FSM3 3rd International Faecal Sludge Management Conference

IWA the international water association

Urine Diversion Toilet Waste Removal in eThekwini Municipality

Business Partnership Modeling

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Hanoi – Vietnam
January 2015

ETHEKWINI MUNICIPALITY

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

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PID CONSULTING ENGINEERS & PROJECT MANAGERS

Technical and Financial Support

Bill and Melinda Gates Foundation (BMGF) and UK Department for International Development (DFID)

- City Partnerships for Urban Sanitation Services Delivery
- Phase 1 Planning complete
- Phase 2 rollout starting

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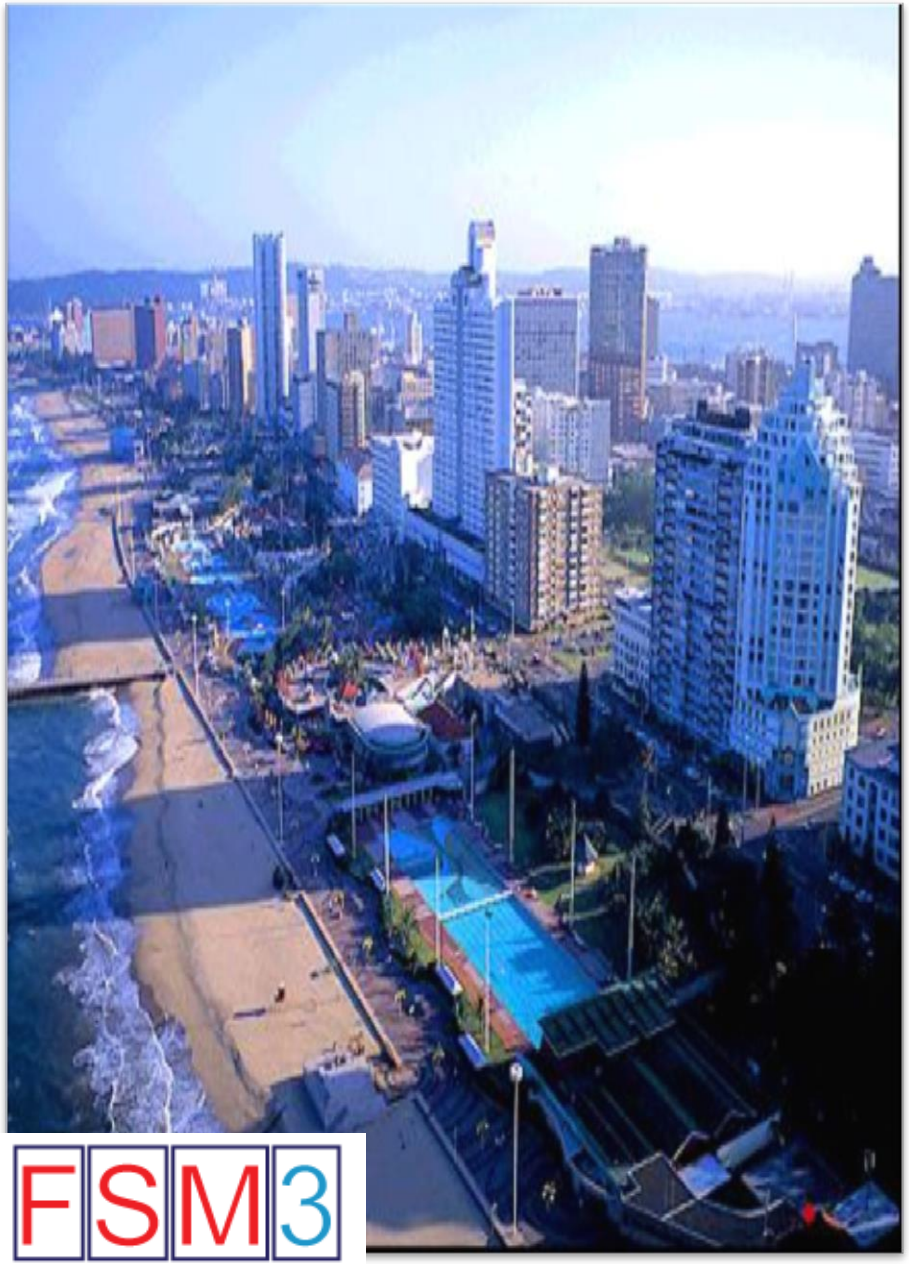

EThekwini Municipality

- Second largest industrial hub
- Fastest growing urban area
- Major tourist destination
- South Africa's major port

