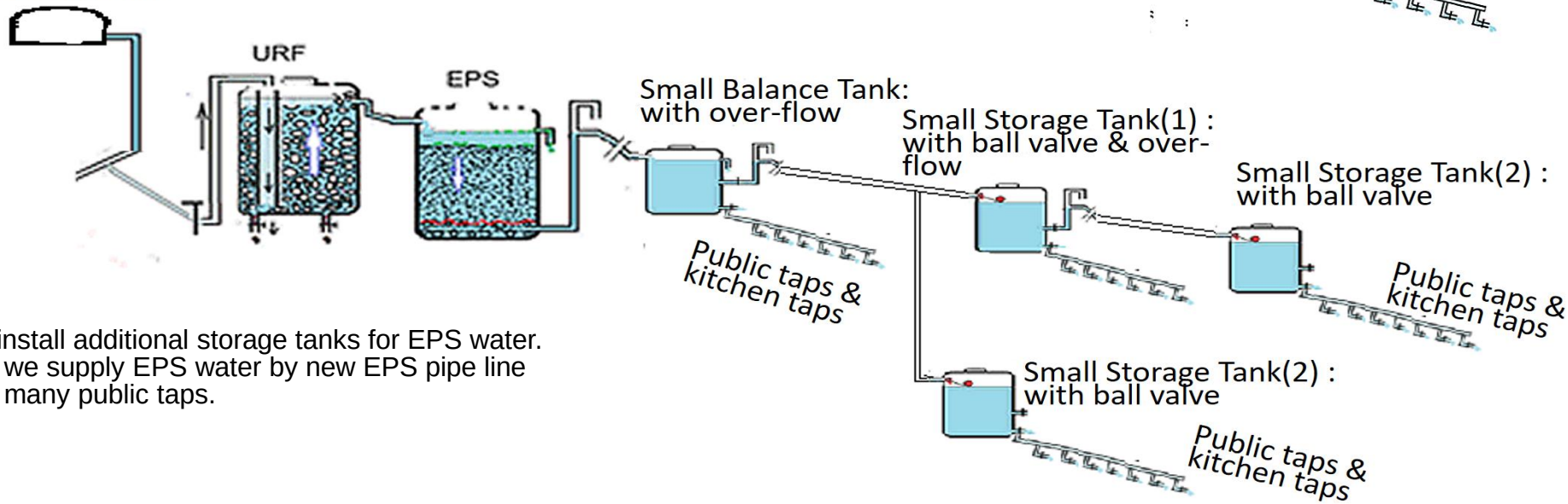

## 200 to 500 persons in a village

We supply EPS water by new EPS pipe line with many public taps. Or we install additional storage tanks for EPS water. And we supply EPS water by new EPS pipe line with many public taps.




## More 500 persons in a village

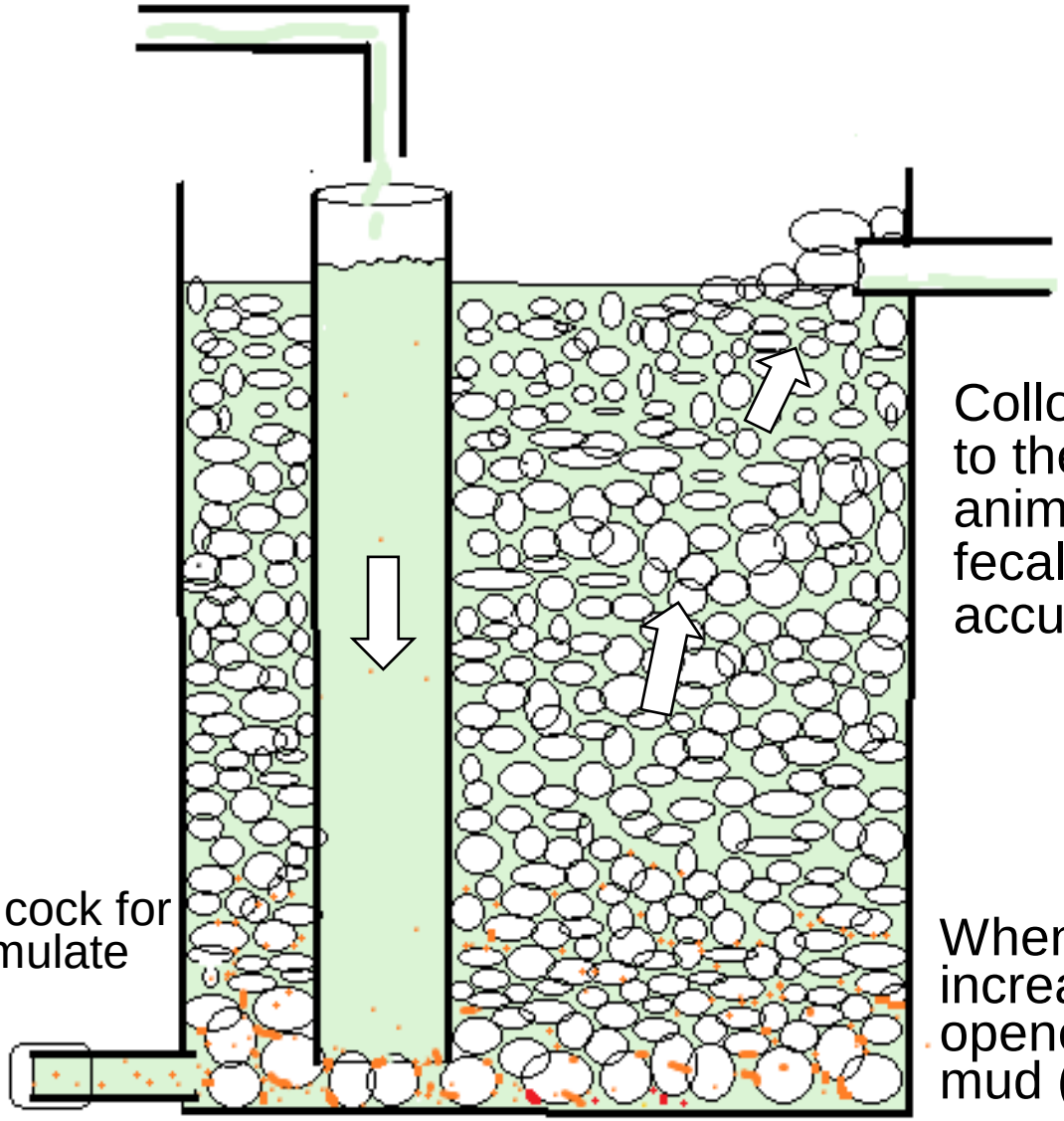
Present
receiving tank




We install additional storage tanks for EPS water. And we supply EPS water by new EPS pipe line with many public taps.

