WRS
Water Revival Systems

Molepolole Sewerage Scheme- Actions for Sustainable Sanitation and Wastewater Management

The Swedish Trade Council and the Swedish Foreign Ministry

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1. Background

This assignment and the mission
The Swedish Trade Council has the assignment from the Swedish Foreign Ministry to market Swedish environmental and sustainable know-how and technology through the framework "SymbioCity Academy". Within this framework the Swedish Trade Council procured Swedish consultants for three short missions to Botswana. The purpose of these three short missions was to give feedback to Botswana stakeholders on three major environmental challenges in Botswana - the water management challenges, the waste management challenges and the sanitation challenges. All missions have been done in cooperation with the main governmental departments in respective sector and all missions have been finalized by a 2 day workshop involving the major stakeholders in Botswana invited by respective department.

The sanitation mission had a focus on giving feedback to the Sewerage Scheme plans in Molepolole in cooperation with the Department of Waste Management and Pollution Control (DWMPC). Two Swedish consultancies in cooperation got engaged, the WRS (Water Revival Systems) and StenStenbeck consultancy and training. This report is about this mission. WRS has extensive experiences of water born and non-water born sanitation projects around the world and StenStenbeck consulting and training is an environmental management consultancy firm that has its base in Botswana.

The objectives of the mission
- Identify and evaluate feasible solutions for upgrading the sanitation systems of Molepolole.
- Assess alternative solutions from a list of sustainability criteria following the method of Open Wastewater Planning (OPW).
- Propose an organization and set up for a potential further Partner Driven Cooperation between institutions in Sweden and Botswana
- An action plan for the further activities
- Demonstrate a tool/method for waste water planning for similar works in other parts of Botswana

2. Method

The method used for achieving the objectives was to go through the following steps:
1. Studies of documents and plans and establishment of key contacts
2. Site visits and interviews in Molepolole and Gaborone
3. 2 days workshop in Gaborone
4. Report

1. Studies of documents and plans and establish key contacts
- Studies of:
    - the existing plans and design in Molepolole for a water-born sanitation system:
    - of the Botswana National Masterplan for wastewater and sanitation,

    - the environmental framework such as water resources, groundwater, soil and climate
- Establish contact with key partners in Botswana such as Mr E Banda at the Department of Waste Management and Pollution Control, Dr Hranova and Dr Odirile at the University of Botswana, Mr Ntana at the Department of Environmental Affairs
- Establish key partners in Sweden such as Prof Håkan Jönsson, SLU (Swedish University of Agricultural Sciences), Elisabeth Kvarnström, Stockholm Environment Institute and Jennifer McConville CIT Urban Water
- Identifying stakeholders to be invited

2. Workshop preparatory visist to Molepolole and Gaborone Sewerage

- A visit to the town- and the district councils to discuss their situation and the plans
- A study visit to the existing sewerage and to the planned area for the new sewerage ponds and treatment plant
- Molepolole city site visits to get a picture on how the sewerage system works today
- Visit to the sewerage plant in Gaborone and
- Meetings with Mr E Banda at DWMPC, Dr Hranova at the University of Botswana and private entrepeneurs with experience in the field of alternative solutions in Botswana

3. Workshop in Gaborone, 2 days

- See the program in appendix 1
- Presentations from Molepolole Town Council, DWMPC, DEA, UB, BK Services and Rob McLaggan
- Presentation on the Swedish experiences of wastewater and sanitation systems
- Group work on what criteria a sanitation system should fulfill regardless of technology chosen
- Presentation of the design for the Molepolole Sewerage
- Presentation of options for wastewater and sanitation measures, which were discussed in connection to the criteria for the solution
- Create an action plan for further cooperation

4. Report and further Partner Driven Cooperation

The report is compiled on the basis of what have been found during especially the workshop but also during the preparations for the workshop. The seeds for a Partner Driven Cooperation is part of the action plan further.

3. Workshop

This chapter summarizes both presentations and discussions held at the workshop. Printouts of the power point slide shows are attached in the appendix.

3.1. Summary of workshop

As a starting point the organizer declared their idea and objectives for the workshop and the participants present themselves and their expectations.

The first block of the workshop gave a general picture on sanitation and water and wastewater situation in Botswana as a hole and Molepolole specifically. Ruling parameters for the planning of sanitation was presented, such as the national framework and policies, legislation, financial system and institutional structure and capacity. Specific attention was given to the scarce water situation in Botswana and the challenges of getting its very limited water recourses in balance with increasing demands.

General experiences on different techniques and system approaches implemented for sanitation and wastewater management was also presented during the first block of the workshop.

The second block of workshop discussed criteria and planning method for sustainable sanitation systems. In working groups participants discussed basic requirements for sanitation and how criteria could be articulated and structured as a base for planning and evaluation of different system options.

During the second day requirements and criteria as a base for planning and evaluation was developed further. The method OWP (Open Wastewater Planning) developed in Sweden was presented, and examples were given on how to use terms of requirements (e.g. sustainable criteria) as a base for planning.

In Botswana the limiting water resource situation put special demands on water efficiency. The concept of Water Saving and Recycling Sanitation (WSRS) was introduced as an overall concept to get water supply and sanitation in Botswana in harmony with the limiting water recourses. The potentials to get different technical systems (such as traditional mixed gravity wastewater vs source separating on site system) in line with the challenge of limiting water resources were discussed.

During the last block of the workshop barriers and possibilities for developing WSRS in Botswana was discussed. It was concluded that even though there are many barriers and difficulties to overcome, a change towards WSRS is urgent. Motives for WSRS are found both from an environmental and recourse conservation perspective and from an investment or growth perspective. In the latter perspective there are potentials of developing new technologies for a commercial market. The landlocked situation with scarce water recourses in combination with Botswana's high developed and stable social and economical situation enables a unique opportunity to take a national and even a global

leadership. Especially since there are many villages and cities that yet haven't implemented any heavy sanitation infrastructure, which means that the home market potential for WSRS could be favourable.

Finally it was suggested that the results from the workshop should be used for a continuing cooperation between Sweden and Botswana. It was decided to try to establish a "Partner Driven Cooperation" project with co-finance from the Botswana government and the Swedish governmental development agency, Sida. A project plan and a project group for such a co-operation were proposed.

3.2. Block 1. Openings and background presentations

3.2.1. Objectives an expectations

After the opening ceremony the Swedish Trade Council and the Swedish consultants welcomed everybody and the program and the objectives for the workshop was presented, see above in chapter 1.

All participants presented themselves and their expectations were listed according to the following:

- Want to see sustainable on-site solutions - Form a partnership for a beter solutions - Want to have ideas to develop water saving solutions - List of sustainable comprehensable solutions and Best Practicies for Botswana which can be adapted for the local area - Continue the work with Sweden? - Benchmark solutions	- Share ideas - Decrease the load on potable resources - See cost effective solutions - See an evaluation method for saving water - Discuss design regarding management and maintenance - Concern of groundwater - How to solve the problems and what is needed to be done next

3.2.2. Molepolole Sanitation and wastewater - plans and challenges. Kweneng, District Council

Molepolole Sanitation Scheme
By Seabe Mabua, chief water and waste water engineer & Marcos M Keetile, principal sewarage engineer.

