PROJECT TITLE	Economic Evaluation of Faecal Sludge Disposal Routes
CLIENT	Bill and Melinda Gates Foundation
CONTRACT #	22834
MADE BY	Ruth Cottingham (RSC)
CHECKED BY	
DATE	2013/11/06
SPREADSHEET TITLE	**Economic evaluation model for faecal sludge disposal**
Description of spreadsheet	Economic model to evaluate different faecal sludge disposal routes
Filing location	
Filename	20131106 UKZN WO3 FS disposal economic model Contract 22834 FINAL

CONTENTS OF SPREADSHEET

#	SHEET	DESCRIPTION
	Notes	General notes on model and its usage
	MAIN MENU	Navigation page
	INPUTS	Inputs sheet - all inputs entered here
	Results LCU	Summary of key results generated by model in Local Currency Units
	Results USD	Summary of key results in United States Dollars
	Rates	Standard rates for labour etc used throughout model
1,1	**Pit conditions**	Characterisation of pit conditions and sludge characteristics, allowing for blend of different sludges
1,2	**Estimate FS properties**	Context parameters entered, model estimates characteristics of FS in the pit
2,1	**Emptying**	Emptying of pits: context data inputs
2,2	**Method choice**	Flowchart to suggest suitable emptying method choice for context
2.3.1	**Human-powered**	Data on human-powered emptying methods
2.3.2	**Small vacuum**	Data on small vacuum tanker emptying methods
2.3.3	**Large vacuum**	Data on large vacuum tanker emptying methods
2,4	**Emptying data**	Summary of data on different emptying methods
2,5	**Emptying CF**	Cash flow tables for different emptying methods and Conveyance Stage 1
3,1	**Conveyance**	Costs and revenue associated with transfer of sludge from the pit to a storage facility at the treatment site
3,2	**Method choice**	Flowchart to suggest suitable conveyance method choice for context
3.3.1	**Handcart**	Data on handcart for FS conveyance
3.3.2	**Pickup**	Data on pickup truck for FS conveyance
3.3.3	**Small vacuum**	Data on small vacuum tanker for FS conveyance
3.3.4	**Large vacuum**	Data on large vacuum tanker for FS conveyance
3.3.5	**Transfer station**	Data on transfer station for intermediate storage during FS conveyance
3.3.6	**Sewer station**	Data on sewer transfer station for FS conveyance
3,4	**Conveyance**	Summary of data on different conveyance methods
3.5.1	**Conveyance Stage 2**	Cost calculations for Conveyance Stage 2
3.5.2	**Conveyance Stage 3**	Cost calculations for Conveyance Stage 3
3.5.3	**Conveyance Stage 4**	Cost calculations for Conveyance Stage 4
3.6.1	**C2 I&R**	Interest & repayment sheets Conveyance Stage 2
3.6.2	**C3 I&R**	Interest & repayment sheets Conveyance Stage 3
3.6.3	**C4 I&R**	Interest & repayment sheets Conveyance Stage 4
3.7.1	**C2 CF**	Cash flow sheet Conveyance Stage 2
3.7.2	**C3 CF**	Cash flow sheet Conveyance Stage 3
3.7.3	**C4 CF**	Cash flow sheet Conveyance Stage 4
3,8	**Levelised costs**	Levelised costs of emptying & conveyance
3,9	**Managing contractor**	Managing contractor costs
4	**LaDePa storage**	Costs of storage and sludge characteristics at output of storage
5	**LaDePa pretreat**	Costs of pre-treating sludge to a state suitable for input to the LaDePa process
6	**LaDePa**	Costs of treating sludge via the LaDePa process
7	**LaDePa product**	Costs and/or revenue associated with sale/disposal of the LaDePa pellets
8	**LaDePa by-product**	Costs associated with disposal of LaDePa process by-products
9,1	**LaDePa cost summary**	LaDePa cost summary
9,2	**LaDePa I&R**	LaDePa interest & repayment sheet
9,3	**LaDePa CF**	LaDePa cash flow sheet
9,4	**LaDePa NPV**	LaDePa NPV sheet
10	**Mass balance**	Mass balance check over LaDePa process
11	**Combustion storage**	Costs of storage and sludge characteristics at output of storage
12	**Combustion pretreat**	Costs of pre-treating sludge to a state suitable for input to the combustion process
13	**Combustion**	Costs of treating sludge via the combustion process
14	**Combustion product**	Costs and/or revenue associated with sale/disposal of the combustion ash
15	**Combustion by-product**	Costs associated with disposal of combustion process by-products
16,1	**Combustion NPV**	Combustion cost summary
16,2	**Combustion I&R**	Combustion interest & repayment
16,3	**Combustion CF**	Combustion cash flows
16,4	**Combustion NPV**	Combustion NPV
17	**Landfill**	Landfill costs and cash flow
18	**Service provider costs**	Service provider costs for managing sludge disposal
19	**Product valuation**	Calculation of potential value of sludge endproducts
20	**Crop application**	Economic feasibility calculation of replacing conventional fertilisers with sludge endproducts
	Calculations	Additional calculations, including fossil fuel usage
G1	**Distances**	Graphic showing labels for distance inputs referred to in the model
	Abbreviations	List of abbreviations used throughout model
	References	List of literature references used throughout model
	Reference values	List of typical values for selected input parameters
	Cost analysis	In development
	Cost analysis chart	In development
	Lists	Used in model inputs
	Sensitivity	Used when carrying out sensitivity analyses

REVISIONS **Current revision** **R**

Rev	**Date**	**Made by**	**Checked**	**Description of changes**
Draft	2013/03/27	RSC		Input and output parameters for each module collated (first draft)
A	2013/03/28	RSC	SM	Input and output parameters for each module collated (first draft) - submitted as part of Phase 1 deliverable
B	2013/04/03	RSC		Detail added to Results, Rates, Modules 1 - 2. Notes & abbreviations sheets added. Sent to DS for review 5/4/2013
C	2013/04/05	RSC		Detail added to Modules 1 - 5
D	2013/04/08	RSC		Financial structure changed - each module to output yearly cash flows to a single combined cash flow and NPV sheet for (i) LaDePa and (ii) total combustion. Cash flow and NPV worksheets added. Detail added to Modules 5 - 9. Sent to SM 8/4/2013

E	2013/04/08	RSC		Detail added to Modules 10 - 14. Sent to SM 9/4/2013
F	2013/04/10	RSC	DS reviewed, not full check	Structure of Mods 2 and 3 revised. Detail added to 10 - 14. Sent to DS 17/4/2013
G	2013/04/18	RSC		Revised detail on various sheets based on meeting with DS.
H	2013/04/26	RSC		Re-structure of Mod 2 to only include inputs on sludge from one pit-emptying area rather than multiple (simplifies financial structure for first version of model). Format changes. Additions to Notes.
I	2013/04/30	RSC		Revisions to chemical property inputs required for sludge and pellets.
J	2013/05/06	RSC		Renamed to Rev J for submission as part of Phase 2 deliverable to avoid confusion between I and 1. Submitted as part of Phase 2 deliverable.
K	2013/05/21	RSC		Terms modified to match terminology in EAWAG Sanitation Compendium. Sheet 3 'Transfer' now 'Conveyance'. Nomenclature for Emptying and Conveyance methods changed to match Compendium nomenclature. Combustion pre-treatment and process modules revised. Major revisions to Modules 1, 2 and 3. Data entered. Sent to DS 21/5/2013
L	2013/05/22	RSC	DS reviewed, not full check	Revisions to Modules 4, 5 and 6. Sent to DS 23/5/2013
M	2013/05/24	RSC		Revisions to Module 6. Used for review meeting 24/5 DS.
N	2013/05/27	RSC		Revisions based on review with DS. Additional inputs added to Rates, Modules 1 - 3 to enable generation of blank input templates. Sent to SM and DS 14/06/2013
P	2013/07/11	RSC		Modules broken up into separate worksheets. Main menu navigation structure inserted. Major revisions to code of modules 2 and 3. Partially reviewed with DS at meeting 31/7/2013.
Q	2013/08/11	RSC		Submitted as part of Phase 4 deliverable.
R	2013/09/15	RSC		Major revisions to all modules. Sent to DS 15/09/2013
S	2013/09/16	RSC		Error fixed - sent to DS 16/09/2013
20130917 Sv2	2013/09/17	RSC		Sent to DS 17/09/2013
20130917 Sv3	2013/09/18	RSC		Reviewed with DS 18/09/2013
20130917 Sv4	2013/09/18	RSC		With changes from DS review 18/09/2013
20130920 S	2013/09/20	RSC		With changes from EWS workshop 20/09/2013
20130930 S	2013/09/30	RSC		Sent to DS and SM for checking 30/9/2013
20131009 S	2013/10/09	RSC	DS	Sent to DS for checking 09/10/2013
20131011 S	2013/10/11	RSC	DS	Sent to DS for checking 11/10/2013
20131028 S	2013/10/28	RSC		**Used for most of sensitivity analysis results RevE** - see note on Reve E spreadsheet re results for costs per tonne dry soldis. 30/10/2012 Sensitivity analysis with results in costs per tonne re-run using corrected version.
20130917 RevS				**Use for sensitivity analyses. Macros use this filename.**
T	2013/11/04	RSC		Formatting finalised for submission with BMGF report. Sensitivity macros will not work in this version.
FINAL	2013/11/06	RSC		Final version for deliverable. Sensitivity macros will not work in this version.

Note on sheet protection

To protect all worksheets at the same time, run the "ProtectAll" macro (will prompt for password)

To unprotect all worksheets at the same time, run the "UnprotectAll macro"

Instructions for using the model

1. Data input values can only be entered / changed via the INPUTS sheet

2. Key to cell colours is as follows:

Input cell
Input with column A highlighted orange: Optional inputs

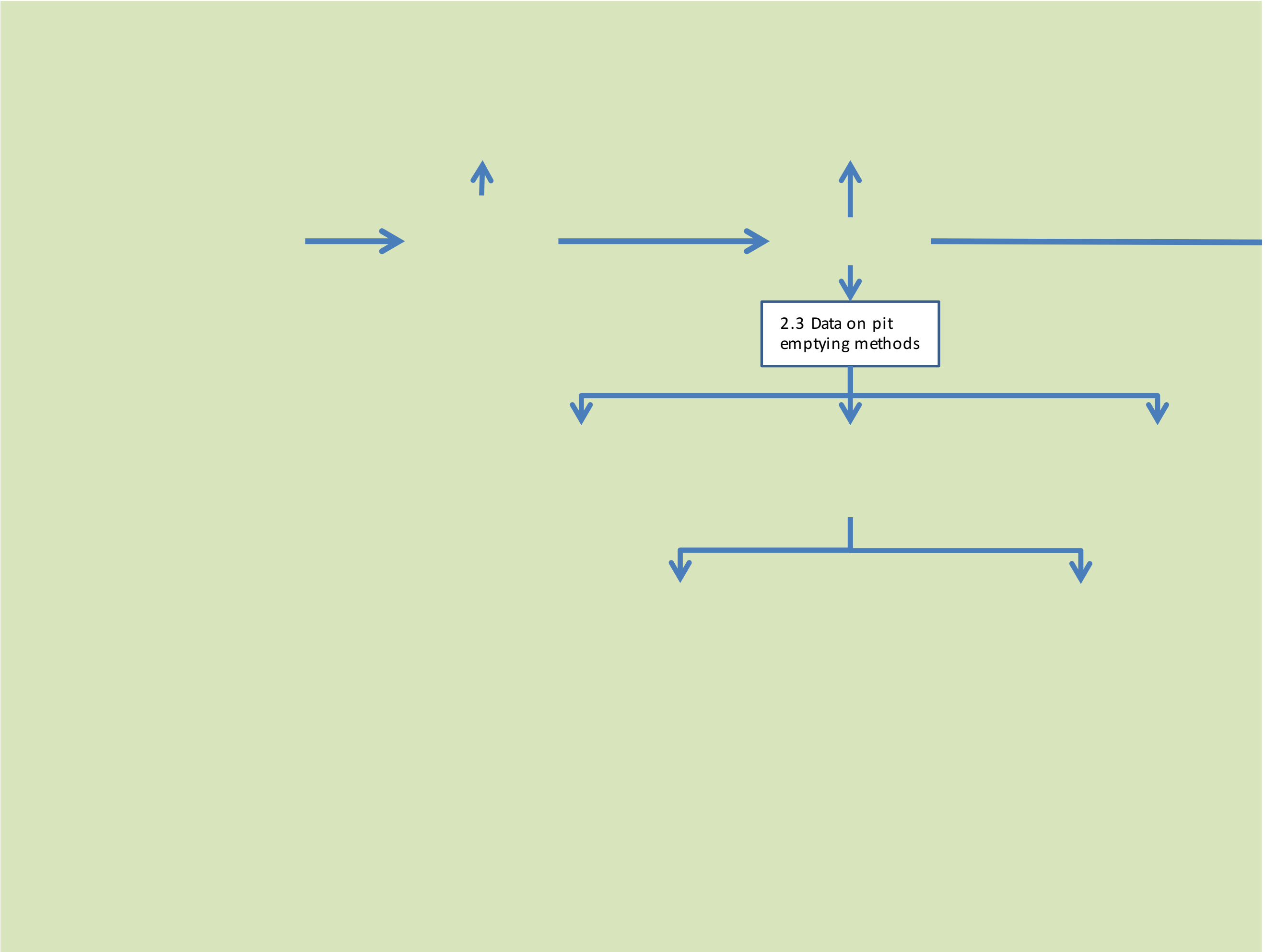
Input with column A highlighted red: Inputs which must be reviewed for accuracy when model conditions are changed and the model re-run

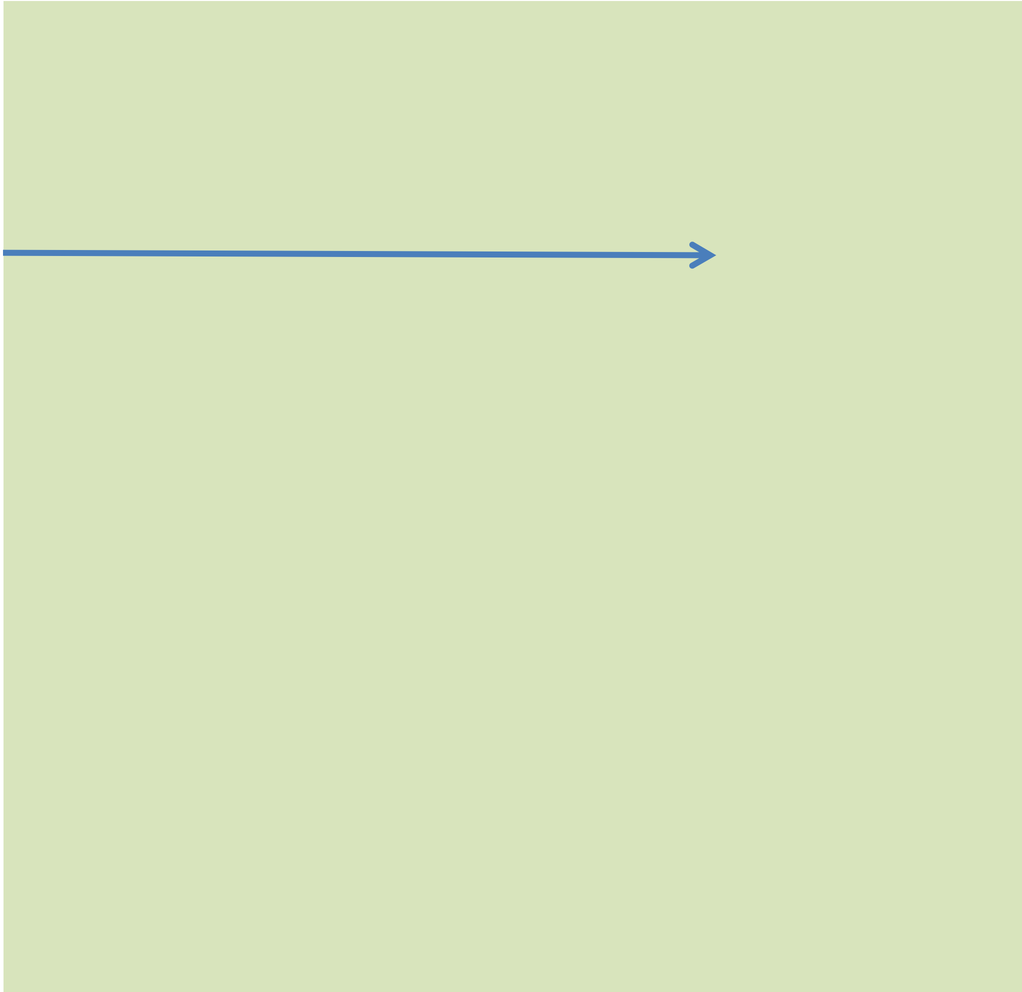
Value carried from another part of spreadsheet
Calculation
Query or user-check required
Example