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The Team

- Funding from Bill and Melinda Gates Foundation and eThekwini Municipality
- eThekwini Water and Sanitation (EWS) Technical Input
- Khanyisa Projects Project Management
- Pollution Research Group (UKZN) Research Support
- Partners in Development (PID) Technical Input

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Background

Why UD Toilets in Rural and Peri-Urban Areas

- Over 80 000 UD double vault toilets installed
- Waterborne sewage is extremely costly
  - Topography
  - Low densities
- Cost of emptying conventional VIPs not sustainable
- Tankers cannot reach many areas
- Desludging difficult due to solid matter
- Manual emptying difficult due to terrain

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Background

Why UD Toilets

- Water scarcity
- Each household receives 300 litres per day of water – dictates dry sanitation
- Waste could be disposed on site safely
- New pits not required
- No need to move top structure
- When waste broken down safer to handle
- No seepage into surrounding water table

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Background

How does the UD Toilet work?

- Two vaults are used – contents of one vault dry-out while second is in operation
- Cover material (sand) is used
- Urine is diverted to soakpit
- Vault contents are buried upon removal
- Structure provided free of charge – national funding
- Households responsible for operation and maintenance

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Project
Problem Statement

- Faecal degradation and pathogens die off not as effective as envisaged
- During removal of vault contents – sludge still has a high pathogenic load
- High risks to households and environment
- Service level inconsistencies - Municipality provides free waste removal to households with VIP toilets

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EThekwini Municipality Decision

- Provide a safe and economically feasible sludge removal option to 80 000 rural houses

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Key Challenges

- Health and Environmental compliance
- Transport costs
- Identify beneficial use of faecal waste
- Meeting expectations of communities
- Identify opportunities for participation of private sector and residents
- Sustainability of local business entities

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Phase 1 – Planning Phase

- **Explore scenarios for removal of waste from UD toilets**
  - Scenario 1

    Burial on-site with tree planting using local businesses and contract incentives
  - Scenario 2

    Beneficial use through processing of faecal waste utilising business partnerships

    Identified Black Soldier Fly technology as suitable process for creating value from the waste

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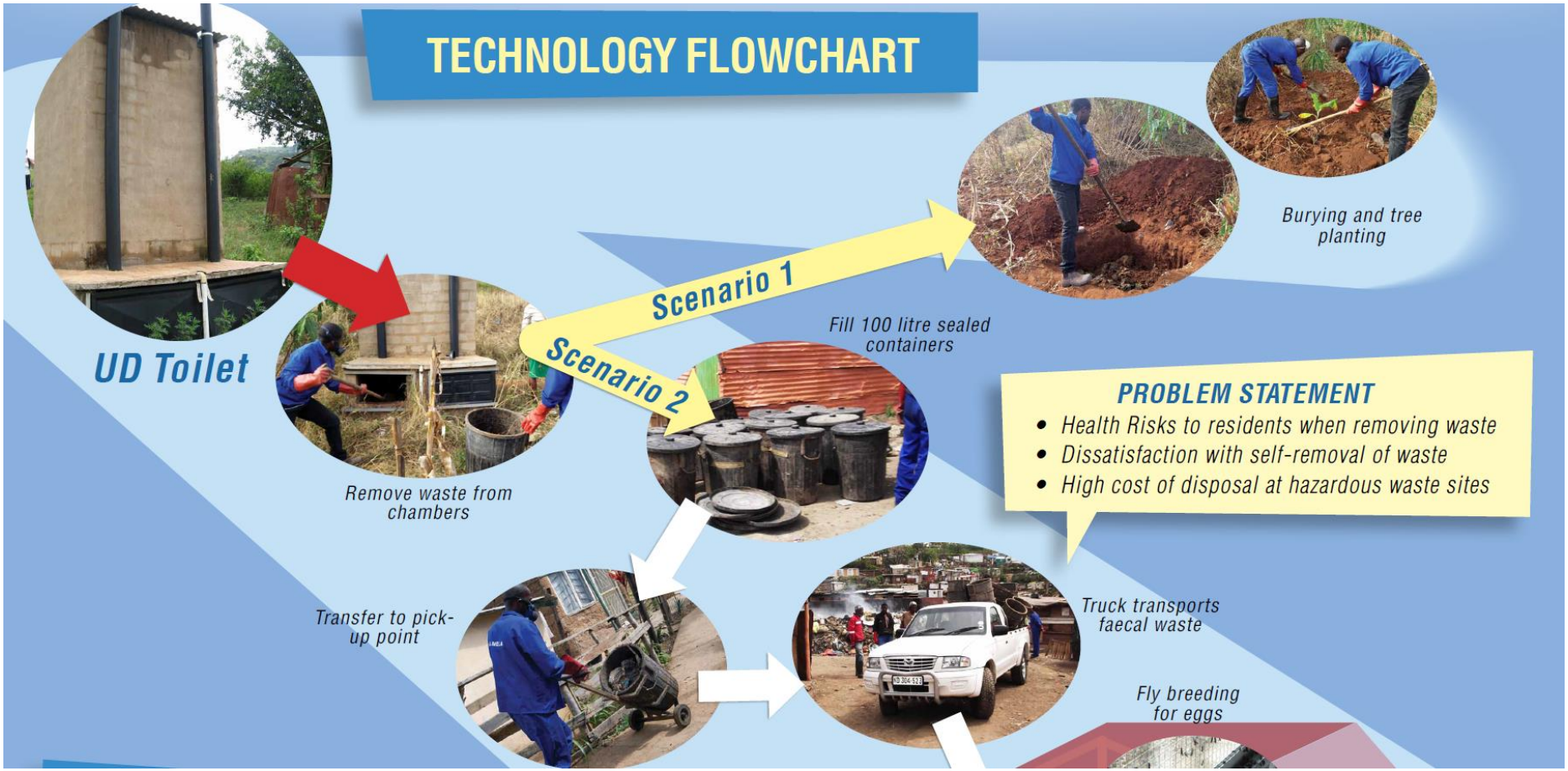
The BSF Faecal Waste Recycling Process



