Integrated waste management using biogas in a decentralised Municipal framework

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Overview

- Introduction to project
- Municipal and social context
- System process
- System details
- Benefits
- Practical challenges
- Conclusions

Context

- The country faces a range of substantial challenges:
  - Housing
  - Water
  - Energy
  - Wastewater
  - Unemployment
- New government has reorganised departments, presenting new efficiencies and opportunities, e.g.:
  - Rural development (new)
  - Energy (separate now from Minerals)
  - Environment & Water
- Delivery services to the unserviced takes up the bulk of the budget – reduced maintenance on existing infrastructure
- Local authorities are at the frontline as it relates to service delivery
- This project is an example of one Municipality trying an alternate service delivery mechanism, that addresses the challenges directly

Social context

- Cato Manor is a low-income suburb in Durban, South Africa
- The area was initially occupied by a predominantly Indian population up to the 1960's
- The notorious Group Areas Act displaced the Indians to the township of Chatsworth – the land was left idle for several decades
- In 1994, the need for housing for blacks and Indians became an issue that required urgent attention
- Many blacks from the rural areas and the Indians who were displaced during apartheid era laid claim to the land
- The city decided that both groups should be accommodated and the area was divided and low cost housing was built for both the Indian and black communities
- There was much tension initially especially when blacks tried to forcefully occupy houses that were built for the Indian community. This tension has eased considerably over the years.

Neighbourhood

Municipal context

- Cato Manor is one of five Area Based Management (ABM) precincts identified by the eThekwini Municipality (Durban) for addressing social, economic and spatial development needs and priorities
- In the formulation of an appropriate response to unemployment and the need to improve the socio-economic status of Cato Manor residents, the ABM has developed a multi-culture programme that seeks to involve community members in urban agricultural initiatives
- The programme involves a considerable amount of investment in infrastructure and programme development

Munic Context contd.

- The eThekwini Municipality through their Cato Manor ABM Branch is currently developing this site to accommodate aquaculture, poultry farming, mushroom farming, organic fruit and vegetable farming initiatives, etc
- Through various innovative techniques, the agricultural systems are being developed with a view to achieve maximum benefits from each site
- The Cato Manor project has been established as a registered Co-operative, with community members being members of the Co-op
- The investment in the facilities owned by the Co-op is being made by eThekwini Municipality

Project aim

- The objective of the project is to investigate integrated waste management with the benefit of energy production, aquaculture and food in a municipality
- This would help turn a waste disposal and treatment problem into a much needed resource within the municipal border.

The project

- The project focuses on closing ecological loops within an agricultural context
- At Cato Manor, there are 15 ha of land set aside for agricultural/food security activities - not all the land is suitable for agriculture
- There is no natural water supply and a bore hole was sunk to access water for irrigation
- The quality of the water was unsuitable as it was high in aluminum.
- Potable water for irrigation was not an option due to the cost.
- It was decided to pursue the option of installing a biogas digester.
- The initial feasibility started some three years ago when AGAMA Biogas was engaged in the project

The project – contd.

