Partners for Water and Sanitation

Note on project reports

The following report has been prepared by Partners for Water and Sanitation in response to a project Terms of Reference.

The content of the report is based on the opinion of the author(s) and does not necessarily represent the opinions of the wider PfWS partnership, or the project funders.

Partners for Water and Sanitation

Sludge Recycling, Energy Generation and Effluent re use in Waste Water Treatment

Submitted by:

Nick Mitchell

Wessex Water

April 2009

Contents amendment record

This report has been issued and amended as follows:			
Revision	Description	Date	Signed
1.0	First draft – Pre visit report	18/12/08	
2.0	First Draft – Post visit	05/02/09	
3.0	Amended draft following feedback	09/03/09	
4.0	Final draft for comment	04/04/09	

PAWS visit January 2009
Opportunities for alternative technologies in Waste Water Treatment
N Mitchell – Wessex Water
January 2009

1.0 Introduction

Wessex Water is supporting PAWS to look at sludge recycling, energy generation and use of effluent in the Ugu District Municipality, South Africa. This report discusses each of these areas in detail and suggests some development opportunities to be explored together with some detailed recommendations.

South Africa's National Joint Water Services Sector Support Strategy emphasises support to Water Service Providers (WSPs). The support programme is currently focusing on four learning sites, one of which is the Ugu Municipality. PAWS country manager Amina Ismail together with Nick Mitchell and Andy Cox from Wessex Water visited Ugu
on 26th January 2009 for a weeks visit. The visit was aimed at establishing a base line for current operational activity and establishing how the municipality could adopt alternative practices or technologies.

Prior to the visit at Ugu municipality, there was a visit to eThekwini offices in Durban to discuss their experiences of alternative technologies.

2.0 Observations following the E Thekwini visit

The eThekweni Municipality was visited on the morning of the 26th of January 2009 to look at alternative water and sanitation technology initiatives at the metropolitan municipality. Max Pawandiwa and Mthokozisi Ncube from the Ugu Municipality joined the PAWS team to get an idea of what projects were being tested and implemented under South African conditions

Frank Stevens and Speedy Moodley of eThekwini municipality presented an overview of the organisation together with a review of technologies respectively. The review of technologies was most enlightening as the organisation has initiatives in progress, amongst others, for the following;

- Recycling of Biosolids to land via composting
- Rainwater harvesting
- Low volume potable water supply
- Effluent re use
- Micro digestion

All of these areas will be discussed in detail within this report. It is recommended that contact is maintained to share experiences and learning.

Recommendation one; Maintain contact with eThekwini on an annual basis to see if there are any shared learning experiences for both organisations

3.0 Ugu municipality site visits

Ugu District Municipality was visited from the 26th to the 30th of January 2009. Site visits and assessments were carried out on the 27th, 28th and 29th of January 2009, and findings were reported to Ugu and provincial DWAF officials on the 30th of January 2009. The PAWS team also had the opportunity to join a meeting between the DWAF WSP project team and Ugu Municipality to gain an understanding of the context in which the PAWS appropriate technologies investigations were being undertaken.

The following sites were visited in the Ugu municipality;

- Tweni residential area
- Mbango WWTW
- Bobhoyi WTW and Laboratory
- Shelley Beach WWTW
- Margate WWTW
- Red Desert WWTW
- Munster Ponds
- New Prison site
- A rural WTW together with village areas

Observations; There is a good asset base and in places the sites are being expanded. The staff are helpful and committed. On some sites there has been some good process improvements such as the installation of scum boxes. There appears scope to improve the performance of the works with additional process improvements and advice.

Recommendation two; Recruit a process scientist with sewage treatment experience to advise and support the operational managers to run the sites. This is to include advice on process improvements including minor capital investments.

4.0 Biosolids recycling

4.1 Current practices

At present sewage sludge is dried on sludge beds, although at one site cake was being produced through a Huber dewatering unit. All sludge is disposed of to landfill at a cost of R49.50 per tonne. The sludge cake being produced appears very dry and is clearly stackable. This material is already in a form that could be transported and potentially recycled as a biosolid material.

In addition at Scottburgh WWTW the sludge is digested before drying.

Photograph 1: Dried sludge, stored prior to disposal

4.2 Options for recycling

Department of Water Affairs & Forestry, South Africa (DWAF) has produced a document outlining the requirements for sewage sludge recycling. This is a comprehensive document and details the quality standards and environmental benefits of biosolids recycling.