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Fly Breeding

Photograph - Agriprotein

Photograph - Agriprotein

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Bioconversion

Photograph - Agriprotein

Photograph - Agriprotein

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Chicken farming using larvae as feed

Photograph - Agriprotein

Food gardens use soil conditioner

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Optimum Growing Conditions

- Food with a moisture content of 65%
- Temperatures between 25^{o} C and 35^{o} C for egg laying
- pH - neutral
- Some fibre to assist with aeration of the feed media
- Mating requires humidity of 60% and temperatures of 27^{o} C to 30^{o} C
- Mix of faeces and faecal waste for larvae consumption

Durban is well suited to the temperature and humidity requirements

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BMGF Phase 1 Activities

- Institutional Analysis
- Environmental and Health Compliance Study
- Concept Testing
- Business Modelling
  - UD waste removal
  - Processing of waste
- Procurement / Contract Options
- Policy Development
- Contractor Support Framework

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Institutional Analysis of Municipality

- Sourcing and review of all policy documents (National and Municipal)
- Engagement with key municipal officials
- Case studies of existing or completed municipal business partnerships and contracts
- Assessment of procurement / supply chain options
- Assessment of institutional readiness of the Municipality to implement

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Environmental Health & Compliance

- SA law regulates handling of hazardous material
- Guidance for beneficial use of sludge from WWTW exists
- Limited legislation on the harvesting and use of sludge from on-site sanitation
- Use of guidance documents from SA and internationally
- Study of existing practices
- Include in tender document but balance budgeting constraints

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Concept Testing (Ground Truthing)

- Beneficiary Survey
  - Community attitudes to toilets and emptying requirements
  - Toilet usage patterns
  - Volumes measured

- UD Emptying Trials
  - Resource requirements (personnel, tools)
  - Time requirements
  - Samples taken for testing
  - Onsite factors e.g. access to toilets

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Key Results of Beneficiary Survey

- 75% of residents using UDs
- 70% of users not satisfied with UDs
- 80% of UDs not well maintained
- High density factor levels linked to emptying process
- Residents were very positive about a removal programme

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Key Results of UD Emptying Trials

- Average volumes of waste from both vaults, was approximately 0,7m^3
- Two workers could remove and bury contents from three toilets in one day
- Once worker could excavate two appropriate sized holes per day in intermediate soil

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Business Modelling: UD Sludge Emptying and Disposal

- Modelling exercise to estimate costs for Scenario 1 and 2
- Assumptions
  - Number of UDs
  - Sludge volumes (0,6 and 0,8m^3 per UD)
  - Labour requirements and costs
  - Travel and transport requirements
  - Supervision and overheads
  - Costs associated with disposal (burial and tree planting or processing)
  - Working days in hours
  - Emptying rate