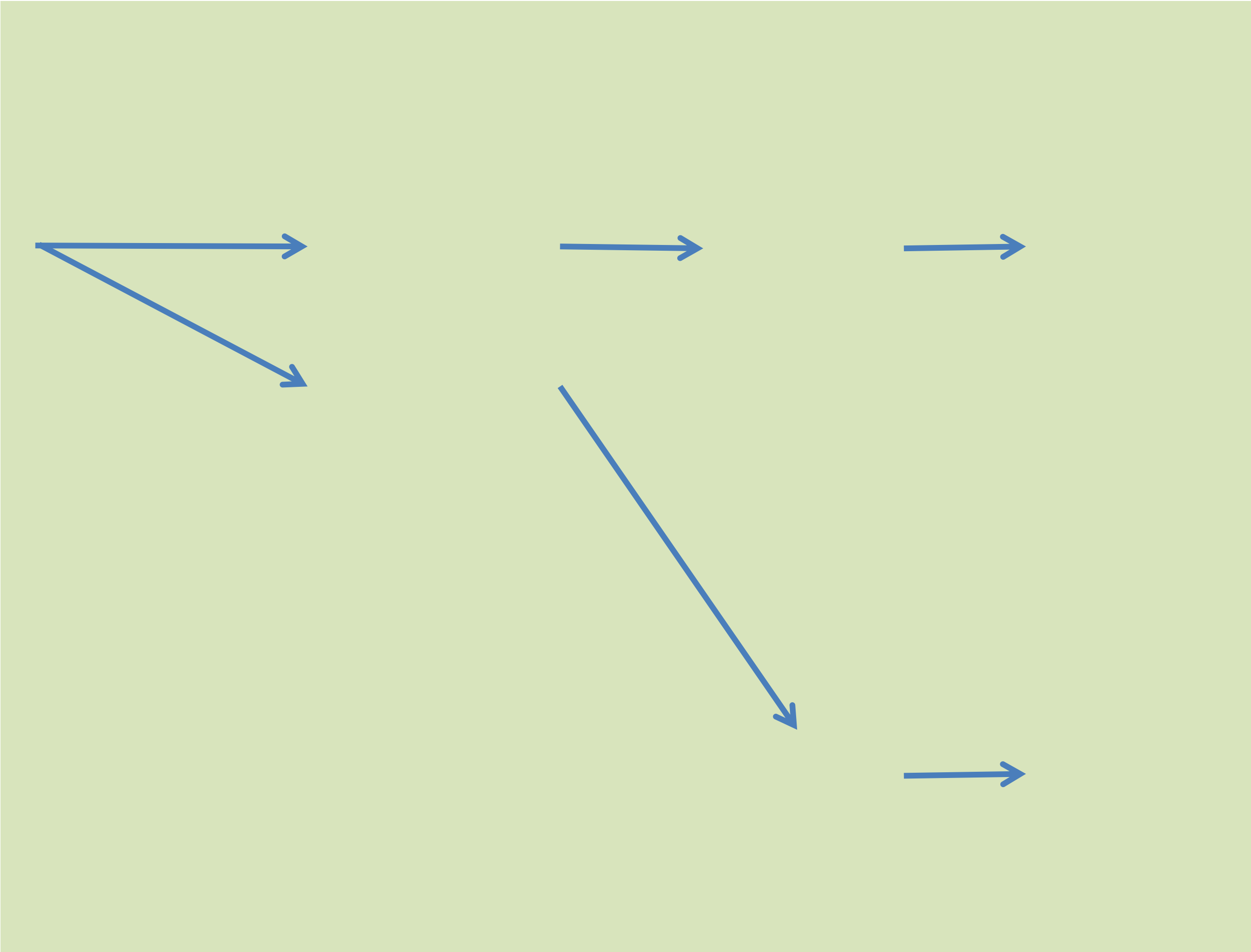
3. The following cells / worksheets can be edited by the user (all other cells are locked):
Input cells (blue) on the INPUTS sheet
References colum on the INPUTS sheet
User notes column on the INPUTS sheet
Reference worksheet
Abbreviations worksheet

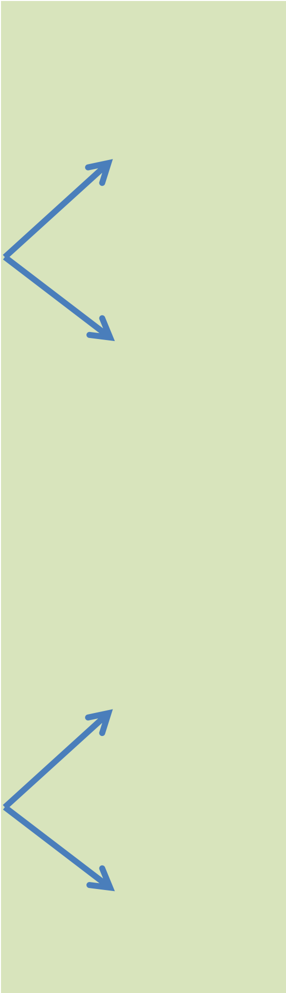
4. Navigate between sheets using the MAIN MENU page, or the menu bar in the top row of most sheets

5. Model outputs are shown in the Results LCU and Results USD tabs.


2.3 Data on pit emptying methods







Input data

Enter all input data into this sheet. Cells are linked to the rest of the model.

Notes

1. LCU = local currency unit
2. BLUE cells: DATA INPUT cells.
3. Input with column A highlighted orange: Optional inputs
4. Input with column A highlighted red: Inputs which must be reviewed for accuracy when model conditions are changed and the model re-run
5. BLANK cells: provide additional information
6. Record the source for each piece of data in the 'Reference / source' column.
7. List full references / bibliography on the 'References' worksheet
8. The 'Template Notes' column gives additional explanation on each input field.
9. User comments provides space for the user to record notes

Links to inputs for different model sections

1. Pit conditions
2. Emptying
3. Conveyance

4. LaDePa Storage
5. LaDePa pre-treatment
6. LaDePa process
7. LaDePa product
8. LaDePa by-product
9. LaDePa cost calculations

11. Combustion Storage
12. Combustion pre-treatment
13. Combustion process
14. Combustion product
15. Combustion by-product
16. Combustion cost calculations

17. Landfill

18. Service provider costs
19. Product valuation
20. Crop application

Location	eThekwini municipality, South Africa
Date made	2013/09/15

Rates

Parameter	Value	Unit	Reference / source	Template notes	User comments
Financial					
Local currency	South African Rand	ZAR		Name and units are inputs	
Exchange rate Local currency -USD	10	Local currency / USD			
Escalation rate on O&M costs and revenues, excluding fuel	6	%			
Escalation rate on fuel	12	%			
Interest rate on debt	9	%			
Debt proportion in debt:equity ratio	70	%			
Discount rate	8	%			
Income tax rate	28	%			
Lifetime used to caculate depreciation rate for civils	20	years			
Lifetime used to calculate depreciation rate for large mechanical items	10	years		Large mechanical item: e.g. vacuum tanker	
Lifetime used to calculate depreciation rate for small mechanical items	5	years			
Terminal value of assets	10	% of initial value			
Cost of general landfill	1300	LCU / tonne			
Cost of hazardous landfill	1700	LCU / tonne			
Consumables					
Gasoline	12,88	LCU / ℓ	Automobile Association 2013		
Diesel	12,34	LCU / ℓ	Automobile Association 2013		
Water	-	LCU / ℓ			
Vehicle oil	26,52	LCU / ℓ			
Vehicles					
Pick up truck - typical costs				If the breakdown of operating costs is now known, a total yearly operating cost can be entered under the "Other costs" input	
Pick up truck rental rate	7 000,00	LCU / month		Used if vehicles are not purchased. For example, municipal vehicles may be internally hired to different departments.	
Driver labour rate	30	LCU / hour			
Pick up truck capital cost	175 000	LCU	Department of Agriculture Machinery Guide 2011. 3000 cc 1 tonne club cab diesel pick up truck. 2010-2011 price ZAR 296,265. 2013 price at 6% escalation 332,883. Lower value chosen based on local experience of actual prices available.		
Average travel speed of pick-up truck	50	km / h			
Fuel consumption for pick-up truck	10,53	km / ℓ	Dept. of Agriculture Machinery guide 2010 -2011: 9.5 L/100 km		
Oil consumption for vehicle	1	% of fuel consumption	Dept. of Agriculture Machinery guide 2010 -2011		
Price of set of tyres	5 339,00	LCU / set	Dept. of Agriculture Machinery guide 2010 -2011: R4751.75 2011 price, R5339 2013 price		

Distance for which new set of tyres lasts	50 000	km	Dept. of Agriculture Machinery guide 2010 -2011	
Equipment repair and maintenance cost over lifetime	50	%	Dept. of Agriculture Machinery guide 2010 -2011	Used to calculate repair and maintenance rate per km
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 rate per km
Repayment period for debt	3	years		Debt for capital borrowed to buy equipment.
Vehicle insurance cost	3,5	% of purchase price / year		
Vehicle licence	482,00	LCU / year	Dept. of Agriculture Machinery guide 2010 -2011 price R429, 2013 price R482	
Other costs	-	LCU / year		Sundries, or enter total yearly costs for vehicle here if the cost breakdown is not known.

3 - 5 tonne truck - typical costs

If the breakdown of operating costs is now known, a total yearly operating cost can be entered under the "Other costs" input

Truck rental rate	30 000,00	LCU / month		
Driver labour rate	30	LCU / hour		
Truck capital cost	350 000	LCU	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry	
Average travel speed of truck	50	km / h		
Fuel consumption for truck	6,66	km / ℓ diesel	15 l/100km Dept of Agriculture Machinery guide 2010 - 2011 for 3 - 5 tonne lorry single differential	
Oil consumption for vehicle	2	% of fuel consumption	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry	
Price of set of tyres	18 418,00	LCU / set	Dept. of Agriculture Machinery guide 2010 -2011 for 3 - 5 tonne lorry single differencial : 2011 price: R16392; 2013 price: R18418	
Distance for which new set of tyres lasts	45 000	km	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry	
Equipment repair and maintenance cost over lifetime	50	%	Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry	Used to calculate repair and maintenance rate per km
Lifetime of vehicle	10	years		Used to calculate depreciation rate for vehicle
Vehicle life (distance for accounting purposes)	300 000	km	Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry	Used to calculate repair and maintenance rate per km
Repayment period for debt	5	years		Debt for capital borrowed to buy equipment.
Vehicle insurance cost	4,0	% of purchase price / year	Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry	
Vehicle licence	819,00	LCU / year	Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry	
Other costs	-	LCU / year		Sundries, or enter total yearly costs for vehicle here if the cost breakdown is not known.

Fuel properties

Diesel lower calorific value	43,4	MJ / kg	Lower calorific value. Engineering Toolbox 2013
Diesel density	833	kg / m3	At 15 deg C. Dieselnet 2013
Coal lower calorific value	31	MJ / kg	Biomass Energy Centre 2013

1.1 - Pit conditions

Go to top

Inputs

Parameter	Value	Unit	Reference / source	Notes	User comments
Area name	Test 1				
Number of households in area	35 000	No.	eThekwini municipality first round of pit-emptying: 35000 - pers. comm. EWS 4 March 2013 31856 - Salisbury et al 2011 In Durban the municipality empties 35 000 pit latrines across the whole municipality area, over a 5 year cycle.	This is the total number of households served by the organisation responsible for pit-emptying.	
Average number of people per household	5	No.	eThekwini 4.7 - 5.3 persons/household reported. Pers. comm. D Wilson & J Harrison 20 Sep 2013.		
Per capita annual FS accumulation rate	40	ℓ / person / year	Still & Foxon 2012 40 l/person/year - WHO nd for high groundwater areas, 60 l/p/year for low groundwater areas Besters in eThekwini: 18.3 - 120.5 l/person/year recorded (Still 2002 in Buckley et al 2008). Average 69.4	Note - this is **accumulation** rate, not **production** rate, i.e. should also take into account soil conditions [guidance table needed in future version of model].	

Length of pit-emptying cycle	5	years	eThekwini municipality first round of pit-emptying	The time set by the sanitation service provider to empty all pits in an area once. If no regular pit-emptying cycle exists, then enter the average time between pit-emptyings here, and set the 'Time between pit emtpying cycles' input as zero.
Time between pit-emptying cycles	0	years		The time between regular pit-emptying cycles. The sum of this figure and the length of the pit-emptying cycle therefore equals the total time between emptyings for any pit. Sludge may still be processed by LaDePa or combustion during this period.
Typical sludge composition data				
Average %DS of FS in pit	30	%DS	Zuma et al 2013 - 21.25% average of 48 VIP sludge samples from 'dry' pits in eThekwini. PSS recommended feed %DS to LaDePa is 30 - 35%.	
Detritus fraction in sludge	20,00	%	Pers. comm. D Wilson & J Harrison 4 March 2013	
Average calorific value of FS	12,35	MJ / kg DS	Zuma et al 2013 - average of 28 VIP sludge samples	
Average sand/grit fraction of FS	3	%	Estimate	
Typical density of VIP sludge	1150	kg / m3	Zuma et al 2013 - 1374 kg / m3 average value from 72 VIP sludge samples. At 30% solids actual density likely to be lower than this as significant portion of solids are suspended.	
COD	-	g COD / g DS		Data for COD to faecal coliforms for information only - data on the changes to sludge composition across the LaDePa process is not currently available. If these factors could be entered into the model the data below could be used to calculate the expected LaDePa pellets composition.
Ammonium & urea	-	mg ammoniacal N / g DS		
Nitrate	-	mg NO3- / g DS		
Total nitrogen	-	mg N / g DS		
Total phosphate	-	mg P / g DS		
Orthophosphate	-	mg ortho-P / g DS		
Potassium	-	mg K / g DS		
Calcium	-	mg Ca / g DS		
Magnesium	-	mg Mg / g DS		
Sulphur	-	mg S / g DS		
Ascaris - Undeveloped eggs	-	No. possible viable Ascaris / 20g DS		If Ascaris measurements are not segregated into the three different categories, enter the total figure of viable eggs in this input field
Ascaris - Motile larvae in eggs	-	No. possible viable Ascaris / 20g DS		
Ascaris - Immotile larvae in egg	-	No. possible viable Ascaris / 20g DS		
Trichuris	-	Potentially viable eggs / 20g		
Taenia	-	Potentially viable eggs / 20g		
Faecal coliforms	-	CFU / g DS		

1.2 - Estimate FS properties

SECTION NOT CURRENTLY LINKED TO MODEL

Questions below provide factors to consider when determining sludge characteristics to be entered into the model

	Option selection	Reference	Template notes	User comments
How is greywater (kitchen and washing water) usually disposed of?			Link to %DS of sludge in pit	
Into the latrine pit		WHO nd (Pit latrine design Annex 5) gives values for FS accumulation in high and low groundwater areas		
Elsewhere				
Is the latrine area used as a washing / showering area, with greywater run-off into the pit?				
Yes				
No				
Does effective stormwater drainage exist?				
Yes				
No				
Is the area prone to flooding?				
Yes				
No				
How high is the water table?				
Very high: 10 - 20 cm below surface				
Medium: 0.2 - 2 m below surface				
Below 2m				
What is the soil type?			Link to corresponding infiltration rates	
Sand				
Loamy Sand				
Sandy Loam				
Loam				
Silt				
Silt Loam				
Clay Loam				
Sandy Clay Loam				
Silty Clay Loam				
Clay				
Sandy Clay				
Silty Clay				
What is the predominant form of anal cleansing?			Link to detritus content of sludge	
Toilet paper				
Newspaper / packaging / plant matter				
Water washing				
Does an effective solid waste collection service function in the area?			Link to detritus content of sludge	
Yes				
No				
How frequently is the pit de-sludged?			Link to calorific value / COD content	

Every few months
Every year
Every 5 years or more

What is the predominant diet in the area?

Vegetarian
Non-vegetarian

Link to nutrient content / calorific value

Emptying of pits & conveyance of sludge

Go to top

1. Pit is emptied
2. Sludge is transported by one or more methods of conveyance (Conveyance Stages 1 - 4)
3. Sludge enters a storage tank facility at the LaDePa or combustion process site.

Emptying	Choice of 3 emptying methods
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 by pick-up truck on main roads.
Conveyance Stage 2	
Conveyance Stage 3	
Conveyance Stage 4	
Storage	Storage facility prior to sludge processing - may be very small if no buffer storage required

Emptying methods:

1. Human-powered: bucket & shovel or handpump
2. Motorised: small vacuum tanker
3. Motorised: large vacuum tankerr

Conveyance methods:

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, later pumped out
6. Transfer station with liquid-only connection to sewer
7. Sewer discharge station - solids & liquids to sewer

Example sequence:

Example	Stage in sequence	Link to data entry
Manual pit-emptying	(Emptying)	Choose emptying method
Sludge transported in containers on a handcart	(Conveyance Stage 1)	Choose Conveyance Stage 1 method
Containers of sludge transported on a pick-up truck	(Conveyance Stage 2)	Choose Conveyance Stage 2 method
Sludge deposited at storage facility	(Storage)	Enter data on Storage facility

2.1 - Emptying

Removal of faecal sludge from pit latrine to a container or transport mechanism situated next to the pit

Notes

1. User chooses the emptying method - e.g. manual, vacuum tanker
2. User chooses an appropriate method for the first stage of sludge conveyance - e.g. hand cart with containers of sludge
3. The following section requires inputs for the Emptying and Conveyance Stage 1 stages, section 3 requires inputs for Conveyance Stages 2 - 4, if applicable.
4. This schematic explains what the distance inputs are that are referred to in the inputs below.