# Up-Flow Roughing Filter (URF : gravel filter)

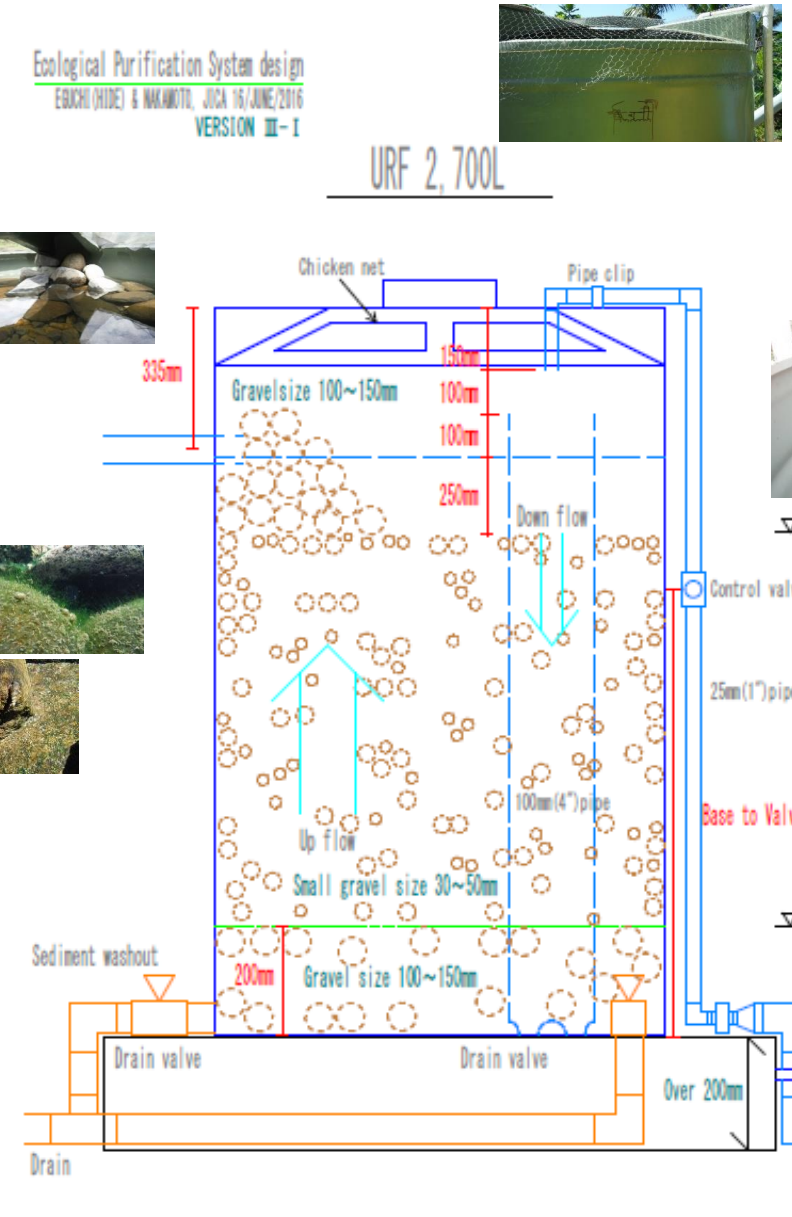
*Additional URF if necessary*



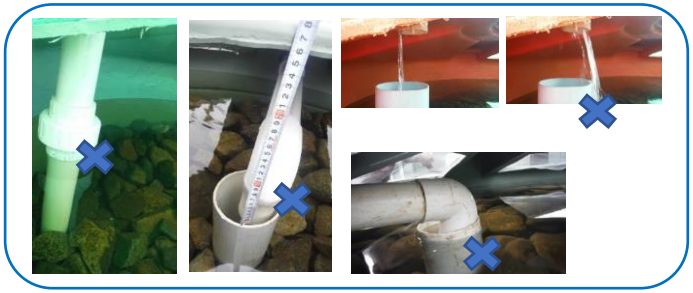
drain cock for accumulate mud

Colloidal fine particles adhesive to the surface of gravels. Small animals scrap them and produce fecal pellets. Fecal pellets accumulated to the bottom.

When the filter resistance increase, the drain cock is opened in short time to drain the mud (accumulated fecal pellets).

