Factsheets on Small-Scale Sanitation Initiatives in Egypt

Addendum to the Report "Small-Scale Sanitation in Egypt: Challenges and Ways Forward"

Philippe Reymond

ESRISS: Egyptian - Swiss Research on Innovations in Sustainable Sanitation

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Pictures cover page *(from left to right and top to bottom):1. Anaerobic baffled reactor in Abdel Kareem Issa, Fayoum; 2. Waste stabilisation ponds in El Moufty, Kafr El Sheikh; 3. Biogas digester in Fayoum; 4. Constructed wetlands in Samaha, Dakahlia; 5. Activated sludge in Kom el Naggar, Gharbeya; 6. Compact anaerobic tower, Zawyat el-Karatsah, Fayoum; 7. Physico-chemical treatment unit, Kafr el Hammam, Sharqiya; 8. Settler and constructed wetland in Sheikh Yacoub, Beni Suef; 9. Filter media for trickling filters, Fayoum.*

(Photos: Philippe Reymond, Eawag)

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ESRISS Factsheets

on small-scale sanitation initiatives in Egypt

ADDENDUM to the Report
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ADDENDUM to the Report
"Small-Scale Sanitation in Egypt: Challenges and Ways Forward"

Authors: Philippe Reymond, ESRISS Project Coordinator, Eawag/Sandec

Place and date: Cairo, December 2013

Contact: philippe.reymond@eawag.ch

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This collection of factsheets is an addendum to the report entitled "Small-Scale Sanitation in Egypt: Challenges and Ways Forward". This addendum provides the detailed information collected during the field visits and interviews for each selected initiative. The full list of small-scale initiatives in Egypt in to be found in the aforementioned report, as well as the main lessons learnt from all this past experience.

Next to that, the ESRISS project published a "Research for Policy" Brief, entitled "Small-Scale Sanitation in Egypt: 10 Points to Move Forward" (in English and Arabic), and the report "Small-Scale Sanitation in the Nile delta: Baseline Data and Current Practices", all to be downloaded on ESRISS webpage.

Acknowledgments

The authors would like to thank the different partners who opened their door for discussions or took the time to accompany us on the field to show their treatment system. Without their support, the elaboration of these factsheets would not have been possible.

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ANAEROBIC BAFFLED REACTOR – TAREK SABRY
ABDEL KAREEM ISSA - FAYOUM

Warning: the data and information given in this factsheet is the result of observation and interviews of the main stakeholders. As such, full exactitude is not guaranteed.

Date of the visit:	19 September 2011
Participants to the visit:	Philippe Reymond, Dr. Moustafa Moussa, Dr. Tarek Sabry (designer), Anastasia Papangelou, Mohamed El Sayed.

MAIN FACTS

Location:	Abdel Kareem Issa, Menshiet Bany Atman, Sanhorus District, Fayoum Governorate
Coverage:	Serves the village of Abdel Kareem Issa, 1078 inhabitants in 2005 based on data from the Local Authority – about 1,500 inhabitants now.
Technology:	Collection / transport : conventional sewer system
	Treatment: ABR with upflow filter (also called “USBR” = Upflow Septic Tank / Baffled Reactor, “improved ABR”, “advanced septic tank” or “biological reactor”).
Leader of the initiative:	Ministry of Water Resources and Irrigation (MWRI), Dr. Hussein El Gamal
Designed by:	Dr. Tarek Sabry, Ain Shams University
Design capacity:	200 m^3 (for 2,000 inhabitants, counting 100 L/cap/day)
Actual inflow :	N.A.
Operation started in:	2006
Financed by:	MWRI
Link with HCWW:	No link
Contacts:	Designer: Dr. Tarek Sabry - tsabry68@yahoo.com
	Plant manager: Abdel Tawab - 01002868771

TECHNICAL SUMMARY

Abdel Kareem Issa is an example of primary treatment at community level. As such, it does not produce an effluent up to the standards, but still manages to reduce the loads significantly.

Abdel Kareem Issa has the merit to be a full-scale trial of academic results, thanks to MWRI. As such, it is a step on the way of optimisation. Dr. Tarek Sabry began with two first pilots in El Tel el Sagheer (100 inhabitants) and in Ezbet Al Arab (200 inhabitants), Tel el Kebeer District (Ismailia), improved the model in Abdel Kareem Issa, developed it further into a anaerobic tower with a pilot in Zeneen WWTP (Giza) and a full-scale implementation in Zawyat El-Karatsah (Fayoum).

The system implemented in Abdel Kareem Issa is good for medium-strength wastewater. However, in this village, high-strength wastewater (COD very high - around 1,200 mg/L) is observed, hence a need for improvement.

The table below shows the observed pros and cons of this initiative.

ABDEL KAREEM ISSA - Dr. Tarek Sabry	
Pros	**Cons**
• The WWTP is working since 2006; there is a strong motivation and ownership of the operator. • The system is low-cost and needs little space • Only very little smell • Success of a design-build model	• No proper sludge management; sludge is not treated. The operator does not know exactly how to desludge (level of the sludge blanket) • Desludging is not easy: the openings of the first compartment are not practically disposed for effective sludge removal. • The steel used for lids is corroded by H2S and gas • No flow measurement; everything managed by feeling

Main pros and cons of Abdel Kareem Issa sanitation system

ENGINEERING & OPERATIONS

DESIGN

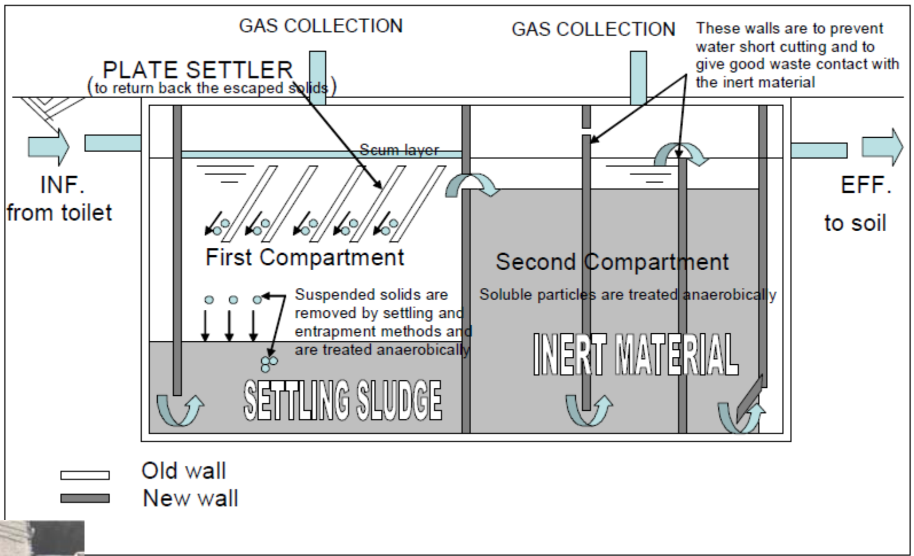
Sewer system: Type: conventional
Network length: N.A.
Depth: 3.5 meter when reaching the sump at the WWTP.

Treatment plant: Inflow: N.A.
Hydraulic retention time (HRT): 20-22 hours
Quantity of sludge:N.A.
Disposal: the treated wastewater is disposed of in a drain (not for agriculture); sludge is reused as a fertiliser by local farmers; it seems that some of them mix it with organic waste.

Design parameters: 100 L/cap/day

Loads: N.A.

Description of the system: In the upflow septic tank/ anaerobic baffled reactor system, the up-flow mode of operation in the first compartment improves the physical removal of suspended solids through gravity settling and an entrapment mechanism. Whereasa sludge blanket forms in the first compartment, the second compartment serves as a polishing step thereby converting most of the remaining volatile fatty acids and BOD into biogas. This second compartment is divided into three sections through vertical baffle walls. These baffle reactors can be regarded as a quasi-plug flow reactor configuration that provides kinetic benefits to enable microorganisms to degrade the residual organics to lowest level of concentration possible (Sabry, 2006)



Scheme from Sabry, 2006

The plate settler during construction (©Tarek Sabry)

USBR system has the following advantages over the other anaerobic modified septic tank systems such as:

1. Lower head loss indicating lower power requirement for system operation. (Sabry T. et al, 2004).
2. Satisfactory results obtained from operating the system in treating typical village wastewater under shock hydraulic loading, which promotes this system to be used to serve one household or small to medium communities (Sabry T. et al, 2004; Sabry T, 2007; Sabry T. et al, 2007; Sabry T. et al, 2010).
3. The use of the anaerobic baffled reactor as a second compartment, considered as completely mixed tank in series, apparently resulted in a good mixing in the reactors and high stability to hydraulic shock loads (Sabry T. et al, 2010).

CONSTRUCTION

Responsibilities: Consultant: Dr. Tarek Sabry

O&M

Roles and responsibilities: Two labourers for the O&M, the Local Council for fee collection

Labourers: Two responsible persons, working in shifts, responsible for the plant and for the sewer system. The manager, Abdel Tawab, is an inhabitant living next to the plant. He seems to know the system pretty well, as well as his son, which is a good sign. They do this job as a side activity. It seems that there has not been any complaint so far.

Activities and schedule: Sludge management: the USBR should be desludged every 6 months. It is not sure that this is done so regularly. It is also not clear to the operator at which depth he should pump the sludge (sludge blanket); the value of 1 meter from the bottom has been articulated. Besides, the operator has no idea of the thickness of settled sludge.

According to the operator, the grid should be cleaned once a day (below water during the visit) and the sump should be cleaned once a week.

PERFORMANCE

Data: Past monitoring showed a decrease in load of about 85% *(reference needed)*

Observations: Not smelly

Risk of clogging of the filter?

Manure residual in the sump

No systematic sludge management.

Miscellaneous: The sludge at the bottom of the first compartment (settled sludge) has a high VSS and is of “good quality”. Then, it gets more diluted the further up in the tank. The sludge blanket looks like black water.