Sewage sludge has been used in agriculture for many years in the UK. The sludge or biosolids contain a range of nutrients which are useful in growing crops and enhancing soil structure. The DWAF guidelines support the use of sludge in agriculture. Attached to this report is a Water UK document which supports the use of recycling biosolids to land and details the agricultural benefits.

It should be noted that the use of sludge to land has been closely monitored by the big supermarkets in the UK. The improvement in standards has been driven by the supermarket buyers. The need for compliance with the regulations is paramount as supermarket buyers will not purchase crops which have been grown in non compliant sludge.

The current cost of disposal could be returned into the community by employing labour to assist in the composting process. In addition the composted material would be a valuable source of fertiliser.

Having reviewed the DWAF guidelines together with current practices it is recommended that Ugu establish a project with the aim of recycling all sludges to land. Outlined below is a suggested draft implementation plan.

4.3 Draft implementation plan for biosolids recycling

Activity	Comment
Nominate or appoint an individual with responsibility for the project	Ideally this would be an Ugu employee
Establish clearly the project aims and objectives. Identify key stakeholders.	Management input at outset to support the project. Establish review periods.
Work with DWAF to understand the guidelines and set a target for the standard of sludge to be produced.	Recommend a target of a DWAF A1a class product. This would give maximum flexibility should there be any failures in the treatment processes

Visit other municipalities already recycling to land	Suggest e Thekwini municipality
Set up a sampling programme to establish the current standard of the sludge cake	This will be essential to establish the treatment processes that will follow. Wessex Water with PAWS would be pleased to assist in commenting on any laboratory analysis including the potential suitability for land application.
Should there be contaminants in the sludge it will be necessary to identify the sources & isolate them or treat separately	Contaminants likely to come from trade effluent sources
Develop a treatment option to meet the stability class 1 outlined in the DWAF document	Treatment options are outlined in the DWAF report. Subject to sampling some current practices may already be compliant .e.g. Digestion. It is likely that one option will be digestion & another composting.
Identify a suitable land bank and agree application rates as set out in the DWAF report.	There is an opportunity to recycle biosolids to land in rural villages for growing crops. Should composting be required this could be undertaken locally in the community and possibly generate some income from turning windrows and mixing amendment material. Note that crops grown for export may attract interest from supermarket buyers.
Agree a monitoring programme to meet the DWAF requirements	A HACCP programme will have to be developed to ensure that the sludge meets the standards as set out in the DWAF guidelines.

Recommendation three; Plan to recycle all sludges to land.

5.0 Renewable Energy Generation

Sewage sludge can be used as a source of renewable energy. Energy can be generated from anaerobicly digesting sewage sludge and piping off the methane gas to an engine which in turn generates electricity.

The broad economics of this option are as follows;

- Consider WWTW site with a population catchment of 100,000.
- With this population there will be 2200t DS of sludge pa.
- With 15 days retention this will produce 2500m3 of methane gas per day
- This in turn will generate 2100Mwh of power pa or 250Kw continuously.

Clearly the total investment would have to be established including the capital expenditure of installing an engine and the potential revenue from power sales. It is seldom economic to include the cost of the digestion assets unless a very low cost option can be identified.

Renewable energy projects usually have a tax or feed in tariff incentive. It is understood that the tariff is under discussion at the moment. It is recommended that as part of the project economics the power tariffs are reviewed to see if there are any commercial benefits.

At Scottburgh WWTW there is already a digester on site and the methane gas is vented to atmosphere. Energy could be generated from the methane gas and used to power the site. It is suggested that the costings be established for this proposal. However, it is understood that the site is subject to coastal erosion and will have to be re-sited in the near future. With this in mind any investment will be subject to timing of this re-siting.

Should there be more power than required for the WWTW the balance could be exported to the grid. In this case the suitability of the grid will have to be assessed with the local power company.

e Thekwini District Municipality indicated that they were involved in a low cost digestion project. In this project a digester was installed in a school washroom block and power was generated for school use. It is recommended that this project be investigated further to see if the process could be adopted and potentially expanded into Ugu municipality.

5.1 Draft implementation plan for renewable energy generation

Activity	Comment
Nominate or appoint an individual with responsibility for the project	As this is a capital investment the PMU section may be able to assist.
Establish clearly the project aims and objectives.	Aims at this point will be to review the economics and understand the cost issues.
Meet with engine suppliers to discuss the project	Suggest caterpillar or similar manufacturers
Collect gas sample for analysis	Analysis to include for all contaminants & calorific value of the gas
Assess volume of gas	Conduct tests to establish the volume of gas available
Include in assessment cost of new digesters	Appraisal to include both marginal cost of a renewable energy facility where there are existing digesters and the effect of building new assets.

