

# Economic Model of the Costs of Emptying On-site Sanitation Facilities: from Emptying to Resource Recovery or Disposal

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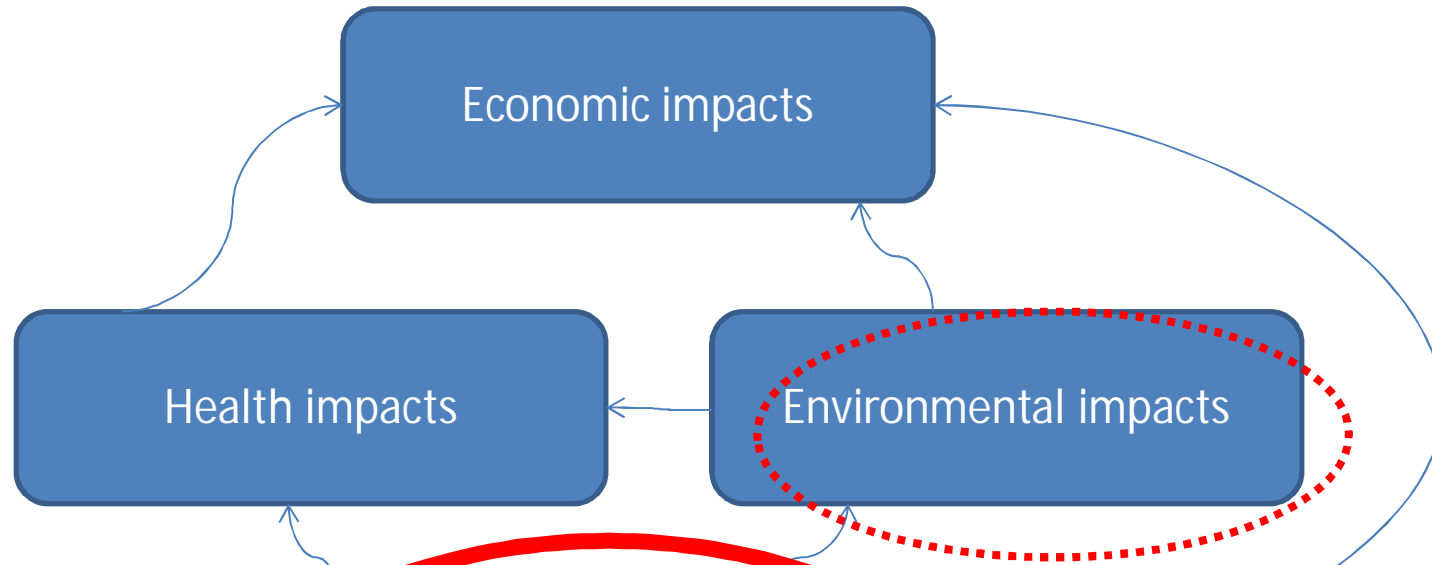
Pollution Research Group  
University of KwaZulu-Natal (UKZN)  
Durban, South Africa



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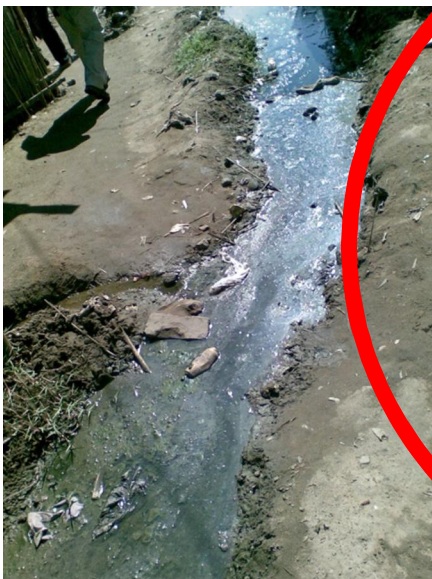


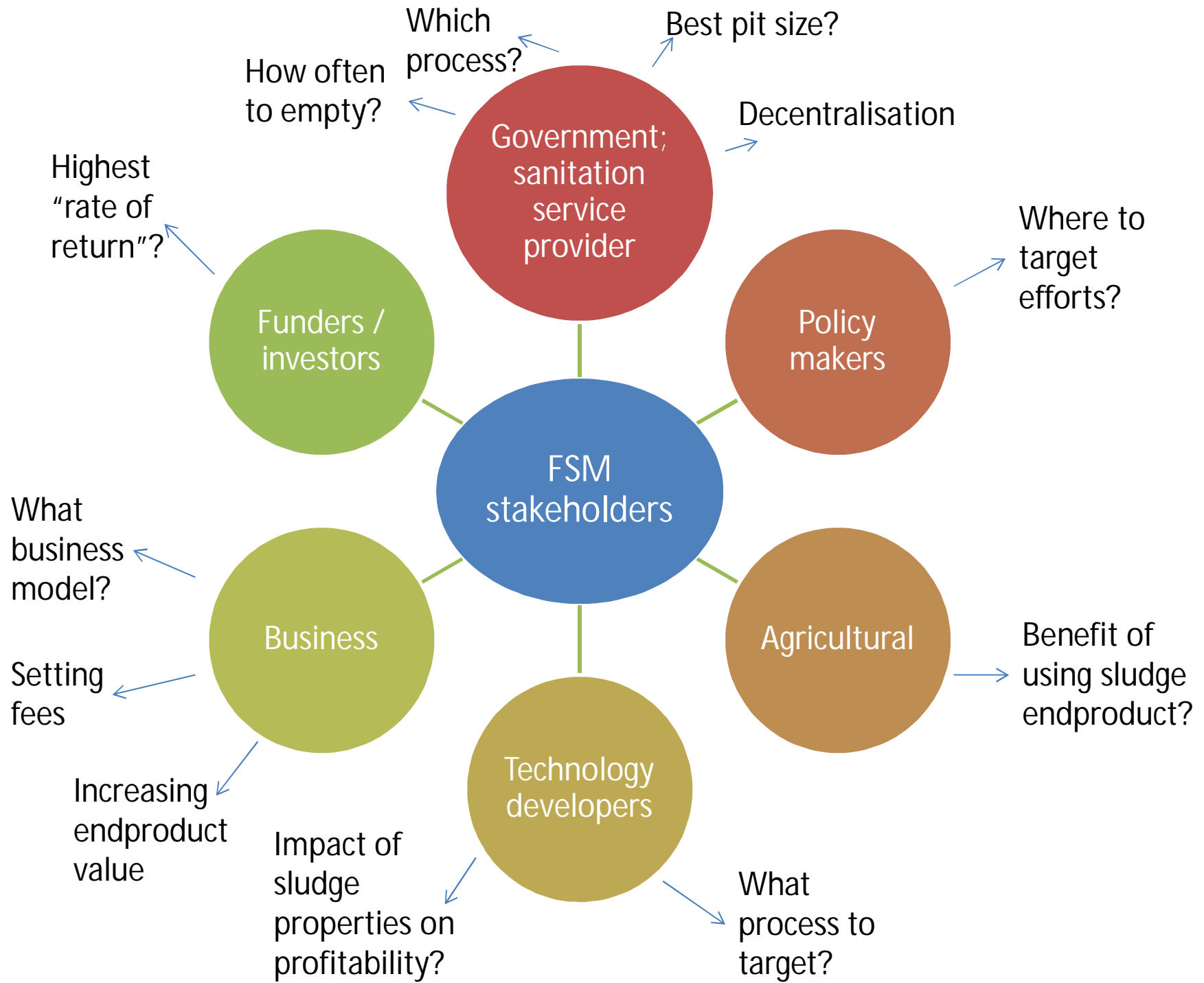
**eawag**  
aquatic research 000



Poor sanitation & hygiene

- Many inter-dependent factors
- Environmental
  - Human
  - Policy
  - Financial
  - ...etc





# Modelling sludge **quantity & characteristics**, costs & revenues through the FSM system



Emptying



Conveyance



Treatment



Reuse / end disposal

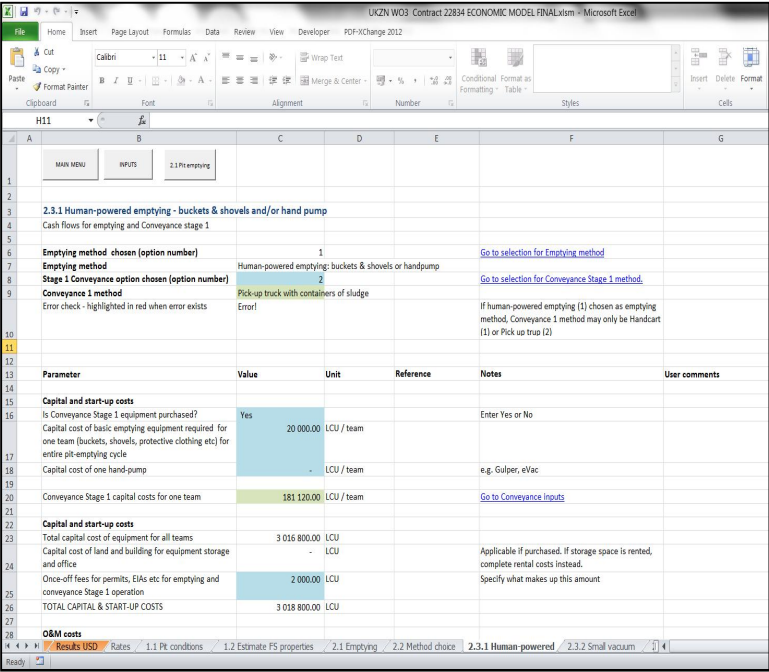
Changing sludge quantity

Changing sludge characteristics  
(solids, nutrients, calorific value,  
pathogens)

Changing costs & revenues

# Scope of model

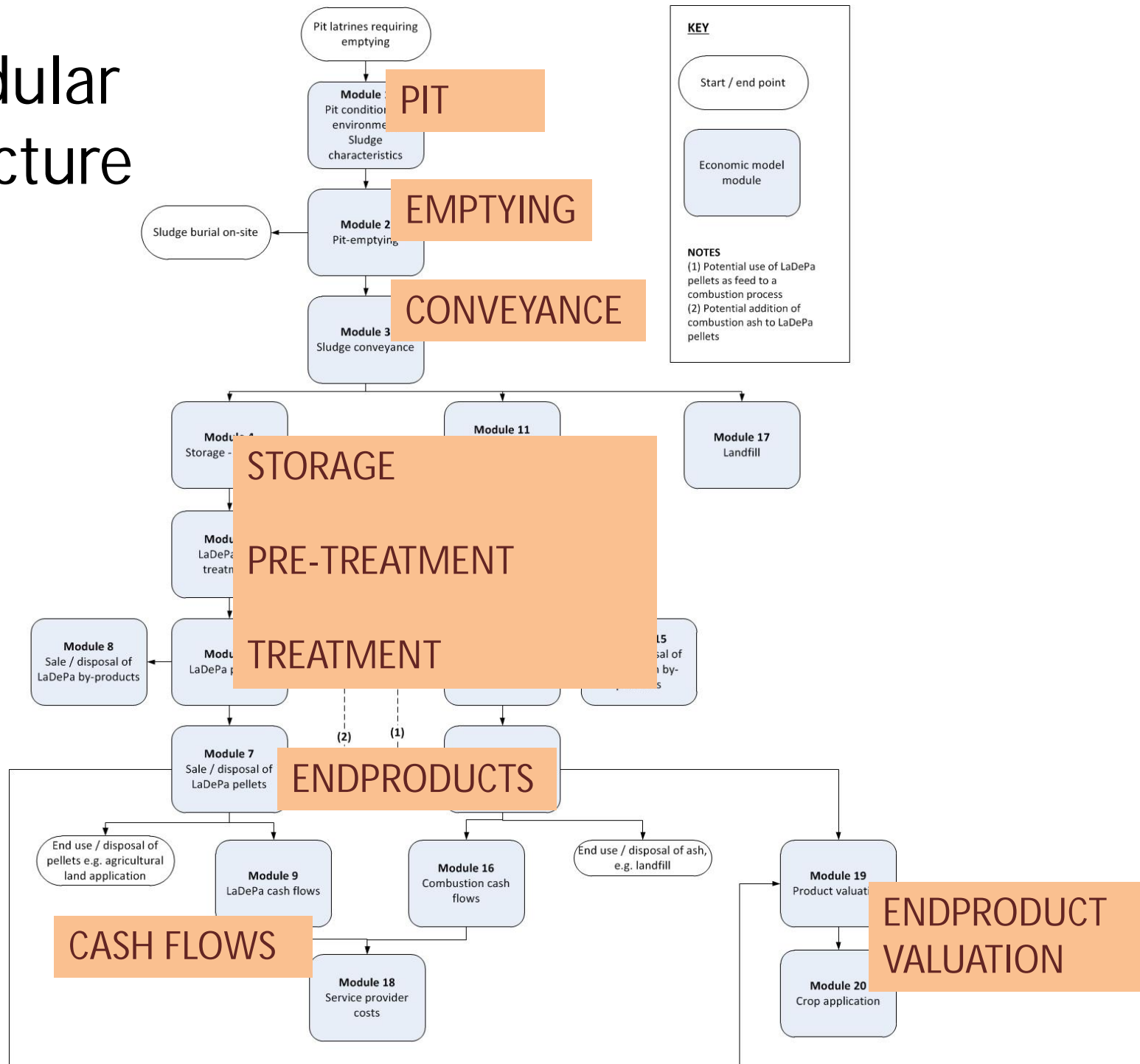
- **Excel** spreadsheet
- On-site sanitation
  - Pits
  - Septic tanks
  - Urine diversion
- Sludge removed off-site
- **Multiple options** for each stage of FSM chain
- Outputs
  - Financial
  - Non-financial