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Example of Model

ASSESSMENT OF ETHEKWINI UD SLUDGE EMPTYING AND DISPOSAL COSTS

General Assumptions

Number of UD latrines		90 000
% of UD latrines in use		71.5%
Number of UD latrines requiring emptying		64 350
No. Emptying Teams per subcontractor		7.6
No. Workers per team		2
No. Subcontractors		6
No. Supervisors/Subcontractor		1
No. Trucks/Subcontractor		1
No. workers per truck		4
Working Day	hours	9
Working Days per month (excl. holidays)	days	20
Supervisor vehicle size	ton	1
Sludge transport vehicle effective capacity	ton	6
Average distance to or from emptying site from base	km	20
Average distance to disposal location	km	20
Distance between latrines	km	0.5
Average Volume of Sludge /pit	**m3**	**0.6**
Emptying Rate	m3/manhour	0.25
Average haulage distance to collection point	km	0.08
Average haulage rate	km.m3/manhr	0.04
Morning Loading Time	hours	0.5
Time to move between latrines	hours	0.25
Setup time at latrine	hours	0.2
Dealing with difficult access to pit	hours	0.05
Latrine Cleanup time	hours	0.25
Afternoon Cleaning / putting away equipment	hours	1
Daily Travel Distances		
Efficiency factor - supervisor		0.67
Supervisor's vehicle	km	76
Mass of sludge to collect per day per subcontr.	tons	18.8
Number of trips required per day	no.	4
Efficiency factor - truck		0.9
Sludge Haulage Vehicle	km	190
BSF Gate Fees		
BSG gate fee per ton	ton	R 250
Density of sludge	ton/m3	1.4
Tons per site	tons	0.84
Gate fee per site		R 210

BSF DISPOSAL OPTION

Cost Assumptions

Subcontractor	day	R 800
Supervisor	day	R 250
Storeman/day security	day	R 150
Night watchman	day	R 150
Community Liaison	day	R 150
Driver	day	R 250
Labourers	day	R 140
Monthly health interventions	Worker	R 200
Provision and upkeep of tools and PPE	Worker.month	R 80
Supervisor vehicle cost	km	R 4
Sludge transport vehicle cost	km	R 8.00
Supervisor vehicle monthly fixed cost	month	R 2 500
Sludge transport vehicle associated labour cost	month	R 11 200
Storage site monthly rental	month	R 6 000
Subcontractor's Overhead rate	%	20.0%
Productivity per team		
Time required for start-up and finish-up each day	hrs	1.5
Available time for emptying/disposal	hrs	7.5
Time required for start-up and finish-up each pit	hrs	0.8
Time required for emptying of waste	teamhrs	1.2
Time required for haulage of waste to collection site	teamhrs	0.6
Number of sites serviced per team per day	no	**2.9**
Number of sites serviced per subcontractor per day	no	22
Number of sites serviced per subcontractor per month	no	447
Number of sites serviced per annum by all subcontractors	no	32 188
Volume of sludge moved per subcontractor per day	m3	13.4
Volume of sludge moved per day all subcontractors	m3	80.5
Tonnage of sludge moved per subcontractor per day	t	18.8
Tonnage of sludge moved per day all subcontractors	t	112.7

BSF OPTION	
Emptying and Haulage Cost per site serviced	R 379
BSF Gate Fee per site serviced	R 210
TOTAL COST PER SITE SERVICED	R 589
Sites Serviced per Two year Cycle	64 376
Programme Cost per Two year Cycle	R 37 893 881
% of demand met in 2 year cycle	100.0%

Cost per subcontractor per day

Subcontractor	day	R 800	
Supervisor	day	R 250	
Community Liaison	day	R 150	
Driver	day	R 250	
Labourers	day	R 2 128	
subtotal			R 3 578
Supervisor's vehicle	day	R 306	
Sludge Haulage vehicle	day	R 1 522	
subtotal			R 1 827
TOTAL		**R 5 405**	

Subcontractor's monthly costs

Worker's health	R 3 040
Supervisor's vehicle	R 2 500
Sludge Haulage Vehicle (labour team)	R 11 200
Rental of storage site	R 6 000
Replacement of tools and equipment	R 1 216
Storeman / day security	R 4 500
Nightwatchman	R 4 500
Labour	R 71 560
Transport	R 36 542
Sutotal	**R 141 058**
Overheads	R 28 212
TOTAL per Subcontractor per month	**R 169 270**
TOTAL Cost per month all Subcontractors	**R 1 015 618**
Cost per site serviced (excl. BSFL fee)	**R 378.63**

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Business Modelling: Black Soldier Fly (BSF) Processing Plant

- BSF identification as suitable processing technology
- Engagement with Biocycle / Agriprotein
- Identification of site for pilot plant
- Infrastructure options
- Business modelling based on 10 tons and 20 tons of faecal waste
- Business feasibility study – viability over 3 years and 5 years – different CAPEX arrangements
- Income sources
  - Municipal Gate Fee
  - Sale of Products
- Profit share