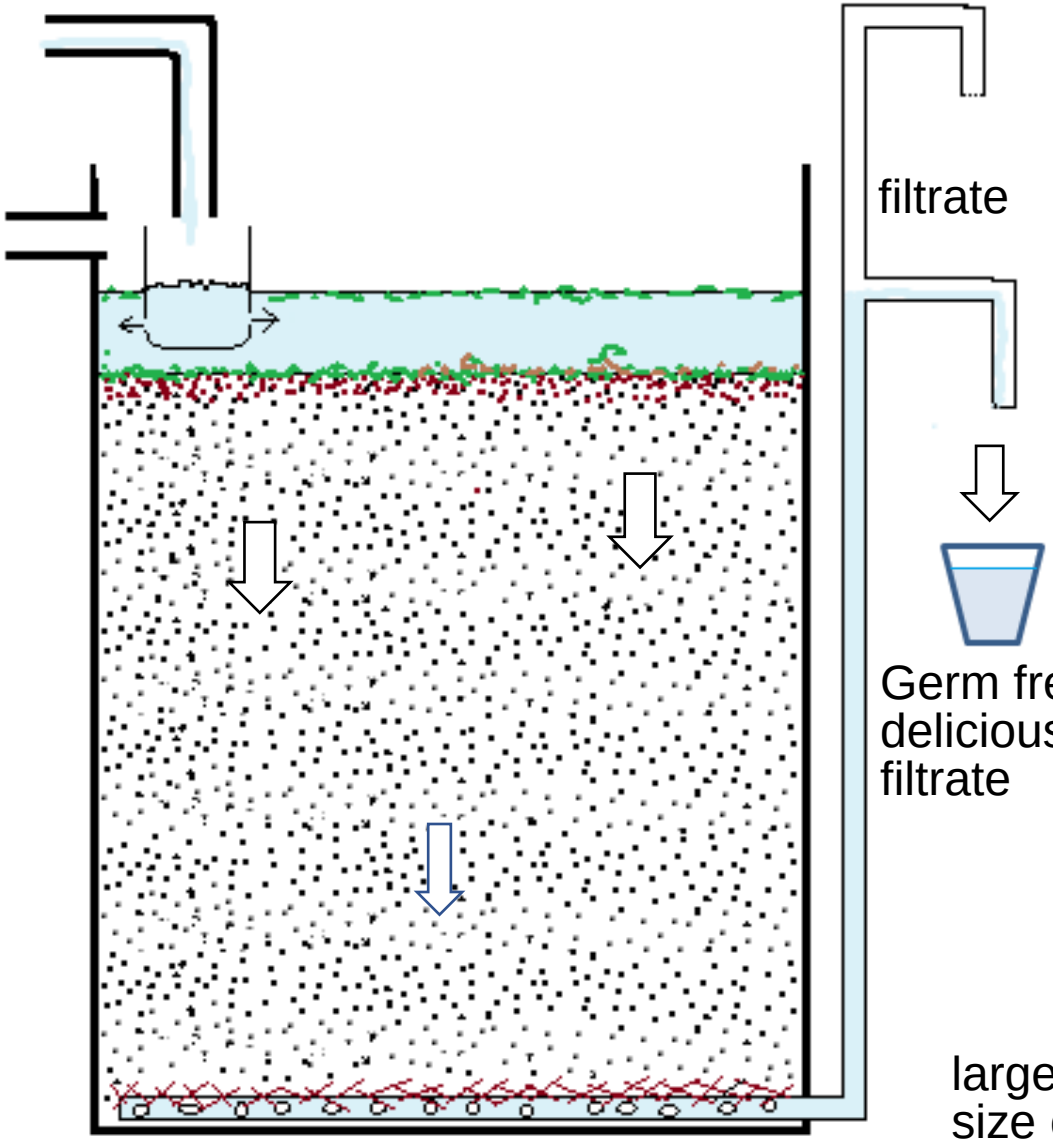



1) Inlet pipe size is 1 inch and is fixed with a clip to avoid any damage of the inlet pipe by shaking.
2) Flow rate can be controlled using a control valve (1 inch size) by watching the pouring of an inflow water. (Suitable valve setting height is 1,100 mm from the base.)
3) A gap of 100 mm between the inlet pipe (1 inch size) and the inner pipe (4 inches size) is necessary to confirm the flow rate and to sampling the raw water.
4) The height difference of 100 mm between the top edge of the inner pipe (4 inches) and the bottom height of the outlet (over-flow) pipe is requested to keep the level of seepage water from gravels. In order to guard the outlet pipe against the excess floating scum, the larger size of gravels are heaped up the outlet pipe
5) Insert a mosquito mesh (plastic) between the bottom a large gravel layer ( 100-150 mm size) and a gravel layer (30-50 mm size) to avoid dropping small stones from the gravel layer and to easy drain the accumulated muddy matter.
6) One drain pipe and valve are set near the bottom of the inner pipe to easy drain.
6) Open (cut) windows are covered with chicken mesh to avoid fallen leaves. And one cover near the inlet pipe can be lifted for a caretaker maintenance.
7) Each tank connecter must be tightly connect from both sides (inside and outside) by two persons. Then the empty tank is filled with water. After the confirmation of no leakage from the connect point, this tank can be filled with the large gravel, mesh and small gravel.



# EPS (sand) tank (natural down flow)

Ecological Purification System



filtrate

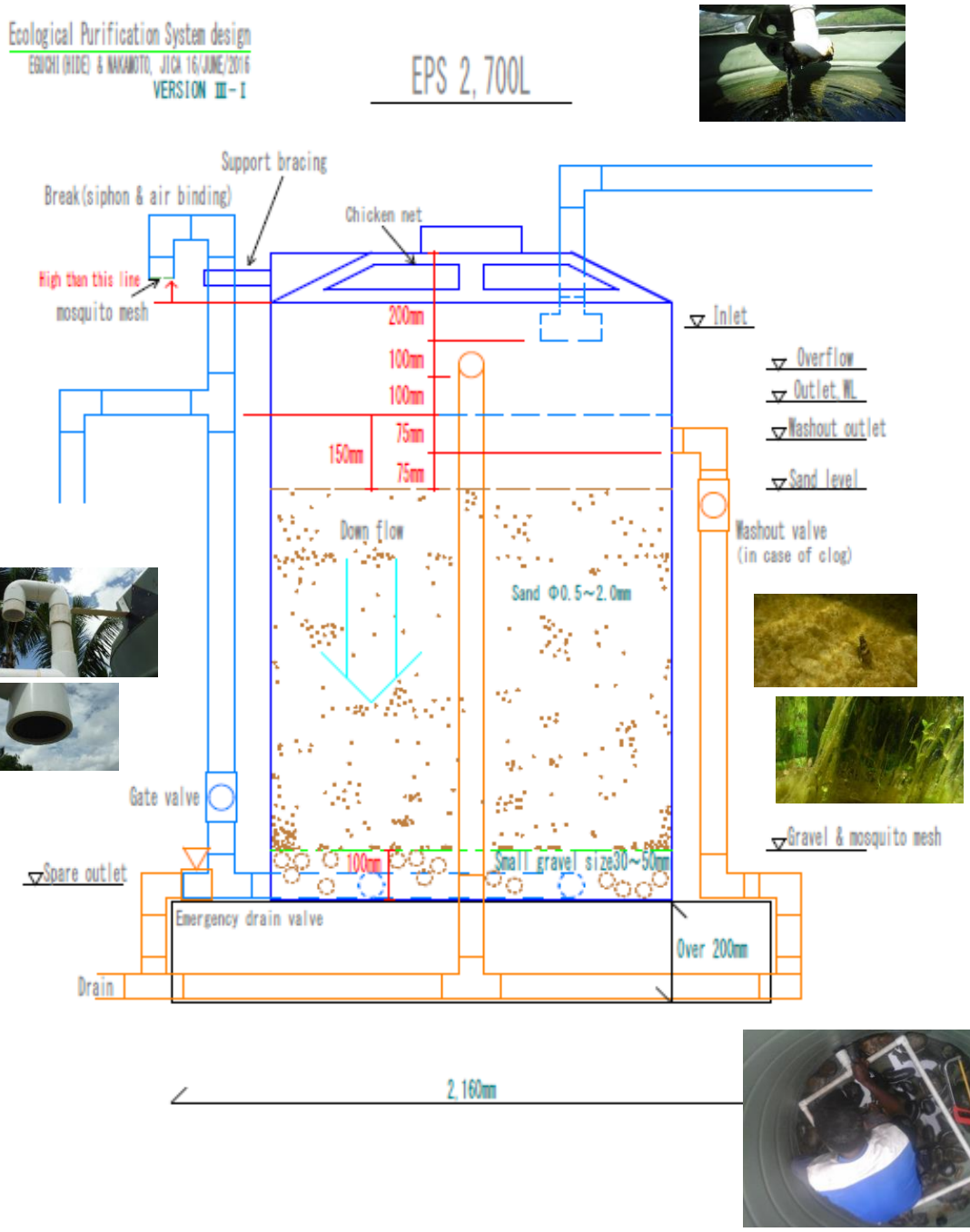
Germ free delicious filtrate

Mesh over a porous pipe

large size of sand

Food comes from the top.

Biological active layer is only the surface and thin layer beneath the surface.
















1) T pipe is connect to the inlet pipe. to avoid the disturbance the sand surface. This is protect the disturbance of sand surface from the un-expected large amount of inflow water.
2) Open (cut) windows are covered with chicken meth same as URF.
3) Height difference of each pipe are the key for normal operation. The order is siphon, inlet, over-flow, outlet, scum out and sand surface.
4) At the bottom, one layer of gravels (30-50 mm size) is placed until little bit over the drainage porous pipe (50 mm) for the filtrate in order to easy drain.
5) Insert mosquito mesh (plastic) between the gravel layer and the sand layer (sand size: 0.5 – 2 mm) to avoid the leak of sand particle.
6) At the bottom end of the siphon break system for filtrate is sealed with a mosquito mesh to avoid dust, rain drop and inversion of any animals.
7) Outlet pipe for the filtrate must be tighten using a brace or a clip to avoid any damage of the inlet pipe by shaking.
8) Each tank connecter must be tightly connect from both sides (inside and outside) by two persons.
9) Then the empty tank is filled with water. After the confirmation of no leakage from the connect point, this tank can be filled with the gravel, mesh and sand.