The screenshot shows an Excel spreadsheet with a parameter table for '2.3.1 Human-powered emptying'. The table has columns for Parameter, Value, Unit, Reference, Notes, and User comments. The parameters listed include capital and start-up costs for various equipment and operations.

Parameter	Value	Unit	Reference	Notes	User comments
Is Conveyance Stage 1 equipment purchased?	Yes			Enter Yes or No	
Capital cost of basic emptying equipment required for one team (buckets, shovels, protective clothing etc) for entire pit-emptying cycle	20 000.00	LCU / team			
Capital cost of one hand-pump	-	LCU / team		e.g. Gulper, eVac	
Conveyance Stage 1 capital costs for one team	181 120.00	LCU / team		<a href="#">Go to Conveyance Inputs</a>	
<b>Capital and start-up costs</b>					
Total capital cost of equipment for all teams	3 016 800.00	LCU			
Capital cost of land and building for equipment storage and office	-	LCU		Applicable if purchased. If storage space is rented, complete rental costs instead.	
Once-off fees for permits, EAs etc for emptying and conveyance Stage 1 operation	2 000.00	LCU		Specify what makes up this amount	
<b>TOTAL CAPITAL &amp; START-UP COSTS</b>	3 018 800.00	LCU			

# Modular structure



# 4 emptying options



Human-powered:  
manual



Human powered:  
improved manual –  
e.g. Gulper, eVac



Small vacuum tanker



Large vacuum tanker

# 7 conveyance options & combinations of these



Container on handcart



Pick up truck with containers



Small vacuum tanker



Large vacuum tanker



Intermediate storage tank



Transfer station – liquid connection to sewer



Sewer discharge station

## Example combination:





# Treatment



LaDePa (Latrine  
Dehydration  
Pasteurisation)



PELLET  
PRODUCT



Combustion



ASH  
PRODUCT



Landfill ('do  
nothing' option)

# Model

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Insert Delete For Cells

H11 A G

1	MAIN MENU	INPUTS	2.1 Pit emptying			
2						
3	<b>2.3.1 Human-powered emptying - buckets &amp; shovels and/or hand pump</b>					
4	Cash flows for emptying and Conveyance stage 1					
5						
6	<b>Emptying method chosen (option number)</b>		1		<a href="#">Go to selection for Emptying method</a>	
7	<b>Emptying method</b>	Human-powered emptying: buckets & shovels or handpump				
8	<b>Stage 1 Conveyance option chosen (option number)</b>		2		<a href="#">Go to selection for Conveyance Stage 1 method.</a>	
9	<b>Conveyance 1 method</b>	Pick-up truck with containers of sludge				
	Error check - highlighted in red when error exists	Error!				If human-powered emptying (1) chosen as emptying method, Conveyance 1 method may only be Handcart (1) or Pick up trup (2)
10						
11						
12						
13	<b>Parameter</b>	<b>Value</b>	<b>Unit</b>	<b>Reference</b>	<b>Notes</b>	<b>User comments</b>
14						
15	<b>Capital and start-up costs</b>					
16	Is Conveyance Stage 1 equipment purchased?	Yes			Enter Yes or No	
17	Capital cost of basic emptying equipment required for one team (buckets, shovels, protective clothing etc) for entire pit-emptying cycle	20 000.00	LCU / team			
18	Capital cost of one hand-pump	-	LCU / team		e.g. Gulper, eVac	
19						
20	Conveyance Stage 1 capital costs for one team	181 120.00	LCU / team		<a href="#">Go to Conveyance inputs</a>	
21						
22	<b>Capital and start-up costs</b>					
23	Total capital cost of equipment for all teams	3 016 800.00	LCU			
24	Capital cost of land and building for equipment storage and office	-	LCU		Applicable if purchased. If storage space is rented, complete rental costs instead.	
25	Once-off fees for permits, EIAs etc for emptying and conveyance Stage 1 operation	2 000.00	LCU		Specify what makes up this amount	
26	<b>TOTAL CAPITAL &amp; START-UP COSTS</b>	<b>3 018 800.00</b>	<b>LCU</b>			
27						
28	<b>O&amp;M costs</b>					



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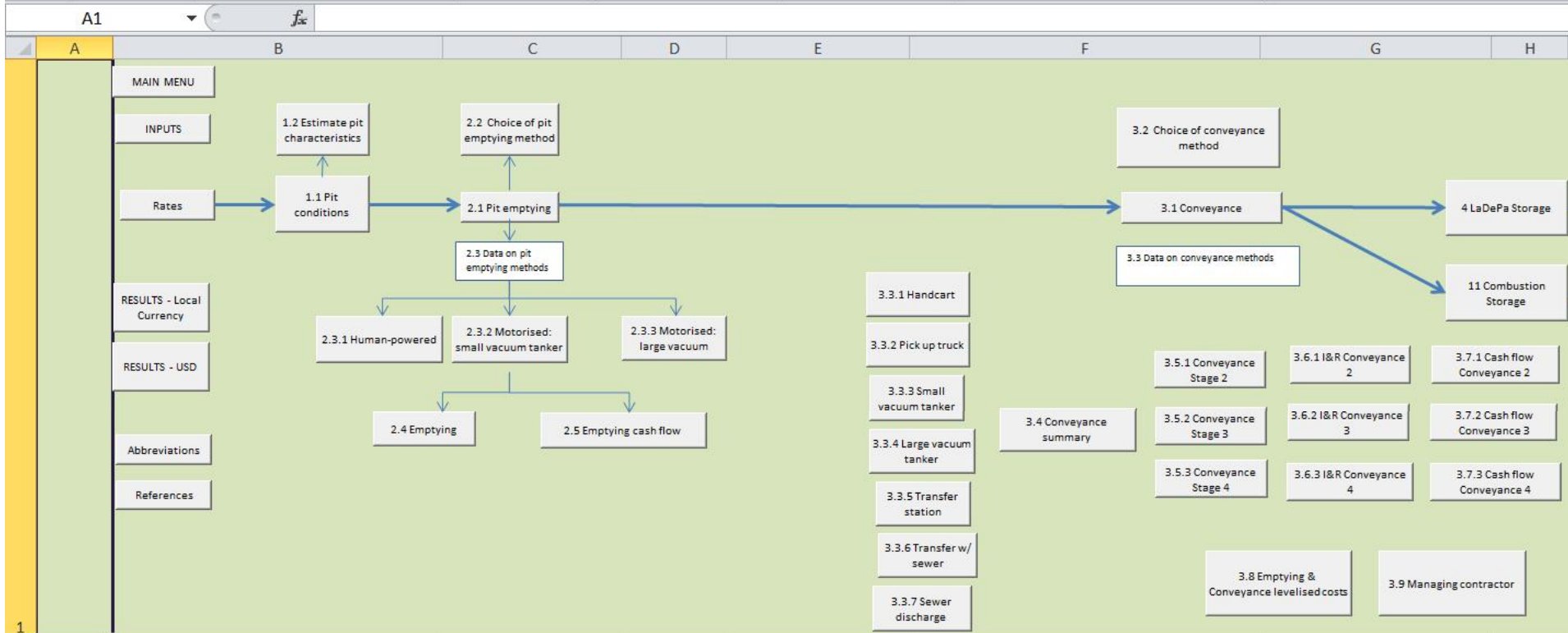
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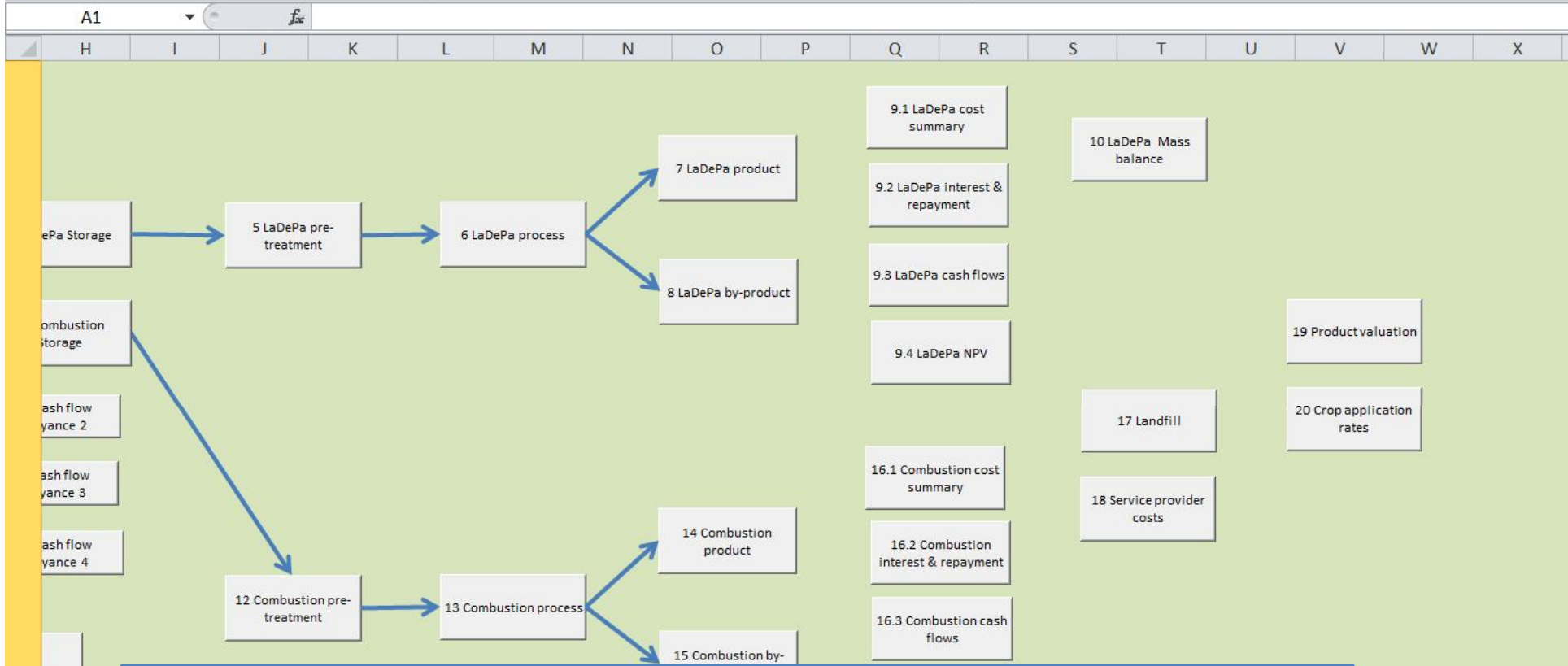
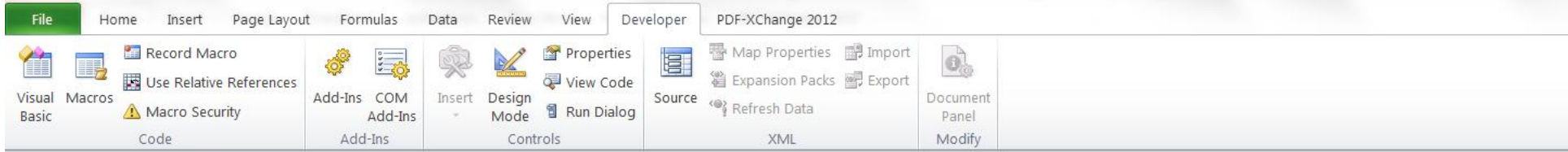
General

