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JICA training in Okinawa, Aug. 2015.

JICA 沖縄研修　2015年8月

Ecological Purification System

*New Concept and New Name of **Slow Sand Filtration***

生物浄化法
緩速ろ過の新しい
概念と新しい名前

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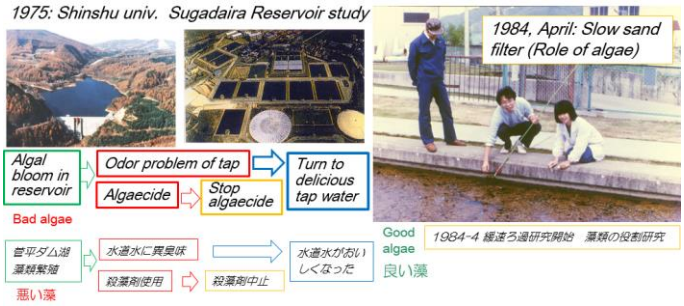
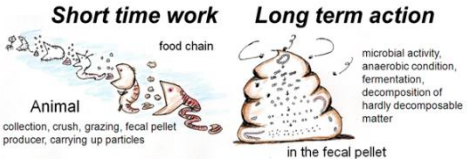


Change the Image

Slow Sand Filter⇒ ***Ecological Purification System***

Food chain



Content of Ecological Purification System JICA training text in Okinawa, August, 2015

Slide No.	
1-10	Introduction *Where is safe and clear water in natural environment?*
11-16	History *English filter was completed in 1829 in London. American filter of chlorinated water was completed in 1910.*
17-22	Refocus *Odor problem by dead algae in American filter. Tri-halo-methane produced by chlorination. Cryptosporidium outbreak. International SSF conference.*
23-53	Mechanism *Misunderstand of SSF as mechanical filter. Food chain is focused in Japan. Filamentous algae and grazing animals in aerobic condition. DO, Filter resistance, Scraping. Trickling filter.*
54-66	Pacific: Samoa *Refocus on Ecological purification System, shallow depth. Faster rate.*
67-112	Pacific: Fiji *Public tap system by EPS.*
113-114	Nagano *Non-treated water is main in mountain region.*
115-122	Miyako *Stop algaecide.*
124-131	Ishigaki *Ishigai plant is the largest plant by SSF in Okinawa. In Ishigaki, there are several small scale SSF plants.*
132-141	Aerator *Aeration for low dissolved oxygen water such as underground water is general treatment.*
142-150	Model *Model is useful for understand and deep experiments.*
151-153	Flood *Heavy particles are quickly set down, but light colloidal matters are not easily set down.*
154-155	Bacteria *Bacteria incubation paper is useful tool. See slide No.70.*
156-158	Change Image *From Mechanical filter of SSF to Ecological Purification System. Food chain is the Key. Aerobic condition is necessary.*
159-160	Smart Technology *Wise application of natural phenomena is really smart. This is our technology for ours.*
161-162	From Japan to the World *This is simple when we can understand. We can make EPS by ourselves. Let's try to make EPS.*

Supplement: CAD design of EPS in Fiji

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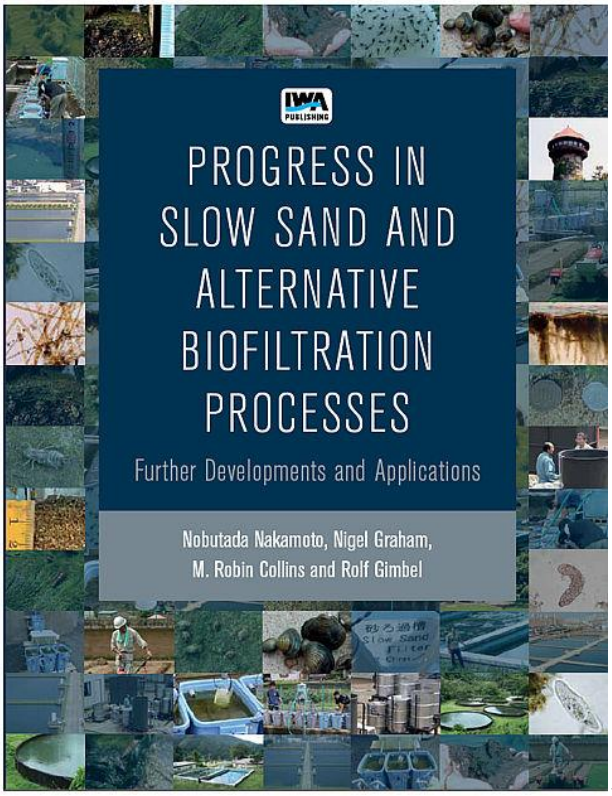
EPS water is super clean delicious like a natural spring water.
生物浄化法の水はおいしい天然の湧水の様だ

Proc. 5th International Conference in June, 2014
第5回 緩速・生物ろ過国際会議論文集 2014.6.



1

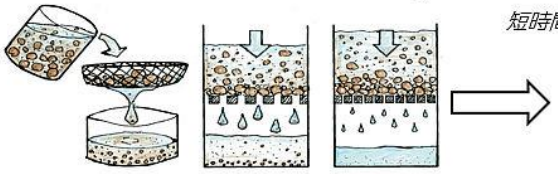
THIS is FOOD CHAIN　食物連鎖だ

The first use of slow sand filter for the public supply of drinking water began in 1804 in Paisley, Scotland. The present vertical type of slow sand filter was devised by James Simpson in 1829 after his 2,000 miles inspection trip all over the Britain. This filter provided safe drinking water, free of pathogens to residents in London. This vertical type of filter spread round the world and was known as the “English Filter”. Slow sand filter has been believed that it was a mechanical filter with fine sand under slow current. However, the major contribution of the purification of the impurities is the food chain in this system. The word of “**slow**” was “**gentle for organisms**”. Recently, the English filter of “**Slow Sand Filter**” has been recognized as “**Ecological Purification System**” in Japan.

緩速ろ過での公共水道の始まりは1804年スコットランド。英国中を調べたJ. Simpsonは1829年ロンドンで上から下への流れの緩速砂ろ過を考えた。ロンドンで病原菌がでないと評判になり、世界中へ英国式ろ過として広まった。ゆっくりの細かな砂でのろ過で機械的篩いろ過と考えられていた。しかし、食物連鎖による浄化だった。緩速ろ過の「ゆっくり」とは「生物群集にやさしい」ということ。最近、日本で、緩速砂ろ過は「生物浄化法」と認識された。

緩速（砂）ろ過　→　生物ろ過　→　生物浄化法

Slow Sand Filter → Biological Filter → **Ecological Purification System**



English Filter : Mechanical filter
英国式ろ過　：　機械的篩いろ過

短時間の仕事 **Short time work**　　**Long term action** 長時間の作用

New Concept and New Name
新しい概念　：　新しい名前

2

Are YOU sure this tap water is safe?

この水道水は安全ですか？

Fish is killed by chlorinated water. This water has not **acute toxicity for human** in the case of low level of chlorination. However it may get into chronic illness.

魚は塩素で死にます。塩素濃度が低ければ人間には急性毒でありません。でも慢性毒はわかりません。

皆さんは自然の湧水が大好きです。売られているペットボトルは無処理の自然の湧水を詰めているのを知っています。

People does not trust chlorinated water.

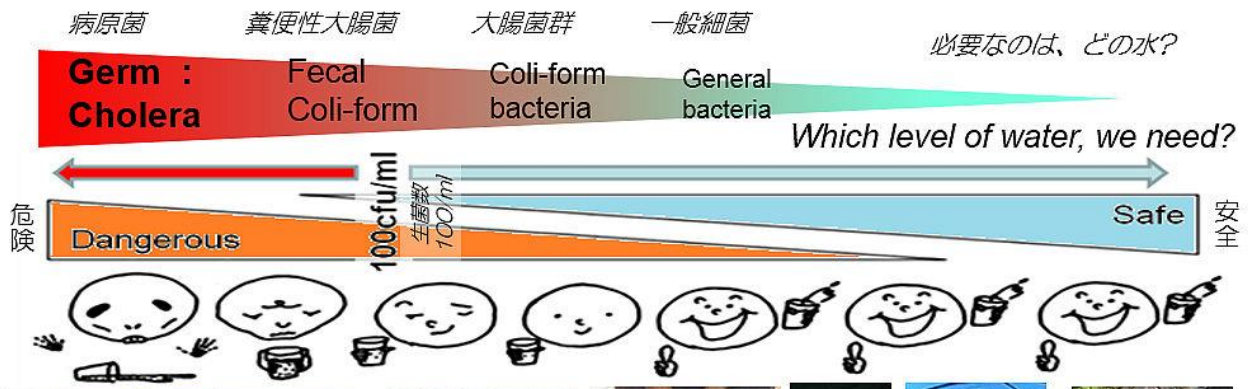
皆さんは塩素滅菌された水を信用していません。

People loves natural spring water.
People know "commercial bottled water is filled non-treated natural spring water.

People response instinctively.

皆さんは本能で反応します。

3



Is this, safe or not?

この水は安全？

We have to think about acceptable risk and treatment.

許容できる危険性、許容できる処理を考えよう。

Which level of treatment, we need?

必要なのはどの程度の処理なの？

4

Sweet drop(honey dew)
Natural sweet and delicious water

甘露水,天然の甘いおいしい水

Rain harvesting

雨水利用

Natural spring water and rain water are usually sweet and delicious.

天然の湧水や雨水は、普通、甘く、おいしい

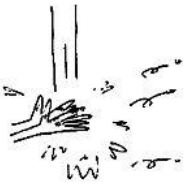
5

240 liters : one day water use per person (Tokyo, 2012)

東京都一般家庭での水の使用割合(一人1日240リットル)

This one day use per person for drink and cook is really large. It this is true or not?

口に入る水は少ない。本当に、こんなに使っているのかな。



Water supply system for drinking water is already broken by chlorinated water supply system of American filter. We don't believe any propaganda of the company. In Japan, people buy pet bottle water and to go to get spring water. The public tap is located at a super market.

急速ろ過により塩素臭い水道水による給水方法は、既に、崩壊している。私たちは、業者の宣伝を信用していない。日本ではペットボトルを買い、天然の湧水を汲みに行く。スーパーが共同水栓になっている。

6

共同水栓方式 *Public tap system*

Tap keeper collects money of filling the bottle for the maintenance cost of the plant.

水栓人が瓶に詰め、集金。施設の維持管理に使う。

Delivery service to other village. 隣村へ配送

Villager maintains over 10 years by themselves. 住民は、自分らでこの施設を維持管理している。

Application of the mechanism how to turn clean water in a paddy field.

水田の水には多くの生物がいて水がきれいになる仕組みの応用。

Two bottles of 20liters per 1 family. This water is used for drinking and cooking only. This water is not used for bath and washing hands. Diarrhea and eye sickness are disappeared. →Health village →sanitary sense and its level are distributed among the villagers. →This acts to protect against sickness.

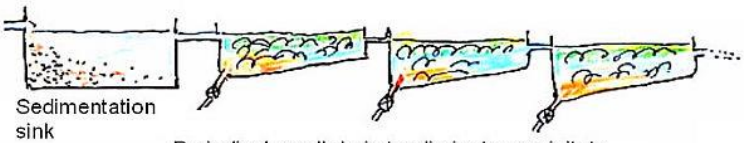
1家族当たり飲料と料理用に20リットルタンク2本。洗濯などには使わない。下痢や眼の病気がなくなり、健康村になった。住民の中で、衛生意識が浸透し、病気に対して耐性ができたのであろう。

New biological pre-treatment for SSF

Active growth of algae : holding stick (code) for filamentous algae

O2↑ →bubbles →keep aerobic condition

pH↑ → precipitate oxide and hydroxide complexes.



Sedimentation sink

Periodical small drain to eliminate precipitate material and unhealthy organisms.

Metal-OH↓ Oxide complexes can react with anions and precipitate.

Animals grazed particulate matter (living and non-living).

Slow sand filter

Slow velocity of water for microbe to eliminate bacteria.

Safe drinking water

Acceptable Risk

7

Welcome to lightning bug!! This is sweet water.

ほ！ほ！ホタル来い。こっちの水は甘いぞ！

Small wild organisms are sensitive to nature.

野外の小さな生物の方が感度が良い

Salmons come back to their mother river. 鮭は生まれ育った河川に戻ってくる

Butterfly and bird migrate far distance. We cannot explain this by our latest technology. チョウ・鳥の渡りを、最新計測機器でも説明できない

Animals escape from risky environment, and move to better place. 動ける動物は悪い環境から逃げて、良い環境へと移動する

Gold fish cannot escape from this box to survive. *水槽では逃げられない*

Plants produce seed to avoids from risky condition. They wait until recovery of better environmental condition. 動けない植物は悪い環境から逃げるため⇒ハナ⇒種で良い環境が来るまで待つ

Result First

まず結果

⇒ *Reason and Theory is after the result.*

理論、理由は後

Good result. No problem!.

結果良ければ問題なし！

Logic and standard value are after the result. *理論・数値は後でつけた理屈*

We need not to wait the logic. *理屈を待つ必要ない*

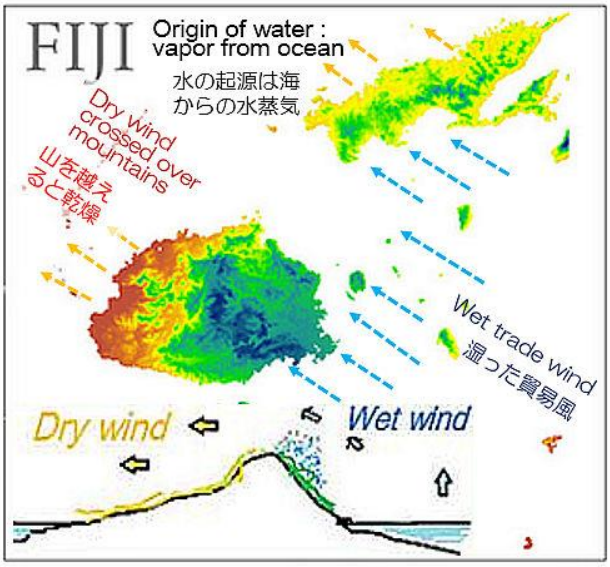
Is this water is safe or not ? 安全という、本当かな

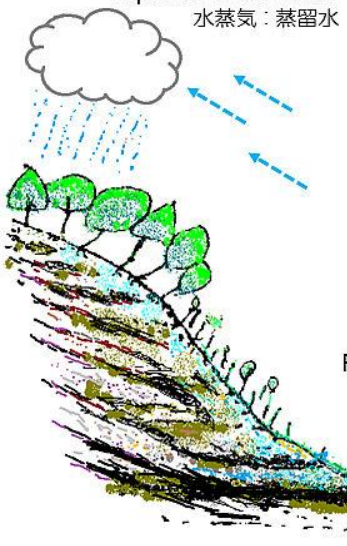
What is safe standard? 安全基準は何だろうか

8

Where we can find Clean and Safe Water in Nature ?

自然界で、どこに、清澄で安全な名水があるのか？





9

Muddy water due to a heavy rain. Soil is easily flushed out and flow into a river.

豪雨で河川水は濁水に。土壌が流されて河川に入る。

Just after storm event, stone and sand are clear.

豪雨の後は、河床の礫や砂はきれいになる。

砂礫の表面や間にいた生物は流された。

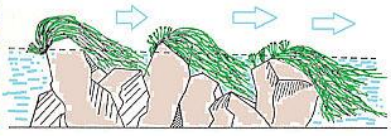
Small organisms on and among rocks were flushed out.

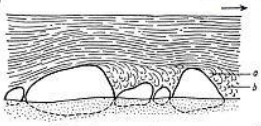
*Sand, stone and rocks **don't role and move** in a small creak among dense forest.*

森林の中の渓流は砂礫が動かず流されない。

When plants and animals do not flush out, water is always clear.

植物や動物が流されないなら水は常に清澄。





Small animals on the surface of rocks collect turbid matters.

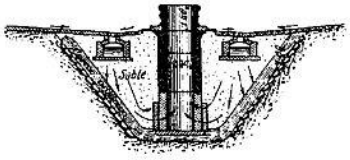
礫の表面にいる動物が濁りを捕まえる。

10

Origin of slow sand filter　緩速砂ろ過の起源

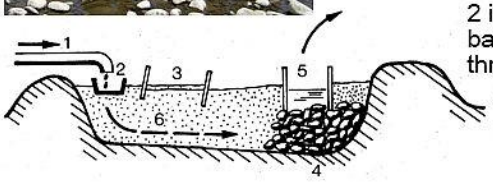
Artificial system of natural safe filtered water was originated from clear seepage water in the flood plain of a river.

自然のろ過で人工的に安全な水をつくったのは、河原で湧き出る清澄な水を真似たのが起源。



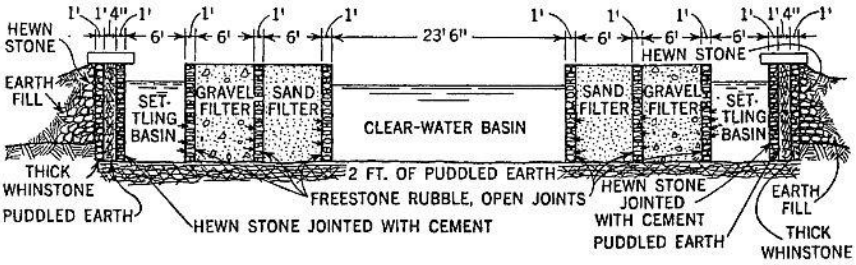
Venetian Filter, 16th century

16世紀、ベネチェアろ過



Horizontal flow sand filter : 1 inlet pipe, 2 inlet through to prevent scouring, 3 barriers, 4 gravel 50 mm, 5 outlet through, 6 flow direction

水平流れ砂ろ過：1 流入パイプ、2 流入水による掘られ防止、3 堰、4 礫（径 50 mm）、5 流出、6 汲み出し

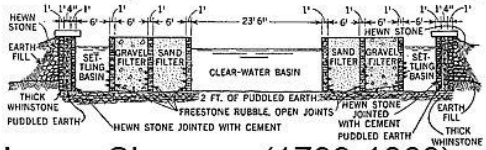


John Gibb in **Paisley near Glasgow**, Scotland. Bleacher of textile made an artificial clear seepage water of the flood plain for his factory in 1804, industrial revolution period. He delivered the clear water to Paisley town. This is the origin of Public water supply of treated water.

スコットランド、グラスゴー郊外ペーズリーで、産業革命時代の1804年、繊維を漂白する仕事をしていたJ. ギブは、自分の工場のため、河原で湧き出す仕組みで人工的に清澄な水を大量につくった。余ったので、ペーズリー中を売り歩いたのが公共水道の始まり。

11

Completion of English Filter



Horizontal

Vertical

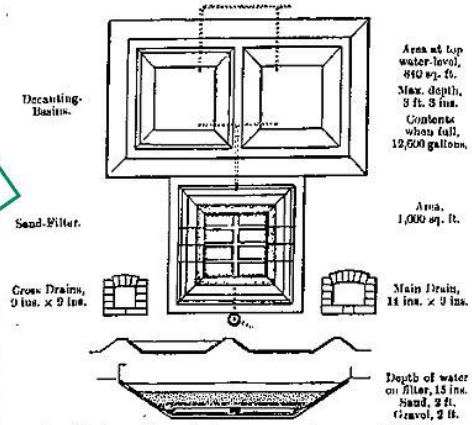


FIG. 28. JAMES SIMPSON'S EXPERIMENTAL FILTER OF 1827–1828

James Simpson (1799-1869) worked at Chelsea Water Works Company in his age of 24 (1823) which was his father's company. At 28, he started "**2,000-mile inspection trip**" all over the Britain.

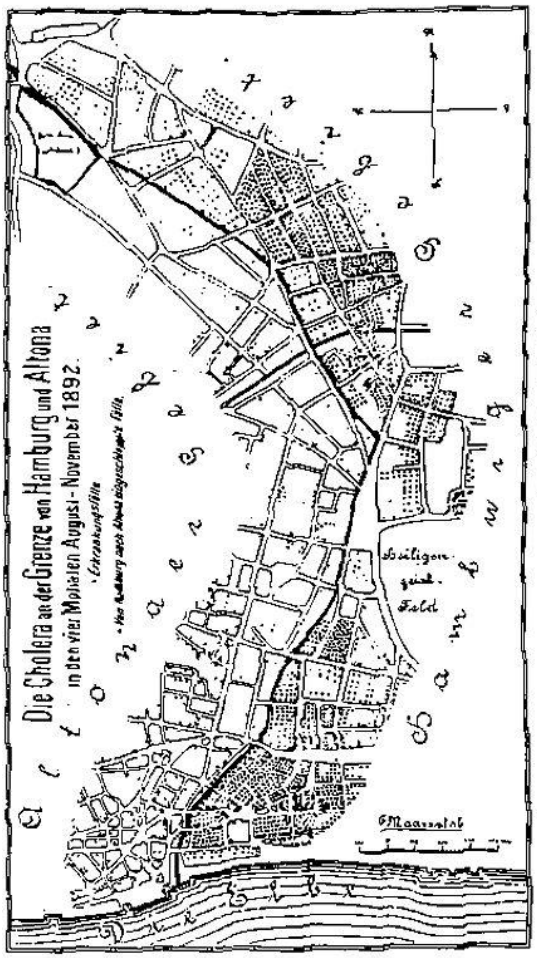
He examined vertical type of slow sand filter from 1827-1829 and made one acre filter for practical use in 1829.

This filter rate was 2-3 m/d (10cm/h).

英国式緩速ろ過の完: J.シンプソン(1799-1869)は24歳の時, 父のチェルシー水道会社に就職、28歳の1823年、英国中を2,000マイルの調査旅行をした。横流れから上から下へ流す緩速ろ過の実験を1827-29年にし、1829年に1エーカー（4,047m2=約100mx400m）の実用ろ過池を完成させた。この時のろ過速度は、2-3m/d (10cm/h)だった。

Polluted Thames water	⇨	*Sedimentation basin*	⇨	*Vertical Slow Sand Filter*	⇨	*Germ free filtrate*
汚れたテムズ河の水		沈殿池		垂直方向の流れの砂ろ過		病原菌が除かれた安全なろ過水

12



The clear proof of the filtration was provided in **1892**. **Hamburg** suffered from a cholera epidemic that infected and caused more than 7,500 deaths, while **Altona** was almost unscathed.

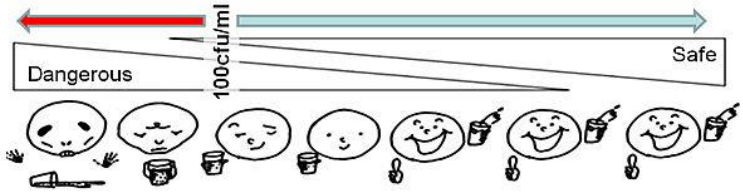
ろ過の有効性は1892 年に明白な証明がなされた。ハンブルグではコレラが大流行し7,500人以上が亡くなった。隣接したアルトナではほとんど患者がでなかった。

Dr. **Robert Koch** tested the bacteria in the water with slow sand filtration. When bacterial counts were less than ***100 colony-forming units per ml*** (cfu/ml), epidemics of cholera and typhoid were reduced.

R.コッホが緩速ろ過のろ過水の細菌検査をした。一般細菌の生菌数が１ml中100個以下なら、コレラやチフスなどの伝染病菌は除かれていた。

Present WHO safe standard for bacteria is referred to this 100 cfu/ml by Dr. R. Koch.

現在のWHOの細菌基準はコッホが調べた一般細菌の生菌数が１ml中100個以下を採用している。



This idea is so called "acceptable risk".

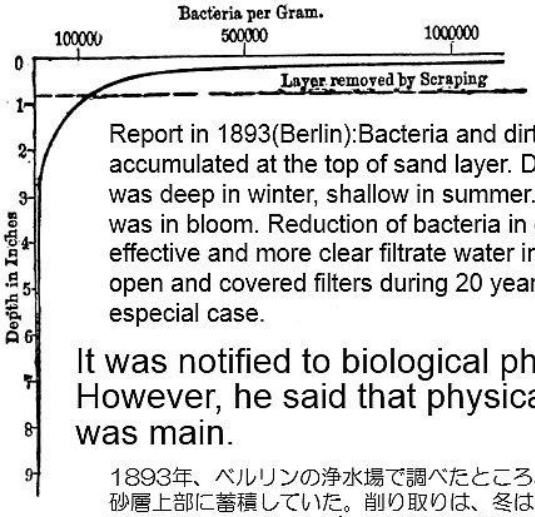
この考えは、許容できるリスク（危険性）と言われている。

Monster Soup commonly called Thames Water on the Metropolitan Water supply in 1828.

モンスタースープと言われていたテムズ河、水道水源。

1832 : The great common sewers discharged into the Thames river. This was the Source of the Southwark Water Works.

下水が流入しているテムズ河。これが水道水源。

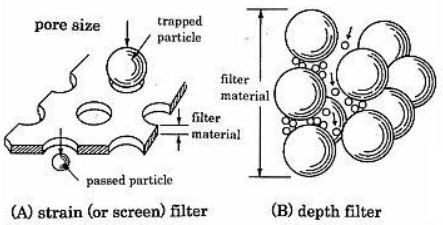


Report in 1893(Berlin):Bacteria and dirty matter were accumulated at the top of sand layer. Depth of scraping was deep in winter, shallow in summer. However, algae was in bloom. Reduction of bacteria in open filters is effective and more clear filtrate water in comparison with open and covered filters during 20 years. It may be especial case.

It was notified to biological phenomenon. However, he said that physical process was main.

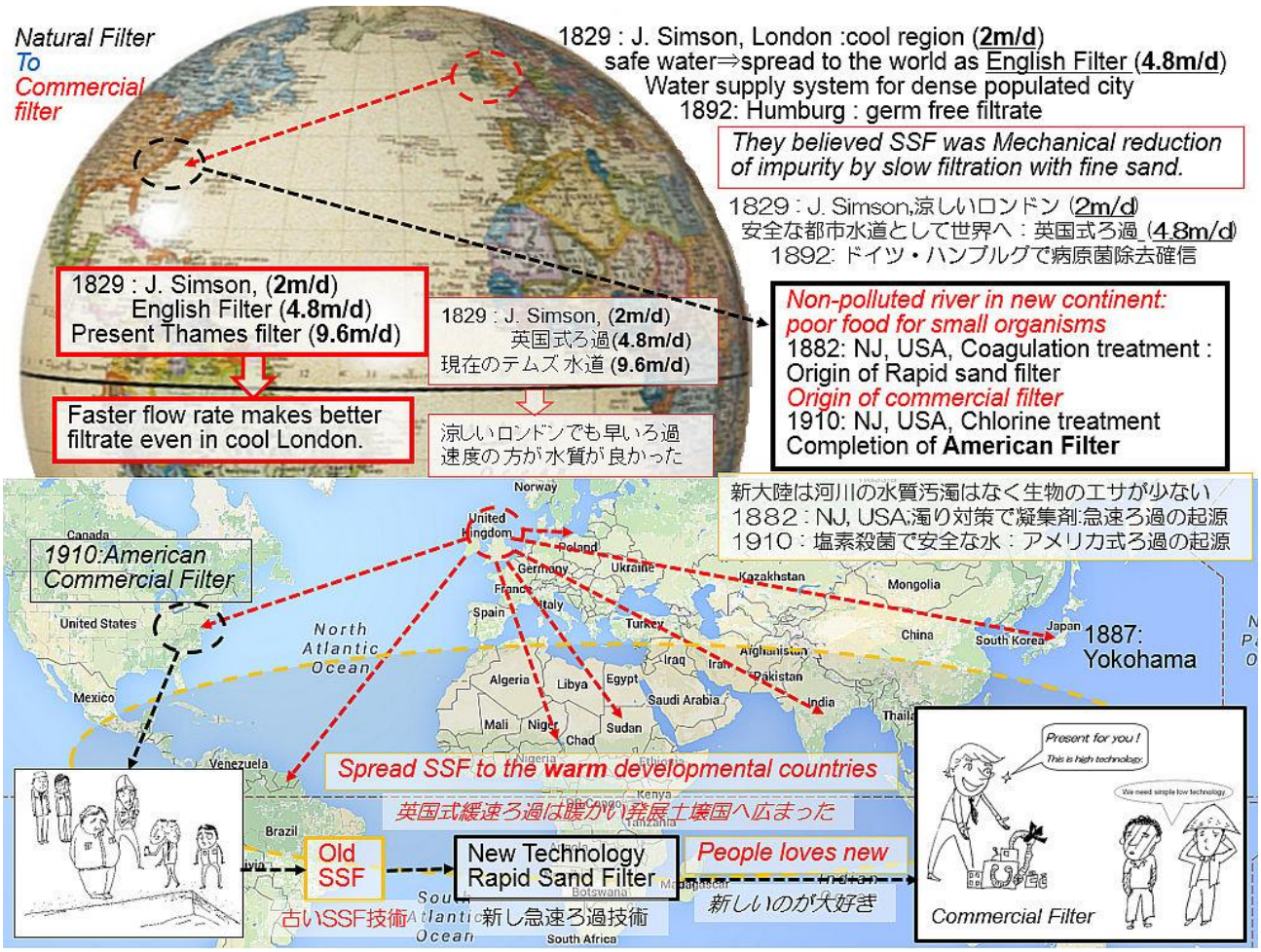
1893年、ベルリンの浄水場で調べたところ、細菌や汚泥が砂層上部に蓄積していた。削り取りは、冬は深く、夏は浅い。覆い緩速ろ過池とオープンのろ過池を20年間調べたところ、オープンのろ過池の方が、細菌除去率は良く、ろ過水も清澄であった。これは、もしかしたら特例かもしれない。

生物現象について注目したが、物理的（機械的）な除去過程が主と述べていた。

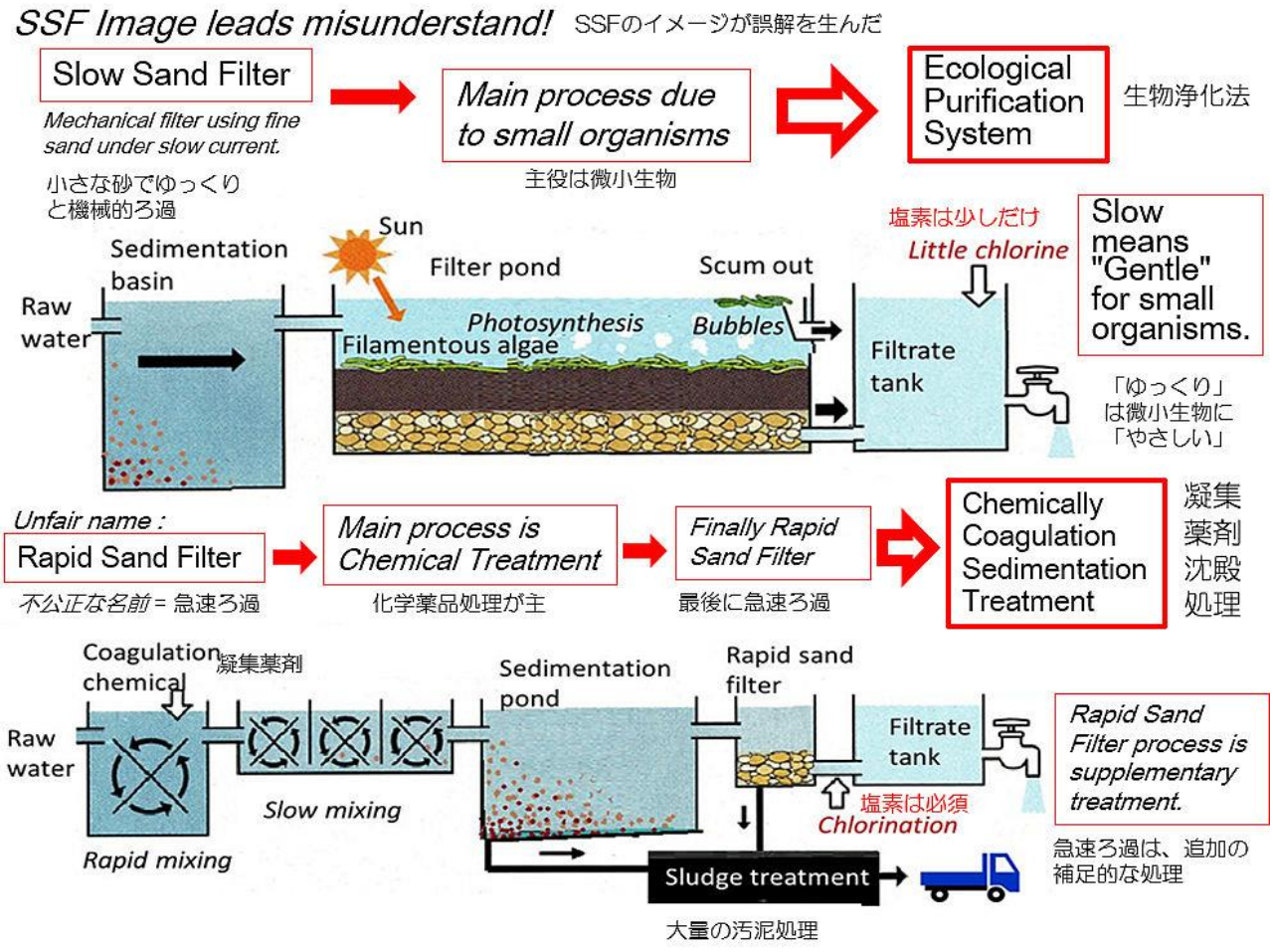


Removal of pathogens is not explained by these phenomena in comparison with size of microbial pathogens and opening space of sand grains. We can operate the filter without any clog during long filter run. We can not explain the reduction mechanism of pathogens by physical phenomena.

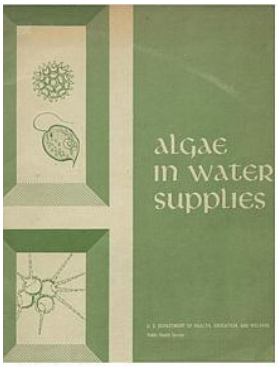
病原菌の除去は微生物の大きさと砂の間隙では説明できない。砂ろ過池はろ過閉塞しないで長期間使える。病原菌の除去の仕組みは物理的（機械的）な仕組みでは説明できない。


Natural Filter
To
Commercial
filter
1829 : J. Simson, London :cool region (2m/d)
safe water⇒spread to the world as English Filter (4.8m/d)
Water supply system for dense populated city
1892: Humburg : germ free filtrate
They believed SSF was Mechanical reduction of impurity by slow filtration with fine sand.
1829 : J. Simson,涼しいロンドン (2m/d)
安全な都市水道として世界へ：英国式ろ過 (4.8m/d)
1892: ドイツ・ハンブルグで病原菌除去確信
1829 : J. Simson, (2m/d)
English Filter (4.8m/d)
Present Thames filter (9.6m/d)
1829 : J. Simson, (2m/d)
英国式ろ過(4.8m/d)
現在のテムズ水道 (9.6m/d)
Faster flow rate makes better filtrate even in cool London.
涼しいロンドンでも早いろ過
速度の方が水質が良かった
Non-polluted river in new continent:
poor food for small organisms
1882: NJ, USA, Coagulation treatment :
Origin of Rapid sand filter
Origin of commercial filter
1910: NJ, USA, Chlorine treatment
Completion of American Filter
新大陸は河川の水質汚濁はなく生物のエサが少ない
1882：NJ, USA;濁り対策で凝集剤:急速ろ過の起源
1910：塩素殺菌で安全な水：アメリカ式ろ過の起源
1910:American
Commercial Filter
North
Atlantic
Ocean
1887:
Yokohama
Spread SSF to the warm developmental countries
英国式緩速ろ過は暖かい発展十壊国へ広まった
Old
SSF
古いSSF技術
New Technology
Rapid Sand Filter
新し急速ろ過技術
People loves new
新しいのが大好き
Present for you !
This is high technology.
We need simple low technology
Commercial Filter

15


SSF Image leads misunderstand! SSFのイメージが誤解を生んだ
Slow Sand Filter
Mechanical filter using fine sand under slow current.
小さな砂でゆっくり
と機械的ろ過
Main process due to small organisms
主役は微小生物
Ecological Purification System
生物浄化法
Sedimentation basin
Raw water
Sun
Filter pond
Photosynthesis
Filamentous algae
Scum out
Bubbles
塩素は少しだけ
Little chlorine
Filtrate tank
Slow means "Gentle" for small organisms.
「ゆっくり」
は微小生物に
「やさしい」
Unfair name :
Rapid Sand Filter
不公正な名前 = 急速ろ過
Main process is Chemical Treatment
化学薬品処理が主
Finally Rapid Sand Filter
最後に急速ろ過
Chemically Coagulation Sedimentation Treatment
凝集
薬剤
沈殿
処理
Coagulation chemical
凝集薬剤
Raw water
Rapid mixing
Slow mixing
Sedimentation pond
Rapid sand filter
Filtrate tank
塩素は必須
Chlorination
Rapid Sand Filter process is supplementary treatment.
急速ろ過は、追加の
補足的な処理
Sludge treatment
大量の汚泥処理

16



Algae in water supplies: an illustrated manual on the identification, significance, and control of algae in water supplies. C. M. Palmer 1962

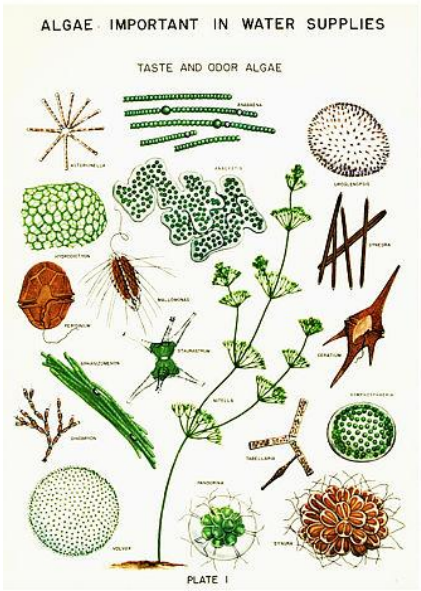
用廃水藻類学、パーマー　桑原訳　用水と廃水 6(7):59-,1964～7(1)59-,1965

http://digital.library.unt.edu/ark:/67531/metadc9129/m1/

Algae had been trouble for the conventional filter (rapid sand filter) in US. Taste and odor algae, filter clogging algae are important in water supplies (Rapid Sand Filter).

米国で急速ろ過では藻類は障害生物とされ、味、臭い、ろ過閉塞を生じさせる。

In slow sand filter, the algae and other aquatic microorganisms may play a useful part in the treatment process. They form a loose, slimy layer over the surface of the sand and act as a filter. The algae in this layer release oxygen during photosynthesis, and the oxygen in turn is utilized by aerobic saprophytic bacteria, fungi, and protozoa which establish themselves in and on the filter. This permits the decomposition or stabilization of the organic material that was present in the raw water. In p.22.



緩速ろ過では、藻など水生生物は処理上有用な働きがある。それらは砂層にルーズで粘質状の層を形成し、ろ過膜として機能している。藻は光合成で酸素を放出し、ろ過層や砂層の上で生息している好気的分解細菌、菌類、原生動物が酸素がある状態での働きを助けている。こうして原水中の有機物は分解し安定（無機化）する。

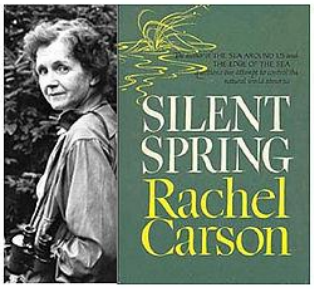
参照：桑原訳：用水と廃水6(9):65,1964

*Main focus is how to kill algae for **Rapid Sand Filter**.*

急速ろ過での殺藻が主目的

17

1962　Rachel Carson *Silent Spring*　1962 レーチェル　カールソン　沈黙の春　（生と死の妙薬）

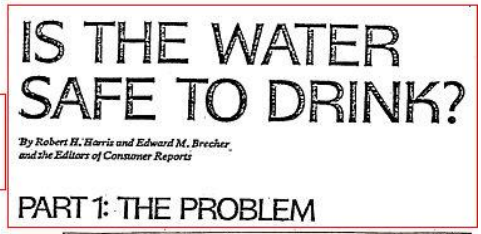


Pesticide of DDT, food chain, biological concentration, caution to chlorine compounds

殺虫剤のDDT、食物連鎖、生物濃縮、
有機塩素化合物の危険性

1974-6　ハリス 消費者報告

飲み水は安全か

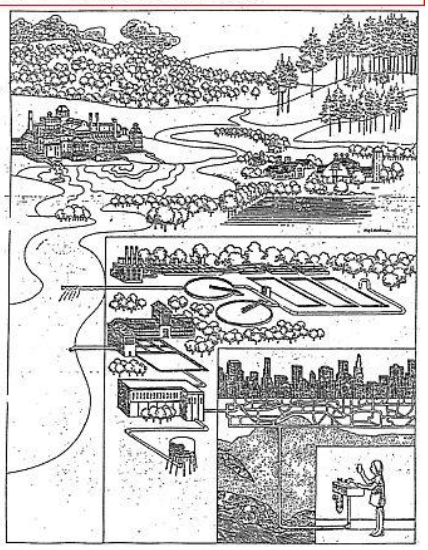


Robert H. Harris and Edward M. Brecher and the Editors of Consumer Reports

Consumer Reports 1974.June:436-443:Part 1:The Problem:

New Orleans, like many other American cities, gets its drinking water from a heavily polluted source – the Mississippi River. Many industries discharge their wastes into the river, and many upriver cities discharge their sewage into it. The rainwater runoff from farmland carries a wide variety of pesticides, herbicides, fertilizers, and other agricultural chemicals that swell the Mississippi's pollution burdens.