Ecological Purification System design

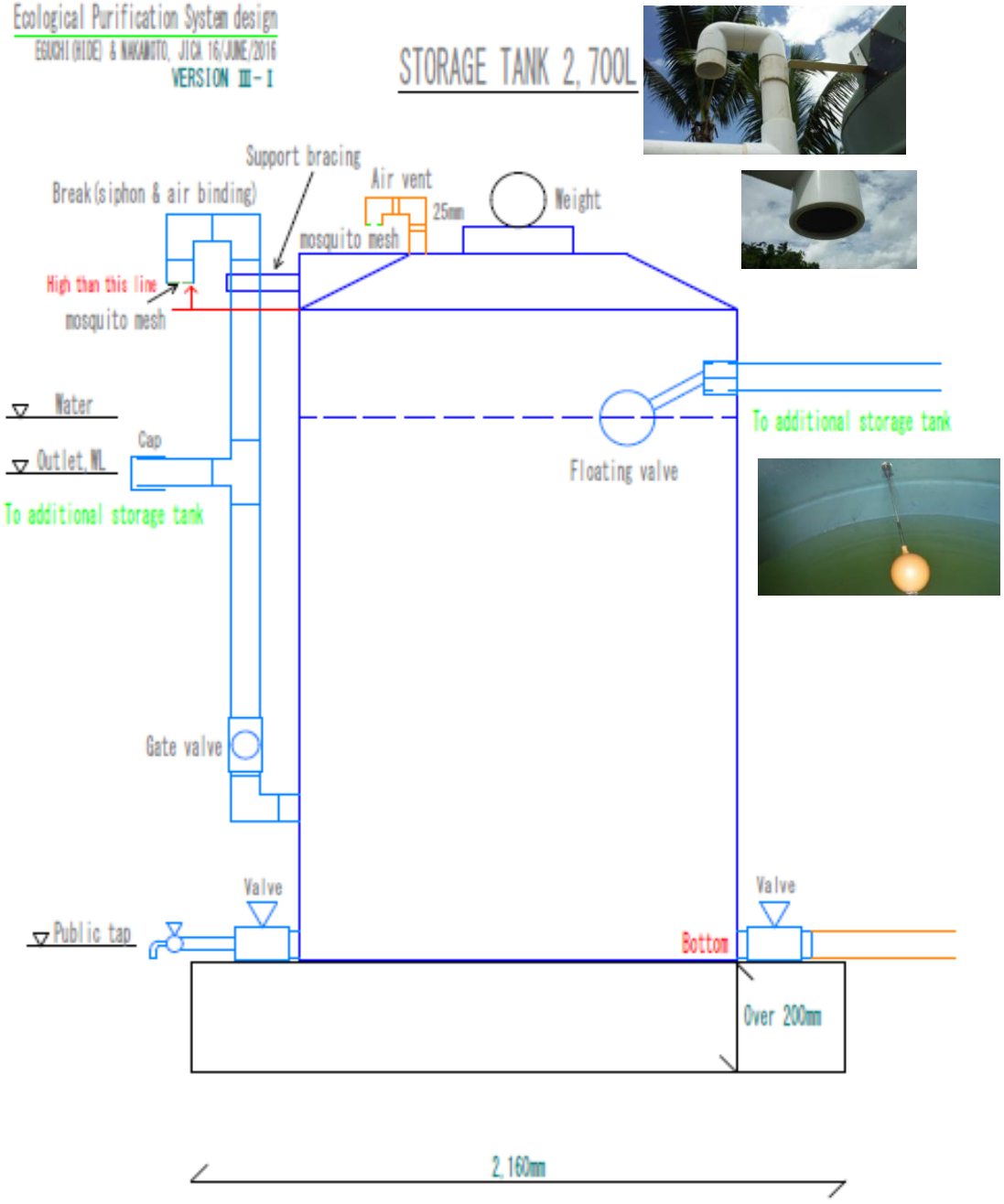
EBUCHI(HIDE) & MAKAMOTO, JICA 15/JUNE/2016

VERSION III-1

# BALANCE TANK 300~2,700L




1) A sampling tap is set before the inlet point to the balance tank in order to start up operation and to check the water quality of the filtrate.
2) Correct pipe setting order is the key to normal operation. The order of setting height is siphon, inlet, over-flow and outlet.
3) At the downward ends of a siphon break system and an air ventilation are sealed with a mosquito mesh to avoid dust, rain drop and inversion of any animals.
4) Outlet pipe for the filtrate must be tighten using a brace or a clip to avoid any damage of the inlet pipe by shaking.
5) Adjust the height of the water level of the outlet of the balance tank in case of usage of a storage tank. Caution to natural gravidity flow to a storage
6) S shape over-flow should be set to avoid inversion of any animals.
7) A screw plug is set at the bottom for an emergency drain and cleaning.
8) Each tank connecter must be tightly connect from both sides (inside and outside) by two persons.
9) Then the empty tank is filled with water. After the confirmation of no leakage from the connect point, this tank can be use for normal storage.





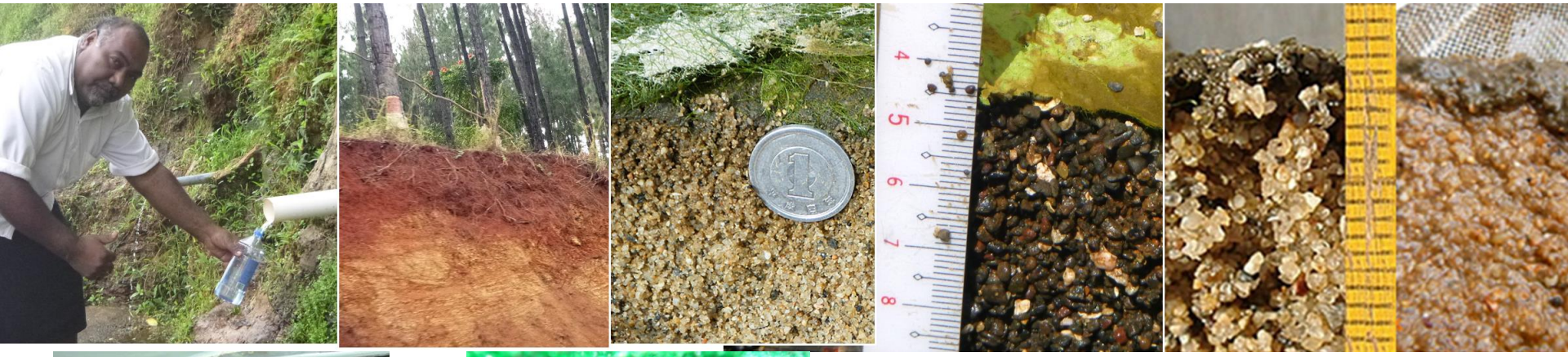





1) Floating valve is set to the inlet from a balance tank.
2) Correct pipe setting order is the key to normal operation. The order of setting height is siphon, inlet, over-flow and outlet.
3) At the downward ends of a siphon break system and an air ventilation are sealed with a mosquito mesh to avoid dust, rain drop and inversion of any animals.
4) Outlet pipe for the filtrate must be tighten using a brace or a clip to avoid any damage of the inlet pipe by shaking. If any other optional storage tank is not necessary in future, this outlet pipe is not necessary to set.
5) Each tank connecter must be tightly connect from both sides (inside and outside) by two persons.
6) Then the empty tank is filled with water. After the confirmation of no leakage from the connect point, this tank can be use for normal storage.