Allowable combinations of Emptying and Conveyance Stage 1 methods

Emptying method	Conveyance Stage 1 method
1. Manual emptying (buckets & shovels and/or handpump)	1. Handcart with containers of sludge; 2. Pick-up truck with containers of sludge
2. Small vacuum tanker	3. Small vacuum tanker
3. Large vacuum tanker	4. Large vacuum tanker

Inputs

Parameter	Value	Unit	Reference / source	Template notes	User comments
Distance E2: Average distance between pits to be emptied	0,3	km	eThekwini - households generally closer together than this, but pits to be emptied consecutively are not necessarily next door to each other	Refer to 'G1 Distances' sheet	

Ease of access to households - access level factor	1	Rating 1 - 3	Ease of access varies greatly across municipality. Factor of 1 chosen as the arrangement is for an advance team to prepare access to pits before emptying team arrives. This is accounted for in labour numbers.	Choose a rating: 1, 2 or 3. 1 indicates best ease of access to pits (wide streets, smooth road surface, no removal of toilet superstructure required etc). 3 indicates most difficult and time-consuming access to pits. Further down the list of inputs is space to assign a time to each of the ratings (i.e. the extra time spent accessing the pit because of access issues).	
Emptying method used	1	Number 1 - 3	Manual - buckets & shovels - standard for eThekwini. Sludge dry solids and detritus content is too high for removal by pumping.	Choices are: 1. Human-powered: bucket & shovel or handpump 2. Motorised: small vacuum tanker 3. Motorised: large vacuum tanker For vacuum tankers, consider the pumpability of the sludge	
Emptying method	Human powered emptying - buckets & shovels				
Conveyance Stage 1 method used	2	Number 1 to 4	Pick-up truck can normally be used as the first stage conveyance	Choices are: 1. Handcart with containers of sludge 2. Pick-up truck with containers of sludge 3. Motorised transport - small vacuum tanker 4. Motorised transport - large vacuum tanker Allowable Emptying - Conveyance Stage 1 combinations 1 - 1 1 - 2 2 - 3 3 - 4	
Conveyance Stage 1 method	Pick-up truck with containers of sludge				
Distance T1: one-way distance for Conveyance Stage 1	12	km	Distance between pit & sludge storage, or transfer to next conveyance stage. 8 km chosen as average applicable distance for eThekwini.	Refer to 'G1 Distances' sheet	8
Distance E1: to pit emptying area from storage depot	15	km		Refer to 'G1 Distances' sheet	

2.2 - Choosing the appropriate emtpying method

A decision tree to aid the user in choosing the appropriate emptying method for the given environmental conditions

SECTION NOT CURRENTLY LINKED TO MODEL

Notes

1. The Emptying and Conveyance 1 options chosen on Sheet 2.1 (above) will be those used by the model to calculate the overall cash flows for sludge management
2. You are only required to fill out the data sheets corresponding to the Emptying and Conveyance 1 options chosen above
3. To view the cost comparison of emptying methods on Sheet 2.4 you must also fill out the data sheets for all Emptying methods and their corresponding Conveyance Stage 1 method that you want to compare

2.3 - Emptying & Conveyance Stage 1 input data

User notes

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
2. You are only required to fill out the data sheets corresponding to the Emptying and Conveyance 1 options chosen above
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

2.3.1 - Human-powered emptying parameters: buckets & shovels and/or hand-pump

Is the section required data? Yes — If No, go to section 2.3.2

Parameter	**Value**	**Unit**	**Reference**	**Template notes**	**User comments**
Conveyance Stage 1 method	2			Choice of: 1. Handcart with containers of sludge 2. Pick-up truck with containers of sludge	
Conveyance Stage 1 method	Pick-up truck with containers of sludge				
Capital & startup costs					
Emptying equipment only: Capital cost for <u>one</u> team (buckets, shovels, protective clothing etc)	20 000,00	LCU / team		If equipment is rented, not purchased, complete hire cost instead.	
Is Conveyance Stage 1 equipment purchased?	Yes			Capital cost of Conveyance 1 equipment is accounted for in model - input not required here	
Capital cost of one hand-pump		LCU / team		If applicable - e.g. Gulper, eVac. If figure entered assumed one pump per team used.	
Once-off fees for permits, EIAs etc for emptying and conveyance Stage 1 operation	2 000,00	LCU			
O&M costs					
Yearly cost of health & safety measures, licences, permitting for all teams	100 000,00	LCU / year	Salisbury et al 2011 gives R29/pit for medical costs (R203,000/year for 7000 pits/year). Reduced somewhat as some of this cost will be covered under capital costs for emptying equipment		
Operating parameters					
Proportion of total pit contents removed	95	%			
Morning equipment loading time	0,3	h / day		Time taken to load equipment at the start of each working day, before driving to site	
Number of return trips made from storage depot to pit emptying area per day	1	No. / day			
Chosen access level factor	1				

Parameter	Value	Unit	Reference	Template notes
Access level factor times			Go to choice of access factor	These times for access level factors 1 -3 are the extra time it takes to actually be able to start emptying the pit - negotiating narrow streeets or having to remove the toilet superstructure before emptying can start.
1	0,1	h / pit	Low for eThekwini as advance team goes ahead of pit-emptiers to prepare access.	Access level 1 = easiest access to pit (good roads, low density housing, no superstructure dismantling required)
2	0,33	h / pit		Access level 2 = medium ease of access to pit
3	0,75	h / pit		Access level 3 = hardest access to pit (poor roads, high density housing, steep gradients, significant dismantling of latrine superstructure required).
Set up time at pit	0,25	h / pit		Time to get machinery in position at the pit so that emptying can start.
Time taken to remove one kℓ of FS from pit	2	h / kℓ of FS		
Clean up time at pit	0,5	h / pit		
End of day clean-up & equipment store time	0,5	h / day		Time taken to put equipment away when back at the storage depot at the end of the day.
Calculated number of pits possible to empty per day per team	2,05	pits / day / team		Calculated based on the times entered above
Number of pits emptied per day (optional input - overrides the calculated number of pits possible to empty in a day)	2,0	pits / day / team	Number specified by EWS in first pit-emptying cycle	Optional input - overrides the calculated number of pits possible to empty in a day. Compare to the calculated value for a sense-check
Proportion of downtime per year	5	%		To allow for machinery repairs, labour strikes etc.
Number of pit-emptying teams in operation	15	No. pit-emptying teams		
Number of supervisors required to manage all teams	3	No.		Choose based on number of pit-emptying teams in operation. Max 5 per supervisor recommended
Number of paid months per year for supervisors	12	paid months / year		If labour is retained full-time enter 12.
Number of labourers per team	6	No.	eThekwini - 4 labourers to empty pits, 2 labourers concurrently working on preparing access to the next pit to be emptied	
Number of paid months per year for labourers	12	paid months / year		If labour is retained full-time enter 12.
Working hours per day	9	h / day		
Working days per month	21	days / month		Allow for public holidays.
Volume of water required for clean-up per pit	25	ℓ / pit		
Sludge pump fuel consumption		ℓ / kℓ sludge pumped		Only applicable if a pump is used
Storage area for ONE team's emptying equipment (buckets, shovels, clothing)	2	m2		Recommend 2 m2 per team
Total office, ablutions and parking area required at pit emptying company's base	40	m2		Choose based on number of pit-emptying teams in operation
Financial parameters				
Lifespan of Conveyance 1 vehicle	7	years		Used to calculate depreciation rate
Time period used for cash flows	5	years		Suggest setting to length of one pit-emptying cycle, or lifetime of major capital items, whichever is shorter.
Monthly cost for consumables	15 000,00	LCU / month	Recommended ZAR 1000 per team per month	
Labour - supervisor rate	10 000,00	LCU / month		
Labour - labourer rate	3 000,00	LCU / month		
Rental rate for one team's emptying equipment, excluding conveyance vehicle		LCU / day		Not applicable if emptying equipment purchased
Monthly maintenance for hand pump		LCU / month / pump		
Monthly maintenance for other manual emptying equipment per team	100,00	LCU / month / team	Recommend ZAR 100 / month / team	
Revenue generated per pit		LCU / pit	No revenue applicable for eThekwini case, as municipality pays for pit-emptying and model aims to calculate cost to municipality	Enter a revenue value per pit OR per litre of FS removed. This is total revenue for emptying the pit and transporting the FS away on the first stage of the disposal journey.
Revenue generated per litre FS removed for emptying and Conveyance Stage 1		LCU / kℓ		
Property rental rate	25,00	LCU / m2 / month	Applicable rate for industrial area	If property is purchased, not rented, complete purchase price instead
Number of months per year office/storage property rented for	12	months / year		
Land purchase price		LCU / m2		Applicable if office / storage facility purchased
Overhead rate (admin, security, bookkeeper)	10	% of total annual operating costs		Choose dependent on nature of the business - could be zero for small informal business
Repayment period for debt	4	years		Repayment period for debt

Go to Inputs for 3.3.1 Conveyance - Handcart with containers of sludge
Go to Inputs for 3.3.2 Conveyance - Pick-up truck with containers of sludge

2.3.2 - Motorised emptying & conveyance - small vacuum tanker

NOTE: Pumpable sludge is required. The model allows for addition of extra water to dry sludge to make it pumpable.
However, the practicalities of making dense, solid sludge pumpable are considerable - simply adding water and stirring is often ineffective
If sludge dry solids are very high, user must decide wether the sludge can be made pumpable or if an alternative emptying method is required.

Is the section required data? No If No, go to section 2.3.3

Parameter	Value	Unit	Reference	Template notes	User comments
Capital costs					
Type of vacuum tanker used	Vacutug MK II				
Vacuum tanker volume	700	ℓ	MAWTS 2013		
Capital cost of one vacuum tanker and associated equipment	99 300,00	LCU / tanker	Yoke 2009 gives USD5000 - USD7000 as 2007 price. Taking USD7000 gives USD 9930 2013 price.	Must enter a value here - used for insurance calculation. If vehicle is hired, also enter rental cost under operating parameters.	
Once-off fees for permits, EIAs etc for emptying and conveyance operation at startup	2 000,00	LCU		Specify what makes up this amount	
O&M costs					
Is vehicle rented?	No				
Annual cost of health & safety measures, permitting, licences for all teams	10 000,00	LCU / year			

Other miscellaneous costs		LCU / year		Any other costs in addition to vehicle rental, storage and office rental, fuel, water, labour, vehicle maintenance, insurance, and licences.
Operating parameters				
Proportion of total pit contents removed	80	%		Vacuum tankers will not always remove the solid consolidated sludge at the bottom of the pit
Proportion of tanker volume used	95	%		
Morning loading time	0,5	h / day		Time taken to load equipment at the start of each working day, before driving to site
Average driving speed of tanker	5	km / h	MAWTS 2013	Taking into account road and traffic conditions.
Number of return trips made from storage depot to pit emptying area per day	1	No.		
Chosen access level factor	1			
Access level factor times			Go to choice of access factor	Factor was chosen under section 2.1 These times for each factor 1 -3 are the extra time it takes to actually be able to start emptying the pit - negotiating narrow streets or having to remove the toilet superstructure before emptying can start.
1	0,15	h / pit		Access level 1 = easiest access to pit (good roads, low density housing, no superstructure dismantling required)
2	0,5	h / pit		Access level 2 = medium ease of access to pit
3	1	h / pit		Access level 3 = hardest access to pit (poor roads, high density housing, steep gradients, significant dismantling of latrine superstructure required).
Set up time at pit	0,25	h / pit		Time to get machinery in position at the pit so that emptying can start.
Machine time per kℓ of FS removed	0,125	h / kℓ of FS	8 kℓ /hour rate chosen.	
Clean up time at pit	0,25	h / pit		
End of day clean-up & equipment store time	0,75	h / day		Time taken to put equipment away when back at the storage depot at the end of the day.
Time to discharge full load of sludge	0,1	h / load		
Calculated number of complete pits possible to empty per day	0,08	complete pits / day / team		Calculated figure based on times entered above.
Number of pits emptied per day (optional input - overrides the calculated number of pits possible to empty in a day)		pits / day / team		Optional input - overrides the calculated number of pits possible to empty in a day. Leave blank otherwise.
Proportion of downtime per year	10	%		To allow for machinery repairs, strikes etc.
Number of tankers in operation	372	No. tankers		Calculated based on the number of pits emptied per day.
Total number of supervisors (for all tankers)	65	No.		Choose based on the number of tanker teams in operation. Suggest max five teams per supervisor
Number of paid months per year for supervisors	12	paid months / year		If labour is retained full-time enter 12.
Number of labourers per tanker	2	No. / tanker		
Number of paid months per year for labourers	12	paid months / year		If labour is retained full-time enter 12.
Working hours per day	9	h / day		
Working days per month	21	days / month		
Fuel consumption for sludge pump	0,094	ℓ diesel / kℓ FS pumped	Maputo operation. Based on 3L tank on pump, 4 hours operation from one tank, 8m3/hour pump rate.	
Fuel consumption for vacuum tanker	0,15	ℓ diesel / km	Vacutug uses same engine for pumping as for locomotion. Based on 3L for 4 hours operation, 5 km/h average speed.	
Oil consumption for vehicle	1	% of fuel consumption	Dept. of Agriculture Machinery guide 2010 -2011	
Volume of water required for clean-up	50	ℓ / pit		
Area required to store ONE small vacuum tanker	3	m2		
Storage area for ONE team's other emptying equipment (tanker and tools)	1	m2		
Total number of staff	809	No.		
Total office, ablutions and parking area required	100	m2		Choose based on total number of staff employed

Special parameters for dry pits

Calculation of volume of water that must be added to make sludge pumpable

NOTE: the practicalities of making dense, solid sludge pumpable are considerable - simply adding water and stirring is often ineffective

If sludge dry solids are high, user must decide wether the sludge can be made pumpable or if an alternative emptying method is required.

Maximum pumpable dry solids of sludge	12	% DS	Approximate pumpable limit for sewage sludge is 12%. Pump-dependent - 40% DS achieved with one setup.	Determines how much extra water has to be added to the pit
Additional man and machine time taken to empty pit if water has to be added to make sludge pumpable	0,5	h / pit		Time required for water collection, addition and mixing
Financial parameters				
Lifespan of small vacuum tanker - years	10	years		Used to calculate depreciation rate
Equipment lifespan - distance	160 000	km	Dept. of Agriculture Machinery guide 2010 -2011 for LDV	For repair and maintenance rate calculation
Time period used for cash flows	5	years		
Labour - supervisor rate	10 000,00	LCU / month		
Labour - labourer rate	3 000,00	LCU / month		
Fee or rental rate for vacuum tanker per month (e.g. for municipal-owned vehicles)	2 000,00	LCU / month		Not applicable if vehicle has been purchased - enter a capital cost instead
Vehicle maintenance parameters				
				Go to input for flat monthly maintenance rate if individual item amounts are not known
Vehicle insurance cost	3,5	% of purchase price / year	Dept. of Agriculture Machinery guide - value for LDV 2010 -2011	
Vehicle licence	-	LCU / year	Vacutug style tanker not licenced for the road	
Repair and maintenance cost for small vacuum tanker	50,0	% of purchase price over lifetime	Dept. of Agriculture Machinery guide 2010 -2011, value for LDV	

Price of set of tyres	2 000,00	LCU / set	Dept. of Agriculture Machinery guide 2010 -2011 Price for LDV: R4751.75 2011 price, R5339 2013 price. Adjusted downwards as tyre costs will be lower for Vacutug.		
Distance for which new set of tyres lasts	50 000	km	Dept. of Agriculture Machinery guide 2010 -2011		
Vehicle maintenance rate		LCU / month		Enter a value here to cover insurance, licence, repairs, tyres and oil if individual rates for these items are not known	
Revenue generated per pit by tanker company		LCU / pit	Not applicable for eThekwini case	Complete this field OR the revenue generated per kilolitre of FS removed.	
Revenue generated per litre FS removed by the tanker company		LCU / kℓ			
Property rental rate	25,00	LCU / m2 / month	Industrial area rate		
Number of months per year property rented for	12	months / year			
Property/land purchase price		LCU / m2			
Overhead rate (admin, security, bookkeeper)	10	% of total annual operating costs		Choose dependent on nature of the business - could be nil for small informal business	
Repayment period for debt	5	years		Repayment period for debt	

2.3.3 - Motorised emptying & conveyance - large vacuum tanker

NOTE: Pumpable sludge is required. The model allows for addition of extra water to dry sludge to make it pumpable.
However, the practicalities of making dense, solid sludge pumpable are considerable - simply adding water and stirring is often ineffective
If sludge dry solids are very high, user must decide wether the sludge can be made pumpable or if an alternative emptying method is required.

Is the section required data?	No	If No, go to section 3.1			
Parameter	**Value**	**Unit**	**Reference**	**Template notes**	**User comments**
Capital costs					
Vacuum tanker volume	10 000	ℓ	Clean Fossas company (Maputo, Mozambique)		
Capital cost of one vacuum tanker and associated equipment	350 000,00	LCU / tanker	Estimated based on cost of 3 - 5 tonne lorry, Dept of Agriculture Machinery guide 2010 - 2011	Must enter a value here - required for insurance calculation. If vehicle is hired then also enter the rental rate, under operating parameters	
Once-off fees for permits, EIAs etc for emptying and conveyance operation	10 000,00	LCU			
O&M costs					
Is vehicle hired?	No				
Cost of health & safety measures for all teams	10 000,00	LCU / year			
Other costs		LCU / year		E.g. additional consumables	
Operating parameters					
Proportion of total pit contents removed	90	%		For example, some operators may remove only the top, watery layer of sludge and leave a considerable amount in the pit.	
Morning loading time	0,5	h / day		Time taken to load equipment at the start of each working day, before driving to site	
Average driving speed of tanker	50	km / h		Taking into account road and traffic conditions.	
Number of return trips made from storage depot to pit emptying area per day	1	No.			
Chosen access level factor	1				
Access level factors		Go to choice of access factor		Access factor selected in section 2.1. These times for access level factors 1 -3 are the extra time it takes to actually be able to start emptying the pit - negotiating narrow streeets or having to remove the toilet superstructure before emptying can start.	
1	0,25	h / pit		Access level 1 = easiest access to pit (good roads, low density housing, no superstructure dismantling required).	
2	0,5	h / pit		Access level 2 = medium ease of access to pit	
3	1	h / pit		Access level 3 = hardest access to pit (poor roads, high density housing, steep gradients, significant dismantling of latrine superstructure required).	
Set up time at pit	0,25	h / pit		Time to get machinery in position at the pit so that emptying can start.	
Machine time per kℓ of FS removed	0,0133	h / kℓ of FS	Uprent 2013 - 75 kℓ/hour	The inverse of the pumping rate for the vacuum tanker	
Clean up time at pit	0,5	h / pit			
End of day clean-up & equipment store time	0,75	h / day		Time taken to put equipment away when back at the storage depot at the end of the day.	
Time to discharge full load of sludge	0,1	h / load		Time taken to pump out a full load from the vacuum tanker	
Calculated number of pits possible to empty per day	4,18	pits / day / team		Calculated based on times entered above	
Number of pits emptied per day (optional input - overrides the calculated number of pits possible to empty in a day)		pits / day / team		Optional input - overrides the calculated number of pits possible to empty in a day	
Proportion of downtime per year	10	%		To allow for machinery repairs, strikes etc.	
Number of tankers in operation	8	No. tankers		Calculated based on number of pits possible to empty per day	
Number of supervisors - total for all tankers	2	No.		Choose based on number of teams in operation. Recommend max of 5 teams / supervisor	
Number of paid months per year for supervisors	12	paid months / year		If labour is retained full-time enter 12.	
Number of labourers per tanker	2	No.			
Number of paid months per year for labourers	12	paid months / year		If labour is retained full-time enter 12.	
Working hours per day	9	h / day			
Working days per month	21	days / month			
Fuel consumption for sludge pump	0,0533	ℓ diesel / kℓ FS pumped	Based on 75 m3/h pump rate at 4L/h diesel consumption. Uprent 2013	Sludge pump	

Fuel consumption for vacuum tanker	0,15	ℓ diesel / km	15 l/100km Dept of Agriculture Machinery guide 2010 - 2011 for 3 - 5 tonne lorry single differential	
Oil consumption for vehicle	1,5	% of fuel consumption	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry	
Volume of water required for clean-up	50	ℓ / pit		For cleaning around the pit, rinsing equipment at site etc.
Storage area for ONE team's other emptying equipment (tanker and tools)	2	m2		
Total staff employed	18	No.		
Total office, ablutions and parking area required	50	m2		Choose based on total number of staff employed

Special parameters for dry pits

Calculation of water required to make sludge pumpable

NOTE: the practicalities of making dense, solid sludge pumpable are considerable - simply adding water and stirring is often ineffective

If sludge dry solids are high, user must decide wether the sludge can be made pumpable or if an alternative emptying method is required.