Asbestos in the water :Temporizing with cancer. Bacteria, Viruses, Heavy metals, Organic compounds, Hazards after the treatment. July:538-542: How to make it safer August:623-627: What you can do

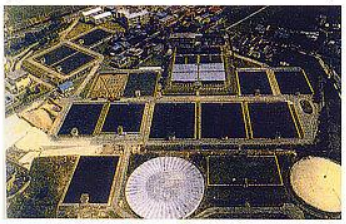


ニューオリンスなどアメリカの多くの都市は、ミシイッピ河の様に極度に汚染された水から飲み水をつくっている。多くの工場からは廃水が川へ、上流の多くの都市下水も川へ排出している。降った雨は、殺虫剤、除草剤、肥料や他の農業用薬剤を洗い流し、ミシシッピ川への汚染負荷を増やしている。

水中のアスベストは発がん性の危険性がある。細菌、ウイルス、重金属、有機化合物、処理後の危険物質など問題だ。

18

1975: Shinshu univ. Sugadaira Reservoir study



Algal bloom in reservoir → Odor problem of tap → Turn to delicious tap water

Algaecide → Stop algaecide

Bad algae

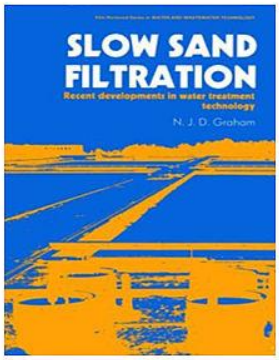
Good algae

1984-4 緩速ろ過研究開始　藻類の役割研究

菅平ダム湖 藻類繁殖 → 水道水に異臭味 → 水道水がおいしくなった

殺藻剤使用 → 殺藻剤中止

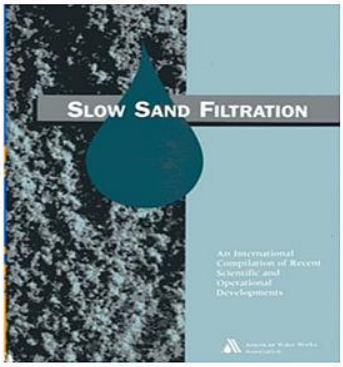
悪い藻　良い藻



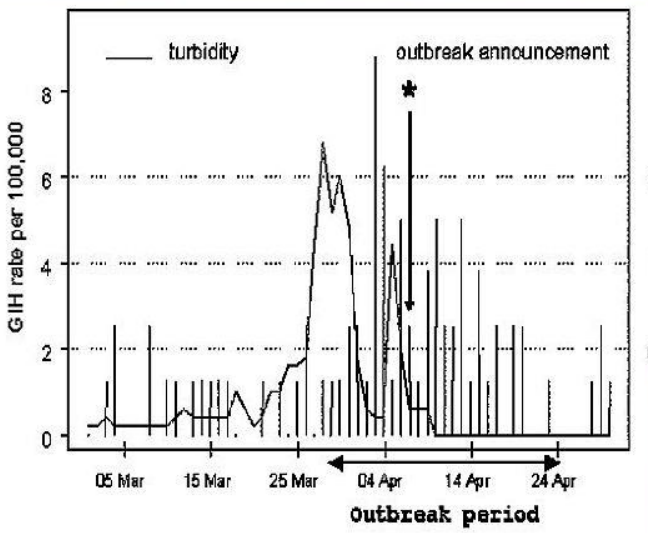
1988,November
1st International SSF Conf. in London, UK
Imperial College of London
第1回、緩速ろ過国際会議
英国・ロンドン　1988

1991,Octover
2nd SSF Conf. in New Hampshire, USA
第2回、緩速ろ過国際会議
米国・ニューハンプシャー
1991

Supported by AWWA
アメリカ水道協会後援



19



A large outbreak of diarrhea was occurred in Milwaukee, USA, in 1993.

Over 400,000 people were sickened by cryptosporidium.

1993年4月、40万人以上がクリプト原虫による大規模の集団下痢事故。

Slow sand filtration system was refocused and a workshop on it was held at Salem city, Oregon state by American Water Works Association in Sept.1994.

再認識、再発見、現代に通じる技術

Refocus, Rediscovery, Timeless Technology for Modern Application.

人は新しい技術が好きなんだ

However, people loves New Technology.

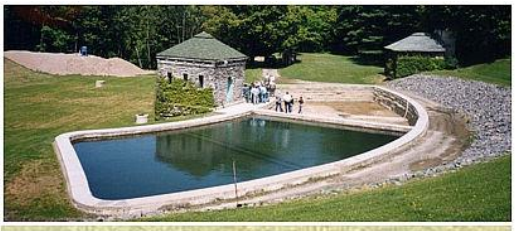
20

The village of Ilion, NY maintains the second oldest working slow sand filter bed system (in 1891) in the United States.

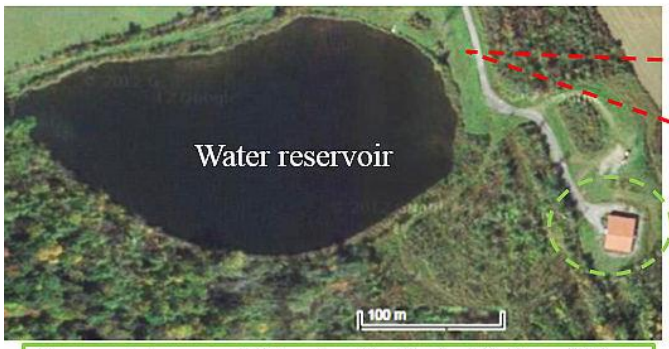
現在稼働している緩速ろ過の浄水場で2番目に古いのはニューヨーク州イリオンにある。

Mr. Michael McCormack (Ilion Water Commission) organized "The American Slow Sand Association" in 1994 (until 2004 at his retirement) after the large outbreak in 1993.

イリオンのマイクは、クリプト大事故の翌年1994年、アメリカ緩速ろ過研究会を組織し、定年退職の2004年まで続けた。



Filtrate storage tank was not covered in 1907. 昔は、浄水池に蓋がなかった。



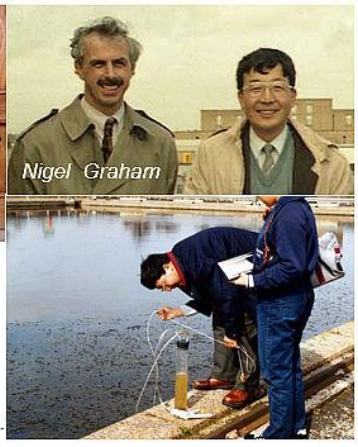
Covered slow sand filter plant in Central Bridge, NY was constructed in 1997.

ニューヨーク州セントラルブリッジに、1997年、新しく覆い緩速ろ過の浄水場が完成した。

They did not care about the farm animals around the water reservoir.

水源貯水池の周囲には、牛が放牧されていた。緩速ろ過なのでクリプト原虫による汚染は心配していない。

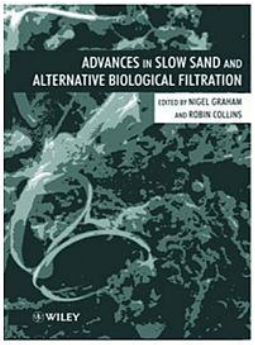
21



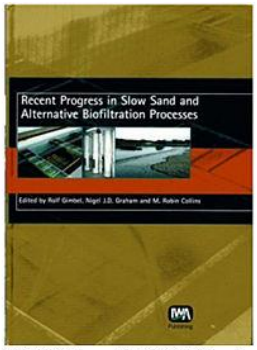
My first visit to Thames Filter was Aug. 1991. I discussed on SSF with Thames scientists.

1991-8テムス水道研究者と情報交換 1994-1996テムズ調査

I could study on Thames Filters during 1994 to 1996.



1996 April, 3rd SSF Conf. in London, UK



2006 May, 4th SSF Conf. in Mulheim, Germany

2014 June, 5th SSF Conf. in Nagoya, Japan

May, 2002.

Aug. 2005.

For Miyako wks.

Aug. 2005.

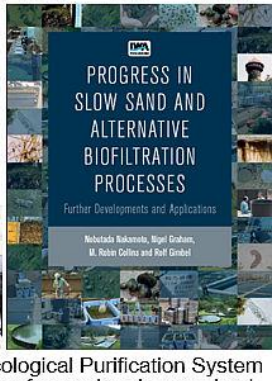
May, 2009.

Eco-Tech Award. World Expo. 2005. Aichi, Japan. 愛知万博 愛・地球賞

***Natural** filter of slow sand filter*

How to make drinking water by **Ecological purification system**

Chinese, China



March, 2009.

Internet text by JICA

July, 2010.

Portuguese, Brazil

https://stream.jica-net-library.jica.go.jp/lib2/08PRDM007/index.html

生物浄化法に注目

Ecological Purification System was focused and recognized.

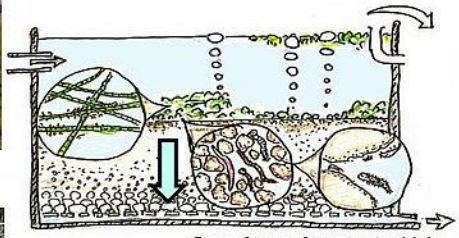
22

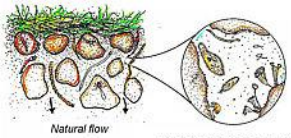
There is vertical downward current in a filter pond. This is gentle environment for small organisms where sand does not move.

ろ過池は、上から下への流れは、砂が動かず生物群集にやさしい環境。

Filamentous algae grow well on the sand surface. Microscopic and small animals live on and among the sand layer where food comes.

流れがあるので糸状藻類が砂層の上で繁殖。エサを求めて微小生物が砂の上、砂の間で活躍。





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

エサは上から来る。顕微鏡生物が病原菌を捕捉する。

Germ free safe water to drink

病原菌のいない安全な飲料水

Small animals collect any turbid matters near the surface where food comes.

エサがくる表面近くで微小生物は濁りを捕捉する。

There is no food in deep place.

深いところにはエサがない。

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

微小生物は短時間で懸濁物を捕捉する。消化管の中を通過する時間も短い。

Oxygen is necessary for small animals.

微小動物にとって酸素は必須。

短時間作業

Short time work

長時間の作用

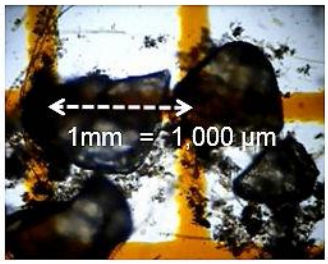
Long term action

microbial activity, anaerobic condition, fermentation, decomposition of hardly decomposable matter in the fecal pellet

糞塊の中で発酵

微小生物群集による食物連鎖が浄化のカギ

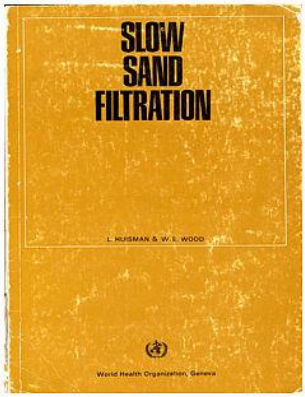
Food chain by small animals is the key for purification system.



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

空腹で、健康な微小動物が安心して活躍できるのが大切。

23



SLOW SAND FILTRATION

L. HUISMAN

Professor of Sanitary Engineering, Department of Civil Engineering, Technological University, Delft, Netherlands

W.E. WOOD, F.I.C.E.

formerly Chief, Community Water Supply, World Health Organization, Geneva

WORLD HEALTH ORGANIZATION

GENEVA

1974

The most referred text on SSF is this book published by WHO in 1974. This is copy free through the internet from WHO. PDF file: 6.43 MB

最もよく参照されている教科書はHuisman and Wood 1974でWHOから出版されている。ネットで無償で手に入る。PDF 6.43MB.

They misunderstand the real purification process based on ecological function.

生物群集による浄化が主過程というのを理解していない。

p14 原水中の大多数の生物は貯水している間に死滅するが、残存したら塩素で死滅させる。

(3) Most of the organisms are allowed to die off in storage and the remainder are killed by chlorination, the water having first been prepared (e.g., by removing ammonia and organic matter) to enable the applied chlorine to exert the maximum disinfecting action.

They notified on biological phenomenon. However, they believed that physical process was main.

Their knowledge was not enough to understand the real phenomena on SSF as Ecological Purification System.

生物現象の記載があるが、物理的作用が主と信じている。

彼らの知識は緩速ろ過を生物群集による生物浄化法と考えるには不十分。

p20 砂の上に生物起源の薄い粘質状の膜があり、糸状藻類と生物群集がいる。

On the surface of the sand there is a thin slimy matting of material, largely organic in origin, known as the *schmutzdecke*, or filter skin, through which the water must pass before reaching the filter medium itself. The *schmutzdecke* consists of threadlike algae and numerous other forms of

p23 原水濁度100mg/lまで大丈夫。20ー100mg/l：沈殿池、1リットル中数グラムまで：金網篩いと数週間からスか月の貯水、取水の工夫、20ー50mg/l粗ろ過、50ー200 mg/l :凝集剤・沈殿・粗ろ過。

maximum that should be permitted for longer periods, and the best purification occurs when the average turbidity is 10 mg/l or less (expressed as SiO_2). When higher turbidities are expected, biological filtration should be preceded by other forms of treatment, such as (in ascending order of efficiency):

(1) plain sedimentation (for turbidities of 20–100 mg/l);
(2) storage with microstraining for algae removal, the detention periods varying from a few weeks to a few months (for turbidities of up to several grams per litre);
(3) natural screening prior to intake (for turbidities of 10–20 mg/l, depending on the degree of clogging of the river bed);
(4) rapid "roughing" filtration (for turbidities of 20–50 mg/l); and
(5) sedimentation preceded by chemical coagulation (if necessary) and followed by rapid "roughing" filtration (for turbidities of 50–200 mg/l).

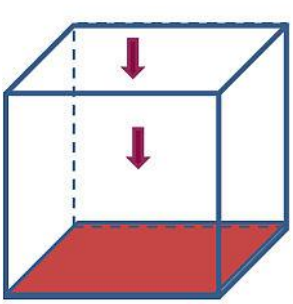
I know microscopic organisms is very sensitive to non-detectable amount of chemicals. They scare risky chemicals. They escape from the risk. EPS is wise use of natural phenomena.

顕微鏡生物は、検出できないような濃度の薬品にも大変に敏感。危険な薬品を恐れ、リスクから回避します。生物浄化法は、自然現象の賢い活用です。

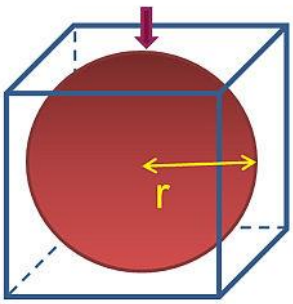
24

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.

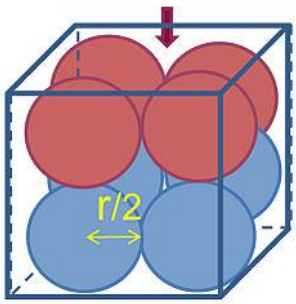
ゆっくりの流れ環境では、大部分の微小生物は基質（砂）の表面に生息している。エサがくる砂層上部にいる。エサを常に待っていて空腹だ。



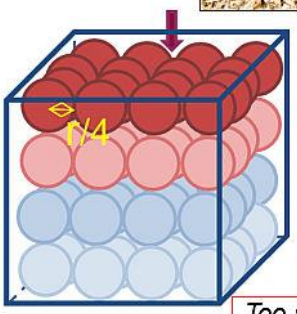
Bottom surface area



radius = 0.5
Surface area
= 4 x π x r x r
= 3.14



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.

小さくなり過ぎると平面状態になる。

平面より球だと表面積は3.14倍

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

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

上部第1層の球の総表面積は、常に3.14倍。　　球が小さくなると単位容量当たりの表面積は増える。

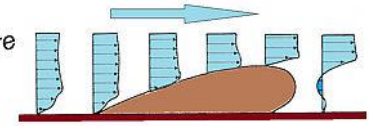
And, total volume of balls is always same of 52 % (porosity : 48%) in a box.

箱の中の球が増えても総体積は変わらず、52%（空隙率：４８%）。

Filter resistance increases toward smaller size of particle.

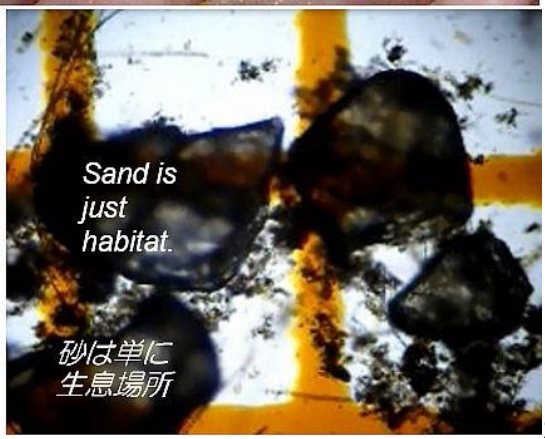
砂粒子が小さくなるとろ過抵抗が大きくなる

Viscosity : temperature
粘性・温度



25

英国ロンドンのテムズ水道で洗ったろ過砂を調べた。砂の大きさや均一性は問題にしていない。



I checked the washed clean filter sand of the filter bed in London. Thames water utility does not care about sand size and uniformity.

26

In the text, on the surface of the sand there is a thin slimy (gelatinous) mat known as the *Schmutzdecke*, or filter skin. This explanation is not correct.

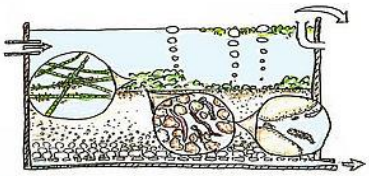
教科書では、砂層状に薄い粘質状の膜、Scmutzdeckeと言われているろ過膜がある。この説明は、正しくない。

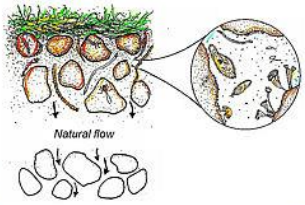
On the surface of sand layer, there is a soft mat like light feather mat. Filamentous algal mat is just lay down.

砂層の表面には、フワフワとした羽毛の様な膜がある。糸状藻類膜が横たわっている。

Sand is clear at the site in water. When we pull up this mat from the bottom to surface and in air, sand turns dirty color. A large amount of trapped SS among filamentous algal mat drops into sand layer.

水中では砂はきれいである。砂層上の藻類膜を底から取り上げ空中に出すと、糸状藻類膜に捕捉されていた濁りが落ちて砂層は汚れる。





On the shallow bottom, filamentous algae grow well.

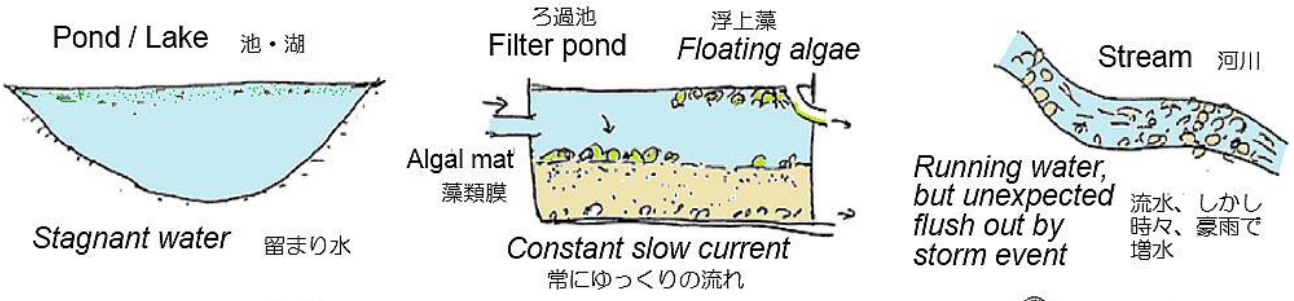
浅い底では、糸状藻類が繁殖する。

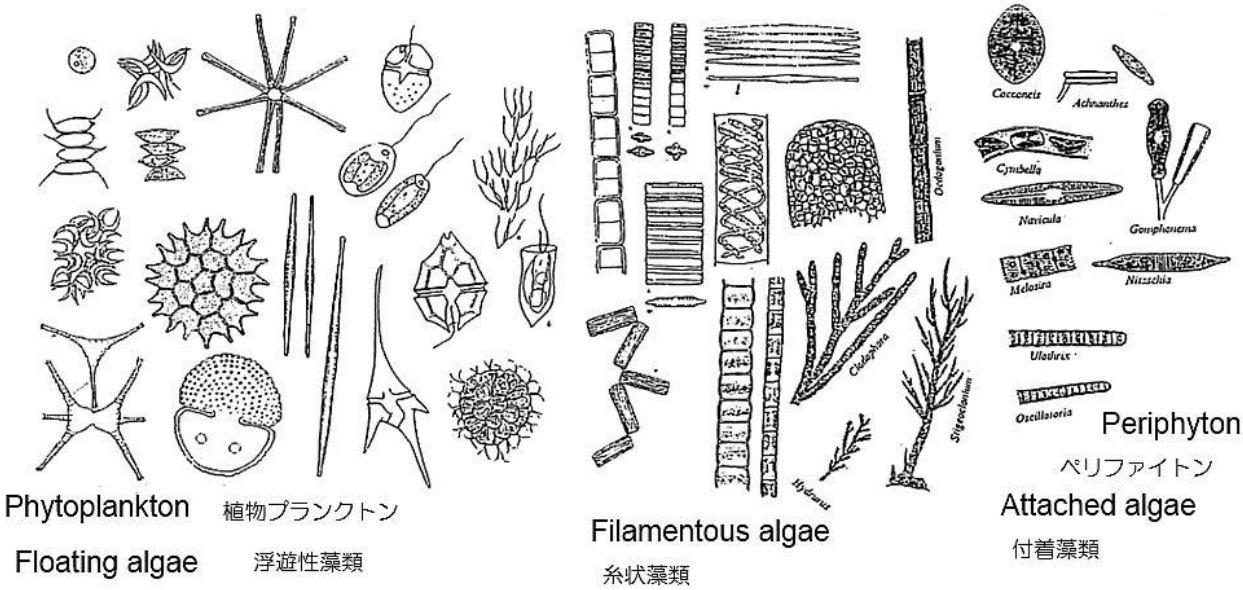
Algae are the best food for animal. 藻は動物の最良のエサ

Filamentous diatom is a pioneer plant in cold water. 糸状珪藻は水温が低い水温で最初に成長する。

27

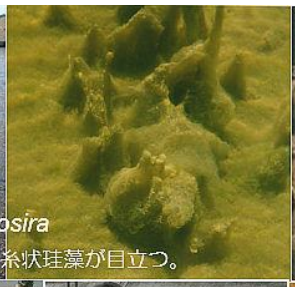
Filter pond (Ecological Purification System) where is slow down ward current is the suitable environment for filamentous algae. 下向きの流れがあるろ過池（生物浄化法池）では、糸状藻類が繁殖





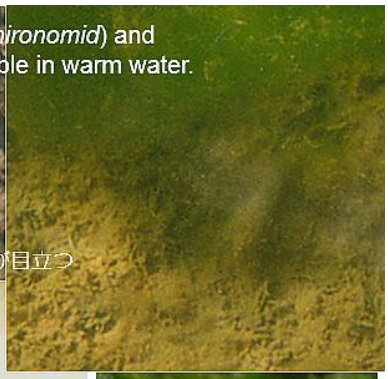
28

Filamentous diatom of *Melosira* in cold water. 水温が低いと糸状珪藻が目立つ。



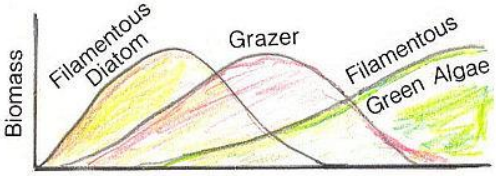
Casting skin of midge(*Chironomid*) and adult midge are remarkable in warm water.

水温が暖かいとユスリカが目立つ



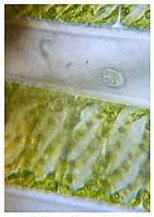
Filamentous diatom was grazed up and filamentous green algae are remarkable in warm water or in case of long filter run.

糸状珪藻が食べられると糸状緑藻が目立つ。暖かい地域やろ過が長いと目立つ。



At the beginning, filamentous diatom dominates. However, filamentous green algae becomes dominant during the long filter run.

最初は糸状珪藻が優先するが、動物に食べられ、ろ過を長くなると、水温が高いと糸状緑藻になる。



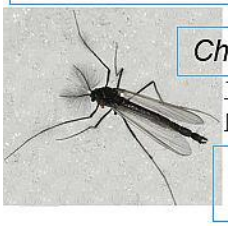
After diatom is grazed by small animals, filamentous green algae (*Cladophora, Spirogyra, Hydrodictyon, etc.*) are remarkable algae. These green algae have hard cell wall and larger size. After that , Mollusk appears.

糸状珪藻が動物に食べられ、細胞が大きく固い細胞膜をもつ糸状緑藻（シオグサ、アオミドロ、アミミドロなど）が顕著になる。その後、軟体動物（貝類）があらわれる。

29

Chironomid is not same as *Mosquito*.

ユスリカと蚊は同じでない

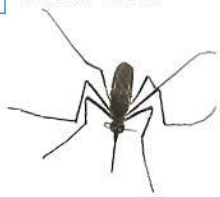


Chironomid

ユスリカは血を吸わない

Non-biting Mosquito

Mosquito

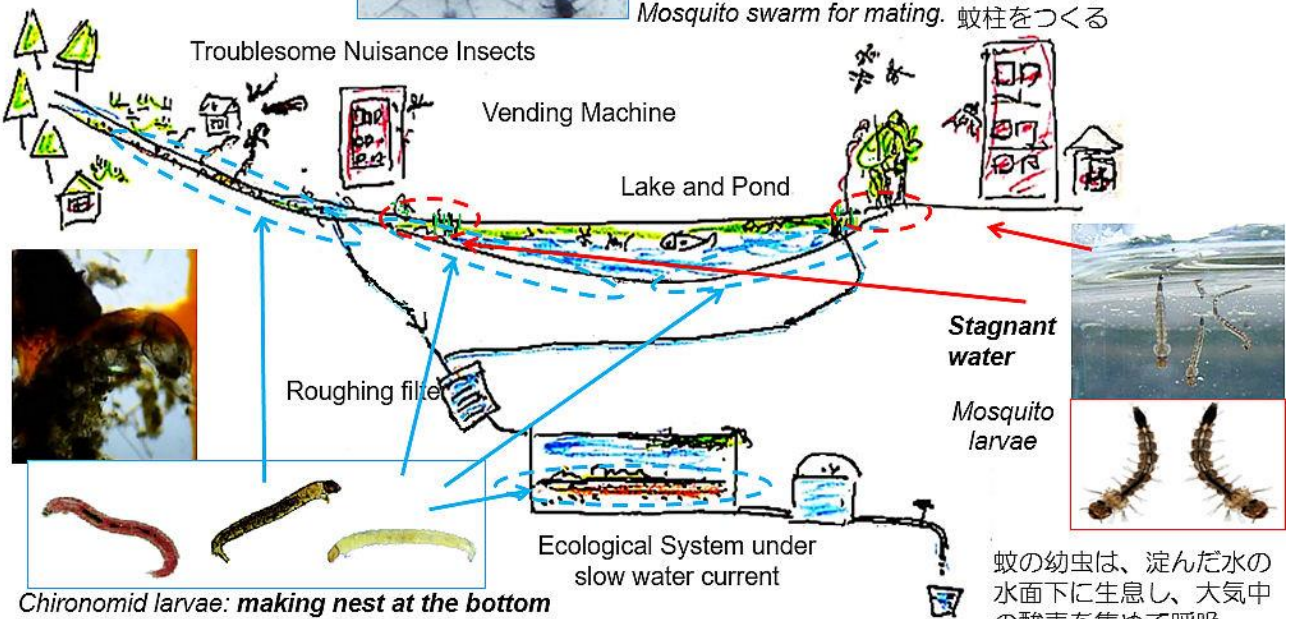


Biting Mosquito (Female)

蚊のメスは血を吸う

Both of Chironomid and Mosquito swarm for mating.

ユスリカも蚊も蚊柱をつくる

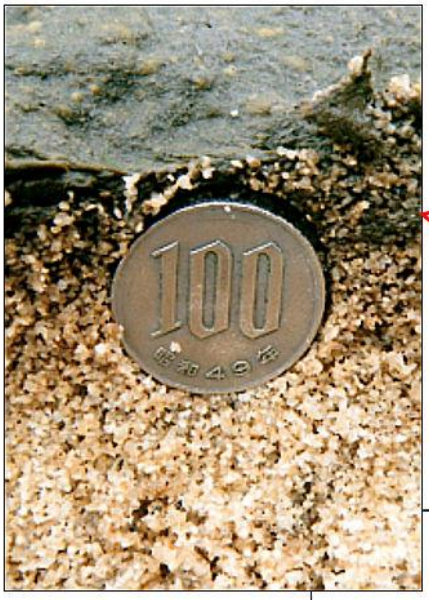


Chironomid larvae: ***making nest at the bottom***

ユスリカは酸素がある場所（川底・湖底）で巣をつくる

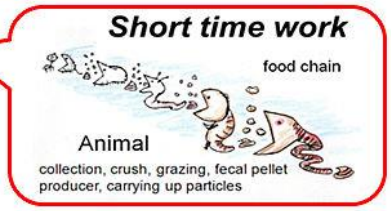
蚊の幼虫は、淀んだ水の水面下に生息し、大気中の酸素を集めて呼吸。

30



Name of Slow Sand Filter makes un-correct image “It takes so long time to purification”.

EPS is an instant purification system.



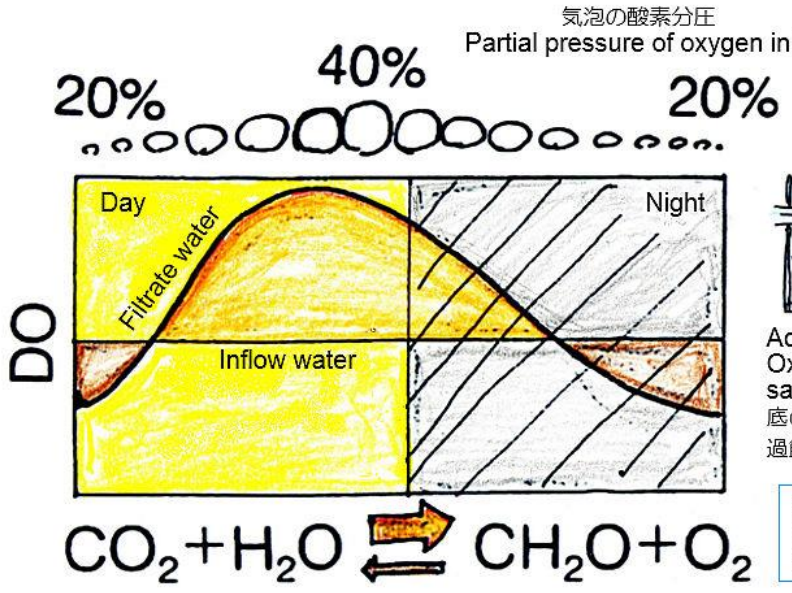
緩速砂ろ過では浄化に時間がかかるというイメージ

生物群集による濁りの捕捉は瞬間

		英国式	現在のテムズ水道	サモアでの実験
ろ過速度	unit	Simpson 1829	English Filter	Present Thames Filter	Experiment in Samoa
砂層の空隙率５０%での砂層のろ過速度	Flow rate	m/d	2	4.8	9.6	20
	Flow rate	cm/h	8.3	20	40	83
	Flow rate in sand layer (50% porosity)	cm/h	16.7	40	80	167
砂層の１mの通過時間（時間）	Passing time of 1 m sand layer	hr	6	2.5	1.25	0.6
生物活性が良い1㎝の通過時間　（分）	Passing time of upper active 1 cm	min	3.6	1.5	0.75	0.36

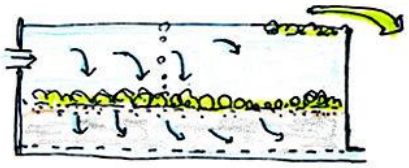
31

Diurnal change of dissolved oxygen in inflow and in filtrate water and the partial pressure oxygen in bubbles. 流入およびろ過水中の溶存酸素濃度の日変化および気泡の酸素分圧の変化



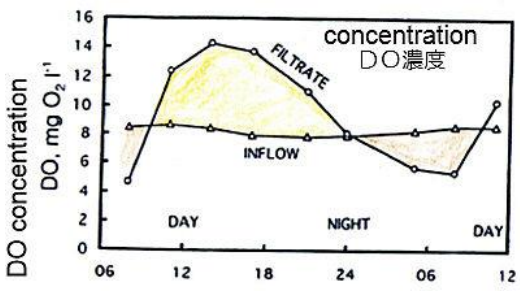
浮上藻排出

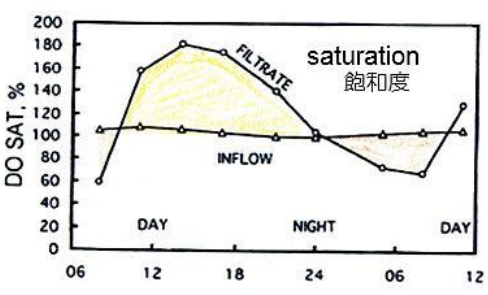
Scum out of algae



Active growth of algae on the sand bed. Oxygen bubbles are formed under super saturated condition.
底の砂層上で活発に藻類は繁殖。光合成が盛んで過飽和状態で気泡が生じる。

Continuous culture condition of algae keeps aerobic condition in the filtrate even in the night.



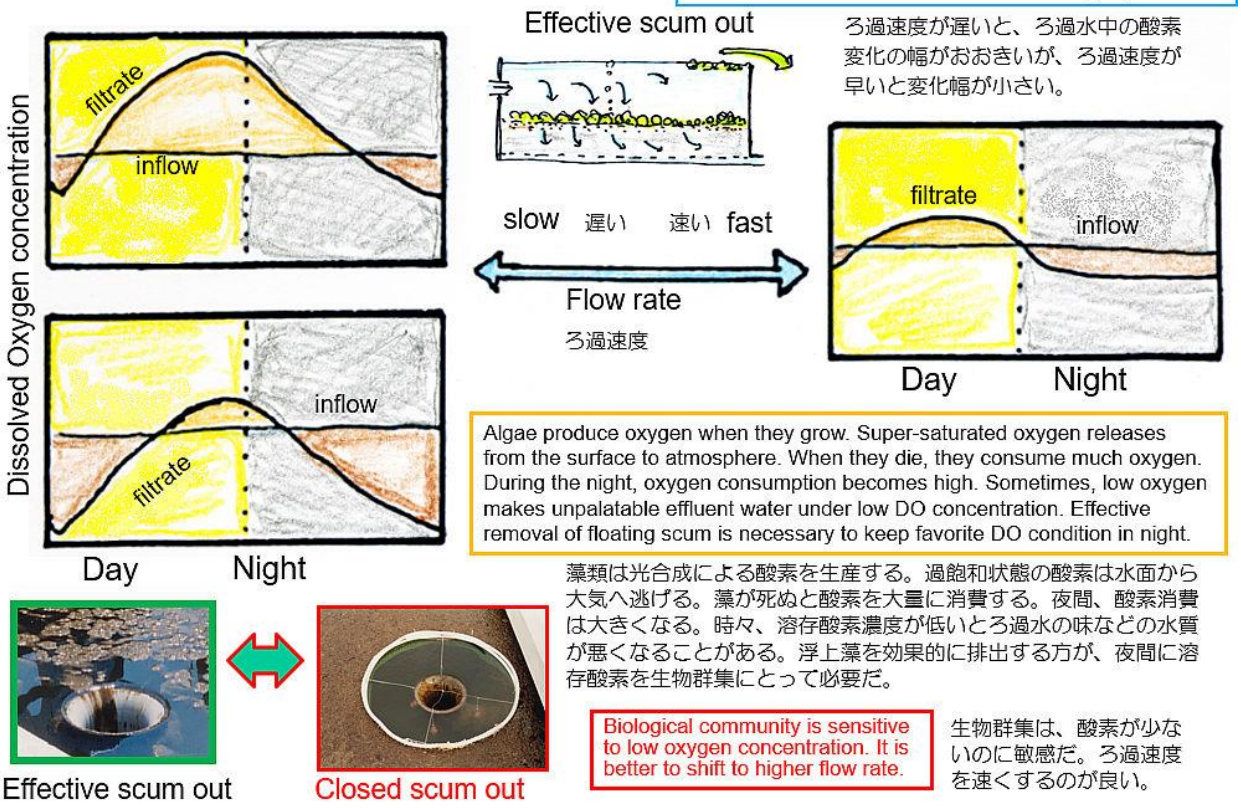


藻類の連続培養状態は、夜間でも砂層内を好気的に保つ。

32

Importance of effect of scum outlet and DO change related with flow rate.
浮上藻の越流、流速とろ過水の溶存酸素濃度の関係

Large fluctuation is observed under low speed of filtering rate. Small fluctuation is observed under high speed.



Algae produce oxygen when they grow. Super-saturated oxygen releases from the surface to atmosphere. When they die, they consume much oxygen. During the night, oxygen consumption becomes high. Sometimes, low oxygen makes unpalatable effluent water under low DO concentration. Effective removal of floating scum is necessary to keep favorite DO condition in night.

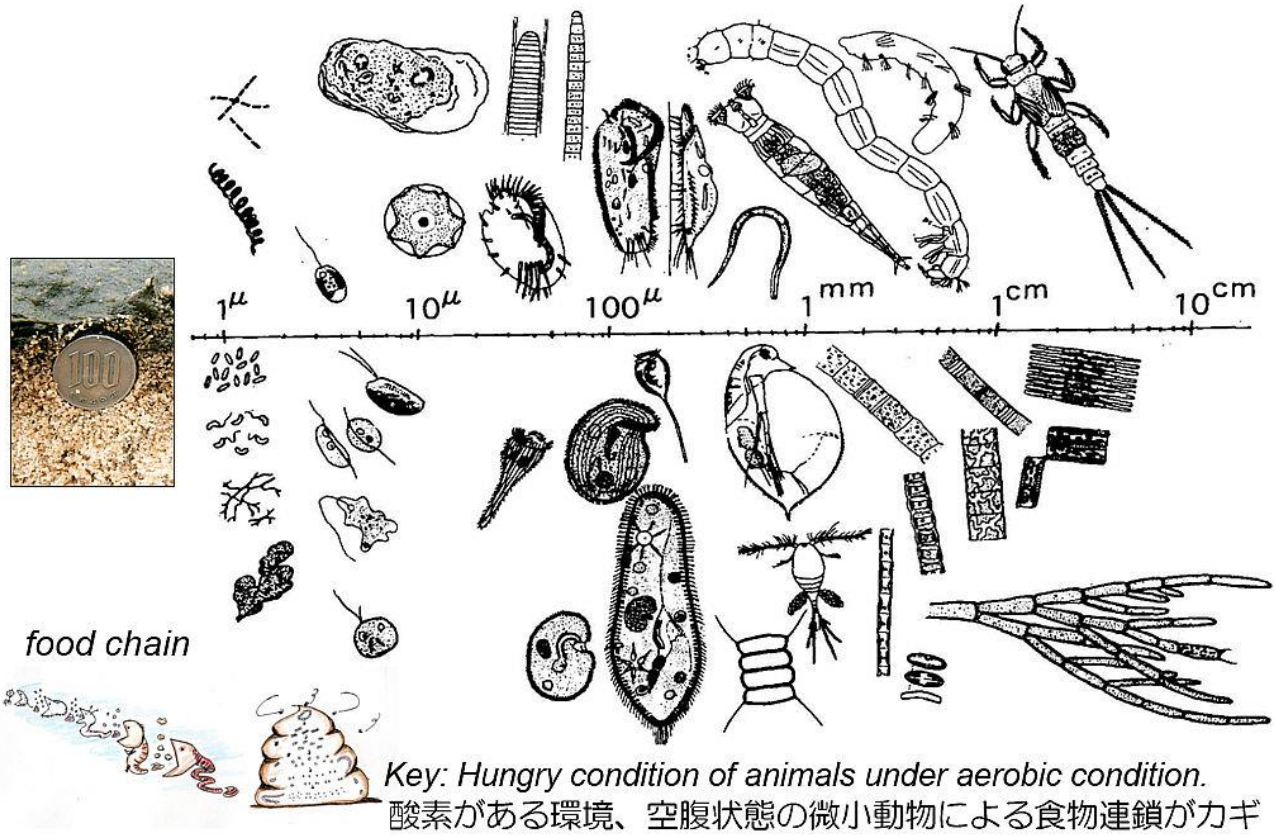
藻類は光合成による酸素を生産する。過飽和状態の酸素は水面から大気へ逃げる。藻が死ぬと酸素を大量に消費する。夜間、酸素消費は大きくなる。時々、溶存酸素濃度が低いとろ過水の味などの水質が悪くなることがある。浮上藻を効果的に排出する方が、夜間に溶存酸素を生物群集にとって必要だ。

Effective scum out　　Closed scum out

Biological community is sensitive to low oxygen concentration. It is better to shift to higher flow rate.

生物群集は、酸素が少ないのに敏感だ。ろ過速度を速くするのが良い。

33



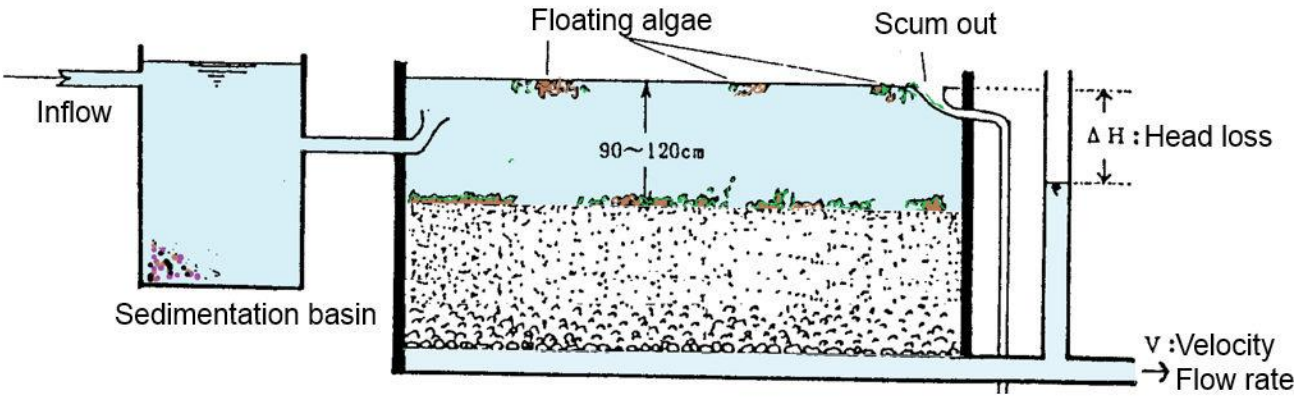
Key: Hungry condition of animals under aerobic condition.
酸素がある環境、空腹状態の微小動物による食物連鎖がカギ

Animals collect and take anything into mouth and produce fecal pellet.
動物は、何でも捕捉し、口に入れ、糞塊にする。

34

Clog indicator: Head Loss (Filter Resistance) is proportional to flow rate.