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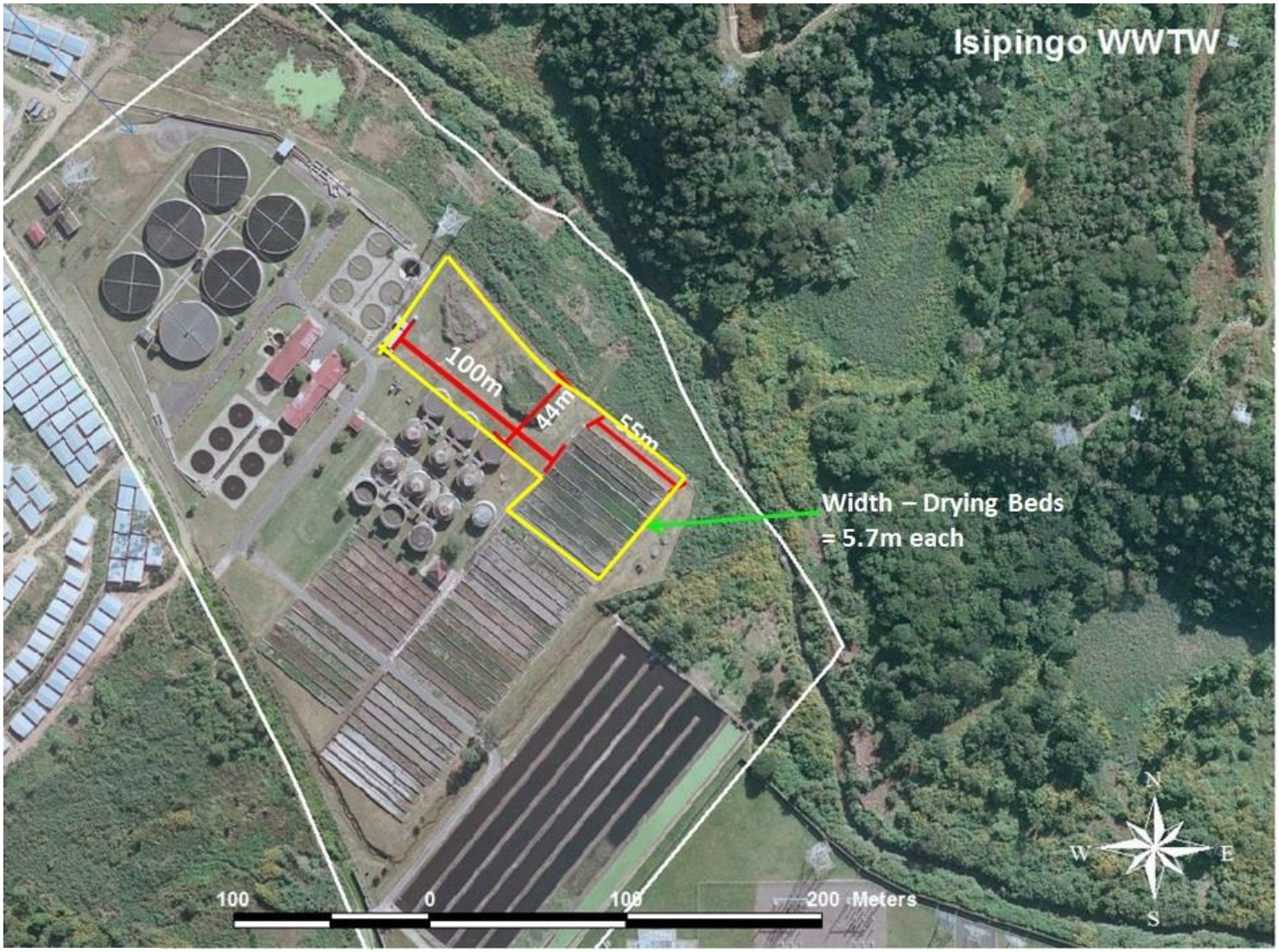
Selected site for Plant at WWTW