Molepolole village is one of the major villages in Botswana with a population of 54 561 (CSO-2001), with an estimated 13000 households. The village has a projected average water demand **of 9 446m3/day** for 2009 according to Molepolole Sanitation Design report of September 2005 by Bergstan Africa Consulting and Development Engineers. Using the average water demand, the village is currently producing **7 557m^3/day** of Wastewater. The wastewater

production figure could be more than the projected figure. Some upcoming major developments are Botswana Housing Corporation, which is intending to build close to 500 units in the near future and Molepolole Bus Rank

The village does not have a conventional Wastewater networks and treatment plant. In July 2005, Bergstan Africa Consulting and Development Engineers was engaged by Department of Waste Management and Pollution Control to carry out Design and Tender Documentation for Molepolole Sanitation Scheme. This has been completed but the construction of the Scheme was deferred due to lack of funds. The village has two existing Waterborne Sewerage Systems as follows:

1. Prisons Sewage Works
This scheme is for Molepolole prisons and is designed to handle **50m^3/day** of Wastewater. According to Department of Water Affairs (DWA) Billing records, Molepolole Prison is having an average Water Demand of **210m^3/day**, giving a return flow of approximately **170m^3/day**. This shows that the treatment plant is already overloaded.

2. Council Sewage Works
Molepolole Sewerage ponds (works) were upgraded in 1996 to handle **345m^3/day** of wastewater. The works were design to cater for the following Government Institutions:

1. Rural Administration Centre(RAC) and Government offices including staff house near RAC.
2. Molepolole College of Education(MCE)
3. Kgari Sechele Senior Secondary School
4. Scottich Livingston Hospital (before up-grading)
5. Co-operative Stores

Currently Molepolole Sewerage Works is receiving **770m^3/day** of Wastewater as compared to the design capacity of **345m^3/day**, that is more than double its capacity. The following developments have contributed to the increase in Wastewater generation:

a) Introduction of double shift at Kgari Sechele Senior Secondary School.
b) Commissioning of New Mafenyatlala Complex.
c) Upgrading of Scottish Livingstone Hospital.
d) Increased discharge from Vacuum Tankers due to increase in the number of Commercial and Residential plots using septic tanks.

Due to lack of a conventional Sanitation scheme for Molepolole village, other services are negatively affected. These services include empting of septic tanks by Public Health Department which is not able to service septic tanks in time. Groundwater is also at high risk of being polluted by seepage from septic tank and soak ways that are not serviced in time. Any planned new development (e.g Molepolole Bus Rank) would not be connected to the current Mini-sewage works. Also some Government institutions are requesting new connections into Council Sewer. Recently Molepolole Institute of Health Sciences (IHS) requested to discharge **100m^3/day** of Wastewater, Council could not approve the connection due to overloading of the ponds. However Kweneng District Council is currently addressing the issue of over loading of ponds so as to

connect IHS. The rehabilitation Works has been awarded to Evolution Engineers (PTY) LTD at a Tender Sum of P1, 884,232.00 for duration of Six months. The Constructor has already signed the Contract Agreement and the project is at 5% physical progress. It should be noted that this is a short term measure that will only address the connection of IHS.

Proposed Molepolole Sanitation Scheme
The proposed Molepolole Sanitation Scheme is designed to be implemented on phases as follows:

Short-term Development
The scheme was designed with a design horizon 2011. This has already being overtaken by events; therefore cannot be implemented.

Medium-term Development
The scheme was designed with a design horizon 2021. This is the Scheme that can be implemented as a short term measure because development in Molepolole are already on the medium term phase, example upgrading of IHS and Scottish Livingstone Hospital, Development of the Molepolole Bus Rank. There is also an urgent need to connect all the Community Junior Secondary schools to the scheme

Long-term Development
The scheme was designed with a design horizon 2031. This phase can be implemented at a later stage.

Conclusions Molepolole
Molepolole Village being the largest village needs a conventional Sewerage system which is complete with sewer net works that will cover the whole village. At present the village is producing an estimates wastewater quantity of **7800m^3/day**. Designs for this type of sanitation project have been completed in 2008 but construction was not done due to lack of funds. Construction of a conventional Sanitation Scheme for Molepolole village has to be given priority.

Discussions
A main argument for the waterborne system is that existing onsite systems course risk for contaminate groundwater: - but has such contamination been proven and if so, does it jeopardize the potable water?
Answer: there are local ground "shelled" aquifers in the groundwater sealed on impermeable layer of shield clay. Some household with private wells use such aquifers. The central supply system uses a deep aquifer outside the settled area.

Has other options beside the waterborne system been investigated?
Answer: No

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3.2.3. National framework and policy for Wastewater and Sanitation- Overview and challenges, DWPC, Mr E Banda

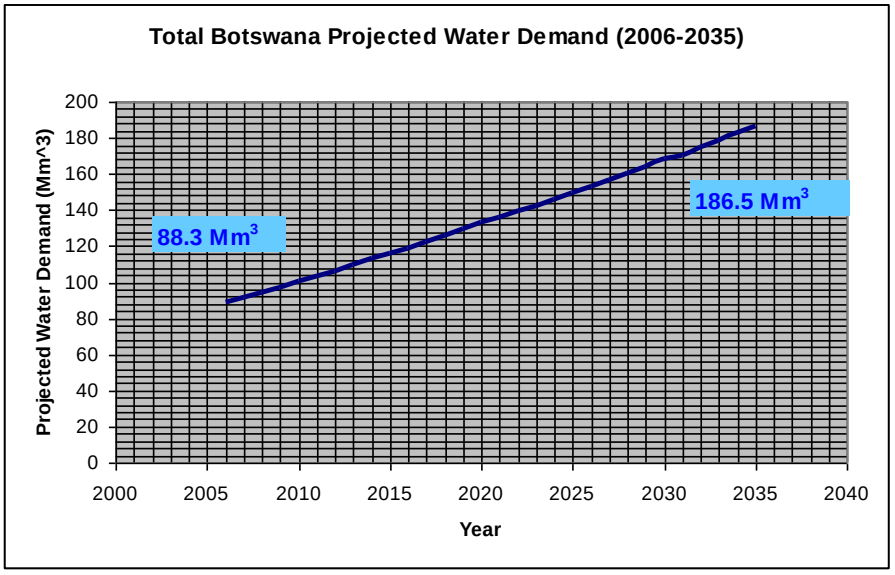
Mr Banda started of his presentation by going through the definitions stated in the official documents and policies.

Wastewater is polluted water discharged to a public sewer system from various premises in a community i.e. houses, shops, offices, hospitals & industries

Sanitation: facilities or actions aimed at improving public health, including, in particular the proper disposal of human body wastes e.g. pit latrines in low income areas.

The goal of treatment is to reduce or remove organic matter, solids, nutrients, disease causing organisms and other pollutants from wastewater

Background to the situation today
Rapid economic growth through the mining of diamonds coupled with good economic policies by government over 40 years have led to the rapid urbanization resulting in the increase in demand for water and sanitation services. However, since Botswana is a water scarce country, it would appear that priority was given to the provision of water supply provision of adequate



wastewater and sanitation services lagged behind. Except for a few towns and centres, the rest of the country depends on on-site sanitation (pit latrines, septic tanks) as form of treatment of the sewage. Pit latrines were sited and constructed without due regard to the vulnerability of groundwater which is the major source of water for Botswana. The government introduced the National On Site Sanitation Programme (NOSSP) and the Policy for Wastewater and Sanitation Management.