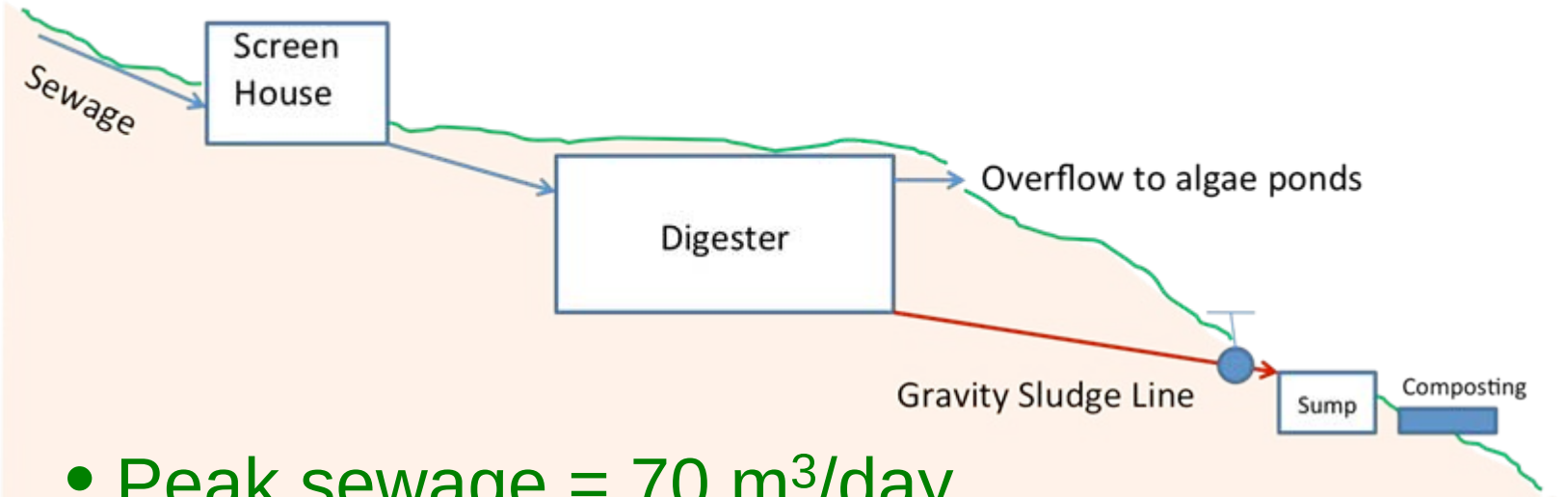
- The project involves intercepting the municipal sewer, installation of a biogas digester as first stage treatment, followed by algae raceways as a second stage treatment, followed by aquaculture ponds as a third stage treatment, with the final discharge water being used for irrigation and food production.
- The digester will process the effluent flow from a sewage line that traverses the agricultural site.
- A multicultural zero waste layout for the site will maximize the use of the site with intensive agricultural activities including aquaculture, free range poultry, gourmet mushrooms, honey, fruit and vegetables.
- The treated water from the digester will flow into a series of algae & aquaculture tanks
- After the water exits the last of the tanks, it will be pumped to a panned reservoir that has a capacity of 150,000 litres and then be gravity fed to the crops below