Factory Design Specifications

Waste In	20	Tonnes per day 70 MC
	15%	Biconversion Feed to Larvae
	18%	Waste to Residue
	150	Kg/m2 Feeding
Harvesting	133	m2 per day Harvested
	18	Growout Days Outside Nursery
	2400	Total Growout Space Required
	3.0	Tonnes of Wet Maggots Produced per Day
Breeding	20	g of Eggs Needed per m2
	2.7	Kg of Eggs needed per day
	15	g of Eggs generated per Cage
	178	Cages Needed
	12%	Wet Larvae kept for Breeding
Magmeal	32%	Wet Larvae to MagMeal
	12%	Wet larvae to MagOil
Output	0.84	Tonnes of Magmeal per Day
	0.32	Tonnes of MagOil per Day
	3.60	Tonnes Residue per day

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BSF Business Model with De-Risked Scenarios

		BASE CASE	DE-RISKED SCENARIOS. NO CAPEX, NO TAX, PROFIT SHARE TO ETHEKWINI S2 and S3 DEVELOPMENT FUND				
	Gate Fee (R per ton UD sludge)	R 250	R 350	R 350	R 350	R 350	R 350
	Product Prices (R8000/t mag meal, R7000/t mag oil, R200/t residue compost)	-	-	-20%	-40%	-60%	-80%
	CAPEX	R 6 468 000	R 0	R 0	R 0	R 0	R 0
KEY INDICATORS	Comment						
Cash Positive Month	[first month cash balance turns positive]	Month 36	Month 8	Month 9	Month 11	Month 26	n/a
Cash Flow Max	[lowest liquidity point	R (6 450 147.14)	R (912 225)	R (912 225)	R (912 225)	R (912 225)	R (4 793 357)
Cash requirement Year 1	[sum of first 12 months cash requirement - if negative]	R (5 713 465.75)	R 1 828 598	R 1 004 095	R 179 591	R (644 913)	R (1 469 416)
Cash Flow Max Month	[month after which negative cash balance starts reducing]	Month 9	Month 5	Month 5	Month 5	Month 5	Month 60
Months to Positive Profit After Tax	[first month business has positive PAT]	Month 6	Month 6	Month 6	Month 6	Month 6	n/a
Net Current Assets after 3 years	Equity less fixed asset value	R 179 985	R 11 474 107	R 7 822 734	R 4 171 360	R 519 987	R (3 131 387)
Net Current Assets after 5 years	Equity less fixed asset value	R 6 073 437	R 21 119 616	R 14 641 373	R 8 163 130	R 1 684 886	R (4 793 357)
Total Gate Fee paid over 5 years		R 8 365 500	R 11 711 700	R 11 711 700	R 11 711 700	R 11 711 700	R 11 711 700
Profit Share % Retained for S2-S3 Development Fund		0%	70%	70%	70%	70%	0%
(Assumption: Fixed Asset fully depreciated over 5 years)							
Profit Share to S2-S3 Development Fund		R 0	R 14 783 731	R 10 248 961	R 5 714 191	R 1 179 420	R 0
Balance of Profit retained by Biocycle		R 6 073 437	R 6 335 885	R 4 392 412	R 2 448 939	R 505 466	-R 4 793 357

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Risks Identified & Included in SLA

- Environmental Compliance
- Market reaction to products
- Sand content
- Consistent delivery of sludge
- Labour disputes
- Machinery breakdown

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Performance Based Contracts

- Procurement Options
  - Standard tender process (>R200 000)
  - Deviation from procurement process
  - Public Private Partnership as per National Treasury requirements
  - Operation and Maintenance Contract
  - Service Level Agreement (SLA) with Section 36

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Selected Procurement Options

- **Waste removal element:**
  - Standard tender using an incentivised contract
  - Detailed specification ensuring adherence to health, safety and environmental requirements
  - Pricing on a per task basis
  - Use of local teams
  - Tender process will exclude contractors with limited experience in the management of local labour in rural areas