According to the 2001 census and by WHO definition of adequate sanitation, Botswana had an overall 77% of the household with access to adequate sanitation. In 2007 – 2008 DWMPC conducted a survey in the districts Kgatleng (90%), Kweneng (81%), South East (95%) and Southern (83%). There are currently 65 wastewater treatment facilities in Botswana. The bulk of these treatment facilities are ponds (70%).

The treatment technologies used in Botswana so far are sewage ponds, activated sludge, trickling filters, rotating biological contactors, the petro system and wetlands. The collecting systems used in Botswana are so far gravity systems, vacuum systems and small bore systems.

Operational requirements on treatment facilities are in a short form what each wastewater facility must fulfil. They must:

- have a permit listing the allowable levels of:
  - BOD5
  - Suspended solids, coliform bacteria and other pollutants(Metals, nutrients)
- meet discharge requirement into the environment (BOS93:2004)
- have trained and experienced staff
- have a maintenance plan
- appropriate equipment
- convey wastewater to a treatment facility without any spillage into the environment
- be easy to maintain
- have maps for existing and future sewer lines, manholes, sewage pump stations indicating their locations.

Challenges today

- Inadequate operations and maintenance of wastewater treatment facilities is leading to unsatisfactory effluent standards
- No measurement of inflow and outflow of wastewater from treatment facilities
- Industries are not monitored through Trade Effluent Agreement by the Local Authorities
- Treatment facilities are not licensed
- Sludge is not monitored
- Reuse of waste water is not monitored
- Lack of awareness campaigns on waste water

Policies and tools for management of waste water and sanitation

- Botswana's Policy for Wastewater and sanitation management
- National Master Plan for Wastewater and Sanitation

  Purpose: 'evaluate the current scenario on wastewater generation and disposal, on site sanitation facilities and their impact on the environment, and to develop planning and implementation strategies for regulating the generation, collection and disposal of wastewater in an environmentally friendly and acceptable manner'

- Wastewater and Sanitation Management Bill (2003)
- Planning and Design Manual(part of the Master plan for wastewater and sanitation)

The "Policy for Wastewater and Sanitation Management" has the overall purpose:

- to promote the health and well being of the people of Botswana through the provision of appropriate and sustainable wastewater/sanitation management and to introduce mechanisms for the protection and conservation of water resources.

- to foster a proper enabling environment through institutional and organizational rationalization
- to develop the appropriate legislative and regulatory framework on wastewater/sanitation issues
- to introduce development planning concepts in the wastewater/sanitation sector at national and local levels
- to involve Local Authorities, communities and users in the planning and management of wastewater /sanitation systems
- to promote and develop appropriate, affordable and sustainable wastewater/sanitation systems in both urban and rural contexts
- to introduce effective and sustainable operation and maintenance of wastewater/sanitation systems
- to establish basic principles and guidelines for pricing and cost recovery for wastewater/sanitation facilities
- to determine a framework for the prevention of pollution of the environment by the establishment of national effluent discharge quality standards
- to establish a framework for the control of industrial effluent pollution based upon the "Polluter Pays Principle"
- to conserve the country's natural resources by encouraging the utilization of treated wastewater
- to highlight the need for human resources development and capacity building
- to promote health and sanitation education/awareness campaigns
- to encourage and facilitate private sector participation in the sector

Way forward for the DWMPC

- In the absence of a Waste Water & Sanitation management Bill the use of the Waste Management Act 1998 needs to be considered
- Local Authorities (LA) need to submit monthly/quarterly report about the performance of Waste Water Treatment Works (WWTW) and the sewer systems
- Quality monitoring of effluent needs to continue for as long as LA do not have the capacity to do so themselves
- Public awareness campaigns especially with the LA on management of Waste Water and the sewer system
- Conduct inspections of WWTW by DWMPC
- Develop guidelines for management of WWTW and sewer system
- Develop guidelines for reuse of treated effluent to augment the demand for potable water
- Monitor the quantities of treated effluent available for reuse
- Consider use of GIS to manage the sewer systems (maintenance and new connections)

Discussions

What are the reasons making maintenance so difficult?

Answer: The government provide with water supply but the waste water is very much lagged behind. The investments are paid by the government but not the maintenance costs. It's important to establish a better system for pricing where the polluters pay maintenance and operational costs and where the capital costs can be recovered.

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3.2.4. Water management challenges in Botswana, Mr G. Thabeng, Dep Water Affairs

PRESENTATION on Botswana's Water Resources focus Sanitation
George Thabeng, Principal Hydrological Engineer I, Department of Water Affairs

The average rainfall is about 450 mm/year. Temperatures range from below zero in winter in the south and can be greater than 40 degrees in the summer. The topography is very flat with low rates of surface runoff and deep (< 250 m) overburden. The recharge of the groundwater range from 40 mm in some small areas in the Chobe District in the north down to zero mm over most of the Kalahari region.

Botswana is a landlocked country with a severe scarcity of water. Groundwater is the major source of water supply in Botswana, serving in average 80% of the population. As can be seen in the table below almost half of all demand comes from the people and their settlements. In the forecast for 2020 it reaches half of the demand.

Botswana is a landlocked country with a severe scarcity of water.

Table 1.1 Forecast Water demands

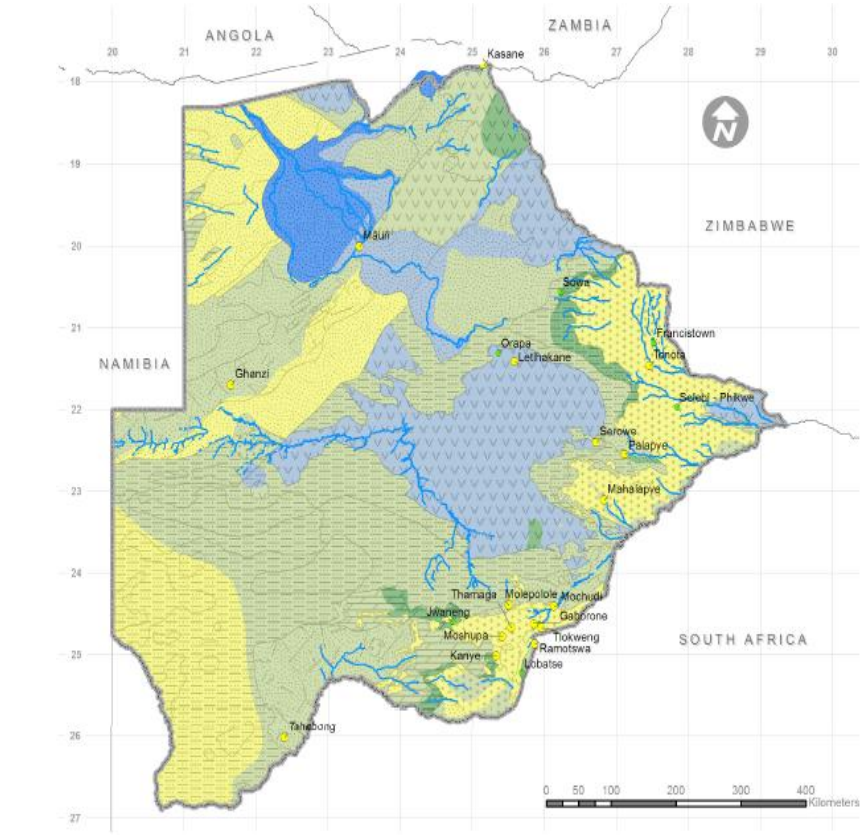
Demand category	Estimated demands ($10^6 m^3/a$) in the year		
	1990	2000	2020
Settlements	34	69	168
Mining and energy	23	33	59
Livestock	35	45	45
Irrigation and forestry	19	29	46
Wildlife	6	6	6
TOTAL	117	182	324