Drying-Rewetting phenomena in nature

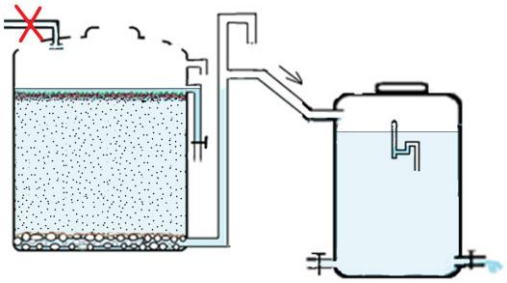
Anhydrobiosis and cryptobiosis phenomena

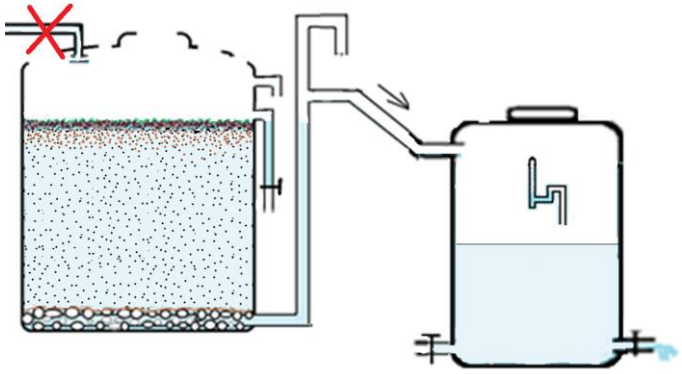


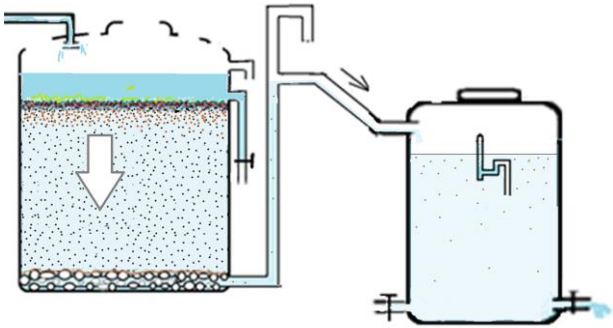
Constant flow condition

Intermittent flow, dry up condition

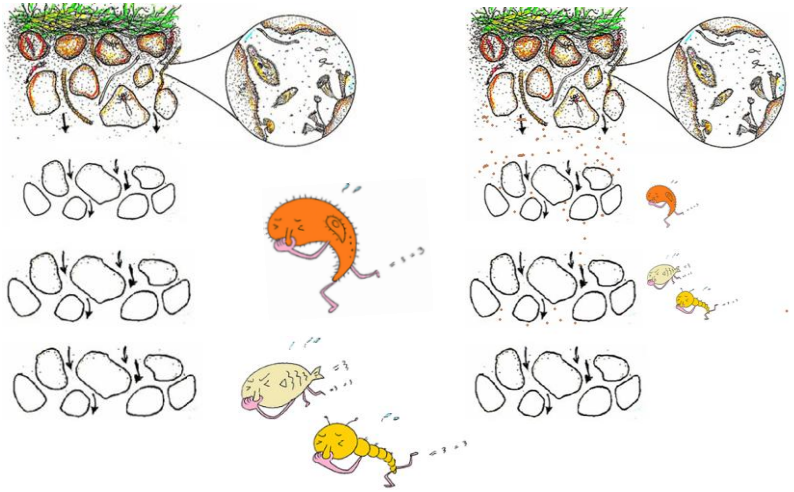
*Don’t stop water flow.*
*Small organisms escape to better site and change to resting form.*







*Inflow water stop to EPS. Small organisms at the top feel to risky. They like gentle down flow.*



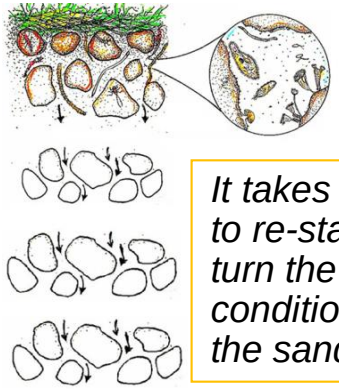
*Don’t scare small animals.*

*Small organisms escape from the top and some particles leak through the sand layer.*

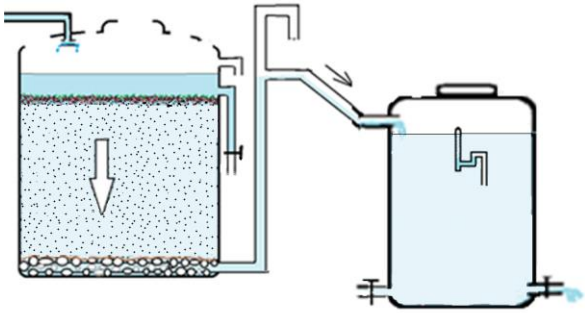
*Dry filter bed.*

*This filtrate is something risky which contains dirty particle. This passes through the filter..*