Maximum pumpable dry solids of sludge	12	% DS		Approximate pumpable limit for sewage sludge is 12%. Pump-dependent - 40% DS achieved with one setup.
Additional man and machine time taken to empty pit if water has to be added to make sludge pumpable	0,5	h / pit		Time required for water collection, addition and mixing

Financial parameters

Lifespan of vacuum tanker	10	years		Used to calculate depreciation rate
Equipment lifespan - distance	300 000	km	Dept. of Agriculture Machinery guide 2010 -2011 for 3 - 5 tonne lorry single differencial	
Time period used for cash flows	5	years		
Labour - supervisor rate	10 000,00	LCU / month		
Labour - labourer rate	3 000,00	LCU / month		
Fee or rental rate for vehicle per month (e.g. for municipal-owned vehicles)		LCU / month		Not applicable if equipment purchased - enter capital cost only

Vehicle maintenance parameters — Go to input for flat monthly maintenance rate if individual items below are not known

Price of set of tyres	18 418,00	LCU / set	Dept. of Agriculture Machinery guide 2010 -2011 for 3 - 5 tonne lorry single differencial : 2011 price: R16392; 2013 price: R18418	
Distance for which new set of tyres lasts	45 000	km	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry	
Equipment repair and maintenance cost over lifetime	50	%	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry single differential	
Vehicle insurance cost	4	% of purchase price / year	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry single differential	
Vehicle licence	819,00	LCU / year	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry single differential	
Vehicle maintenance		LCU / month		Enter a value here to cover insurance, licence, repairs, tyres and oil if individual rates for these items are not known
Revenue generated per pit by tanker company		LCU / pit	Not applicable for eThekwini case	Complete this field OR the revenue generated per litre of FS removed.
Revenue generated per kilolitre FS removed by the tanker company		LCU / kℓ		
Property rental rate	25,00	LCU / m2 / month		Not applicable if property purchased - complete purchase price instead
Number of months per year property rented for	12	months / year		
Land purchase price		LCU / m2		
Overhead rate (admin, security, bookkeeper)	15	% of total annual operating costs		Choose dependent on nature of the business - could be zero for small informal business
Repayment period	5	years		Repayment period for any debt taken out, e.g. for purchase of vacuum tanker

3. Conveyance — Go to top

Choice of Conveyance methods — Go to explanation of Emptying & Conveyance system

Conveyance method choices

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 holding tank later pumped out, no sewer connection
6 - Transfer station with liquid connection to sewer
7 - Sewer discharge station with screening

Conveyance Example 1

Example	Stage in sequence
Manual pit-emptying ↓	(Emptying)
Sludge transported in containers on a handcart ↓	(Conveyance Stage 1)
Containers of sludge transported on a pick-up truck	(Conveyance Stage 2)

Sludge deposited at storage facility	(Storage)

Conveyance Example 2

Example	Stage in sequence
Manual pit-emptying	(Emptying)
Sludge transported in containers on a handcart through dense urban settlement to reach road.	(Conveyance Stage 1)
Containers of sludge transported on a pick-up truck to neighbourhood storage tank.	(Conveyance Stage 2)
Transfer station - neighbourhood storage tank	(Conveyance Stage 3)
Large vacuum tanker - intermittently pumps out the transfer station	(Conveyance Stage 4)
Sludge deposited at storage facility	(Storage)

3.1 - Choice of Conveyance methods

Conveyance method choices

0 - None
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 holding tank later pumped out, no sewer connection
6 - Transfer station with liquid connection to sewer
7 - Sewer discharge station with screening

Notes
1. Unless the final Conveyance stage is a sewer discharge station, the sequence of Conveyance stages should end with a vehicle (options 1 - 4).

Conveyance method Stage 1	2	No.	Go to choice of Conveyance Stage 1 method
Conveyance method Stage 1	**Pick-up truck with containers of sludge**		
Distance T1: one-way distance for Conveyance Stage 1	12	km	Refer to 'G1 Distances' sheet
Conveyance method Stage 2	0	No.	Refer to list above for codes
Conveyance method Stage 2	**#N/A**		
Distance T2: one-way distance for Conveyance Stage 2		km	Refer to 'G1 Distances' sheet
Conveyance method Stage 3	0	No.	Refer to list above for codes
Conveyance method Stage 3	**#N/A**		
Distance T3: one-way distance for Conveyance Stage 3		km	Refer to 'G1 Distances' sheet
Conveyance method Stage 4	0	No.	Refer to list above for codes
Conveyance method Stage 4	**#N/A**		
Distance T4: one-way distance for Conveyance Stage 4		km	Refer to 'G1 Distances' sheet

3.2 - Choice of appropriate Conveyance methods

A decision tree to aid the user in choosing the appropriate conveyance method for the given environmental conditions
SECTION NOT CURRENTLY LINKED TO MODEL

3.3 Data on different conveyance methods

Enter data for the conveyance methods chosen above

Data must be entered for the following sections:

Pick-up truck with containers of sludge	Conveyance Stage 1	1 - Hand cart with containers of sludge
#N/A	Conveyance Stage 2	2 - Pick up truck with containers of sludge
#N/A	Conveyance Stage 3	3 - Small vacuum tanker
#N/A	Conveyance Stage 4	4 - Large vacuum tanker
		5 - Transfer station: intermediate holding tank later pumped out, no sewer connection
		6 - Transfer station with liquid connection to sewer
		7 - Sewer discharge station with screening

Notes:
1. Data entered below is compiled to the table in Section 3.4
2. Section 3.5 uses the appropriate data to calculate costs for each Conveyance stage, depending what methods have been chosen in Section 3.1

3.3.1 Hand cart with containers of sludge

Parameter	Value	Unit	Reference	Notes	User comments
Capital costs					
Capital cost of one handcart and sludge containers, capacity as stated below	1 000,00	LCU / unit			
Once-off start up fees (EIAs, permits etc)		LCU			
Operating parameters					
Volume of sludge container	20	ℓ / container			

Number of sludge containers per handcart load	6	containers / load			
Working volume proportion	90	%			
Average travel speed of handcart	4	km / h			
Labourers required per handcart	2	No. / handcart			
Time to set up transfer of sludge between conveyance stages	0,025	h		Time taken to set up handcart for loading / un-loading	
Sludge loading rate	2	kℓ FS / hour		Rate of loading sludge onto handcart (transfer of containers only, no travel)	
Morning loading time	0,25	h			
Evening clean up and storage time	0,5	h			
Change in volume of FS during conveyance	0	%		Positive value indicates increase.	
Change in calorific value of FS	0	%		Negative value indicates reduction. Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value.	
Change in dry solids of FS	0	%		Negative value indicates reduction. Is water added to or lost from the sludge during conveyance?	
Storage area required for ONE handcart and associated equipment	2	m2		Used to calculate property rental rate per month	
Financial parameters					
Equipment rental rate		LCU / working day		Not applicable if equipment purchased - complete capital cost (section above) instead.	
Equipment O&M rate	0,05	LCU / km			
Lifetime of vehicle	5	years		Used to calculate depreciation rate	
Repayment period for debt	2	years		Debt for capital borrowed to buy equipment.	
Other costs		LCU / year		Specity what constitutes these costs, e.g. additional consumables	
Revenue generated per load	5,00	LCU / load		Revenue generated for this stage of conveyance. Option to enter revenue per pit or per litre of FS removed.	
Revenue generated per kilolitre FS removed		LCU / kℓ			

3.3.2 Pick-up truck with containers of sludge

Parameter	Value	Unit	Reference	Notes	User comments
Capital costs					
Capital cost of one pickup truck	175 000,00	LCU / unit	Department of Agriculture Machinery Guide 2011. 3000 cc 1 tonne club cab diesel pick up truck. 2010-2011 price ZAR 296,265. 2013 price at 6% escalation 332,883. Lower value chosen based on local experience of actual prices available.	Enter value here even if vehicle is hired - capital value used in insurance calculations	
Capital cost of sludge containers to fill pick-up truck, capacity stated below	3 120,00	LCU / team	R260 / 120L bin Makro 13 Sep 2013 - set of 12 per team (allows 4 spares)		
Capital cost of other equipment, per team	3 000,00	LCU / team		Tools, safety equipment - will be minimal if used for Conveyance Stage 1.	
Once-off start-up costs: environmental permits etc, for all teams		LCU		Applies only to year 1	
Operating parameters					
Volume of one sludge container	120	ℓ / container	R260 / 120L bin Makro 13 Sep 2013		
Number of sludge containers per pick-up truck load	8	containers / load			
Working volume proportion	90	%		To account for containers not being completely filled	
Average travel speed of pick-up truck	50	km / h		Accounting for road and traffic conditions	
Fuel consumption for pick-up truck	10,53	km / ℓ	Dept. of Agriculture Machinery guide 2010 -2011: 9.5 L/100 km		
Oil consumption for vehicle	1	% of fuel consumption	Dept. of Agriculture Machinery guide 2010 -2011		
Labourers required per pick-up truck team	2	No. / team		If the pick-up truck is used only for Conveyance Stages 2 - 4. If used for Stage 1 then Emptying labourers will operate and no additional labour will be required. This is taken into account in the calculations.	
Setup time for transfer of load between conveyance options	0,05	h		Time taken to set up truck for loading / un-loading	
Sludge loading rate	9,0	kℓ FS / hour	Average 1 x 100 litre container of sludge per 40 seconds	Rate of loading sludge onto pick up truck (transfer of containers only, no travel)	
Morning loading time	0,25	h		Loading of equipment at depot at start of day	
Evening clean up and storage time	0,5	h		Cleaning and storage of equipment at depot at end of day	
Change in volume of FS during conveyance	0	%		Positive value indicates increase.	
Change in calorific value of FS	0	%		Negative value indicates reduction. Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value.	
Change in dry solids of FS	0	%		Negative value indicates reduction. Is water added to or lost from the sludge during conveyance?	
Storage area required for ONE pick-up truck and associated equipment	21	m2		Used to calculate property rental cost	

Financial parameters				
Equipment rental rate	250,00	LCU / working day		Applicabe if equipment is hired rather than purchased.
Price of set of tyres	5 339,00	LCU / set	Dept. of Agriculture Machinery guide 2010 -2011: R4751.75 2011 price, R5339 2013 price	
Distance for which new set of tyres lasts	50 000	km	Dept. of Agriculture Machinery guide 2010 -2011	
Equipment repair and maintenance cost over lifetime	50	%	Dept. of Agriculture Machinery guide 2010 -2011	Used to calculate repair and maintenance rate per km
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 rate per km
Repayment period for debt	3	years		Debt for capital borrowed to buy equipment.
Vehicle insurance cost	3,5	% of purchase price / year		
Vehicle licence	482,00	LCU / year	Dept. of Agriculture Machinery guide 2010 -2011 price R429, 2013 price R482	
Other costs		LCU / year		Sundries
Revenue generated per load		LCU / load		Option to enter revenue per pit or per litre of FS removed.
Revenue generated per kilolitre FS removed		LCU / kℓ		

3.3.3 Small vacuum tanker

NOTE: Pumpable sludge is required. If a vacuum tanker is chosen to be used for conveyance, it is assumed that the sludge is pumpable.
If sludge dry solids are very high, an alternative method is required.

Parameter	Value	Unit	Reference	Notes	User comments
Capital and start-up costs					
Vacuum tanker nominal volume	500	ℓ	Yoke 2009		
Capital cost of one vacuum tanker and associated equipment	99 300,00	LCU / tanker	Yoke 2009 gives USD5000 - USD7000 as 2007 price. Taking USD7000 gives USD 9930 2013 price.	Must enter value - used for insurance calculations. If vehicle hired, enter rental rate as well.	
Once-off fees for permits, EIAs etc for emptying and conveyance operation	2 000,00	LCU		Specify what makes up this amount	
Operating parameters					
Working volume proportion	95	%			
Average driving speed of tanker	5	km / h	Yoke 2009	Taking into account road and traffic conditions.	
FS removal rate - suction pumping rate	8	kℓ FS / h			
Discharge pumping rate	8	kℓ FS / h			
Fuel consumption for sludge pump	0,094	ℓ diesel / kℓ FS pumped	Maputo operation. Based on 3L tank on pump, 4 hours operation from one tank, 8m3/hour pump rate.	The sludge pump on the vacuum tanker, as opposed to the engine that moves the tanker around.	
Mileage for vacuum tanker	0,15	ℓ / km diesel	Based on 3L tank, 4 hours operation per tank, 5 km/h average speed.		
Oil consumption for vehicle	1	% of fuel consumption	Dept. of Agriculture Machinery guide 2010 -2011		
Number of labourers per tanker team	2	No. / team			
Set-up time for discharging load of sludge	0,0833	h / load			
Clean-up time after discharging full load of sludge	0,0833	h / load			
Time required for changeover of sludge to next conveyance stage, per load	0,100	h / load		Time to connect / disconnect hoses at start / end of pumping	
Morning loading time	0,5	h / day		Time taken to load equipment at the start of each working day, before driving to site	
End of day clean-up & equipment store time	0,75	h / day		Time taken to put equipment away when back at the storage depot at the end of the day.	
Change in volume of FS during conveyance	0	%		Positive value indicates increase.	
Change in calorific value of FS	0	%		Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value (enter a negative value)	
Change in dry solids of FS	0	%		Is water added to or lost from the sludge during conveyance? Negative value indicates reduction.	
Storage area required for ONE tanker and associated equipment	3	m2		Used to calculate property rental rate per month	
Financial parameters					
Capital cost of vacuum tanker (for insurance calculations)	20 000,00	LCU			
Rental rate for vehicle (e.g. for municipal-owned vehicles)	1 000,00	LCU / working day			
Lifetime of vehicle	10	years		Used to calculate depreciation rate	
Vehicle life - distance for accounting purposes	160 000	km	Dept. of Agriculture Machinery guide 2010 -2011 for LDV		
Other costs	2 000,00	LCU / year		Sundries	
Price of set of tyres	5 339,00	LCU / set	Dept. of Agriculture Machinery guide 2010 -2011: R4751.75 2011 price, R5339 2013 price. Price for LDV		
Distance for which new set of tyres lasts	50 000	km	Dept. of Agriculture Machinery guide 2010 -2011		
Equipment repair and maintenance cost over lifetime	50	% of purchase price	Dept. of Agriculture Machinery guide 2010 -2011, for LDV		
Labour - supervisor rate	10 000,00	LCU / month			
Labour - labourer rate	3 000,00	LCU / month			
Revenue generated per load by tanker company	300,00	LCU / load			
Revenue generated per litre FS removed by the tanker company		LCU / kℓ			
Repayment period for debt	5	years			
Vehicle insurance cost	3,5	% of purchase price / year	Dept. of Agriculture Machinery guide - value for LDV 2010 -2011		

Vehicle licence	-	LCU / year	Dept. of Agriculture Machinery guide 2010 -2011 price R429, 2013 price R482, value for LDV	Vacutug style vehicle not licenced for the road.	

3.3.4 Large vacuum tanker

NOTE: Pumpable sludge is required. If a vacuum tanker is chosen to be used for conveyance, it is assumed that the sludge is pumpable.
If sludge dry solids are very high, an alternative method is required.