ろ過閉塞指標:損失水頭（ろ過抵抗）は流速に比例する。



Clog indicator: Head loss（ΔH)

Head loss（ΔH) is proportional to velocity (V).

$\Delta H = kV$

Normal filter rate is 20cm/h (4.8m/d ： Vn).

世界的には、実測の損失頭を標準ろ過速度（4.8m/d)でろ過した場合に換算した損失水頭（標準化ろ過水頭）の値をろ過抵抗の指標として用いられている。

NHL(Normalized Head Loss ：Hn) at normal flow rate can calculated by the observed head loss and the observed flow rate.

NHL: Normalized head loss：Hn (cm)

$Hn=(H \times Vn) \div V$

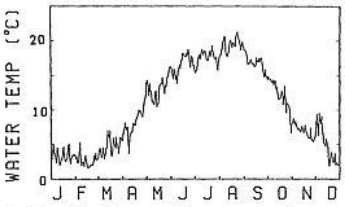
Observed head loss：H (cm)

Observed flow rate：V (cm/h or m/d)

Normal flow rate：Vn (20cm/h or m/d)

Filter run and filter resistance (NHL) in Ueda, Nagano, Japan, 1988. 上田市染屋浄水場におけるろ過継続とろ過抵抗

During water temperature is less than 5 C in cold winter, filter resistance rapidly increased. When algae grow in spring (May), resistance did not increase.



流入水温が5度以下の時期は、ろ過抵抗は急激に上がる。ろ過池で藻類繁殖が見られる5月からろ過抵抗は一切上がらなくなる。

In cold season, air bubbles are trapped among sand layer after scraping. However, in warm period these bubbles are easily released. This phenomena is due to the viscosity of water.

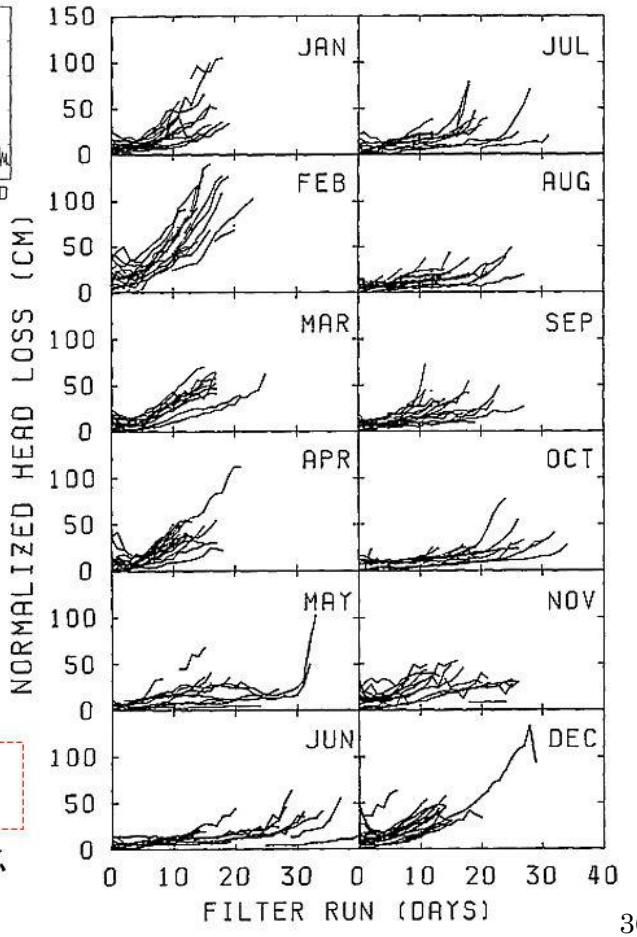
流入水温が5度以下の時期は、砂層表面削り取り時に、砂層内に気泡が入り、ろ過開始時にろ過抵抗は上がる。やがて、この気泡が無くなるので抵抗が小さくなる。水温が上がると、この気泡は、簡単に消失する。この現象は、水の粘性変化による。

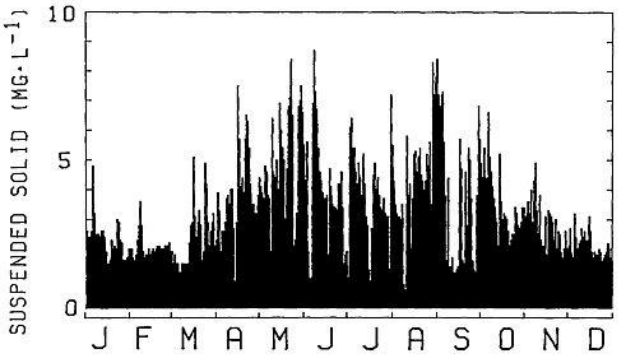
In summer, at the end of filter run, head loss increased rapidly. It was caused by suddenly rapid change of high filter rate before scraping event.

夏にろ過継続の最後にろ過抵抗が急激に上昇するのは、削り取り前に、急激にろ過速度を上げるために砂層上部で捕捉されていた懸濁物が砂層内に落ち込むためと考えられる。

This result indicates that filter does not clog over 5 C temperature in inflow water.

この結果は、流入水温が5度以上なら、ろ過池は、ろ過閉塞しないことを意味している。



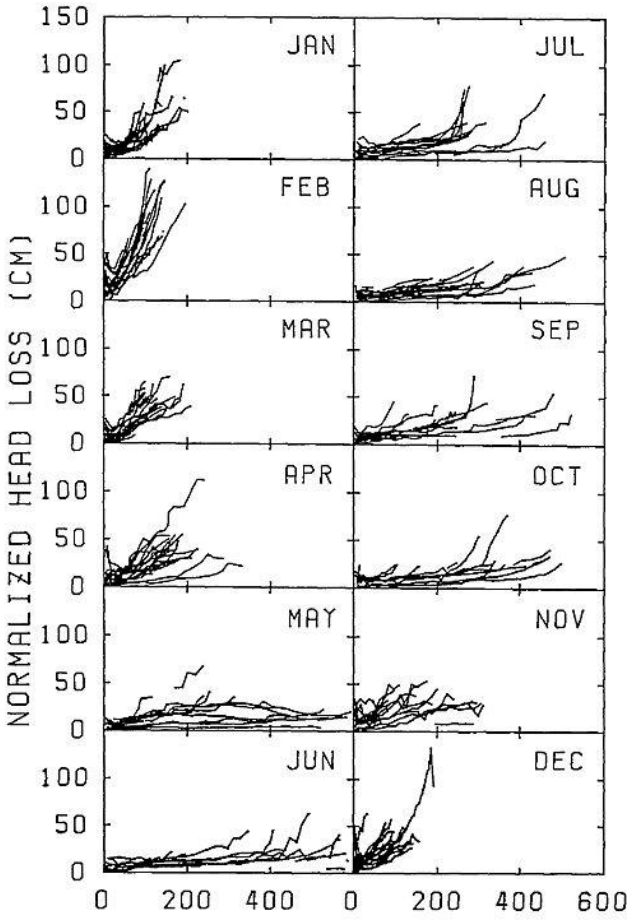


In summer, filter resistance does not increase even high turbidity after sedimentation basin. High biological activity is the most important to keep the low filter resistance.

生物活性が高い夏は、沈殿池後の流入懸濁物が多くなってもろ過抵抗は上がらない。生物活性を高くすることがろ過抵抗を小さくするのに大切。

Continuous culture system of filamentous algae is important. Small animals are also important in this system to collect particles and to keep a better condition of filter.

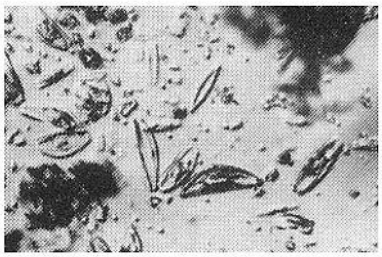
糸状藻類の連続培養系が良い。あらゆる濁りを捕捉する微小動物の活躍が大切。これらの動物群集は、ろ過池の砂層を良い状態に保つ。

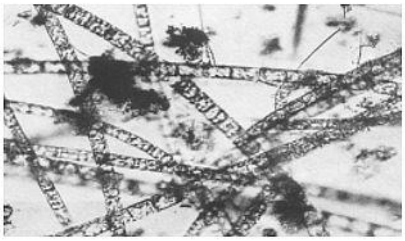


ろ過池の砂層表面への流入懸濁物負荷

Don't use coagulant, algaecide for pre-treatment.
Small organisms are sensitive to small amount of chemicals.

前処理に凝集剤や殺藻剤は使ってはいけない。
微小生物は、少しの薬品でも敏感に反応する。



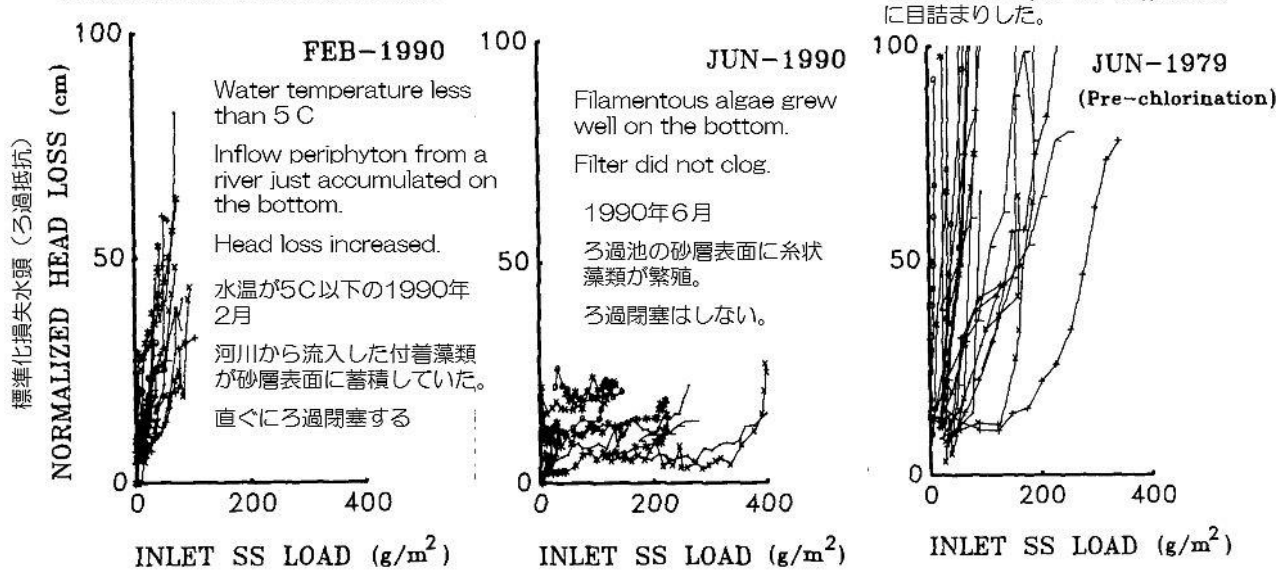


In June 1979, pre-chlorination was treated in order to prevent algal growth in the filters.

The filters quickly were blocked like in cold winter.

1979年6月、ろ過池で藻類繁殖を防ぐために、前処理で塩素を添加していた。

ろ過池は寒い冬（2月）の様に直ぐに目詰まりした。



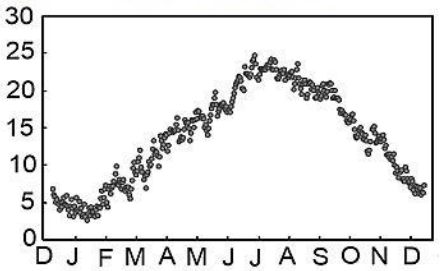
ろ過池への流入懸濁物負荷

Wakata plant, Takasaki city, Gunma, Japan

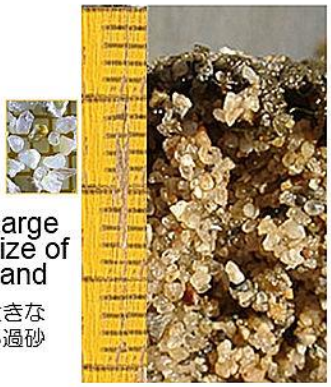
Surface water of river ⇨ Sedimentation basin ⇨ Slow Sand Filter

Filter does not clog in all the year.

高崎市若田浄水場は1年中ろ過閉塞しない

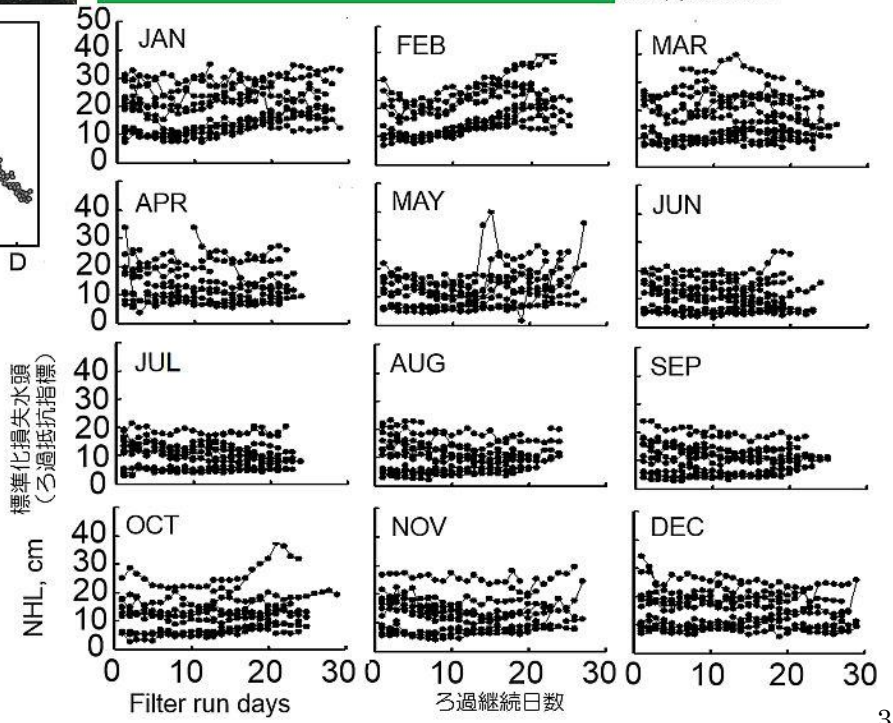


Inflow water temperature (C) to the filters: from Dec, 2003 to Dec.2004.



Large size of sand

大きなろ過砂



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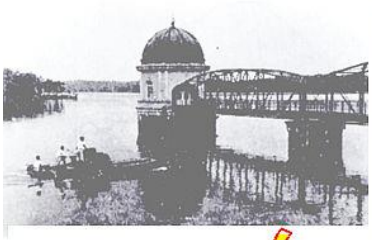
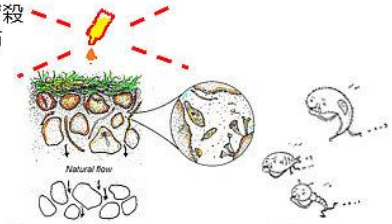
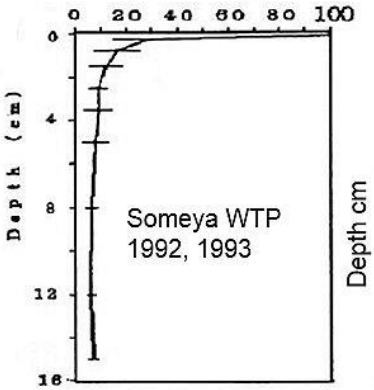
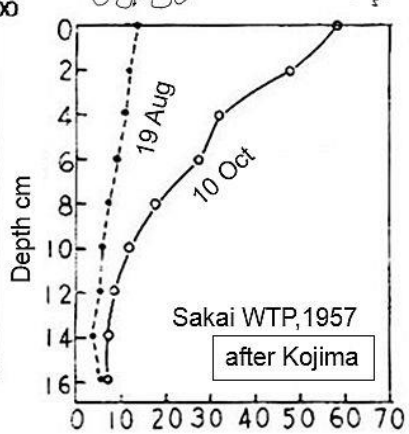




Phytoplankton from the reservoir is just accumulated on the filter bed. There is no growth of algae in this filter due to the influence of algaecide in the reservoir.

ろ過池の砂層表面には貯水池で繁殖した植物プランクトンが蓄積している。ろ過池では藻類は繁殖してない。

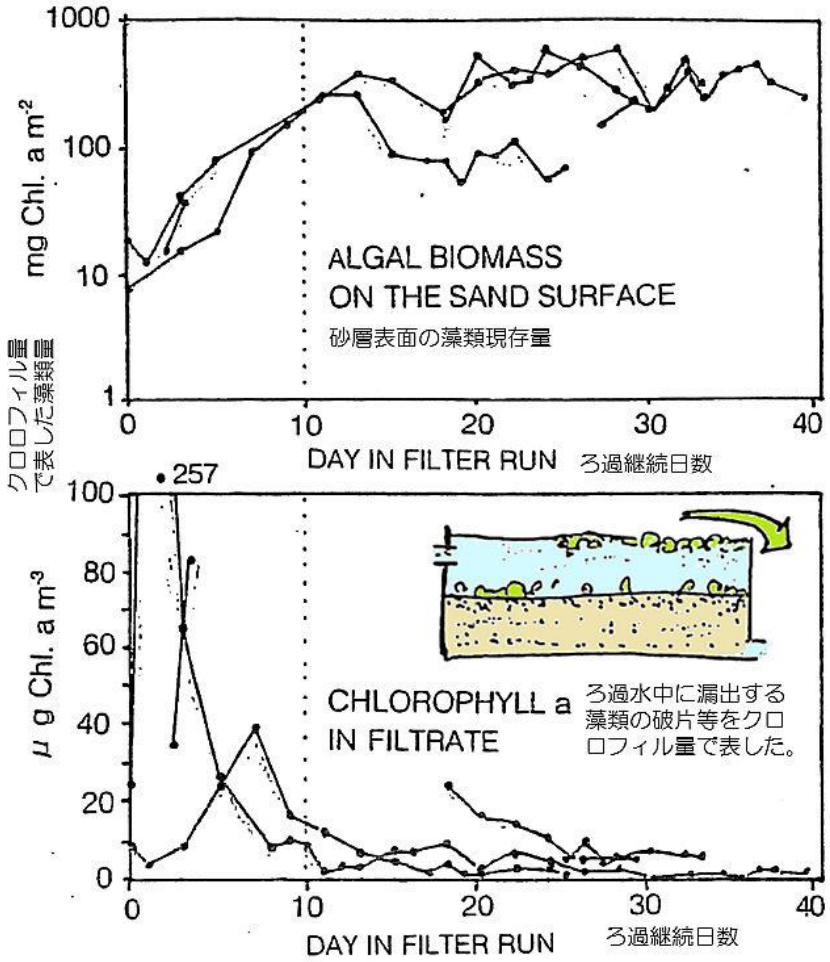




Microscopic organisms is very sensitive to small amount of toxin.

微小生物は、微量の毒物質にも敏感に反応する。

40



Algae grow well in summer. Continuous culture system of filamentous algae becomes after 10 days.

夏は糸状藻類の繁殖は良い。約10日で連続培養状態になった。

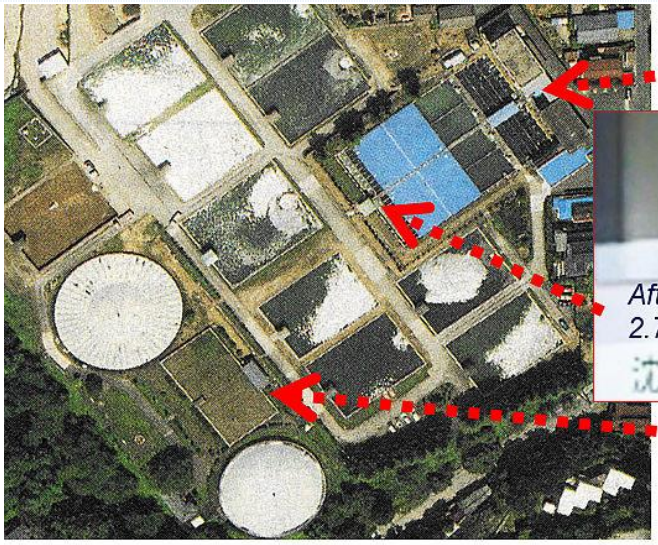
Filtrate water became clear water in 10 days. Grazing animal community grew well within 10 days.

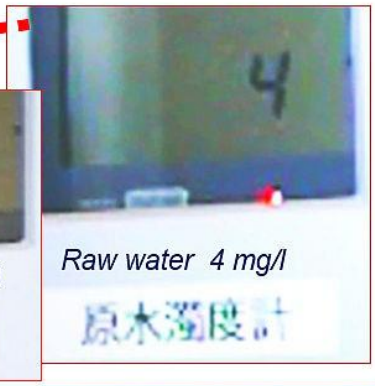
ろ過水は約10日で清澄になった。捕捉動物群集が発達したことを意味する。

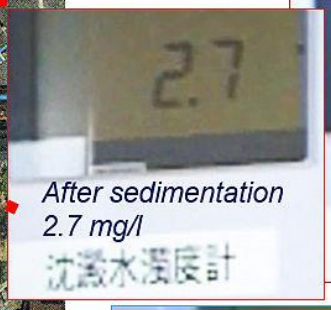
In summer, scrapping of surface mud is not necessary.

夏は、削り取り作業は必要ない。

41







Quality of filtrate can be evaluated by turbidity. Someya Water wks (1st May, 2012) produced "Super clean filtrate" of 0.000 mg/l.

ろ過水の水質は濁度計で確認できる。2012年5月1日の染屋浄水場のろ過水濁度は、0.000 mg/lで"超清澄な水"であった。

Japanese standard level is 2.0 mg/l and recommended level is 0.1 mg/l after cryptosporidium accident.

日本の水道水基準の濁度は、2.0 mg/l、クリプト事故後、望ましい濁度基準は0.1 mg/l と指導している。

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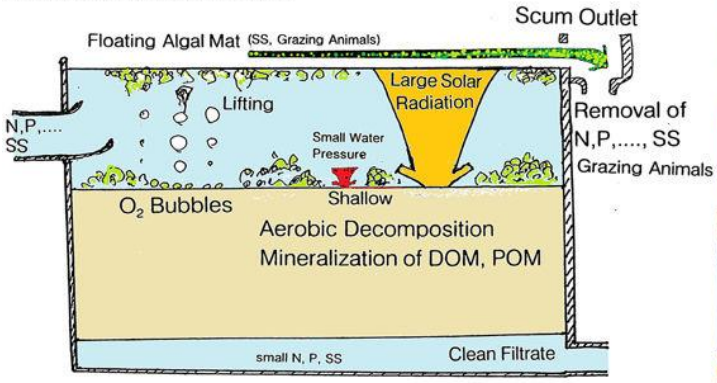
Shallow depth is important for algal activity.
浅い水深は藻類に重要

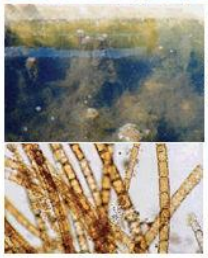


$$106CO_2 + 16HNO_3 + H_3PO_4 + 122H_2O + \text{Minerals} \rightleftarrows (CH_2O)106(NH_3)16H_3PO_4 + 138O_2$$

Algae produce oxygen by photosynthesis. Algal growth promotes heterotrophic activity (bacteria, animal), removal of nutrient and suspended matter and prevention of filter clog.

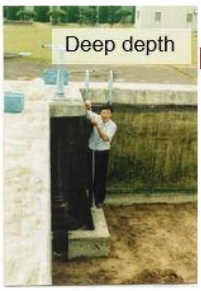
藻は光合成により酸素を生産。細菌や動物活性が良くなり、栄養塩や濁りも除け、ろ過閉塞も防止する。

When no growth of algae was observed on the filter bed in winter, active growth of filamentous diatom was observed in a shallow model.
冬、ろ過池の底では藻類の成長が見られなかったが、浅い実験モデルでは糸状珪藻の繁殖が凄かった。

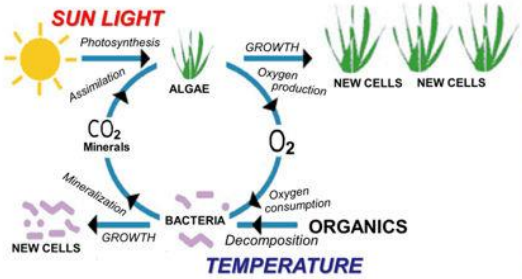


Active growth of filamentous diatom was observed in a pool in flood plain in cold winter where the grazing activity by animal was weak in cold water.

冬、河原の浅い場所では、糸状珪藻の繁殖が見られた。水温が低いので捕食動物の活性が悪い。



From deep depth to shallow depth.
深い水深を浅く。

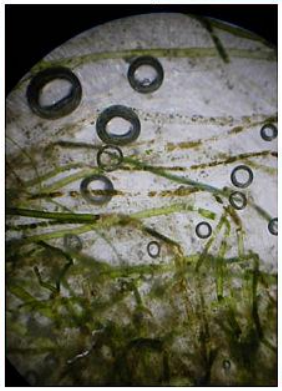


Coral Island :Miyako Jima, Okinawa.
隆起サンゴ礁の島、宮古島

Water source of Sodeyama Plant is underground hard water which contains high concentration of calcium carbohydrate.
袖山浄水場の水源は地下水で炭酸カルシューム濃度が高い。

They believed algal bloom produced odor problem, they injected chlorine as algaecide to raw water. After stopping of chlorine injection from July 1997, tap water became suddenly better taste (and soft water). However, heavy algal bloom happened in filter pond.

人々は藻類が繁殖するのは水道水に臭いを付けるとして、原水に殺藻目的として塩素を添加していた。1997 年7月に前塩素処理を中止したところ、住民から「水道水がおいしくなった」との反響があった。しかし、ろ過池では藻の繁殖が著しくなった。



Dropping a vinegar drop into slide glass, bubbles formed and crystals were disappeared.

スライドグラスに酢を滴下すると泡が生じ、結晶は消失した。

Calcium carbohydrate crystals were observed on algal filament under microscope.
顕微鏡で観察すると糸状藻類に白い四角の結晶がみられた。

Bio-mineralization is occurred by algal photosynthetic activity under high pH condition. Saturated calcium carbohydrate was crystalized. This phenomenon means softening under high pH condition and reduction of nutrient by algal growth.

生物による鉱物化（バイオミネラリゼーション）が藻類の光合成により高いｐＨ環境になり生じていた。飽和状態の炭酸カルシュウムが結晶化した。この現象は高いｐＨで、軟水化、栄養塩の除去が生じているのを意味していた。

Phenomena of Ecological Purification System(EPS) related with algae

藻類に関連するEPSの現象

☆Oxygen Production by Photosynthesis $CO_2+H_2O \rightarrow CH_2O+O_2\uparrow$

Gives a better condition for heterotrophs. (Decomposer: bacteria, small animals)
光合成による酸素生産：従属栄養生物（分解者：細菌、微小動物）に良い状態にする。

☆Reduction of Nutrients in Water by Algal Growth 藻類成長による栄養塩削減

$$106CO_2+16HNO_3+H_3PO_4+122H_2O+(micronutrients,energy)$$

↓ Photosynthesis 光合成　　↑ respiration, decomposition 呼吸・分解

$$(CH_2O)_{106}(NH_3)_{16}H_3PO_4 + 134O_2\uparrow + micronutrients$$

Oligo-trophication (opposite process of eutrophication:shift to less polluted water)
貧栄養化：富栄養化の逆：汚染が少ない方向へ

☆Production of Food and Energy Source for Heterotrophic Organisms 従属栄養生物へのエサとエネルギー生産

Alga is one of the best food for animals in EPS.
藻は動物の最良のエサ

☆Shift to High pH and High DO Concentration by Photosynthesis 光合成でｐＨを高く、酸素濃度を高くする

(Low CO_2 concentration shifts to high pH condition)
低炭酸ガス濃度は、ｐＨを高くする

Easily precipitate:***bio-mineralization***

Metal ions are easily changed to hydro-oxide compounds. 容易に沈積：バイオミネラリゼーション
金属イオンは容易に水酸化化合物になる

Reduction of metal ions : Reduction of toxic heavy metals 金属イオン減少：毒性重金属イオン減少

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K-wks: Raw water: SS free water of underground subsurface water which is taken several under drainage pipes in the flood plain. Filter does not clogged due to SS free water. Standard flow rate is 8.5 m/d (K.K.) and 9.5 m/d (K.S.).

原水は濁りがない河原の伏流水で濁りがなく、ろ過閉塞しない。標準ろ過速度は8.5m/d,9.5m/dだ。

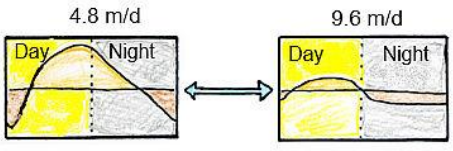
However this plant operated less than 2m/d. The bloom of algae were remarkable, dissolved oxygen consumed up during the night. Then, they tried to kill the algae. Finally, they covered the filter. At present time, this plant changed to membrane filter plant.

しかし、2m/d以下のろ過速度で運転し、栄養塩が多いのでろ過池で糸状藻類が大繁殖し、夜間に酸素不足になった。そこで、殺藻剤を添加、ろ過池を覆ってしまった。現在は膜処理になった。

Underground water is source water of Nishihara plant, Nagano. This plant does not clog over 5 years even in cold region. This plant is maintenance free filter.

長野県須坂市西原浄水場の原水は山の麓の地下水。建設して5年間以上も、削り取りなしでろ過閉塞しない。

Thames Utility made an experiment to cover a practical filter pond to control the heavy algal bloom in 1998. Finally, in order to prevent low oxygen concentration in water, Thames utility selected an open filter under higher flow rate of 9.6 m/d.



テムス水道は、酸素不足を解消するために、ろ過池を覆う実験をし、結果は、オープンでろ過速度を速くした。

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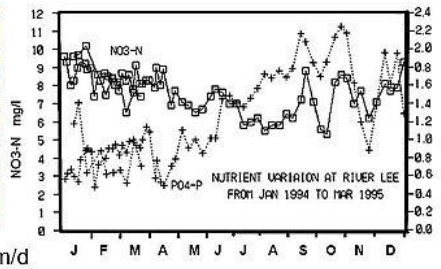
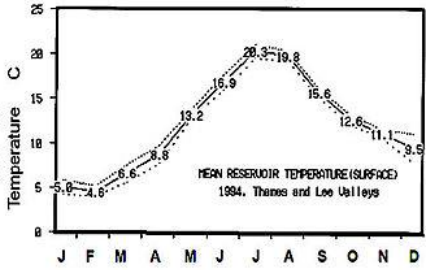
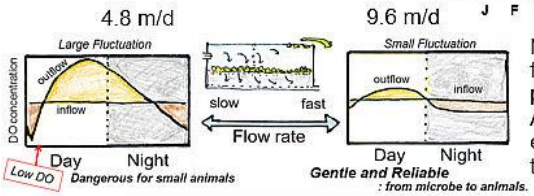






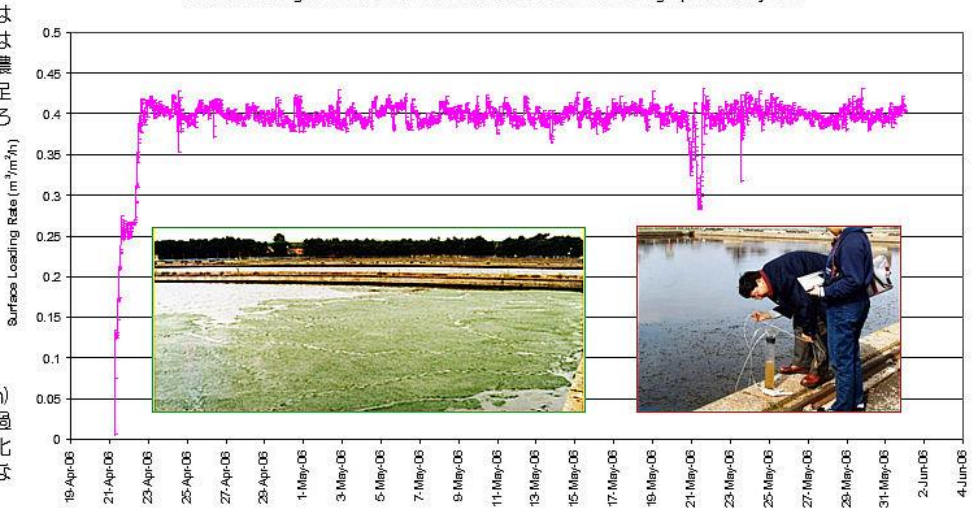
Nutrient level of raw water is highly rich. Algal growth is always remarkable, filamentous diatom in cold season, and filamentous green algae in warm period. This change from diatom to green algae is caused by grazing animals. And DO fluctuation is large in filtrate water. There is serious level of DO in early morning. Thames utility made various experiments on flow rate. Finally they decided faster flow rate was the best solution to make better filtrate.

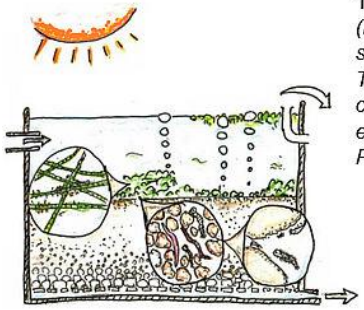
原水の栄養塩濃度は極端に高いので、藻類繁殖は一年中ものすごく、冬は珪藻、夏は緑藻である。この変化は捕食動物の活性による。溶存酸素濃度の変化は顕著で、朝方に酸素不足になる危険性があり、実験をし、ろ過速度を速くした。

All the plant of Thames waterworks adopted 9.6m/d (0.4m/h). Higher flow rate makes better quality in the filtered water. Diurnal change of DO in filtrate becomes small. It is better to avoid low oxygen concentration in the morning.

テムス水道は、9.6m/d (40cm/h) を採用した。ろ過速度を上げ、ろ過水の水質が良くなった。酸素日変化幅が小さくなり、朝の酸素不足にならなくなった。

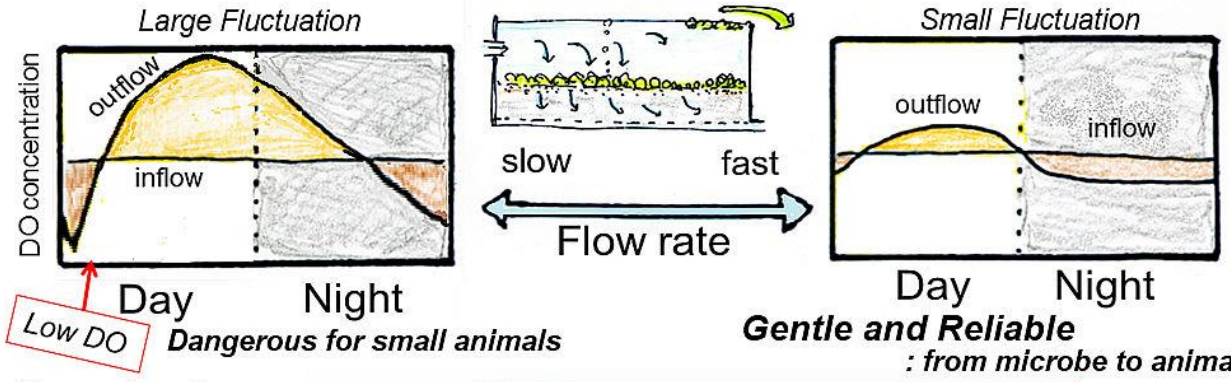
Surface Loading Rates for a SSF at Ashford Common AWTW during April and May 2006



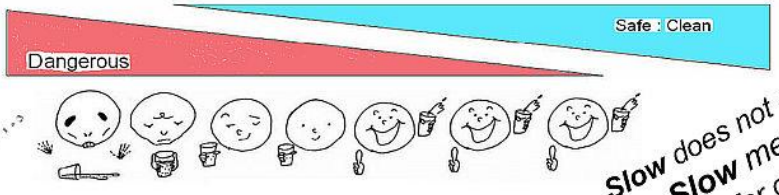


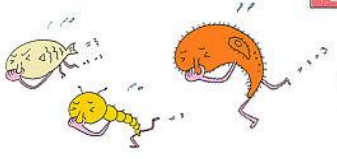
1. Algae produce oxygen under the sunshine. 2. Algae and other hetero-trophic organisms (bacteria, protozoa, other small animals, etc.) consume DO in night. 3. And algae are food for small animals. 4. Small animals on and at the top of sand layer graze any particulate matters. 5. They live near the surface of sand layer. 6. And these animal among sand grains avoids filter clog. 7. A large biomass of algae and animals occurs a large fluctuation of DO in filtrate. 8. In early morning, DO in filtrate becomes sometimes serious level in case of slow flow rate. 9. Faster flow rate makes better environment for small animals. 10. This is gentle for small animals.

1．藻類は光合成で酸素を生産。2．藻類および従属栄養生物（細菌、原生動物、微小動物）は夜も酸素を消費する。3．藻は動物のエサ。4．砂層面、表面直下の微小動物は何でも捕捉し食べる。5．微小動物は砂層表面近くに住んでいる。6．砂層粒子間に生息する動物は、ろ過閉塞を防止する。7．藻類や従属栄養生物（動物）の量が多いと溶存酸素濃度の日変化が大きくなる。8．ろ過流速が遅いと、朝方、溶存酸素濃度が少なくなり危険になる。9．ろ過速度が速いと動物にとって酸素濃度が十分になり良い。10．これは、微小動物にとって「やさしい」。

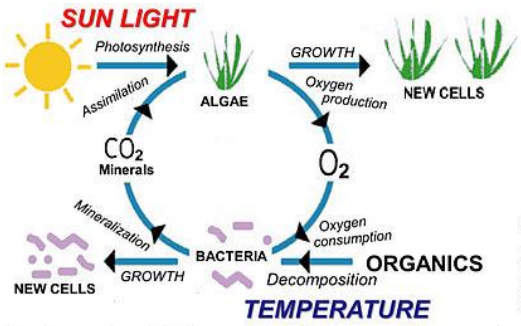


They rush and escape from a risky water.





*Slow does not express **Speed**.*
***Slow** means **Gentle** for organisms.*

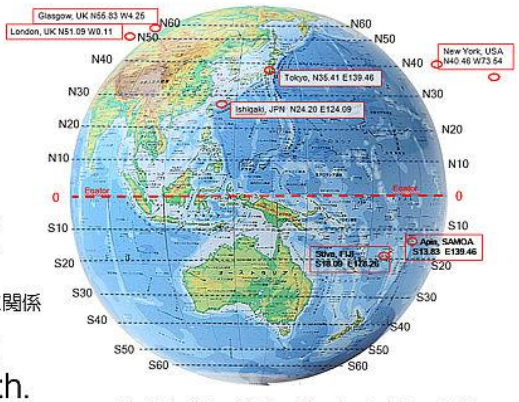


Production of Oxygen relates with radiation (photosynthesis).

酸素生産は日射量（光合成）に関係

Consumption of Oxygen relates with temperature (respiration).

酸素消費は温度（呼吸）に関係



Saturated Dissolve Oxygen in water is related with temperature, atmospheric pressure and water depth.

溶存酸素濃度は温度、気圧、水圧に関係する

Dsat(O2 mg/l)=14.161 - 0.3943xT + 0.007714xTxT - 0.0000646xTxTxT
Dabsat(O2 mg/l)= Dsat x (Ba+Bw)/1013
T:C:temperature, Ba:hPa:atmospheric pressure, Bw:cm (water depth)

Saturation (Equilibrium) dissolved oxygen

Cold water	Hot water
Large DO	Small DO
Low Activity	High Activity

Shallow water	Deep water
Small Pressure	Large Pressure
Small DO	Large DO

Easy to Aerobic

水温が低い
酸素豊富

Easy to Anaerobic

水温が高い酸素不足になりやすい

High Altitude	Low Altitude
Small Pressure	Large Pressure
Small DO	Large DO

溶存酸素濃度は海抜（気圧）と水温に関係

Saturation DO at altitude and temperature					
mgO2/liter			Truesdale et al. 1955		
	meter above sea level				
Temp.	0	500	1000	2000	3000
0	14.16	13.29	12.51	11.11	9.80
10	10.92	10.25	9.65	8.57	7.56
20	8.84	8.30	7.82	6.94	6.12
30	7.53	7.07	6.65	5.91	5.21
40	6.60	6.19	5.83	5.18	4.57

溶存酸素濃度は水深（水圧）と水温に関係

Saturation DO at depth and temperature					
	mg O2/liter				
		depth,cm			
Temp.	0	50	100	150	200
0	14.16	14.86	15.56	16.26	16.96
10	10.92	11.46	12.00	12.54	13.08
20	8.84	9.28	9.71	10.15	10.59
30	7.53	7.90	8.27	8.65	9.02
40	6.60	6.92	7.25	7.57	7.90

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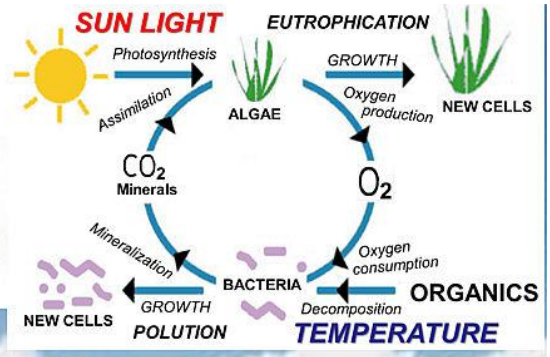
Water purification process is based on the activity of heterotrophic organisms from bacteria to small animals that is food chain. Presence of dissolve oxygen is necessary for these organisms.