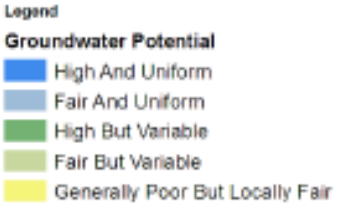
There are more than 25 000 boreholes in the country of which the government of Botswana owns 10 000. **The average groundwater recharge is about 1 mm/year**. Therefore groundwater abstraction has an element of mining. Abstraction from well fields generally exceeds the annual recharge rate and all major well fields have increasing demand trends.

The catchment area for the water demand

According to DWMPC the average estimation of water use for a consumer with water supplied indoors is 165 litres per day. For a year this means 60 m3. The catchment area with a recharge of 10 mm to supply the consumer with 60 m3 becomes 0.6 hectares or 6 000 m2 per individual (60 m3/10 mm = 0.6 ha). For all 55 000 inhabitants of Molepolole the water catchment area becomes 33 000 ha or 330 km²! To be kept in mind is that it could be as low as 1 mm recharge rate instead of as above counted on 10 mm.

For all 55 000 inhabitants of Molepolole the water catchment area becomes more than 330 km²!





Challenges in Water Resources Management

- Flat topography making development of surface water resources less favourable with high costs of development of surface water resources and high operation and maintenance costs
- High evaporation rates well in excess of 2 metres per year

- Rampant pollution of both surface and groundwater resources
- Minimal recharge rates of groundwater which aggravate groundwater mining which in turn has high costs of drilling as freshwater aquifers are often deep > 300m in the Kalahari Desert
- Desalinated groundwater in some areas
- Lack of skilled manpower in the fields of modelling, groundwater investigations, geographic information systems etc
- Lack of modern data collection platforms
- The advent of climate change

***Discussion**s:*
The lack of renewable water seems scary. Are there calculations on how long the groundwater recourses in BW will last?
Answer: Well, there are possibilities to calculate. Groundwater has already been exploited in many areas. In some sites ground water level is lowered many decimetres per year. Problems with bad water quality (e.g. salinity) increase with deep extracting. New ground water must on some sites be searched very deep (> 400 m) and that is very costly.

Is it possible to get sanitation in balance with water recourses?
Answer/comments: Yes it is (must be) possible. Maybe water technologies for rainwater harvesting must be developed.

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3.2.5. Botswana experience of vacuum sanitation systems – Mr Rob Mc Lagean

Mr Rob McLaggan presented an interesting slide show on the reasons behind the use of vacuum sewer systems and what experiences there are around the world, in Africa and in Botswana. The main reasons for vacuum sewers are to:

1. Save water
   The system can operate on very low volumes, no flush tanks required for new urban / village development. Water can be saved by using appropriate systems in houses and buildings
2. Save power
   As there is a need for much fewer pumping stations to transport the water to the sewerage plant compared to a gravity system (in a flat landscape)
3. Well suited for flat and/or rocky terrain
4. Well suited for low densitity populations
5. Hygenic sealed system
   Too many gravity systems eventually leak or block due to sedimentation
6. Easier construction
   Easy excavation with shallow trenches and 50 % construction time
7. Easy to find leaks
   Much easier than for gravity systems
8. Flexible development
   The system can be built and expanded in modules over time

Vacuum trials in Botswana
Vacuum collection systems have been tried in several locations in Botswana:

Shoshong
Now in 7th year of operation. Many leaks during initial testing due to 'more haste less speed' by contractor. Flood damage to pipes & initial vandalism

Jwaneng
Very slow contractor, with careless plant operators who broke pipes, repeatedly. Collection chamber placement not accurate on plots. A number too shallow

BDF Phikwe
No supervision of contractor on site. Poor standard of work as a result. Contractor ran out of money & did not pay bills / wages

Goodhope
Too much haste – as a result too much of 'fixing' mistakes. Attempted short cuts to save money. Poor communication with contractor foremen – very stubborn. Lack of supervision.

More details regarding experiences and technical details can be seen in the attached print outs of the presentation.

Discussions:
You conclude that vacuum has many advantages compared to traditional gravity, but nevertheless there have been many problems in the installations done?
Answer: The problems are mainly with the contractors such as mistakes and careless construction but also lack of maintenance.

You conclude that gravity system is more costly to construct and that blockages are common (due to lack of water). Why are still waterborne systems primary options in BW?
Answer: Good question. The consultants and the contractors are probably more used with these kinds of systems. There is also more money for them to earn in designing and building gravity compared to vacuum.

Does vacuum really work?
Answer Yes it works very well, but like all mechanic systems it needs to be properly installed and maintained. A good thing is that a blockage (e.g. due to misuse) occurs in the first valve chamber. That means that the consequences of a non working drain and the work of unblocking will only affect the responsible household. The rest of the system will continue to work and it's easy to find who to pay.

Are there fabricates besides Roediger in Germany that you can recommend?
Answer: We have investigated markets in USA and Australia but found Roediger best so far.

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3.2.6. The system approach to wastewater handling and sanitation, Dr R. Hranova, University of Botswana

Dr Hranova presented important perspectives on how to approach different solutions to waste water handling and sanitation systems.

- Objectives of a sanitation system
  - To collect, convey, treat and dispose/reuse the wastewater in order to protect public an environmental health
- Sustainable solutions
  - Environmental sustainability – environmental protection
    - Energy consumption
  - Technical viability and soundness
  - Public awareness and social acceptability
  - Economic sustainability
    - Cost effectiveness
    - Cost recovery

To systemise the different options she strucured them into centralised systems and de-centralised (on-site) systems.

- Centralized systems
  - Wastewater is collected by one bulk sewer system and treated in one or several wastewater treatment plants.
  - Large volume of effluent
  - Classical approach – main goal is the discharge of effluent in natural water bodies
  - Operation/maintenance / effluent control by a central authority
- Decentralized systems
  - Large number of small wastewater systems
  - Small volume of effluent
  - Possibility for flow segregation – gray water, black water, urine separation
  - New approach – main goal is the reuse of treated effluent
  - Operation/maintenance / effluent control by the owner
  - Levels of decentralization
    - On-site level
    - Neighborhood level
    - Suburb level
- Mixed pattern systems

Dr Hranova also showed what constraints there are to different solutions, which is important to analyse for every independent project:

- Existing water supply structures
  - stand pipes, yard connections, indoors water supply
- Urban development plans
  - Population growth
  - Other infrastructure development – sizes of plots, water mains, power, roads/streets

- Environmental and public health regulations
  - Water quality requirements for discharge into natural water bodies or different reuse alternatives
- Geological and climate conditions
  - Types of soils
  - Ground water tables
  - Rainfall and evaporation/evapotranspiration data

She further stressed the importance to make a proper waste water and sanitation analyse already in the planning process. In that way the most appropriate solution will be found for every case.