SITE

Location: Edge of the village, next to a road

Acquisition procedure: The land has been bought by the Local Authority to Abdel Tawab, the current plant manager (price ? included in the 300,000 EGP ?); the selection criterion given by MWRI was to gain land quickly.

ENVIRONMENTAL FACTORS

Groundwater table: ?

Storm water: Precipitations + seasonality ; storm water management ?

Drinking water supply: Quality of drinking water supply:

→ Constant and sufficient pressure ? It seems that there was little water for the 14 days preceding; this could explain the concentrations found in the influent.

→ Water scarcity problem, seasonality ?

Electricity supply: Cut two-three times per month for 0.5-1 hour each time

Demographics: Population growth (annual rate) ?

ECONOMICS & FINANCE

Financed by: The capital costs of the treatment plant have been covered by MWRI through a funding program of the Netherlands and the sewer system by the Local Authority (construction delayed because of that)

Capital costs (CAPEX):
- WWTP : 300,000 EGP
- Sewer system: 630,000 EGP

Operational costs (OPEX):
- labourers: 500 EGP/month (twice 250 EGP) + 100 EGP for the billing man
- electricity: 60 EGP/month
- chlorine: 60 EGP/month
- maintenance of the plant (spare parts, cleaning, changing gravel): average of 700 LE/month

Financial sustainability: Households pay 10 EGP/month (average of 8 persons/households) to the Local Authority. In 5 years, it seems that 60,000 EGP have been collected, and that now, the sum collected per month reaches 1,500 EGP (169 households connected - 150 of them paying the fee). It is probable that the Local Authority keep part of the money, as those 60,000 EGP are superior to the O&M costs (the loan of the plant manager is only 200 EGP/month).

Project mobilisation costs: ?

Contracting procedures:
- Contracting and bidding processes, price negotiation
- Disaggregation level of mandate / full package?
- Local / regional contractor(s)

MANAGEMENT SCHEME & INSTITUTIONS

Ownership: Governor ?

Roles and responsibilities: Everything is managed by the Local Authority. The Local Authority had to be part of the initiative as in this case, it was the only body to which the population accepted to pay a fee.

The Local Authority had the following role throughout the project (Sabry, 2006):

- Fund and supervise the construction of the wastewater collection system.
- Agree to hand over the treatment plant (to operate and maintain the plant) after construction.
- Facilitate the procedure (governmental paper works) of buying land from the farmer for the pump station and the treatment plant.
- Maintain, operate, and monitor the complete system after the hand over.

Governmental influence: None

AWARENESS, BEHAVIOUR & PARTICIPATION

Participation: A collaboration has been established with an NGO, Menshiet Bany Atman community service in the Sanorus district, to carry out the following tasks (Sabry, 2006):

- Buy land from the farmers for use in the project. E.g. location to build pumping station and treatment plant.
- Safe location for storage of construction materials .
- Prepare awareness team to conduct awareness campaign to the people served by this project as to aware people of what materials should not be disposed into sewer pipeline.
- Facilitate the execution of works (with the coordination with the house holders) by supplying site of construction by water and by avoiding any obstacles can render the execution works such as removing agricultural waste from the execution place.

Awareness: Manure: the solid part is reused, and the liquid part is absorbed by the soil of the stables.

Kids around use described the treatment plant as a “fertiliser factory” !

Behaviour: Cases of manure in the sewer system ?

IMPACT ON AREA SERVED

Household coverage rate: In 2005, a few houses in the village not connected to the water network due to their inability to pay for connecting their houses to the network (it costs LE 300- 400) (Sabry, 2006)

Now: 100 % connected ?

FUTURE

Replication: This system has been replicated in Al Qassim District in Saudi Arabia for a sweet producing company.

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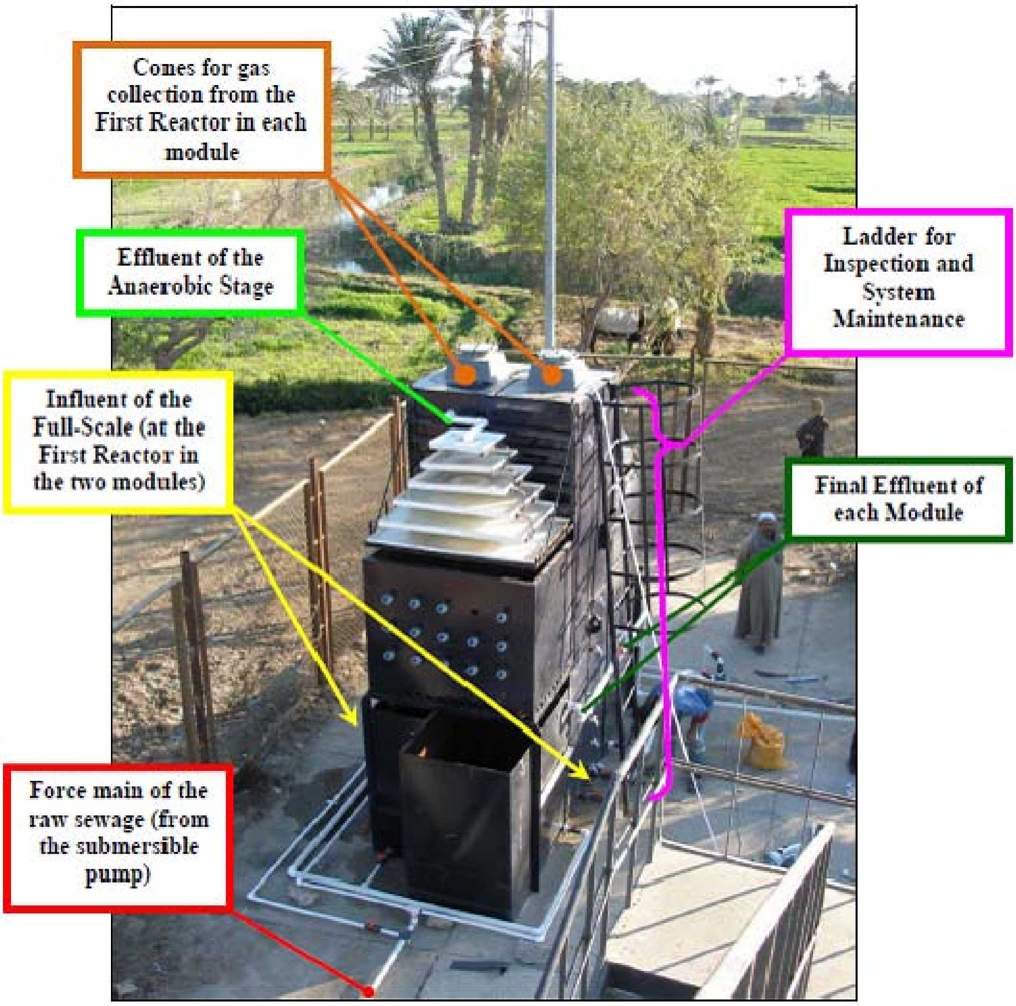
COMPACT ANAEROBIC TOWER – TAREK SABRY
ZAWYAT EL-KARATSAH - FAYOUM

Warning: the data and information given in this factsheet is the result of observation and interviews and the main stakeholders. As such, full exactitude is not guaranteed.

Date of the visit: 5th May 2012

Participants to the visits: Philippe Reymond, Dr. Tarek Sabry, Dr. Ahmed El Gendy, Jörg Haucke (BORDA)



Inlets and Outlets of the Full-Scale System

© Tarek Sabry and Ahmed El Gendy

MAIN FACTS

Location:	Zawyat El-Karatsah, Fayoum, within the existing WWTP
Coverage:	N.A.; the full-scale pilot is fed by wastewater arriving in the WWTP which hosts it, covering the villages of Zawyat el-Karatsah and Manshiet Abdallah
Technology:	Compact Anaerobic Tower, consisting off: - a first UASB compartment - an anaerobic filter compartment on top of the UASB compartment - an effluent distribution system made out of perforated plates - a trickling filter on the side of the tower, based on the Downflow Hanging Sponge system (DHS – see picture below), investigated by NRC (cf. Prof. Rifaat Abdel Wahaab and Prof. Fatma El Gohary) - a sand filter
Leader of the initiative:	Dr. Tarek Sabry and Dr. Ahmed El Gendy
Designed by:	Dr. Tarek Sabry and Dr. Ahmed El Gendy
Design capacity:	9 m3/day, which corresponds to about 90 people
Actual inflow :	9 m3/day
Operation started in:	2012
Financed by:	Research grant; one module costs about 70,000 EGP (price 2012)
Link with HCWW:	Initiative implemented in collaboration with HCWW (Dr. Ahmed Moawad); supposedly overall supervision and operation by Fayoum AC.
Contacts:	Dr. Tarek Sabry - tsabry68@yahoo.com

TECHNICAL SUMMARY

The compact anaerobic tower, developed and patented by Dr. Tarek Sabry and Dr. Ahmed El Gendy is the fruit of a long research and development process. It is a further development of the USBR (type of anaerobic baffled reactor) implemented in Abdel Kareem Issa (Fayoum – see respective factsheet), and was first tested as a small research pilot in Zenein WWTP (Giza), in partnership with the National Research Centre (NRC) – see picture below.

The table shows the observed pros and cons of this initiative.

ZAWYAT EL-KARATSAH – COMPACT ANAEROBIC TOWER	
Pros	**Cons**
• Very compact, as the different units are arranged in a vertical way • Prefabricated • Modularity • Success of a design-build model • Desludging easy • Biogas collection is possible	• Need for continuous flow and constant upflow velocity to keep the sludge blanket at a constant height • Risk of clogging of the distribution system • So far, lack of industrial design

FURTHER ILLUSTRATIONS

Left: the compact anaerobic tower; below: the pilot in Zenein WWTP, Giza, visited on 18.09.2011

Different filter media: plastic chips found on the Egyptian market (top) and sponges in plastic frame (down)

WASTE STABILISATION PONDS - GIZ INITIATIVE
EL MOUFTY - KAFR EL SHEIKH

Warning: the data and information given in this factsheet is the result of observation and interviews and the main stakeholders. As such, full exactitude is not guaranteed.