*Re-start and re-mature again the active ecosystem.*

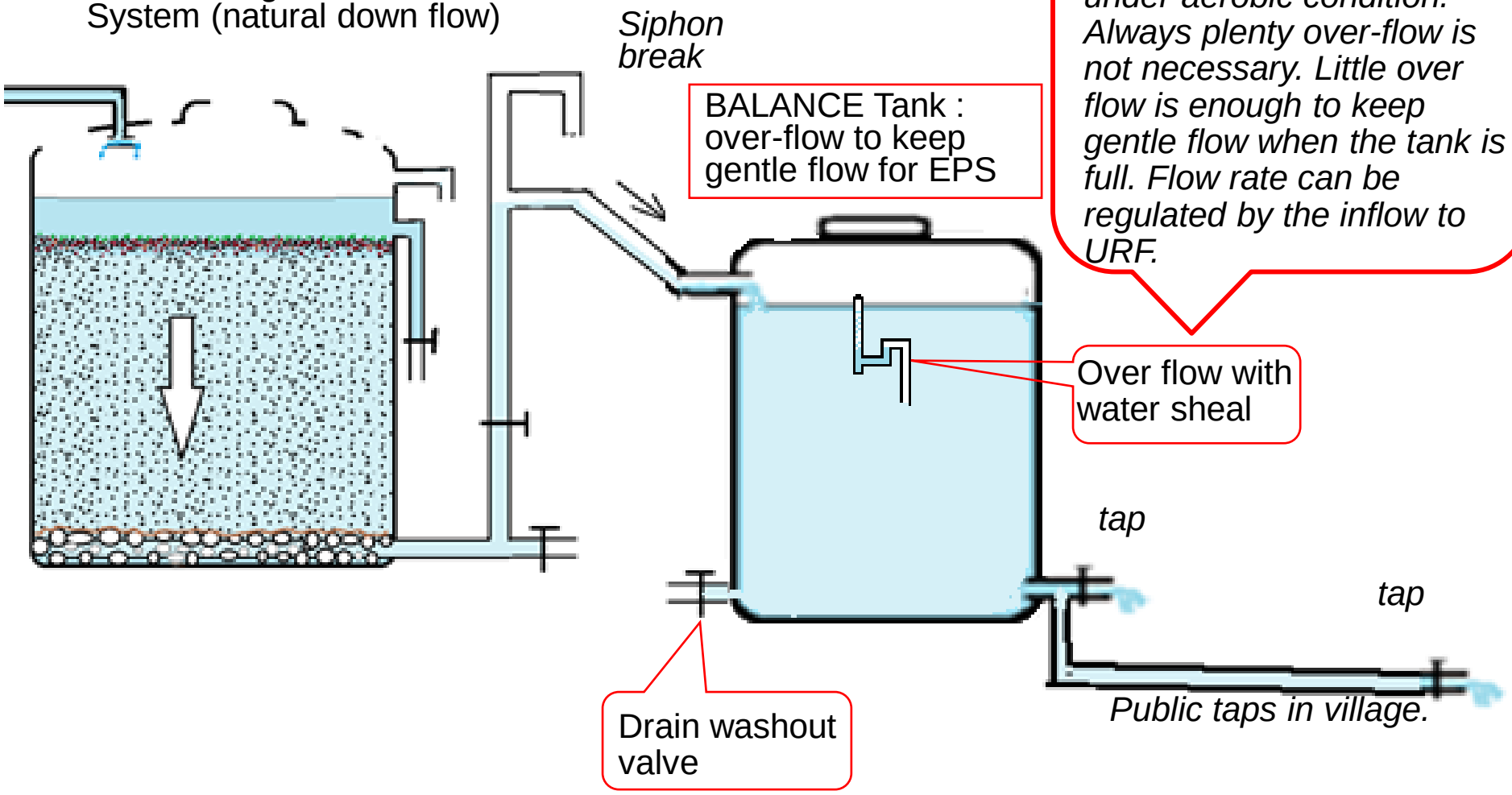


*It takes time to re-start and turn the active condition in the sand tank.*



# *Balance tank (storage tank)*

EPS: Ecological Purification System (natural down flow)

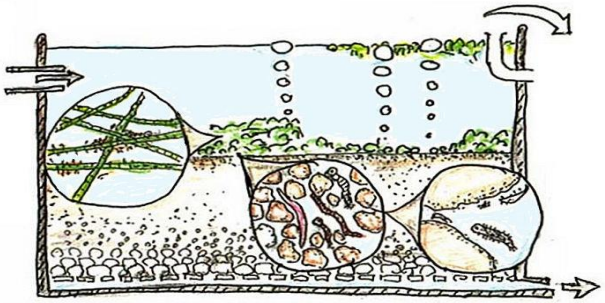


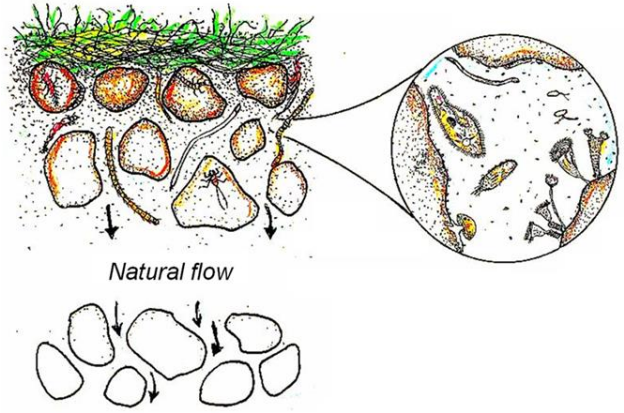

*At the beginning, dirty water from EPS (sand) tank flows into the tank. We have to wash out from the drain valve until filtrate becomes clean and safe water. It takes time to develop mature ecosystem. This is usually one month under normal condition.*