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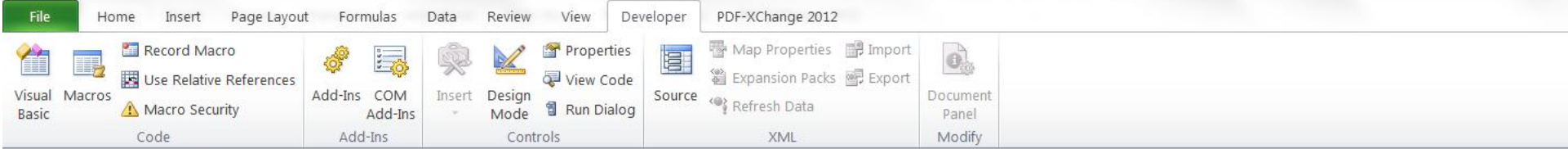


# Model navigation



Model navigation  
60+ calculation worksheets





For model user:  
**INPUTS** worksheet

13	7. List full references / bibliograph					
14	8. The 'Template Notes' column gi					
15	9. User comments provides space					
16						
17	<b>Links to inputs for different mod</b>					
18						
19	<a href="#">1. Pit conditions</a>					
20	<a href="#">2. Emptying</a>					
21	<a href="#">3. Conveyance</a>					
22						
23	<a href="#">4. LaDePa Storage</a>					
24	<a href="#">5. LaDePa pre-treatment</a>	<a href="#">12. Combustion pre-treatment</a>				
25	<a href="#">6. LaDePa process</a>	<a href="#">13. Combustion process</a>				
26	<a href="#">7. LaDePa product</a>	<a href="#">14. Combustion product</a>				
27	<a href="#">8. LaDePa by-product</a>	<a href="#">15. Combustion by-product</a>				
28	<a href="#">9. LaDePa cost calculations</a>	<a href="#">16. Combustion cost calculations</a>				
29						
30	<a href="#">18. Service provider costs</a>					
31	<a href="#">19. Product valuation</a>					
32	<a href="#">20. Crop application</a>					
33						
34						
35						
36	<b>Location</b>	eThekwini municipality, South Africa				
37	<b>Date made</b>	2013/09/15				
38						
39						
40	<b>Rates</b>					
41	<b>Parameter</b>	<b>Value</b>	<b>Unit</b>	<b>Reference / source</b>	<b>Template notes</b>	<b>User comments</b>
42						
43	<b>Financial</b>					
44	Local currency	South African Rand	ZAR		Name and units are inputs	
45	Exchange rate Local currency -USD		10 Local currency / USD			
46	Escalation rate on O&M costs and revenues, excluding fuel		6 %			
47	Escalation rate on fuel		12 %			
48	Interest rate on debt		9 %			
49	Debt proportion in debt:equity ratio		70 %			



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Visual Basic Macros Record Macro Use Relative References Macro Security Code Add-Ins COM Add-Ins Insert Design Mode Run Dialog Source Map Properties Import Expansion Packs Export Refresh Data XML Document Panel Modify

	A	B	C	D	E	F	G
34							
35							
36		<b>Location</b>	eThekweni municipality, South Africa				
37		<b>Date made</b>	2013/09/15				
38							
39							
40		<b>Rates</b>					
41		<b>Parameter</b>	<b>Value</b>	<b>Unit</b>	<b>Reference / source</b>	<b>Template notes</b>	<b>User comments</b>
42							
43		<b>Financial</b>					
44		Local currency	South African Rand	ZAR		Name and units are inputs	
45		Exchange rate Local currency -USD	10	Local currency / USD			
46		Escalation rate on O&M costs and revenues, excluding fuel	6	%			
47		Escalation rate on fuel	12	%			
48		Interest rate on debt	9	%			
49		Debt proportion in debt:equity ratio	70	%			
50		Discount rate	8	%			
51		Income tax rate	28	%			
52		Lifetime used to caculate depreciation rate for civils	20	years			
53		Lifetime used to calculate depreciation rate for large mechanical items	10	years		Large mechanical item: e.g. vacuum tanker	
54		Lifetime used to calculate depreciation rate for small mechanical items	5	years			
55		Terminal value of assets	10	% of initial value			
56		Cost of general landfill					
57		Cost of hazardous landfill					
58							
59							
60		<b>Consumables</b>					
61		Gasoline					
62		Diesel					
63		Water					
64		Vehicle oil					
65							
66							
67		<b>Vehicles</b>					

# INPUTS worksheet Rates

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Alignment: Wrap Text, Merge & Center

Number: General, Percentage, Decimals, Thousands Separator

Styles: Normal, Bad, Good, Neutral, Calculation, Check Cell

# INPUTS worksheet Vehicle costs

	A	B	C	D	E	F
		Pick up truck capital cost	175 000	LCU	Department of Agriculture Machinery Guide 2011. 3000 cc 1 tonne club cab diesel pick	
73						
74						
75		Average travel speed				
		Fuel consumption for vehicle				
76					Machinery guide 2010 -2011: 9.5 L/100 km	
77		Oil consumption for vehicle	1	% of fuel consumption	Dept. of Agriculture Machinery guide 2010 -2011	
78						
79		Price of set of tyres	5 339.00	LCU / set	Dept. of Agriculture Machinery guide 2010 -2011: R4751.75 2011 price, R5339 2013 price	
80		Distance for which new set of tyres lasts	50 000	km	Dept. of Agriculture Machinery guide 2010 -2011	
81		Equipment repair and maintenance cost over lifetime	50	%	Dept. of Agriculture Machinery guide 2010 -2011	Used to calculate repair and maintenance km
82		Lifetime of vehicle	5	years		Used to calculate depreciation rate for vehicle
		Vehicle life (distance for accounting purposes)	160 000	km	Dept. of Agriculture Machinery guide 2010 -2011	Used to calculate repair and maintenance km
83						
84		Repayment period for debt	3	years		Debt for capital borrowed to buy equipment
85		Vehicle insurance cost	3.5	% of purchase price / year		
		Vehicle licence	482.00	LCU / year	Dept. of Agriculture Machinery guide 2010 -2011	



B208 Emptying of pits & conveyance of sludge

297						
298		<b>2.3 - Emptying &amp; Conveyance Stage 1 input data</b>				
299						
300		<b>User notes</b>				
301		1. The Emptying and Conveyance 1 options chosen under 2.1 (above) will be those used by the model to calculate the overall cash flows for sludge management				
302		2. You are only required to fill out the data sheets corresponding to the Emptying and Conveyance 1 options chosen above				
303		3. To view the cost comparison of emptying methods on Sheet 2.4 you must also fill out the data sheets for all other Emptying methods and their corresponding Conveyance Stage 1 method that you want to compare				
304						
305						
306		<b>2.3.1 - Human-powered emptying parameters: buckets &amp; shovels and/or hand-pump</b>				
307						
308		<b>Is the section required data?</b>	Yes	If No, go to section 2.3.2		
309						
310		<b>Parameter</b>	<b>Value</b>	<b>Unit</b>	<b>Reference</b>	<b>Template notes</b>
311		<b>Conveyance Stage 1 method</b>		2		Choice of: 1. Handcart with containers of sludge 2. Pick-up truck with containers of sludge
312		<b>Conveyance Stage 1 method</b>	Pick-up truck with containers of sludge			
313						
314		<b>Capital &amp; startup costs</b>				
315		Emptying equipment only: Capital cost for one team (buckets, shovels, protective clothing etc)	20 000.00	LCU / team		If equipment is rented, not purchased, complete hire cost instead.
316		Is Conveyance Stage 1 method				
317						
318		Capital cost of one hand				
319		Once-off fees for permitting and conveyance Stage 1				
320						
321		<b>O&amp;M costs</b>				
		Yearly cost of health & permitting for all teams				

INPUTS worksheet  
Conveyance costs





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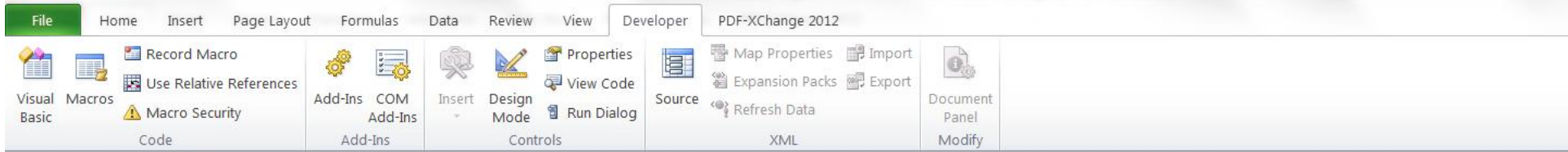
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Number: General, Percentage, Decimals, Thousands Separator, Currency, Accounting

Styles: Normal, Bad, Good, Neutral, Calculation, Check Cell

B208		Emptying of pits & conveyance of sludge			
A	B	C	D	E	F
208	<b>Emptying of pits &amp; conveyance of sludge</b>				<a href="#">Go to top</a>
209					
210	1. Pit is emptied				
211	2. Sludge is transported by one or more methods of conveyance (Conveyance Stages 1 - 4)				
212	3. Sludge enters a storage tank facility at the LaDePa or combustion process site.				
213					
214	Emptying		Choice of 3 emptying methods		<b>Emptying methods:</b> 1. Human-powered: bucket & shovel or ha 2. Motorised: small vacuum tanker 3. Motorised: large vacuum tankerr
215					
216	Conveyance Stage 1		Conveyance Stage 1 must be completed. Stages 2 - 4 are optional - only applicable if several forms of transport are used, e.g. handcart for initial transport stage in a dense settlement followed		<b>Conveyance methods:</b> 1. Hand-cart with containers of sludge 2. Pick-up truck with containers of sludge 3. Small vacuum tanker 4. Large vacuum tanker 5. Transfer station - intermediate storage,
217	Conveyance Stage 2				
218	Conveyance Stage 3				
219	Conveyance Stage 4				
220	Storage				
221					
222					
223					
224					

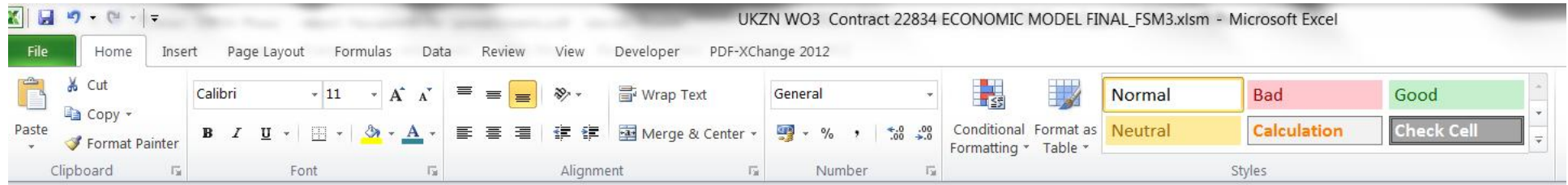
# INPUTS worksheet Conveyance options



B1261 6 - LaDePa process						
A	B	C	D	E	F	G
1263						
1264	<b>Parameter</b>	<b>Value</b>	<b>Unit</b>	<b>Reference</b>	<b>Notes</b>	<b>User comments</b>
1265						
1266	<b>Actual pre-treated feed properties</b>					
	Average daily volumetric feed rate per LaDePa plant		6 m <sup>3</sup> / day / plant	Pers. comm. EWS 4 March 2013 - operational experience in previous pit-emptying cycle, but not measured directly at the plant.		
1267						
1268						
1269	<b>LaDePa operational parameters</b>					
	Number of LaDePa plants required		4.66 No.			
1270	Number of LaDePa plants in operation		5.00 No.		Assumes that sludge can be processed by LaDePa in the years between pit-emptying cycles. Choose based on the number of LaDePa plants required, and the desired timeframe for processing all the sludge produced. The most economic option is to round up the calculated number of plants required. A higher number of plants will reduce processing time.	
1271						
1272	Length of pit emptying cycle		5.0 years			
1273	Number of years between pit emptying cycles		0.0 years			
	Number of years required to process all sludge from one pit-emptying cycle		5.0 years		If the number of plants is set very high, then the limiting factor is the number of years of sludge production. If the number of plants is set very	
1274						
1275						
1276	<b>Plant data</b>					
	Plant size (design feed rate of sludge)					
1277	Design average feed solids					
1278						

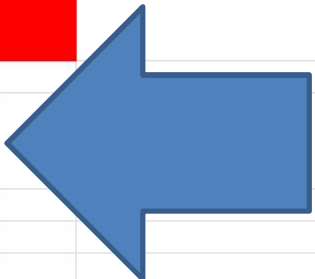
# INPUTS worksheet Treatment parameters





A	B	C	D	E	F
		Sample price 1	Calculate price of pellets that results in equal costs for LaDePa and	Value of pellets based on nutrient content of LaDePa pellets alone	

~2000 inputs to model  
(but do not need to enter all!)