Recommendation four; Review the economics of a renewable Energy facility at Scottburgh WWTW.

6.0 Effluent Re-use, Grey Water and Rainwater Harvesting

This is a large area and has been broken into the three areas listed above. Each will be treated in turn. *However, in any of these projects it is prudent to work backwards from the proposed end use and hence the required end standard*. Shown below, for instance, is a simple table that can be used to determine the likely forms of treatment required, depending on the proposed uses for the effluent.

Table 1: Levels of treatment required for the proposed use of the effluent

Level of Treatment	Crops not for direct consumption	Cooked crops or fish	Crops eaten raw	Irrigation no contact	Irrigation contact	Industrial use
Primary Treatment	**XX**	**XX**	**XX**	**XX**	**XX**	**XX**
Secondary Treatment		**XX**	**XX**	**XX**	**XX**	**XX**
Sand Filtration or equivalent		**X**	**X**		**XX**	**X**
Disinfection		**X**	**XX**	**X**	**XX**	**X**
Nitrification, Chemical clarification etc						**X**

XX Required treatment, **X** Treatment subject to end use
Reference; Water, Wastes and Health in Hot Climates, 1977, by R Feachem, M McGarry, D Mara.

There are many Waterbourne diseases which can be transmitted when recycling effluent. The table above provides a good indicator for treatment and is aimed at health protection.

6.1 Effluent re-use

Effluent use can come in several forms. Effluent from both industrial processes and WWTW's can be re-used. The treatment processes are interchangeable and should be selected for specific re-use of the effluent.

As stated above with effluent re use it is necessary to consider the end standard required first and work backwards to establish the most suitable form of treatment. For example it may be necessary to have a disinfected product in which case this would affect the chosen process.

Effluent re use can come in many forms from recycling of laundry water or shower water to sewage Treatment Works effluent. The appropriate technology can be one or more of the following;

Process	Capital Cost	Operational cost
Ion exchange plant	High capex	High opex
Membrane treatment	Capex fair for a new development	Main cost is around cleaning of membranes. Opex is fair
Sand filtration	Low capex	Low opex easy to operate
Disinfection through UV, or Sodium Hypochlorite	Capex for UV can be high. Process requires a clean effluent. Capex for Hypochlorite is low.	Opex for UV is high, UV lights are expensive & require considerable power, Chemical costs for Hypochlorite vary.

Stabilisation ponds	Low capex	Low and effluent can be of suitable quality for re use.
Micro Strainers	Low capex	Low opex
Reverse Osmosis	High caex	High opex
Aquifer recharge	Fair capex	Low opex

Some of these technologies are quite expensive and require considerable skills in maintaining the process. Diagrammatic representations of these processes are shown on the attached presentation (see appendix A). From the site visits it is understood that effluent re use is an opportunity worth exploring on a case by case basis. For example there are two possible openings that are worth exploring;

- Mbango WWTW – there is a concrete manufacturer, PSP, next to the works. This is an opportunity to reduce the supply of potable water and supply final effluent from the WWTW for the manufacturing process.
- New Prison development and WWTW. This is an opportunity to design the entire plant from the outset with effluent re use in mind. Effluent and rainwater could be used for applications within the prison such as WC flushing together with the irrigation of farmland areas.

Draft implementation plan for Mbango WWTW effluent re use;

Activity	**Comment**
Review potable water consumption of PSP	Check meter readings and water sales
Visit PSP and discuss the possibilities of supplying final effluent.	Establish required standard of water & possibility of long-term contract
Review shortfall of standard from the WWTW if any	Can the current WWTW supply the required standard with minimal improvements? If not establish what improvements are required.
Construct a business model to supply treated effluent to include recovery of any asset improvements.	Suggested model to include standing charge for a given take and a variable element thereafter. Consider an offer to PSP

Recommendation five; Review the possibility of supplying PSP with treated effluent.