View of project site

Digester details

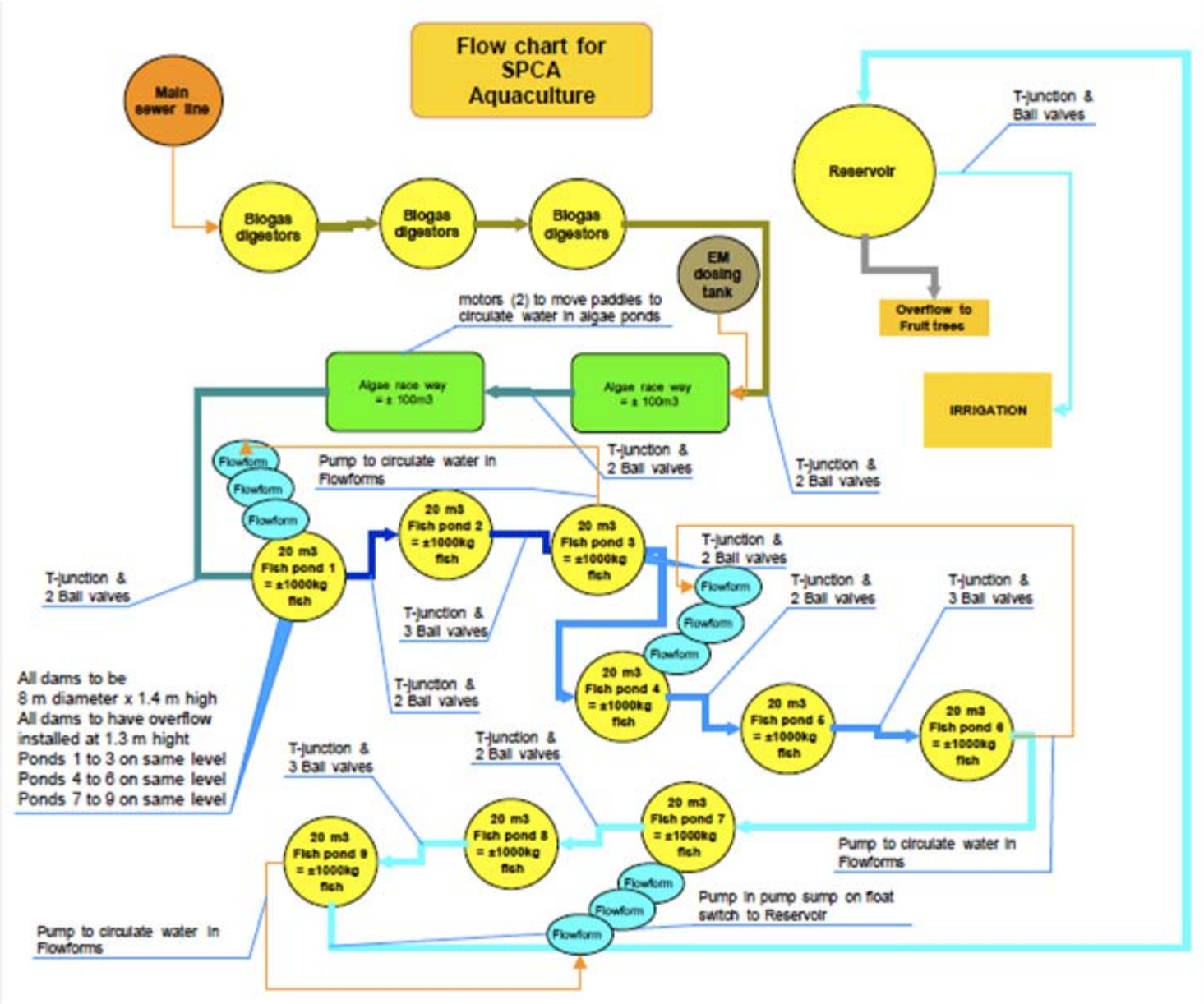
- The digester is of a hydraulic slab design and has a reactor volume of 288 m^3 with two reactor chambers
- The finished top slab is available for later utilisation for example as a community netball court
- The digester is designed to co-digest different substrates, not just the sewage
- It is anticipated that the digester will also biodegrade food wastes from the community, chicken manures from the on-site chicken production, water hyacinth from municipal waste collections and fish manures from the downstream aquaculture ponds, amongst other organic substrates
- The connection between the sewer and the biogas digester has an inlet screen separator, which ensures that no foreign non-biodegradable objects enter the digester
- The two digester chambers have sludge removal devices operating under gravity to discharge sludge periodically to a composting pit, for further nutrient addition to the food production areas