2365	
2366	
2367	
2368	
2369	
2370	
2371	
2372	

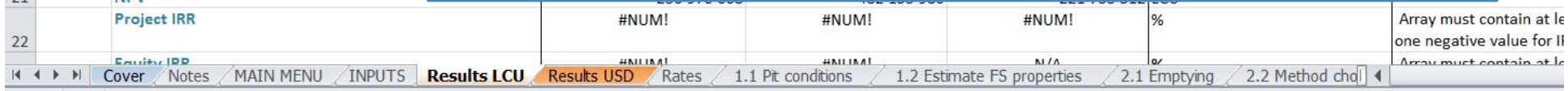
	Summary table of calculate				
2372					
2373	LaDePa pellets based on inorganic fertiliser nutrient prices	480	LCU / tonne		
2374	LaDePa pellets based on organic fertiliser 1 nutrient content and markup rate	3 578	LCU / tonne		
2375	LaDePa pellets based on organic fertiliser 2 nutrient content and markup rate	2 114	LCU / tonne		
2376	LaDePa pellets based on the calculated sale price for their application to have the same overall costs as conventional inorganic fertiliser application	-833	LCU / tonne		Maximum limit on sale price to enable cor with inorganic fertilisers. If negative LaDePa are not competitive.
2377	LaDePa pellets based on the calculated sale price for their application to have the same overall costs as conventional organic fertiliser application	175	LCU / tonne		Maximum limit on sale price to enable cor with organic fertilisers. If negative LaDePa are not competitive.
2378	LaDePa pellets based on their calorific value	102	LCU / tonne		
2379	Ash based on inorganic fertiliser nutrient content prices	359	LCU / dry tonne		
2380	Ash as a construction material		LCU / dry tonne		





	A	B	C	D	E	F	G
1							
2		<b>RESULTS - LOCAL CURRENCY UNITS (LCU)</b>					
3							
4		<u>Currency: LCU</u>					
5							
6			<b>LaDePa</b>	<b>Combustion</b>	<b>Landfill (base case)</b>	<b>Units</b>	<b>Comments</b>
7							
8		Number of households served per pit emptying cycle		35000		Total number per pit-emptying cycle	
9		Sludge removed from pit emptying area during pit emptying cycle		2294		Tonnes dry solids / year	Includes detritus
10		Planning horizon	10	20	10	years	This is the period that LaDePa cash flow sheets and the landfill sheets are for.
11							
12		<b>Total cost of sludge disposal (emptying, conveyance and processing via chosen route)</b>					
13		Is the cost of emptying and conveyance included?	Yes	Yes	Yes		
14		Levelised cost of pit-emptying & sludge disposal per dry tonne FS	11 473	10 947	9 955	LCU / dry tonne FS	Includes managing contractor costs. Based on the LaDePa cost sheet.
15		Levelised cost of pit emptying & sludge disposal					
16		Levelised cost to produce product					(as is - including combustion)
17							factor cost
18		Total initial capital investment in LaDePa / process (excludes emptying & conveyance)					pre-treatment
19							distillation process
20							
21		NPV					
22		Project IRR	#NUM!	#NUM!	#NUM!	%	Array must contain at least one negative value for IRR

RESULTS worksheet  
Local Currency



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Alignment: Wrap Text, Merge & Center

Number: General, Percentage, Decimals

Styles: Normal, Bad, Good, Neutral, Calculation, Check Cell

	A	B	C	D	E	F
1						
2		<b>RESULTS - UNITED STATES DOLLARS (USD)</b>				
3						
4		<u>Currency: USD</u>				
5			<b>LaDePa</b>	<b>Combustion</b>	<b>Landfill (base case)</b>	<b>Units</b>
6						
7						
8		Number of households served per pit emptying cycle		35000		Total number per pit-empt cycle
9		Sludge removed from pit emptying area annually		2294		Tonnes dry solids / year, in detritus
10		Planning horizon	10		20	10 years
11						
12		<b>Total cost of sludge disposal (emptying, conveyance and processing via chosen route)</b>				
13		Is the cost of emptying and conveyance included?	Yes	Yes	Yes	
14		Levelised cost of pit-emptying & sludge disposal per dry tonne FS	1 147		1 095	995 USD / dry tonne FS
15		Levelised cost of pit emptying & sludge disposal				
16		Levelised cost to produce product				
17						
18		Total initial capital investment in LaDePa process (excludes emptying & conveyance)				

**RESULTS worksheet**  
**US dollars**

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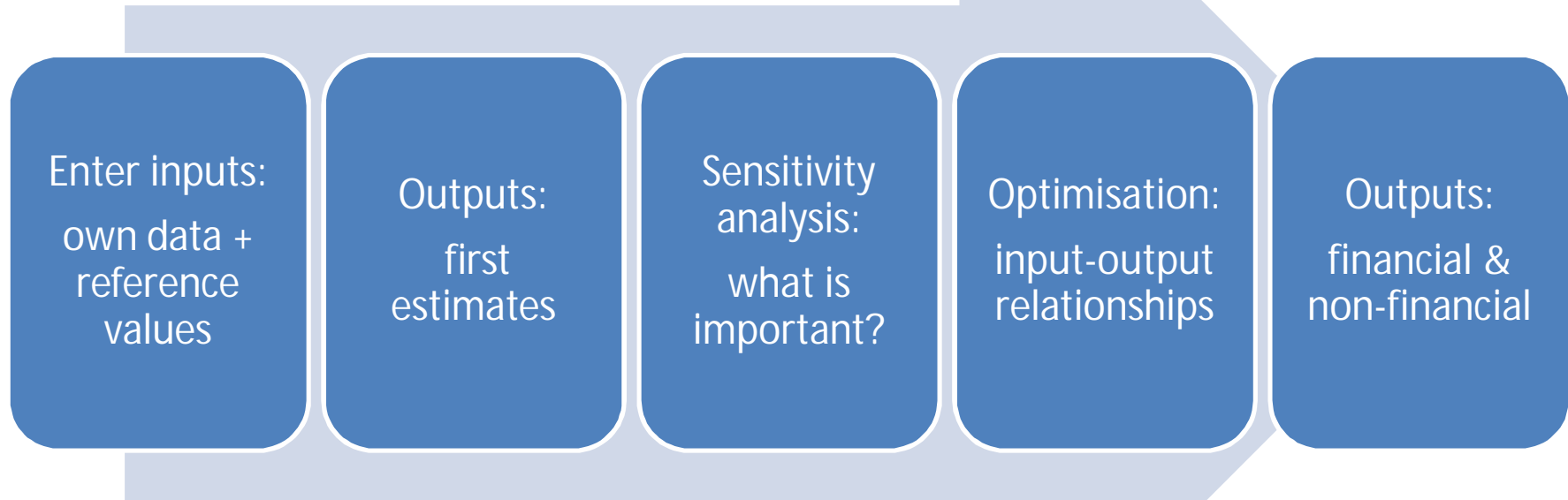
Alignment: General, Number, Percentage, Decimals, Thousands Separator

Styles: Normal, Bad, Good, Neutral, Calculation, Check Cell

	A	B	C	D	E	F
31						
32		<b>Product</b>				
33		Possible fertilizer value of product based on non-organic fertilizer NPK value	48.0	35.9	N/A	USD / tonne
34		Annual quantity of product	2146.67	1 195.43	N/A	tonnes / year
35						
36		<b>Operational parameters</b>				
37		Percentage reduction in tonnes of waste going to landfill	81.0	63.7		0 %
38		Time taken to process sludge from one pit-emptying cycle through LaDePa or combustion	5.00	5.00	N/A	years
39		Annual fossil fuel energy used	5 699	TBC		1 162 GJ / year
40		Combined mass of NPK produced in process				
41		COD reduction across process				
42						
43						
44		<b>Agricultural value of product</b>				
45		Value based on non-organic fertilizer price				
46		Value based on organic fertiliser 1 price	358	N/A		N/A LCU / tonne
47		Value based on organic fertiliser 2 price	211	N/A		N/A LCU / tonne

# RESULTS worksheet Non-financial outputs

# Using the model



eThekwini (South Africa) example –  
show type of information model can  
produce

NOTE – Figures quoted are **model case-  
specific**, not generalised values!

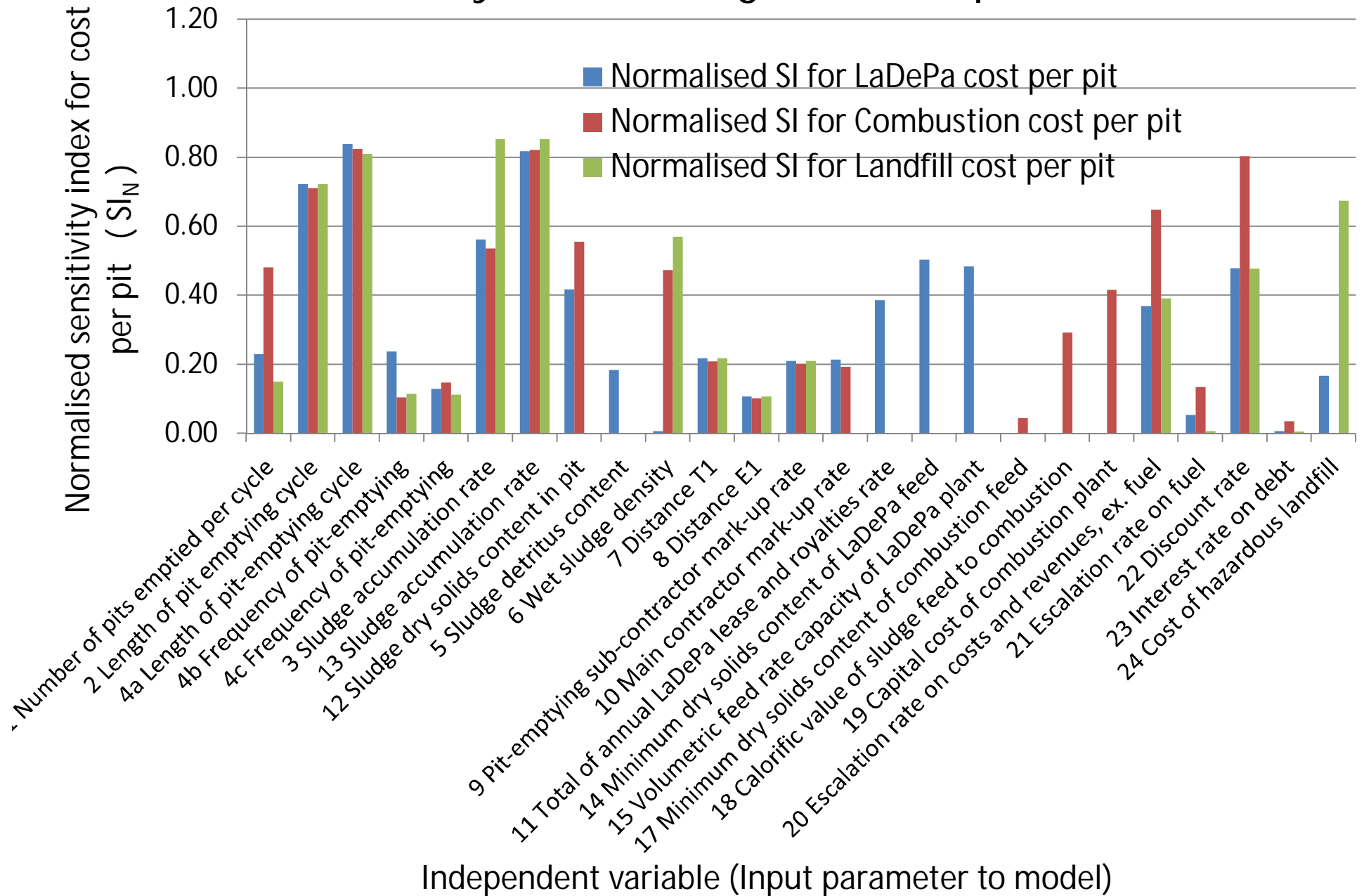
# eThekwini first estimate outputs: LaDePa cost > incineration > landfill