Draft implementation plan for the new Prison and WWTW;

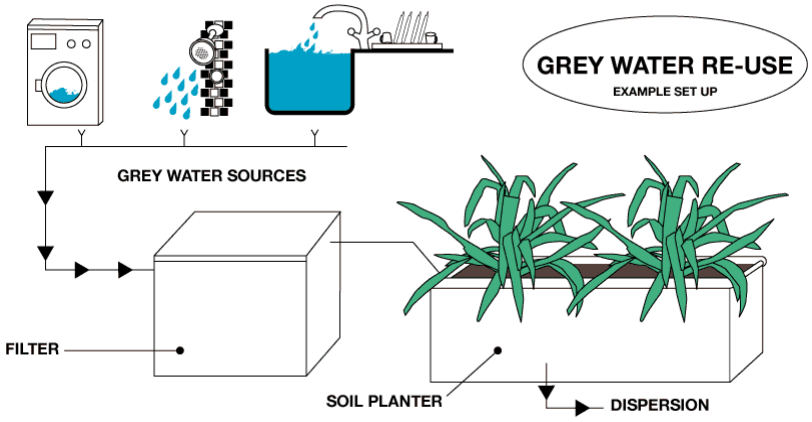
Activity	**Comment**
Engage at the earliest opportunities with the client to discuss recycling options	Scope out the proposed options to include; rainwater harvesting and re use, effluent re use, biosolids recycling.
Cost up the treatment options including potential benefits.	Appraise the treatment options to include appropriate treatment for re use. Include also the possible savings in potable water of rainwater harvesting and use in the prison. There my also be savings in the extensions to the potable water network.

Recommendation six; appraise the treatment options for the new prison to include rainwater harvesting, effluent re use and biosolids recycling. Aim to complete assessment in timeline with the client.

6.2 Grey Water

Grey water is defined as all of the water coming from the house with the exception of the water from the WC. Clearly the amount of Grey water is entirely linked with the supply practices. As with effluent re use, the proposed use of the water has to be considered at the outset. For grey water, source control is important and use of detergents for example will have to be considered. In a similar fashion to effluent re use it is easier to consider greywater re use in any initial design. Shown below is a typical; example of a greywater installation. In this example the water is used for irrigation purposes. The filter is a simple grease trap.

Figure 1: Example arrangement for greywater re-use
Figure extracted from www.rainwindsun.com



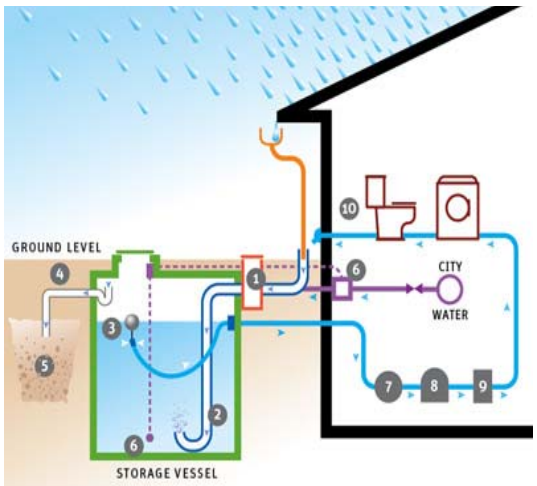
Typically upto 65% of water entering a house is potentially available for greywater use. The water is usually high in suspended solids with a ph in the range of 6.5 – 8.4. the PH will vary according to the water use in the house such as laundry washing. In addition the salt content maybe high which may reduce crop yield and in extreme cases necessitate the requirement for salt resistant crops.

6.3 Rainwater harvesting

This is a far simpler concept than grey water harvesting and the geography of Ugu municipality lends itself to this option. There were some good examples of this practice already taking place in certain areas and this could be extended further.

Rainwater harvesting could be used for irrigation or recycled into the home for use in the WC. Shown below is a typical schematic arrangement that could be incorporated in new developments

Figure 2: Example of rainwater harvesting for new build properties
Figure extracted from www.starkenvironmental.com



1. Filter
2. Inlet
3. Intake
4. Overflow
5. Soak away
6. Top up from mains water
7. Pump control
8. Pump
9. Pressure tank
10. rainwater used in the house

This is still a relatively complex arrangement. A far easier arrangement is to collect the water from gutters and use accordingly. Shown below is an example of a school within the municipality where the rainwater is collected. In this example there are no pumping requirements and the system operates entirely by gravity.

.

Photograph 2: School in Ugu municipality collecting rainwater

6.4 Tweni residential area

Ugu municipality asked a specific question regarding Tweni residential area. In this area the houses are on mains water. There are no sewers, the waste flows to septic tanks and subsequent French drains. The municipality is concerned that there is a pollution risk with the amount of free water in the area.

This is a difficult problem to solve. Clearly the installation of sewers would relieve the issue however this is considered to expensive. There are a couple of options that may be considered.