Digester schematic

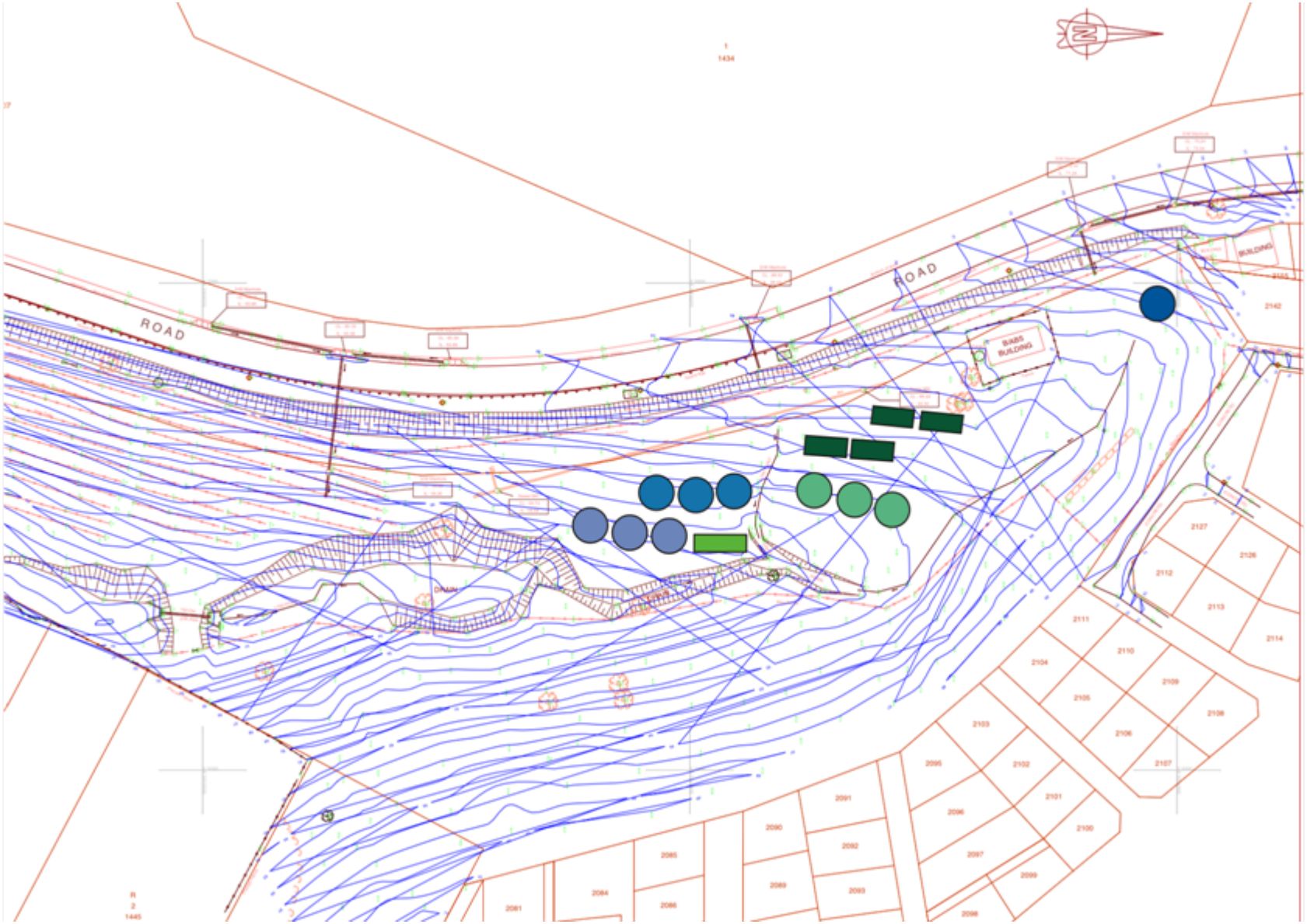


- Peak sewage = 70 m^3/day
- Digester volume = 288 m^3
- Sludge removed periodically, composted
- Supernatant flows to algae ponds