Total cost of sludge disposal (emptying, conveyance and processing via chosen route)

	LaDePa	Combustion	Landfill	
Levelised <b>cost</b> of pit-emptying & sludge disposal <b>per dry tonne FS</b>	1 150	1 100	1000	USD / dry tonne FS
Levelised <b>cost</b> of pit emptying & sludge disposal <b>per pit</b>	380	360	330	USD / pit
Levelised cost to produce product	1 230	2 100	N/A	USD / tonne product

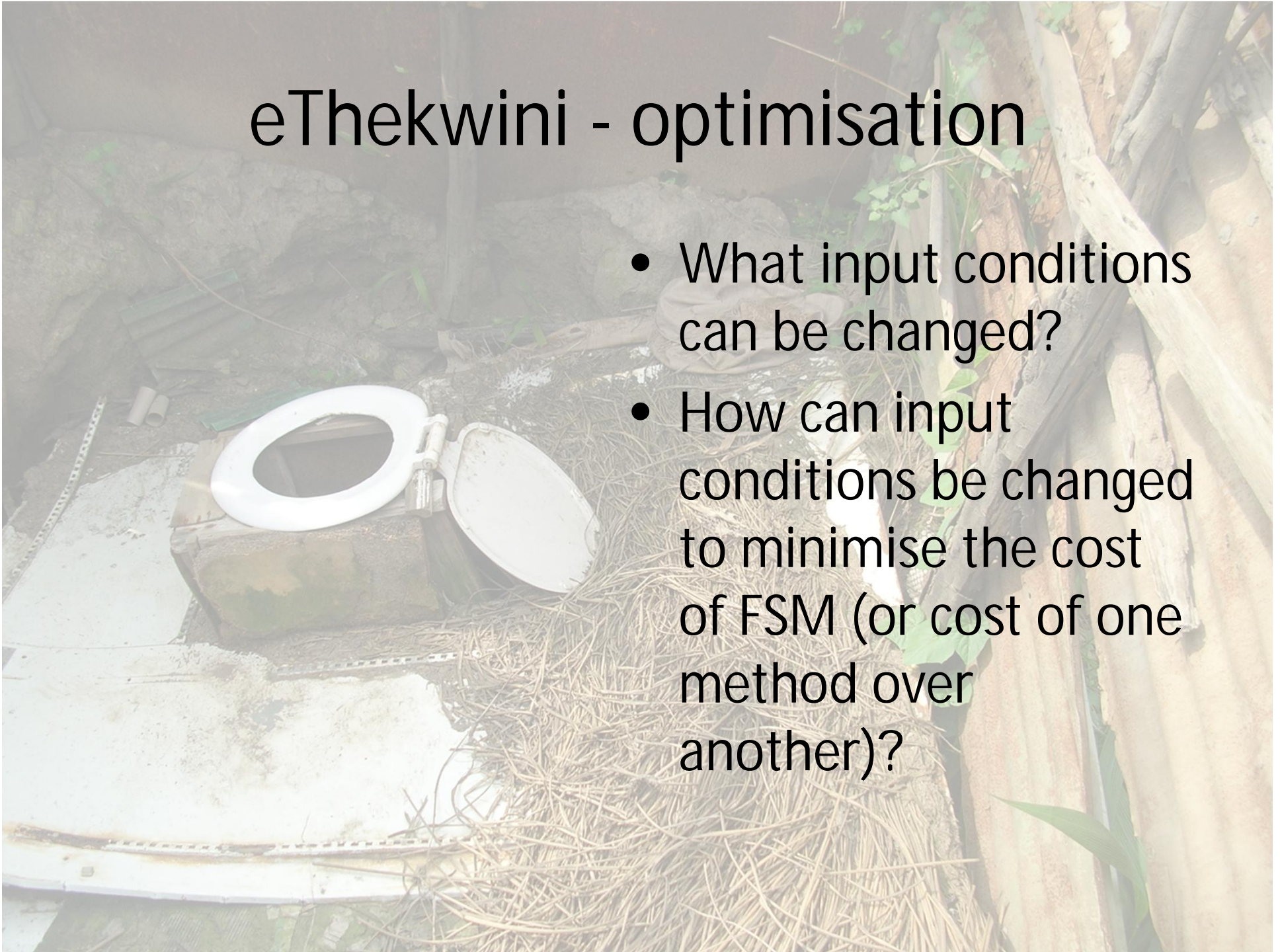


# Sensitivity - what has greatest impact on costs?

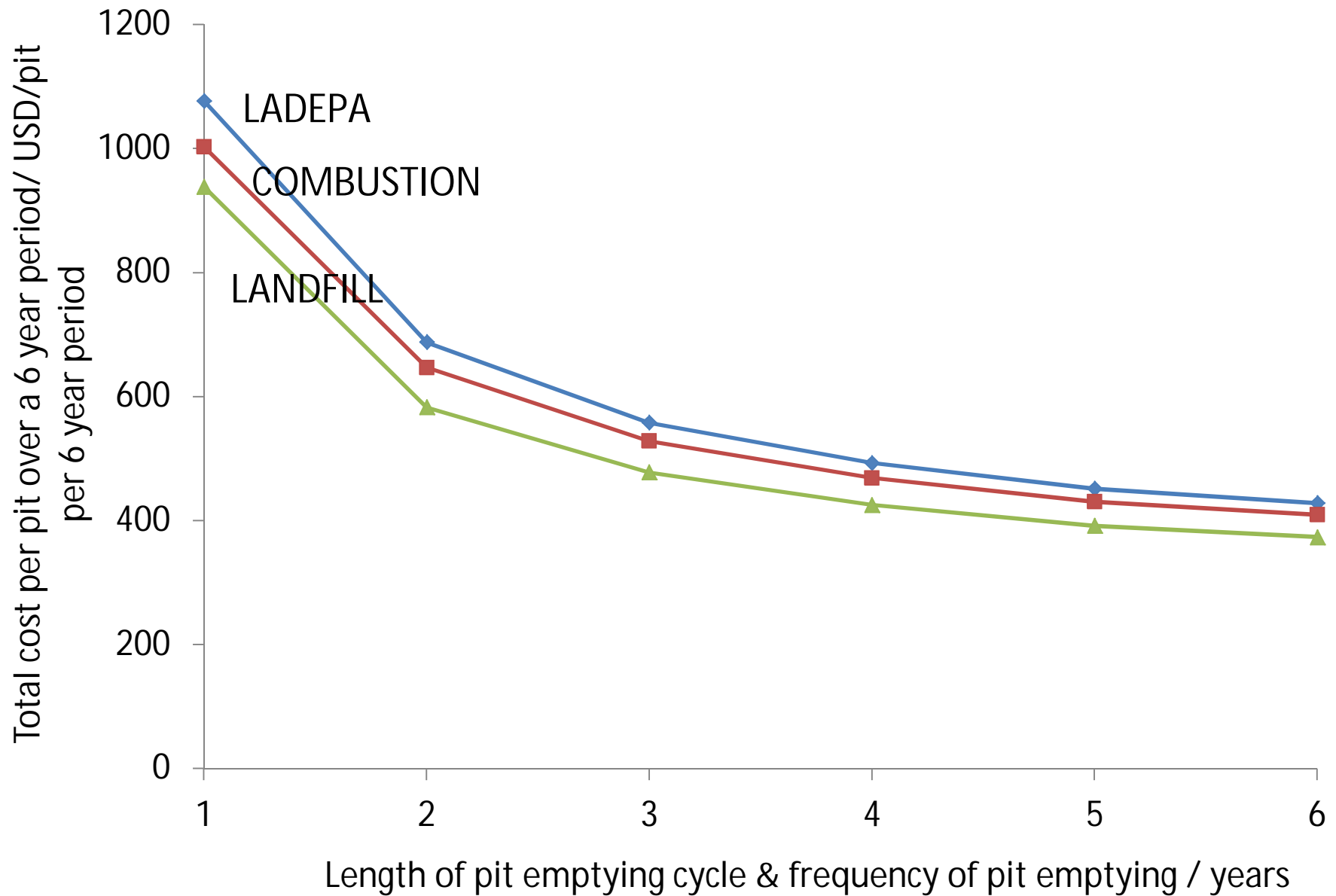


# eThekwini - optimisation

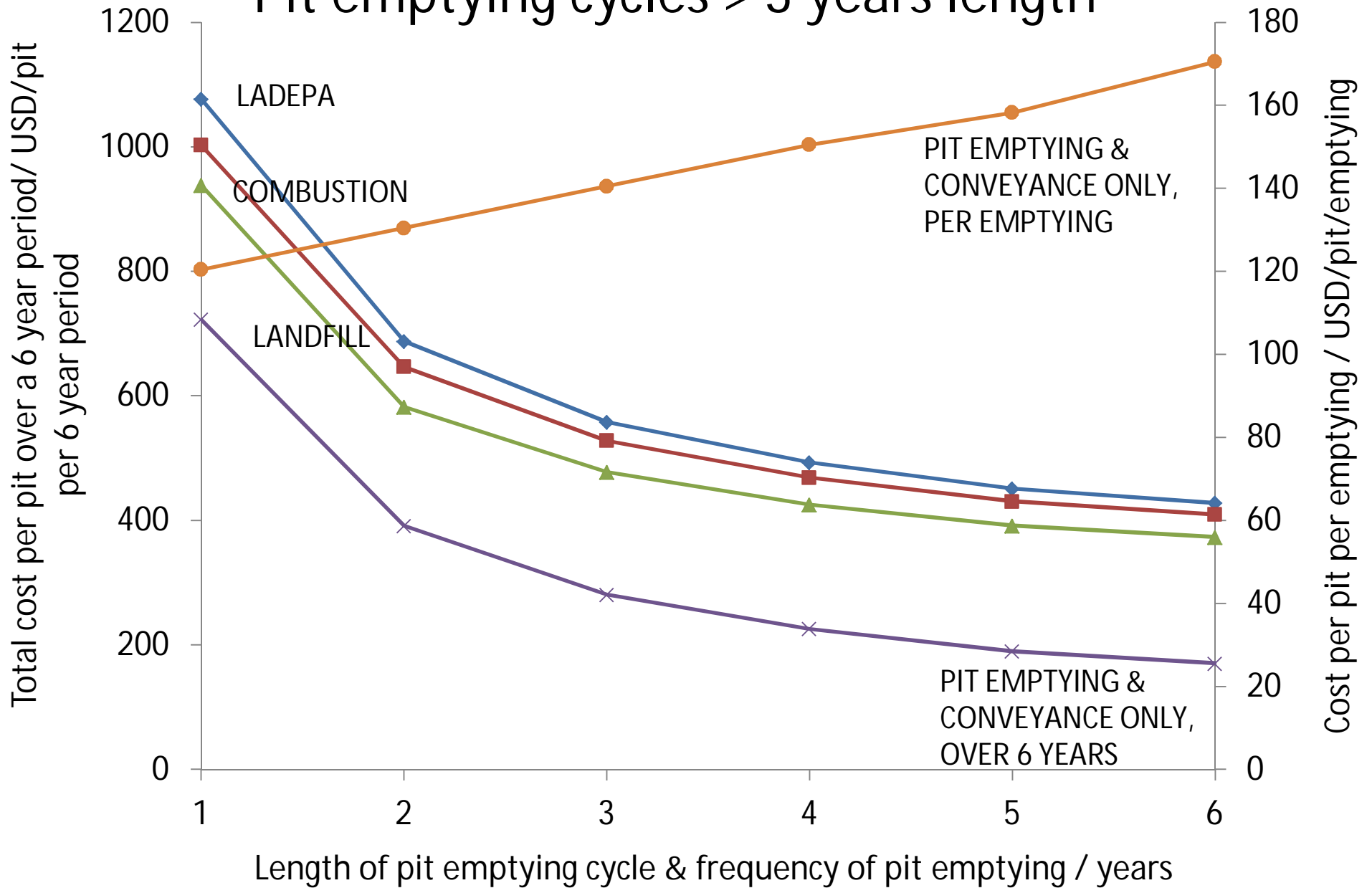
- What input conditions can be changed?
- How can input conditions be changed to minimise the cost of FSM (or cost of one method over another)?