水の浄化は、微生物および微小生物群集の活躍・食物連鎖による。溶存酸素が無いと、微小動物は活躍できない。

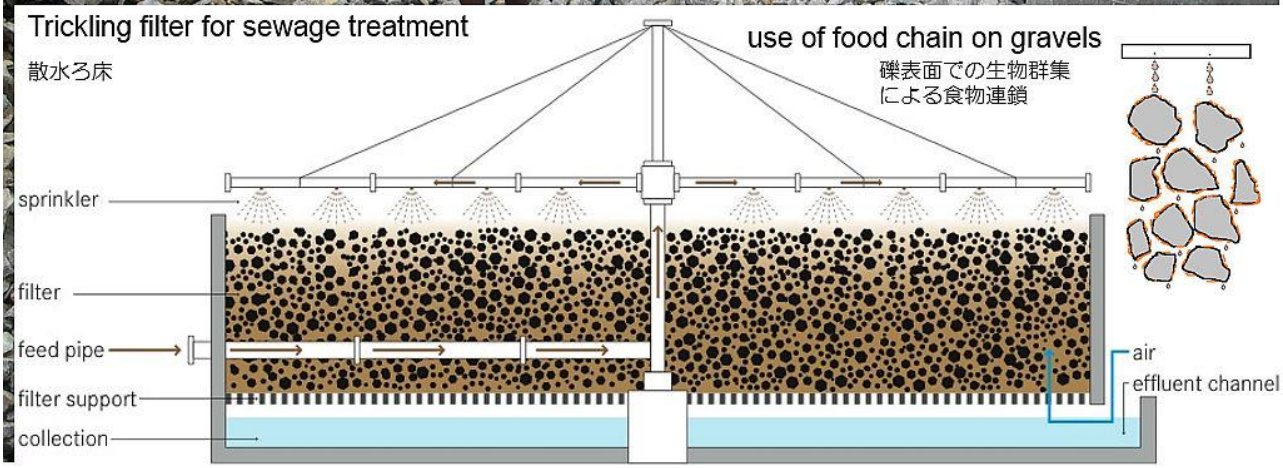


The Thames Bubbler is a boat operated by Thames Water to monitor oxygen levels and oxygenate the river.

テムズバブラー：テムズ河の溶存酸素濃度が少なくなったときに、曝気する。

50


Application of EPS for sewage treatment
生物群集による浄化：生物浄化法の下水処理への応用


Trickling filter for sewage treatment
散水ろ床
use of food chain on gravels
礫表面での生物群集による食物連鎖
sprinkler
filter
feed pipe
filter support
collection
air
effluent channel

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Trickling filter for sewage
散水ろ床
散水ろ床
覆い散水ろ床
Covered trickling filter

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Pre-Treatment is the key for easy maintenance of EPS.

Basic points are how to treat for Suspended Matter and Reduced Substances (biologically toxic matter).

Don't use chemical treatment.
Ordinal organisms don't like any chemicals.

Surface water from stream

Avoid too much direct load of SS to EPS
(Sedimentation, Roughing Filter)

Acceptable normal SS load
We can see the bottom surface. Make a shallow depth.

Lake water (There is a possible intake oxygen deficient water originated from bottom.)

Aeration and Roughing Filter

Algae is food for animal. Algae is not any problem of odor and filter clog in case of EPS.

Subsurface water (underground water: well, spring)

Check the taste, DO concentration, Iron and Manganese.
Oxygen deficient water: Aeration and Roughing Filter

原水の前処理が EPSの維持管理を楽にする

濁りと還元物質（生物毒）対策が基本

⇒薬品処理は生物にやさしくない

河川表流水 ⇒沈殿、粗ろ過⇒リスク回避

（濁り⇒沈殿・粗ろ過）

ろ過池：底が良く見える程度：許容濁度

（水深を浅くする）

湖沼 （環期などで底からの酸素不足の水を取水の可能性あり） ⇒曝気＋粗ろ過

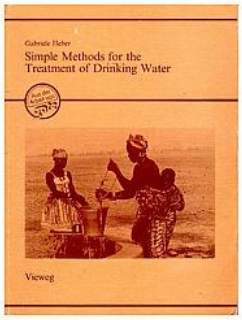
藻は動物のエサ、異臭味やろ過閉塞の原因にならない

伏流水（井戸・湧水）：味・溶存酸素チェック

（鉄・マンガン）

酸素不足⇒曝気＋粗ろ過

Key is "Gentle for small organisms".

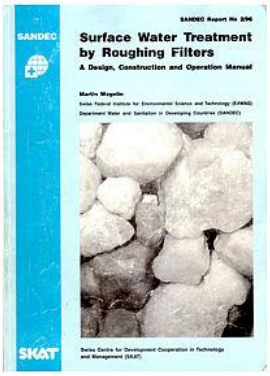


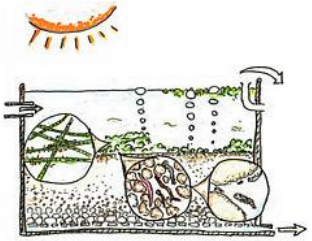
Gabriele Heber 1985

Simple Methods for the Treatment of Drinking Water

Martin Wegelin 1996

Surface Water Treatment by Roughing Filter





カギは微小生物にやさしく

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JICA training on EPS from 7th to 12th August, 2010 in Miyako and Ishigaki islands, Okinawa, Japan.

2010年8月7日～12日、宮古島と石垣島で、生物浄化法のJICA研修、2010年から3年間プロジェクト「島嶼における水資源保全管理コース」：サモア、トンガ、バヌアツ、ナウル、ニウエ、マーシャル、クック、ソロモン

This speech by Ms. Manista from Solomon islands on 1st September, 2010.

JICA研修の最後(2010.9.1)にソロモン諸島から参加したマリスタさんが研修生を代表して感謝の挨拶

It is also worth appreciating the Ecological Purification System as taught by you, Dr. Nakamoto; a simple, natural and yet an effective water purification technology, we can all agree to as the most relevant technology for the Islands. It is cheap to construct, operate and maintain which makes it even more attractive. We are grateful to your pioneering research on this technology and for generously impart this to us, so that the people of the pacific may in the very near future will have access to the high quality and delicious taste that this technology provides.

教わった生物群集による浄化方法（緩速ろ過）には大変に感謝しています。それは、簡単で、自然で、でも、水の浄化方法として効果的です。私たち全員、島国に最も適した技術として重要だと確信します。建設費、操作、維持に関する経費が安く、最も魅力的です。私たちにとって大変に重要な博士のバイオニアー的研究成果を惜しみなく私たちに伝えてくれ大変に感謝します。大洋州の人々は、近い将来、この技術で、良質でおいしい水を得ることができるでしょう。

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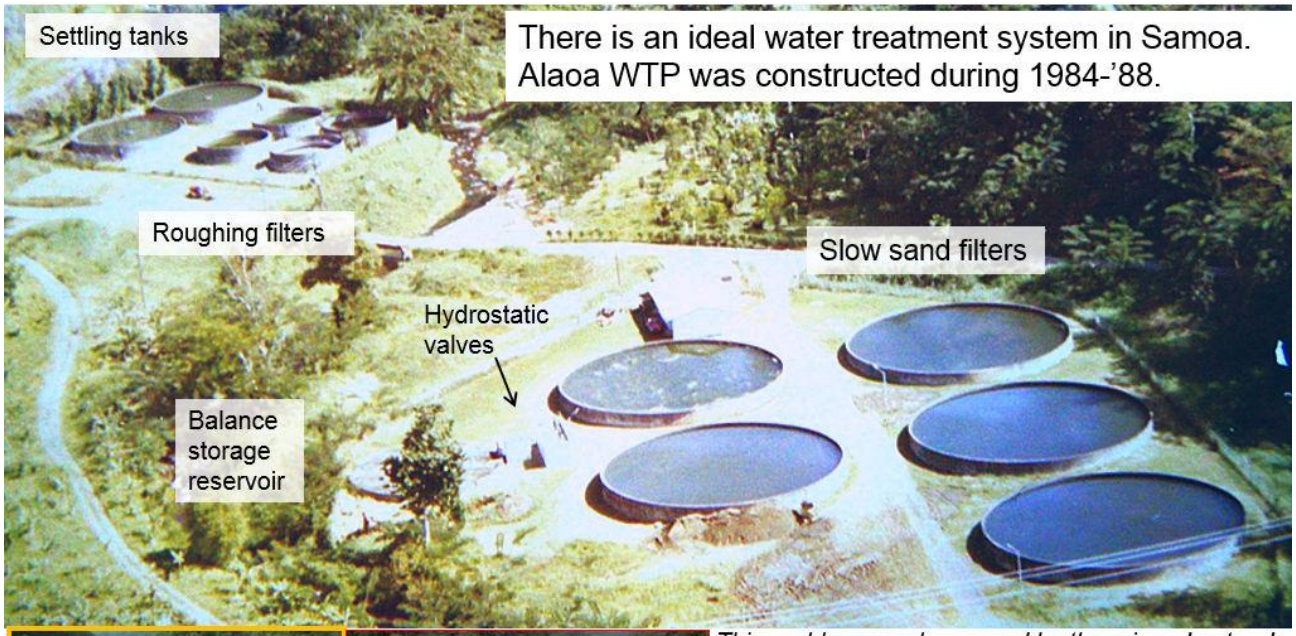

This problem was happened by the misunderstand of the real mechanism. Slow sand filter system is not simple mechanical filter. This is a real Ecological Purification System.

ろ過池が流入してくる泥水で閉塞するということが、頻発していた。閉塞の原因は、仕組みを理解してなく、浄水場の維持管理方法を誤解していた。

We solved the filter block problem by turbid water in Samoa, even in heavy rainy days.

豪雨の泥水が流入しろ過池は閉塞する問題を解決できた。

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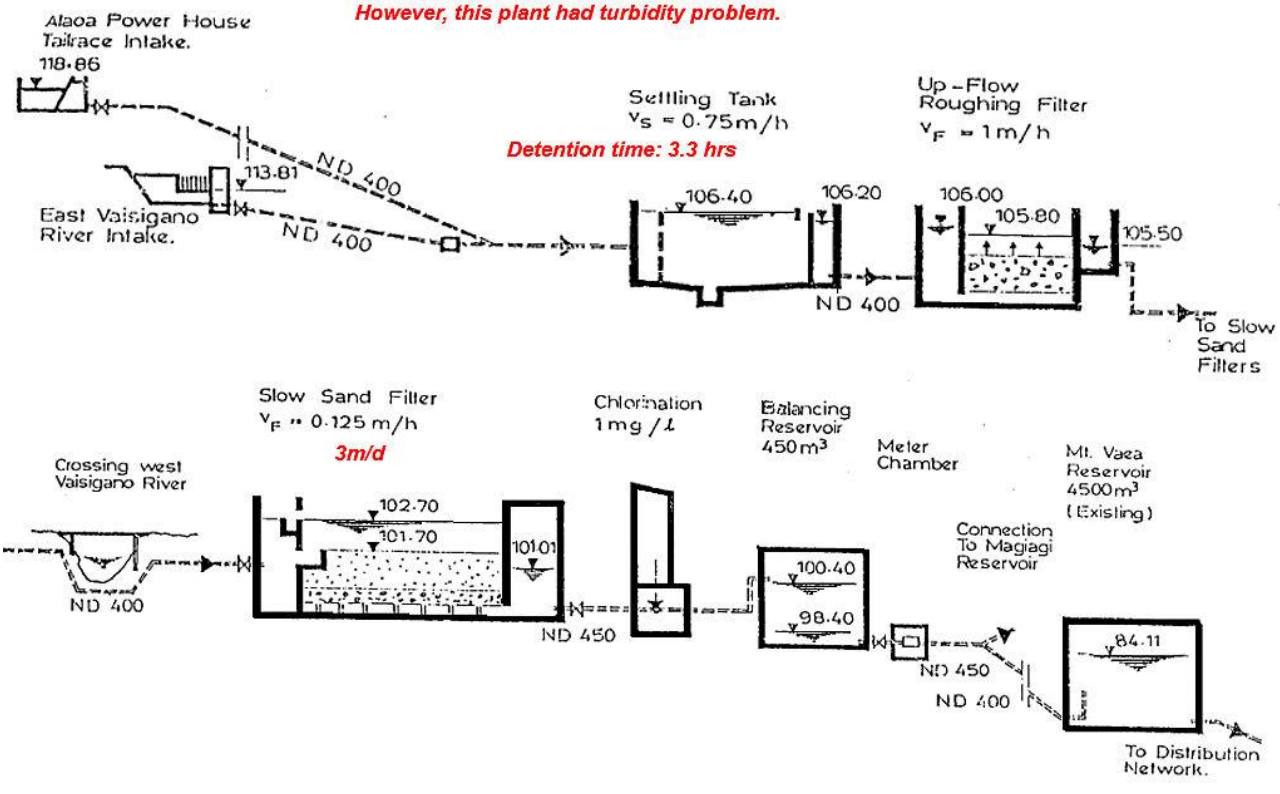
In Samoa, there are several slow sand filter plants. Three plants of JR type in Upolu island were constructed during 1984-'88. And two plants of EU type in both islands of Upolu and Savai and were constructed in 2002-'04. Alaoa plant had problem on turbidity during heavy rainy days.

サモアには、何か所かに緩速ろ過の浄水場があった。ウポル島には3ヶ所に1994-88年に建設されたＪＲタイプと、ウポルとサバイには2002－04年に建設されたＥＵタイプがあった。Alaoa浄水場のろ過池は豪雨の泥水でろ過池が閉塞する問題があった。

Original Alaoa plant design (JR type) adopted the natural gravidity.
However, this plant had turbidity problem.



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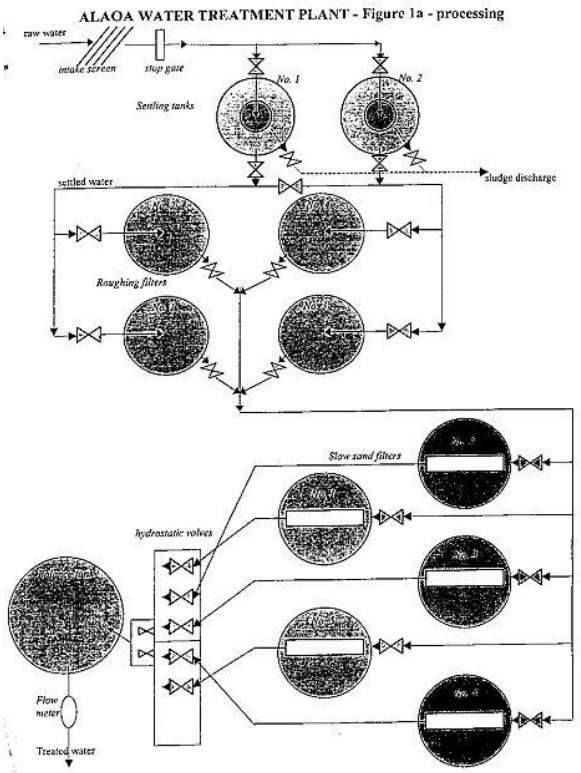
Jica project in Samoa, Nov.8-17,2008

Surface water from a river, settling tank, up-flow roughing filter and sand filter.

河川表流水⇒沈殿池⇒上向き粗ろ過⇒砂ろ過池



ALAOA / VAISIGANO WTP

FLOWS AND LOADING

Design Flow	ML/day	9.125	Actual Average	ML/day	12.096
	m^3/hour	380		m^3/hour	504
	L/s	105.6		L/s	140
				% increase over design	33

TREATMENT SYSTEM

Raw Water Intake Bar screen			
No. of units			1
Width	m	approx	1.25
Bar Aperture	mm		25
Settling Tank			
No. of tanks			2
Diameter	m		17.8
Surface Area	m^2		248.8
Side Water Depth	m		2.5
Tank volume	m^3		622.1139
Overflow Rate @ Design Flow	m^3/m^2.hour		0.76
Overflow Rate @ Actual Average Flow	m^3/m^2.hour		1.01
Detention time @ Design Flow	hours		3.3
Detention time @ Actual Average Flow	hours		2.5
Outlet Weir length (per tank)	m		53.7
ROUGHING FILTERS *(Gravel media)*			
No. of tanks			4
Diameter	m		11.2
Surface Area	m^2		98.5
Media Depth	m		2
Media volume	m^3		197.0407
Surface Loading Rate @ Design Flow	m^3/m^2.hour		0.96
SLR / design flow / 1 filter off-line	*m^3/m^2.hour*		*1.29*
Surface Loading Rate @ Act. Avg Flow	m^3/m^2.hour		1.28
SLR / actual average flow / 1 filter off-line	*m^3/m^2.hour*		*1.71*
Detention time @ Design Flow	hours		2.1
Detention time @ Actual Average Flow	hours		1.6
Backwash	Once every 2 weeks		
SLOW SAND FILTERS *(Sand mono-media)*			
No. of tanks			5
Diameter	m		28
Surface Area	m^2		616
Media Depth	m		1
Media volume	m^3		616
Surface Loading Rate @ Design Flow	m^3/m^2.hour		0.123
SLR / design flow / 1 filter off-line	*m^3/m^2.hour*		*0.154*
Surface Loading Rate @ Act. Avg Flow	m^3/m^2.hour		0.164
SLR / actual average flow / 1 filter off-line	*m^3/m^2.hour*		*0.205*
Detention time @ Design Flow	hours		8.1
Detention time @ Actual Average Flow	hours		6.1
Cleaning	Once every 3 months		
BALANCE TANK			
No. of tanks			1
Diameter	m		17.8
Side Water Depth	m		1.8
Active volume	m^3		447.9
Retention time @ Design Flow	hours		1.2
Retention time @ Actual Average Flow	hours		0.9

Gravel	
size (mm)	depth (mm)
4 - 7	750
7 - 10	500
12 - 18	1000
20 - 25	250

	size (mm)	depth (mm)
Sand media	0.15 - 0.60	1000
Supporting Gravel	2 - 4	100
	4 - 10	100
	10 -25	100

Follow up of Miyako-jima from 2010-2013.

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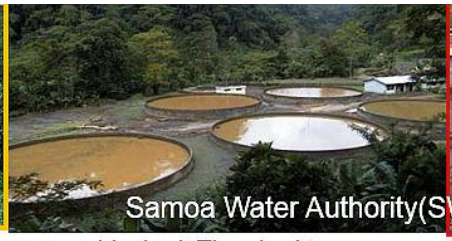
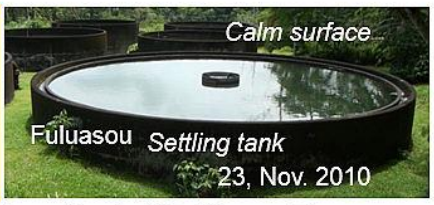
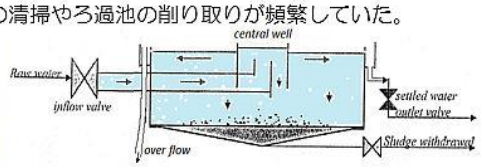


During heavy rainy days, sand filters were blocked. They had to remove mud frequently and to scrape the filter and to clean up the settling tank. 豪雨の泥水でろ過池が閉塞し、沈殿池の清掃やろ過池の削り取りが頻繁していた。

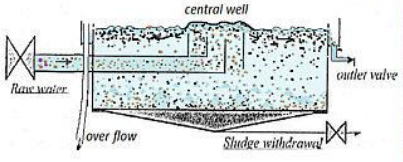




Alaoa浄水場への流入水流はFuluasouと比べると少なく、沈殿池での滞留時間は短かった。水面は波立って、河川の状態と同じだった。濁りは簡単に沈まず、粗ろ過を通過し緩速ろ過池まで流入していた。

The inflow water into Alaoa plant is larger than that into Fuluasou. The detention time is too short in Alaoa. This condition is same as river condition. Muddy matter is not easily settled down. And this muddy matter passed also the roughing filter and into the slow sand filters.

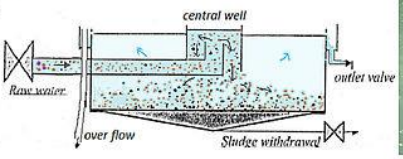
Design condition



We advised to reduce inflow valve

流入弁で水量を少なくする。

Calm surface



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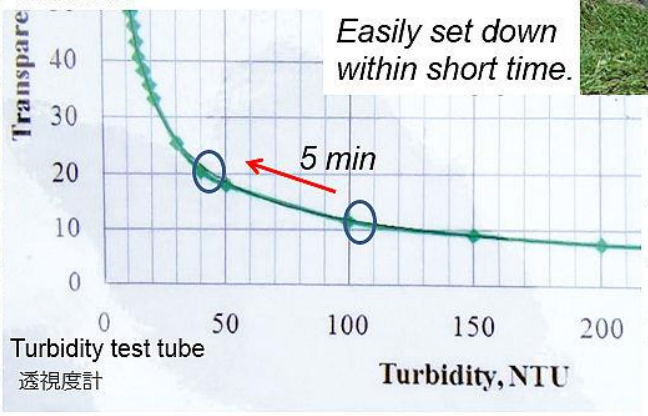
Original design of retention time of settling tank is **3.4 hours**. However, present retention time may be less than **several minutes**. This condition is same as river. Therefore, turbid matter does not sink. Too much water flew into the settling tank. Major amount of water flew out through the over flow outlet.

沈殿池の滞留時間は設計上は3.4時間。しかし、この状態は数分以内で、増水時の河川の状態だ。これでは濁りは沈まない。大量の流入水が入り込み、越流していた。



Easily set down within short time.

Turbidity test tube
透視度計

The sedimentation rate of this water was checked. Even this low turbid water, turbidity became less than half within 5 minutes.

濁りが少ない水でも、5分以内で半分以下に簡単に沈む。

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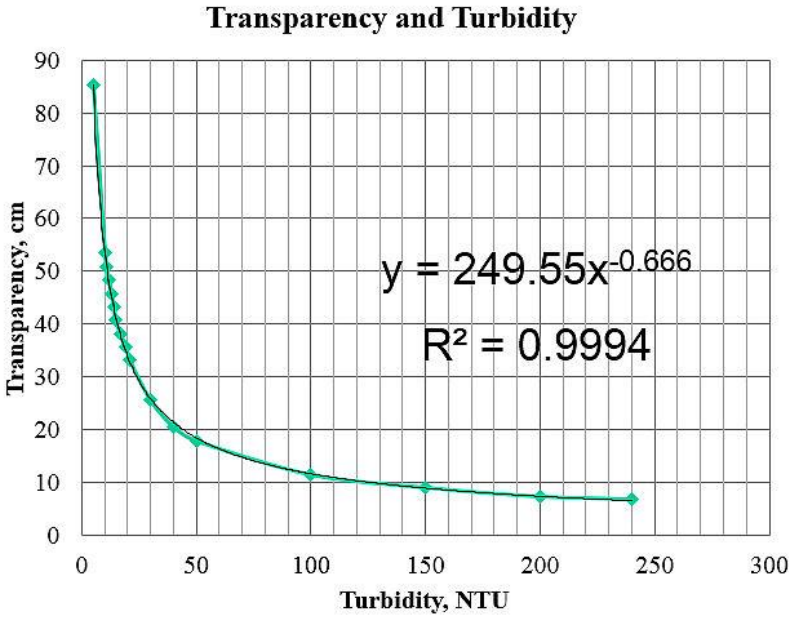
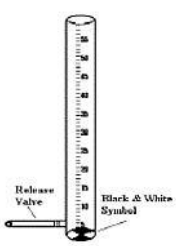
NTU	cm
10000	0.5
5000	0.9
4000	1.0
3000	1.2
2000	1.6
1500	1.9
1000	2.5
750	3.0
500	4.0
300	5.6
200	7.3
150	8.9
100	11.6
90	12.5
80	13.5
70	14.7
60	16.3
50	18.4
40	21.4
30	25.9
20	33.9
15	41.1
10	53.8
8	62.5
7	68.3
6	75.7
5	85.4
4	99.1
3	120.1

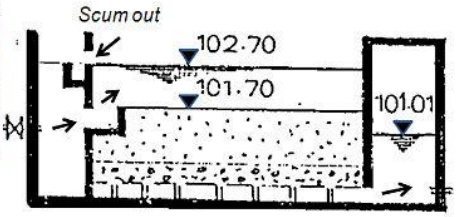


Transparency(cm) =249.55*POWER(*NTU*,-0.666)

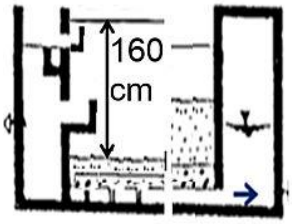
Data from:
http://www.cee.mtu.edu/sustainable_engineering/resources/technical/Turbidity-Myre_Shaw.pdf



60

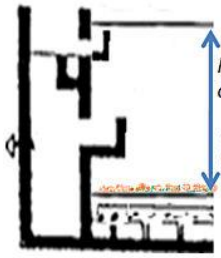


Original depth of supernatant is 1m.
設計上の砂面上の水深は１ｍ。



Shallow water depth(No.4): Bottom algal mat with mud lifts up from the bottom by the oxygen bubbles.

浅い水深（160 cm）のろ過池（No.4）では、底で繁殖した藻が光合成の気泡の浮力で泥と一緒に浮き上がっていた。

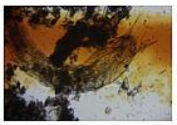


Thick mud layer was seen on the bottom at Alaoa No.1 deep filter on 26th Nov. 2010.

深い水深（220 cm）のろ過池（No.1）では、底には泥が厚く積もっていた。

Hardly growth of algae at the bottom due to low radiation. High pressure on the bottom. ***Easily block.***

深い水深で日射量が少なく藻類繁殖が悪く、水圧が高いのでろ過閉塞しやすい。



Algae grow well at shallow depth. This means a lot of food for animals.

水深が浅いなら藻の繁殖が良く、動物のエサも多くなる。

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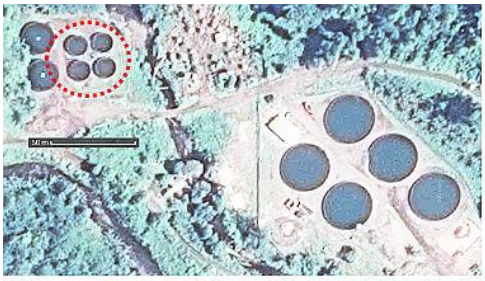


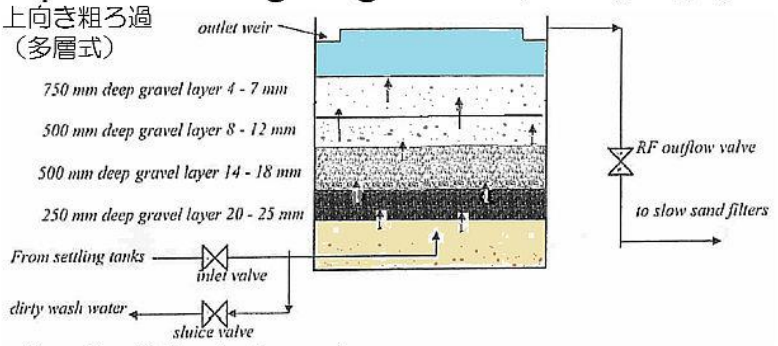
Silt and colloidal matter are trapped in roughing filter.

沈降性の悪い粘土やコロイド粒子は粗ろ過で捕捉される。多くのエビが見つかった。エビは食物連鎖の頂点の動物。

Many shrimp were found in this roughing filter.
Shrimp is top animal of the pyramid of food chain.

Up Flow **Roughing Filter** (Multi layer type)

上向き粗ろ過（多層式）



Open the **Sluice** (**not scour**) valve fully and dump the contents to waste. This sluice procedure may need to be **one time enough.**

Each filter should be cleaned fortnightly or more regularly.

However, this drain had been not operated. This was the first time.

排泥弁を開けて蓄積した泥を排出。この排出は1回で十分。この排泥を2週間、または1月に1度する。しかし、この排泥をしていなかった。この排泥は初めてだった。

Sluiced mud sank quickly.
この泥の沈降性は良い。

Mud like an activated sludge.

活性汚泥みたい

Up Flow Roughing Filter is also ***Ecological Purification System.***

上向き粗ろ過も生物浄化系だ。

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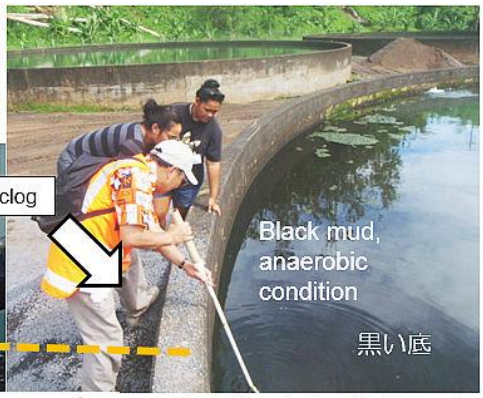
Filter clog



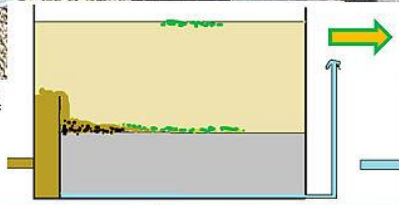
Shift to shallower depth and faster flow rate

Large radiation to the bottom, small water pressure, easy produce bubbles by active photosynthesis

浅い水深に、ろ過速度を速く：底まで十分に日射が、水圧が小さくなる。光合成が盛んになり捕捉した藻が浮き上がる。

Black mud, hydro sulfuric smell

黒い泥と硫化水素臭



Turn to aerobic sand layer, recover the filter clog and better quality of filtrate.

好気的な砂層になり、ろ過閉塞がなくなり、水質が良くなった。

Faster filter rate

ろ過速度を速くした

Floating algal mat with mud

浮上藻に泥が

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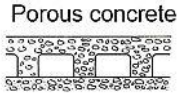
I advised to SWA to make shallow depth with any large size of sand. SWA putt washed beach sand to make shallow depth. Textile over the under drain and sand only.

どんな砂でも良いから浅い水深にと助言。海岸の砂を洗って補砂。集水渠の上に布。その上は砂だけ。

Porous concrete



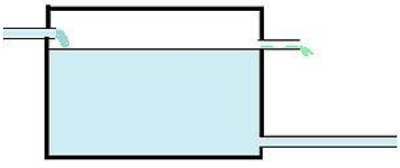
I also advised to SWA that textile is one of the way instead of gravel layer. SWA followed my advice.

SWAへ礫層は必要ない、布で良い助言した。SWAは助言に従った。

Shallower depth of supernatant, faster flow rate makes lager amount of filtrate and better quality.

水深を浅く、ろ過速度を速くしたらろ過水量が多くなり、水質も良くなった。

Full of Balance tank
調整池が満タン



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Points: shallow depth, enough radiation on the bottom, rapid growth, large size of sand.

浅い水深、底へ十分な日射、早い成長、大きな砂

Sand separated with mosquito mesh (1-2 mm)

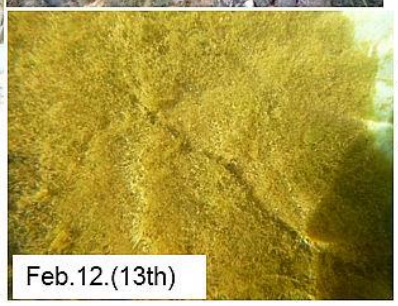
防虫網で砂を篩い

Feb.14.(15th)

Shallow depth: Algae grow well

浅い水深で藻の繁殖が良い。

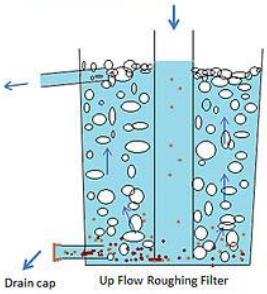
Feb.7.(8th)



Feb.12.(13th)

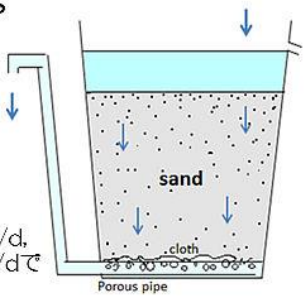
Two up-flow roughing filters

上向き粗ろ過２段



Sand filters (5m/d, 10m/d, 20m/d) All good filtrates.

ろ過速度　5m/d, 10m/d, 20m/dで実験：
全部ろ過水が良い



The model was moved ton Feb.21, 2013

モデルを２月２１日に移設

All the drinking water was supplied by this model in the Dave Parker Eco-Lodge.

全ての飲料水をロッジで使用

Algae grew well in intake vinyl pipe, sedimentation tank and pressure control tank. Algal growth made the pipe clogging. We covered them with aluminum foil and tape, and pained the tanks.

導水ビニール管、沈殿槽、圧力調整槽で藻が大量繁殖し、水が流れないので、アルミホイルとペンキ塗装した。

Filtrate is delicious and safe water of Bacteria free water.

ろ過水は、おいしく、細菌が検出されない安全な水

Mr. Vishwa Jeet from Fiji gave many questions to us.

2011年8月JICA沖縄で、Fijiからジートさんは、多数の質問をした。

He returned back to Fiji, he made a model to make safe drinking water by EPS technology at the yard of Department of Sewage and Water. Water source was rain harvest tank.

Fijiから参加したジートさんは、帰国すると、早速、雨水利用タンクの水を水源としモデルをつくった。

The PM had attention for EPS display during the World Marine Time Day on Sept. 28, 2012. Our Director informed the PM on the functions of the EPS and reference to JICA was made.

2012年9月12日海洋博で首相にJICA研修で学んだEPSの有用性を説明した。

The Fiji Times ONLINE

Quality water for all

Priya Chand
Thursday, January 17, 2013

WITH the new Ecological Purification System (EPS) in the pipeline, water quality enjoyed by urban people can now also be made available in rural villages and communities.

A workshop on a new water treatment system, hosted by the Department for Water and in collaboration with the Japan International Cooperation Agency (JICA) in Suva yesterday, revealed that EPS was an economical and ecological way of purifying water.

Works permanent secretary Commander Francis Kean said the vision to provide safe adequate water and efficient sanitation to the whole population in Fiji was in government's roadmap.

"About 70 per cent of our rural population drink water directly from creeks and river sources which are most

New plans for cleaner water

Water treatment expert Dr Nakamoto Nobutada speaking at the Holiday Inn. Picture: ELIKI NUKUTABU

Kick off Workshop on Jan. 16. 2013. at Holiday Inn. Commander Francis B. Kean, Permanent Secretary, Ministry of Works, Transport, Public Utilities.

2013年1月16日、公共事業省大臣F.キーンを迎えて研修会を開催した。「新しい技術EPSで清澄な水」、「皆に質の良い水」

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Opening ceremony of public tap on July 16, 2013.

THE FIJIAN GOVERNMENT

EPS technology is our technology for ours. We can make it by ourselves.

EPS技術は私たちの技術。私たちでできる技術。

KALOKOLEVU VILLAGERS WELCOME ACCESS TO CLEAN DRINKING WATER

7/17/2013
More than 270 villag
ecological purificatio
and Sewerage, the W
(JICA).

The EPS, which is the
the Ministry of Works
in Kalokolevu village,

Reverend Uraia Fesi Volavola, left, JICA Fiji resident representative Shunsuke Yoshiara and Ministry of Works permanent secretary Commander Francis Kean cut the ribbon to officially commission the new ecological purification system at Kalokolevu Village on

Timaima Solaeti, carrying Taniela Tabukarawa, and Una Koroi try out the new ecological purification system at Kalokolevu Village yesterday. Picture: JONACANI LALAKOBAU

THE FIJIAN GOVERNMENT

Opening ceremony of public tap on September 11, 2013. at 2nd Eps.

NAVATUVULA VILLAGERS GET ACCESS TO CLEAN DRINKING WATER

9/12/2013
Improving the living standards of the rural c
safe drinking water and sanitation is one of th

This was highlighted today by the Ministry for
secretary, Mr Francis Kean at the commissioni
(EPS) at Navatuvula village in Sawani, Naitasi

The first EPS was commissioned at Kalokolevu

Mr Kean said his ministry's aim is to install EP
removal of contaminants before water is consu

"The incorporation of the EPS into rural water projects will take place after further moni
the results of the pilot projects by the Water Authority of Fiji (WAF)," Mr Kean added.

Clean, safe water brings joy to village

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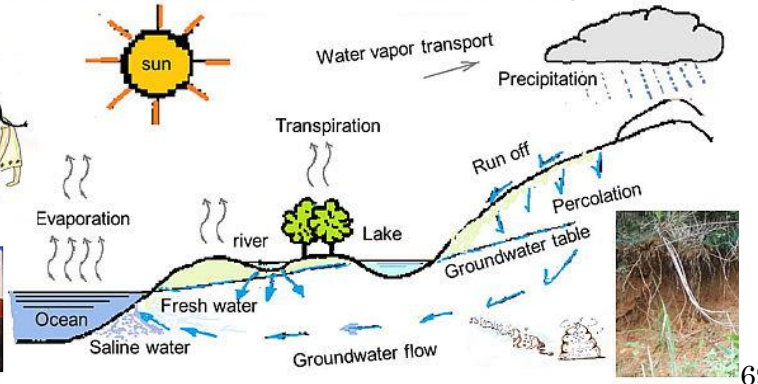
We have been use natural safe water which is natural spring water. This water is purified in nature without any chemical. We prefer this water than chlorinated tap water. Commercial bottle water is just filled with this water.