- Choice of best alternative
  - Assessments and alternatives development
  - Optimal solutions - optimization criteria
  - Economic analysis
  - Social acceptability

***Discussion**s:*
What are the priorities and demands of the people?
People are not prepared to pay for sanitation services. They necessary don't demand water borne systems and they don't think pit latrines are too bad.

What do you think about the plans for Molepolole?
I am not sure if it's a good idea to bring standpipes indoors. If the pipes are in the yard the water consumption will be kept down and sanitation and wastewater can be handled quite simple on site. Pit latrines are not a problem if groundwater table is more than 5 m. It is very difficult to make a pipe system to work in this kind of unplanned and scattered settlement. With no streets the pipe system will be a mess!

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3.2.7. EIA and wastewater systems- Mr M. Ntana, Department of Environmental Affairs

Mr Ntana went through how the EIA act is making an impact on the planning and construction of waste water and sanitation solutions. He went through the following topics:

- Development of EIA Legislation
- The EIA Process in Botswana
- Challenges of the EIA Process in Botswana

For more details check the print out of the slide show among the appendices.

***Discussion**s:*
Legislation demand for protection and conservation but still these aspects are not influencing planning enough. It's necessary to find mechanisms on how to get EIAs to be a ruling prerequisite on decisions.

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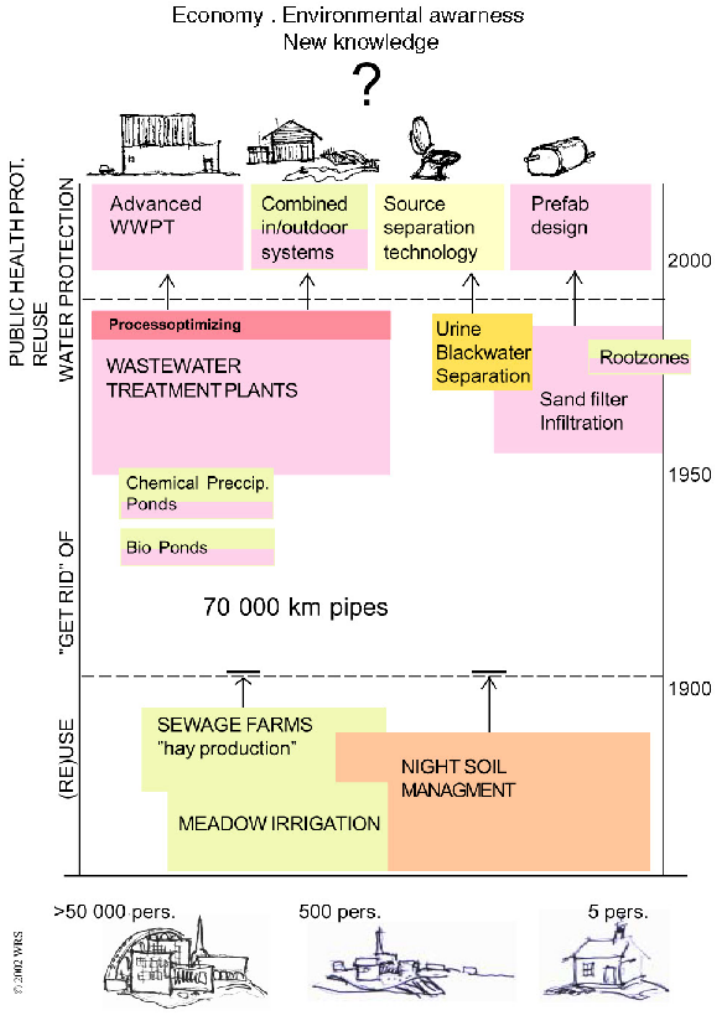
3.2.8. Swedish experiences of wastewater and sanitation systems. Mr Peter Ridderstolpe, WRS, Sweden

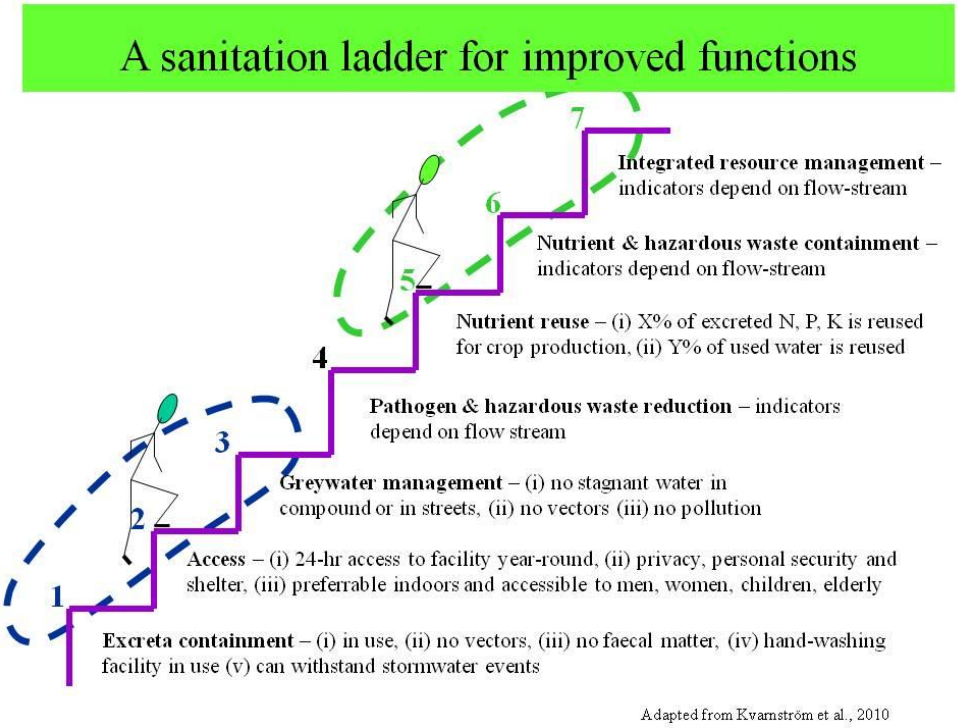
Mr Peter Ridderstolpe presented some relevant Swedish experiences of having constructed water born centralised sewerage systems for almost 90 % of the Swedish population. The bottom line of the presentation was to say that even though Sweden really has vast amount of fresh water and good technologies the experiences from all these years are that these extensive systems creates problems for the society regarding non-recycling of nutrients and environmental problems in recipients.



There are still existing risks for the spreading of deceases, multi resistant microorganisms and still active pharmacephticals. The systems urge a lot of water to work properly. Constructing and maintaining costs increases, as systems expands and become elder. These are reasons why Sweden is interested in no- mix sanitation options such as urine diversion and black water systems.