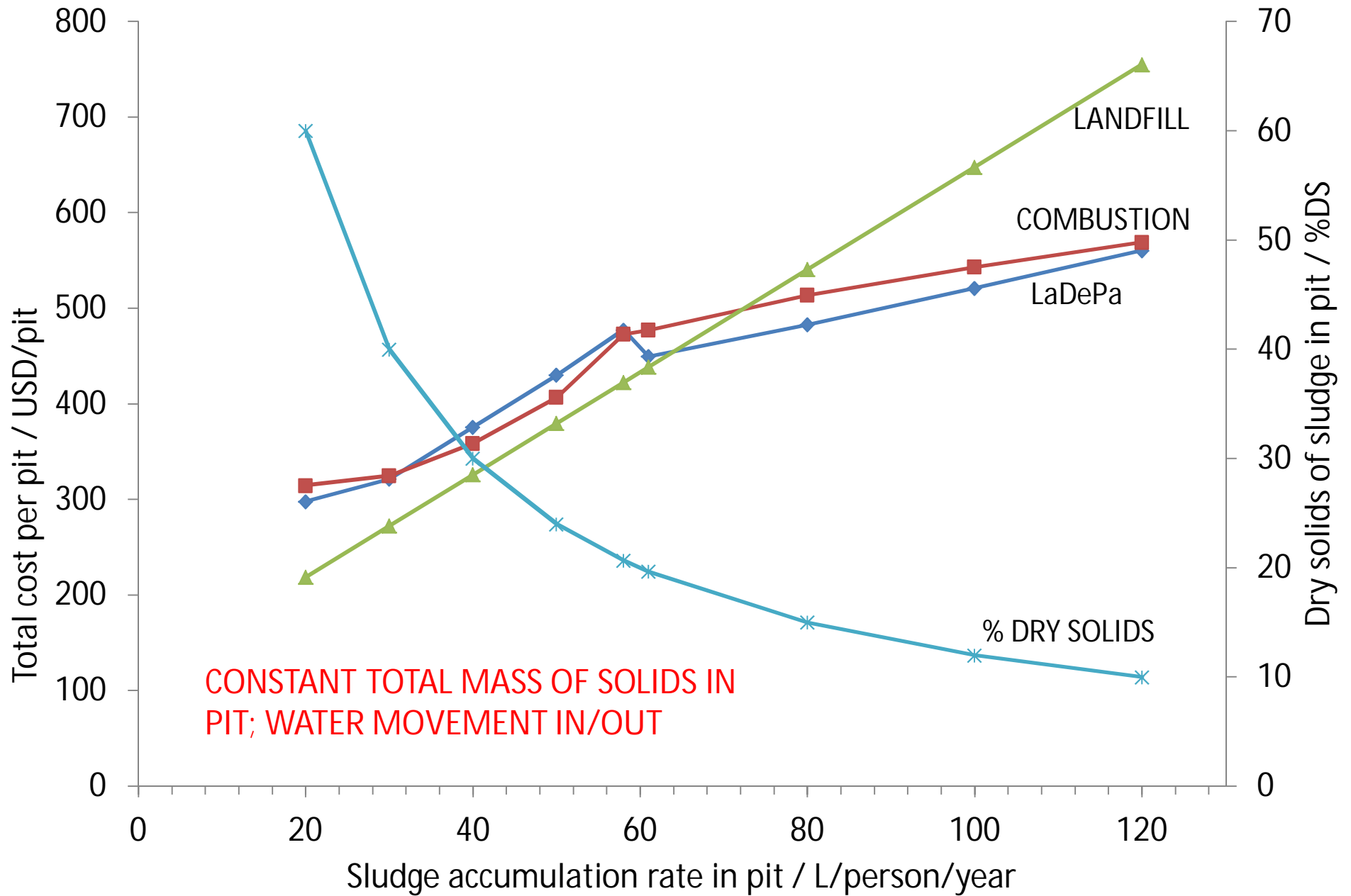
# Pit emptying cycles > 3 years length



# Pit emptying cycles > 3 years length

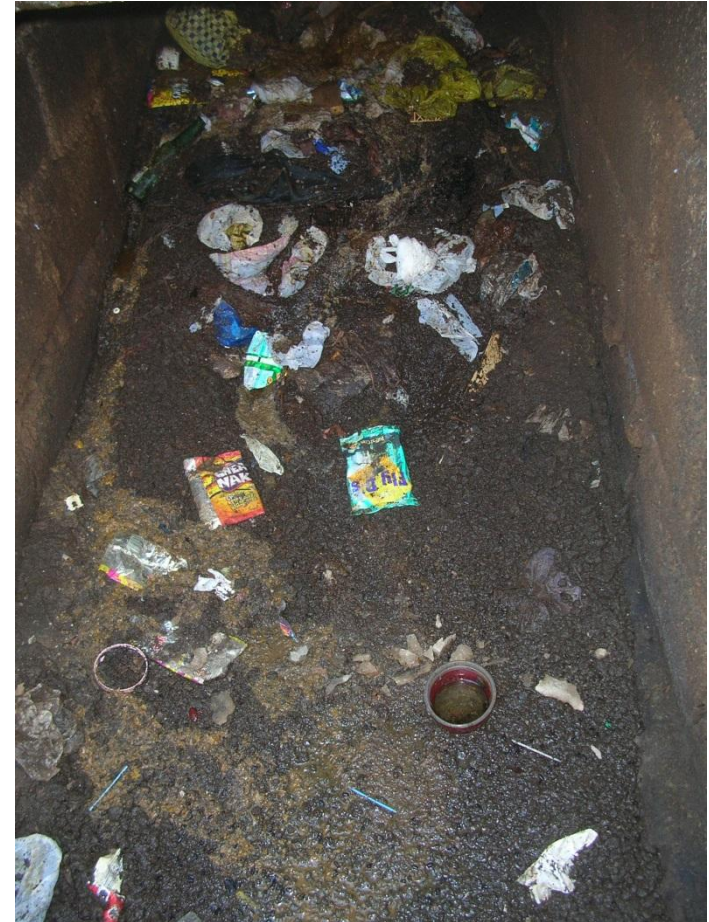


# Produce drier sludge in pits



# eThekwini – minimising cost of FSM

- Maximise no. of households included
- Longer pit emptying cycles
- Minimise sludge accumulation rates
  - Solid waste; pit drainage
- Match %DS required for treatment to %DS obtained in raw sludge
- Optimise decentralisation of treatment plants



# Endproduct values – how significant?

- Product valuation: Partial Budget Analysis
- For a specific crop, soil & distance to market, what price makes a sludge end-product competitive with a conventional fertiliser?
  - NPK content
  - Distance to market
  - Fertiliser application costs
- Increasing endproduct value by changes to FSM chain



# Limitations & future work

- Improve input data:
  - Sludge, LaDePa pellet & ash properties
  - LaDePa & combustion operational data
  - Other locations
- User interface
- Refine the model:
  - Predicting endproduct composition & value from feed sludge data
  - Monetising micro-nutrient & carbon benefits
  - Develop combustion module; energy recovery
  - Determine optimal conditions for LaDePa & combustion
  - Value of ash - construction material
- Link to other FSM models

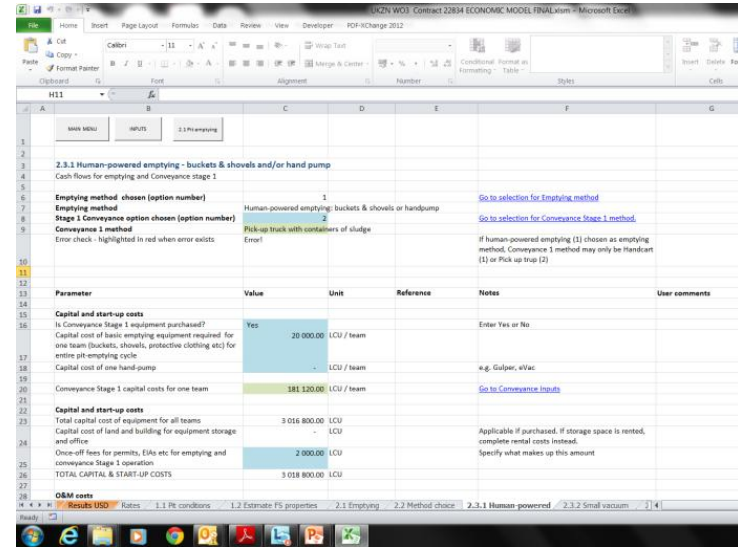


LaDePa plant



# Project outputs

- Spreadsheet **model**
- Report:
  - Guide to using the model
  - Application to eThekweni
- FSM **data sets**
  - Durban, South Africa: majority dry pits
  - Dakar, Senegal: majority septic tanks
- All available for use  
[rscottingham@cantab.net](mailto:rscottingham@cantab.net)



The screenshot shows an Excel spreadsheet with a model interface. The interface includes several input fields and a table of parameters. The table below is a summary of the parameters shown in the spreadsheet.