私たちは、昔から自然界の安全でおいしい水と利用していた。この水は自然界で薬品を使わないで浄化された。塩素で殺菌された水道水より清水の方が好きです。売られているペットボトルはこの水を詰めただけ。



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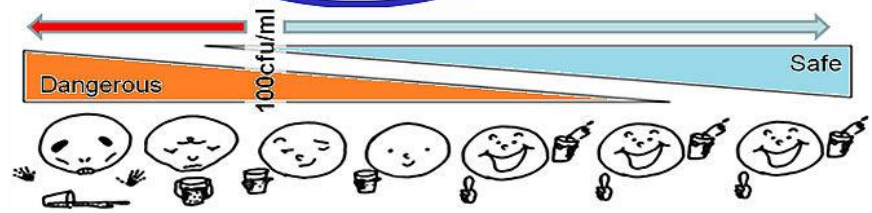
General bacteria: many in the natural environment 自然界に多数いる一般細菌

Group of coli-form bacteria : an indicator of pollution: many in the natural environment 大腸菌群細菌:自然界に多数いるが汚染の指標

Escherichia coli : indication of intestinal bacteria.大腸菌:腸内細菌の指標

Fecal *Escherichia coli* : an indicator of fecal contamination of mammals.糞便性大腸菌:哺乳動物の糞便由来の指標

Pathogenic bacteria 病原菌



We must think about acceptable risk. *許容できるリスクを考えよう*

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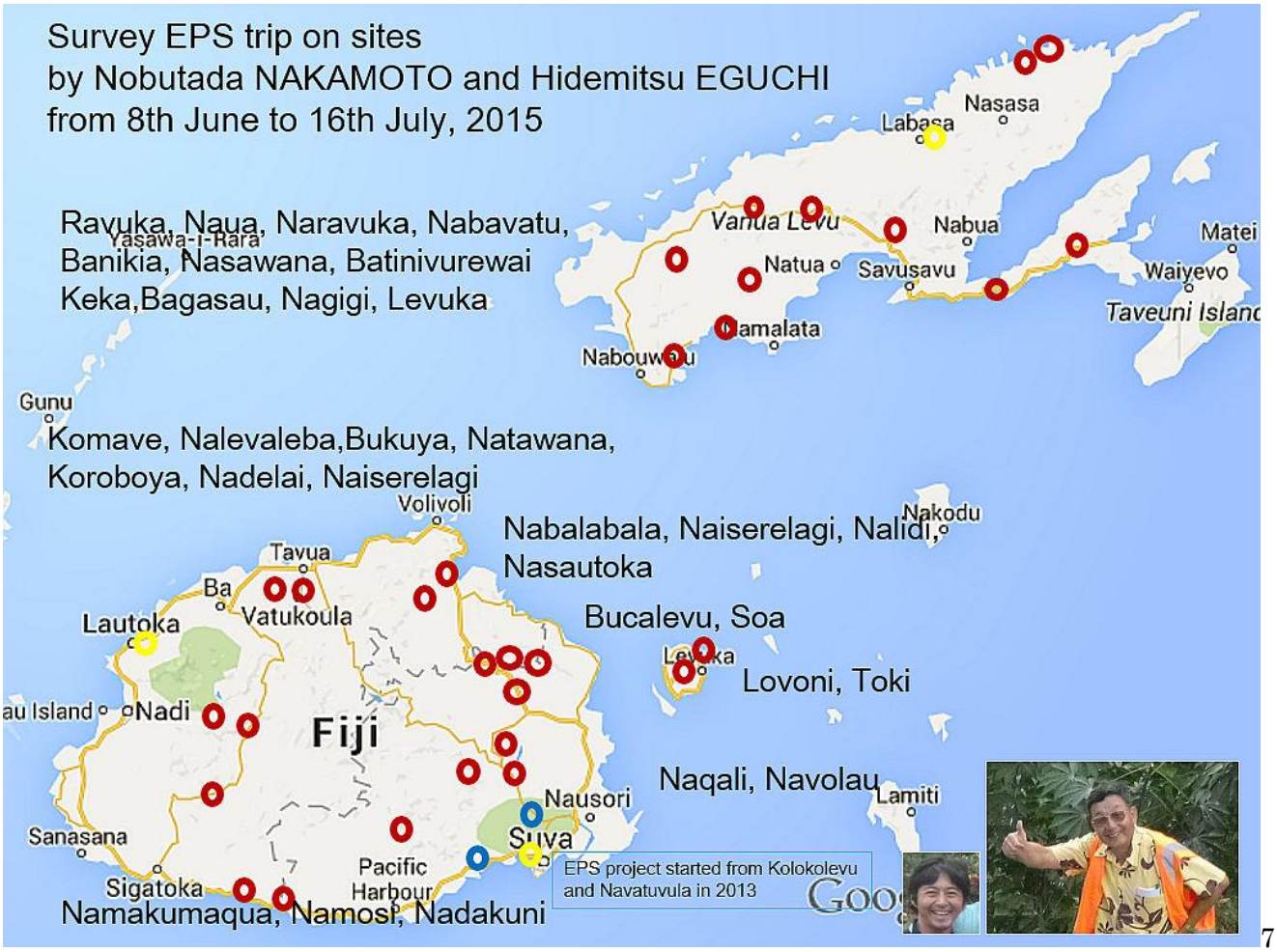
Survey EPS trip on sites
by Nobutada NAKAMOTO and Hidemitsu EGUCHI
from 8th June to 16th July, 2015
Ravuka, Naua, Naravuka, Nabavatu,
Banikia, Nasawana, Batinivurewai
Keka,Bagasau, Nagigi, Levuka
Komave, Nalevaleba,Bukuya, Natawana,
Koroboya, Nadelai, Naiserelagi
Nabalabala, Naiserelagi, Nalidi,
Nasautoka
Bucalevu, Soa
Lovoni, Toki
Naqali, Navolau
Namakumaqua, Namosi, Nadakuni
Nasasa
Labasa
Vanua Levu
Nabua
Natua
Savusavu
Matei
Waiyevo
Taveuni Island
Yasawa-i-Rara
Gunu
Volivoli
Nakodu
Tavua
Ba
Vatukoula
Lautoka
Nadi
Fiji
Nausori
Suva
Lamiti
Sanasana
Pacific Harbour
Sigatoka
EPS project started from Kolokolevu and Navatuvula in 2013

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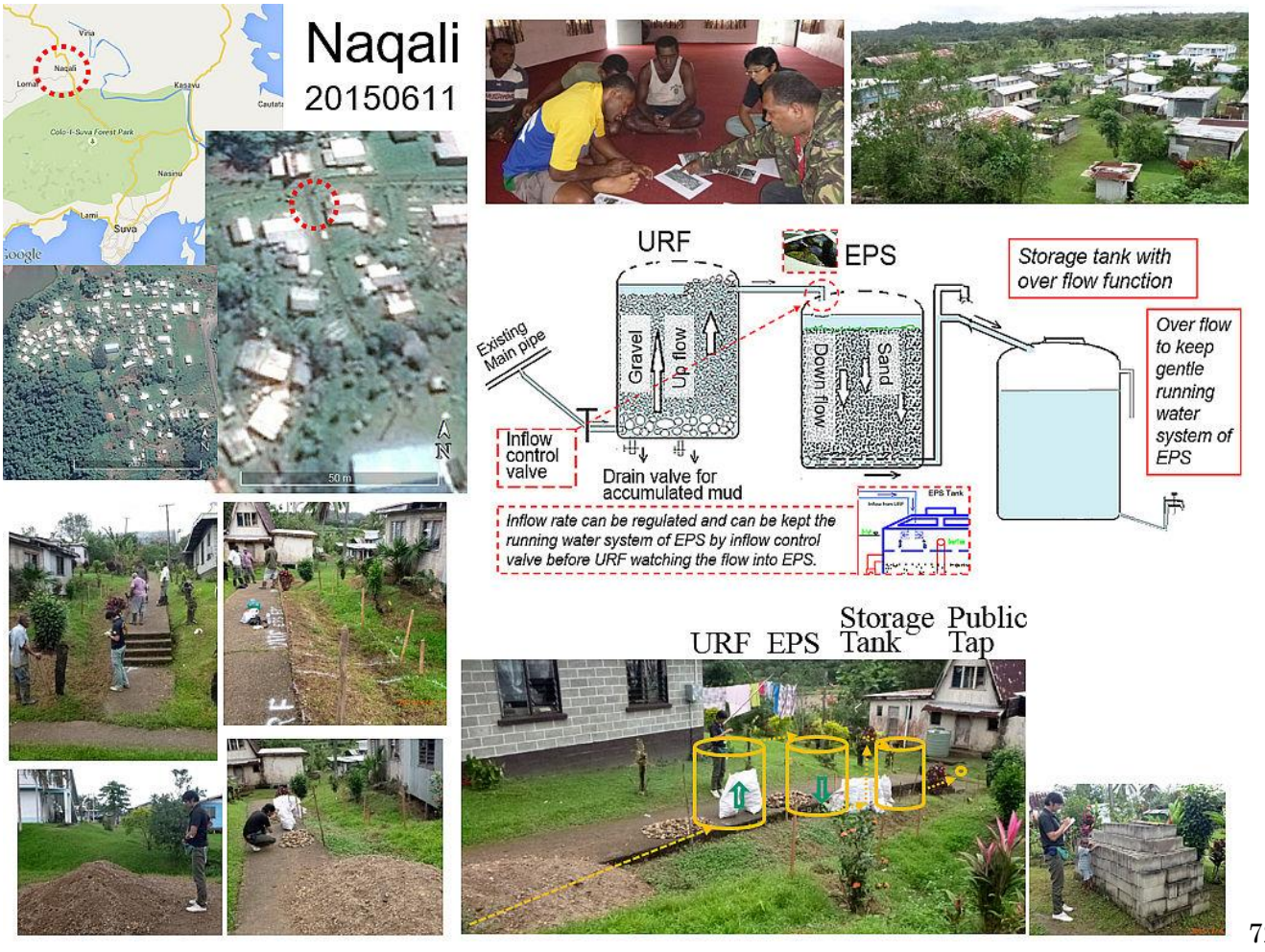
Naqali
20150611
URF
EPS
Storage tank with over flow function
Existing Main pipe
Gravel
Up flow
Down flow
Sand
Over flow to keep gentle running water system of EPS
Inflow control valve
Drain valve for accumulated mud
Inflow rate can be regulated and can be kept the running water system of EPS by inflow control valve before URF watching the flow into EPS.
URF
EPS
Storage Tank
Public Tap

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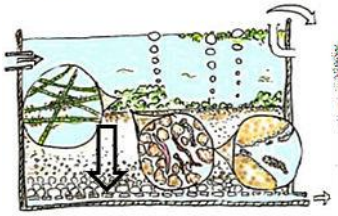
Sand, stone and rocks ***don't role and move.***

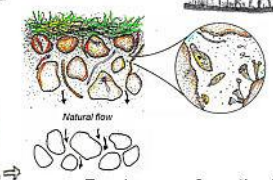
There is vertical current in **Ecological Purification System**. This is gentle system for small organisms where sand does not move.

Small animals on the surface of rocks collect turbid matters.

When plants and animals do not flush out, water is always clear.



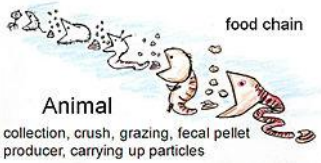
Germ free safe water to drink



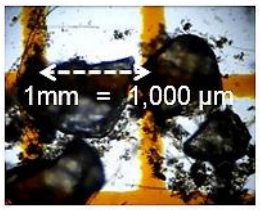
Trap and collection time of particle by small organisms is very short. Passing time of food in body is also very short.

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

Short time work



Long term action



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.

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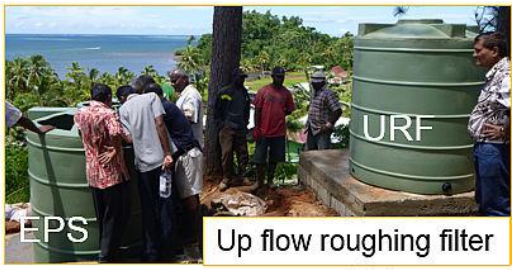
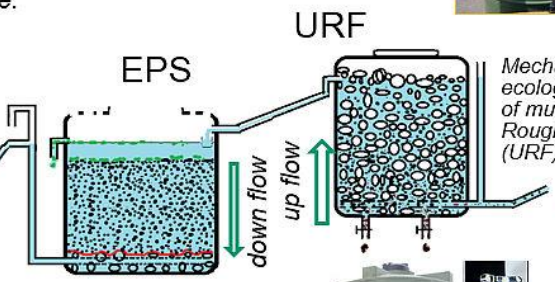
Fiji Government Plan of Ecological Purification System: EPS provide Safe Drinking Water for Rural People.
1.Water source
2. Reduce load of muddy matter using Up-flow Roughing Filter (URF) of gravel tank.
3. Final treatment for germ free water with natural down flow of EPS tank (filled with large size of sand).
4. Storage tank for public use.

フィジー政府はEPSで地方の住民に安全な飲み水供給事業。1．原水。2．礫槽の上向き粗ろ過（URF）で濁り負荷を削減。3．粗い砂槽の生物浄化槽（EPS）で細菌を除く処理。4．公共水栓用の貯留槽。



貯留槽・公共水栓
Storage tank and public tap in a village



Mechanical and ecological reduction of mud by Up-Flow Roughing Filter (URF).

上向き粗ろ過
URF:機械的および生物群集による泥の除去。
Gentle condition: Almost constant natural flow.
ほとんど同じ自然の流れが「やさしい」

Don't stop the natural flow to keep aerobic condition.

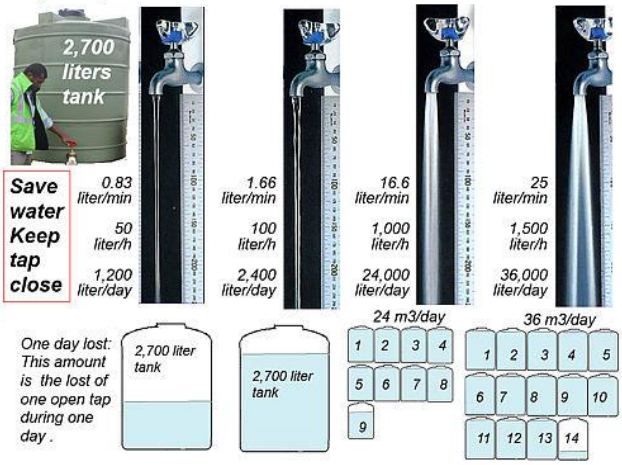
Don't scare any small animals which live in the top of sand layer.

DWS plan is 2 liters per person for drinking water.

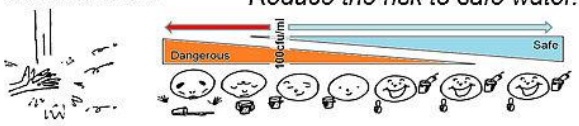
As EPS capacity is big, an EPS system may provide 6 liters per person for drinking and cooking.

局案は一人1日飲料水2ℓだが、EPSの能力があるので、飲料と料理で6ℓを供給。

Don't stop the inflow water into the EPS, even in case of over flow from the storage tank. This is gentle for natural organisms.



Reduce the risk to safe water.



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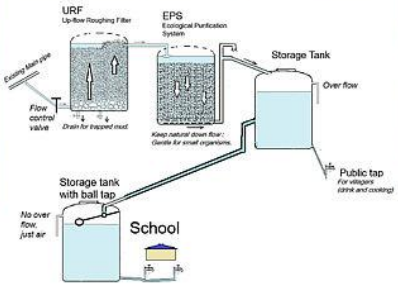
SOA (Bureivanua school)

20150618

Tk. Paula Seru (7616760)

Mesu (Water authority)



Storage tank with ball tap (no over flow) for school

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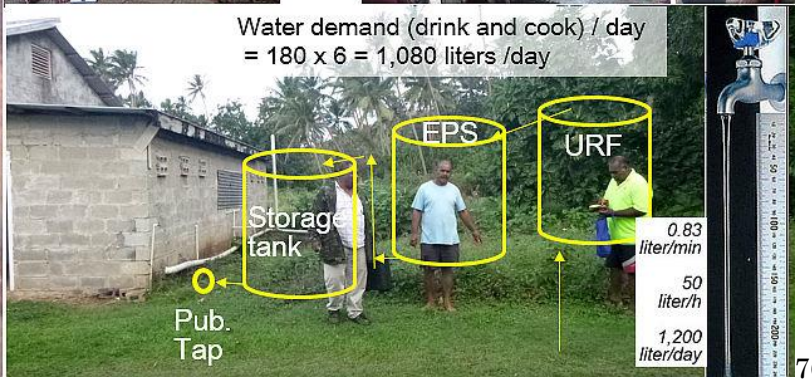
Ovalau Toki

2015-6-24

TK: Joseph Taylor cell: 9448113
Village population of TOKI: 164+9 teachers + some = ca 180 persons
TOKI school students = 120 pupils from 5 villages.
Students in TOKI village is 30 persons.



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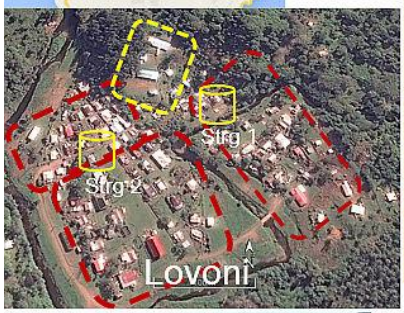
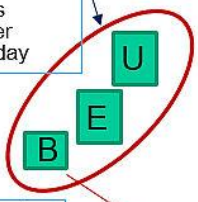
Lovoni
2015-6-24

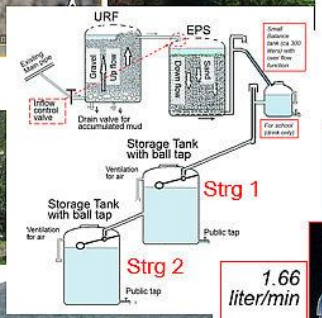
Avili SALAVOU Tk 7351639
500 persons in 3 villages

Lovoni primary school
Paulo Talavutu
7445060
120 students

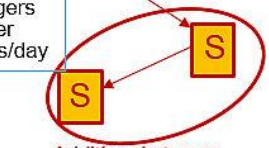


Water source
Existing storage tank for school
Drink only: school
Water demand for 120 students
= 120 x 2 liter
= 240 liters/day





Water demand for 500 villagers
= 500 x 6 liter
= 3,000 liters/day



Additional storage tanks and pipe will be covered by local.

1.66 liter/min
100 liter/h
2,400 liter/day

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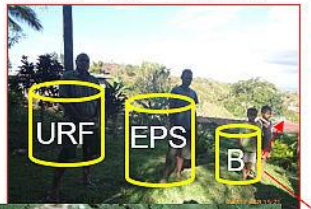
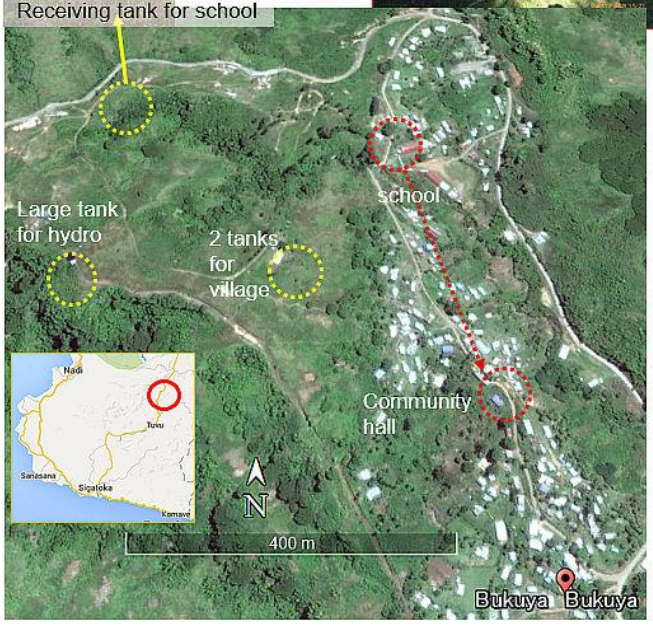
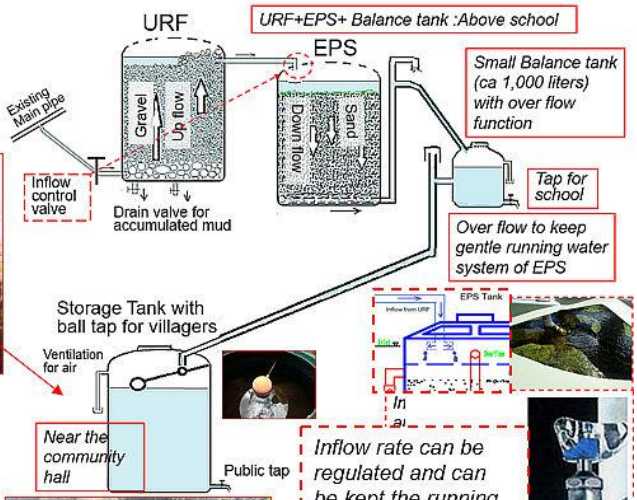
Bukuya 20150708

Tk FREDI 8740783
808 persons 167 houses



Receiving tank for school





Storage tank with ball tap for villagers.

Inflow rate can be regulated and can be kept the running water system of EPS by inflow control valve before URF watching the flow into EPS.

One day water demand
(drink and cooking)
808 x 6 liters = **4,848 liters/day**

This flow :
1.66 liter/min
100 liter/h
2,400 liter/day

Bukuya demand is double flow of this flow for a day.

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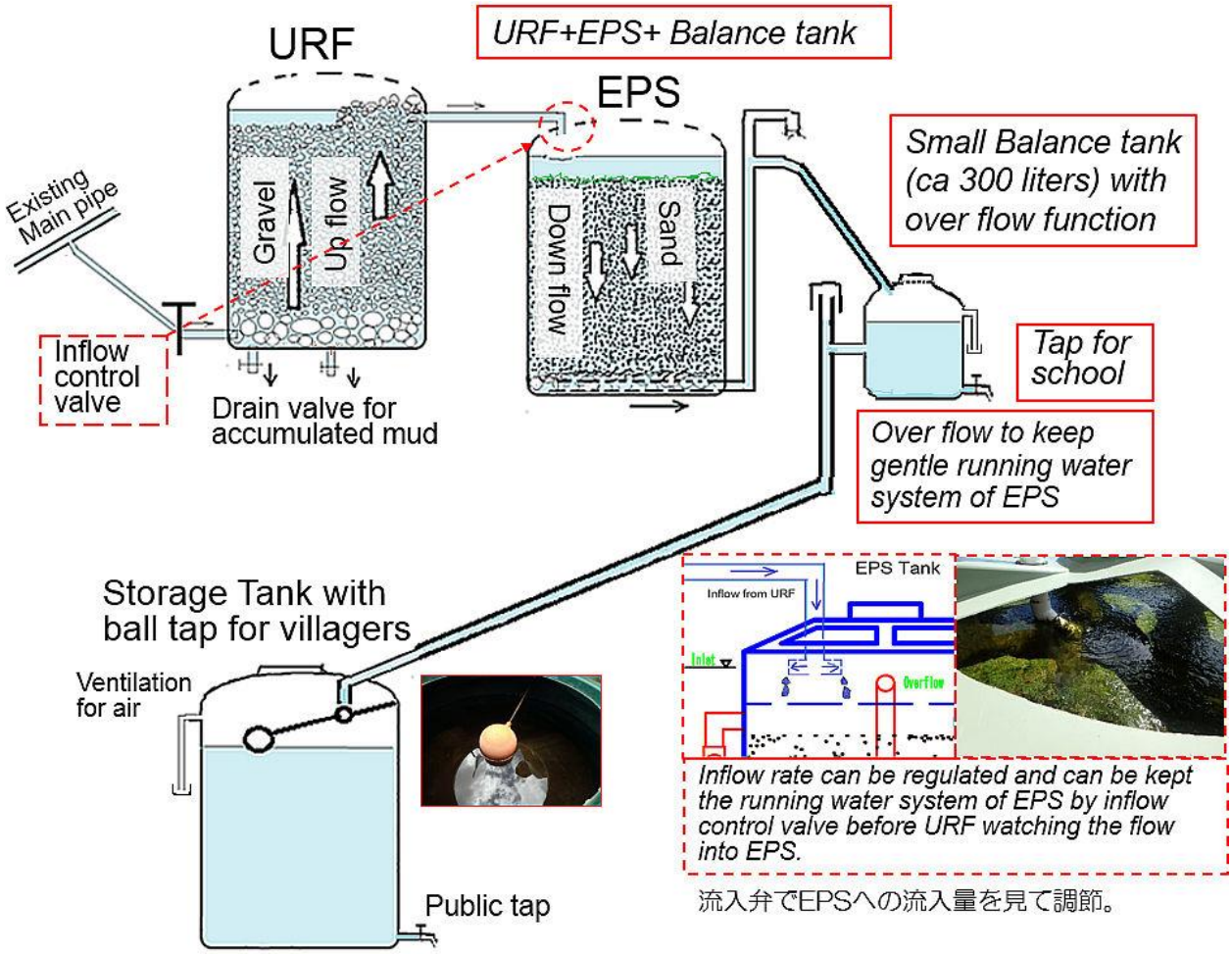


Calculation on EPS capacity and Storage tank for EPS (in case of 2,700 tank)

EPS能力について

Slow sand filter (SSF) started from UK in cold region. EPS treatment capacity is related with filter area and biological activity which means temperature. We can adopt higher flow rate in warm climate region.

EPS Capacity of Tank (2,700 liter tank) *Radius of tank (r):0.7m = Filter area (pxrxr), 1.54 m2*									
Flow rate		Filtrate rate				Suppy capacity for person			remarks
m/d	cm/h	m3/d	liter/d	liter/h	liter/m	2 liter/d	6 liter/d	100 liter/d	
2	8	3.1	3,080	128	2.1	1,540	513	31	Original filter rate in UK, in 1829
5	20	7.4	7,392	308	5.1	3,696	1,232	74	Traditional English standard
10	42	15.4	15,400	642	10.7	7,700	2,567	154	Present Thames rate
15	63	23.1	23,100	963	16.0	11,550	3,850	231	Acceptable rate in warm region
20	83	30.8	30,800	1,283	21.4	15,400	5,133	308	Acceptable rate in warm region

緩速（砂）ろ過は、涼しい英国が起源。生物浄化法（EPS)の浄化能力は、ろ過面積と生物活性に関係する。生物活性は水温に関係するので、暖かい地域では、早いろ過速度にすることができる。

EPS 能力 (2,700 リットル槽) *半径 (r):0.7m = ろ過面積 (pxrxr), 1.54 m2*									
ろ過速度		ろ過水量				給水可能人口			備考
m/d	cm/h	m3/d	liter/d	liter/h	liter/分	2 liter/d	6 liter/d	100 liter/d	
2	8	3.1	3,080	128	2.1	1,540	513	31	英国で1829年の最初のろ過速度
5	20	7.4	7,392	308	5.1	3,696	1,232	74	英国式として広まった標準ろ過速度
10	42	15.4	15,400	642	10.7	7,700	2,567	154	涼しいテムズ水道の現在のろ過速度
15	63	23.1	23,100	963	16.0	11,550	3,850	231	暖かい地域での可能ろ過速度
20	83	30.8	30,800	1,283	21.4	15,400	5,133	308	暖かい地域での可能ろ過速度

Volume of Storage tank for filtrate which we need.

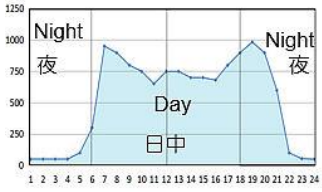
受水槽の必要容量

Volume of storage tank which we need.			
persons	Water daily demand *(liter)*		
	only drink	drink+ cook	drink+ wash+ shower
1	2	6	100
100	200	600	10,000
200	400	1,200	20,000
300	600	1,800	30,000
400	800	2,400	40,000

受水槽の必要容量			
人数	1日、必要量 *(liter)*		
	飲料のみ	飲料+ 調理	飲料+ 洗濯+シャワー
1	2	6	100
100	200	600	10,000
200	400	1,200	20,000
300	600	1,800	30,000
400	800	2,400	40,000

水の使用量の日変化　例

An example of demand variation of water in a day.



Treatment process by EPS runs always by almost same flow rate during a whole day. This is gentle condition for small organisms under current condition. EPS water is stocked during the night in the storage tank and fill up the tank when water demand is small.

EPSの処理は常に1日中、同じような速度で行われている。これが生物群集に「やさしい：Gentle」流水環境である。EPSでつくられた安全でおいしい水は、水道需要が少ない夜間に満タンにする。

Don't leave tap open!!

蛇口を開けたままにしない

Change rubber washer !!

ゴムパッキングを交換しよう

Save Water, Keep Tap Close.

1.66 liter/min

100 liter/h

2,400 liter/day

水を大切に、蛇口を閉めよう。

One day lost. This amount is the lost of one open tap during a day.

1日の損失。この容量が一つの蛇口から流れ出る量。

81

Save water Keep tap close

0.83 liter/min

50 liter/h

1,200 liter/day

1.66 liter/min

100 liter/h

2,400 liter/day

16.6 liter/min

1,000 liter/h

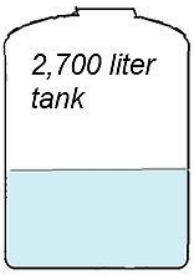
24,000 liter/day

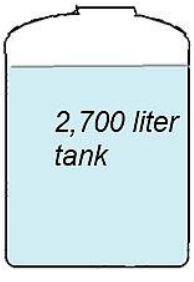
25 liter/min

1,500 liter/h

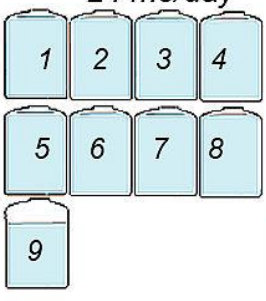
36,000 liter/day

One day lost: This amount is the lost of one open tap during one day .

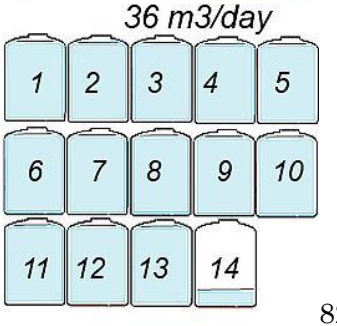




24 m3/day



36 m3/day



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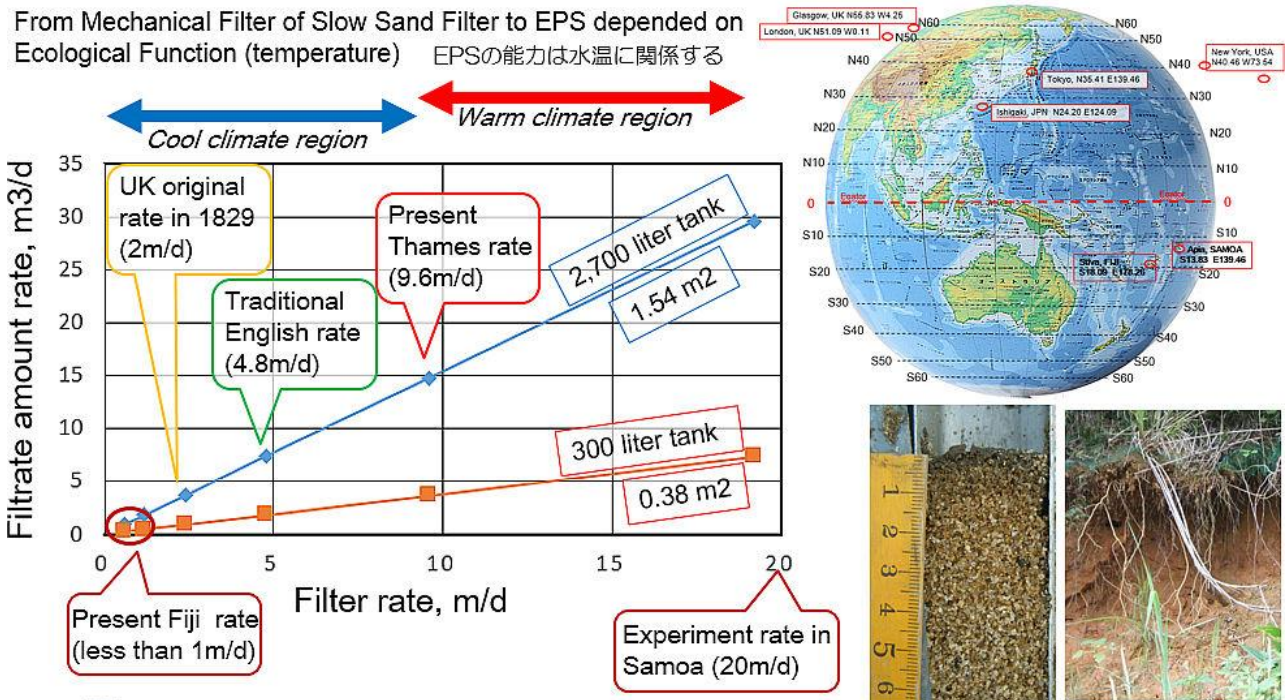
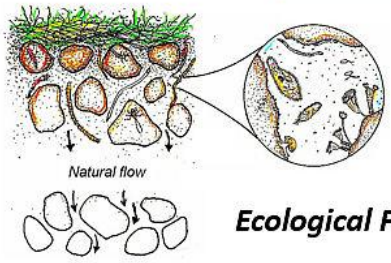
From Mechanical Filter of Slow Sand Filter to EPS depended on Ecological Function (temperature)　EPSの能力は水温に関係する



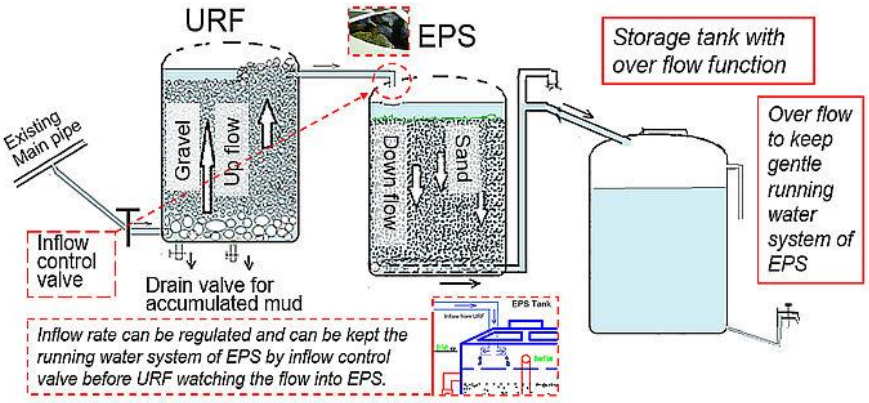


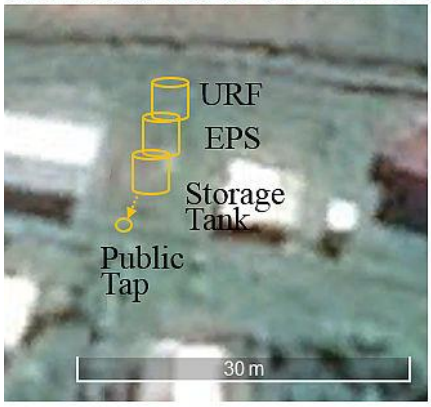
Food Chain is the Key.

Ecological Purification System

83

Navolau
20150611



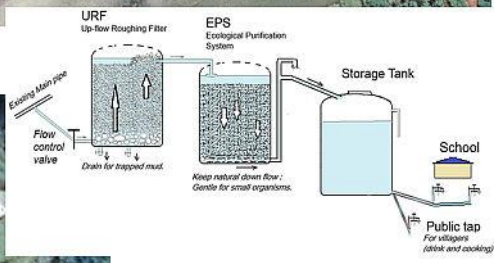


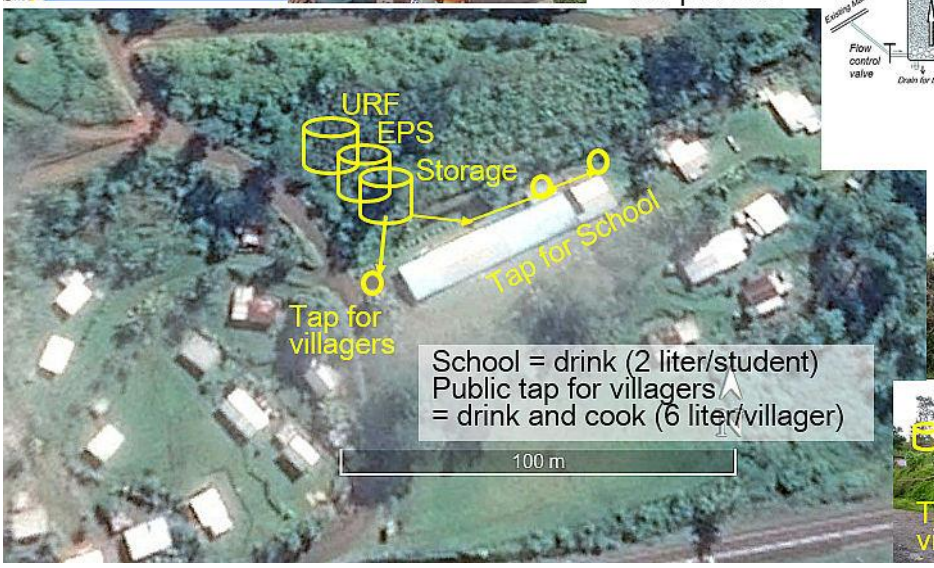
84

Bucalevu
20150618

EPELI Tk 8678871

School student
= 136 persons





85

Ravuka
2015-6-29

Matainadoi Turaga

Seva Father of Tk

Electiacota Tk 8812044
10 houses 40 persons in Ravuka, however
200 persons return back in holiday from town.

Existing storage tank and pipe line were built in 1983.

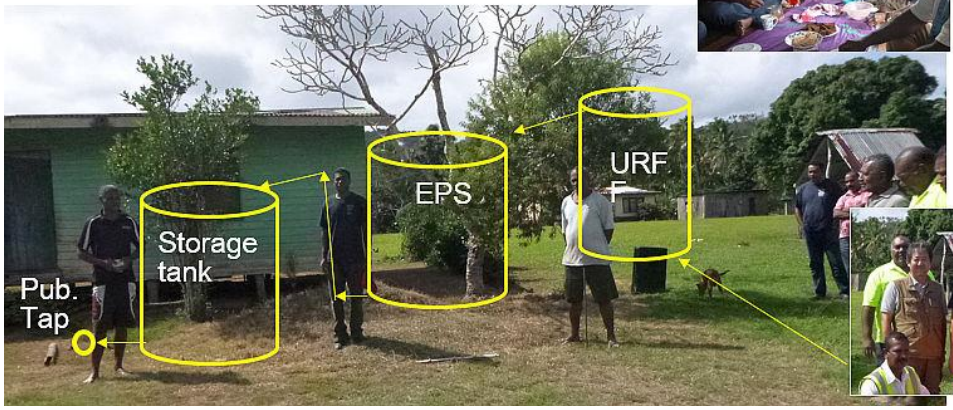
1,100 liters tank is enough size for Ravuka

20 m3 receiving tank, tank cleaning: 3-4 months interval

One day water demand (drink and cooking)
60 persons x 6 liters (per person) = 360 liters
200 persons x 6 liters = 1,200 liters in holiday

Keep almost this inflow rate to EPS system.

liter/min	0.83
liter/h	50
liter/day	1,200



86

Naua
20150629

Tk Jonasa 9910847
40 persons, 7 houses

There is a receiving tank. Interval of tank cleaning is over 1 year.

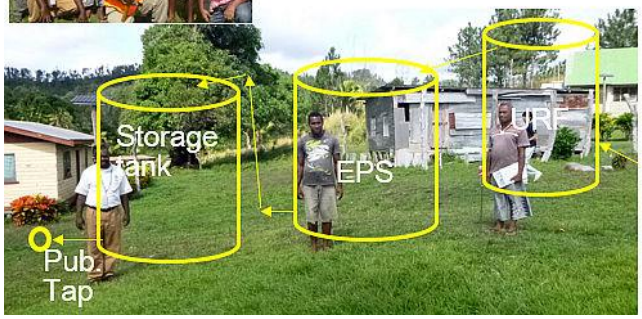
This village is small demand due to small population. According to "Practical Guidelines for Rural Water Supply Management Plan, May 2012" Domestic consumption: 1,00 liters/person/day

One day water demand **(all use for villager)**
40 persons x *100* liters/person
= *4,000* liters /village

One day water demand (drink and cooking)
40 persons x 6 liters/person
= 240 liters /village

1,100 liters tanks are enough size for Naua.

In case of the worst condition, larger size of tanks are recommended.



Keep almost this inflow rate or less into EPS.

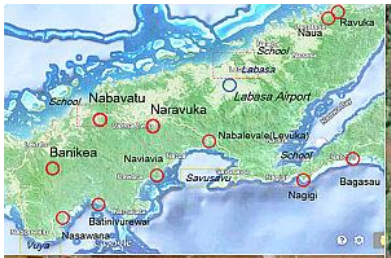
0.83 liter/min
50 liter/h
1,200 liter/day

Double rate into EPS is over the all demand.

We can cover the full demand by EPS.

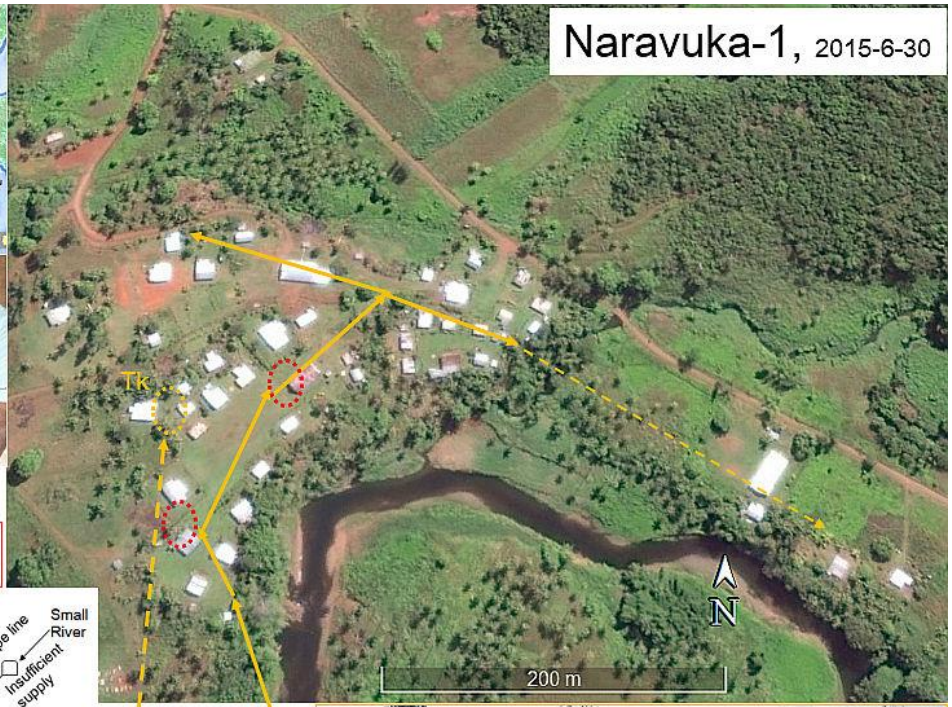
1.66 liter/min
100 liter/h
2,400 liter/day

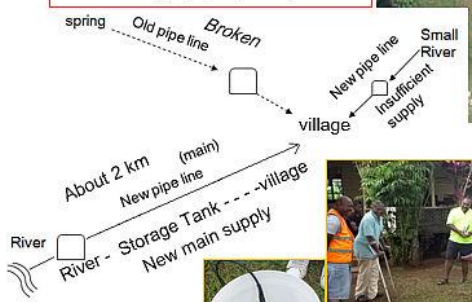
87



DRUGA Tk 9941046
250 persons, 37 families

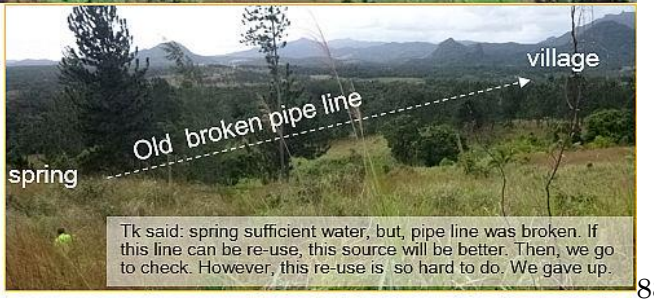
Spring- - - - Storage Tank - - -village
sufficient supply (Old, broke)





Beside Tk house
Enough pressure
Turbid water (ca 30 ntu)
Due to yesterday rain

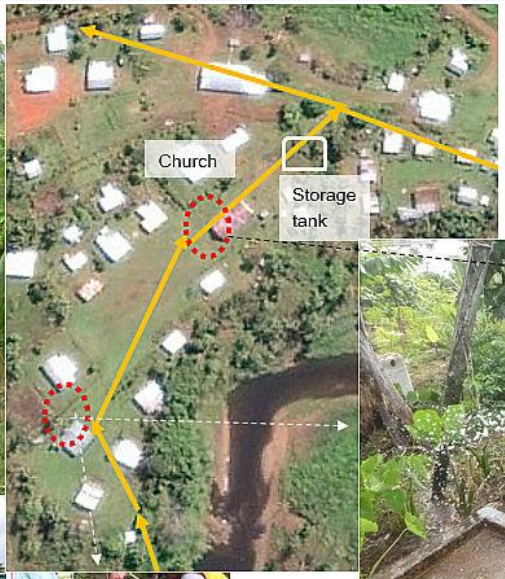
Present new line



NARAVUKA-1

88

Naravuka-2, 2015-6-30



Check main pipe line and valves and water pressure.

No water near the church.
But, he said "sufficient water, and always"

We check the water pressure of the taps by our side. again.

Tap near the pipe entrance to the village is looks like enough pressure.

This tap located before the first valve which was the half open valve. Water committee controls these valves in order to supply the water to each house block. This means water pressure is not enough.

We found it is necessary to set a new storage tank in the center of this village to keep water pressure at the end user of the village.

Check main pipe line and valves and water pressure.
Where is the suitable place in this village?

We check the influence the pressure by valve control.

If EPS is installed in this village, water shortage will appear at the end of village. EPS requires the running water condition.
We conclude : EPS should be installed after the build of new storage tank in the center of village to hold the water pressure.

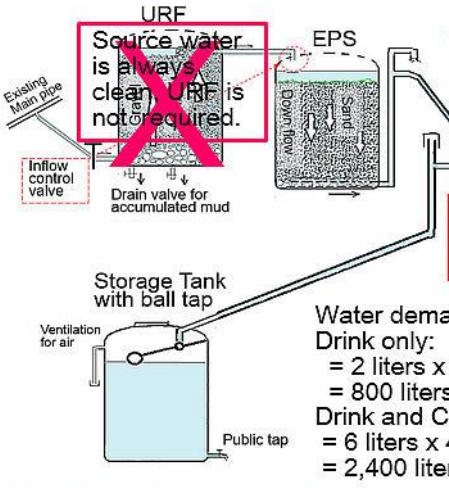
89

Nabavatu, 2015-6-30

Divisional Engineer Northern already started to construct EPS at this village.

PONIPATE Tk 8789972
400 persons, 78 families

Inflow to receiving tank



liter/min	1.66
liter/h	100
liter/day	2,400

This inflow rate into EPS must be kept for running water system of EPS.