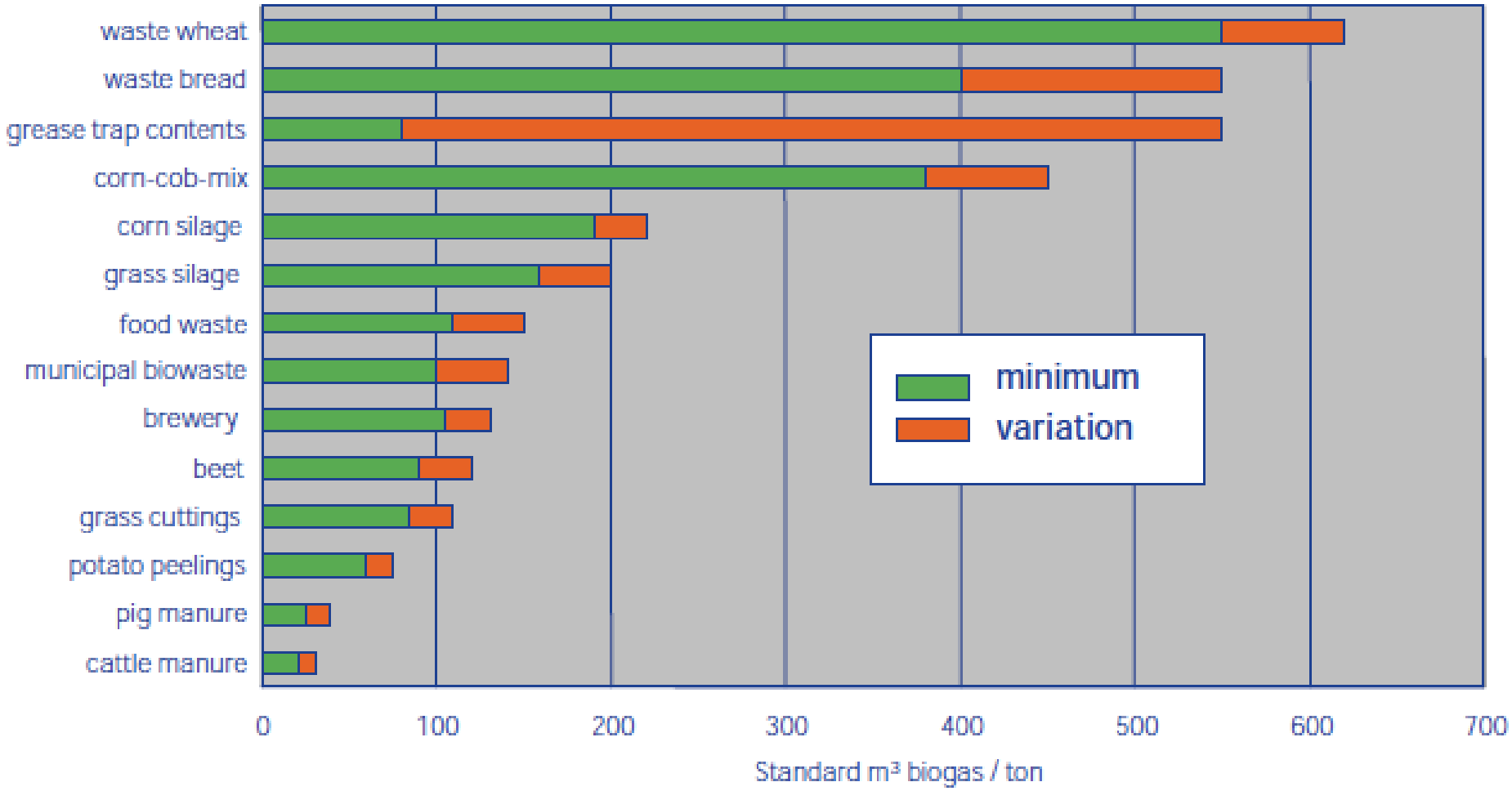
Process schematic



System layout



Gas yields


waste wheat
waste bread
grease trap contents
corn-cob-mix
corn silage
grass silage
food waste
municipal biowaste
brewery
beet
grass cuttings
potato peelings
pig manure
cattle manure
minimum
variation
0
100
200
300
400
500
600
700
Standard m³ biogas / ton

Gas details

- There is no current clear plan for the use of the biogas
- Options include direct use in the community for cooking, or electricity generation
- Decision rests on degree of utilisation of the digester

	Biogas from 200 HHs	**LPG replacement**		**Electricity**		
	m3/day	kg	HHs cooking	kW	kWh	HHs
Sewage only	6	2.6	26	0.4	10.2	1
Sewage + HH food waste	26	11.2	112	1.8	44.2	4
Sewage + HH food waste + other biodegradable wastes	326	140.2	1402	23.1	554.2	55

Aquaculture

CATO MANOR AQUACULTURE

Calculations: Supply the info required in the green blocks, and enter to see how it changes the profitability/loss:
Assumptions: Water kept at 28°C, harvest weekly, Optimal feed application.
PLEASE NOTE: the variables at this stage are: price of complete system, supply of fingerlings, electricity consumption and skill level of labour. Calculations below are for a 'state of the art' intensive system. At Cato Manor we have proposed 3 times the vollume of water, so can expect a greater return than indicated below, over time. Calculations are per site, i.e.we will have two pilot sites, Nsimbini and SPCA