Parameter	Value	Unit	Reference	Notes	User comments
Emptying method chosen (option number)	1			Go to selection for Emptying method	
Emptying method	Human-powered emptying: buckets & shovels or handpump			Go to selection for Conveyance Stage 1 method	
Stage 1 Conveyance option chosen (option number)	2				
Conveyance 1 method	Pick-up truck with containers of sludge				
Error check - highlighted in red when error exists	Error!			If human-powered emptying (1) chosen as emptying method, Conveyance 1 method may only be Handcart (1) or Pick-up trap (2)	
Is Conveyance Stage 1 equipment purchased?	Yes			Enter Yes or No	
Capital cost of basic emptying equipment required for one team (buckets, shovels, protective clothing etc) for entire pit-emptying cycle	20 000.00	LCU / team			
Capital cost of one hand-pump	-	LCU / team		e.g. Gulper, eVac	
Conveyance Stage 1 capital costs for one team	181 120.00	LCU / team		Go to Conveyance inputs	
Total capital cost of equipment for all teams	3 016 800.00	LCU			
Capital cost of land and building for equipment storage and office	-	LCU		Applicable if purchased. If storage space is rented, complete rental costs instead.	
Once-off fees for permits, E&S etc for emptying and conveyance Stage 1 operation	2 000.00	LCU		Specify what makes up this amount	
TOTAL CAPITAL & START-UP COSTS	3 018 800.00	LCU			

<http://prg.ukzn.ac.za>

# Acknowledgements

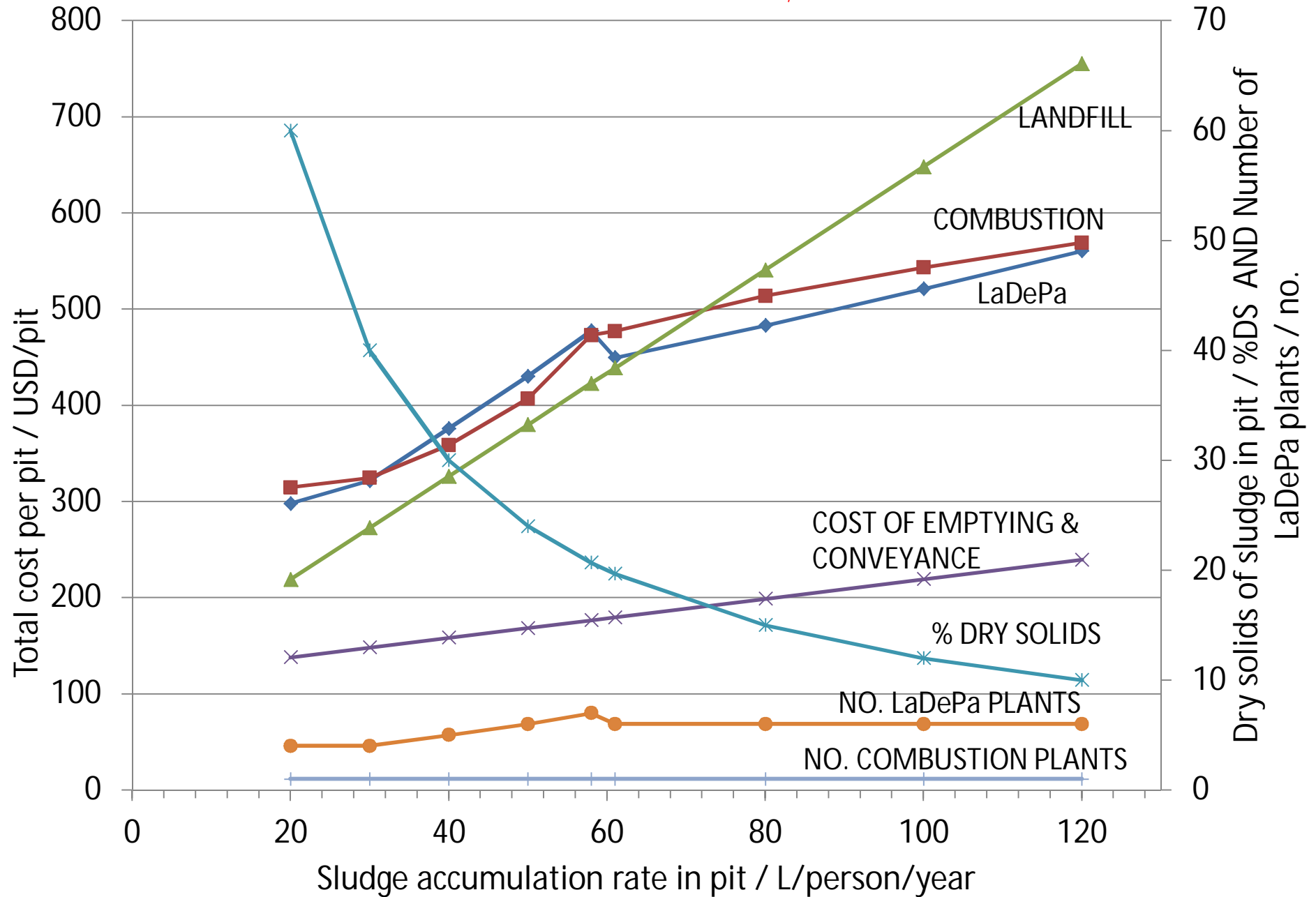


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- UKZN School of Life Sciences: Nicola Rodda, Colleen Archer
- Coal & Waste Utilisation: Jason Germanis
- Fertiliser Society of South Africa: Adam Mostert
- Cedara: Dr Luiz Pereira