Water demand per day
Drink only:
= 2 liters x 400 persons
= 800 liters/day
Drink and Cooking:
= 6 liters x 400 persons
= 2,400 liters/day

This village has not enough amount of water. "Water source is limited. We have to keep tap close always. Save the water."

90

Banikea 20150630

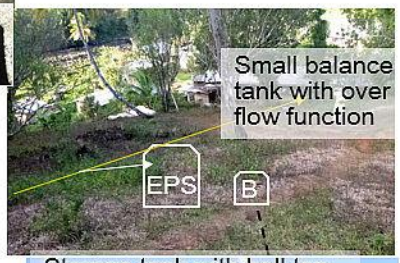
Spring

Receiving tank

Village

Tk PITAE 9797207
162 persons, 37 families

URF is not required, due to clean water source.



Water demand per day
Drink only:
= 2 liters x 162 persons
= 324 liters/day
Drink and Cooking:
= 6 liters x 162 persons
= 972 liters/day

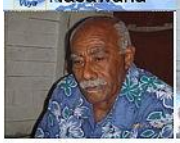
Plenty water in this village

Inflow rate into EPS is about this rate.

liter/min	0.83
liter/h	50
liter/day	1,200

91

Nasawana, 20150701



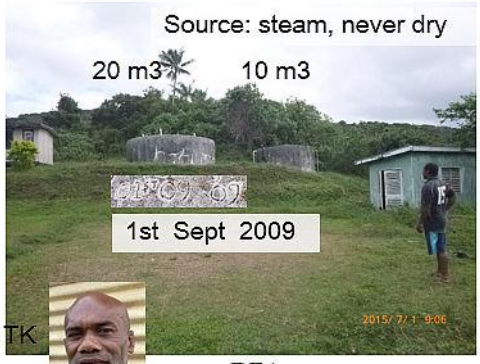
Chairman of Water committee KAMINIONI

Brother of TK AKUILA
7433733
7423988

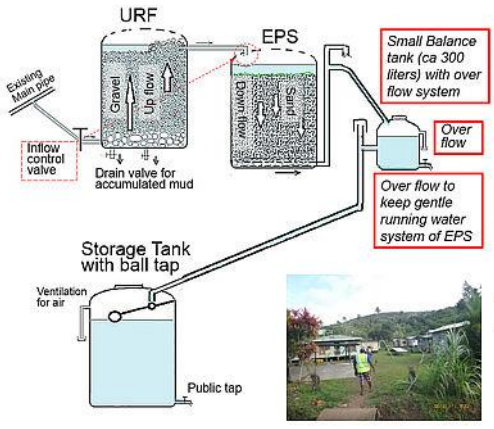
LIVA TK

300 persons, 50 families

Source: steam, never dry



Small balance tank (ca 300 liter) with over flow function

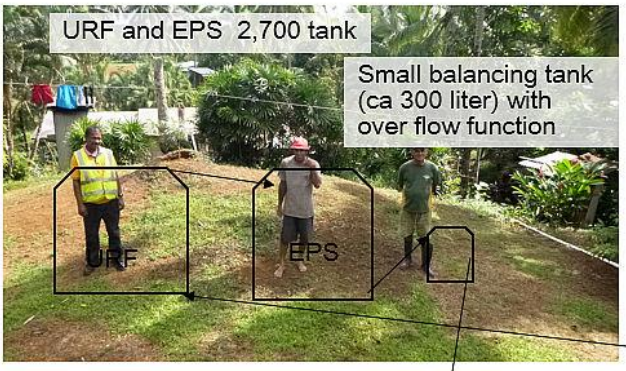


Small balance tank (ca 300 liter) with over flow function

92

Batinivurewai 20150701

Fathor of Tk (76 years old)
BERITITI BROWN
9641448
Son TK Wiliam Brown
(absent)
Son
AUTHER BROWN



Spring
fall
Weir
Village

150 persons,
20 houses
+teachers
24 houses(Total)

93

Keka
20150701

Tk SANAILA 8222091
90 persons, 24 families

5m3 receiving tank

Plenty of water

Enough water pressure

Easy to install EPS

94

Bagasau 20150702

Village under cloud on google map

Tk SAILOSI K. D. 9598871
80 + persons, 27 families

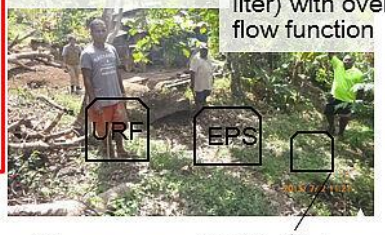
Epineri	Nina	Losalini	Tarisi
Maint-ainace	Treas-urer	Ass. Treas-urer	Secre-tary

Flow rate into tank
1 liter/6 sec
= 0.16 liter/sec
= 10 liter/min
= 0.6 m3/h
= 14.4 m3/d

14.4 m3/80 persons/d
= 180 liter/person/d

URF and EPS
1,100 tank

Small balancing tank (ca 300 liter) with over flow function



liter/min	0.83
liter/h	50
liter/day	1,200

Inflow rate into URF: Keep half of this rate

Spring water source is poor.

Spring

Receiving tank
20 m3

Tank cleaning
Once/month

Village

2 liter x 80 persons = 160 liters/ day
6 liter x 80 persons = 480 liters/ day

Small size (300 liter) of storage tank with ball tap.

95

Nagigi 20150702

Time supply controlled by valve at tank
Close 12:00(mid night) - am6:00
Open am6:00 - am9:30
Close am9:30 – pm3:00
Open pm3:00 - 12:00(mid night)

METUI last Tk 9342823 mobile
220 persons, 68 families

Stream
5km

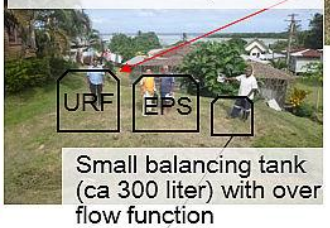
2 Receiving tanks
(10 m3 x 2)

Village

Flow rate into tank
1 liter/2.5 sec
= 0.4 liter/sec
= 24 liter/min
= 1.44 m3/h
= 34.56 m3/d

34.56 m3/220 persons/d
= 157 liter/person/d

URF and EPS 2,700 tank



Small balancing tank (ca 300 liter) with over flow function

Inflow rate into URF: Keep this rate

liter/min	0.83
liter/h	50
liter/day	1,200

2 liter x 220 persons = 440 liters/ day
6 liter x 220 persons = 1,320 liters/ day

Small size (1,100 liter) of storage tank with ball tap.

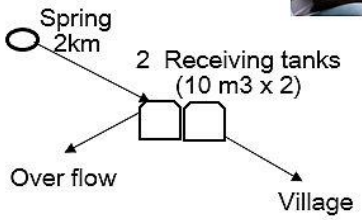
INOSI Water Authority
8423829

Sediment mud clean
Interval: 5 weeks
Max. accumulated mud:
the ankle depth (ca. 7 cm)

96

Levuka
20150702

SIVO Tk 8453864 mobile
8207428 line
120 persons, 30 families



Always clean water during the year.
0.24 ntu, conductivity = 50 micro S

There is no eye sickness patient and no diarrhea patient. This is a healthy village.

Tanks (10 m3 x2) were set Feb. 2015. Tank cleaning is not necessary. The first cleaning was at the setting time only.

Always overflow was observed from the receiving tanks.

Village water is already EPS water.

EPS installation is not necessary.

97

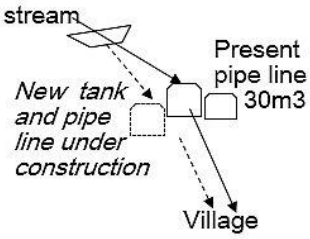
Komave
20150708

BUKE BUKE Ass. Tk
9774529 (Tk LUKE)
Village Total:
360+persons 32 houses
Center: 200 persons 32 houses
Several settlements are located outside of the concentrated village.

JOPE
Western Div

Water committee

Never dry, Tank cleaning interval: 6months



New tank under construction

30m3 tank (1988)
Full of water

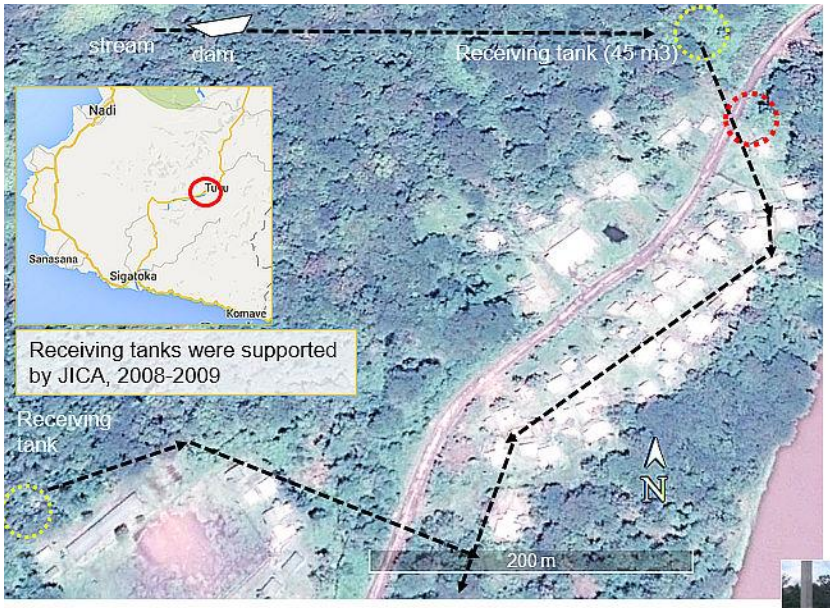
One day water demand
(drink and cooking)
360 x 6 liters
= 2,160 liters/day

Demand is this flow for a day.

This flow :
1.66 liter/min
100 liter/h
2,400 liter/day

Keep this flow into EPS.

98

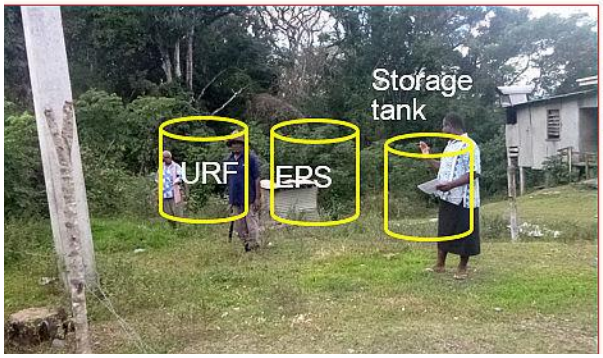


Nalevaleba 20150708

Tk NAIBUKA 9677612
Village: Total:
360+persons 86 houses
Center: *200 persons 30 houses*
Several settlements are located outside of the concentrated village.

Water chairman
ULAIASI VASU
Mbl: same as Tk

Water always comes.
Sometimes, water becomes low pressure at the end.
Tap water becomes dirty after heavy rain.



One day water demand
(drink and cooking)
360 x 6 liters = **2,160 liters/day**

This flow :
1.66 liter/min
100 liter/h
2,400 liter/day

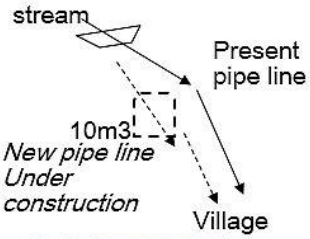
Demand is this flow for a day.

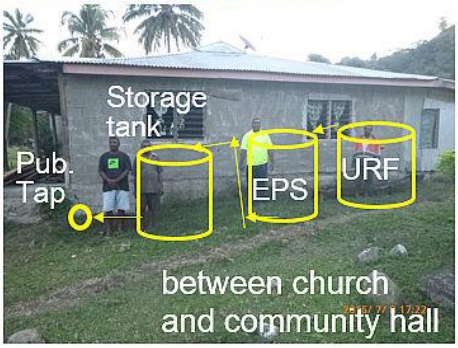
99

Natawa 20150708

Tk MANOA 8708405
225 persons 50 houses

Plenty of water, always:
Present situation: no receiving tank
New storage tank (10m3) and pipe line are under construction.





New pipe line under process will be allocated between church and community hall.

One day water demand
(drink and cooking)
264 x 6 liters
= 1,584 liters/day

Keep almost this inflow rate to EPS system.

liter/min	*0.83*
liter/h	*50*
liter/day	*1,200*

100

NaKoroboya
20150709

Tk JOSEFO NAKIDA
8748456 (m) 6030154 (h)
200+persons 40 houses

Turaga ESIRA VUDA
67ys

1 liter/4.5 sec
= 0.22/sec
= 13 liters/min
= 800 liter/h
= 19,200 liters/d
(19.2 m3/d)

= 19,200 liters/200 persons/d
= 96 liters/person/d

One day water demand
(drink and cooking)
200 x 6 liters
= **1,200 liters/day**

Keep almost this inflow rate to EPS system.

0.83 liter/min
50 liter/h
1,200 liter/day

101

Nadelai
20150709

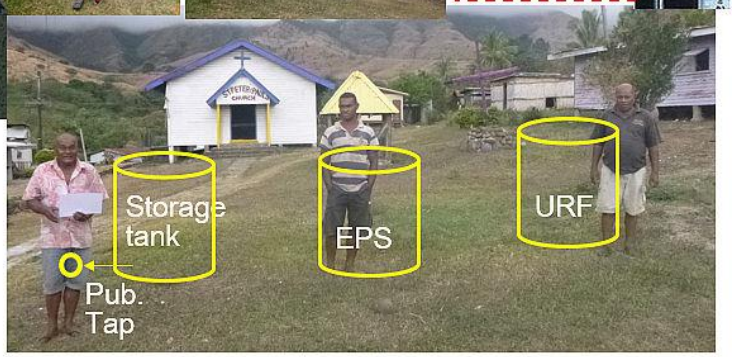
Tk ILAI MANOA 9054724
400 persons 75 houses

One day water demand
(drink and cooking)
400 x 6 liters
= 2,400 liters/day

Demand is this flow for a day.

This flow :
1.66 liter/min
100 liter/h
2,400 liter/day

Keep this flow into EPS.



102


Naiserelagi
20150709
Storage tank
URF+EPS
Balance tank
(recommend)
Storage
+pub.tap
Base of
URF+EPS
100 m
Base of Storage+public tap
Filipe (DWS Suva) contacted to advise an additional small balance tank after EPS to Western division office after watching this site on 9 July on the way back to Suva.

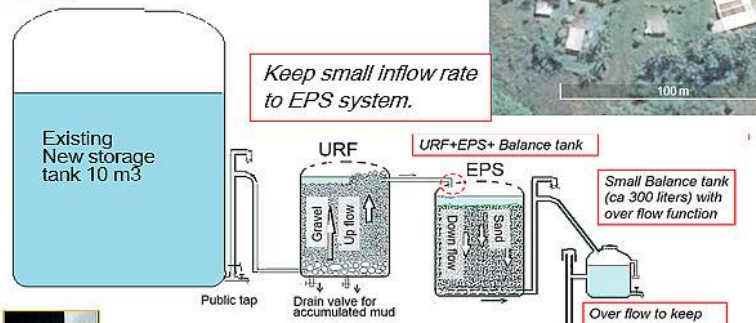
103


Naiserelagi
20150715
Filipe (DWS Suva) contacted to advise an additional small balance tank after EPS to Western division office after watching this site on 9 July on the way back to Suva.
Storage tank
URF+EPS
Balance tank
(recommend)
Storage
+pub.tap
URF+EPS+ Balance tank
URF
EPS
Small Balance tank (ca 300 liters) with over flow function
Inflow control valve
Drain valve for accumulated mud
Over flow to keep gentle running water system of EPS
Storage Tank with ball tap for villagers
Ventilation for air
Public tap
Inflow rate can be regulated and can be kept the running water system of EPS by inflow control valve before URF watching the flow into EPS.
Base of URF+EPS
on 9 July
New Base of Balance Tank
on 15 July
So quick response to our recommend
WELESI from Lautoka
wtuirakiwaimaro@mwtpu.gov.fj

104

Tk Mario
9818843
100+ (220 include settlements)

One day water demand
(drink and cooking)
220 x 6 liters
= **1,320 liters/day**



Keep almost this inflow rate to EPS system.

0.83 liter/min
50 liter/h
1,200 liter/day

105

LUKE Tk 9665952
Nalide Village 300 persons
Naituvatuvatu village 200 persons
Total: 500 persons

One day water demand
(drink and cooking)
500 x 6 liters
= 3,400 liters/day

Demand is a litter larger of this flow for a day.

This flow :
1.66 liter/min
100 liter/h
2,400 liter/day

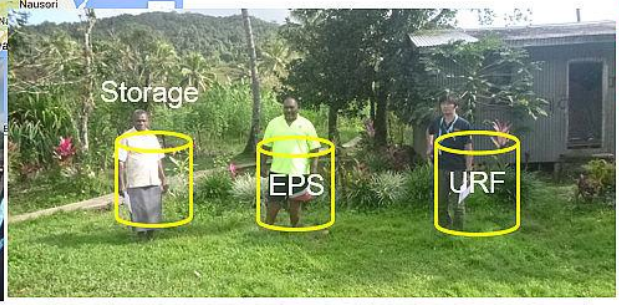
106

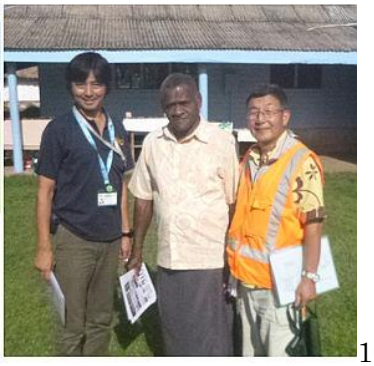
Ravuama Koroibulooeka Tk
844579-9329890
300 persons, 50 houses

One day water demand
(drink and cooking)
300 x 6 liters
= 1,800 liters/day

Demand is enough of this flow for a day.

This flow :
1.66 liter/min
100 liter/h
2,400 liter/day

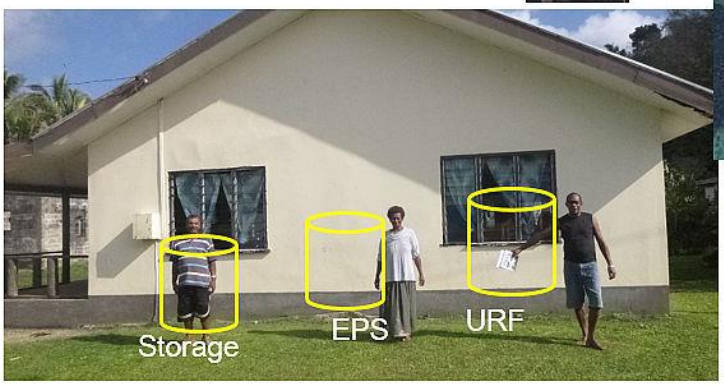




107

Iveri Lavou Tk
9084684
224 persons, 52 houses
Water Committee
Meri Meli
Jute

Always, plenty of water



One day water demand
(drink and cooking)
224 x 6 liters
= 1,344 liters/day

Keep almost this inflow rate to EPS system.

0.83 liter/min

50 liter/h

1,200 liter/day

108

Namosi 20150716

Always, plenty of water

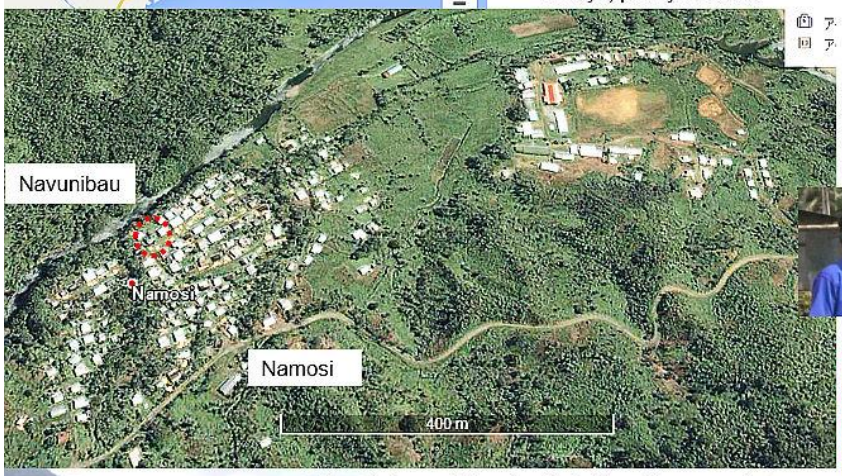
Antonio Tk of Namosi
6030520 Public phone

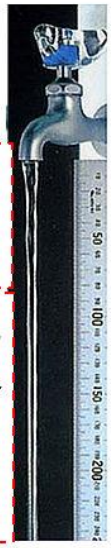
Namosi village
500 persons 97 houses
Navunibau (neighbor village)
100 persons 23 houses

Total 600 persons

Water demand
600 persons x 6 liters
=3,600 liters/day

Bottling station for pet bottle maker is located near this village.

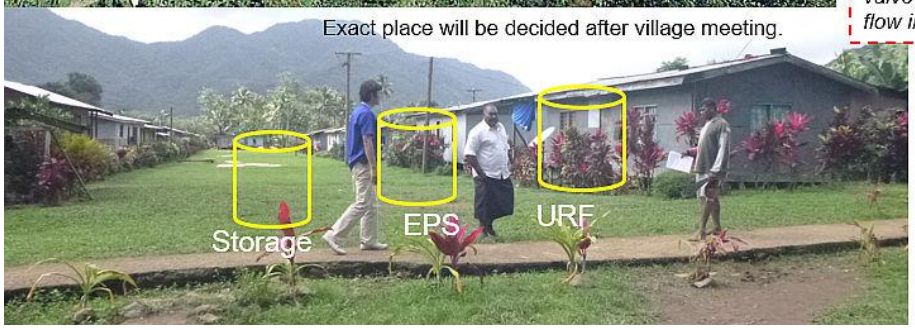




Inflow rate can be regulated and can be kept the running water system of EPS by inflow control valve before URF watching the flow into EPS.

This flow :
1.66 liter/min
100 liter/h
2,400 liter/day

Demand is 1.5 times of this of this flow for a day.



109

Nadakuni 20150716

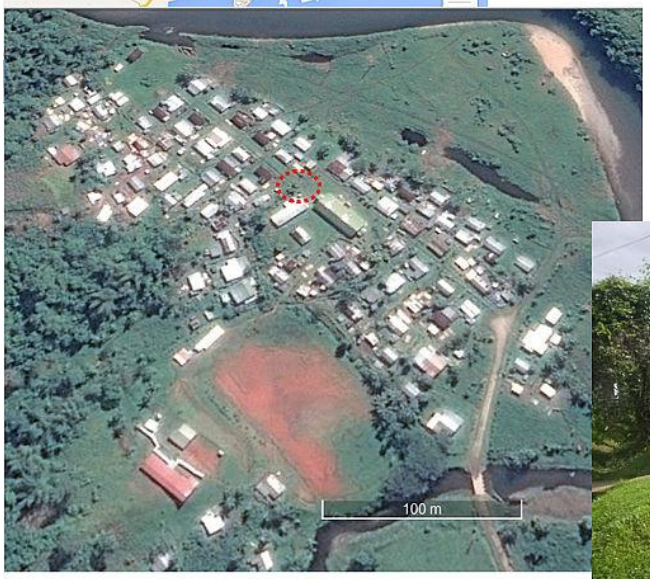
Always, plenty of water

Paula
Water committee

Matereti
Water chair man
6030627

300 persons 100 houses

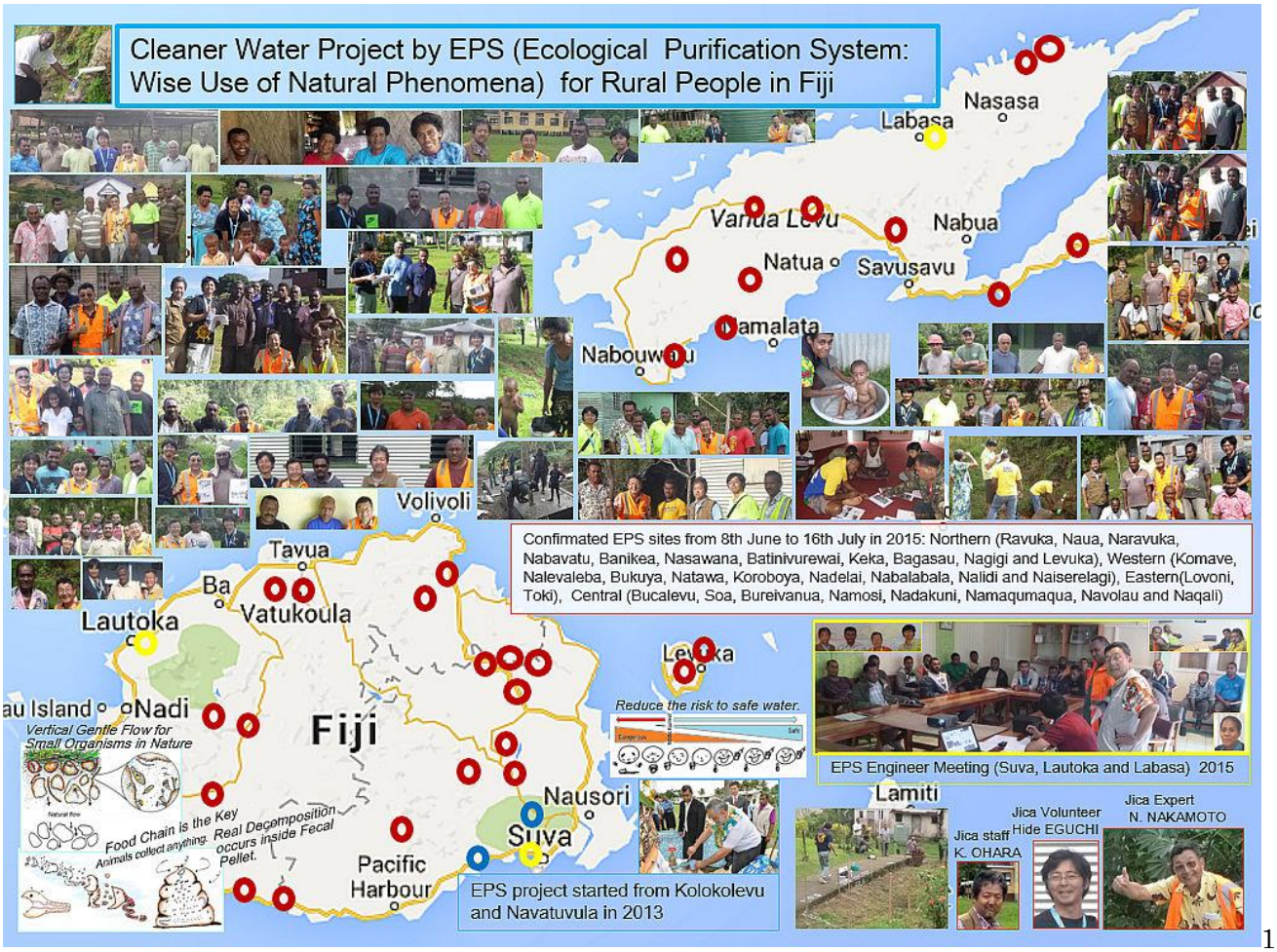
Water demand
300 persons x 6 liters
=1,800 liters/day



This flow :
1.66 liter/min
100 liter/h
2,400 liter/day

Demand is less than this flow for a day into EPS.

110



111

Naqali village
20150714 construction started.
20150812 completed
20150814 raw water introduced (filter run started)
20150818 villagers already drink filtrate.

Filtrate:
clear, sweet and delicious.
ろ過水は清澄で甘くおいしい水

Naqali 村 2015年7月14日建設開始 8月12日完成
8月14日原水通水（稼働）開始 8月18日利用中
（雨期で原水は濁っていても、ろ過水は清澄で甘くおいしい水）

Navolau village
20150814 completed
20150817 raw water introduced.
20150818 Filtrate already clear.

Navolau 村 2015年8月14日完成
8月17日原水通水（稼働）開始
8月18日ろ過水、清澄

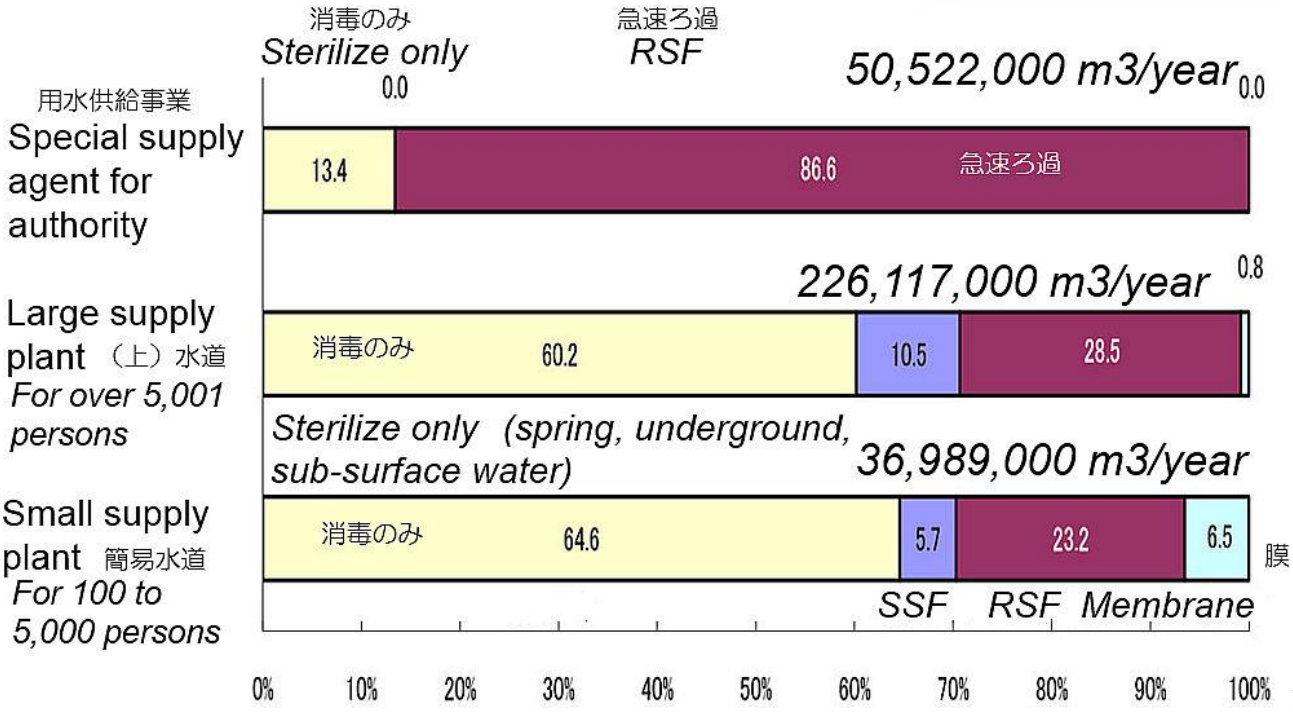
112

Statics of water supply in Nagano (2012) *Nagano is mountain region.*

山地の長野県の水道統計　（2012）

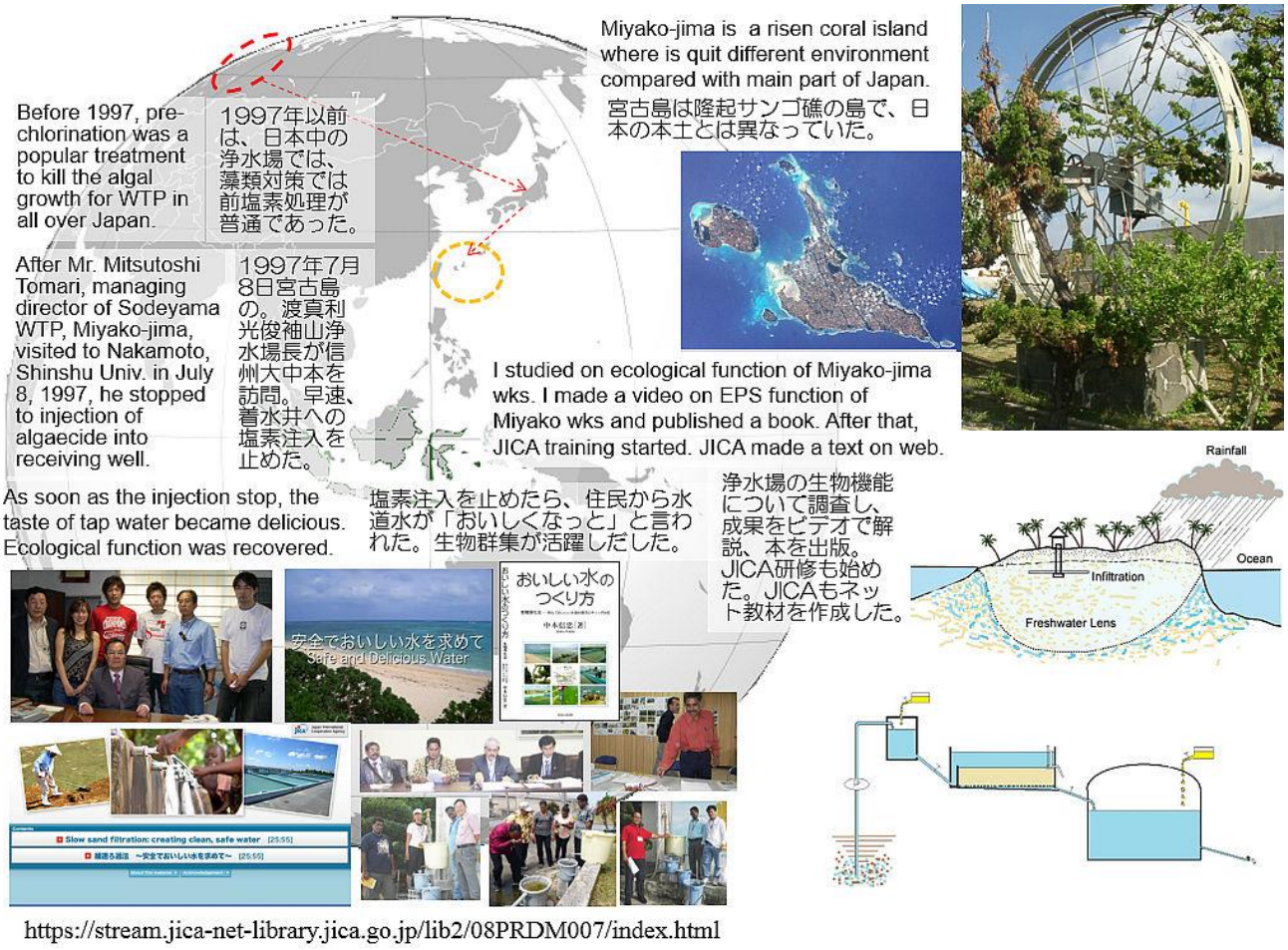
浄水処理方法別、浄水量の割合（%）

Ratio(%) of water supply by different system.



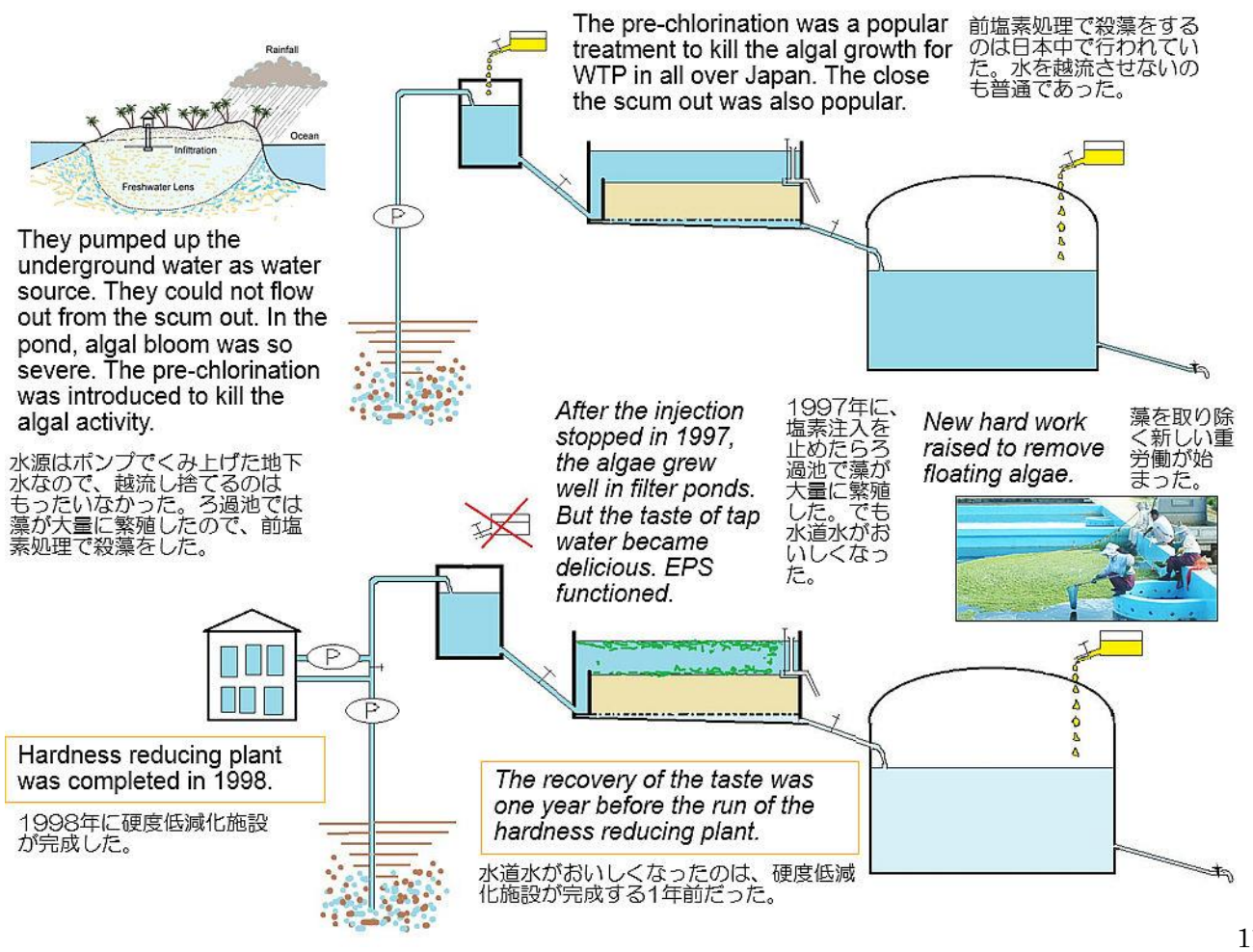
113

114

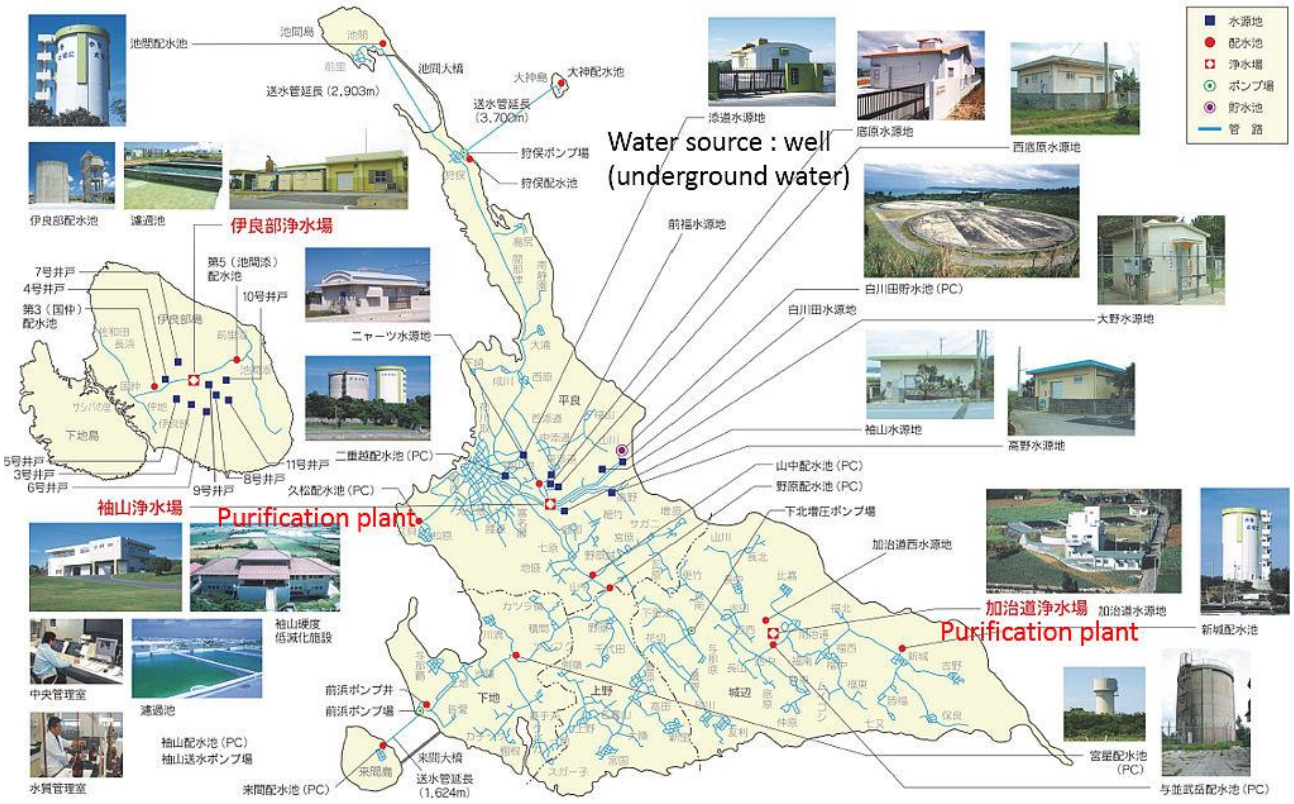


https://stream.jica-net-library.jica.go.jp/lib2/08PRDM007/index.html

115



116



Miyako island is a raised coral island. There is no mountain and no river. They used rain harvesting and underground water. Occupied government of US to this made a purification plant by SSF. The water source of water purification plants is only the underground water which is hard water. And algal grew well. They treated algaecide.