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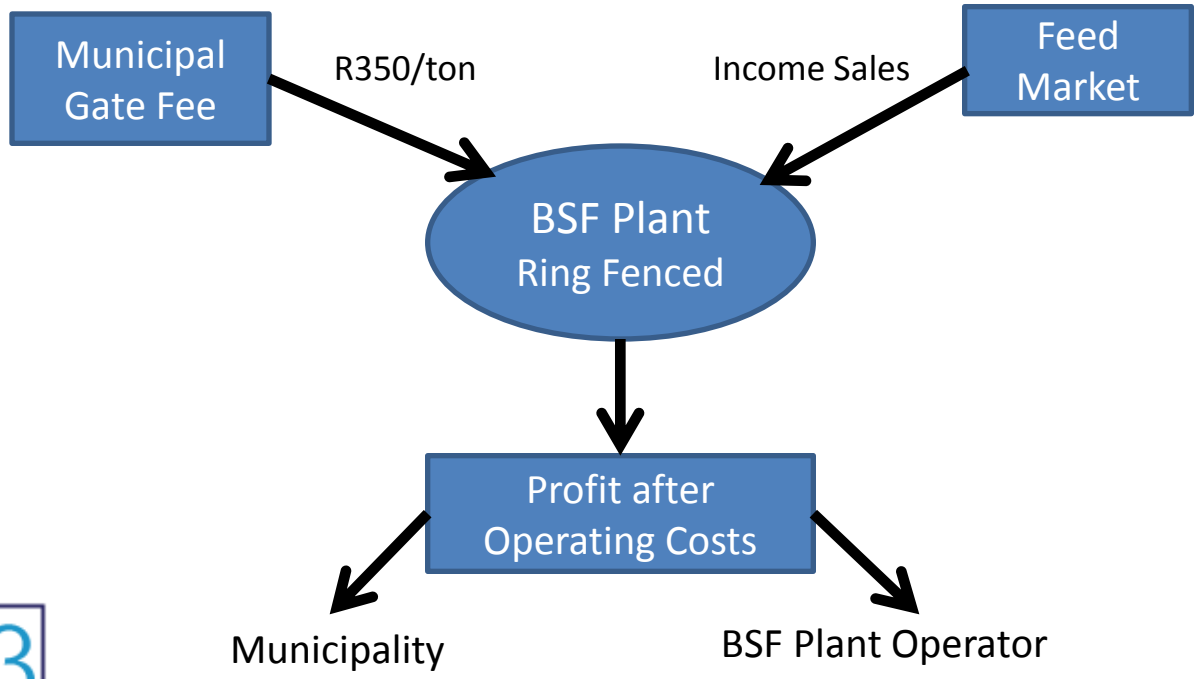
Selected Procurement Options

- **BSF Processing Plant**
  - Service Level Agreement for O & M
  - Approval to deviate from normal tender procedure
  - Uncertainty on costs and income
  - Proposed financial mechanism



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Policy Development

- Institutional Analysis identified Municipality as having good structures and policies
- Models can be implemented using existing procurement, health and safety and environmental legislation

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Contractor Support Framework

- SA has identified vibrant small, medium and micro enterprise development (SMMEs) as key to economic growth
- UD waste removal program ideal for development of SMMEs
- Activities included:
  - Assessing existing sanitation projects using SMMEs
  - Assessing other business support programs in the City and Nationally
  - Assessing other enterprise development models
- Setting out a proposed approach using a business incubator

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Phase 2 Proposal

- Developed and submitted on 15 August
- Includes detailed process steps with milestones
- Risks to project identified
- Detailed budget for project team, research and BSF CAPEX requirements

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Current Activities

- GIS analysis of UD toilets within the City
- Improvements to existing database
- Developments of Tender document for UD waste removal with detailed specifications and pricing
- Unpacking CAPEX requirements for BSF processing plant
- Development of Contract specifications for tender to establish plant
- Finalising SLA
- Acquiring all necessary approvals for project