# Supplementary slides

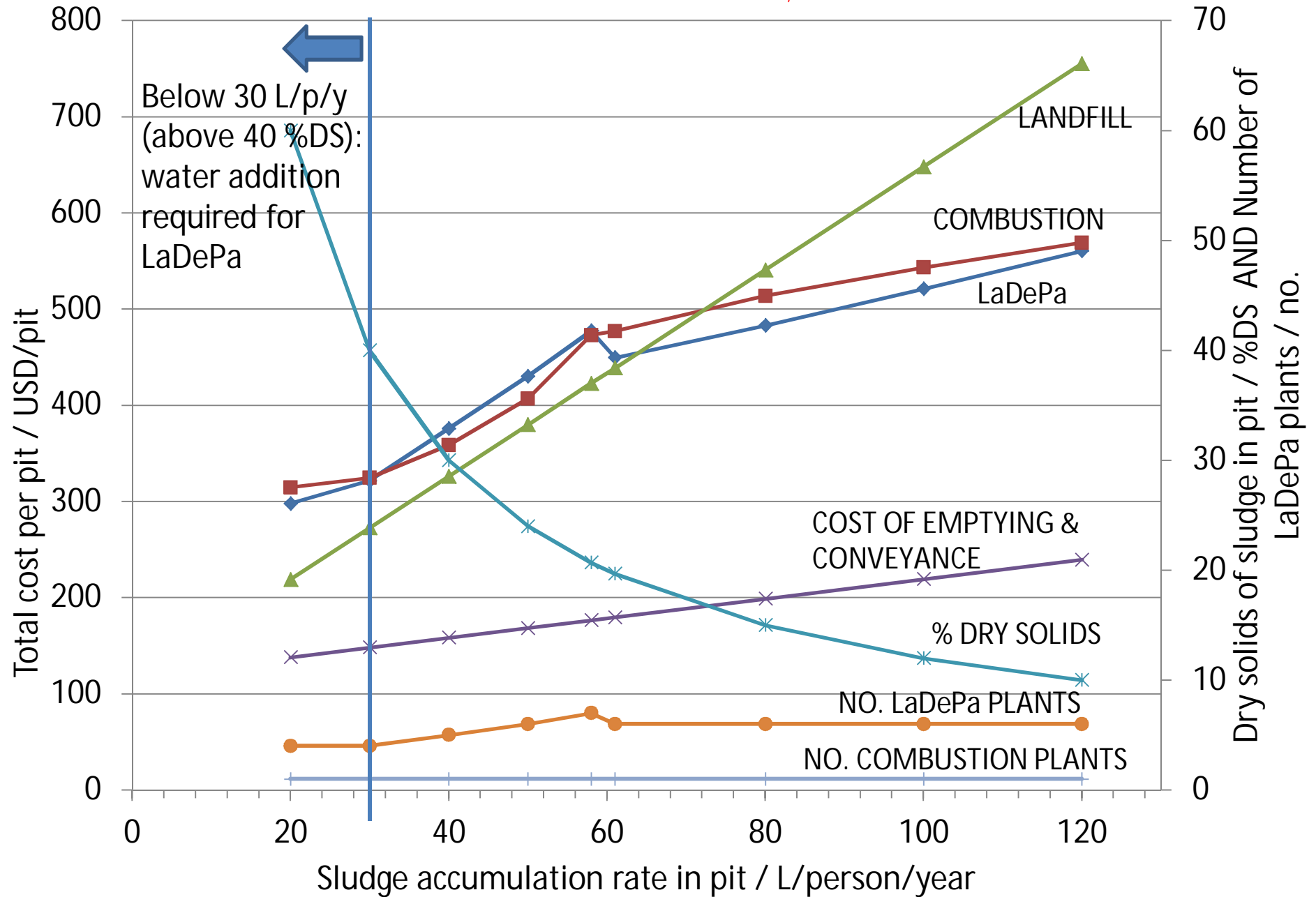
# Produce drier sludge in pits

CONSTANT TOTAL MASS OF SOLIDS IN PIT; WATER MOVEMENT IN/OUT



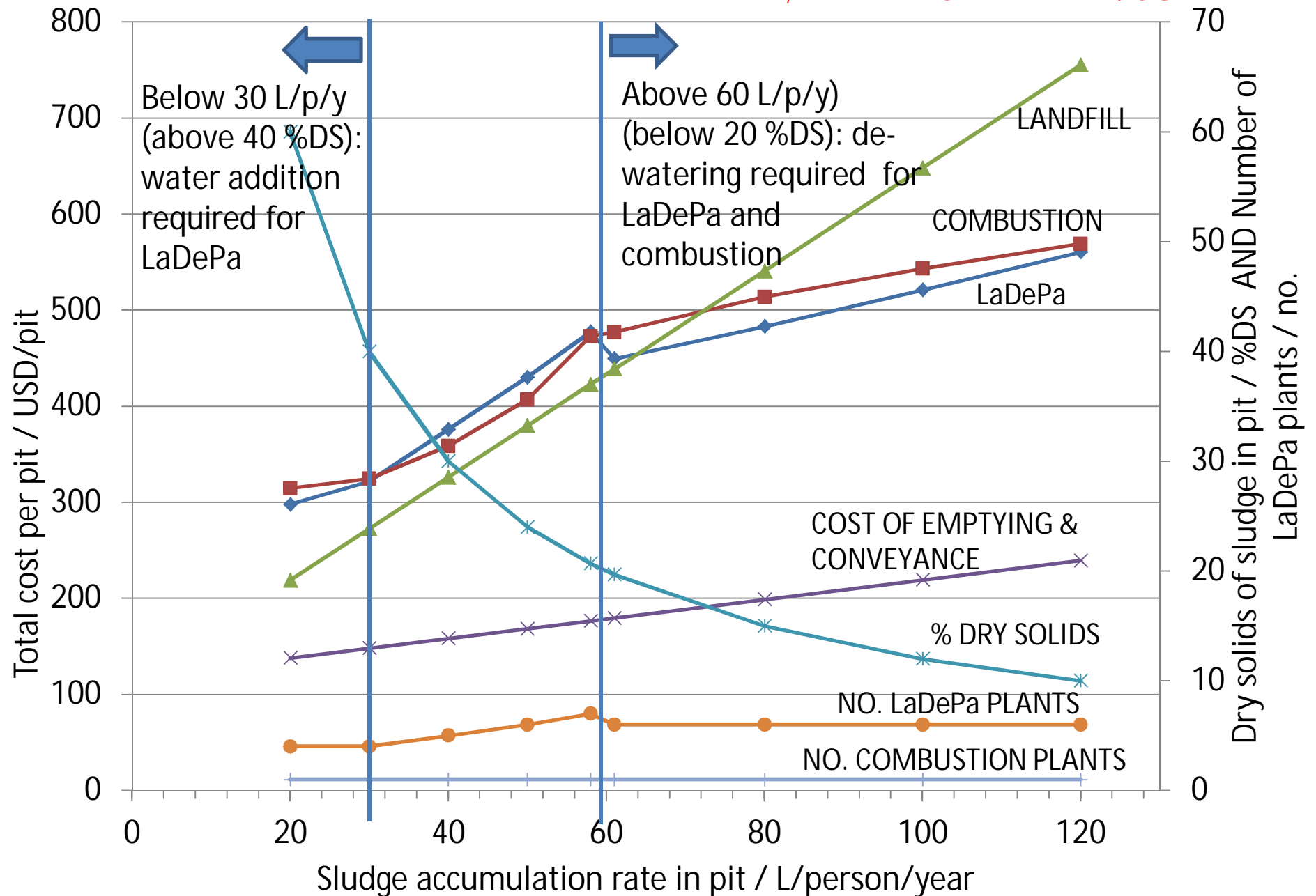
# Produce drier sludge in pits

CONSTANT TOTAL MASS OF SOLIDS IN PIT; WATER MOVEMENT IN/OUT

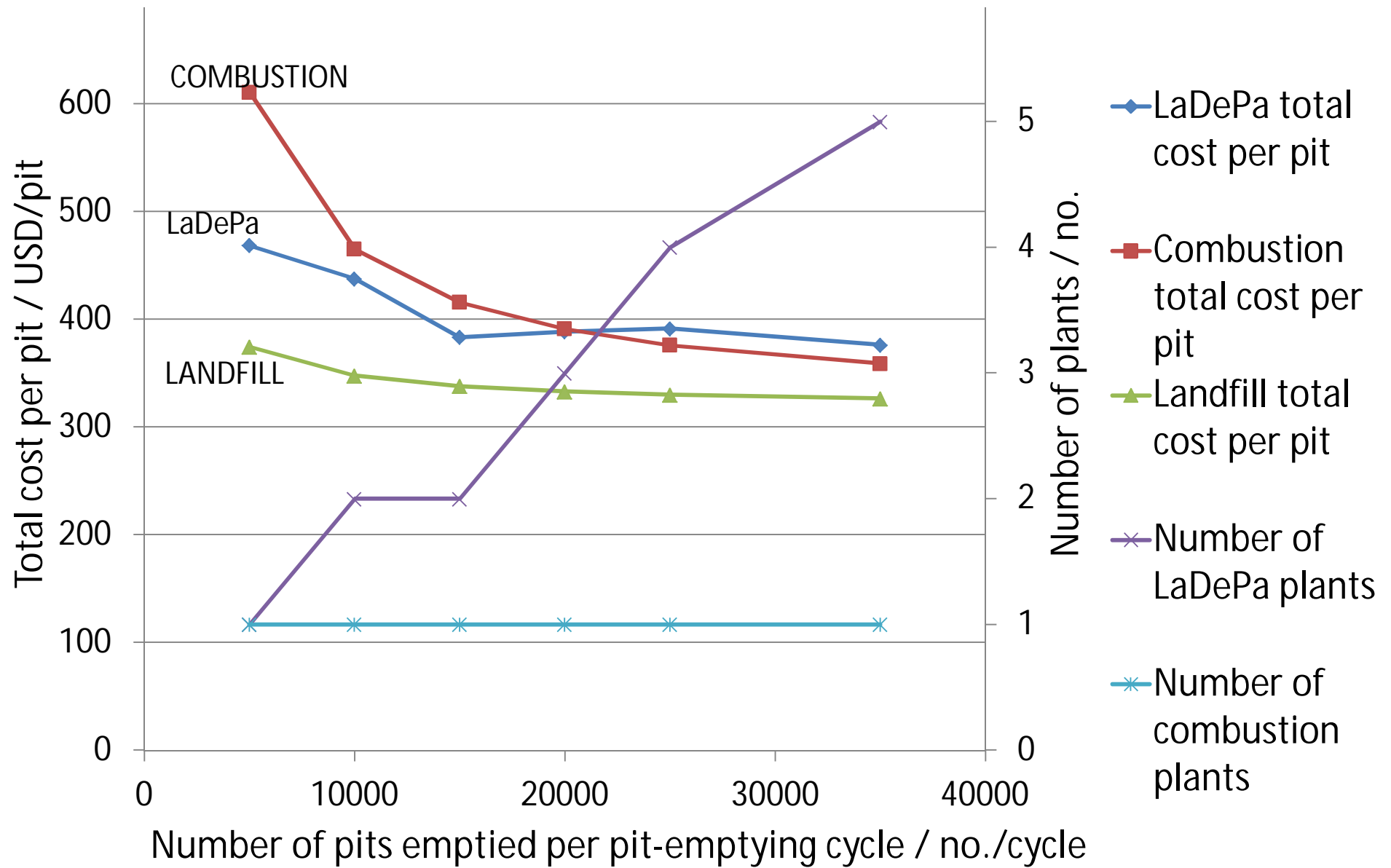


# Produce drier sludge in pits

CONSTANT TOTAL MASS OF SOLIDS IN PIT; WATER MOVEMENT IN/OUT



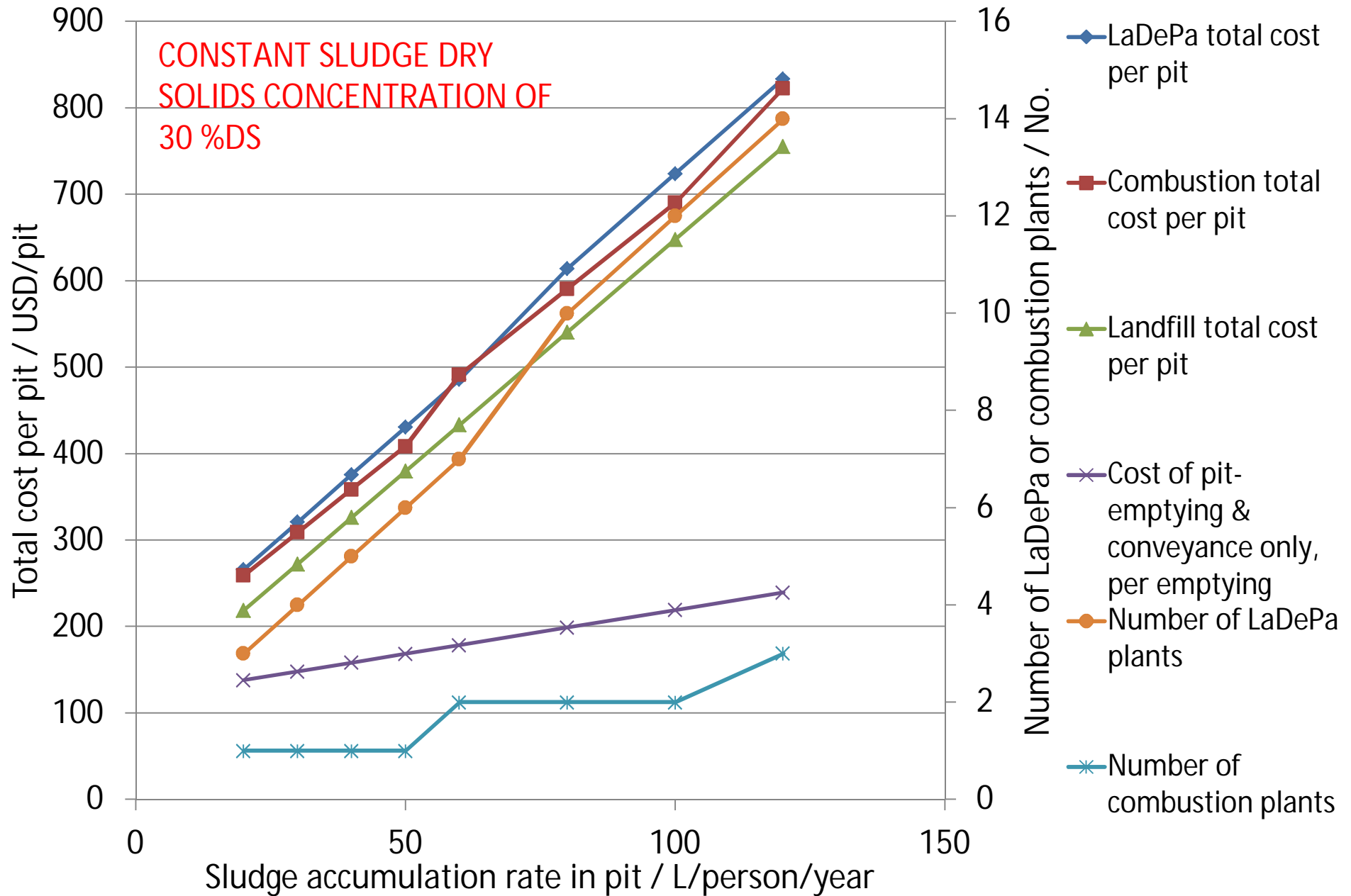
# Maximise the number of pits emptied



# Produce less sludge per pit

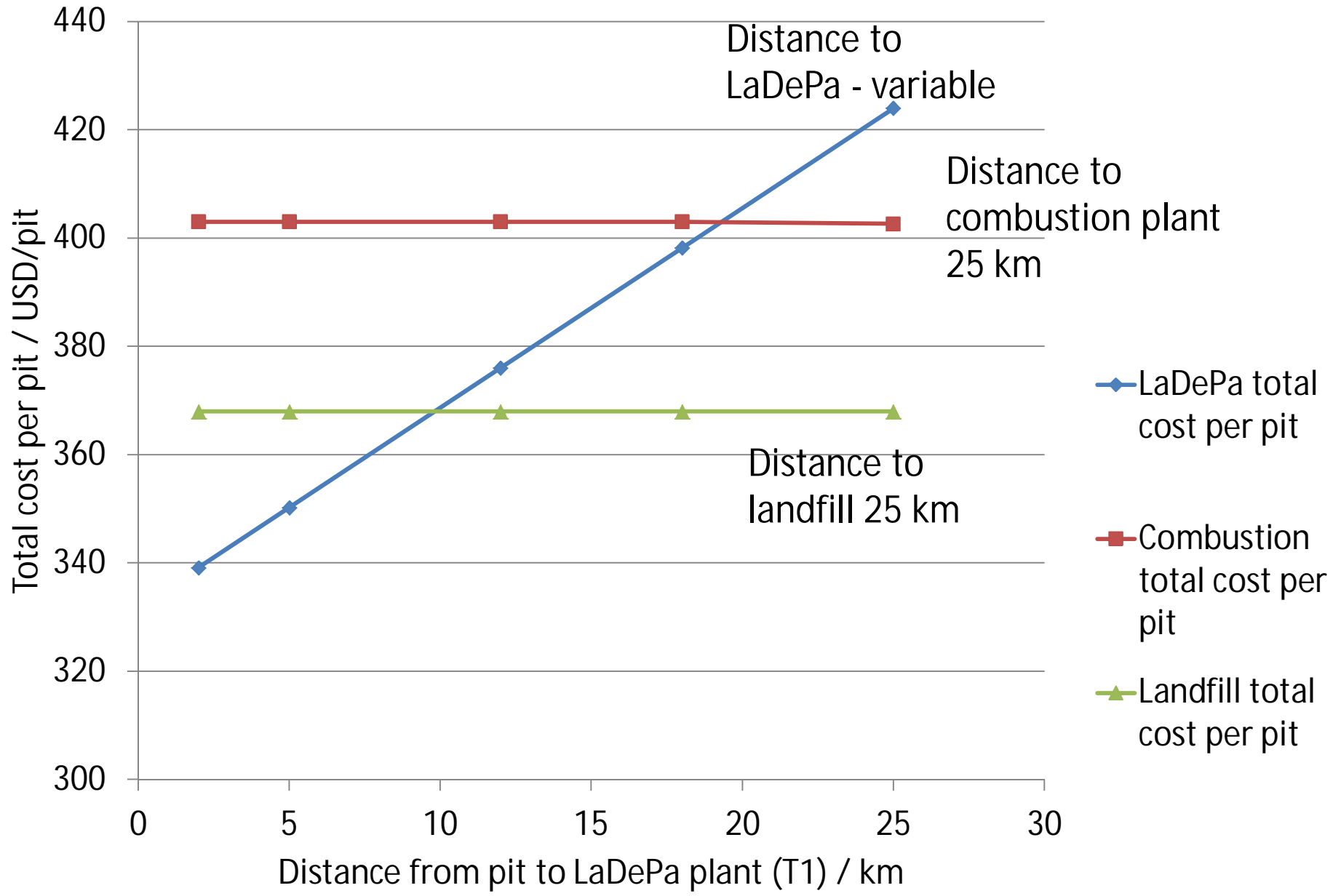
(e.g. better solid waste collection)

VARIABLE TOTAL MASS OF SOLIDS IN PIT IN PROPORTION TO ACC. RATE





# Decentralise effectively – mobile LaDePa plants



# Calculation of SI\_N

- $SI_I = (I_{max} - I_{min}) / I_{max}$
- $SI_D = (D_{max} - D_{min}) / D_{max}$
- $SI_N = SI_D / SI_I$

# EWS business model