The Swedish Sanitation and sewerage history summary and discussion
Before second world war:
"Recycling" systems (organised by the agricultural sector)

After second world war until now:
"Get rid of inconvenient dirt" … and recipient protection" (a giant monopoly of Water and Wastewater sector was created, conserving and blocking more economic and sound options)



In Future?

- We will keep on with waterborne systems and centralised WWTW but other, more sustainable systems will also develop.
- When retrofitting and constructing new systems, we will use functional criteria. All primary functions put in focus.
- More co-operation with the agricultural sector.

3.3. Block 2. Criteria and techniques for creating sustainable sanitation and wastewater

Criteria/requirements for sanitation systems - Group work

The Group work was organised into 3 groups. Every group had the same questions to discuss and work through:

- Specify the criteria/requirement for the sanitation system in Molepolole
  - Public functions
  - Practical considerations

- Try to quantify the criteria/requirement for Molepolole (by words or figures)

All of the three groups answered differently but complimentary. Both in the contents and in the format.

Group 1

PUBLIC REQUIREMENTS	II PRACTICAL CONSIDERATIONS
1. Public health	**Cost effectiveness**
2. Environmental protection	**Easiness of operation/maintenance**
2.1 Surface/ground water	**Legislation, regulation documents – public health & environment**
2.2 Soils 2.3 Air	3.1 Public health 3.2 Environment 3.3 Reuse of water and by-products
3. Social acceptability	
3.1 User friendly	**Preferred water reuse alternatives**
3.2 Cultural mind set 3.3 Odourless 3.4 Aesthetics	4.1 Agricultural, landscape irrigation 4.2 Sludge reuse 4.3 Biogas
4. Resource effectiveness	**Water supply – saving water appliances**
4.1 Saving water	**Building control**
4.2 Saving Energy 4.3 Using by-products	
5. Affordability	

Group 2

BENEFITS TO THE PUBLIC	PRACTICAL CONSIDERATIONS
Health • Compliance with BOS 93:2004 • Prevents waterborne diseases • Hygienic • Sludge treatment facility (odour free) **Recyclable** products • Utilization of sludge for soil treatment • Effluent utilisation **Health** education • Hygiene education • Social acceptability och re-use/recycling **Affordability** • Low capital investment • Cost of sanitation embedded into water consumption bill	**Affordability** - A system with minimal O & M - Low capital investment - Combine both gravity and vacuum for WC measures - Treat to tertiary level **Self monitoring system** - Packaged to be able to monitor its performance **Conservation oriented** - Conserve resources **Fully utilize by products**

Group 3

Protect public health • No bacteria spread • Vectors unable to compromise the system **Social acceptance** • No unnecessarily exposure of excreta **Affordability** • 4% of annual income • should be customized case by case (or place to place) **Water efficiency** • 50 litres per person per day • In balance with water supply **Recyclable effluents** • Should be utilizable for gardens and agriculture • 60% recycling of grey water • 60% recycling of black water	**Cost effective sanitation system** • Shouldn´t cost more than 10 000 per person **Robust** • able to cope with Botswana electricity supply problems **Flexible in development** • able to adapt to the future growth or decline of a population **Acceptable public amenities for guaranteed utilisation** **No noise, odour and spillage** • treatment centres should be located so that neighbouring areas are not adversely effected

Conclusions of the group work

The conclusions of the group work was that there is a need to go much deeper and accurately into these questions and to form a group of knowledgable and experienced people that can create workable and defined criteria or requirements for the waste water and sanitation systems.

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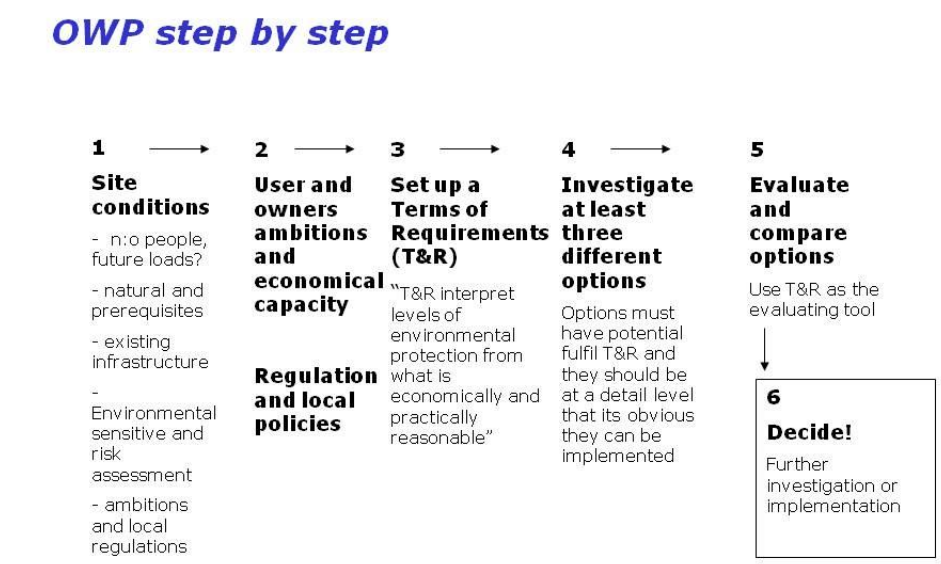
3.3.1. The Open Wastewater Planning (OWP) method Mr Peter Ridderstolpe, WRS, Sweden

Mr Ridderstolpe went through the purpose and objectives for the Open Wastewater Planning method (OWP).



How to find the right Sanitation and Wastewater treatment solution? Arbanassi, Bulgaria, Peter Ridderstolpe WRS AB, 2006

Basically it's a method that is technology neutral when it comes to find a waste water and sanitation solution for an area. In every project the stakeholders need to set up and decide what sort of criteria/requirements that must be in place for the solution, as just have been done in the group work.

Different options for the whole system and parts of the system are then evalutated against these criteria/requirements (which then must be technology neutral).

For more details on the method see the attached print out of the slide show.

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3.3.2. Water Saving Recycling Sanitation (WSRS) Mr Peter Ridderstolpe, WRS, Sweden

For water born systems and for alternative systems (e.g. source separating systems)

Mr Ridderstolpe did a presentation with the following objectives:

- Comprehensive overview of system options considerable in Botswana with a focus on Molepolole. (The overview is not complete, but could be further complemented within a further cooperation)
- Exemplify different technology solutions
- Show and discuss potentials for water saving and water and nutrient reuse.

The comprehensive overview of system options was structured as followed:

A. Waterborne systems (toilet waste and greywater mixed)

1. On site waterborne system
2. Centralized waterborne system
3. Semi- centralized waterborne system (Cluster systems)

B Alternative system (source separating systems)

1. *Onsite outdoor* source separating systems
2. *Onsite indoor* source separating systems
3. Cluster systems

Mr Ridderstolpe went through the following system options and some of them were more discussed than others. The discussion was done in connection to the criteria/requirements from the group work. More detailed information and pictures for the different options below can be seen in the attached print-out of the presentation.