- Maintenance of existing infrastructure to ensure that the current drains are working properly.
- Installation of rainwater collection butts to slow the impact of surface water run off and subsequent slow release to the ground.
- Installation of a Ranney well system. In this system a large diameter well is constructed in the ground and drainage channels connected to the well. The well is then pumped down to reduce the water table level to allow other drains in the area to work more effectively.

Of these techniques it is recommended that Ugu municipality investigate the first two options prior to considering a large capital solution.

The issues at Tweni also offer an option to consider for future development. Throughout this report the need to highlight the end use for water has been stressed. It is recommended that Ugu municipality look to influence the building regulations so that rainwater harvesting for both in house use and for irrigation is incorporated in new development. This will serve to reduce the impact on potable water supplies and alleviate the issues of retrofitting recycling equipment to property. In determining a strategy this can be considered in two main categories;

1. Source control and prevention. In this technique the volume of water discharged from a development is limited. Water can be limited by diverting rainwater underground, use of green roofs, permeabable pavements, rainwater harvesting and infiltration trenches
2. Permeable conveyance systems. These are channels which run to watercourses slowly by diverting the water through storage ponds, filter drains or swales(long, grassy trenches)

Such techniques can be applied to individual property levels such as rainwater harvesting. At an overall development where a swale or detention tank maybe considered. At a strategic level, where a balancing pond or wetland area maybe considered.

Recommendation seven; Develop a strategy to ensure that surface water runoff and water reuse is considered in the design of new developments and is part of the building regulations.

7.0 Next Steps

There are a large number of potential projects here and it is recommended to select two or three areas that can be achieved within the next twelve months. The following is proposed;

Recommendation	Timescale
Maintain contact with eThekwini on an annual basis to see if there are any shared learning experiences for both organisations. It is suggested that this role is incorporated into one of the operations managers' responsibilities	*June 09*
Develop a strategy to ensure that surface water runoff and water reuse is considered in the design of new developments and is part of the building regulations.	*September 09*

Appraise the treatment options for the new prison to include rainwater harvesting, effluent re use and biosolids recycling. Aim to complete assessment in timeline with the client.	To suit client requirements
Plan to recycle all sludges to land. • *Nominate responsible person & develop a plan* • *Work through DWAF guidelines and establish the current standard of the sludge cake.* • *Determine what additional treatment options are required to meet the DWAF guidelines and set up trials on one site. Identify a suitable land bank* • *Agree an outline HACCP plan and seek DWAF approval* • *Roll out programme to other sites*	*June 09* *June 09 – Sept 09* *Oct 09 – Dec 09* *Dec 09 – March 10* *March 10* *March 10 to Sept 10*

Wessex Water through PAWS would be delighted to support any ongoing recommendations in the form of advice by E mail or phone and in coming months a visit to review progress.

8.0 Summary

Working with Ugu municipality has been a great pleasure. There are a number of opportunities to develop the business further that have been highlighted in this report. This includes;

- Recycling of Biosolids to land
- Assessment of the potential energy opportunities from digestion
- Encourage effluent reuse at industry specific locations
- Influence the design of the prison to minimise the use of potable water
- Develop a strategy for new property development to maximise the use of rainwater harvesting and greywater recycling

Attached to this report is the presentation plus a number of articles from water UK together with the regulations on safe use of sludge.

9.0 Contact details

PAWS

Amina Ismail
PAWS in Country Manager
E mail ismaila@dwaf.gov.org
Mobile +27 84 252 1013

Ugu District Municipality

Max Pawandiwa
General Manager
E mail max@ugu.org.za
Mobile +27 82 552 8591

Mthokozisi Ncube
Senior Manager
E mail mthokozisi.ncube@ugu.org.za
Mobile +27 71 603 1513

Johan Van der Walt
Senior Manager
E mail Johan.vanderwalt@ugu.org.za
Mobile +27 71 603 1491

Dave Macintosh
Manager Administration
E mail dave.macintosh@ugu.gov.za
Mobile +27 82 552 0244

DWAF

Angela Masefield
Senior Manager
E mail angelam@dwaf.gov.za
Mobile +27 83 625 6247

Wessex Water

Nick Mitchell
Business Development Manager
E mail nick.mitchell@wessexwater.co.uk
DD 0044 1225 424749
Mobile 07831 141950

Andy Cox
Group Manager – Business Continuity
E mail andy.cox@wessexwater.co.uk
DD 0044 1225 526000
Mobile 07831 139341