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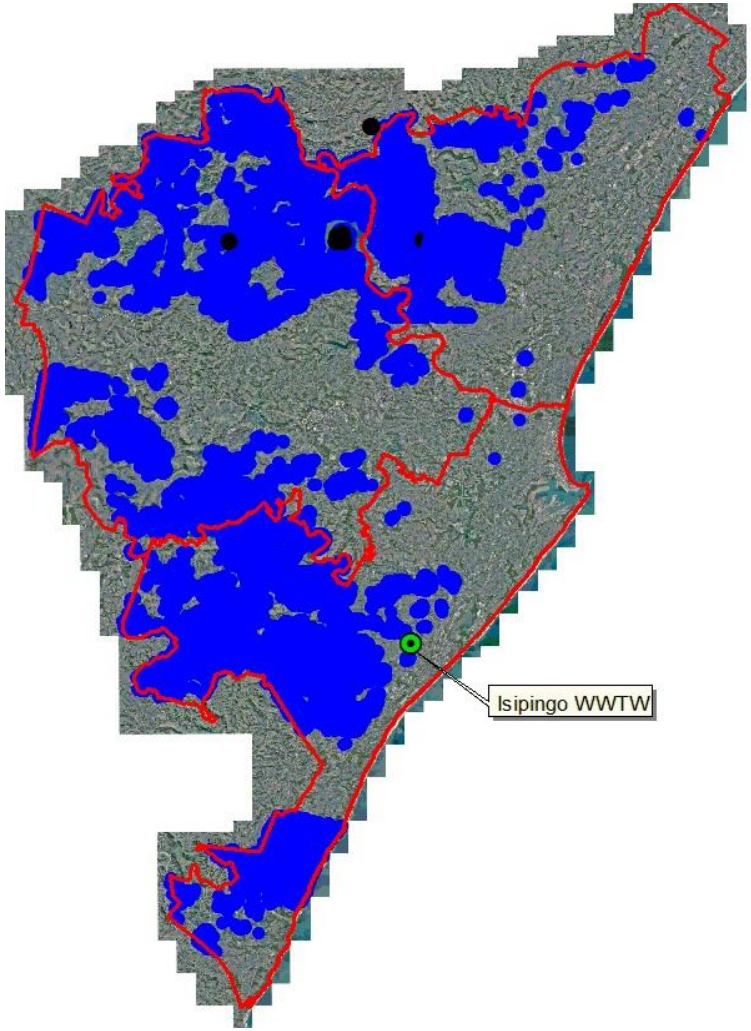
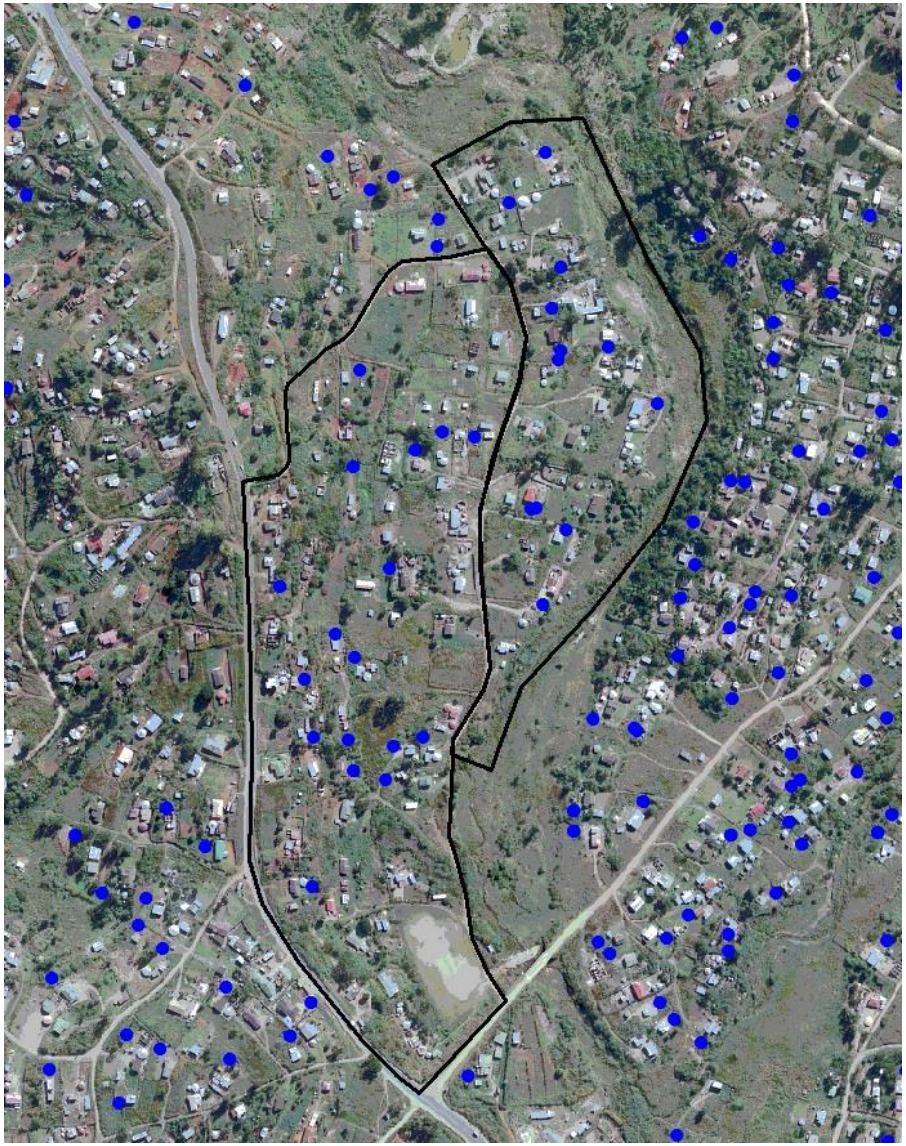
GIS Strategic Planning

Geographic Distribution of UD toilets



Use of Geographic Pockets to Target Areas



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Concluding Remarks

- Looking forward to rolling out this exciting but challenging program
- Thank you to BMGF for their on-going support

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