A. Mixed black- and grey- waterborne systems

1. On site mixed waterborne system

A.1.1. Septic tank +soak away (commonly used today)
A.1.2. Septic tank + irrigation (and soak away)
A.1.3. Compact treatment plant- prefabricated + irrigation

2. Centralized mixed waterborne system

A.2.2. Gravity system + bioponds (Molepolole)
A.2.3. Gravity system activated sludge + ponds + irrigation (Gaborone)
A.2.4 Gravity system Trickling filter + irrigation

A.3. Vacuum conveying systems (such as in Shoshong etc)
Water efficient compared to above as the pipes don´t need water to transport the waste to the treatment plants.

B **Alternative systems (source separating systems)**

1. *Onsite outdoor* source separating systems

B.1.1 Pit latrine
B.1.2. VIP
B.1.3. Single Vault (Burkina Faso concept)
B.1.4 Double Vault (Durban Concept)
B.1.5 EnviroLoo
B.1.6. Hybrid Toilet

2. *Onsite indoor* source separating systems

B.2.1 Urine diverting dry toilets
B.2.2 Vacuum toilets
B.2.2 Urine diverting flushing toilets

Greywater Management

Is often neglected but could become a big problem. There are many different options, which would need special attention in a further cooperation. Mr Ridderstolpe just showed some short experiences of resource efficient options.

Discussions

Options were discussed in connection to the criteria/requirements from the group work.

A big discussion araised regarding the affordability of a centralised gravity system. For the user it is of course very affordable as the user themselves don't have to pay directly to the investment, but only indirectly through taxes etc. But the question then is if it is an affordable and economy efficient investment for the public? The cost per household is 900 miljon Pula divided by 13 000 households = 70 000 Pula per household. The question is then if there are more efficient WSRS systems that can be built for the same amount of money or even less money? For 70 000 pula per household there are quite a few WSRS efficient systems that can be built. If these options are delivering better results according to the criteria/requirements set, it should indicate that these options are better systems for the public to pay for – even if they are built on site and not centralised. Hence, out of a cost-benefit analyses for the public, it is important to be careful in how to analyse and evaluate the criteria "affordability".

Another discussion was around the social acceptability of separating urin and feaces and the further handling of these. Many thought there is a cultural resistance to deal with this. According to Swedish experiences there is a traditional built-in resistance among humans in general, but when the benefits are realised in terms of creating possibilities for economic growth through better and more cost efficient agriculture and even in some cases energy production, the preferences are slowly changed. But this is a true barrier for these technologies to be established, which means it has to be handled with care when it comes to information and pilot cases.

It was appreciated that some criteria/requirements were more important than others. For instance the criteria of public health, where the sanitation system must prevent deseases to be spread through air, water and groundwater. The question then is how important the water saving criteria/requirement is. For an outsider considering the severe water situation for Botswana, water saving solutions should be very very high on the agenda.

3.4. Block. 3- The way forward

Group discussion on" Barriers for WSRS in Botswana and how do we overcome them? "

3.4.1. What are the main barriers?

- Political interference – political power is disturbing the process of finding an appropriate solution. The political effects of promising sewerage schemes to the people are very tempting for politicians. *(mentioned by 4 persons)*
- Lack of exposure to WSRS technology – general unawareness of WSRS technologies *(mentioned by 3 persons)*
- Water saving is not a political priority – as the severe problems are not on the public agenda
- Lack of education, public awareness and of data for the public
- Lack of incentives for individual WSRS investments and/or lack of individual investment capital *(mentioned by 3 persons)*
- No social acceptability to deal with for instance sludge and excreta *(mentioned by 4 persons)*
- The general un-prioritized perception of sanitation systems
- Lack of responsibility and interest in the engineering/consulting industry
- Lack of infrastructure
- Fear to try something new – reluctance to change
- Approaches to physical development – the planning process lack sustainability approaches
- Poor consultations with stakeholders
- Too many institutions dealing with waste – no coordination
- Lack of human resources
- Poor maintenance of installations
- Land use planning or pattern – the villages are scattered and very difficult to manage
- Lack of land use criteria – viable data for land use
- Lack of reliable electricity

- Lack of Botswana adjusted design standards – difficult to find
- Lack of updated policies regarding e.g. building control act doesn't include WSRS aspects

3.4.2. How do we overcome the barriers?

From the barriers discussed above a lot of ideas were suggested. It was concluded that many actions are needed to be done by many different stakeholders of the society to change the mind sets of sanitation. The proposed ideas for actions can be divided in three main groups:

1. Awareness rising and education,
2. Intuitional strengthening and
3. Method and Technical improvement

1. Actions mentioned for awareness and education rising:

- A monthly column in the private newspapers on the water and groundwater status.
- Public education
- Relevant training to the professionals in the field

2. Actions mentioned for Intuitional strengthening

- Review of policies and acts
- Bringing together those institutions that are managing the water institutions
- Making land use data available to the public
- Establish a water recycling framework
- Establish the Polluters Pay Principle for maintenance, operations and enforcements

3. Actions mentioned for Method and Technical improvement

- Project development strategies where environmental and sustainable development are on the agenda from the start
- As a public servant you should be able to communicate your opinions from a professional perspective
- Find technologies that can match needs such as comfortability and acceptability
- Governmental institutions could take the lead – create showcases

3.4.3. Botswana Sweden PDC- project

In this final session of the workshop there was a group discussion on how to go forward with all the results from the workshop. It was concluded that WSRS system technologies should be given much more attention in Botswana and that the most promising way forward could be to create a partnership with Swedish partners interested in the Botswana situation. Read more about the conclusions in the chapter 4 below, "Conclusions and recommendations". A proposed way forward was outlined which can be found below in the chapter 5, "Way forward".

4. Conclusions and recommendations

As a result of the mission to Botswana and mainly the workshop, we have the following very short conclusions and recommendations:

Getting the society in balance with its limited water recourses should be an overall ruling parameter for all kinds of development in Botswana
Botswana is in a severe water situation as it is a landlocked country with little surface water and a groundwater that is defined as non-renewable. The consumption of water and the increase of the consumption in line with the economic growth seem to be on non sustainable track forward.

Botswana has extensive challenges in the planning and construction of sewerage schemes in a country that is flat, scarcely populated and very dry. Apart from Molepolole there are plans made for two other major villages: Kanye and Kasane/Kazungula Village.

Before too much is invested in heavy infrastructure there is a unique opportunity of structuring and plan for a system that saves water and uses the energy potential and agriculture goods from human waste.

Traditional centralized waterborne systems can hardly be seen as a sustainable solution in Botswana
Several stakeholders (governmental, academic and private institutions) have showed interest in finding alternative system solutions. A system which is not water born for transportation could save vast amount of water and create business opportunities and the base for a more sustainable and economically more efficient system solution. Sweden has proven technologies in these areas and even fully functioning products and services that just need to be adjusted to the local circumstances. In cooperation with Sweden both countries could be benefitting in the development of sustainable systems.

Developing alternative systems for sanitation based on water saving and recycling (WSRS), is both necessary and a big opportunity for Botswana.
There are many studies showing that centralised water borne sanitation systems need massive amounts of water (high connection rate of water consuming toilets or flush tanks) to work properly. Out of this we think it is very necessary to start the process of developing water saving systems. But it is also an opportunity for Botswana to develop systems that can be implemented in many different settlements and which could even be exported into other parts of the world with similar problems. There is a vast market potential for tried WSRS systems around the world as the water scarcity is a global problem stated in the Millennium Development Goals. Botswana could be among the first serious developers of systems working in a development and rural setting.