Parameter	**Value**	**Unit**	**Reference**	**Notes**	**User comments**
Capital and start-up costs					
Vacuum tanker nominal volume	10 000	ℓ	Clean Fossas company (Maputo, Mozambique)		
Capital cost of one vacuum tanker and associated equipment	350 000,00	LCU / tanker	Estimated based on cost of 3 - 5 tonne lorry, Dept of Agriculture Machinery guide 2010 - 2011		
Once-off fees for permits, EIAs etc for emptying and conveyance operation	5 000,00	LCU		Specify what makes up this amount	
Operating parameters					
Working volume proportion	95	%			
Average driving speed of tanker	50	km / h		Taking into account road and traffic conditions.	
FS removal rate - suction pumping rate	75	kℓ FS / h	Uprent 2013		
Discharge pumping rate	75	kℓ FS / h	Uprent 2013		
Fuel consumption for sludge pump	0,0533	ℓ diesel / kℓ FS pumped	Based on 75 m3/h pump rate at 4L/h diesel consumption. Uprent 2013	The sludge pump on the vacuum tanker, as opposed to the engine that moves the tanker around.	
Fuel consumption for vacuum tanker	0,15	ℓ / km diesel	15 l/100km Dept of Agriculture Machinery guide 2010 - 2011 for 3 - 5 tonne lorry single differential		
Oil consumption for vehicle	1,5	% of fuel consumption	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry		
Number of labourers per tanker team	2	No. / team			
Set-up time for discharging load of sludge	0,0833	h / load	0.0833 h = 5 mins		
Clean-up time after discharging full load of sludge	0,0833	h / load	0.0833 h = 5 mins		
Morning loading time	0,5	h / day		Time taken to load equipment at the start of each working day, before driving to site	
End of day clean-up & equipment store time	0,33	h / day		Time taken to put equipment away when back at the storage depot at the end of the day.	
Change in volume of FS during conveyance	0	%		Positive value indicates increase.	
Change in calorific value of FS	0	%		Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value (enter a negative value)	
Change in dry solids of FS	0	%		Is water added to or lost from the sludge during conveyance? Negative value indicates reduction.	
Storage area required for ONE tanker and associated equipment	25	m2		Used to calculate property rental rate per month	
Financial parameters					
Capital cost of vacuum tanker (for insurance calculations)	350 000,00	LCU	Estimated based on cost of 3 - 5 tonne lorry, Dept of Agriculture Machinery guide 2010 - 2011		
Rental rate for vehicle (e.g. for municipal-owned vehicles)	1 000,00	LCU / working day			
Lifetime of vehicle	10	years			
Vehicle life - distance for accounting purposes	300 000	km	Dept. of Agriculture Machinery guide 2010 -2011 for 3 - 5 tonne lorry single differential		
Price of set of tyres	18 418,00	LCU / set	Dept. of Agriculture Machinery guide 2010 -2011 for 3 - 5 tonne lorry single differential : 2011 price: R16392; 2013 price: R18418		
Distance for which new set of tyres lasts	45 000	km	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry		
Other costs		LCU / year			
Equipment repair and maintenance cost over lifetime	50	%	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry single differential		
Vehicle insurance cost	4	% of purchase price / year	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry single differential		
Vehicle licence	819,00	LCU / year	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry single differential		
Revenue generated per load by tanker company	500,00	LCU / load			
Revenue generated per litre FS removed by the tanker company		LCU / kℓ			
Repayment period for debt	5	years			

3.3.5 Transfer station: intermediate storage tank

Parameter	**Value**	**Unit**	**Reference**	**Notes**	**User comments**
Capital and start-up costs					
Tank nominal volume	20 000	ℓ			
Area required for one tank	20	m2			
Cost of land preparation for each holding tank	10 000,00	LCU / unit		Capital costs not applicable if facility is hired - enter a yearly operating cost instead to cover rental fees.	
Civils costs for plinth and bund	10 000,00	LCU / unit			
Cost of tank	20 000,00	LCU / unit			
Once-off fees for permits, EIAs etc for emptying and conveyance operation	5 000,00	LCU			

Operating parameters					
Working volume proportion	95	%			
Number of labourers per facility	0,2	No. / facility		No full time personnel required - will be shared between several facilities.	
Additional time required per working day	0,50	h / working day		Cleaning etc	
Proportion of total volume removed as detritus during conveyance	-4	%		Is any large detritus screened out manually before the sludge is transferred? E.g. screens at a sewer discharge station? Negative value indicates reduction.	
Overall change in volume of FS during conveyance, including detritus removal	-4	%		Negative value indicates decrease. Accounts for any further loss of sludge or liquid volume, in addition to detritus	
Change in calorific value of FS	-15	%		Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value (enter a negative value)	
Change in dry solids of FS	-5	%		Is water added to or lost from the sludge during conveyance? Negative value indicates reduction.	
Financial parameters					
Rental rate for tank and/or equipment	200,00	LCU / working day		Not applicable if facility is purchased.	
Lifetime of facility	20	years			
Other costs		LCU / year			
Revenue generated per load accepted by facility		LCU / pit			
Revenue generated per kilolitre of FS accepted by the facility		LCU / kℓ			
Repayment period for debt	5	years			

3.3.6 Transfer station with liquid connection to sewer

Parameter	Value	Unit	Reference	Notes	User comments
Capital and start-up costs					
Tank nominal volume	25 000	ℓ			
Area required for one tank	20	m2		Used to calculate property rental rate per month.	
Cost of land preparation for each holding tank	10 000,00	LCU / unit		Capital costs not applicable if facility is hired - enter a yearly operating cost instead to cover rental fees.	
Civils costs for plinth and bund	10 000,00	LCU / unit			
Capital cost of one holding tank (tank only)	100 000,00	LCU / unit			
Costs of pump and connection to sewer for all tanks	20 000,00	LCU / unit			
Once-off fees for permits, EIAs etc for emptying and conveyance operation	5 000,00	LCU			
Operating parameters					
Working volume proportion	95	%			
Number of labourers per facility	0,2	No. / facility		No full time personnel required - will be shared between several facilities.	
Additional time required per working day	0,50	h / working day		Cleaning etc	
Proportion of total volume removed as detritus during conveyance	0	%		Is any large detritus screened out manually before the sludge is transferred? E.g. screens at a sewer discharge station? Negative value indicates reduction.	
Overall change in volume of FS during conveyance, including detritus removal	-50	%		Negative value indicates decrease. Accounts for loss of liquid portion of sludge to sewer	
Change in calorific value of FS	-15	%		Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value (enter a negative value)	
Change in dry solids of FS	90	%		Negative value indicates reduction. Takes into account loss of large amount of water to sewer and a small amount of suspended solids	
Financial parameters					
Rental rate for tank and/or equipment		LCU / working day		Not applicable if facility is purchased.	
Lifetime of facility	20	years			
Other costs	1 000,00	LCU / year			
Revenue generated per load accepted by facility		LCU / pit			
Revenue generated per kilolitre of FS accepted by the facility	200,00	LCU / kℓ			
Repayment period for debt	5	years			

3.3.7 Sewer discharge station: screening only

Parameter	Value	Unit	Reference	Notes	User comments
Capital and start-up costs					
Area required for one screening facility and equipment storage area	8	m2		Used to calculate property rental rate per month.	
Cost of land preparation for each discharge station	10 000,00	LCU / unit		Capital costs not applicable if facility is hired - enter a yearly operating cost instead to cover rental fees.	
Civils costs for plinth and bund	10 000,00	LCU / unit			
Capital cost of screens	10 000,00	LCU / unit			
Costs of connection to sewer	20 000,00	LCU / unit			
Once-off fees for permits, EIAs etc for emptying and conveyance operation	5 000,00	LCU		Specify what makes up this amount	
Operating parameters					
Number of labourers per facility	1	No. / facility			
Additional time required per working day	0,50	h / working day		Cleaning etc	
Change in volume of FS during conveyance	-100	%		All FS disposed of to sewer	
Financial parameters					
Rental rate for equipment		LCU / working day		Not applicable if facility purchased	

Lifetime of facility	20	years			
Other costs		LCU / year			
Revenue generated per load accepted by facility		LCU / pit			
Revenue generated per kilolitre of FS accepted by the facility	200,00	LCU / kℓ			
Repayment period for debt	5	years			

3.5 Conveyance cost calculations

Costs calculated for each conveyance stage

Data must be entered for the following sections (where a method name is shown):

#N/A	Conveyance Stage 2
#N/A	Conveyance Stage 3
#N/A	Conveyance Stage 4

Abbreviations used:

C1 - Conveyance Stage 1
C2 - Conveyance Stage 2
C3 - Conveyance Stage 3
C4 - Conveyance Stage 4

3.5.1 Conveyance Stage 2 calculations

Calculation of capital and operational costs associated with Stage 2 conveyance

Parameter	Value	Unit	Reference	Notes	User comments
Conveyance Stage 2 method	**#N/A**				
Distance T5: One-way distance from work site to Conveyance 2 storage depot	0	km		Refer to 'G1 Distances' sheet	
Working hours per day	9,00	h / working day			
If C2 is a storage facility					
Number of sludge discharge points at facility		discharge points		Allows several vehicles to discharge simultaneously into the facility	
Number of times per day C2 is emptied	1	No. / day		May be dictated by the management of the facility	
Number of C2 teams/facilities required					
Number of C1 teams in operation	15	No. of C1 teams in operation		For information - use when deciding number of C2 teams in operation.	
Calculated number of C2 vehicle teams required in operation	#N/A	C2 teams required		If C2 is a vehicle - calculated minimum number required	
Calculated number of C2 storage facilities required in operation	#N/A	No. C2 facilities required		If C2 is a storage facility - calculated minimum number required	
Chosen number of C2 teams in operation (optional input - overrides calculated minimum figure)		C2 teams in operation		Optional override - e.g. if require every C1 team to be attached to a dedicated C2 team	
Actual number of C2 teams in operation	#N/A	C2 teams in operation		Used in cost calculations	
Labour costs					
Total number of supervisors required for all C2 teams / facilities	1	No.		Recommend maximum of 1 supervisor per 5 teams/facilities	
Working days per month	21	working days / month			
Minimum number of months staff can be employed for per year	12,0	months / year			
Supervisor salary rate	10 000,00	LCU / month			
Number of months supervisor employed for per year	12	months / year		Choose based on minimum number of months required	
Labourer salary rate	3 000,00	LCU / month			
Number of months labourers employed for per year	12	months / year		Choose based on minimum number of months required	
Number of labour working days for C2	252	working days / year			
Error check	0			Highlighted if number of months labourers are employed for is lower than the calculated number of months required	
Operating and fuel costs					
Additional distance factor - used in calculating transport costs		%		Accounts for miscellaneous journeys in addition to the calculated distance travelled - re-fuelling, repairs etc	
Hazardous landfill cost for disposal of detritus	1700	LCU / tonne		For the cases where detritus is screened out at conveyance, e.g. transfer station	
Property costs					
Number of C2 teams in operation	#N/A	No. C2 teams			
Office and parking area required at C2 storage depot	15	m2		Choose based on number of teams in operation	
Property rental cost	25	LCU / m2 / month		Not applicable if property purchased	
Number of months per year rented	12	months / year			
Property purchase cost		LCU / m2		Not applicable if property rented	
Capital costs of equipment					
Is the equipment purchased?	Yes			Choose Yes or No	
Overhead					
Overhead rate	10	%		Proportion of total operating costs per year, to include admin and security	
Financial					
Time period used for Emptying & Conveyance cash flows	5	years		Time period used for cash flows	

3.5.2 Conveyance Stage 3 calculations

Parameter	Value	Unit	Reference	Notes	User comments
Conveyance Stage 3 method	**#N/A**				
Distance T6: One-way distance from work site to Conveyance 3 storage depot		km		Refer to 'G1 Distances' sheet	
Working hours per day	9,00	h / working day			
If C3 is a storage facility					
Number of discharge points at facility	3,00	discharge points			
Number of times per day C3 emptied	1	No. / day			
Number of C3 facilities required					
Number of C2 teams / facilities in operation	#N/A	No. C2 teams			
Calculated minimum number of C3 vehicle teams required in operation (rounded up)	#N/A	C3 teams/facilities required		Calculated minimum number required if C3 is a vehicle, based on timings entered	

Calculated minimum number of C3 storage facilities required	#N/A	C3 teams/facilities required	Calculated minimum number required if C3 is a storage facility, based on timings entered. If C3 is a vehicle no value will be displayed.
Chosen number of C3 teams/facilities in operation (optional input - overrides calculated minimum figures)		C3 teams/facilities in operation	Optional override - e.g. if only a fixed number of transfer stations exists. Does not take into account timings above.
Actual number of C3 teams/facilities in operation	#N/A	C3 teams/facilities in operation	Used in cost calculations
Labour costs			
Number of supervisors required for all facilities	1	No.	Recommend maximum of 1 supervisor per 5 teams/facilities
Working days per month	21	working days / month	
Minimum number of months staff can be employed for per year	0,0	months / year	Takes into account number of equipment working days per year required
Supervisor salary rate	10 000,00	LCU / month	
Number of months supervisor employed for per year	12	months / year	Choose based on minimum number of required months calculated
Labourer salary rate	3 000,00	LCU / month	
Number of months labourers employed for per year	12	months / year	Choose based on minimum number of required months calculated
Number of labour working days for C3	252	working days / year	
Error check	0		Highlighted if number of months labourers are employed for is lower than the calculated number of months required
Operating and fuel costs			
Additional distance factor	5	%	Account for miscellaneous journeys - re-fuelling, repairs etc in addition to the calculated distance travelled moving sludge.
Hazardous landfill cost for disposal of detritus		LCU / tonne	For the cases where detritus is screened out at conveyance, e.g. transfer station
Property costs			
Number of C3 teams required in operation (rounded up)	#N/A	C3 teams required	
Office and parking area required	20	m2	Choose based on number of teams/facilities in operation
Property rental cost		LCU / m2 / month	Not applicable if property purchased
Number of months per year rented		months / year	
Property purchase cost	100,00	LCU / m2	Not applicable if property rented
Capital costs of equipment			
Is the equipment purchased?	Yes		
Overhead			
Overhead rate	10	%	Proportion of total operating costs per year to include admin and security
Time period used for Emtpying & Conveyance cash flows	5	years	

3.5.3 Conveyance Stage 4 calculations

Parameter	Value	Unit	Reference	Notes	User comments
Conveyance Stage 4 method	**#N/A**				
Distance T7: One-way distance from work site to Conveyance 4 storage depot	0	km		Refer to 'G1 Distances' sheet	
Working hours per day	9,00	h / working day			
If C4 is a storage facility					
Number of discharge points at facility		discharge points			
Number of times per day C4 emptied		No. / day			
Number of C4 teams / faclities required					
Calculated minimum number of C4 vehicle teams required in operation	#N/A	C4 teams/facilities required		Calculated minimum number required if C4 is a vehicle, based on timings entered. If C4 is a storage facility, no value will be displayed	
Calculated minimum number of C4 storage facilities required	#N/A	C4 teams/facilities required		Calculated minimum number required if C4 is a storage facility, based on timings entered. If C4 is a vehicle, no value will be displayed.	
Chosen number of C4 teams/facilities in operation (optional input - overrides calculated minimum figure)		C4 teams/facilities in operation		Optional override. Does not take into account timings above.	
Actual number of C4 teams/facilities in operation	#N/A	C4 teams/facilities in operation		Used in cost calculations	
Labour costs					
Number of supervisors required for all facilities	1	No.		Choose based on number of C4 teams in operation. Recommend max of 1 supervisor per 5 teams / facilities	
Working days per month	21	working days / month			
Minimum number of months staff can be employed for per year	0,0	months / year		Based on the equipment working days required	
Supervisor salary rate	10 000,00	LCU / month			
Number of months supervisor employed for per year	12	months / year		Choose based on calculated minimum number of months required	
Labourer salary rate	3 000,00	LCU / month			
Number of months labourers employed for per year	12	months / year		Choose based on calculated minimum number of months required	
Number of labour working days for C4	252	working days / year			
Error check	0			Highlighted if number of months labourers are employed for is lower than the calculated number of months required	
Operating and fuel costs					
Additional distance factor	5	%		Account for miscellaneous journeys - re-fuelling, repairs etc, in addition to calculated distance travelled whilst moving sludge.	
Hazardous landfill cost for disposal of detritus		LCU / tonne		For the cases where detritus is screened out at conveyance, e.g. transfer station	

Property costs

Number of C4 teams required in operation (rounded up)	#N/A	C4 teams required		
Office and parking area required at operator's base	0	m2		Choose based on number of teams/facilities in operation
Property rental cost	25,00	LCU / m2 / month		Not applicable if property purchased
Number of months per year rented	12	months / year		
Property purchase cost		LCU / m2		Not applicable if property rented

Capital costs of equipment

Is equipment purchased?	Yes			

Overhead

Overhead rate	10	%		Proportion of total operating costs per year to include admin and security
Time period used for Emtpying & Conveyance cash flows	5	years		Normally use length of one pit-emptying cycle

3.9 Managing contractor costs

Pit-emptying sub-contractors

Pit emptying sub-contractor markup rate	30	%		Mark up by pit-emptying sub-contractor on costs

Managing contractor

Site establishment	1 000 000,00	LCU	c.f. Value of ZAR 1800302 extrapolated from previous pit emptying cycle costs	
Monthly costs	50 000,00	LCU / month	c.f. value of ZAR 34861 extrapolated from previous pit emptying cycle	
Markup rate	15	%		Markup rate by managing contractor on all operating costs

4 - Storage

Go to top

Parameter	Value	Unit	Reference	Notes	User comments
Working days per month	21	working days / month			
Number of months per year Storage facility operates	12	months / year			
Minimum storage volume required across all LaDePa plants (calculated)	0	m^3	Note in South Africa waste licence is required if more than 35 m3 is to be stockpiled	See below for equivalent volume of the storage tank required at each LaDePa site.	
User-specified storage volume required		m^3		Optional input - overrides the calculated volume requirement.	
Capital and start-up costs					
Number of LaDePa facilities	5	No. LaDePa plants		Go to number of LaDePa plants required	
Number of storage tanks	5	No. tanks		Each LaDePa facility has a storage facility attached to it.	
Volume of each storage tank	-	m3 / tank			
Cost of land preparation for each holding tank	10 000	LCU / tank		Choose based on tank size	
Civils costs for plinth and bund	10 000	LCU / tank		Choose based on tank size	
Cost of tank per kℓ of capacity	2 500	LCU / kℓ		Work on approx. R2 500 per kℓ	
Capital cost of other equipment, per tank		LCU / tank		Specify what makes up this amount	
Once-off fees for permits, EIAs etc, per tank	-	LCU / tank			
O&M costs					
Fuel costs for all tanks		LCU / year		Optional input if any further pumping is required	
Operating parameters					
Number of supervisors per tank	0	No. / tank		If Storage facility is operated by LaDePa plant staff then no additional personnel required.	
Number of months per year supervisor employed for		months / year		Choose based on number of months storage facility operates for per year	
Number of labourers per tank	0	No. / tank			
Number of months per year labourers employed for		months / year		Choose based on number of months storage facility operates for per year	
Volume of each storage tank	-	m3 / tank			
Height of each tank	2,00	m			
Land area occupied by each holding tank	-	m2			
Financial parameters					
Lifetime of storage tank facility	10	years			
Labour - supervisor rate	10 000,00	LCU / month			
Labour - labourer rate	200,00	LCU / day			
Maintenance rate per tank	200,00	LCU / month			
Consumables cost per tank per month		LCU / month			
Overhead rate	10,0	%		Covers cost of security and admin staff	
Revenue generated per kilolitre of FS received at storage		LCU / kℓ		A positive value entered here is a gate fee charged to operators dumping sludge at the treatment facility. A negative value entered here is equivalent to the facility paying for sludge to be dumped (incentiviser for correct disposal).	