Date of the visit: several visits from July 2010 to January 2011

Participants to the visits: Philippe Reymond, Magda Riad (RODECO), Ahmed Atta (World Bank)

MAIN FACTS

Location:	El Moufty, Kafr El Sheikh Governorate
Coverage:	Serves the village of El Moufty, about 2,750 inhabitants in 2002
Technology:	Collection / transport : shallow sewer system, described as a “small-bore sewer system” Treatment: two parallel sets of anaerobic, facultative and maturation ponds. Sludge should be pumped regularly and disposed on drying beds. Note: on-site interceptor tanks at each household where most of the solid part is separated and retained
Leader of the initiative:	GIZ
Designed by:	Dr. Mahmoud Abdel Azeem (ALDAR Consulting)
Design capacity:	for 4,500 inhabitants, assuming a consumption of 90 L/cap/day
Actual inflow :	?
Operation started in:	2005
Financed by:	GIZ
Link with HCWW:	Supposedly overall supervision and technical advice by Kafr el Sheikh Affiliated Company (role not fulfilled)
Contacts:	Kafr El Sheikh Affiliated Company – GIZ Water and Wastewater Programme

SYNTHESIS

GIZ model is the most famous small-scale initiative in Egypt, especially its first pilot in El Moufty. Often praised in the past, the model later suffered from important shortcomings, the main ones being:

1. Drastic price hikes for the new treatment plants;
2. Existing treatment plants that no longer comply with the law.

These problems threaten the replication of the system. They are also very symptomatic of the barriers and constraints found in the Egyptian context.

The GIZ model features a very integrated approach with strong guiding principles (see (Wehrle, Burns et al. 2007)). It is the most integrated and documented approach so far, with a detailed stakeholder analysis, study of the managerial and financial mechanisms and as well as a comparison of small-scale technical options. In 2007, after one and half year of operation, the system in El Moufty was running properly and it was depicted as a successful model. However, since then, the situation has been degrading steadily, culminating in a total dysfunction at the beginning of 2011. At the same time, external factors contributed to hinder the replication of the system.

After the first pilot in El Moufty, the model has been adapted and replicated in six villages: Om Sen and El Koleeah, Kafr El Gedid, Kozman, Om Elshour and Al Handaoaa (all in Kafr El Sheikh Governorate). After that, HCWW decided not to replicate the model further.

The table shows the observed pros and cons of this initiative.

EL MOUFTY - GIZ	
Pros	**Cons**
• The WWTP has been working properly for a few years • The technology per se is low-cost and has very low energy cost requirements • Simplicity of operation and maintenance • Strong awareness-raising component • The shallow sewer/small-bore sewer system is working, except the maintenance of the interceptors • Full-cost recovery for O&M costs • Improvement of the hygienic situation at the community level	• Large amount of land required in the delta context; difficult to extend • Lack of capacity of the CDA to solve major breakdowns and misuses • CDA covering harmful behaviours from relatives • Lack of ownership of the treatment plant; operation not done properly • No flow assessment, no characterisation of raw wastewater • Vulnerability to shock loads • Weak hydraulic design, leading to short-circuiting • Poor sludge management, from the ponds as from the interceptors; interceptor are not emptied as frequently as they should, hence hindering their primary settling function • Lack of trust atmosphere between CDA and Affiliated Company

Main pros and cons of El Moufty sanitation system

The price per unit asked by building companies has more than doubled from 3,000,000 to more than 7,000,000 EGP, which is not cost-effective. It threatens the designation "low-cost" of the model.

Several reasons have been advanced during our interviews:

- Inappropriate bidding process
- Inflation of material prices
- Hike in Land prices
- Use of unfamiliar techniques in Egypt and that are not mentioned in the Egyptian Code of Practice (i.e. small-bore sewer system)

The bidding process leading to the price currently requested by construction companies remains obscure. It seems that the bidding process was not fully open, and that a few companies colluded in order to increase the price. Land and material prices are always a problem and reflect the tight supply of land in the delta. It may be one of the reasons for price increases, but definitely does not explain the doubling in price.

According to Prof. Mahmoud Abdel Azeem, the designer of this model, one of the reasons may be the choice of the small-bore sewer system. Although this system has been applied successfully in El Moufty, GIZ had to renounce to the small-bore sewer system in its two next WWTP (Om Sen and El Koleeah), as NOPWASD (ministry responsible for implementation) asked to shift to so-called "shallow sewer systems" (which, strictly speaking, is not shallow sewerage). NOPWASD is (i) not convinced by this system (after failure in two other villages - Badr Halawa and Nawag[1]) and (ii) small-bore sewer systems are not in the Code of Practice for WW treatment in Egypt, and thus lack a legal basis. Besides, in that case, according to the Egyptian Law, construction companies must guarantee the total cost in case of failure. As this system has a poor record till now, constructing companies set a much higher price than the pure construction price in order to cover the risks. This legal constraint may be a hindrance to any innovative system.

Another major problem faced by GTZ is that the plants of El Moufty and Om Sen no longer comply with Egyptian water quality standards as they suffer from overloading. The Ministry of Health and Population (MoHP), in charge of effluent control, identified the problem and sent the case to Court. The CDAs are now required to find a solution if they do not want to pay a penalty. Having asked KSWC for help, KSWC proposed to take control of the plant, which the CDA refused. On the other hand, the CDA refused to pay for the help that KWSC could provide.

This shows a major shortcoming: the model is disconnected from governmental authority. It can work very well as long as there is no problem. However, if any problem appears, as it has been the case, the community has to face governmental agencies and penalties that are beyond their reach. They may lose control over what they jointly built. The solution appears to lie in a system where roles and responsibilities between communities and governmental entities are shared from the very beginning.

Design details are provided in (Wehrle, Burns et al. 2007) pp.68-79 and (ALDAR 2003). Design weaknesses were already observed by international experts during the review of the design documents (ALDAR 2003):

- "*The retention time, which seems to be at the very lower end with 8 days (typically 10 to 20 days). The selected ratio of width to length (19 m to 36.5 m or 1:2) is geometrical not satisfactory and will lead to short circuit flows. Recommended ratios are 1:3 to 1:5. The provision of baffle plates may improve the performance of the ponds in addition. In order to support the performance it is recommended that the flow in the facultative pond be against the main wind direction*."
- "*The management of treatment plant will not at all be simple (as suggested in chapter 2 " No need of skilled supervision"). Many of the exciting pond systems are not working effectively. The pond system's absorption of shock load is limited. The interval for emptying can only be decided when the system is under*

[1] *Badr Halawa suffers from system clogging. According to Prof. Abdel Azeem, the problem may be the use of the existing trenches (bottomless cesspools) as interceptors regardless of their dimensions or geometrical arrangements. In Nawag, the system does not cover the whole village.*

operation. A monitoring program needs to be installed to collect record of the key indicators such as height of sludge in the ponds."

- *"Management of interceptor tanks: insufficient handling of these aspects is too often the reason that decentralized sanitation is not working."*

From the beginning, Duncan Mara (2005) made two important points:

- *"As the wastewater entering the WSP at El Moufty has been settled in the interceptor tanks, anaerobic ponds should not have been used."*
- *"The design criteria used for these WSP are less than wholly satisfactory."*

However, the anaerobic ponds ended up being useful, as the WWTP experienced overloading due to animal manure dumped in the sewer system (according to RODECO).

On the contrary to ESDF in Kom El Dabae, GIZ didn't want to give the responsibility of WWTP O&M to the CDA, but to a local contractor, paid 1'500 EGP/month. As has been shown, the CDA was not as strong in El Moufty as in Kom El Dabae. Moreover, GIZ wanted to avoid the problems of excessive human resources experienced in Kom El Dabae and costs incurred, as they hardly could refuse work to community members.

However, the CDA in El Moufty is the formal owner of the sewer network, pumping station and waste stabilisation ponds. They collect a monthly fee (7 EGP per household) in the village and, with this income, pay an employee from the village to operate and maintain the system, as well as to purchase any spare parts needed in the future and to pay for the interceptor tanks to be desludged.

It seems that governmental agencies do not like the fact that Moufty's CDA can make a surplus from the 7 EGP/month collected from each household (O&M costs amount to 2.000 EGP/months and money collected to 4.000 EGP/month - the difference is stored on a bank account in prevision of problems). They can argue that it is not legal, as a CDA can only collect money to directly finance initiatives of public interest (cf. Ministry of Social Solidarity - "fees for service provision").

Contracting for construction works seem to be an issue as well. GIZ experienced problems of connivance between KWSC and local contractors, so that they mandated the same contractor as in Kom El Dabae.

Concerning the participative approach, Om Sen and El Koleaah differed also from El Moufty in the village selection process: after the first pilot, communities were then asked to show interest in order to participate in the selection process.

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TOGETHER ASSOCIATION'S INITIATIVE
SHEIKH YACOUB - BENI SUEF

Warning: the data and information given in this factsheet is the result of observation and interviews and the main stakeholders. As such, full exactitude is not guaranteed.

Date of the visit: 5 December 2011

Participants to the visit: Philippe Reymond, Dr. Moustafa Moussa, Khalaf Baskharon Khalil (chemist at AC Beni Suef, responsible of the effluent quality monitoring for this initiative), Sameh Seif Ghali (Executive Director Together Association), Noshi Zaki Ibrahim (Project Manager Together Association) + one assistant from AC Beni Suef.