Separate and reuse is better than mix and dispose)
The major problems with centralised sewerage schemes experienced in countries like Sweden is that the recycling loop between food-production and human waste becomes inefficient or even lost, creating needs for importing excess amount of fertilisers, lots of energy to treat the waste water, overload of nutrients in the recipients, which all together in turn creates environmental and economic problems for individuals and the public. The mixing of greywater and black water creates a mix which is increasingly difficult to treat along with

increased consumption of pharmaceutics and chemicals in a society with an economic growth and increasing individual income. The early separation of human waste and waste water into a working system for the sustainable handling of the waste is proven to be a very promising method to succeed with reuse and recycling.

Centralised vacuum - or decentralised onsite – systems are often better
A sanitation system for a village can either be planned as a centralised system or planned for a decentralised system with on-site solutions. What is most appropriate is depending on the particular setting.

The good side of a centralised gravity system is that it uses very low-tech technology for the disposure and transport of the waste. In addition if the system is in a slope-high-density-village they need almost no input of energy. It seems though as Botswana has few "slope-high-density-villages". Instead the most villages are low density flat villages. In those circumstances a centralised vacuum system seem to be more appropriate among the centralised options. It is even a Botswana proven technology that really could be considered to be standard in Botswana for centralised systems. We though think it could be worth considering trying systems where there are even vacuum *toilets* in the system. It would save some 70-90 % more of water resources as every flush is reduced from 8-10 litres to 0.5 - 1 litres. The vacuum toilets are as convenient and fresh as water toilets and have been installed in several modern, official and luxurious buildings around the world the last years.

We also think that non-centralised options must always be considered as part of a public investment. The presentation made of Peter Ridderstolpe gives an overview of considerable options relevant for Botswana. During discussions it was concluded that these options have a potential to keep a low consumption/waste of both water and costs in construction and operations as well as securing a public health and the recycling of nutrients and energy. The traditional gravity systems have very big difficulties in competing in these perspectives.

OWP facility helps to find the appropriate solution
The planned sewerage scheme in Molepolole has been estimated to be a project worth 900 million Pula in construction costs, which is about 70 000 Pula per household. There are quite a lot of on-site options that can be done with that amount of money. As mentioned above about onsite systems in general, we think onsite systems in Molepolole have the capacity to get a better harmony in the use of recources, both in terms of monitary costs and in terms of costs for the environment and use (and recycling) of natural recourses.

The preliminary assessment on different sanitation options for Molepolole (according the OWP method) indicated that there are several onsite solutions available on the market that suits sustainable criteria better than the planned centralised gravity system. Among these systems found are separating systems such as single vault or double vault dry closet systems (with or without urine diversion), closet water separating systems based on vacuum flushing, or mixed wastewater systems based on resorption of septic tank effluents. Several

innovative solutions (such as he mulch bed resorption systems) was identified as very interesting options that could be developed to the Botswana market.

Open Waste Water Planning is a simple and parctical method that facilate the finding of an appropriate sanitation solution in both a master planning situation and in a situation where solutions must be found for constructing. The OWP force the planner or land developer to take environmental aspects into consideration as well as practical and economical aspects. Thus EIA will be a ruling parameter for planning instead of a formal and uninteresting appendix in the end of the planning, after all decisions are made. The OWP is a tool that makes it easier to evaluate the most sustainable and cost effective sanitation system for a set location. Therefore we recommend the use of OWP as a tool for all sanitation planning in Botswana.

The Start up of a PDC to develope WSRS for the Botswana market

All findings above though needs to be analysed and assessed in a deeper and practical way as the workshop discussions only touched upon the issues that needs to be further studied. It was concluded that WSRS system technologies should be given much more attention in Botswana and that the most promising way forward could be to create a partnership with Swedish partners interested in the Botswana situation. Sweden has a long tradition and many experiences in planning, organising and maintaining sanitation systems. Long experience of using centralised water born system has tought the Swedes how to make these systems more efficient but also to understand their backlogs. Therefore Sweden is also in the frontline in using new methods for system impact assessments and tecnologies based on source separating and onsite treatment of waste water. All this know-how could be of value for Botswana in a PDC work. For Sweden a PDC with Botswana could stimulate the research and development of sustainable sanitation for an African setting, which could improve the existing sanitation system concepts to become even more sustainable. Both countries thus seem to have a mutual interest in developing environmmentally smart technologies and know how for a commercial global market and to contribute to the Millenium Development Goals of the world.

5. Way forward

In line with the conclusions and recommendations mentioned above the last session of the workshop worked out the following action plan:

Objective: *To increase WSRS in Botswana through its integration into Integrated Water Resource Management (IWRM) planning framework with Molepolole as a pilot in cooperation with Swedish interested partners.*

Work plan:

1. Meeting at the Department of Waste Management and Pollution Control
    a. Dr Hranova (UB) and Mr. Keetile (Kweneng District Council) with assistance from Mr Sten Stenbeck meet with Mr Banda and Ms Serumola at the Department of Waste Management and Pollution Control (DWMPC)
    b. *Output:* The formation of a task force for a partnership with Sweden on WSRS

2. The task force decided above gets in touch with potential Swedish partners with assistance from Mr Peter Ridderstolpe
    a. Express the interests from Botswana and listen to the interests from Sweden
    b. Output: A work plan for further cooperation.

3. The Botswana task force and the Swedish equivalent jointly apply for a Sida Planning Grant to get resources for facilitating a jointly interesting cooperation.

4. Form a jointly interesting cooperation
    Out of the resources that might come out of the Sida Planning Grant, the task forces create a jointly interesting cooperation which initially has the chance of getting support from Swedish Sida and the Botswana government through the co-finance program "Partner Driven Cooperation":

    Potential members of a cooperation team regarding WSRS in IWRM in Molepolole could be representatives from:
    1) Kweneng District Council
    2) Department of Waste Management and Pollution Control
    3) University of Botswana – Drs Hranova and Odirile
    4) Water Utilities Corporation
    5) Department of Environmental Affairs
    6) Ministry of Local Government technical services
    7) Department of Water Affairs
    8) Consultants from the sector

6. List of appendices

1. Workshop program
2. Participant list workshop

PowerPoint presentations:

3. Mr Keetile, *Molepolole Sanitation and wastewater - plans and challenges*
4. Mr Banda, *National framework and policy for Wastewater and Sanitation*
5. Mr Thabeng, *Water management challenges in Botswana*
6. Mr McLagean, *Botswana experience of vacuum sanitation systems*
7. Dr Hranova, *The system approach to wastewater handling and sanitation*
8. Mr Ntana, *EIA and wastewater systems*
9. Mr Odirile, *Botswana Experiences of sanitation systems* (absent – never presented)
10. Mr Ridderstolpe, *Swedish experiences of wastewater and sanitation systems*
11. Mr Ridderstolpe, *The Open Wastewater Planning (OWP) method*
12. Mr Ridderstolpe, *Water Saving Recycling Sanitation (WSRS)*