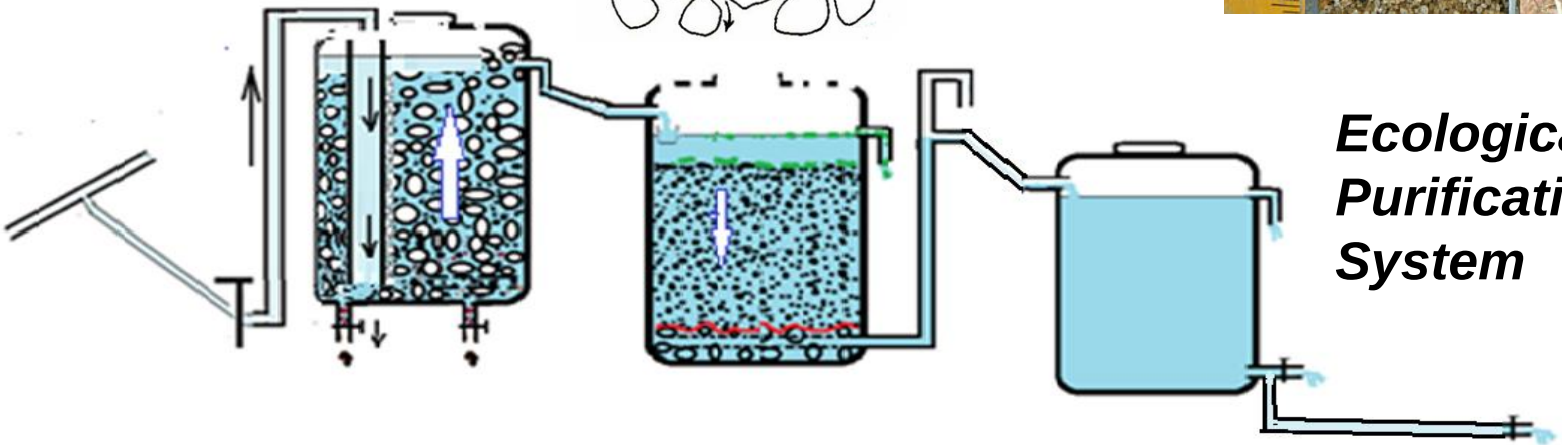
⇨

*After the confirmation of the filtrate condition, we can use as a safe water.*

# KEY is FOOD CHAIN.

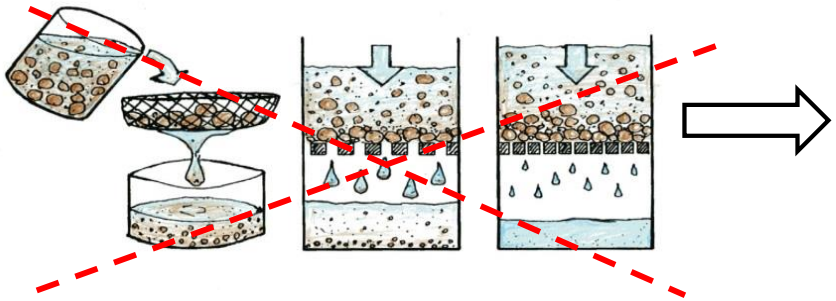


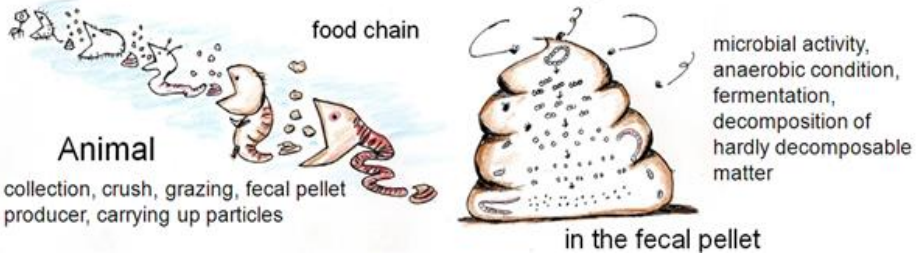


***Ecological Purification System***

*Mechanical filter*





1.Shallow depth

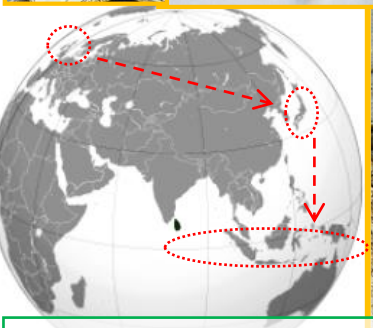
2.Active Photosynthesis

3.Bubble

4.Lift up

5.Microbe to animal

6.Collect, graze and decompose



7.Food chain is the key for purification.

8.Sand is habitat.

9.Large Sand


10.Activety depend on Temp & Radiation.

11.Pass time is 1 or 2 minutes.



*Smart Treatment System to make artificial spring water by Eco-friendly technique.*

**Chemical Free** : Gentle for small organisms



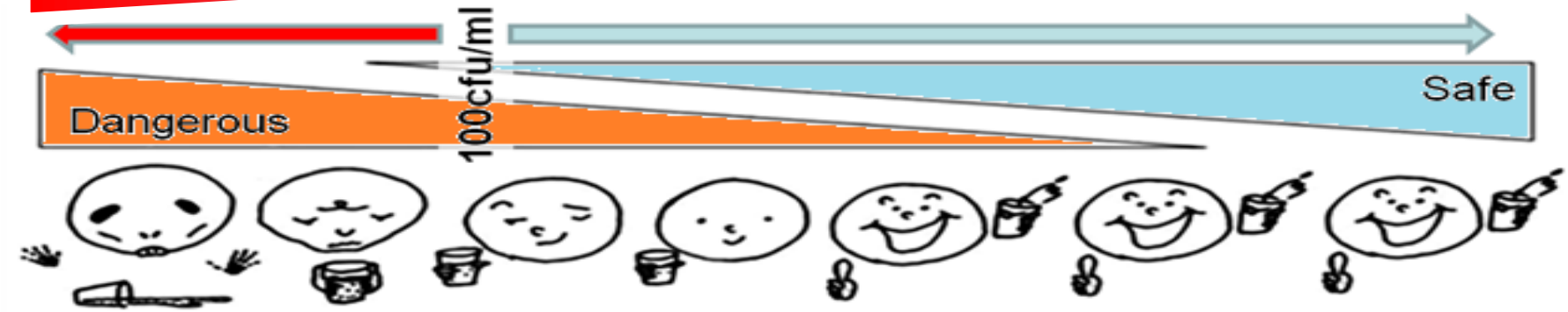





Confirm performance using a model.