MAIN FACTS

Location:	Ezbet Sheikh Yacoub, Fashn District, Beni Suef Governorate
Coverage:	Serves two villages, Yacoub and Jafar, and a third one should be connected soon.
Technology:	Collection / transport : conventional sewer system
	Treatment: primary settling tanks (three in parallel), followed by i. air injection using air compressor, ii. a two stage weir for further aeration, iii. a three-step sub-flow constructed wetland (or "gravel bed hydroponics"), made out of reed beds with gravel filters of different granulometry, decreasing from one step to the other (three lines in parallel) and iv. an oxidation channel; sludge drying beds
Leader of the initiative:	Together Association (TA); Executive Director: Samer Seif Ghali - website: www.together-eg.com. The system is now owned by a CDA.
Designed by:	Dr. Anwar Manaf
Design capacity:	500 m3/day, produced by 417 houses and about 4,000 inhabitants
Actual inflow :	the actual inflow is probably around 300 m3/day, as people in this area are far from consuming 125 L/cap/day, according to a AC representative - Actual water consumption ?
Operation started in:	2009
Financed by:	EFG Hermes Foundation (Egypt), under the name "Ro'ya Project" and SOF Egypt.
Link with HCWW:	Contract with Beni Suef AC to take one sample per month for the effluent quality monitoring
Contacts:	Sameh Seif Ghali (Executive Director Together Association- sameh.seif@together-eg.com)
	Khalaf Baskharon Khalil, chemist at Beni Suef AC, El Fashn branch, responsible for effluent quality monitoring.

SITE PICTURES

TECHNICAL SUMMARY

The sanitation system of Together Association in Sheikh Yacoub is one of the most complete so far; it encompasses an integrate approach, with a compact and well-maintained infrastructure, awareness raising and capacity building components as well as planned full-cost recovery for O&M. The association is backing up and monitoring the initiative, with the support of Beni Suef Affiliated Company.

This initiative is recent and its evolution should be monitored, especially the performance of the plant, the discipline of the population, as well the success of fee collection by the CDA. It must also be acknowledged that this is a quite unique situation, as the whole village has been rebuilt by the project, easing also the planning of the new sanitation system.

The table shows the observed pros and cons of this initiative.

SHEIKH YACOUB - Together Association	
Pros	**Cons**
• The WWTP is above ground, thus easy to operate and maintain; the wastewater is pumped once, and then flows down by gravity; sludge can very easily be removed from the settling tanks by gravity • Strong implementing NGO • Integrate approach to rural village development • Link with Beni Suef Affiliated Company for effluent quality monitoring	• Sludge is not stabilised in the primary settling tanks • Clogging of the gravel beds • Horizontal filter may be partly anaerobic, thus reducing its performance • Infiltration into the ground from gravel filters ? A Swiss mission observed very reduced outflow • Doubtful usefulness of the “oxidation channel”

Main pros and cons of Sheikh Yacoub sanitation system

Clogging of the gravel beds is, according to us, the main threat on the system. During our visit, the gravel of the beds was in the process to be cleaned/replaced. We could see that, at least on another bed, there was some surface flow, showing that it was also experiencing some clogging. Cleaning/replacing gravel is not an easy task, and it is far from guaranteed that every community would do it when needed. What it is more, it has to be considered that at each cleaning/replacement, the plants have to be replanted and time is needed until they reach their full development, guaranteeing an optimal performance of the bed.

It is also recommended to measure the efficiency of the aeration of the system.

Engineering & Operations

DESIGN

Sewer system: Network length: ?

Depth: starts at 60 cm, ends at 6 m when reaching the sump. The sump (and the pumping station) are positioned in the centre of the village. The deepest manhole reaches 4.5 m depth.

Treatment plant: Inflow: ?

Hydraulic retention time (HRT): ?

- in primary settling tanks: 2-8 hours
- in constructed wetland: ?

Quantity of sludge: ?

Disposal: the treated wastewater is disposed of in a drain (not for agriculture); sludge is reused as a fertiliser by local farmers. Is sludge sold ? At which price ?

Miscellaneous: aeration of the primary settlers is done twice a day for one hour each time, when the wastewater is pumped into the plant. Thus, the settlers are operated as batch reactors.

Design parameters: drinking water consumption: 125 L/cap/day; loads ??

CONSTRUCTION

Responsibilities: Consultant: Dr. Anwar Manaf , Sameh Seif
Local contractors: Fady Ramadan

Miscellaneous: Operators have to take care of steel corrosion.
Start up phase and operation of the plants: Jan 2009 to Jan 2010

O&M

Roles and responsibilities: A CDA is owner of the plant and responsible for O&M. Together Association is there for monitoring and to provide technical assistance.

Labourers: Number of employees: 2 for each village
Different people for the management of the sewer system or the same: the same

Activities and schedule: Frequency of switch on/off the plant ?
Frequency of desludging, change of gravel, etc?

Monitoring scheme: ?

PERFORMANCE

Cf. data from Together association

SITE

Location: Along a drain

Acquisition procedure: Given for free by MWRI

ENVIRONMENTAL FACTORS

Groundwater table: ?

Storm water: Precipitations + seasonality ; storm water management ?
Natural disaster risks: flooding ?

Drinking water supply: Quality of drinking water supply:
→ Constant and sufficient pressure ?
→ Water scarcity problem, seasonality ?

Demographics: population growth (annual rate)

ECONOMICS & FINANCE

Financed by: The capital costs of the project have been covered by EFG Hermes Foundation (www.efghermesfoundation.org) and the SOF Egypt

Capital costs (CAPEX): - WWTP (400 m^3/day) amounted to 350,000 EGP

- Sewer system: 850,000 EGP

The total amounts to 1.2 mios EGP. This is a small component of the global Ro'ya project, aiming to develop the whole village.

Availability and cost of gravel ?

Operational costs (OPEX): - labourers: about 500 EGP/person/month for two labourers

- electricity: ?
- maintenance of the plant (spare parts, cleaning, changing gravel): 500 EGP/month
- cost for monthly sampling by Beni Suef AC
- cost of replacing /cleaning the gravel in the beds ?

Financial sustainability: The population has started to pay monthly fees of 5 EGP/month/household. This way, 2,000 to 2,500 EGP/month should collected to cover the O&M costs. Collection is a problem

Project mobilisation costs: ?

Contracting procedures: - Contracting and bidding processes, price negotiation

- Disaggregation level of mandate / full package?
- Local / regional contractor(s)

MANAGEMENT SCHEME & INSTITUTIONS

Ownership: The whole sanitation system is owned by the community (CDA)

Roles and responsibilities: O&M is under the responsibility of the community. Beni Suef Affiliated Company is mandated for a monthly effluent sampling. The CDA is responsible to collect fees that should cover all the costs of O&M.

Governmental influence: This project seems quite isolated from the governmental institutions, except from Beni Suef Affiliated Company.

AWARENESS, BEHAVIOUR & PARTICIPATION

Participation: Together Association has been working since a long time with the community, with a strong focus on empowerment. The community has been involved since the beginning and there is an atmosphere of trust.

Awareness: Awareness-raising done with population regarding manure

Behaviour: manure dumped in the sewer network?

solid waste management ?

Solid manure is collected and sold 100 EGP/ m^3. Some people make compost by adding plant residuals (agricultural waste)

IMPACT ON AREA SERVED

Household coverage rate: 2 village- one village 100% and another village 60% ; coverage to be increased

On-site facilities: Management of sludge from on-site facilities (septic tanks, interceptors…): There is no on-site facilities anymore in Sheikh Yacoub.

FUTURE

Replication: The model has been replicated in Bany Shaitan (Sanhorus), Fayoum Governorate, sponsored by the Japanese Embassy. Five others are under planning.

The price of the new WWTP in Fayoum should amount to 620.000 EGP for one village of about 200 houses.

Collaborations: Sameh Seif Ghali is also a member of Ashoka and is part of knowledge sharing group financed by Siemens Stiftung. Siemens Stiftung provides also technical and financial assistance. In autumn 2011, he received an award as the best social entrepreneur of the year 2011 by the Schwab Foundation, during the World Economic Forum in Jordan.

ADDITIONAL DOCUMENTS & REFERENCES

Documentation of Together Association (contact: Sameh Seif Ghali - sameh.seif@together-eg.com)

Al Raed Jet Master's Kimatech 2000
KAFR EL HAMMAM - SHARQIYA

Warning: the data and information given in this factsheet is the result of observation and interviews and the main stakeholders. As such, full exactitude is not guaranteed.

Date of the visit: 21 September 2011

Participants to the visits: Philippe Reymond, Moustafa Moussa, Mohamed Mahroos (Al Raed), Hazem Shawky (Al Raed), Anastasia Papangelou

Drawing above: design for about 50 m3/day; picture on the right: design for larger capacities - between 300 and 5,000 m3/day (courtesy of Al Raed)

MAIN FACTS

Location:	Kafr El Hammam (next to Zagazig), Sharqiya Governorate
Coverage:	The unit treats 150 m3/day, i.e. 10% coverage of the village. The WWTP covers a new neighbourhood.
Technology:	Al Raed Jet Master "Kimatech 2000"; this technology consists of prefabricated tanks made of steel expoxy sheets and functions as a series of batch reactors: 1. A settling tank, where sedimentation is accelerated through the addition of ferrochlorite, which increases the flocculation and coagulation; 2. An oxidation tank: the oxidation is done through calcium hypochlorite and sodium hydroxide; it kills also a big part of the pathogens; 3. Optional: a cartridge filled with activated carbon filter, a UV tube and a ultrafiltration membrane filter, which represent about 20-30% extra price.
Collection / transport :	Shallow sewer system
Leader of the initiative:	Al Raed
Designed by:	Al Raed; Dr. Ahmed Eissa
Design capacity:	About 1,500 inhabitants
Actual inflow :	?
Operation started in:	2009 ?
Management:	Eng. Sami Abbas, belonging to MWRI and vice-Chairman of the CDA. So far, the Company is paying the operational costs, but it is planned that the inhabitants will pay a monthly fee.
Financed by:	UN funds and own funds
Link with HCWW:	No link
Contacts:	Eng. Mohamed Mahroos, Al Raed Jet Master, Giza

TECHNICAL SUMMARY

Al Raed is a private company specialised in prefabricated systems out of metal sheets. It started in the field of sanitation for ships and resorts. Recently, they started to interest themselves for rural sanitation. Kafr el Dammam was thought as a demonstration unit, which is up to now operated and maintained by Al Raed.