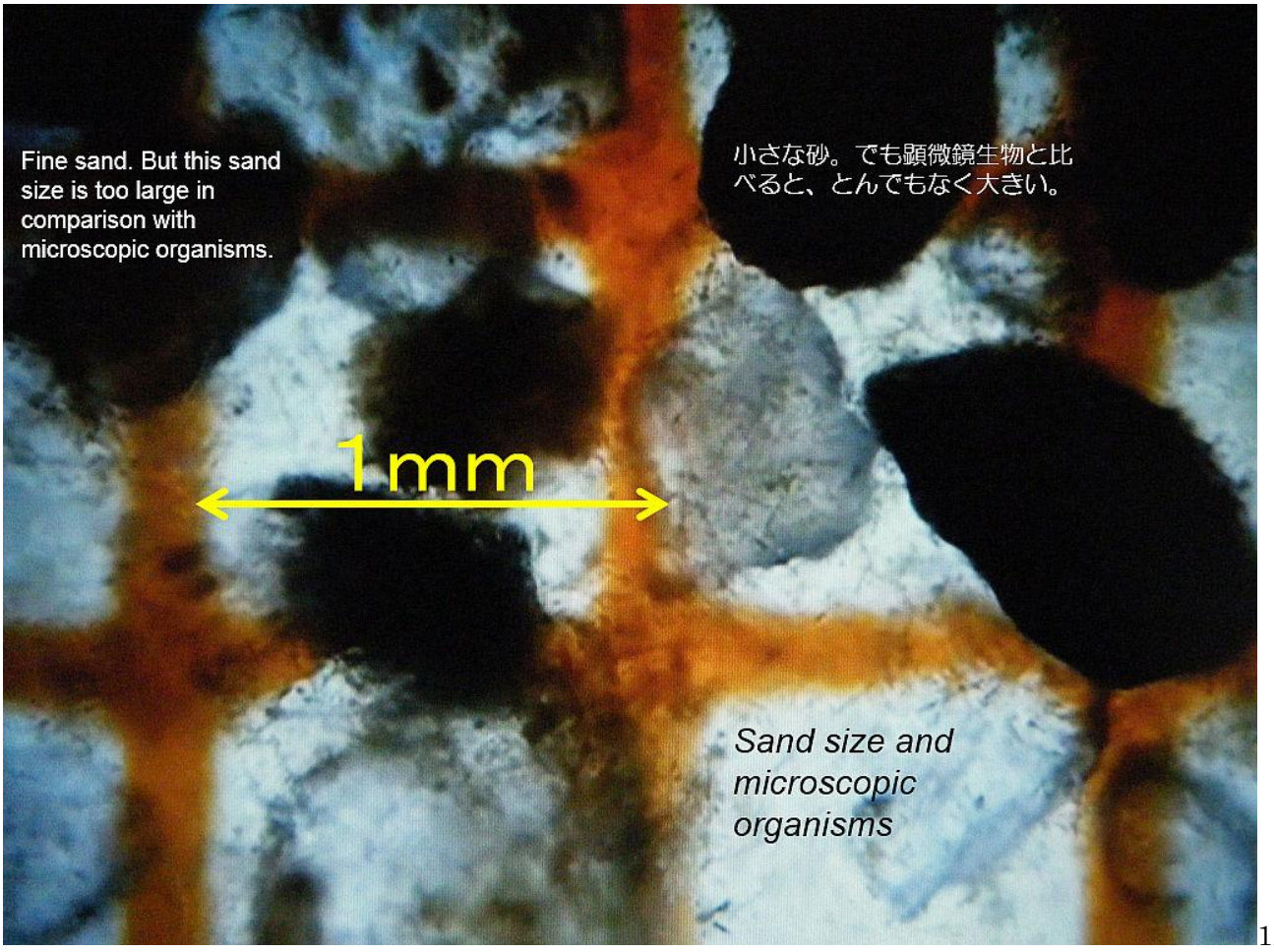
宮古島は隆起サンゴ礁の島で、山もなく、川もない。住民は、雨水利用をし、地下水を利用していた。アメリカの統治政府は、緩速ろ過施設を建設した。地下水を利用したので硬度が高く、藻が盛んに繁殖していた。そこで殺藻剤として前塩素を使用していた。

117

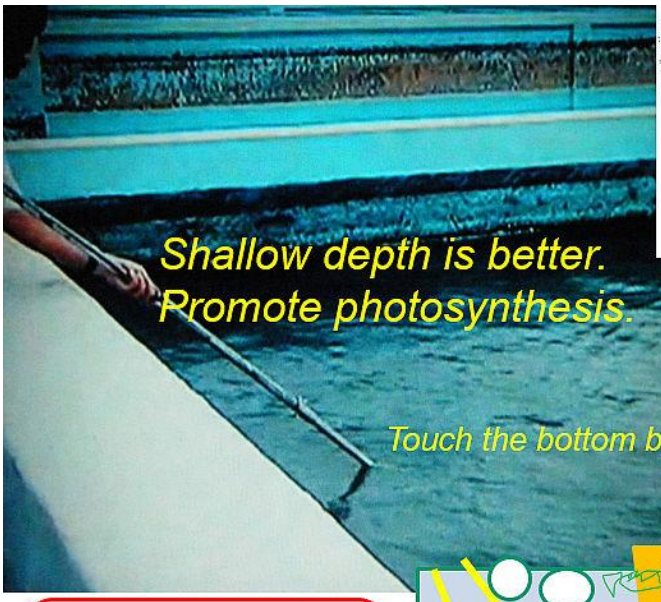
118

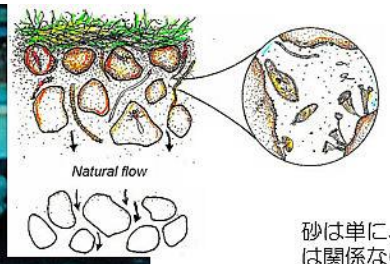

Running model
Lecture
Sand is clear. On the sand surface and in the supernatant water, Many filamentous algae and small animals are active on the sand surface and in the supernatant water. In the water, this is not gelatinous and not slime. When we pull up this layer into air, it becomes gelatinous.
砂は汚れていない。水中では藻や微小動物が立体的だが、底から取り出すと、粘質状になって見える。
Sand surface was taken.

119


Fine sand. But this sand size is too large in comparison with microscopic organisms.
小さな砂。でも顕微鏡生物と比べると、とんでもなく大きい。
1mm
Sand size and microscopic organisms

120



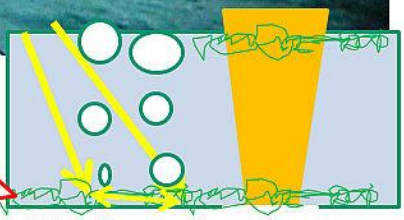


Sand is just habitat. Sand size is not important. Large size of sand and higher flow rate are better for organisms.

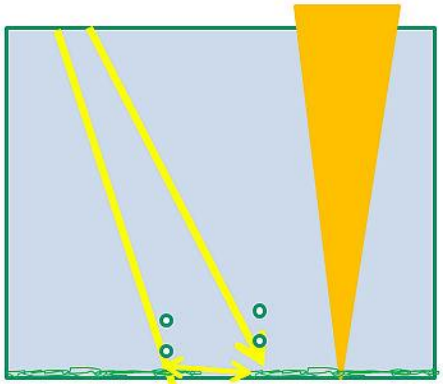
砂は単に、生物の住場所。大きさは関係ない。大きな砂と早い流速が微小生物にとって良い。

浅い水深が良い。
光合成が盛んになり砂面上は、溶存酸素は過飽和状態になるので、気泡が生じやすい。藻は浮き上がりやすい。砂層内部を酸素豊富にし、砂層内部にいる浄化の主役の微小生物にとって良い環境になる。

Super saturated dissolved oxygen at the bottom.



Shallow depth



Deep depth

Aerobic condition for small animals is the key.

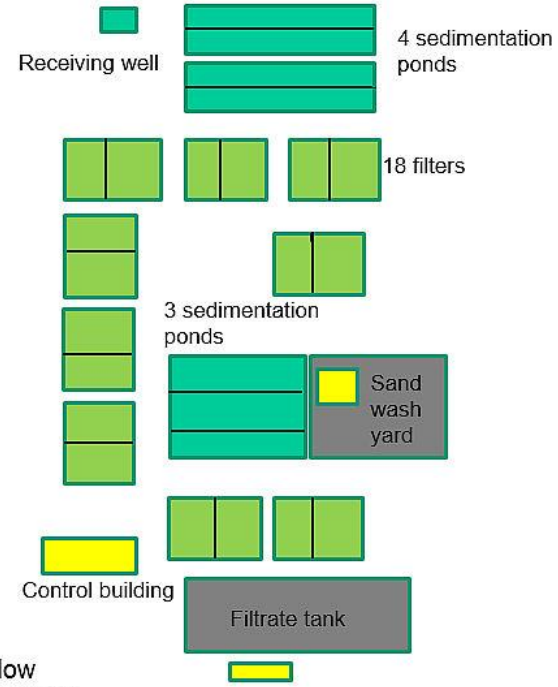
121

Sedimentation tank, inflow regulation system

Slow sand filter

Up-flow roughing filter

122



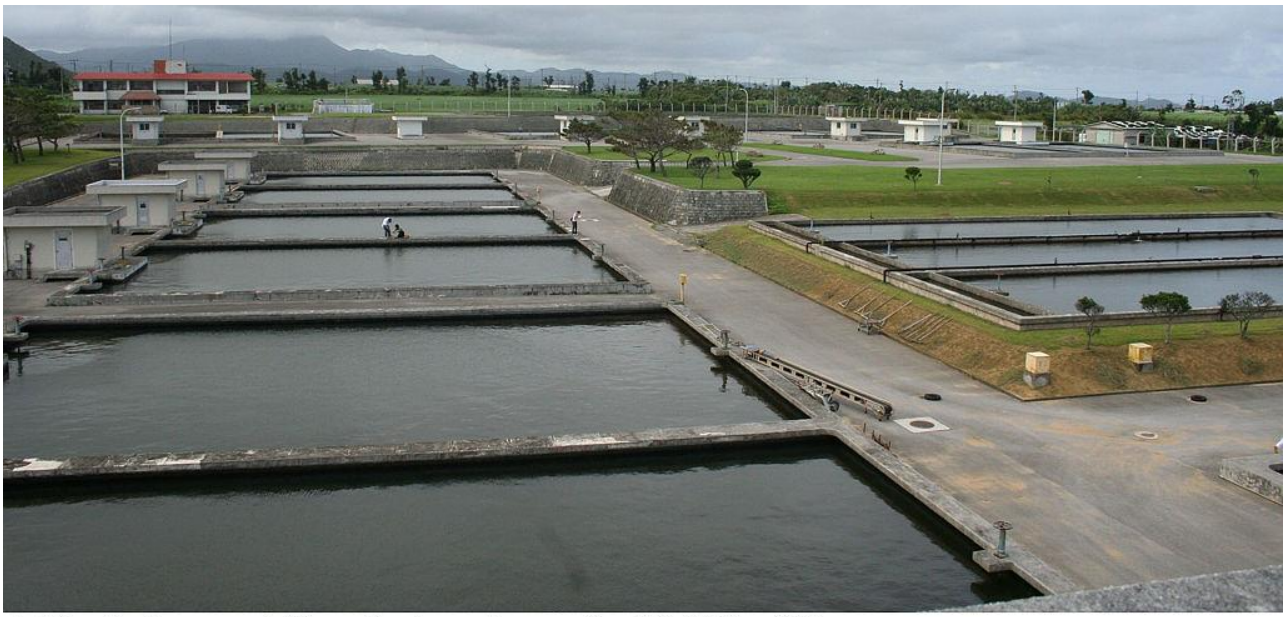
Ishigaki Slow Sand Filter plant

石垣浄水場

沈殿池 Sedimentation pond
10.5 m x 65 m x 3.15 m x 4 ponds
10 m x 40 m x 3.15 m x 3 ponds

ろ過池 Filter: 27 m x 17.6 m x 18 filters

123



Ishigaki slow sand filter: Designed capacity: 30,160 m3/d 石垣浄水場 設計上施設能力

Receiving well 着水井

Sedimentation ponds 12,380 m3 (residence time :0.4 day=10 hrs)

10 x 40 x 3.15 x 3 ponds = 3,780 m3

10.5 x 65 x 3.15 x 4 ponds = 8,600 m3

沈殿池

Slow sand filters ろ過池

27 x 17.6 x 4.08 x **18 filters**

27 x 17.6 = 475.2 m2

475.2 x **4 m/d** = 1,901 m3/d

1,901 x 16 filters = 30,413 m3/d

Designed flow rate 4 m/d 標準ろ過速度 4 m/d

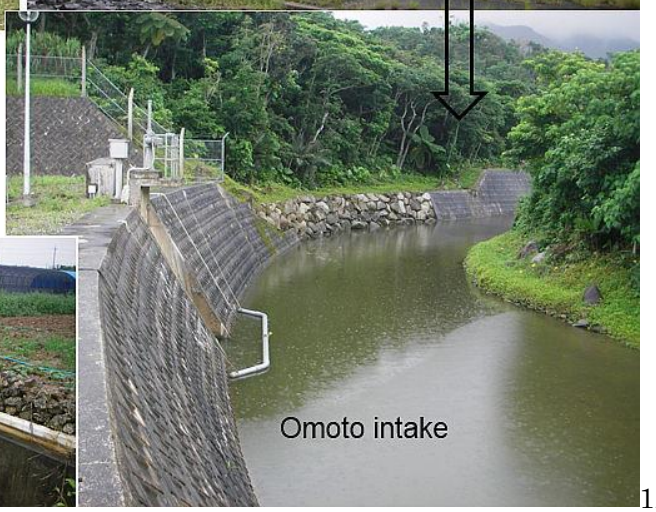
124

Scraping the surface

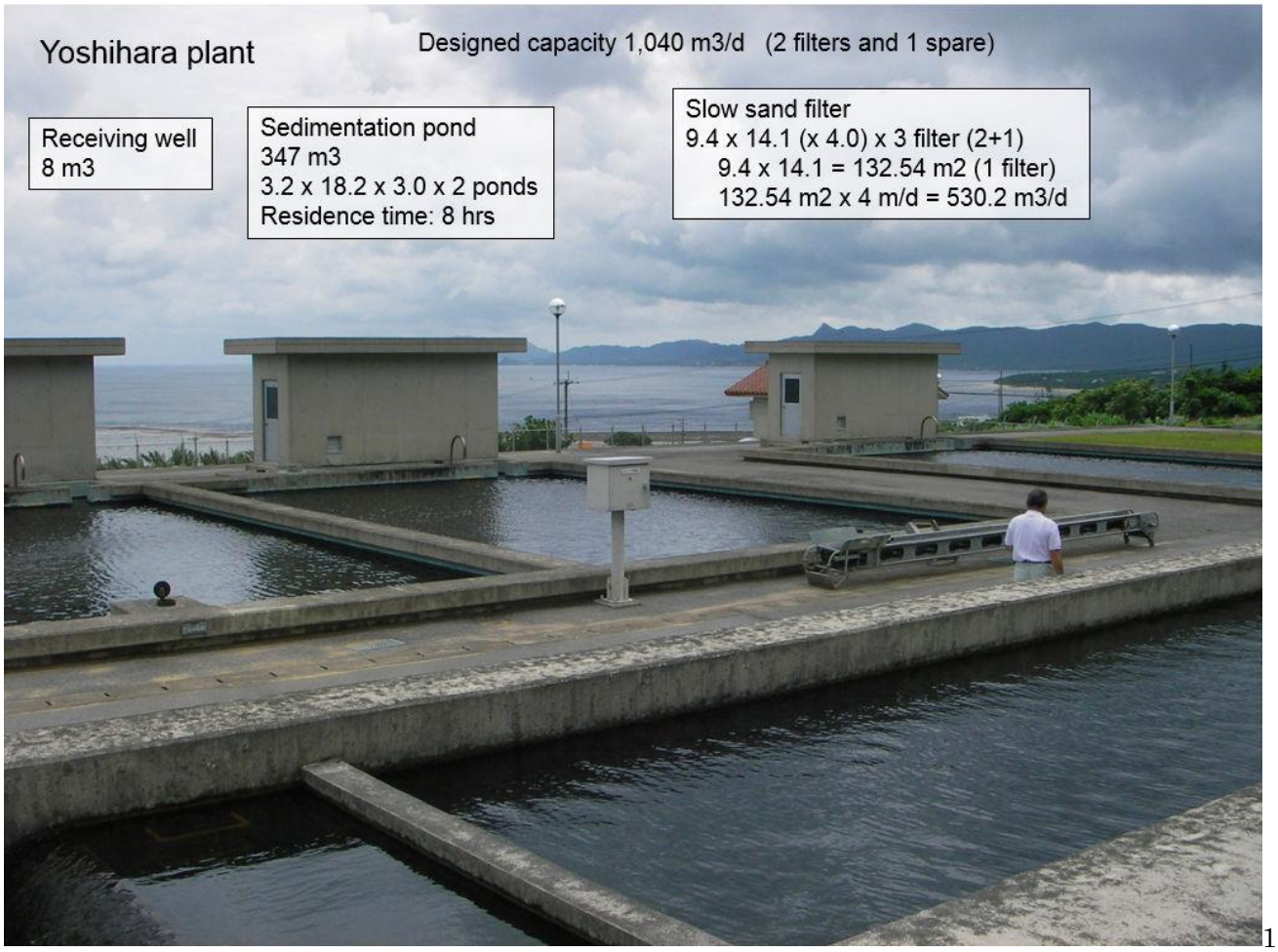
削り取り作業

125

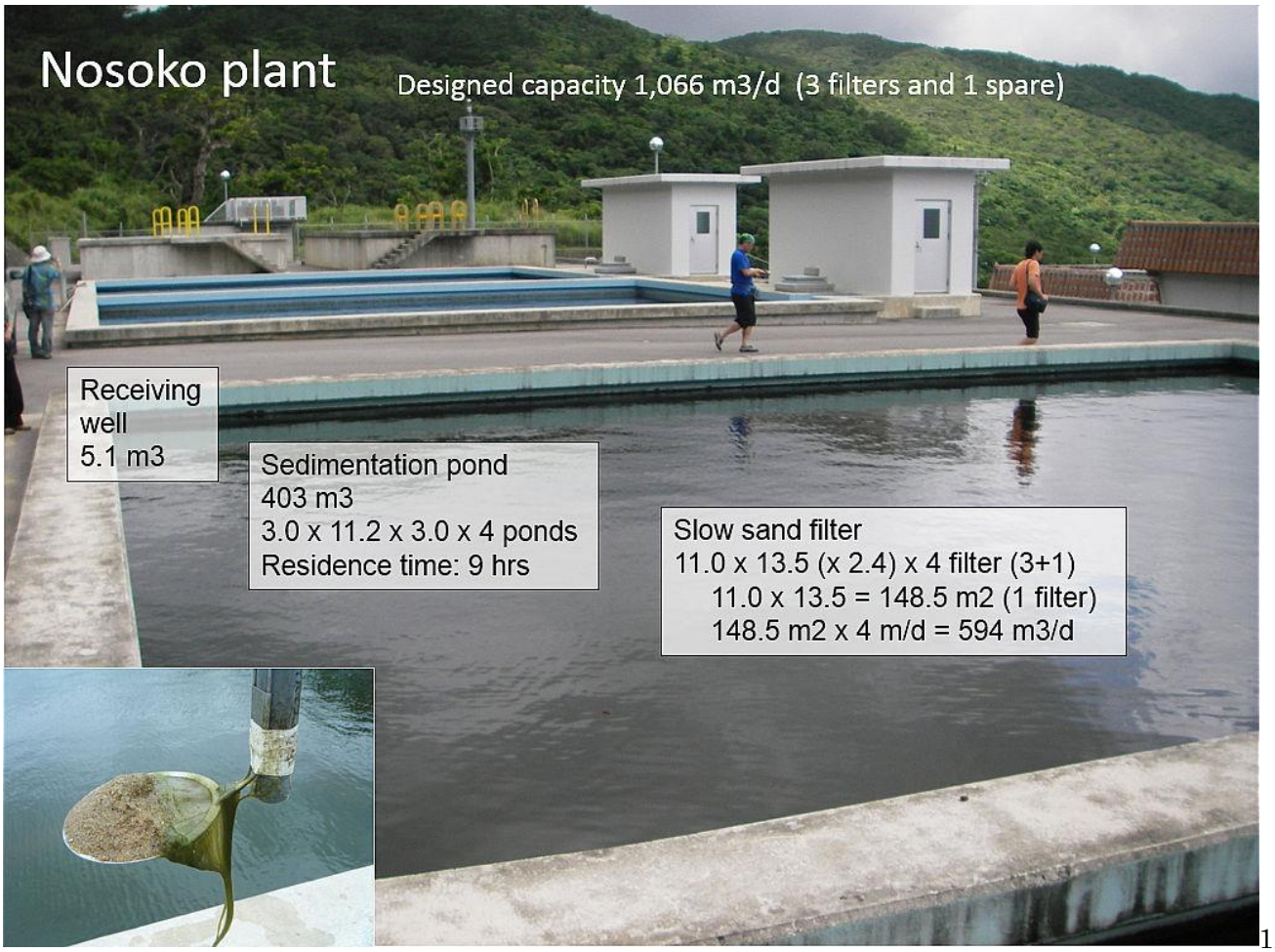
Pump station for
underground water



126


Yoshihara plant
Designed capacity 1,040 m3/d (2 filters and 1 spare)
Receiving well
8 m3
Sedimentation pond
347 m3
3.2 x 18.2 x 3.0 x 2 ponds
Residence time: 8 hrs
Slow sand filter
9.4 x 14.1 (x 4.0) x 3 filter (2+1)
9.4 x 14.1 = 132.54 m2 (1 filter)
132.54 m2 x 4 m/d = 530.2 m3/d

127


Nosoko plant
Designed capacity 1,066 m3/d (3 filters and 1 spare)
Receiving
well
5.1 m3
Sedimentation pond
403 m3
3.0 x 11.2 x 3.0 x 4 ponds
Residence time: 9 hrs
Slow sand filter
11.0 x 13.5 (x 2.4) x 4 filter (3+1)
11.0 x 13.5 = 148.5 m2 (1 filter)
148.5 m2 x 4 m/d = 594 m3/d

128

Shallow depth is the key for algal growth.

水深を浅く：藻類繁殖に良く生物活性を上げる。

薬品を使わず、濁り対策をするのが重要

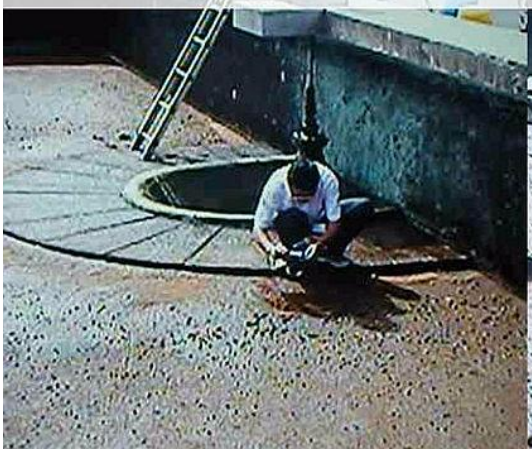
How to reduce the suspended matter without chemicals.

129

Drain off filter for scraping. Many fishes and mollusks are remarkable.

削り取り時、水を排出すると、多くの魚や貝類が目立つ。流入した泥は砂層内に入らず砂はきれい。

Inflow mud does not enter the sand layer. Sand is clear.



130

When surface was dried, they started scraping the surface.

以前は、表面が乾いてから削り取りをしていた。

Before the surface was dried, they scrapped.

表面が乾く前に削り取りをする。

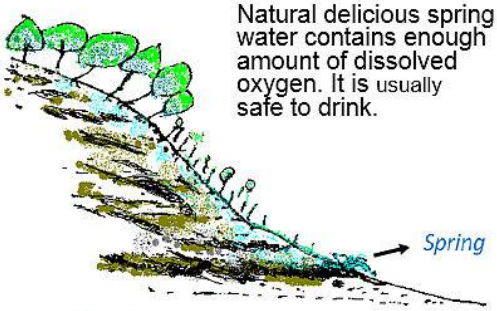
Larger sand size

大きな砂

Scrape in wet condition

湿っている間に削り取り

131



Natural delicious spring water contains enough amount of dissolved oxygen. It is usually safe to drink.

自然界のおいしい湧水には酸素が十分あり、普通は安全。

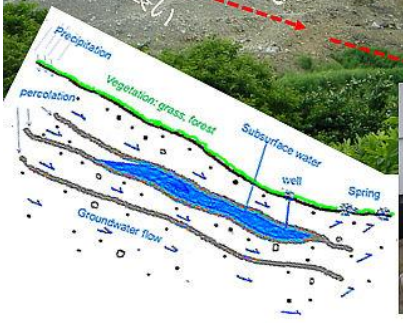
Spring

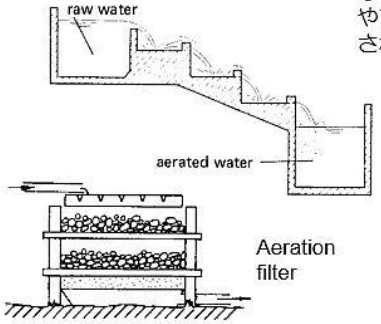
Dissolved oxygen is key.

Addition of oxygen:

Aeration is frequently used for treatment of groundwater (reduction of unpleasant tastes and odors, discoloration, precipitation of iron and manganese).

酸素の負荷：地下水の処理には普通は曝気（エアレーション）が使われる。曝気で美味しくなり臭いや色、鉄やマンガンが沈殿除去される。





Iron and manganese are oxidized and form nearly insoluble hydroxide sludge. They can be removed in a settling tank (a coarse filter).

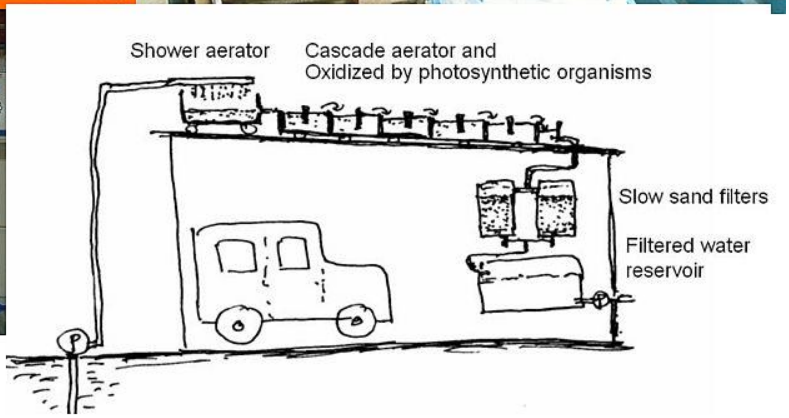
酸素不足の環境で溶存していた鉄やマンガンは酸化され不溶性の水酸化物沈殿になる。それは沈殿槽や粗ろ過で除去できる。

132

133

High concentration of iron and manganese in a tube-well water was treated by a cascade aeration with an ecological purification system.
井戸水に鉄やマンガンが多いなら、階段状にし、酸素付与し生物処理をする。

Final treatment of slow sand filter.
最後に緩速砂ろ過処理



134

Use of natural slope, drinking water could be made by EPS, Bolivia, 2008

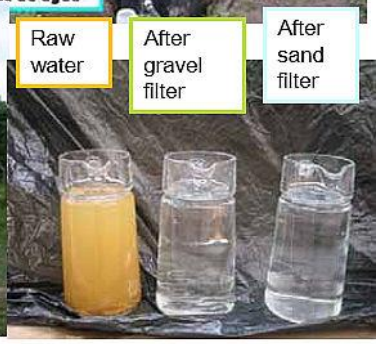
自然のスロープを利用し、井戸水に鉄やマンガンが多い水をEPSで飲料水をつくった。2008年、ボリビア

Pump for groundwater and source water tank
地下水をポンプで揚水。受水槽

3 gravel filters
3段の礫槽

次に砂ろ過 Use of natural slope, pour in sand filter

Filtered water tank
ろ過水貯水槽



原水　粗ろ過後　砂ろ過後

After 4 days, filtered water became clear. After one month, the water became drinkable water, in which coli-form bacteria form was not detected.

4日後、水が清澄に。1月後、処理水には大腸菌群細菌も検出され飲用可能の水になった。

Volunteer JICA's report, Horie, T. 2009

135

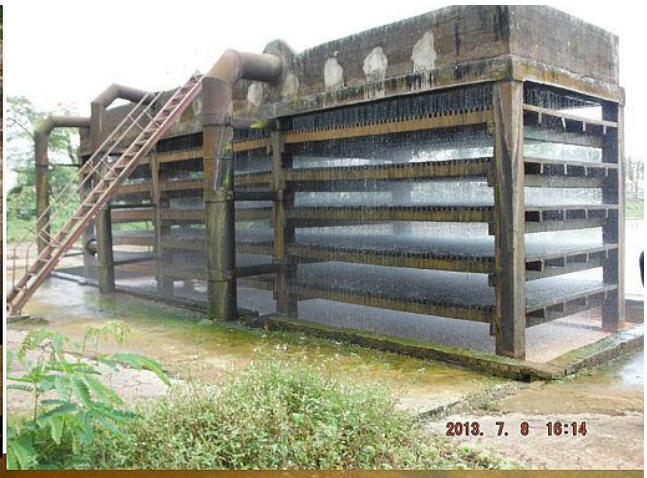
Underground water contains iron and manganese in Jakarta plain. Well water was clear. But the brown colloidal particle was formed soon. They could make clear water using cascade aeration system without any chemical reagent.

インドネシア・ジャカルタ平野の地下水には鉄やマンガンが豊富。井戸水は汲み上げた時は、透明だが、直ぐに褐色の沈殿が生じる。階段状の酸化処理で、薬品を使わず透明な水にすることができた。

Bekasi, Jakarta, Indonesia

インドネシア
ジャカルタ
ブカシ

136



Aeration system for underground water, Chittagong, Bangladesh

地下水の酸化処理、チッタゴン、バングラデッシュ

By Mr. N. Iwase

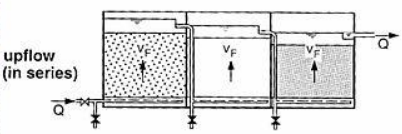
137

In Bangladesh, surface water is contaminated by germ bacteria.
バングラデッシュでは表面水は病原菌で汚染されているのが普通。

Underground water must be oxidized.
地下水は必ず酸化処理する。

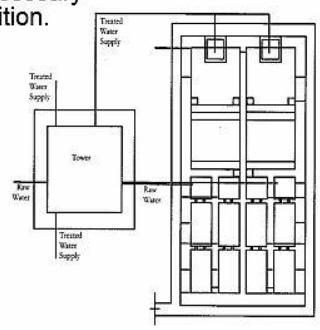
Underground water contaminated with arsenate.
地下水は砒素に汚染されていた。

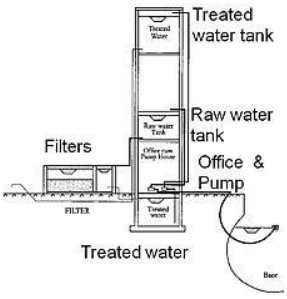
Mechanical SSF was used.
機械的緩速砂ろ過が行われていた。



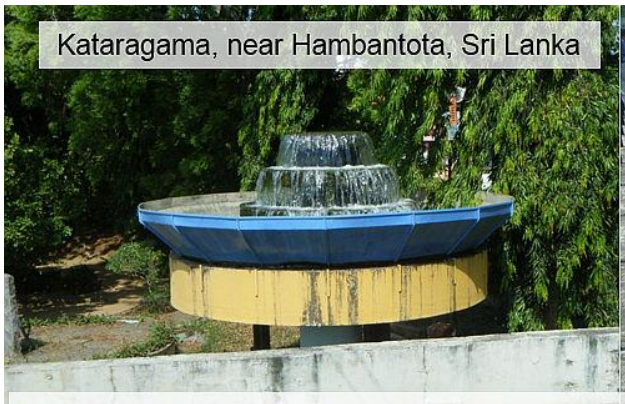
Faster flow rate is necessary to keep aerobic condition.
速いろ過速度は好気的状態を保つ。

I recommended use of EPS using up-flow roughing filter for contaminated shallow lagoon water. I tried to eliminate herbicide and insecticide.
汚染された三日月湖の水を処理するために、上向き粗ろ過を何度も通し、農薬除去も考えたEPSを勧めた。





138



Reservoir, aerator, sedimentation (horizontal roughing filter), then slow sand filter.

貯水池 ⇒ 曝気噴水 ⇒ 沈殿（横向き粗ろ過） ⇒ 緩速砂ろ過

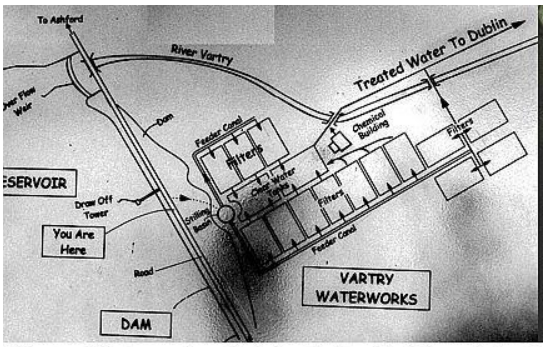
Flow rate is about 10m/d. But deep filter (1.5 m) and frequent scrape of 3 days interval.

ろ過速度は約 10m/d 水深は1.5m と深く、3日に一度の削り取り。

I recommend them to keep long filter run. It is necessary to grow for the small animals.

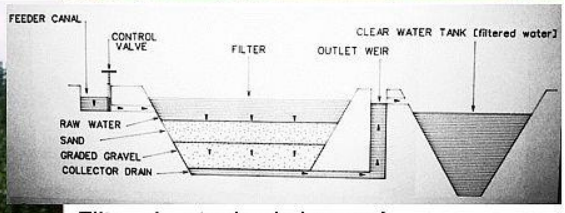
ろ過継続を長くするように勧めた。ろ過閉塞を防止する動物群集の発達に必要である。

139



Vartry Waterworks, Dublin, Ireland. The original scheme was constructed in 1862, and almost unchanged over 150 years.

アイルランド・ダブリンには1862年に建設された緩速ろ過による浄水場が現役で稼働している。



Filtered water basin is open!

ろ過した後の浄水池は、オープン（蓋がない）。

Brown filtered water : This is safe water during 150 years.

150年間、褐色の安全な水を給水し問題ない。

Chlorination is necessary for rapid filtration.

塩素処理は急速ろ過に必要と言っていた。

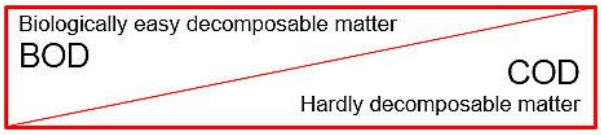
140

Brown color water contains humic substances which are the end products of decompose process. These are hardly decomposable matters by biological action.

褐色の水には、生物分解過程の最終産物の腐食物質が含まれている。この褐色の物質は、生物処理では、分解するのは難しい。

Color water is low BOD (Biochemical Oxygen Demand) value but is high COD (Chemical Oxygen Demand) value.

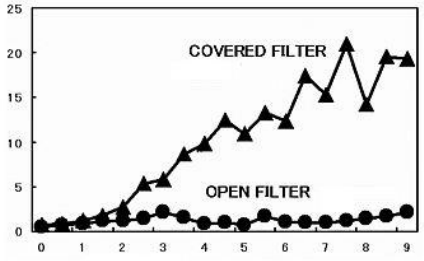
褐色の色水は、BOD(生物化学的酸素要求量)は少ないがCOD(化学的酸素要求量)は大きい。



Humic substances are oxidized by chemical oxidize reagent. The oxidized matters may not always safe for organisms.

腐食物質は酸化薬品で分解できる。
分解されて物質は、必ずしも生物にとって安全とは限らない。

141



Open filter: Algal growth. Production of food for animals. In open filter, biological community of algae and animals are active in the filter. Small animals collect small particle in water.

オープンろ過池では藻類繁殖が良い。動物のエサの生産が良い。オープンだと植物も動物も活発。微小動物はエサだけでなく、何でも微小な濁りを捕捉し動き回る。

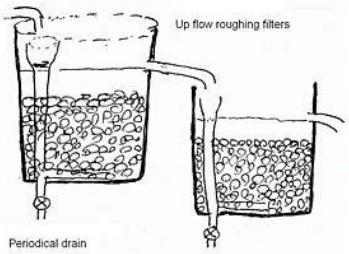
Covered filter: no algal growth
→There is rare food for small animals.
→increase filter resistance : clog easily.

覆いろ過：藻類が繁殖できない。
⇒微小動物のエサが少ない。
⇒ろ過抵抗が増える。ろ過閉塞。

Surface water of a river＋sub-surface water (low oxygen concentration)

河川の表流水＋伏流水
（酸素不足の水が含まれる）

Up flow roughing filters



142







Small Ecological Purification system was set up at Jessore in Bangladesh, in December, 2006. One day capacity is 0.5 m3. In Bangladesh, one person demand is 10 liter per day. This capacity corresponds to 50 persons (10 families). Two times of pumping up is required in one day.

2006年12月バングラデッシュで小さな装置を作った。1日2度、揚水する必要がある。1日に0.5m3、一人1日10リットルとすると、50人分、10家族分だ。

My student rebuilt concrete one. Plastic bottle was very expensive than brick price. This was cheaper than plastic one. Handy pump was used to fill up raw water.

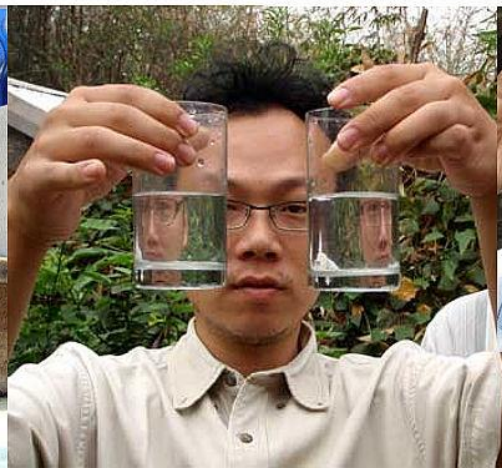
学生がコンクリートブロックで作り直してくれた。プラスチックの大きなタンクは、煉瓦でつくるよりも大変に高価であった。手動ポンプで揚水するようにした。

Storage tank capacity=1.2t/d, Up-flow roughing filters (3 steps: 30X30cm2 gravel), 40x82cm2:sandfilter, 50cm depth.



143


ApamNapat Art Project (Mr. Sohei Iwata managed near Korcata in 2008).　岩田さんはコルカタ郊外でEPSで飲用可の水を


144

OISCA Tokyo:
polluted water (Kanda river) → gravel → gravel → small sand → safe water

オイスカの木附さんは、汚染した東京・神田川の水を揚水し、2段の粗ろ過、砂ろ過で、飲料可の水をつくった。

Sri Lank: three Up flow roughing filters → sand filter → safe drinking water (300 liters / day). This water is the demand of safe drinking and cooking water for 5-6 families.

スリランカで、3段の粗ろ過、砂ろ過で1日300リットルの飲料可の水をつくる装置を作った。この量は、5～6家族分の飲料水と料理に必要な水量です。

Wise use of natural phenomena.
We can easily get safe drinking water by ourselves.

自然現象の賢い活用。
私たちは、簡単に自分らで安全な飲料水をつくることができる。

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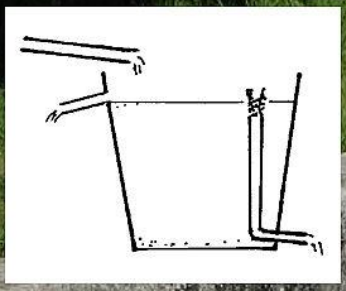
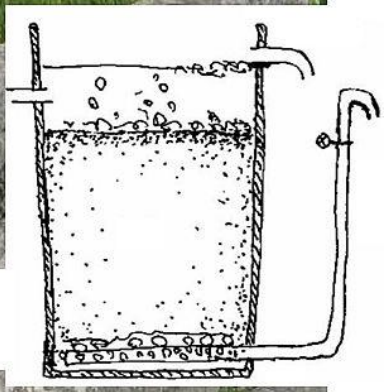
Sedimentation basin

A simple model　簡単なモデル





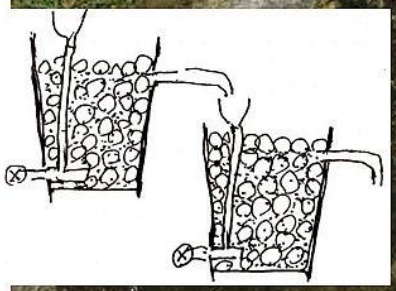
Flow rate is controlled to keep the water level using an over flow pipe.