*Which level of water, we need?*

**Germ : Cholera** | Fecal Coli-form | Coli-form bacteria | General bacteria



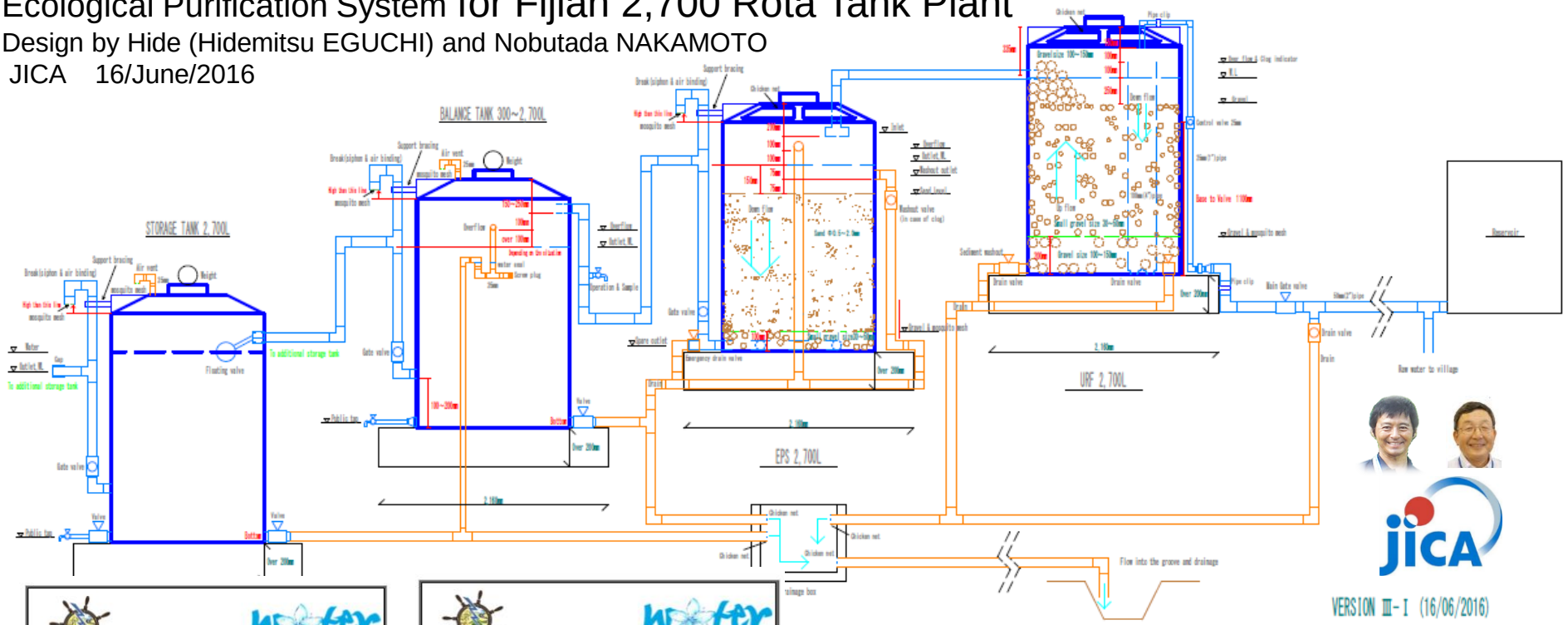

*We have to think about acceptable risk and treatment.*

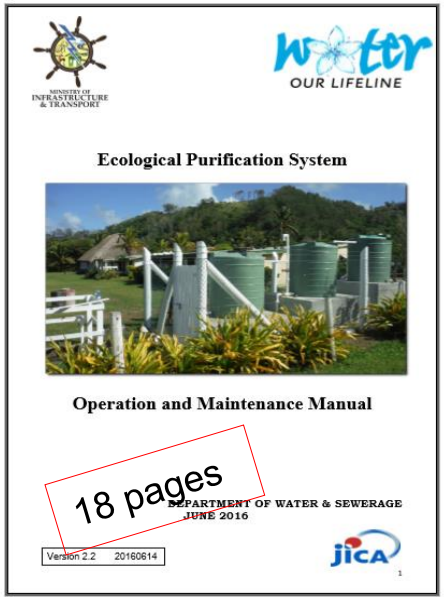
*Which level of treatment, we need?*

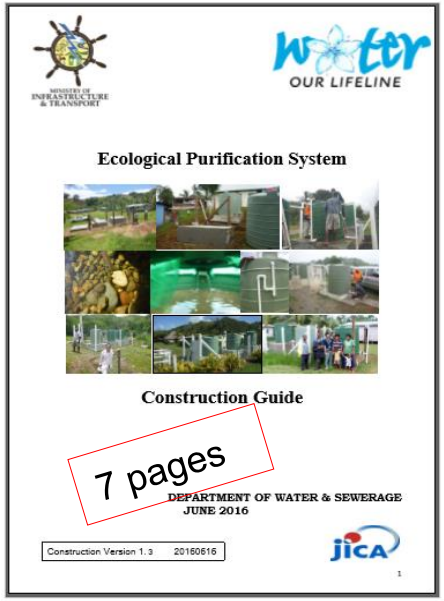
*Is this, safe or not?*

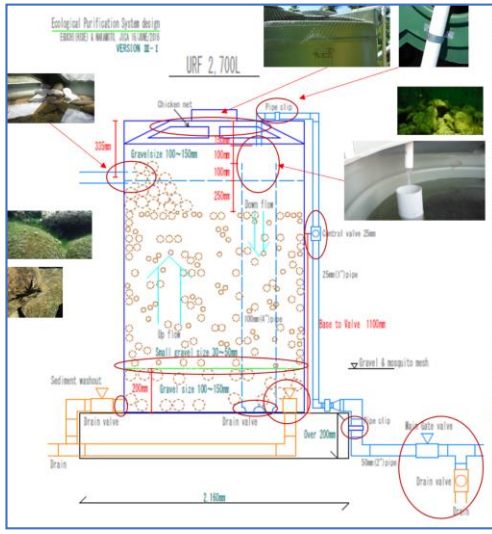
# Ecological Purification System for Fijian 2,700 Rota Tank Plant

Design by Hide (Hidemitsu EGUCHI) and Nobutada NAKAMOTO
JICA 16/June/2016

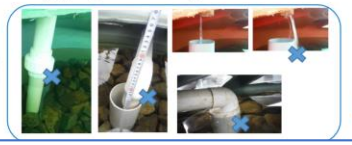



1) Inlet pipe size is 1 inch and is fixed with a clip to avoid any damage of the inlet pipe by shaking.
2) Flow rate can be controlled using a control valve (1 inch size) by watching the pouring of an inflow water. (Suitable valve setting height is 1,100 mm from the base.)
3) A gap of 100 mm between the inlet pipe (1 inch size) and the inner pipe (4 inches size) is necessary to confirm the flow rate and to sampling the raw water.
4) The height difference of 100 mm between the top edge of the inner pipe (4 inches) and the bottom height of the outlet (over-flow) pipe is requested to keep the level of seepage water from gravels. In order to guard the outlet pipe against the excess floating scum, the larger size of gravels are heaped up the outlet pipe
5) Insert a mosquito mesh (plastic) between the bottom a large gravel layer ( 100-150 mm size) and a gravel layer (30-50 mm size) to avoid dropping small stones from the gravel layer and to easy drain the accumulated muddy matter.
6) One drain pipe and valve are set near the bottom of the inner pipe to easy drain.
6) Open (cut) windows are covered with chicken mesh to avoid fallen leaves. And one cover near the inlet pipe can be lifted for a caretaker maintenance.
7) Each tank connecter must be tightly connect from both sides (inside and outside) by two persons. Then the empty tank is filled with water. After the confirmation of no leakage from the connect point, this tank can be filled with the large gravel, mesh and small gravel.



http://www.cwsc.or.jp/files/member_lmtd/doc25.pdf

# Ecological Purification System for Safe Drinking Water

## - Application of Natural Process -

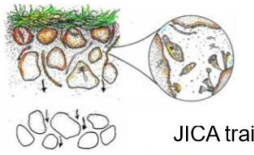
Eco-friendly technique to make artificial spring water

NAKAMOTO Nobutada, Dr. Science
Prof. Emeritus of Shinshu University, Japan

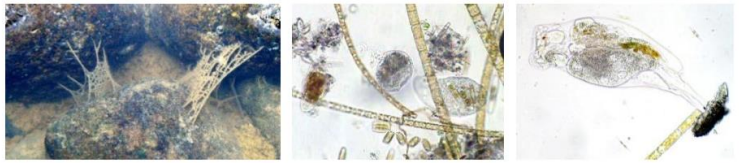

August 2018

*Smart Treatment System to make artificial spring water by Eco-friendly technique.*

*Toward Zero Waste World by Chemical-free System*



JICA training



Microscopic organism is the key of EPS.

Biological activity was evaluated by the diurnal change of dissolved oxygen.



http://www.cwsc.or.jp/files/member_lmtd/doc25.pdf

*This is Fijian EPS project.*
*Fijian people made EPS by themselves.*

JICA short term Expert
N. NAKAMOTO
Oct. 2014-Nov.2018
*8 times:*
*Each about one month*

JICA Volunteer
Hide EGUCHI
2015-2016

JICA Volunteer
Isamu SHIOIRI
2017-2018

*We assisted a little for this project.*

*EPS is Our Smart Treatment System.*
*Fijian people realized and certified.*
*We can have safe and delicious water.*

http://www.cwsc.or.jp/files/member_lmtd/doc25.pdf