Al Raed system is based on physico-chemical treatment. According to Al Raed, the use of ferrochlorite is justified by the high COD, reaching up 1700 mg/L, and the high TSS, reaching up to 7,000 mg/l. With ferrochlorite, it takes 20-30 min to remove 80% of the TSS. The solid content of the sludge, withdrawn by gravity from the bottom conical bottom of the tank, reaches about 8%. The hydraulic retention time (HRT) in the oxidation tank is about 30 min. Oxidation is very effective due to the addition of the chemical oxidants.

Liquid manure is dumped into the sewer system, which is one of the main reasons for the high loads; the stables, covered with a cement floor, are cleaned around 6-7 am. A COD peak is also observed at 12 am.

The lifetime of the prefabricated tanks is described as 20 years.

KAFR EL HAMMAM – AL RAED	
Pros	**Cons**
• Effluent quality • No smell (even the sludge) • Very quick and efficient settling • Prefabricated • Very compact • Deals well with load peaks • Easy maintenance • Chemicals readily available on the Egyptian market • Management scheme: Al Raed is ready for Design-Build-Operate	• Use of substantial amounts of chemicals • Vulnerability to power interruptions or electronic failure, as it work in batches • Active carbon filters and ultrafiltration should not be applied in a rural context. • The sludge is contaminated with ferrochlorite.

Main pros and cons of Al Raed's sanitation system

REPLICATION

The system has been implemented in several country (e.g. Jordan, Saudi Arabia). In Egypt, other exemplars are to be found in Fayoum: Kalamsh (500 m3/d) and Abu Dayhoum (100 m3/d) at Markaz Atsaa

ADDITIONAL DOCUMENTS & REFERENCES

See information sheet in Appendix, prepared by Al Raed for ESRISS.

"AERATED" TANKS

MAIMUN - BENI SUEF

Warning: the data and information given in this factsheet is the result of observation and interviews and the main stakeholders. As such, full exactitude is not guaranteed.

Date of the visit: 5 December 2011

Participants to the visit: Philippe Reymond, Dr. Moustafa Moussa + one assistant from AC Beni Suef.

MAIN FACTS

Location:	Maimun, Markaz El Wasta, Beni Suef Governorate
Coverage:	Maimun + ?
Technology:	Collection / transport : conventional sewer system with five collective septic tanks (whose second compartment is filled with gravel) Treatment: aerated biofilter with several compartments, filled with gravel or plastic media; aeration from the bottom through diffuser; cross-flow principle
Leader of the initiative:	Beni Suef Affiliated Company
Designed by:	Dr. Hisham Abdel Halim, Eng. Mohamed Nazih
Design capacity:	720 m^3 (equivalent to about 7,000 inhabitants in this case ?)
Actual inflow :	about 300 m^3
Operation started in:	2010 ?
Financed by:	Government of Egypt

TECHNICAL SUMMARY

The visit of the WWTP showed a highly dysfunctional status, with an anaerobic effluent coming out of the supposedly "aerated biofilter". This initiative is a good example of what should not be done when dealing with small-scale sanitation:

- Huge black box; even the staff present there do not know where the inlet and outlet are and, generally, how it works.
- Huge sump and huge tanks: certainly a big waste of money.
- Wishful thinking while designing: the consultant selected aerated tanks, which is very energy-consuming. He certainly did not consider the local conditions and, as a matter of fact, the aeration is not switched on, which is a major reason for the failure of the system
- The role of the collective septic tanks with gravel filter is not clear. In all case, it appears that they are not maintained.

CONSTRUCTED WETLAND
SAMAHA - DAKAHLIA

Warning: the data and information given in this factsheet is the result of observation and interviews and the main stakeholders. As such, full exactitude is not guaranteed.

Date of the visit: 21st November 2010

Participants to the visits: Philippe Reymond, Eng. Mohamed Ragab (head of Technical Sector at Dakahlia Affiliated Company), Eng. Mohamed Walli, Vania Zillante

MAIN FACTS

Location:	Samaha, Dakahlia
Coverage:	6,500 inhabitants in 2010
Technology:	Horizontal subflow constructed wetlands. First, two stages of constructed wetlands followed by an oxidation pond were constructed. At the time of the visit, the oxidation pond was being replaced by a third stage of constructed wetland.
Leader of the initiative:	Dr. Ahmed Dewidar (former president of Suez Canal University SCU)
Designed by:	University of Portsmouth; University of Suez Canal; Eng. Maher Fares
Design capacity:	1,200 m3/day
Actual inflow :	N.A.
Operation started in:	1999
Financed by:	Ministry of Local Administration (about 1.5 mio LE) while the rehabilitations were paid by Dakahlia company .
Link with HCWW:	Operated by Dakahlia Affiliated Company
Contacts:	Eng. Maher Fares (sanviro@gmail.com); Eng. Mohamed Ragab (Dakahlia Affiliated Company)
Coordinates:	30°52’12.00’’ N – 31°17’22.00’’ E

TECHNICAL SUMMARY

Treatment plant

Samaha's constructed wetland is an outcome of the collaboration between the University of Portsmouth and the University of Suez Canal from 1986 to 2003. The university of Portsmouth set two principles for the sanitation technologies which they tried: no chlorine and no energy. Indeed, chlorine may have two main negative side effects: 1°/ Building of toxic by-products if the BOD in the effluent is too high; 2°/ damage to fauna in the receiving water bodies.

The original design in Samaha consisted of a small sedimentation tank (1 hour retention time) preceded by sedimentation tanks in the sewer system and followed by the horizontal flow constructed wetlands in two stages and by shallow basins for final solar disinfection. The latter was reported not to have given good results and was replaced by chlorination. The rehabilitation increased the CW surface by 40%, and lead the wastewater through three stairs of CW. The new CW consists of gravel only.

Different types of plants have been tried, incl. reeds and papyrus sedges ("pardi" in Egyptian Arabic). The latter were selected for further construction, as it can be used for papyrus production, which provides a small additional income for the WWTP operators.

Samaha has been monitored scientifically for one year. The treated water had a good quality. After that, the WWTP was handed over to the governmental agency. Then, the quality of the effluent deteriorated. The following reasons are advanced:

- 1°/ Staff in charge of the WWTP did not understand the system properly and did not know how to maintain it.
- 2°/ Land is very precious in the delta and hard to find for wastewater treatment. At first, only 1 feddan could be bought to serve the 6,000 inhabitants of Samaha. This was just enough to serve the needs at the time of implementation, but did not account for population increase. Consequently, the WWTP was quickly overloaded.
- 3°/ High suspended solids due to animal manure discharge in the sewer system and the fact that most interceptor/sedimentation tanks were not desludged, hence not fulfilling their role anymore..
- 4°/ Due to clogging of both rootzone and sand filters, the sub-surface filters became free-surface filters, thus the retention time decreased dramatically.

Hence, a first rehabilitation was decided, in the form of[2]:

1. Demolishing the sedimentation tanks.
2. Constructing a secondary settling basin (RT ≈ 4 hr) .
3. Replacing all the filter media by gravel.
4. Replacing reeds by sedges .
5. Construct a handmade unit of sedges paper as a byproduct.

A second rehabilitation was later decided to replace the oxidation ponds by constructed wetlands and construct a disinfection system using calcium hypochlorite.

[2] Information from the presentation given by Eng. Mohamed Ragab El-Zoghby, Dakahlia Technical Support Head, in March 2010 in the 14th International Water Technology Conference, Cairo Pyramisa Hotel.

The cost for the first pilot was 1.5 mio EGP, and 750,000 EGP were necessary for rehabilitation. The labour force salary is about LE 24000 / year and the maintenance cost LE 2300/ year (in 2010). The revenue from the sale of papyrus is expected to be about LE 13000 / year.

Constructed wetlands require well-settled wastewater. It has been suggested to add alum at the suction port of the pumps, however this has been applied for a short period only. It is not realistic.

Regarding bacteria removal in constructed wetlands, the monitoring team found out that a 2-days HRT of the effluent of CW in a disinfection pond was enough to reach the standards. 4 days would be optimal.

The WWTP was built in Samaha because it was the village of the former president of Suez Canal University. But such a system actually should not have been implemented in the delta, where land is scarce. Land in the delta is very precious (not only in financial terms, but also for feeding people). Maher Fares would rather recommend oxidation ditches for such setting with big and densely populated villages, in order to minimise land requirements.

Constructed wetlands should be only applied in non-cultivated areas, like in Upper Egypt. There, it could bring a real added value, especially because the warm Egyptian climate maximises the treatment efficiency.

Sewer system

Samaha is an old delta village, with old buildings and narrow lanes. Studies have been undertaken to determine the best sewer system for such setting, and ended up with a combination of conventional sewers and small-bore sewers.

Small-bore sewers were chosen because of their low-cost and ease of implementation. However, they imply the construction of sedimentation tanks or settling tanks/interceptors for one to three buildings, which was not always possible due to lack of space in the village. Consequently, they chose to build 9 main sedimentation tanks through the village. Buildings were connected to these sedimentation tanks through conventional sewers (i.e. allowing solid loads). Then, the effluent from the sedimentation tanks would be carried to the pumping station through a solid-free (small-bore) sewer system. The wastewater was then be conveyed through a force main to the WWTP itself.

The small-bore sewer system did not work properly however and had to be replaced. It is reported as not suitable for villages in Egypt, because of the high suspended solids. It could work only if good maintenance and periodic desludging of sedimentation tanks can be guaranteed.

Pros & cons table

The table below shows the observed pros and cons of this initiative.