Final weight of fish (g)		450	g			
Food Conversion Ratio		1.1	kg feed per kg fish produced			
Volume of system		250	m^3			
Stock per month		15000				
Price per fingerling	R	1.60	ea			
Feed fed (per day)		1.90%	of total mass in system			
Feed price (per kg)		R 4.20	kg^{-1}			
Electricity cost per month	R	2,209.68	31	24	6.6	R 0.45
			days/mo	hrs/day	kW used	R/kWh
Labour cost	R	1,500.00	p.m.			
Labour required		4				
Price of system	R	969,000.00				
Interest rate		8%				
Repayment period		10	years			
Monthly repayment (approx)	R	11,305.00				
Weight of fish in system (kg)		6412.5	450	g	4 months	
(at harvest)		3870	258	g	3 months	
		2295	153	g	2 months	
		1365	91	g	1 month	
		810	54	g	just stocked	
Price per kg (fry)	R	29.63				
Mass (max) in system		14753	kg	59.01	kg/m^3	
Cost of feed (month)		R 36,494.73				
Amount feed per month		8689	kg			
feed per day (ave)		280.3	kg			
Transport (per kg)	R	1.20				
Fish sold at:	R	18.00	/kg			

Monthly costs:		
Feed	R	36,494.73
Fingerlings	R	24,000.00
Electricity	R	2,209.68
Labour	R	6,000.00
Repayment	R	11,305.00
Transport	R	7,695.00
		R 87,704.41
Income: Monthly	**R**	**115,425.00**
Gross profit(Monthly)		**R 27,720.59**
Monthly production, kg		6412.5
Annual production,kg		76950
Size of fingerlings required, g/each		54
Annual turnover	R	1,385,100.00
Gross profit	R	332,647.03
Profit margin		24%
Production cost/kg		R 13.68

Water sump

Digester

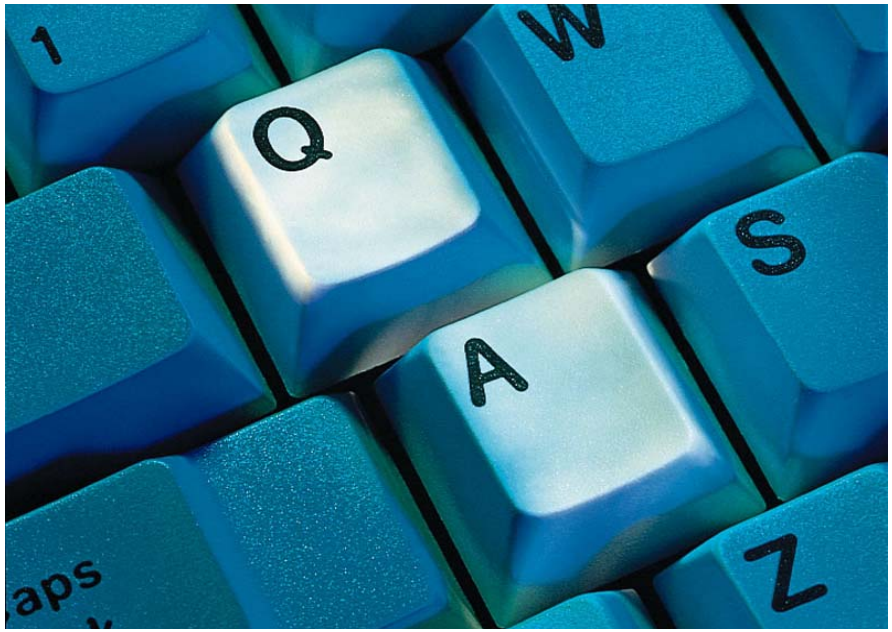
Practical challenges

- Local community politics
- Local unskilled employment
- Project champion
- Municipal capacity
- Contracting environment

Conclusions

- Practical demonstration project aimed at alternate service delivery
- Exciting project to demonstrate a closed ecological system for multiple benefits
- Practical challenges exist
- Benefits will be measured by eThekwini
- Cost-benefit and social impact analyses must be done

Thank you!



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