5 - LaDePa pre-treatment

Go to top

Treatment of sludge prior to LaDePa to remove water and detritus and/or to add additional water or additives to the sludge

Parameter	Value	Unit	Reference	Notes	User comments

Required feed spec to LaDePa process				All LaDePa feed specification parameters need to be determined through further testing at the plant. Values given here are estimates.
Minimum % DS of feed sludge	20,0	%DS	PSS data sheet on EWS LaDePa plant gives feed as 30 - 35% DS	Sludge of too low dry solids will not form pellets
Maximum % DS of feed sludge	41,0	%DS	PSS data sheet on EWS LaDePa plant gives feed as 30 - 35% DS	Sludge of too high dry solids cannot be efficiently extruded, or crumbles on extrusion.
Maximum allowable detritus content	40	%	Allowable detritus content through LaDePa is close to 0. In eThekwini arrangement has been to remove all detritus at the plant, no pre-treatment system - therefore set allowable limit high for feed to LaDePa.	Excessive detritus entering the LaDePa will block the screw feed system, but in practice very large items are manually raked out at the LaDePa hopper.
Maximum allowable sand / gritty solids content	5	%		High levels of sand/grit may affect pellet formation.
Minimum volumetric throughput allowable	600	ℓ/hour	Average feed rate to LaDePa 6m3/day (pers. comm. EWS 4 March 2013), 8 hours/day gives average feed rate of 750 l/hour	To be determined through further testing. This will impact on the number of LaDePa plants required
Maximum volumetric throughput allowable (whilst still achieving required drying and pasteurisation)	1000	ℓ/hour		To be determined through further testing. This will impact on the number of LaDePa plants required. Will be determined by the screw feed system and by the required residence time in the LaDePa system.
<u>**Out of spec feed parameters**</u>				
%DS of sludge too high	0			
%DS of sludge too low	0			
Detritus fraction	0			
Average sand / grit fraction	0			
Number of pre-treatment facilities in operation (equal to number of LaDePa plants)	5	No. facilities		
<u>**Parameters for ONE pre-treatment facility**</u>				
<u>**1 Water addition**</u>				
Is water addition required?	No	m^3		
Does additive addition require more water to be added?	No			
Annual volume of water added	-	m^3 / year		
Capital cost of facility for water addition and mixing		LCU		Small mixing tank, manual mixing
Land area required for mixing tank		m^2		
<u>**2 Water removal**</u>				
Is increase in dry solids required in the stored sludge?	No			
Does additive provide sufficient increase in dry solids content?	Yes			
Annual volume of water removed	0	m^3 / year		
Drying bed parameters				
Drying bed loading rate	300	kg DS / m2 / year	Niang 2012 Uncovered drying beds in Senegal	
Dried sludge solids achieved on drying bed at this loading rate	60	%	Niang 2012 Uncovered drying beds in Senegal	
Total drying bed area required, per LaDePa plant	0	m2 / year		
Area of each bed	10	m2		If unknown choose 10 m2
Construction cost of drying bed facility per m2	4 000,00	LCU / m2	Extrapolating from Matar Dème 2009 gives 2,138,000 ZAR for 128 m2 drying bed - construction costs only, no land cost - ZAR 16703/m2. 4000 ZAR/m2 chosen for eThekwini context based on local experience.	
Capital cost of sludge mixing tank	5 000,00	LCU		For mixing of dried and fresh sludge to achieve required blend. Plastic tank - use 500 USD as a guideline amount.
Additional operational costs for drying beds - assumes the pre-treatment plant is operated by LaDePa plant staff				
Drying bed cleaning costs (required once / month / bed)	50	LCU / 10 m2 / month	Gning 2008 and pers. comm S El Hadji 13 Sep 2013. ZAR 303 / month / 10 m2 bed for Senegal. Lower figure chosen for eThekwini based on local experience.	
Additional labour required for drying beds	0	No. labourers		Labour in addition to LaDePa plant staff. Choose based on drying bed area - assume one 10 m2 bed takes 2 people one day to clear.
Operational parameters for information only				
Proportion of total solids remaining in dried FS	50	%	Sonko 2007, maximum figure: 30-50% range given. For application of unthickened septic tank sludge directly to drying beds.	Figures for information only - loss of solids, COD and N across drying bed not currently accounted for in calculations
Proportion of total suspended solids remaining in dried FS	95		Sonko 2007, maximum figure: 80-95% range given	
Proportion of COD remaining in dried FS	90	%	Sonko 2007, maximum figure: 85-90% range given	
Proportion of nitrogen remaining in dried FS				
Ammonium & urea	-	%		
Nitrate	-	%		
Total nitrogen	-	%		
TKN	70	%	Sonko 2007, maximum figure: 40 - 70% range given	

3 Detritus removal

Is detritus removal required?	No		For eThekwini case all detritust removal will take place as sludge is fed into the LaDePa plant - no dedicated pre-treatment	
Is detritus removed during a dewatering stage?	No			If a dewatering stage is included, it is assumed that all detritus is removed here.
Detritus removed per year	0	m^3 / year		
Capital cost of basic screening facility	0	LCU		
Land area required	0	m2		

5.4.4 Additives

Is an additive to be used?	No		
Additive type		Name	For example, incineration ash or a nutrient supplement.
Additive dry solids content		%DS	
Volumetric proportion of additive in sludge - additive mix	0	%	
Calorific value		MJ / kg	
Cost of additive by mass		LCU / tonne	For ash value see section 20.
Density of additive		kg / m3	
Cost of additive by volume		LCU / m3	
Additive composition			
COD	-	g BOD / g DS	
Nitrogen			
Ammonium & urea	-	mg ammoniacal N / g DS	
Nitrate	-	mg NO3- / g DS	
Total nitrogen	-	mg N / g DS	
Phosphorus			
Total phosphate	-	mg P / g DS	
Orthophosphate	-	mg ortho-P / g DS	
Potassium	-	mg K / g DS	
Calcium	-	mg Ca / g DS	
Magnesium	-	mg Mg / g DS	
Sulphur	-	mg S / g DS	

Financial

Annual volume of additive used	0	m^3 / year	
Capital cost of facility for additive addition and mixing		LCU	Type of facility required will depend on additive - could simply be an additional hopper on the feed to the LaDePa plant, or a mixing tank for sludge and additive prior to being fed to the LaDePa.
Land area required for mixing facility		m2	
Sand/grit fraction error check, after pre-treatment	0		If highlighted, indicates sand/grit fraction of pre-treated sludge is too high. No facility for removal - sludge must be blended with other sludge.

6 - LaDePa process

Costs of treating faecal sludge via the LaDePa process

Go to top

Parameter	Value	Unit	Reference	Notes	User comments
Actual pre-treated feed properties					
Average daily volumetric feed rate per LaDePa plant	6	m^3 / day / plant	Pers. comm. EWS 4 March 2013 - operational experience in previous pit-emptying cycle, but not measured directly at the plant.		
LaDePa operational parameters					
Number of LaDePa plants required	4,66	No.		Assumes that sludge can be processed by LaDePa in the years between pit-emptying cycles	
Number of LaDePa plants in operation	5,00	No.		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.	
Length of pit emptying cycle	5,0	years			
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 low, then the time taken to process sludge will be longer than the time available.	
Plant data					
Plant size (design feed rate of sludge)	1000	wet kg / hour	PSS data sheet on EWS LaDePa plant		
Design average feed solids	32,5	%DS	PSS data sheet on EWS LaDePa plant gives 30 - 35% range	For information only	
Plant size - belt width	950	mm	PSS data sheet on EWS LaDePa plant	For information - PSS gives standard sizes for LaDePa plants in terms of belt length and MIR array power.	
Dryer length	11000	mm	PSS data sheet on EWS LaDePa plant	For information	
Area occupied by one plant	160	m2			
Plant size - MIR array power	144	kW	PSS data sheet on EWS LaDePa plant	For information	
Operational hours per day	9	hours / day			
Working days per month	22	days / month	Pers. comm. EWS 23 April 2013		
Operational months per year	12	months / year			

Average downtime per year	10	%	Pers. comm. EWS 23 April 2013	This may be the maximum downtime allowed contractually over a year
Labour				
Foreman	1	No. / plant		
Labourers	4	No. / plant		
Project manager	0,2	No. / plant		
Commissioning time for new plant	6	months	Pers. comm. EWS 23 April 2013	For information - the cash flow sheet assumes the LaDePa plants is ready to use when the pit-emptying cycle starts
Plant lifetime	10	years		Different parts of the plant have different lifetimes, e.g. Generator - 15 years, belt - 1 year, screw conveyer - 9 months
Power rating for plant (draw at full throughput)	151,75	kW	PSS data sheet on EWS LaDePa plant	
Belt drive	0,75	kW	PSS data sheet on EWS LaDePa plant	For information
2 x Screw drives	1,5	kW	PSS data sheet on EWS LaDePa plant	For information
Blower	5,5	kW	PSS data sheet on EWS LaDePa plant	For information
MIR array	144	kW	PSS data sheet on EWS LaDePa plant	For information: total figure for 3x arrays
Power rating of installed diesel engine	310	kW	PSS data sheet on EWS LaDePa plant	EWS LaDePa plant only requires a 160 kW engine
Diesel usage rate	12	ℓ / hour	Harrison 2012, also PSS data sheet but for a 192 kW LaDePa	
Belt apertures	300	micron	PSS data sheet on EWS LaDePa plant	For information
Screw feed speed (sludge / detritus separation)	-	rpm		For information - to be determined when LaDePa plant testing takes place
Typical belt rotation cycle length	16	minutes	Pers. comm. EWS 23 April 2013	
Target depth of sludge on belt	30	mm	Pers. comm. EWS 23 April 2013	Dependent on feed flow of sludge to plant, controlled by eye
MIR power used	-	kW		MIR power required links to the rate of pre-drying, which is linked to the thermal energy of generator exhaust gases - but not able to quantify at this stage
Typical residence time of sludge in drier	4	minutes	PSS data sheet on EWS LaDePa plant	For information
Typical residence time of sludge under MIR array	4	minutes	PSS data sheet on EWS LaDePa plant	For information
Product temperature	180 - 220	deg C	PSS data sheet on EWS LaDePa plant	For information
Product average solids content	85,5	%DS	PRG lab results - average of 3 samples. PSS data sheet on EWS LaDePa plant: 80 - 85% range	
Product form	Pellets	Description		
Theoretical product rate	300	wet kg / hour	PSS data sheet on EWS LaDePa plant: at 80 - 85% DS	For information
Theoretical product bagging rate	20	x15kg bags / hour	PSS data sheet on EWS LaDePa plant	For information
LaDePa pellet product wet density	877,00	kg / m^3	PRG lab results 2013 - average of 3 samples.	
By-products				
Exhaust gas flowrate		m3 / hour	Unknown	
Detritus density	1150	kg / m^3	Estimate - suggest using similar density to wet feed sludge	
Vehicles				
Is vehicle purchased?	Yes			
No. pick up trucks	1	No.		
Daily distance travelled	25	km / working day		
Facilities				
Area required for equipment storage / office	25	m^2		
Parking area	42	m^2		

6.3 Financial parameters

Capital and start up costs				Need a capacity v. capital cost curve for LaDePa plants - information currently not available from PSS
LaDePa plant (152 kW)	-	LCU	Pers. comm. EWS 23 April 2013. Not applicable in South Africa, where plants are leased from PSS. Estimate of capital cost 4 million ZAR including licence	
Civils cost for plinth	20 000,00	LCU		
Construction of office / storage area	50 000,00	LCU		
Permitting and legal requirements				Permitting costs can be either: (i) once-off at start up (e.g. an Environmental Impact Assessment) - enter costs in this section AND/OR (ii) annual feeds - enter costs under O&M costs
Environmental impact assessment		LCU	Pers. comm. EWS 4 March 2013 - initial EIA cost 127,000 LCU	Cost to EWS of initial EIA LCU 127,000 - likely to be higher than what is routinely required for plants.

Waste licence including EIA	70 000	LCU		South Africa: Approx ZAR 50,000 - 70,000 (2013 estimate). Separate EIA not required. However list of waste management activities specifically excludes treatment of sewage - not clear if dedicated treatment of faecal sludge also excluded.
Atmospheric emission licence		LCU		Currently plant is below trigger for needing one (EWS 2013)
O&M costs				
LaDePa plant				
Lease rate	600 000,00	LCU / year		
Royalties	500 000,00	LCU / year		Includes maintenance contract
Permitting and legal requirements				
Health and safety	10 000,00	LCU/year		
Monitoring	10 000,00	LCU/year		
Revenues from LaDePa plant				
Subsidies		LCU/year		
Financial parameters				
Foreman rate	10 000,00	LCU / month		
Labourer daily rate	135,00	LCU / day		Complete only daily rate OR monthly rate
Labourer monthly rate	-	LCU / month		Not applicable if daily rate completed
Project manager rate	35 000,00	LCU / month		
Miscellaneous consumables	5 000,00	LCU / month	Pers. comm. EWS 4 March 2013	
Land purchase price		LCU / m^2	Land costs 0 for eThekwini case	
Months per year property rented for	12	months / year		
Land and property rental price		LCU / m^2 / month	Land costs 0 for eThekwini case	Combined rate for buildings and land - LEAVE BLANK IF NOT APPLICABLE
Overhead rate	5	%		Covers cost of security and admin staff
Repayment period for debt	5	years		

7 - LaDePa product

Go to top

Costs and/or revenue associated with sale/disposal of the LaDePa pellets

Parameter	Value	Unit	Reference	Comment
<u>**Product characteristics**</u>				
Product form	Pellets	Description		
Approximate pellet diameter	5,7	mm	PRG lab results, average of 27 samples (2013)	
Physico-chemical properties				
Volatile solids	16,17	%VS	PRG lab results, average of 3 samples (2013)	
Calorific value	4,3198	MJ/kg	PRG lab results, average of 3 samples (2013)	
Chemical oxygen demand (COD)	82,2	mg COD / g DS	PRG lab results, average of 3 samples (2013)	
Total carbon content	-	mg / g DS		
Nitrogen				
Total N	9,00	mg N / g DS	Cedara lab results (2013)	
TKN	6,00	mg TKN / g DS	PRG lab results, average of 3 samples (2013)	
Ammonia	0,00	mg / g DS	PRG lab results, average of 3 samples (2013)	
Ammonium & urea	1,82	mg NH4-N / g DS	Calculated on a dry mass basis from Cedara lab results (2013), using 950 kg/m3 for density of pellets	Immediately plant-available form
Nitrate	3,46	mg NO3-N / g DS	Calculated on a dry mass basis from Cedara lab results (2013), using 950 kg/m3 for density of pellets	Immediately plant-available form
Phosphorus				
Total P	17,3	mg P / g DS	Cedara lab results (2013)	
Total phosphate (most of it may become plant-available after decomposition)	1,63	mg P as PO4 / g DS	PRG lab results, average of 3 samples (2013)	
Orthophosphate (plant-available)	0,49	mg ortho-P / g DS	PRG lab results, average of 3 samples (2013)	
Potassium (K)	1,80	mg K / g DS	Cedara lab results (2013)	
Calcium (Ca)	27,6	mg Ca / g DS	Cedara lab results (2013)	macro-nutrient
Magnesium (Mg)	3,00	mg Mg / g DS	Cedara lab results (2013)	macro-nutrient
Sulphur (S)	-	mg S / g DS		macro-nutrient
Boron (B)	0,0504	mg B / g DS	PRG lab results, average of 3 samples (2013)	micro-nutrient
Copper (Cu)	0,1136	mg Cu / g DS	PRG lab results, average of 3 samples (2013)	micro-nutrient
Molybdenum (Mo)	ND	mg Mo / g DS	PRG lab results, average of 3 samples (2013)	micro-nutrient
Zinc (Zn)	0,5076	mg Zn / g DS	PRG lab results, average of 3 samples (2013)	micro-nutrient

<u>Undesirables</u>

Pathogen content

Ascaris

Undeveloped eggs	1	No. possible viable Ascaris / 20g DS	2013 analysis (C Archer). Average of 3 samples, present in 2 samples
Motile larvae in eggs	0	No. possible viable Ascaris / 20g DS	2013 analysis (C Archer). Average of 3 samples
Immotile larvae in egg	0	No. possible viable Ascaris / 20g DS	2013 analysis (C Archer). Average of 3 samples
Trichuris	257	Potentially viable eggs / 20g	2013 analysis (C Archer). Average of 3 samples
Taenia	37	Potentially viable eggs / 20g	2013 analysis (C Archer). Average of 3 samples
Faecal coliforms	-	CFU / g DS	

Heavy metals

Heavy metals (*Cr, Be, *As, *Sb, Ba, *Pb, Ag, *Co, *Ni, *Cu, Sn, *V, *Mn)	-			
Heavy metals (*Cd, *Hg, *Tl)	-			Possible lower permit limit applies to these c.f. group above, as more toxic? (it does for air emissions of heavy metals)

As	0,0063	mg As / g DS	PRG lab results, average of 3 samples (2013)
B	0,0504	mg B / g DS	PRG lab results, average of 3 samples (2013)
Cu	0,1136	mg Cu / g DS	PRG lab results, average of 3 samples (2013)
Co	0,0068	mg Co / g DS	PRG lab results, average of 3 samples (2013)
Ni	ND	mg Ni / g DS	PRG lab results, average of 3 samples (2013)
Mo	ND	mg Mo / g DS	PRG lab results, average of 3 samples (2013)
Pb	0,4000	mg Pb / g DS	PRG lab results, average of 3 samples (2013) - above the regulatory limit
Al	16,8082	mg Al / g DS	PRG lab results, average of 3 samples (2013)
Cr	0,0590	mg Cr / g DS	PRG lab results, average of 3 samples (2013)
Hg	0,0398	mg Hg / g DS	PRG lab results, average of 3 samples (2013) - above the regulatory limit
Zn	0,5076	mg Zn / g DS	PRG lab results, average of 3 samples (2013)

Fertiliser regulation limits

Applicable regulations	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers		
Cd	0,02	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
Co	0,1	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
Cr	1,75	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
Cu	0,75	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
Hg	0,01	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
Mo	0,025	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
Ni	0,2	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
Pb	0,4	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
Zn	2,75	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
As	0,015	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
Se	0,015	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
B	0,08	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers
F	0,4	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers

Bagging costs

Packaging cost per bag	1	LCU / 15kg bag

Storage

Number of days product storage required on-site	10	working days

Disposal routes

Financial parameters
Assumes vehicle already owned - by LaDePa operator, or by buyer. Only maintenance, repair and fuel costs for distance travelled are covered below.