SAMAHA – CONSTRUCTED WETLANDS	
Pros	**Cons**
• Low energy requirements • Good treatment efficiency under warm Egyptian climate • Production of papyrus as additional income source • Effluent suitable for reuse in irrigation	• High space requirements; as a matter of fact, was underdesigned and overloaded almost from the start. • Risk of clogging • Availability of appropriate gravel • Replacement cost of the gravel after ten years • Collapse of the small-bore sewer system

FURTHER ILLUSTRATIONS

Transformation of the oxidation ponds into constructed wetlands in 2010

Satellite image of Samaha WWTP (Google Earth, 2009)

Papyrus production at the WWTP in 2010

ACTIVATED SLUDGE
MASHAL / KOM EL NAGGAR - GHARBEYA

Warning: the data and information given in this factsheet is the result of observation and interviews and the main stakeholders. As such, full exactitude is not guaranteed.

Dates of the visits:	6th June 2010; 14th November 2011
Participants to the first visit:	Philippe Reymond, Dr. Christoph Lüthi (Eawag), Eng. Adel Habib (Gharbeya Affiliated Company), CDA members
Participants to the second visit:	Philippe Reymond, Dr. Moustafa Moussa, Lukas Ulrich (Eawag), Mohamed Hassan Tawfik, Anastasia Papangelou (ETHZ)

MAIN FACTS

Location:	Mashal / Kom el Naggar, Gharbeya
Coverage:	6,000 inhabitants
Technology:	Activated sludge (“conventional WWTP”)
Leader of the initiative:	Egyptian-Swiss Development Fund (ESDF), Eng. Sherif Sadek
Designed by:	Dr. Mahmoud Abdel Azeem (ALDAR Consulting)
Design capacity:	11,000 inhabitants
Actual inflow :	N.A., equivalent to 6,000 inhabitants only
Operation started in:	2010
Financed by:	Egyptian-Swiss Development Fund (ESDF)
Link with HCWW:	From 2012, operated by Gharbeya Affiliated Company
Contacts:	Eng. Adel Habib, Gharbeya Affiliated Company
Coordinates:	30°56’02.78’’ N – 30°51’12.54’’ E
For more information:	ESDF Final Report 2009, pp. 175-185.

TECHNICAL SUMMARY

Kom El Naggar / Mashal is an ESDF initiative that started operations in early 2010. The treatment system relies on activated sludge, and can thus be described as a "conventional treatment system". The treatment system consists of two aerated basins, clarifiers and sludge drying beds. The effluent is chlorinated before discharge in a drain. A shallow sewer system was implemented in the village.

The project designed by ESDF was originally a community-led project, which makes this initiative quite unique. The treatment plant was planned to be owned by the community and managed by the CDA (community development association). However, after one year, the community decided to hand over the treatment plant to Gharbeya Affiliated Company.

The system included a reuse component, where the sludge from the plant was supposed to be dried and mixed with rice waste in order to produce compost (or "co-compost", as the mix of sludge and organic matter is called in the sanitation field). Sludge is processed on drying beds and then mixed with rice straw to make compost. The compost should be sold for agriculture in the desert, but still no marketing channel has been found. The compost was accumulating at the time of the visit.

The project faced various problems, first of which is the wish of CDA members to get more funds, even if they have an important fund to back up O&M. On the long term, it may be difficult for a community to support the O&M of such an advanced system. A conflict even arose between the treatment plant operator and the CDA. Another problem consists of the marketing of co-compost, which was lying within the WWTP boundaries. It seems that the Governorate took up the idea and is now competing with its own compost generation.

The treatment plant was designed for 11'000 inhabitants. It seems, however, that only 6'000 are connected. It is reported that only 50% of the population is connected and that the others did not want to pay for the connection. This refuse to participate is said to be the main failure of this project.

The staff is composed of one electrical engineer and one maintenance person. Eng. Adel Habib is responsible for the plant at Gharbeya Affiliated Company. Management and O&M seems to be an issue. It seems that the role of the community was neglected. Technical control was given to a consultant who was later denied access to the plant!

The total cost of project was 18 mios EGP (13 mios from ESDF + 2 mios from the villages + 3 mios from Gharbeya governorate). According to the CDA, 30,000 EGP/month are necessary for O&M, but only 10,000 EGP are available.

Pros & cons table

The table below shows the observed pros and cons of this initiative.

MASHAL / KOM EL NAGGAR – ACTIVATED SLUDGE	
Pros	**Cons**
• Very good effluent quality • Good quality dried sludge • Shallow sewer system	• High O&M costs, especially due to energy requirements. • The system is too advanced for a small community and cannot be managed by a CDA. • Very high cost/capita in the initial investment. • No business model for the co-composting component, which never took off.

FURTHER ILLUSTRATIONS

Satellite image of the WWTP and waste processing site (Google Earth, 2013)

The drying beds and the waste processing site in 2010, including the compost heap (in front), the solid waste to be sorted out (middle) and the sieved compost (back right)

The clarifiers following the aerated basins, in 2011

ON-SITE SANITATION SYSTEMS
UPPER EGYPT

Warning: the data and information given in this factsheet is the result of observation and interviews and the main stakeholders. As such, full exactitude is not guaranteed.

Interviews by: Philippe Reymond

MAIN FACTS

Location:	Fayoum, Beni Suef, Sohag, Assiut, Qena and Aswan Governorates
Coverage:	Tens of thousands of inhabitants
Technology:	- “Advanced septic tanks”, anaerobic baffled reactors with anaerobic filters.
	- Biogas reactors
Operation started in:	Since 1990
Link with HCWW:	None.

CARE AND ESDF "ADVANCED SEPTIC TANKS"

Date of the visit:	No visit, interviews only
Main interview partners:	Eng. Sherif Sadek, former project manager at CARE and ESDF (interviewed in 2010)
	Eng. Gamal Gaber, Beni Suef Affiliated Company (interviewed on 5th December 2011)
Financed by:	CARE, Egyptian-Swiss Development Fund (ESDF)
Reference for ESDF:	ESDF Final Report 2009, pp. 129-130, for the project in Dandara, Qena, implemented between 2002 and 2006

In the 1990s, CARE launched a broad project of on-site sanitation improvement in the governorates of Fayoum, Beni Suef, Sohag, Qena and Aswan. It implemented so called "advanced septic tanks", which can be described as anaerobic baffled reactors with an upflow gravel filter (fixed-bed biological reactor) in the last compartment. The septic tanks receive blackwater as well as greywater. These units were built at different scales, ranging from households, household clusters to whole hamlets. Some were followed by constructed wetlands for effluent polishing. Their size is calculated on the basis of 100 L/pers/day and retention time of 5 days, hence a volume of 0.5 m3/person. Sherif Sadek's team compared the cost of the system implemented at different levels and found out that topography and space availability around houses were two of the main criteria decision factors.

The advanced septic tanks are followed by a cesspit filled with filter material (sand and gravel), allowing further BOD removal. The filter reaches its full performance after 6 to 12 months, once the biofilm is fully developed. Cesspits are surrounded by bushes that have the role to uptake most of the water infiltrating into the soil.

Desludging is carried out by the Local Administrative Units (LAUs) with pumping trucks (or vehicle + tank + motor). In that case, the septic tanks have to be desludged every 2-3 years only. People relying on pit latrines, on the other hand, have to desludge on a monthly basis, mainly because of biological clogging of the soil. Salt is usually added with water in order to unclog the pit, which then works for a few more months.

Awareness raising has been important in CARE's project. In particular, people were taught not to throw chemicals into the toilets, in order not to kill the bacterial flora in the septic tank.

The system was later upgraded according to DEWATS approach within the framework of ESDF (i.e. in Dandara, Qena), where it took the name of "biological filters" or "hybrid reactors". One or two compartments were added in the reactor, and part of the gravel in the filter was replaced through plastic media. The latter system has been evaluated by Ain Shams University and NRC.

In Dandara, more than 1,300 anaerobic baffled reactors were installed. The farmers carried on the work themselves and electric tubes were inserted in the concrete in order to save materials and costs. The DEWATS design was optimized, resulting in smaller dimension of the tanks. The tanks had to be desludged every two years. In about 20% of the reactors, a tank filled with sodium hypochlorite was added above the unit for effluent disinfection. The effluent was discharged into drains or infiltrated in soak pits, depending on the location of the unit.

This initiative should be evaluated during a field visit. A certain rate of failure was reported, in particular because of inputs of solid waste and animal manure into the tanks. In Beni Suef, these systems have been constructed until March 1998 and then went forgotten. It seems that at the time of interviewing (2012), none of them was properly functioning in Beni Suef Governorate. We do not know how CARE dealt with the communities ; it seems however that CARE, even if working with CDAs, did not work enough on awareness-raising and behaviour change, so that their initiative failed because of solids dumped in the sewer system. It seems also that CARE used local contractor without proper monitoring of construction work. As for the constructed wetlands, presumably failed because of bad design and lack of space.

BIOGAS REACTORS

Date of the visit: 1^{st} December 2013

Main interview partners: Dr. Ahmed Medhat, Ain Shams University

Financed by: UNDP-GEF, Egyptian Environmental Affairs Agency / Ministry of State for Environmental Affairs (EEAA / MoSEA)

Webpage: www.egyptbiomass.com; Facebook: https://www.facebook.com/Egyptbiogas
In Al Ahram: http://weekly.ahram.org.eg/News/4497/24/Energy-from-manure.aspx

Started in 2009 for a duration of 5 years, the project "Bioenergy for Sustainable Rural Development (Biomass)" aims to provide fixed-dome biogas digesters made out of brick and cement to 1,000 households by the end of 2014 in the Governorates of Sohag, Assiut and Fayoum. Thus, this project is developing a real strategy for scaling-up, including the recruitment of local engineers and masons willing to develop their own business around the construction of biogas reactors.

The project targets households owning at least 2 or 3 cows, as these biogas reactors are designed to receive only animal manure as a feedstock. It is reported that, so far, the beneficiaries did not agree to add the black water into the reactor.

The project received support from an Indian NGO, SKG Sangha. Three sizes of biogas digester are available:

- Radius = 1.32 m, leading to a production of about 2 m^3 biogas/day
- Radius = 1.5 m, leading to a production of about 3 m^3 biogas/day
- Radius = 1.65 m, leading to a production of about 4 m^3 biogas/day

It is assumed that the daily need is about 300 to 400 L biogas/capita/day.