越流で、水圧を一定にし、流量を一定にした。

Slow sand filter

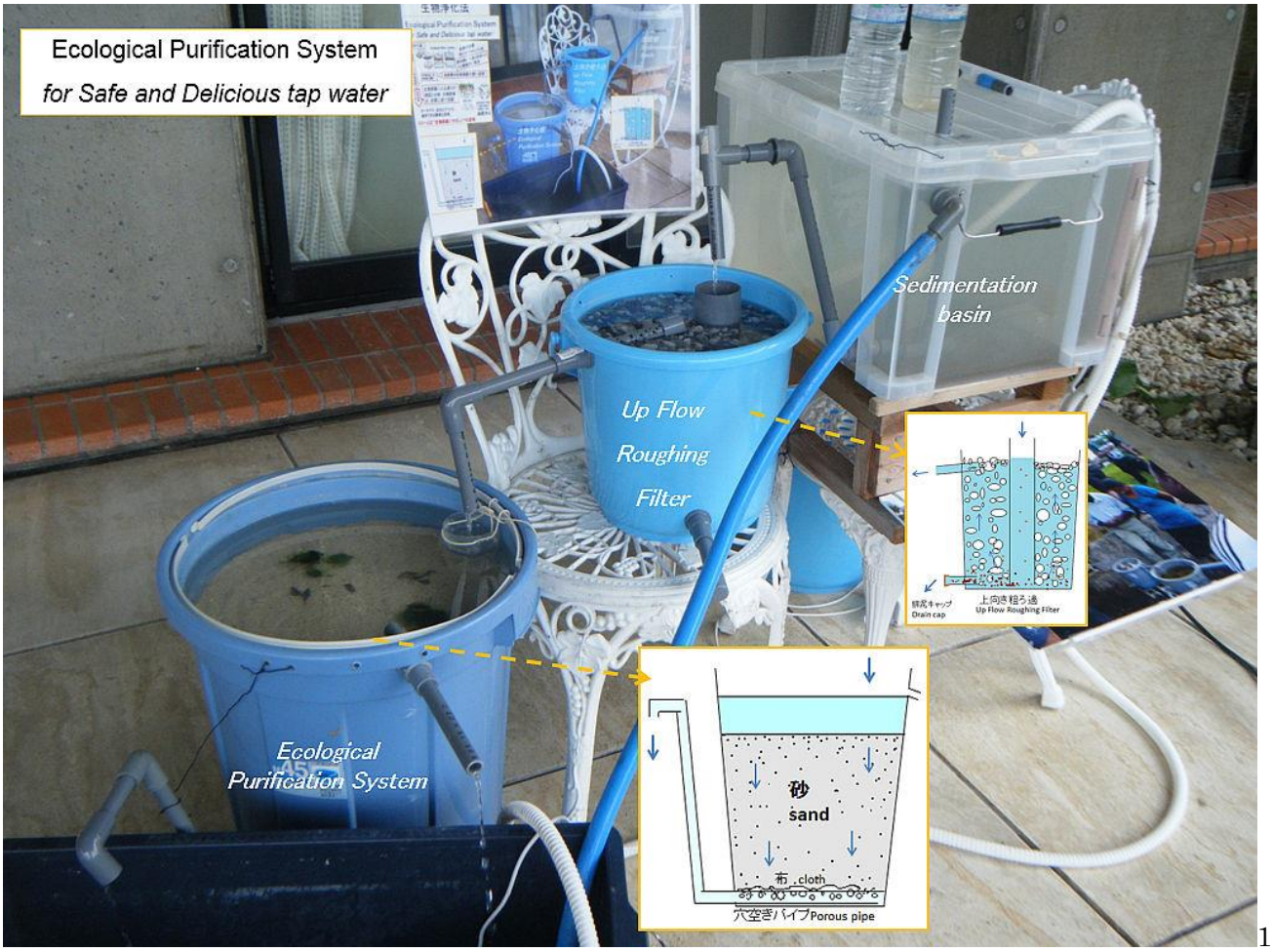
Up-flow roughing filter using gravels.

Over flow

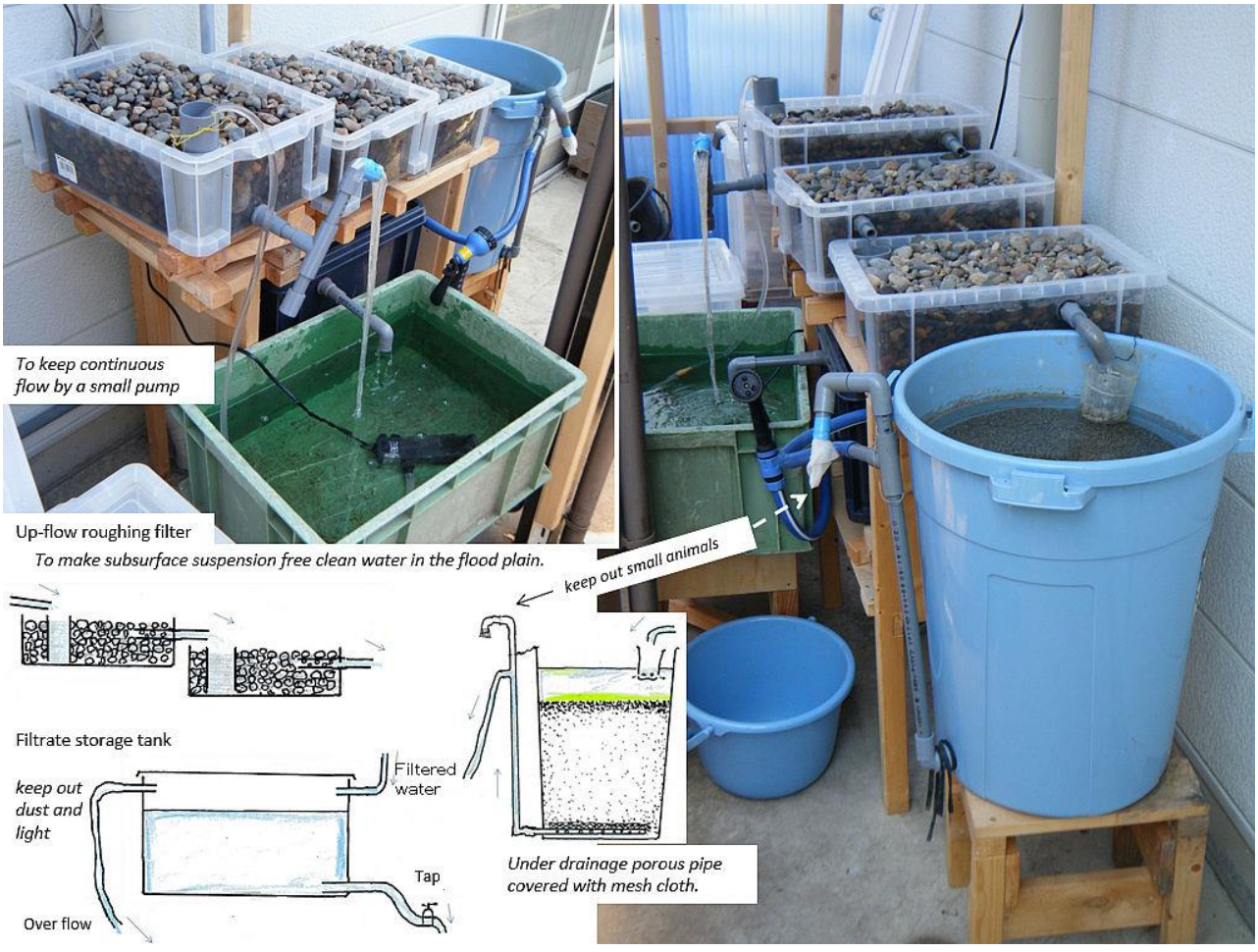


The drain tap in case of filter clog.

146

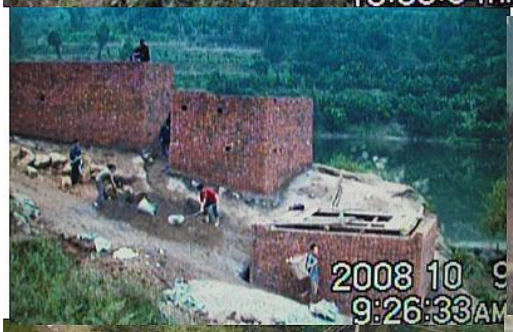

Ecological Purification System
for Safe and Delicious tap water
Sedimentation basin
Up Flow Roughing Filter
Ecological Purification System
砂
sand
布 cloth
穴空きパイプ Porous pipe
Drain cap
上向き粗ろ過
Up Flow Roughing Filter

147


To keep continuous flow by a small pump
Up-flow roughing filter
To make subsurface suspension free clean water in the flood plain.
keep out small animals
Filtrate storage tank
keep out dust and light
Filtered water
Tap
Over flow
Under drainage porous pipe covered with mesh cloth.

148

Mr. Jinshengzhe, translator of Chinese version, made several water plant in China in 2008 after the great earthquake.
「おいしい水のつくり方」を中国語に翻訳していた金勝哲さんは2008年四川大地震の後に、四川でEPSの水道施設を何か所かで建設した。



This is 30 tons per day. Sedimentation, up-flow roughing filter, SSF

日量30トン、沈殿池、上向き粗ろ過、EPS

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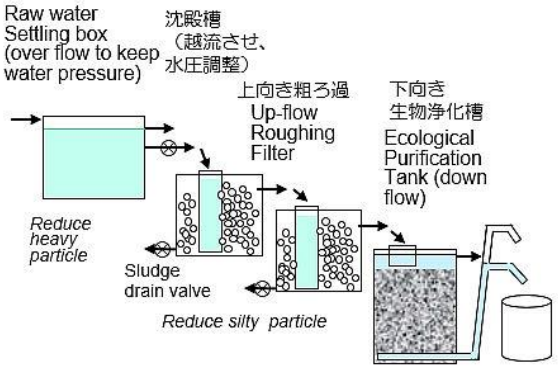
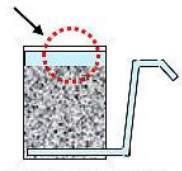
Filter area can be measured using a cup and is regulated by a cock.
ろ過速度はコップを使用して測定、コックで調節する。



Filter area = 30.5 cm x 44 cm = 1,342 cm2　ろ過面積
In case of Present Thames filter rate (40cm/h =9.6m/d)
Filtrate/min = 1,342 cm2 x 40 cm/h/ 60 (min) =895 cm3(ml)/min
Filtrate/h = 1,342 cm2 x 40 cm/h = 53,680 cm3/h =53.7 liter/h
Filtrate/d = 53.7 liter x 24 hrs = 1.29 m3/d

現在のテムズろ過速度を採用すると
1分間のろ過水量
1時間のろ過水量
1日のろ過水量



Shallow water depth over sand is important to keep aerobic condition. Passing time of water is shorter in shallower depth. And higher flow rate is also better to keep aerobic condition.

砂の上の水深を浅くし好気的環境を保つ。水の交換時間が短い。ろ過速度を速くするのも好気状態を保つ。

ろ過速度

砂層の空隙率５０％での砂層のろ過速度

砂層の１ｍの通過時間（時間）

生物活性が良い1㎝の通過時間　（分）

	unit	Simpson 1829	English Filter	Present Thames Filter	Experiment in Samoa
			英国式	現在のテムズ水道	サモアでの実験
Flow rate	m/d	2	4.8	9.6	20
	cm/h	8.3	20	40	83
Flow rate in sand layer (50% porosity)	cm/h	16.7	40	80	167
Passing time of 1 m sand layer	hr	6	2.5	1.25	0.6
Passing time of upper active 1 cm	min	3.6	1.5	0.75	0.36

150

In Japan, river water is usually clear and small amount of water. 日本では、普通は川の水量が少なく水は清澄。

After heavy storm event, river water becomes dirty and rapidly increases. 豪雨があると、水は濁り、水量も急激に多くなる。

Clear and suspended free water from spring is found in a flood plain.

河原には湧水からの濁りがない清澄な水が見られた。

Flood water is dirty. There is huge amount of soil matter from land surface.

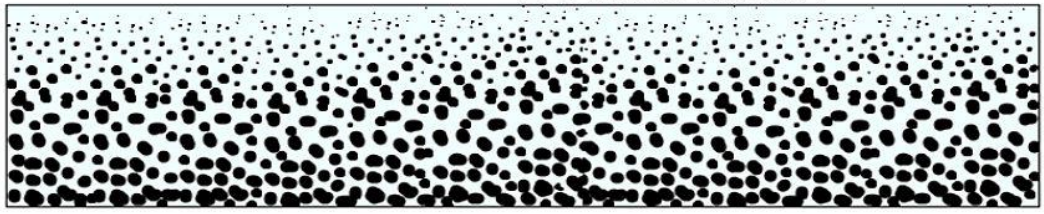
増水した水は、濁度が高い。周囲の地表面から土壌粒子が流入している。

Light and small particle which is not easily settled.

軽く、小さな粒子は沈みにくい。

A large amount of heavy and large particles in a storm water.

増水時は水量も多く、含まれる粒子は、重く、大きな粒子の割合も多い。

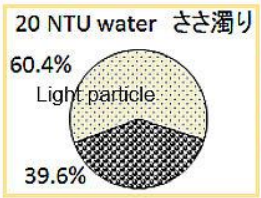


151

*There were extremely small particles like as colloidal particles in case of small turbidity, like as less than 20 NTU. The rapid settling of turbid matters was observed **within 4 hrs**. However, a large portion of turbidity did not decrease.*

濁度20度以下のよう濁りは、粘土・コロイド粒子の大きさの粒子が多い。濁った水の場合、濁りの大部分は4時間以内に沈んだ。4時間以内に沈む粒子もあるが、大部分の濁りは沈みにくい。

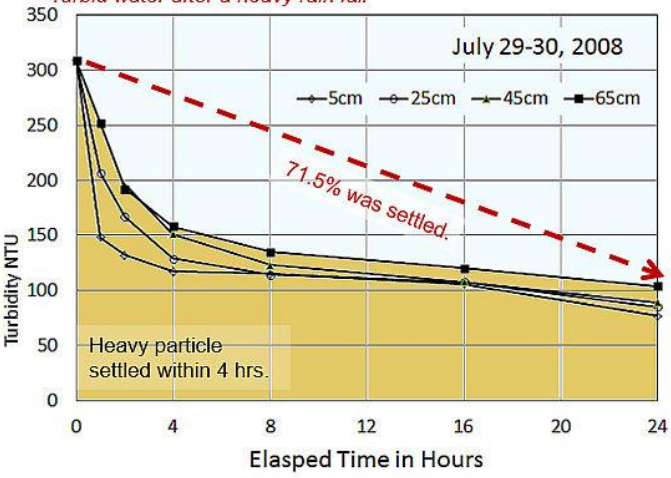
Light turbid water 濁度が小さい水



Light turbid water: small turbidity, a large portion of light particle.

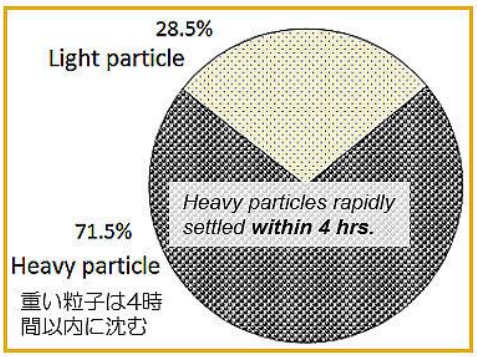
濁度が小さい水は、沈みにくい細かな粒子の割合が多い。

Turbid water after a heavy rain fall 雨の後のこう濁度の水



In case of turbid water, a large portion was heavy particles.

高濁度の水は、重い粒子の割合が多い。



4 hrs. settling is enough. 4時間で十分

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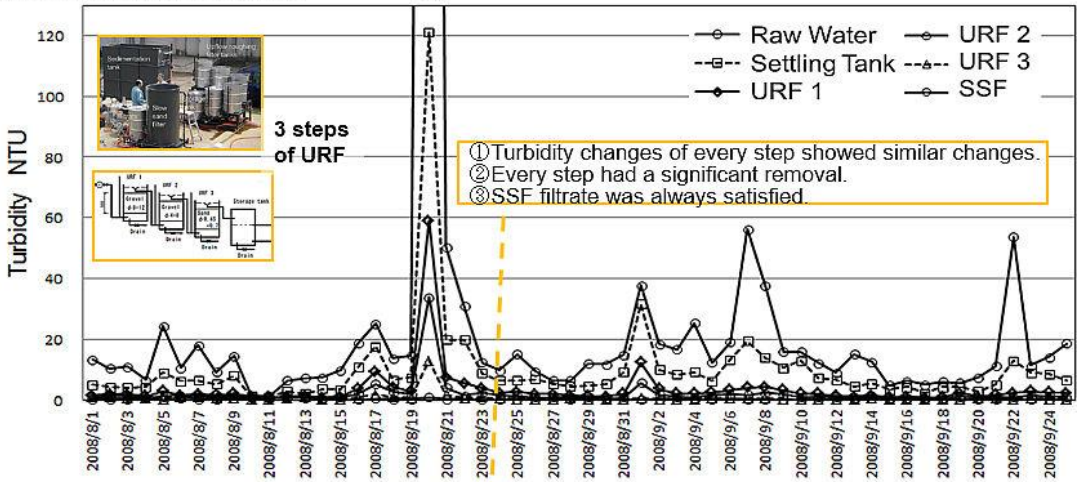
Turbidity change from 1st Aug. to 24th Sept., 2008.

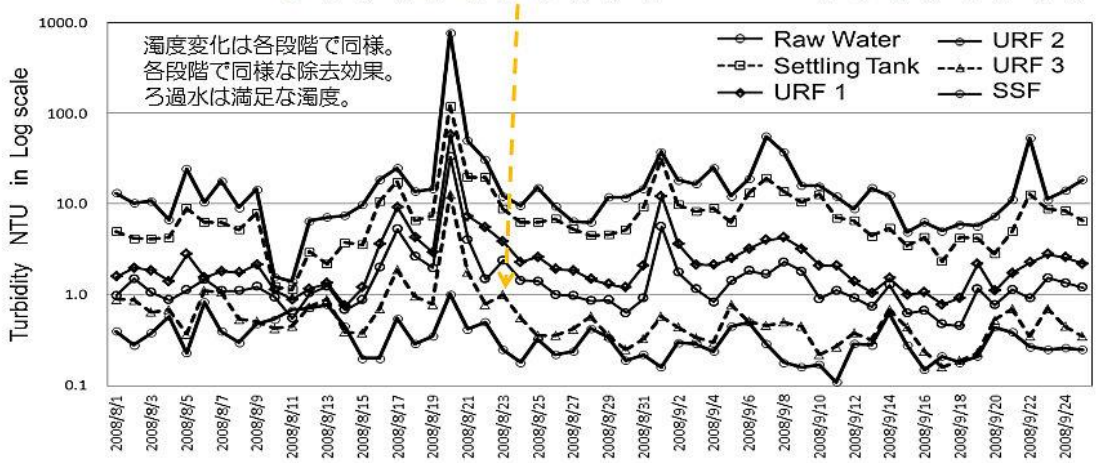
776

2008年8月1日～9月24日の濁度変化



Same data were shown in log scale in order to make clear the removal rate from raw water to SSF filtrate.

濁度変化を普通メモリと対数目盛で表すと変化の詳細がわかりやすい。



Even extra-ordinary high turbid water could be treated to acceptable level of quality by this system.

極端な高濁度の水でも満足する濃度にできた。

153

http://www.suncoli.com/02_1-2.html

Suncoli bacteria test paper
Viable number of coliform group bacteria test paper and general bacteria paper in water are easily counted by this pater.

general bacteria paper

サンコリー般細菌数用簡易検出紙
入数:1箱100枚入
細菌に対する反応色:赤
培養時間:35～37℃24時間

After one day incubation, pink colonies develop. These colonies are general (total) bacteria

赤いコロニーは一般（普通）細菌

You can incubate at room temperature. Development speed relates with temperature.

細菌の成長速度は温度に関係する。室温だと少し遅い。

http://www.sibata.co.jp/english/
E-mail:overseas@sibata.co.jp

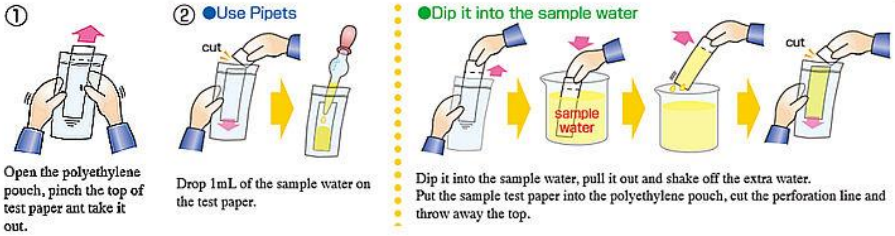
Test Paper for General Bacteria/Coliform Group

coliform group bacteria and coliform bacteria by UV irradiation

サンコリ改変大腸菌群簡易検出紙
入数:1箱100枚入
細菌に対する反応色:大腸菌群:青
大腸菌:紫外線照射でライトブルー蛍光
培養時間:35～37℃24時間

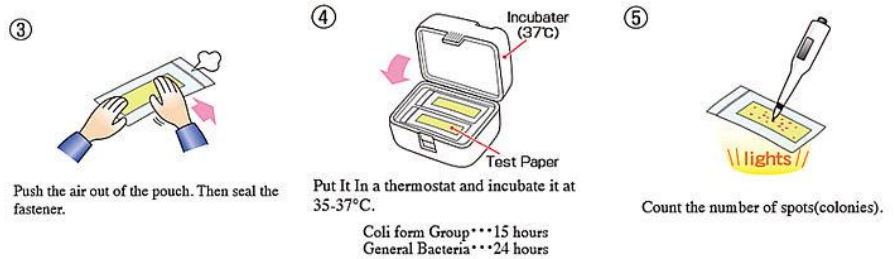
After one day incubation, blue colonies develop. These colonies are Coliform group bacteria. And under UV radiation, luminescence colonies are Coliform bacteria.

1日培養後、青いコロニーは大腸菌群細菌、紫外線を照射すると蛍光を発するのが大腸菌。



We can use this cheap UV light (Magic light pen). 100yen+tax

紫外線ランプは廉価なのでも同じ機能



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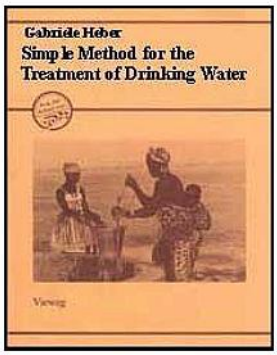
Gabriele Heber 1985: Simple Methods for the Treatment of Drinking Water



(GTZ, 1985, 78 p.)

Acceptable Risk

Turbidity, Average Values (NTU)	E. Coli (MPN/100 ml)	Processes and Combinations
Up to 10	10	No treatment necessary
10	100	Only disinfection
100	1,000	Slow sand filtration
250	1,000	Pretreatment + Slow sand filtration
250	10,000	Pretreatment + Slow sand filtration + Disinfection
1,000	100,000	Two pretreatment methods: e.g. sedimentation + coarse filtration or coagulation/fluctuation + sedimentation Subsequently: slow sand filtration + disinfection
100	2,000	Rapid filtration + disinfection
1,000	3,000	Pretreatment + rapid filtration + disinfection

http://www.cd3wd.com/CD3WD_40/CD3WD/WATSAN/G13SIE/EN/B973.HTM

Table 4: Treatment processes and combinations as a function of turbidity and E. Coli count in the raw water. Additional aeration generally helps to increase the water's oxygen content. The turbidity values refer to the contents of settle-able and non-settle-able substances. The choice of pretreatment method thus depends on the type and composition of turbidity.

原水中の濁度と大腸菌数と処理方法：酸素負荷のため、追加のエアレーションは助かる。濁度は沈降性物の指標。水質と濁度で処理方法を選択する。

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Ecological Purification System is Simple Technology for Ours.

EPS　生物浄化法は私たちのための簡単な浄化法

Slow means "Gentle for organisms".

Slowは｛生物群集にやさしい」の意味

Uniform Fine Sand is not necessary.
Sand is just habitat for organisms.

均一の砂は必要ない。砂は単に住場所

We can construct by ourselves.

私たちは、自分らで建設できる。

Water company does not like this technology.

水道業界はこの技術は好まない。

"This is natural filter, behind is commercial filter".

これはナチュラルフィルター、後ろはコマーシャルフィルター

Don't believe propaganda. 宣伝を信用しない

Clear＝Safe?

きれいとは安全？

Why chlorination is necessary ?

何故、塩素が必要なの？

156

When the raw water is suspended free and water temperature is over 10 degree, the filter does not clog. Biological community can actively work under this condition.

濁りがなく、水温が10度以上なら、ろ過閉塞しないの。削り取りも必要ない。

Nishihara purification plant (Suzaka city, Nagano) was built in Feb. 28th. 2006.
Two filters (area of two filters = 183.6 m2, one filter size: 6.8m x 13.5m (x2.7m)=91.8m2) produces 881.3 m3/day in case of 4.8m/d (English standard rate).
This plant can cover about the one day demand of 3,000 persons in case of 300 liters/day/person.

When the filter clog, the surface of sand layer should be scraped. However, this filter never clog from the beginning (Feb. 2006). The raw water is suspended free spring water at the foot of mountain and water temperature is over 10 degree.

長野県須坂市 西原浄水場（2006（平成１８）年2月28日竣工）は2つのろ過池（2池のろ過池合計面積 = 183.6 m2、1池の大きさ： 6.8m x 13.5m (x 2.7m) = 91.8m2）で ろ過水は、881.3 m3/日 （4.8m/日（英国式標準ろ過速度の場合）できる（但し、能力は能力710 m3/日（標準ろ過速度3.9m/日と記載）。一人1日300リットル、使うとすると、２池で3000人分の水道需要に相当する。

ろ過閉塞（ろ過抵抗が上がる）したら、砂層表面を削り取り閉塞を回避させる。しかし、この浄水場のろ過池は竣工してからろ過閉塞しなかった。それは山の裾野からの湧水が原水で濁りがなく、水温は常に10度以上で、生物群集は常に活躍できた。

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This is Ecological Purification System.

生物群集による浄化　生物浄化法

Gentle for small organisms

生物群集にやさしく

SSFからEPSのイメージに

Change SSF image to EPS

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Ecological Purification System….Smart Technology

Ecological Purification System (EPS), so called Slow Sand Filter (SSF), utilizes an ecological process. The name of SSF came from the mechanical filter through a sand layer under the slow filter rate 4.8 m/day (20 cm/h). The real purification mechanism had been not clear for long time since the system developed in the United Kingdom in 1829, but it was recognized to be an ecological process in the 1990's in Japan.

Algae and associated microscopic organisms which grow on the surface of the filter sand purify the impurities in the water, though some people might think algae can cause odor problem. Algae produce oxygen by photosynthesis and absorb dissolved nutrients such as nitrate and phosphate. In addition, filamentous algae trap particles in the water, and the associate organisms decompose organic matters; and they trap and graze the suspended matters. As the result of ecological process, undesirable impurities such as turbidity, pathogenic bacteria, other organic matters, bad smell, iron and manganese are removed effectively from the original raw water. EPS seems to be a primitive low technology but this is a wise use of natural phenomena. This is a real smart technology for our life.

生物浄化法　スマートテクノロジー

生物浄化法（EPS)緩速ろ過と言われるが生態学的過程による。緩速ろ過という名前は4.8m/d(20cm/h)の「ゆっくり」としたろ過速度で、砂層での機械的ろ過に由来する。本当の浄化の仕組みは1929年に英国で開発された時からはっきりわからなかった。しかし日本で1990年代生態学的過程だと認識された。

ろ過砂の表面上で成長する藻類や顕微鏡生物群集が水中の汚濁物質を浄化していた。しかし人々は藻は臭いの原因と考えた。藻は光合成で酸素を生産し、窒素やリンなどの栄養塩を吸収する。糸状藻類は水中の濁り物質を捕捉し、そこに住む生物群集は有機物を分解、濁り物質を捕捉、分解する。生態学的過程で、濁り、病原菌、有機物、悪臭、鉄、マンガンなどの嫌な汚濁物を原水中から効果的に除く。EPSは原始的なローテクに思われそうだが、自然現象の賢い活用である。EPSは私たちのための本当のスマートテクノロジーだった。

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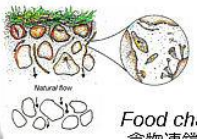
EPS from Japan to the World
日本から世界へ

Wise Use of Natural Phenomena for Human Life.
Safe and Delicious Water by EPS, Our Technology.
自然現象を私たちのために賢い活用
EPSで安全でおいしい水、私たちの技術

Slow Sand Filter
緩速ろ過

Ecological Purification System 生物浄化法



Food chain
食物連鎖

Gentle for small organisms
生物群集にやさしく

Trust Our Sense !
私たちの感覚を信頼しよう

3つのステップを

1：「知っている」だけでなく、「応用」しないと

2：「したい」だけでなく、「計画」し、「行動」しないと

3：「計画」でも十分でない「成果」をださないと

Remember Three Steps

1. Knowing is NOT enough, we must APPLY it to something useful.
2. Willingness is NOT enough, we must PUT it into the PLAN and ACTION.
3. Putting the PLAN into action is NOT enough, we must ACCOMPLISH the goals.

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外務省 Ministry of Foreign Affairs of Japan

Memorial Year of ODA 60 years, July 1. 2014

外務省案内 | 渡航関連情報 | 各国・地域情勢 | 外交政策 | ODA | 会談・訪問

トップページ>報道・広報>広報・出版>わかる！国際情勢>Vol.116「未来への投資」としてのODA ～ 国際協力60周年

わかる！国際情勢　2014年7月1日

Vol.116　2014年7月1日

「未来への投資」としてのODA ～ 国際協力60周年

外務省のHP、わかる！国際情勢　Vol.116　「未来への投資」としてのODA～　国際協力60周年
最初の写真にサモア・水道事情運営（宮古島モデル）支援協力　JICA提供を掲載

2014年は，日本がコロンボ・プランと呼ばれる開発途上国援助のための国際機関に加盟し，政府開発援助（ODA）を開始してからちょうど60年目にあたる節目の年です。「還暦」を迎えた日本の国際協力は，時代や国際社会の変化とともに，どのような役割を担ってきたのでしょうか。今回は日本の国際協力のこれまでの歩みと，今後の展開について解説します。

■国際協力とは

現在世界には 1[illegible]カ国以上が，「開[illegible]開発途上国の多く[illegible]十分な食料や飲み[illegible]を満足に受けら[illegible]破壊や感染症の蔓[illegible]問題も山積してい[illegible]開発途上国だけの問題[illegible]した中で各国は，国際社会全体の[illegible]定，発展のため，開発途上国や地域の人々を支援する取組を行っています。

The first photo is JICA training in Miyako-jima

サモア・水道事業運営（宮古島モデル）支援協力　JICA提供

http://www.mofa.go.jp/mofaj/press/pr/wakaru/topics/vol116/index.html

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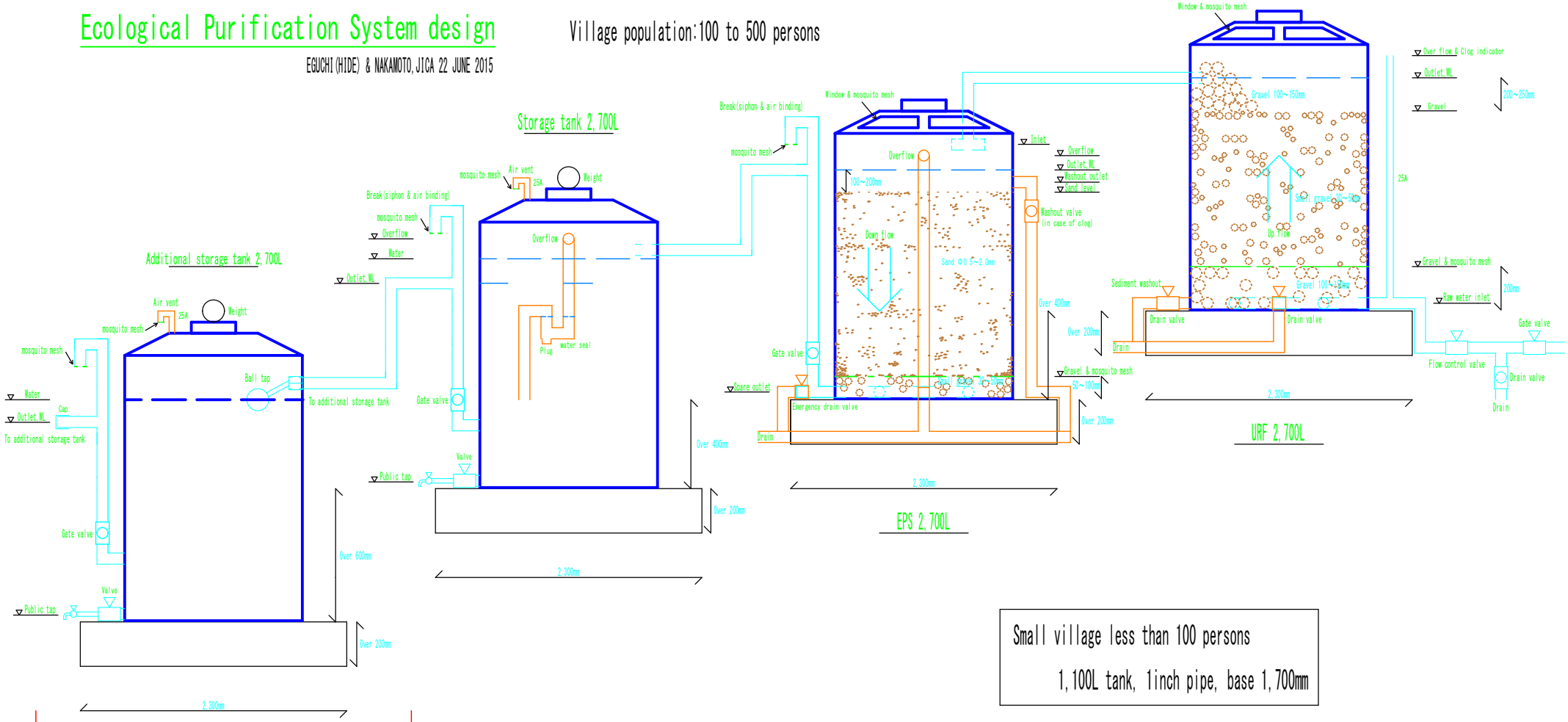
Ecological Purification System design

Village population:100 to 500 persons

EGUCHI(HIDE) & NAKAMOTO, JICA 22 JUNE 2015



Small village less than 100 persons

1,100L tank, 1inch pipe, base 1,700mm

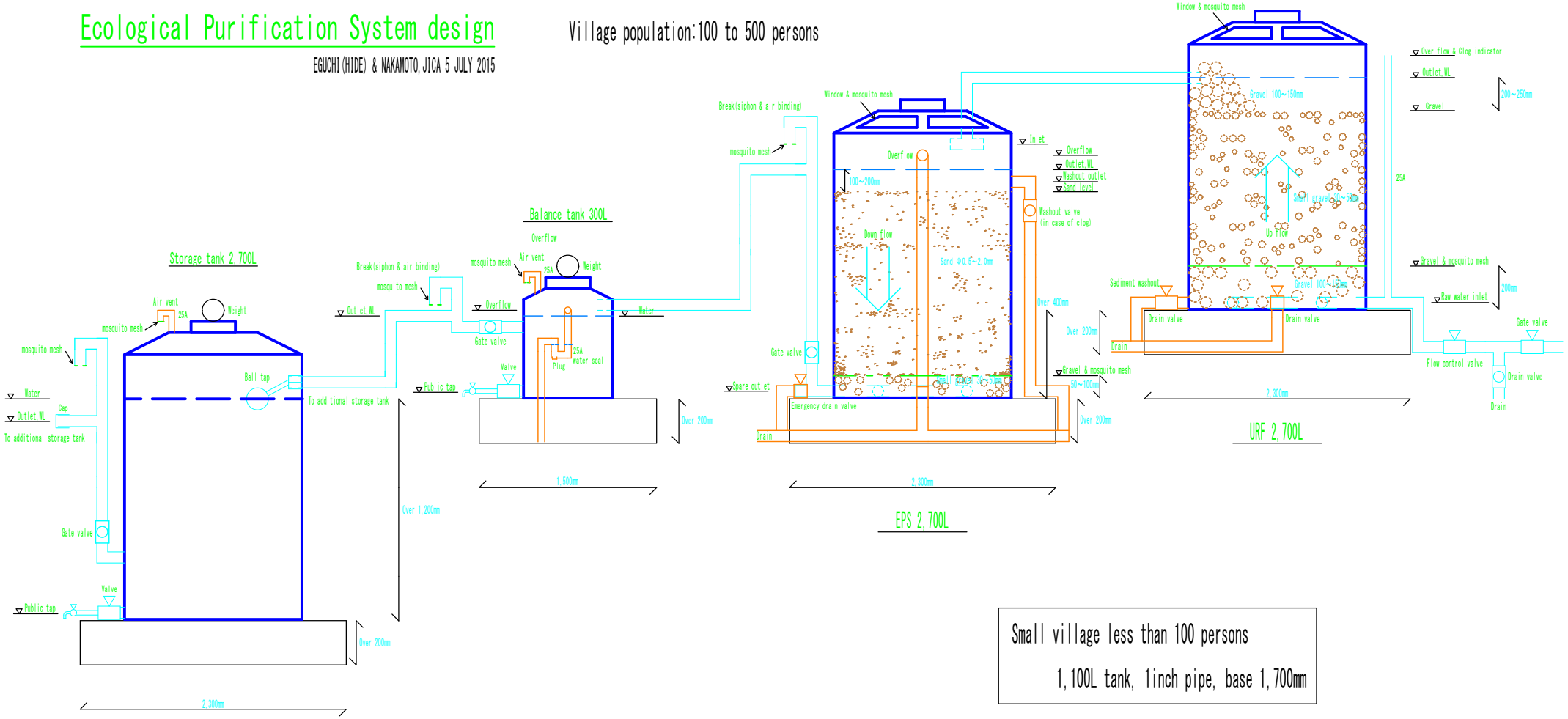
Option:Additional storage tank by local

Government EPS plan of public tap system for rural area

Ecological Purification System design

Village population:100 to 500 persons

EGUCHI(HIDE) & NAKAMOTO, JICA 5 JULY 2015

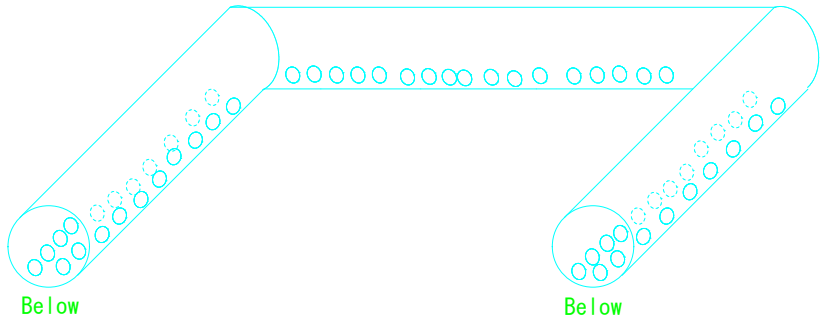


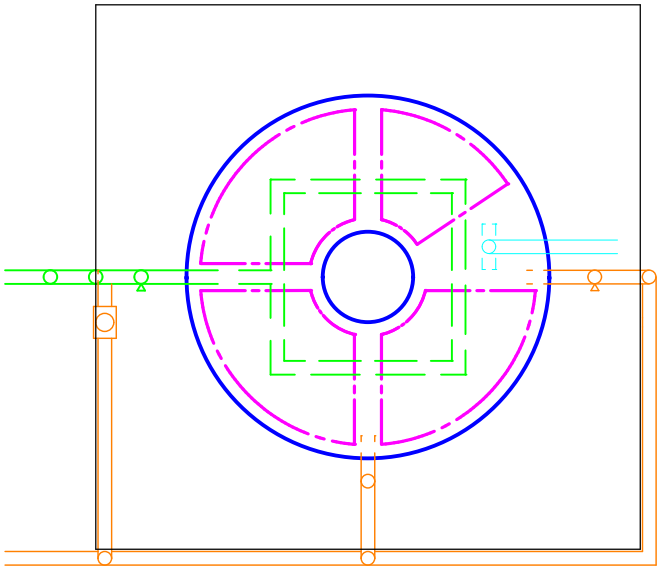
Small village less than 100 persons

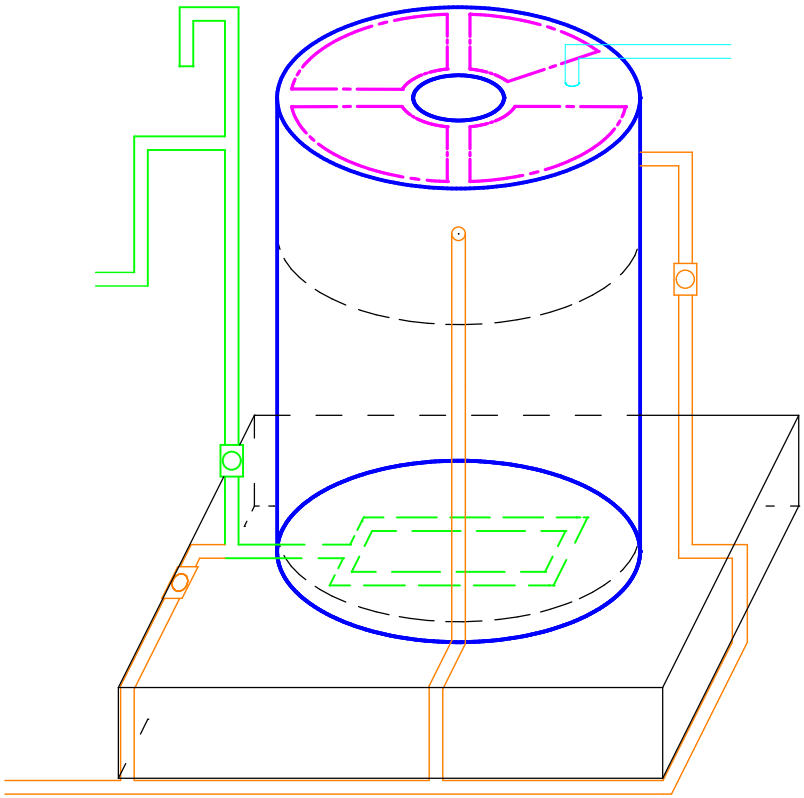
1,100L tank, 1inch pipe, base 1,700mm

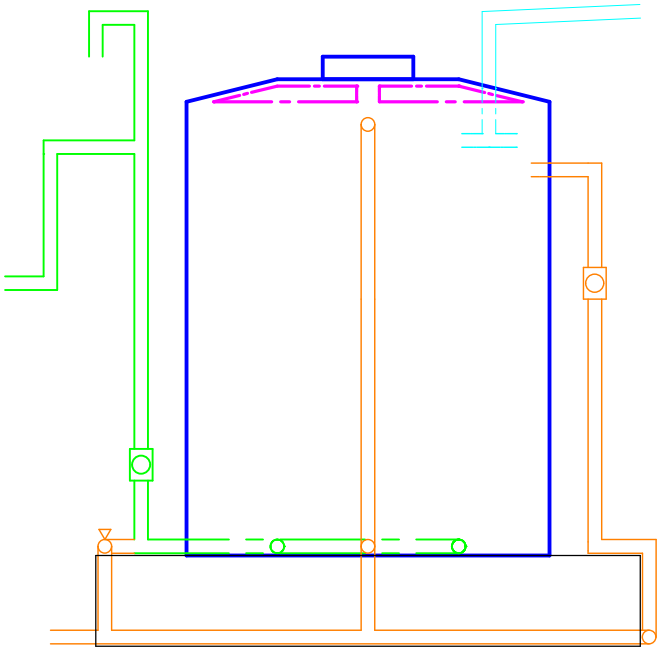
Ecological Purification System

EGUCHI(HIDE) & NAKAMOTO, JICA 22 JUNE 2015









Ecological Purification System

EGUCHI(HIDE) JICA 5 AUG 2015