Transport costs

Truck capacity - mass	3	tonnes		Complete mass OR volume capacity
Truck capacity - volume	-	m^3		
Fuel type	2	No.		Choose 1 for Gasoline or 2 for Diesel
Driver labour rate	30	LCU / hour		
Choice of disposal route	1			**Choices:** **1 - Wholesale to agriculture** **2 - Bag sale to general public / garden centres** **3 - Landfill** **4 - Incineration**
Option 1: Wholesale to agricultural industry				
Cost of fertiliser product registration	3 120,00	LCU	South Africa Government Services 2013	
Cost of analysis accompanying fertiliser product registration	3 300,00	LCU	R1536 Talbot prices for all components on the DAFF regulations. R110 for Cedara elemental analysis (includes NPK). 2 composite samples required to be analysed. Total approx R3300	
Delivery distance	0	km		Set to zero if delivery is not included in the cost to the LaDePa plant operator.
Sale price of product	0	LCU / tonne		Sale prices are selected in section 20, based on product valuation figures
Option 2: Sale to general public / garden centres				
Additional packaging costs per bag	1	LCU / 15 kg bag		
Cost of fertiliser product registration	3 120,00	LCU	South Africa Government Services 2013	
Cost of analysis accompanying fertiliser product registration	3 300,00	LCU	R1536 Talbot prices for all components on the DAFF regulations. R110 for Cedara elemental analysis (includes NPK). 2 composite samples required to be analysed. Total approx R3300	
Delivery distance	0	km		Set to zero if delivery is not included in the cost to the LaDePa plant operator
Sale price of product	0	LCU / tonne		Sale prices are selected in section 20
Option 3: General landfill				
Landfill cost - by volume		LCU / m3		
Landfill cost - by mass	1300	LCU / tonne	Pers. comm. EWS 23 April 2013 ZAR1020/tonne for hazardous landfill - includes transport and disposal KwaMashu - Shongweni landfill (Enviroserve). Pers. comm EWS Sep 2013 - most recent quote ZAR 1700 / tonne for hazardous. Used ZAR 1300 for general landfill.	
Distance to landfill site	40	km		Select Yes or No
Landfill cost includes transport?	Yes			
Option 4: Incineration				
Delivery distance	35	km	Tongaat WWTP to KwaMashu	Set to zero if delivery is not included in the cost to the LaDePa plant operator
Sale price of product	-	LCU / tonne		Sale prices are chosen in section 20

8 - LaDePa by-products Go to top

Parameter	**Value**	**Unit**	**Reference**	**Comment**
8.1 By-product characteristics				
Detritus				
Mass flowrate	1 530	tonnes / year		
Water loss from detritus during storage	5	% of total volume		Evaporation and leaching prior to final disposal
Average calorific value of detritus	-	MJ / kg	Unknown	
Options for disposal				
Hazardous waste landfill	1	Code		
Incineration	2	Code		
Choice of disposal option	1			Choose 1 (Landfill) or 2 (Incineration)
Air emissions				
Exhaust gas flowrate		m^3 / hour	Unknown	
Threshold over which treatment required		m^3 / hour	To be determined	
Constituents & flowrates			To be determined	

8.2 Financial parameters

Detritus

Landfill

Parameter	Value	Unit	Reference	Notes	User comments
Hazardous landfill cost - by volume	-	LCU / m3			
Hazardous landfill cost - by mass	1 700,00	LCU / tonne	Pers. comm. EWS 23 April 2013 ZAR1020/tonne for hazardous landfill - includes transport and disposal KwaMashu - Shongweni landfill (Enviroserve). Pers. comm EWS Sep 2013 - most recent quote ZAR 1700 / tonne for hazardous.	Transport is often charged by volume, landfill charges by mass	
Distance to landfill site	40	km			
Landfill cost includes transport?	Yes			Choose Yes or No. If Yes then not required to fill in transport inputs	
Truck capacity - mass	3	tonnes			
Truck capacity - volume	-	m^3			
Fuel type	2	No.		Choose 1 for Gasoline or 2 for Diesel	
Driver labour rate	30	LCU / hour			
Land area required for storage of detritus	25	m2			
Incineration					
Cost of incineration	-	LCU / tonne		Incinerator operator fee	
Distance to incinerator site	25	km			
Incinerator cost includes transport?	Yes			Choose Yes or No. If Yes then not required to fill in transport inputs	
Truck capacity - mass	3	tonnes			
Truck capacity - volume		m^3			
Fuel type	2	No.		Choose 1 for Gasoline or 2 for Diesel	
Driver labour rate	30	LCU / hour			
Air emissions					
Costs need further detailing - information not currently available					
Atmospheric emission licence	Cost included on LaDePa sheet			Currently plant is below trigger for needing one (EWS 2013). To be determined by EIA currently in progress.	
9.1 - LaDePa cost summary				Go to top	
Is the cost of emptying and conveyance to be included in the LaDePa cash flows?	Yes	Yes or No			
9.3 - LaDePa cash flows					
Does income tax apply?	No			Choose no for the municipal scenario	
11 - Combustion Storage				Go to top	
Minimum number of working days per year required (defined by final conveyance stage)	252	days / year			
Working days per month	21	working days / month			
Number of months per year Storage facility operates	12	months / year			
Number of available working days per year	252	working days / year			
Error check!	0			Highlighted if min number of required working days is higher than available working days	
Minimum buffer storage volume required, for all combustion plants	0	m3		Negative value indicates no buffer storage required - combustion plants can process sludge at a higher rate than it is supplied	
User-specified storage volume	0	m^3	Note in SA waste licence is required if more than 35 m3 sludge is stockpiled	Optional input - overrides the calculated volume requirement	

11.2 Financial

Parameter	Value	Unit	Reference	Notes	User comments
Capital and start-up costs					
Number of storage tanks	1	No. tanks		Equal to the number of combustion facilities	
Volume of each storage tank	-	m3 / tank			
Cost of land preparation for each holding tank	10 000,00	LCU / tank			
Civils costs for plinth and bund	10 000,00	LCU / tank			
Cost per kℓ capacity of tank	2 500,00	LCU / kℓ			
Cost of each tank	-	LCU / tank			
Capital cost of other equipment, per tank		LCU / tank			
Once-off fees for permits, EIAs etc, per tank		LCU / tank	Note that in South Africa waste licence is required if more than 34 m3 of sludge is stockpiled. In this case cost has been covered by licensing associated with the LaDePa plant itself.		
O&M costs					
Fuel costs for all tanks		LCU / year			
Operating parameters					
Number of supervisors per tank		No.	Storage facility operated by LaDePa staff, no additional personnel required		

Number of months per year supervisor employed for		months / year		
Number of labourers per tank		No.	Storage facility operated by LaDePa staff, no additional personnel required	
Number of months per year labourers employed for		months / year		
Number of storage tanks	1,00	No. tanks		
Volume of each storage tank	-	m3 / tank		
Height of tank	4,00	m		
Footprint of tank	0,00	m2 / tank		Includes 10% extra area in addition to tank base.

Financial parameters

Labour - supervisor rate	10 000,00	LCU / month		
Labour - labourer rate	135,00	LCU / day		
Maintenance rate for facility	500,00	LCU / month		
Consumables cost per month		LCU / month		
Overhead rate	10	%		Covers cost of security and admin staff
Revenue generated per kilolitre of FS received at storage	-	LCU / kℓ		A positive value entered here is a gate fee charged to operators dumping sludge at the treatment facility. A negative value entered here is equivalent to the facility paying for sludge to be dumped (incentiviser for correct disposal).

Notes

1. Assumed that storage, pre-treatment, combustion plant and product and by-product facilities are co-located and co-operated
2. The land, office and parking facilities for all of these stages are costed on the Combustion sheet
3. Where additional staff (additional to the team required to operate the combustion plant) are required for any treatment stage this is indicated on the individual sheet

12 - Combustion pre-treatment

Go to top

12.2 Required feed spec to incineration process

Further information required on required feed specifications to the combustion process

Minimum % DS of feed sludge	20,0	%DS	Pers. comm. CWU 2013 (KwaMashu incinerator) - primary sludge thickened to 20% DS before feeding to incinerator	The higher the specified minimum %DS, the lower the supplemental fuel requirements for incineration. MODEL CANNOT CURRENTLY OPERATE IF THIS PARAMETER IS SET BELOW 20%DS
Maximum % DS of feed sludge	95,0	%DS	Estimated	
Maximum allowable detritus content	50	%	Unknown	
Maximum allowable sand / gritty solids content	10	%	Unknown	
Minimum dry mass throughput allowable		kg / hour	Unknown	
Maximum dry mass throughput allowable		kg / hour	Unknown	
Minimum calorific value of feed required (linked to the dry solids content)	20,26	MJ / kg	Linked to dry solids content of feed	Calculated on Combustion sheet, based on the dry solids content of the incoming sludge. This will change if additives are added.

12.3 Out of spec feed parameters

				Parameters highlighted if out of spec
%DS of sludge too high	0			
%DS of sludge too low	0			
Detritus fraction	0			
Average sand / grit fraction	0			
Calorific value too low	1			Can be corrected by addition of additive here, or by addition of supplemental fuel on Combustion sheet

12.4 Pre-treatment processes

12.4.1 Water addition

Is water addition required to stored sludge?	No			
Does additive addition require more water to be added to the fuel-additive mix?	No			
Volume of water required per m3 sludge	0	m3 / m3 FS		
Annual volume of water added	-	m^3 / year		
Capital cost of facility for water addition and mixing		LCU		Small mixing tank, manual mixing
Land area required		m^2		

12.4.2 Increase in dry solids

Is increase in dry solids required?	No			
Does additive provide sufficient increase in dry solids content?	Yes			
Annual volume of water removed	0	m^3 / year		

Drying beds

Drying bed loading rate	300	kg DS / m2 / year	Niang 2012 Uncovered drying beds in Senegal - 300 kg DS/m2/year	
Dried sludge solids achieved at this loading rate	60	%	Niang 2012 Uncovered drying beds in Senegal - 60%	
Drying bed area required	0	m2 / year		
Area of each drying bed	10	m2		Use 10 m2 if unknown.
Construction cost of drying bed facility per m2	4 000,00	LCU / m2	Extrapolating from Matar Dème 2009 gives 2,138,000 ZAR for 128 m2 drying bed - construction costs only, no land cost - ZAR 16703/m2. ZAR 4000/m2 chosen for eThekwini context based on local experience.	
Capital cost of sludge mixing tank	5 000,00	LCU		For mixing of dried and fresh sludge to achieve required blend

Additional operational costs

Assumes the pre-treatment operation is operated by incinerator plant staff

Parameter	Value	Unit	Source	Notes
Drying bed cleaning costs (required once / month / bed)	50	LCU / 10 m2 / month	Gning 2008 and pers. comm S El Hadji 13 Sep 2013. ZAR 303 / month / 10 m2 bed for Senegal. ZAR 50 /10m2/month chosen for eThekwini based on local experience.	
Additional labour	0	No. labourers		Labour in addition to combustion plant staff. Choose based on drying bed area - assume one 10 m2 bed takes 2 people one day to clear.
Proportion of total solids remaining in dried FS	50	%	Sonko 2007, maximum figure: 30-50% range given. For application of unthickened septic tank sludge directly to drying beds.	Figures for information only - loss of solids, COD and N across drying bed not currently accounted for in calculations
Proportion of total suspended solids remaining in dried FS	95		Sonko 2007, maximum figure: 80-95% range given	
Proportion of COD remaining in dried FS	90	%	Sonko 2007, maximum figure: 85-90% range given	
Proportion of nitrogen remaining in dried FS				
Ammonium & urea		%		
Nitrate		%		
Total nitrogen		%		
TKN	70	%	Sonko 2007, maximum figure: 40 - 70% range given	

<u>12.4.3 Detritus removal</u>

Parameter	Value	Unit	Source	Notes
Is detritus removal required?	No		All detritus goes into the combustion process	
Detritus removed per year	0	m^3 / year		
Capital cost of basic screening facility		LCU		
Land area required		m2		

<u>12.4.4 Additives</u>

Additive could be used to adjust the dry solids content of the feed, or to change the composition of the ash product.

Supplementary fuel properties are entered under Section 13, not here.

Parameter	Value	Unit	Notes
Is an additive to be used?	No		Enter Yes or No
Additive type		Name	
Additive dry solids content		%DS	
Volumetric proportion of additive in sludge - additive mix		%	
Calorific value of additive		MJ / kg	
Cost of additive by mass		LCU / tonne	
Density of additive		kg / m3	
Cost of additive by volume		LCU / m3	
Calorific value of sludge - additive mix	12,35	MJ / kg	Average calorific value of the additive + original FS mixture, does not account for any calorific value of detritus content
Error check	1		Highlighted if calorific value of mix is lower than minimum required for feed to incinerator. Can be corrected by addition of supplementary fuel (Combustion sheet)

Additive composition

Parameter	Value	Unit	Notes
BOD		g BOD / g DS	
Nitrogen			
Ammonium & urea		mg ammoniacal N / g DS	
Nitrate		mg NO3- / g DS	
Total nitrogen		mg N / g DS	
Phosphorus			
Total phosphate		mg P / g DS	
Orthophosphate		mg ortho-P / g DS	
Potassium		mg K / g DS	
Calcium		mg Ca / g DS	
Magnesium		mg Mg / g DS	
Sulphur		mg S / g DS	
Ascaris			
Undeveloped eggs		No. possible viable Ascaris / 20g DS	
Motile larvae in eggs		No. possible viable Ascaris / 20g DS	
Immotile larvae in egg		No. possible viable Ascaris / 20g DS	
Trichuris		Potentially viable eggs / 20g	
Taenia		Potentially viable eggs / 20g	
Faecal coliforms		CFU / g DS	
Capital cost of facility for additive addition and mixing		LCU	Type of facility required will depend on additive - could simply be an additional hopper on the feed to the LaDePa plant, or a mixing tank for sludge and additive prior to being fed to the LaDePa.
Land area required for mixing facility		m2	

13 - Combustion process

Go to top

<u>13.3 Number of combustion plants required</u>

Average dry mass feed rate to one combustion plant	400,00	dry kg / hour / plant	KwaMashu incinerator feeds 400 dry kg/hour (2000 wet kg/hour @ 20% DS)	
Number of combustion plants required	0,73	No.	Calculated based on mass feed & mass capacity	Assumes that sludge can be processed by plant in the years between pit-emptying cycles
Number of combustion plants in operation	1	No.		User choice, based on calculated number of plants required.
Time taken to process all sludge from one pit-emptying cycle	5,00	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 low, then the time taken to process sludge will be longer than the time available.