The cost of a digester is around 6-7,000 LE, including the materials, labour, connection and one year O&M. So far, the cost is shared in the proportion of 50% from UNDP-GEF and 50% from the beneficiaries.

Biogas digesters are very promising in such an area in a time where the price of the gas bottles is increasing drastically (from 6 EGP to more than 70 EGP). Next to that, the farmer does not lose the manure as a fertilizer, as he can use the bioslurry (effluent from the digester), which has a better fertilizer value than fresh manure, as it is stabilized.

A functioning biogas reactor: the inlet (in front), the biogas pipe (middle) and the bioslurry chamber (back), Fayoum, December 2013

APPENDIX

APPENDIX 1:

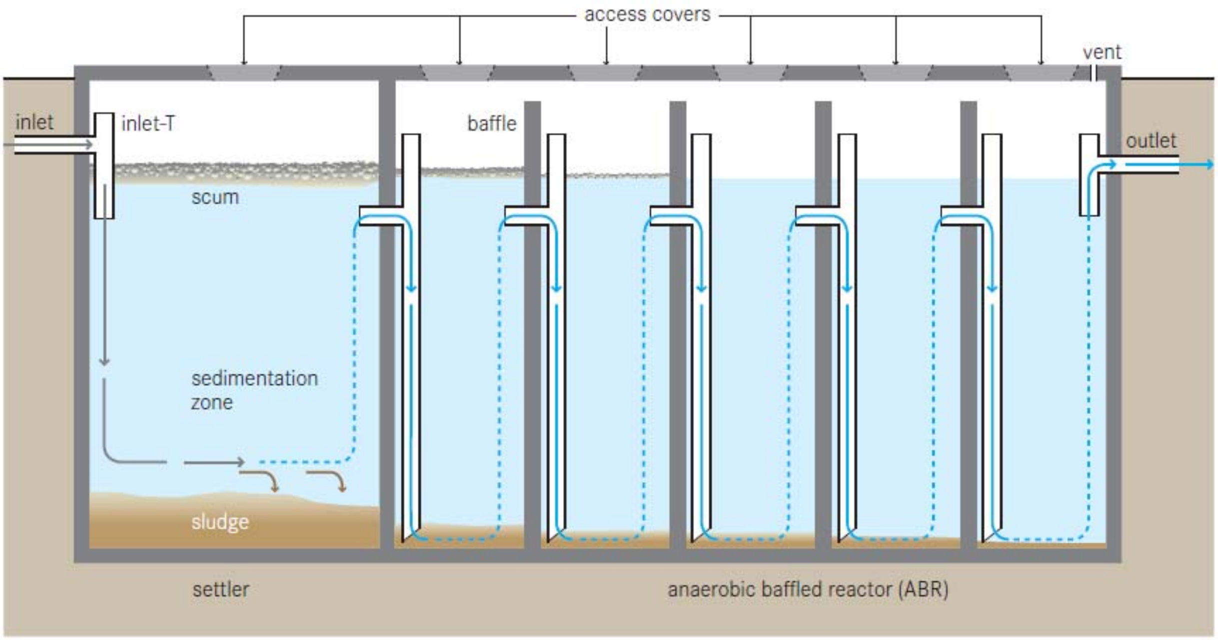
TECHNOLOGY DRAWINGS FROM THE COMPENDIUM OF SANITATION SYSTEMS AND TECHNOLOGIES

Reference for the figures:

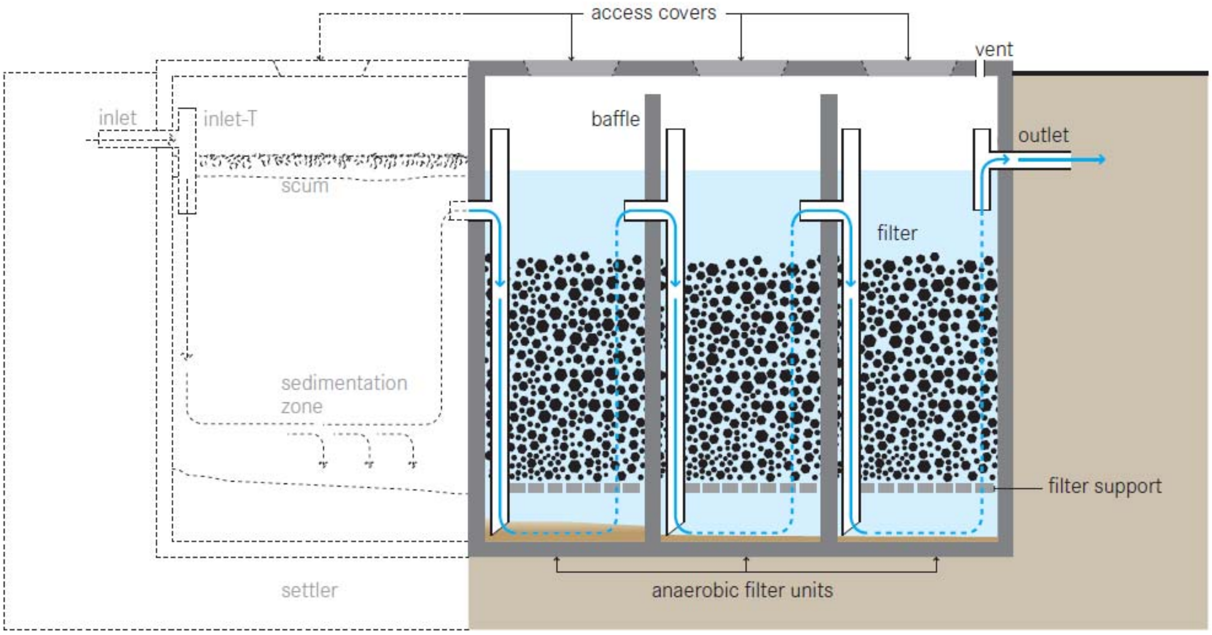
Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph. and Zurbrügg, C., 2014. Compendium of Sanitation Systems and Technologies. 2nd Revised Edition. Swiss Federal Institute of Aquatic Science and Technology (Eawag).

To be downloaded on: www.sandec.ch/compendium

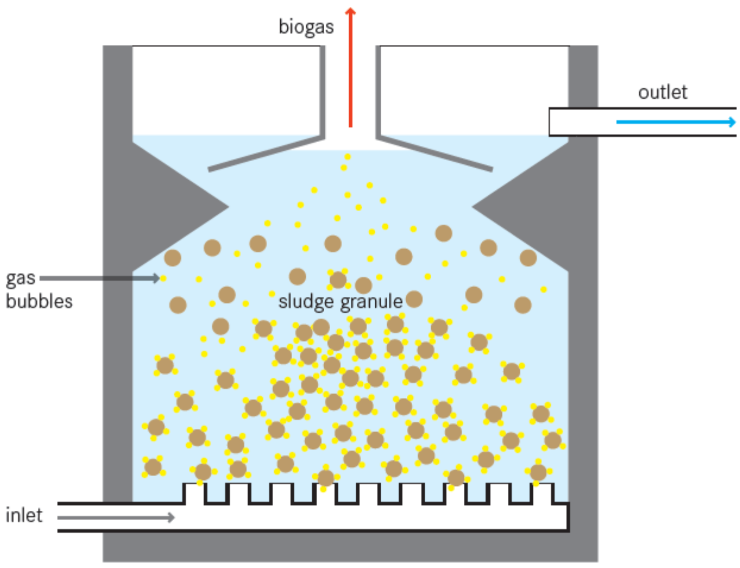
ANAEROBIC BAFFLED REACTOR (ABR)



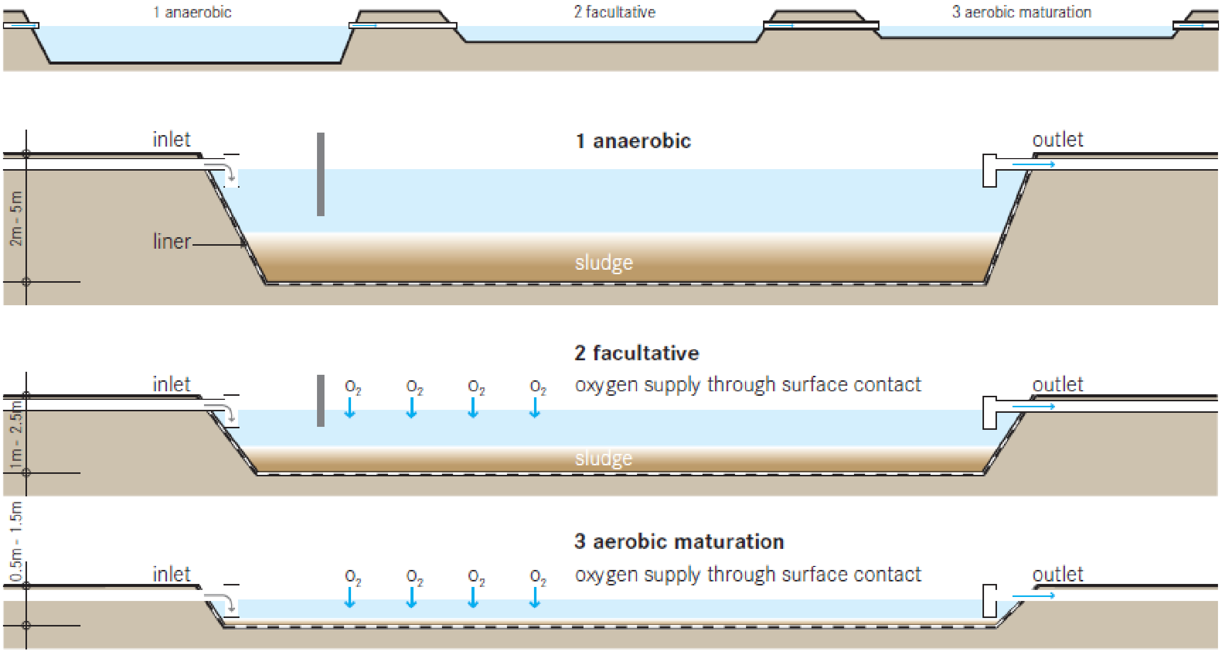
Anaerobic filter



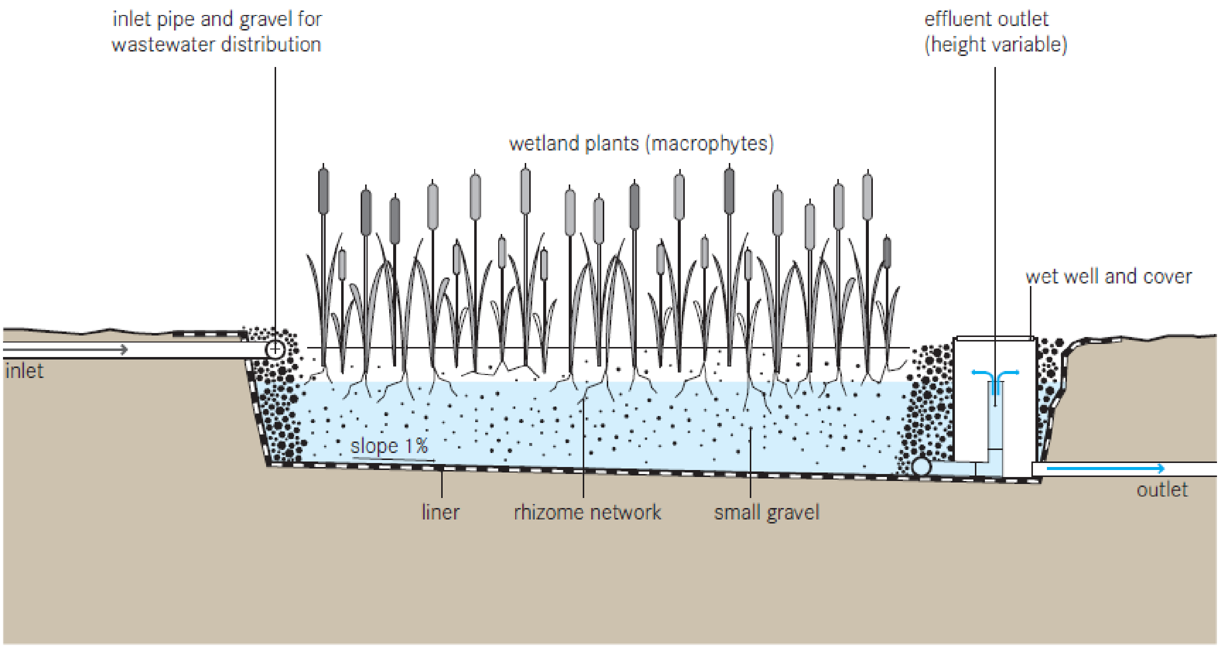
Upflow anaerobic sludge blanket (UASB)



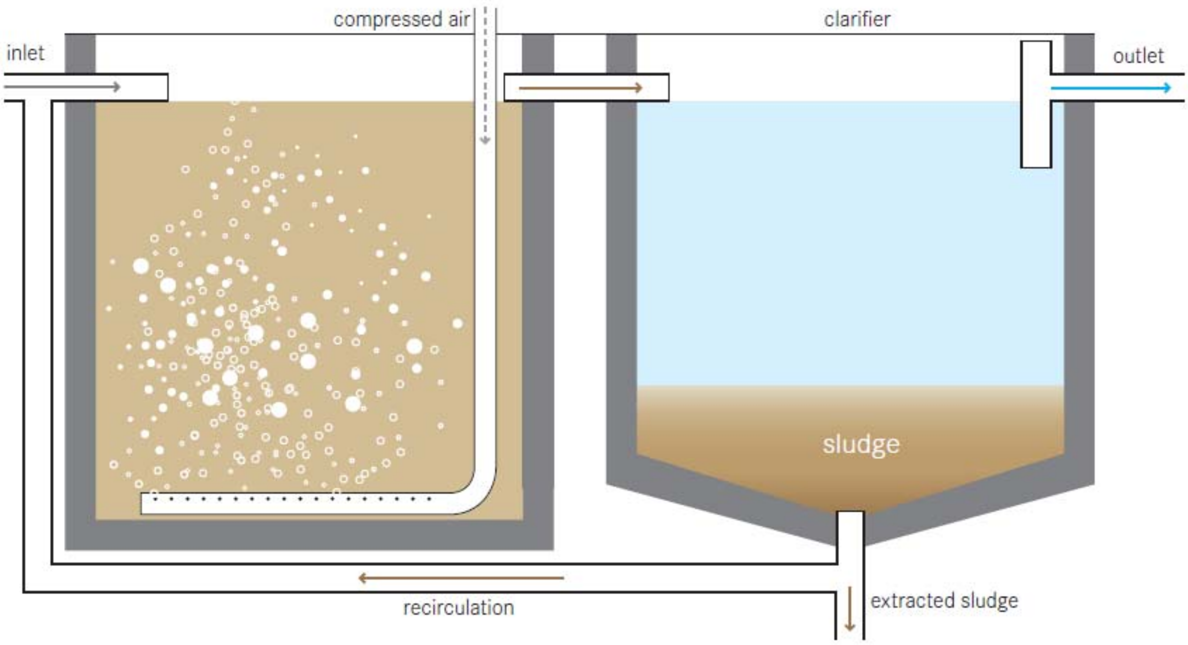
Waste stabilisation ponds (WSP)



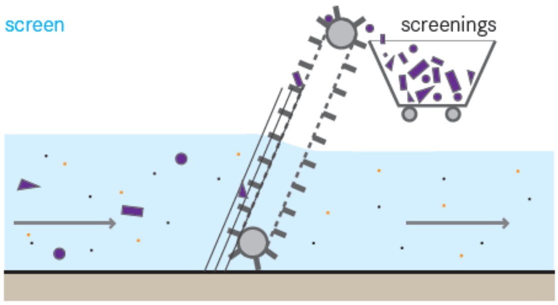
Horizontal subsurface flow constructed wetland

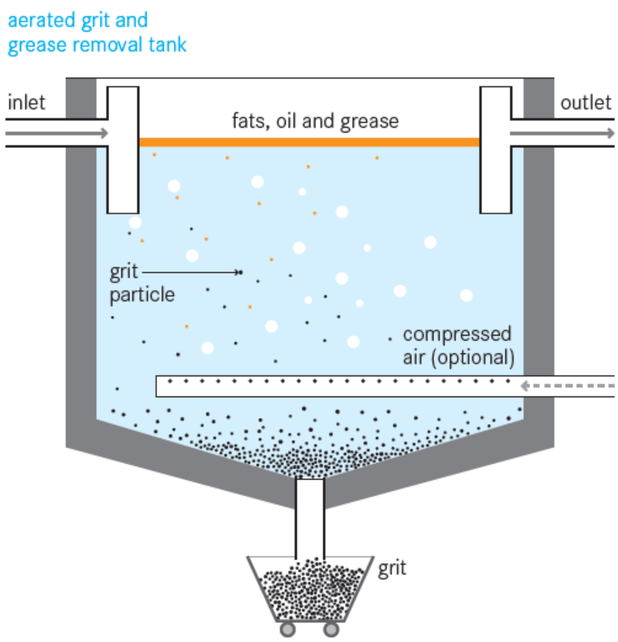


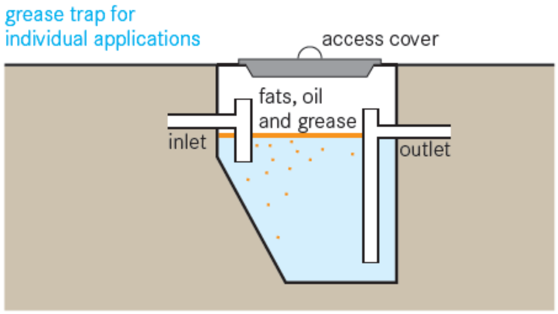
ACTIVATED SLUDGE



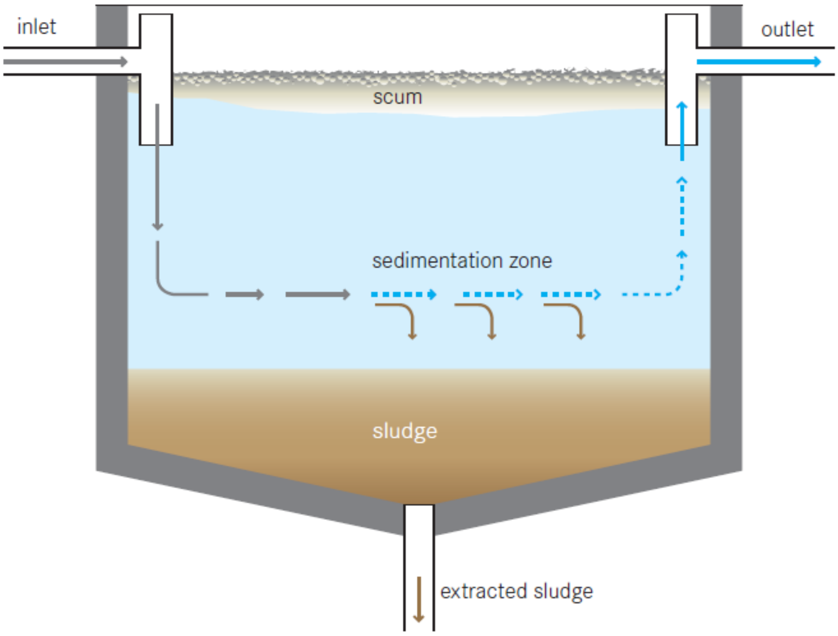
PRE-TREATMENT







SETTLER



ANAEROBIC BIOGAS REACTOR