13.4 Combustion operation parameters for one combustion plant working at full capacity

13.4.1 Furnace conditions				
Temperature of furnace	760 - 815	˚C	Dangtran et al 2000	For reference only. Dependent on furnace type and part of furnace.
Residence time of solids in incinerator	1 to 5	minutes	Dangtran et al 2000	For reference only, furnace-specific
Gas detention time (at high temperature)	6 to 8	seconds	Dangtran et al 2000	For reference only, furnace-specific
Gas exit temperature	815 - 871	˚C	Dangtran et al 2000	For reference only, furnace-specific
Combustion air				
Further information required				
Excess air requirement	40	%	Dangtran et al 2000	For reference only, furnace-specific
Combustion air flow required		Nm^3/hour	Unknown	
Is combustion air pre-heated?	Yes			Choose Yes or No
Energy required to heat combustion air		MW	Unknown	
Pre-heated temperature of combustion air		˚C	Unknown	

13.4.2 Supplemental fuel feed

Calculation of chosen supplemental fuel requirements

Note - these figures assume no pre-heating of the combustion air. Supplemental fuel requirements will be lower if air is pre-heated

Is supplemental fuel required?	Yes			
Additional fuel used	Coal	Name		
Is supplemental fuel a fossil fuel?	Yes			
Fuel dry solids content	85	%DS	Engineering Toolbox 2013	
Calorific value	31	MJ / kg	Biomass Energy Centre 2013	
Cost of fuel by mass	729	LCU / tonne	Indexmundi 2013 - 72.9 USD/tonne Aug 2013 price	
Density of fuel	900	kg / m3	Engineering Toolbox 2013	
13.4.3 Plant operational parameters				
Does the plant operate 24/7?	Yes			
Operational months per year	12	months / year		
Operational days per month (excluding downtime)		days / month		Only required to complete if not 24/7 operation
Operational hours per day	24	hours / day		
Average downtime per year	10	%		
Commissioning time for new plant	6	months		
Plant lifetime	20	years		
13.4.4 Combustion products				
Mass reduction across combustion process	70	%	Lauridsen 2008. 0.24 - 0.9 g VS / g dry mass measured in VIP sludge samples (PRG 2013)	
Volume reduction across combustion process	90	%	Lauridsen 2008	
Proportion of ash going to bottom ash	20	%	Unknown	
Fly ash				
Dry solids of hydrated fly ash flow	51,42	%DS	PRG 2013 Sample data from KwaMashu incinerator - ash water mixture at end of process	
Flue gases				
Further information needed				
Flue gas flow rate		Nm^3/hour	Unknown	
Flue gas water content		%	Unknown	
13.4.5 Polymer use				Used for ash sedimentation
Current year	2013			
Conversion factor	10,00	LCU / USD		Model uses literature prices for polymer use, given in USD for a previous year.
13.4.6 Sand use				Sand loss from bed during operation, in ash flow
Current year	2013			
Conversion factor	10,00	LCU / USD		Model uses literature prices for polymer use, given in USD for a previous year.
13.4.7 Power use				
Electrical power rating for plant (draw at full throughput)		MW	Unknown - further information needed	Assuming no electricity generation at the combustion plant
13.4.8 Vehicle				
Is vehicle purchased?	Yes			
Average distance travelled per working month	210,00	km / month		
13.4.8 Other parameters				
Repairs & maintenance				
% of capital cost per year	5	% of capital cost / year	Laurisden 2008 gives 3 - 5% of capital cost as typical	

Labour

Number of supervisors per plant	2	No. / plant		
Number of labourers per plant	16	No. / plant	KwaMashu - 18 staff total	
Number of project managers per plant	0,2	No. / plant		
Supervisor rate	10 000,00	LCU / month		
Labourer rate	7 000,00	LCU / month		
Project manager rate	35 000,00	LCU / month		

Land requirements

Incineration plant area	400	m^2	Estimate	
Facilities				
Area required for equipment storage / office	10	m^2		
Parking area	60	m^2		

13.5 Financial

13.5.1 Financial parameters

Land purchase price		LCU / m^2	Land costs 0 for eThekwini case - municipal land	Leave blank if land / facility is rented
Land and office property rental price		LCU / m^2 / month	Land costs 0 for eThekwini case - municipal land	Combined rate for buildings and land - leave blank if land and buildings are purchased
Overhead rate	10	%		Covers cost of security and admin staff
Repayment period for debt	5	years		

13.5.2 Costs for ONE plant

Capital and start-up costs - one plant

Combustion plant capacity	400	dry kg / hour	Equivalent to 3.1 dry kte/year or 10.5 wet kte/year plant	
Capital cost of combustion plant	73 000 000	LCU / plant	Scaled from figures in Toronto Water 2011 & Ontario Ministry of Environment 2009. 57.7 million USD (2010) or 68.72 million USD (2103) for 54 dry tonne/day fluidised bed plant. Scaled cost for 5.75 dry tonnes/day plant in 2013: 7.32 million USD. Does not account for economy of scale with larger plant, but may be offset by lower construction costs in South Africa. Scaled cost from Greater London Authority 2008 also gives 73,770,000 ZAR = 7.38 million USD (from 35 million GBP for 100 kte/year plant, 2006 cost)	More research needed - cost curve of of capital cost v. capacity for small (<25 kte/year) fluidised bed plants.
Permitting and legal requirements				Permitting costs can be either: (i) once-off at start up (e.g. an Environmental Impact Assessment) - enter costs in this section AND/OR (ii) annual feeds - enter costs under O&M costs
Environmental impact assessment		LCU / plant		
Waste licence	100 000,00	LCU / plant	South Africa: Approx ZAR 50,000 - 70,000 (2013 estimate). Separate EIA not required. R 100,000 chosen to account for extra complexity of incinerator over LaDePa. Note in SA waste licence is required if more than 35 m3 sludge is to be stockpiled	
Atmospheric emission licence	50 000,00	LCU / plant	Estimate	
Community consultation	25 000,00	LCU / plant	Estimate	

O&M costs- one plant at FULL capacity

Plant O&M				
Sundries	24 000,00	LCU / year		Estimate. Note that costs associated with consumbles for air pollution control devices are accounted for on the 'Combustion by-product' sheet
Permitting and legal requirements				Costs of air emissions monitoring is covered on the Combustion by-product sheet
Health and safety	10 000,00	LCU/year		Estimate
Other		LCU/year		

Revenues

Subsidies		LCU/year		

14 - Combustion product

Go to top

Product characteristics

Fly ash

Volatile solids	5,22	%	PRG analysis of ash from KwaMashu incinerator	Ash/water mixture at end of process
Product form	Hydrated ash	Description		e.g. fine powder, crystals
Particle size	-	µm		important for producing bricks
Carbon content		mg C / g DS		
Nitrogen - total	1,90	mg N / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
Phosphorus - total	11,90	mg P / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
Potassium	2,90	mg K / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	

Calcium	116,10	mg Ca / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
Magnesium	6,30	mg Mg / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
Zinc	0,46	mg Zn / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
Copper	0,23	mg Cu / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
Manganese	0,32	mg Mn / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
Iron	30,95	mg Fe / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
Aluminium	33,32	mg Al / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
Boron		mg B / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
Sulphur		mg S / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
Sodium	1,41	mg Na / g DS	Cedara 2013 analysis of KwaMashu incinerator ash	
CaO content		%		important for brick manufacture - Hersleman et al 2008: should be under 15% to prevent cracking
Heavy metals (*Cr, Be, *As, *Sb, Ba, *Pb, Ag, *Co, *Ni, *Cu, Sn, *V, *Mn)	0	mg / g DS		
Heavy metals (*Cd, *Hg, *Tl)	0	mg / g DS		Possible lower permit limit applies to these c.f. group above, as more toxic? (it does for air emissions of heavy metals)
Cd		mg / g		
Co		mg / g		
Cr		mg / g		
Cu	0,23	mg / g		
Hg		mg / g		
Mo		mg / g		
Ni		mg / g		
Pb		mg / g		
Zn		mg / g		
As		mg / g		
Se		mg / g		
B		mg / g		
F		mg / g		
Chosen disposal route for fly ash	2			Choices: 1 - Addition to LaDePa pellets or other fertiliser product 2 - Landfill 3 - Construction materials

Bottom ash

Bottom ash average dry solids	90	%DS	Estimate
Product form	Dry ash	Description	e.g. fine powder, crystals
Particle size		µm	important for producing bricks

Chemical properties

Carbon content	-	mg C / g DS	
Nitrogen (total) (N)	-	mg N / g DS	
Phosphorus (total) (P)	-	mg P / g DS	
Potassium (K)	-	mg K / g DS	
Calcium (Ca)	-	mg Ca / g DS	
Magnesium (Mg)	-	mg Mg / g DS	
Sulphur (S)	-	mg S / g DS	
Zinc	-	mg Zn / g DS	
Copper	-	mg Cu / g DS	
Manganese	-	mg Mn / g DS	
Iron	-	mg Fe / g DS	
Aluminium	-	mg Al / g DS	
Boron	-	mg B / g DS	
Sulphur	-	mg S / g DS	
Sodium	-	mg Na / g DS	
CaO content	-	%	important for brick manufacture - Hersleman et al 2008: should be under 15% to prevent cracking
Heavy metals (*Cr, Be, *As, *Sb, Ba, *Pb, Ag, *Co, *Ni, *Cu, Sn, *V, *Mn)	-	mg / g DS	
Heavy metals (*Cd, *Hg, *Tl)	-	mg / g DS	Possible lower permit limit applies to these c.f. group above, as more toxic? (it does for air emissions of heavy metals)
Cd	-	mg / g	
Co	-	mg / g	
Cr	-	mg / g	
Cu	-	mg / g	
Hg	-	mg / g	
Mo	-	mg / g	
Ni	-	mg / g	
Pb	-	mg / g	
Zn	-	mg / g	
As	-	mg / g	
Se	-	mg / g	
B	-	mg / g	
F	-	mg / g	

Fertiliser regulation limits

Applicable regulations	Department of Agriculture, Forestry & Fisheries 2012 - Regulations regarding fertilisers

Cd	0,02	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
Co	0,1	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
Cr	1,75	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
Cu	0,75	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
Hg	0,01	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
Mo	0,025	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
Ni	0,2	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
Pb	0,4	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
Zn	2,75	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
As	0,015	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
Se	0,015	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
B	0,08	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
F	0,4	mg / g	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
Chosen disposal route for bottom ash	2			Choices: 1 - Addition to LaDePa pellets or other fertiliser product 2 - Landfill 3 - Construction materials

Storage

Number of days product storage required on-site	10	working days		
Storage area required	50	m2		Skips for ash
Annual income for all combustion plants (excluding income from ash product sales)		LCU / year		Income from subsidies or power generation

Disposal routes - per combustion plant

Financial parameters

Transport costs

Truck capacity - mass (3 - 5 tonne range)	3	tonnes		

Option 1: Addition to fertiliser product or LaDePa pellets

Cost of fertiliser product registration	3 120,00	LCU	South Africa Government Services 2013	
Cost of analysis accompanying fertiliser product registration	3 300,00	LCU	R1536 Talbot prices for all components on the DAFF regulations. R110 for Cedara elemental analysis (includes NPK). 2 composite samples required to be analysed. Total approx R3300	
Delivery distance	30	km		
Is vehicle purchased or hired?	Purchased			
Sale price of ash	-	LCU / dry tonne		Sale prices selected in section 20, based on calculated value of products

Option 2: General landfill

Landfill cost - by mass	1 300,00	LCU / tonne	Pers. comm. EWS 23 April 2013 ZAR1020/tonne for hazardous landfill - includes transport and disposal KwaMashu - Shongweni landfill (Enviroserve). Pers. comm EWS Sep 2013 - most recent quote ZAR 1700 / tonne for hazardous. Used ZAR 1300 for general landfill.	
Distance to landfill site	50	km		
Landfill cost includes transport?	Yes			
Is vehicle purchased or hired?	Purchased			

Option 3: Production of construction materials

Startup costs		LCU		Analysis, any certification requirements
Annual analytical costs	10 000,00	LCU / year	estimate	To guarantee suitability of material for construction - e.g. particle size analysis
Distance to end user's site	50	km		
Transport costs borne by combustion operator?	Yes			
Is vehicle purchased or hired?	Purchased			
Sale price of ash	-	LCU / dry tonne		

15 - Combustion by-products

Go to top

By-product characteristics

Detritus

Detritus density	1100	kg / m3		
Hazardous landfill cost, including transport	1700	LCU / tonne	Pers. comm. EWS 23 April 2013 ZAR1020/tonne for hazardous landfill - includes transport and disposal KwaMashu - Shongweni landfill (Enviroserve). Pers. comm EWS Sep 2013 - most recent quote ZAR 1700 / tonne for hazardous. Used ZAR 1300 for general landfill.	

Air emissions -treated off-gas

*starred items are those listed in the Department of Environmental Affairs (DEA) 2009 policy on air emissions from thermal treatment plants

Further information required

Constituents

Inorganic gases

Carbon dioxide				
*Carbon monoxide				
Water				
*Sulphur dioxide				
*Nitrogen oxides				
*Hydrogen chloride				
*Hydrogen fluoride				
*Ammonia				

Organic compounds

*VOC (volatile organic compounds / volatile organic carbon)				
*Dioxins (PCDD - polychlorinated dibenzodioxins) & *furans (PCDF - polychlorinated dibenzo-furans)				
Odour level				
*TOC (total organic carbon)				

Particulates

*Total particulate matter				
Heavy metals (*Cr, Be, *As, *Sb, Ba, *Pb, Ag, *Co, *Ni, *Cu, Sn, *V, *Mn)				
Heavy metals (*Cd, *Hg, *Tl)				Lower APPA permit limit than other metals above hence grouped separately (Botha et al 2011)

Air pollution control (APC) device

All costs for APC currently assumed to be included under repair & maintenance cost for main combustion plant

Air pollution control device selected	Bag filter			Options could include bag filter, scrubber, bio-filter, electro-static precipitator
Is the capital cost of the air pollution control device included within the capital cost of the combustion plant?	Yes			
Capital cost of air pollution control device		LCU		
Maintenance cost of APC		LCU / month		
Monthly consumables costs for APC		LCU / month		e.g. NaOH for scrubber
Monthly cost of APC residue disposal		LCU / month		e.g. fees to discharge wastewater from a scrubber to sewer
Routine monitoring (checking compliance with emissions limits)		LCU / month	For requirements in SA: See p 37 onwards of Herselman et al 2008 vol5; DEA 2009 p21 See p 35 of Herselman et al 2008 vol5	

Costs per plant

Total revenues		LCU / year		
Additional land area required		m2		

16.1 - Combustion cost summary

Go to top

Is the cost of emptying and conveyance to be included in the combustion cash flows?	Yes			

16.3 Combustion cash flows

Does income tax apply?	No		Not applicable for municipal case	

17 - Landfill

Go to top

Baseline option - pits emptied and sludge conveyed to hazardous landfill

Pits emptied and sludge conveyed to a central point, distance T1 from pits.
Cost of hazardous landfill disposal is calculated from this point.
Excludes the cost of any storage facility.

Distance to landfill site	70	km	Tongaat - Shongweni hazardous landfill, 70 km one way	
Cost of disposal to hazardous landfill	1700	LCU / tonne	Pers. comm. EWS 23 April 2013 ZAR1020/tonne for hazardous landfill - includes transport and disposal KwaMashu - Shongweni landfill (Enviroserve). Pers. comm EWS Sep 2013 - most recent quote ZAR 1700 / tonne for hazardous. Used ZAR 1300 for general landfill.	Includes transport
Lifespan for cashflows	10	years		
Does income tax apply?	No			

18 - Costs to service provider

Go to top

Costs to municipality or company providing sanitation services, as a percentage of levelised costs

Service provider cost	3	% markup on cost

19 - Product valuation

Go to top

__Commercial inorganic fertiliser compositions and prices__

Used to calculate the value of the LaDePa pellets based on their nutrient content, and for partial budget analyses (Sheet 20)

Nutrient content

	N	**P**	**K**	**Price**	**Reference**
	%	%	%	LCU / tonne	
Urea	46			4820	12 June 2013 Kokstad Agricultural Cooperative (RSA)
Limestone ammonium nitrate (LAN)	28			5280	12 June 2013 Kokstad Agricultural Cooperative (RSA)
Mono-ammonium phosphate (MAP)	10	22		6750	12 June 2013 Kokstad Agricultural Cooperative (RSA)
Potassium chloride (KCL)			50	5250	12 June 2013 Kokstad Agricultural Cooperative (RSA)

__Commercial organic fertiliser compositions and prices__

Organic fertiliser 1 name	Neutrog Bounce Back			
Price	8750	LCU / wet tonne	Online retailer (2013)	
Markup rate included in sale price	40	%		Suggested 40% for prices of bagged product sold in shops. 20% for wholesale products.
Water	120	g/kg		
N	**30**	g/kg		
P	**11**	g/kg		
K	**10**	g/kg		
Ca	25	g/kg		
S	6	g/kg		
Mg	8	g/kg		
Zn	0,443	g/kg		
Product density	655	kg/m3		
Organic matter	655	kg/m3		

Organic fertiliser 2 name	**Natural Organic pellet from chicken litter**			
Price	9000	LCU / tonne	Price of 10kg bag R 89.95 at local garden centre	
Markup rate included in sale price	40	%	Estimate	Suggested 40% for prices of bagged product sold in shops. 20% for wholesale products.
Water		g/kg		
N	34,3	g/kg		
P	18,8	g/kg		
K	36,2	g/kg		
Ca		g/kg		
S		g/kg		
Mg		g/kg		
Zn		g/kg		
Product density		kg/m3		
Organic matter		kg/m3		

20 - Crop application

Go to top

Partial budget analysis to evaluate the profitability of using LaDePa pellets as an alternative mineral nutrient source to conventional fertilisers

Objective: Comparing the economic feasibility of using LaDePa pellets instead of conventional inorganic and organic fertilisers

Methodology

Step 1: Determine the additional cost which will result from the change of fertiliser

Step 2: Determine what income will be lost as a result of the change of fertiliser
Step 3: Determine the cost which will be saved as a result of the change of fertiliser
Step 4: Determine the additional income that will be obtained as a result of the change of fertiliser

Partial budget

Existing practice		**Alternative**	
(i) Redduced income:	a	(i) Additional income:	c
(ii) Reduced cost:	b	(ii) Additional cost	d
Difference (i) - (ii)	a - b	Difference ((i) - (ii)	c - d

Analysis
If difference is positive (> 0) the change is desirable; if change is negative (< 0) the change is detrimental

Reference
Finance & Farmers - A Financial management guide for farmers. Standard Bank (1981)

Partial budget 1 - Replacing a commercial inorganic fertiliser with LaDePa pellets

Commercial fertiliser to be replaced:	Compound fertiliser 3:2:1 (25) + 0.5% Zn			
Ratio N	3			
Ratio P	2			
Ratio K	1			
Total % NPK	25	%		
Fertiliser requirements for the production of:	Dry beans			Enter crop name
Application rate	300	kg / ha	KZN Department of Agriculture 2012	Application rate of chosen fertilsier per hectare of chosen crop fertilised
Cost	4,775	LCU / kg	KZN Department of Agriculture 2012	
Delivery distance for conventional fertiliser	25	km		
Spreading costs for conventional fertiliser (labour, machinery, equipment)	0,40	LCU / kg	Cost of freight & spreading given as 40 USD/tonne (Victora State Government 2013).	

Table 20.1 - Quantity of LaDePa pellets needed to supply nutrient requirements for chosen crop

Quantity of LaDePa pellets needed to supply required N	**4873**	kg pellets	Calculated based on the nutrient content of the LaDePa pellets input in Section 7
Quantity of LaDePa pellets needed to supply required P	**1690**	kg pellets	Calculated based on the nutrient content of the LaDePa pellets input in Section 7
Quantity of LaDePa pellets needed to supply required K	**8122**	kg pellets	Calculated based on the nutrient content of the LaDePa pellets input in Section 7

Partial budget analysis - LaDePa pellets
1. A specific nutrient (N, P or K) must be chosen on which to base the partial budget analysis
2. Review the calculated quanties of LaDePa pellets (Table 20.1 above) required to fulfil the crop's requirements for each nutrient.
3. Choosing the nutrient with the highest pellet demand will ensure all the NPK requirements of the crop are met BUT may result in over-application of the other nutrients.
4. Instead, user may choose to satisfy demand of one nutrient using LaDePa pellets, and supplement with another fertiliser to fill the remaining demand for the others.
5. Select the appropriate nutrient code below (1 for N, 2 for P or 3 for K) to base the partial budget analysis on.
6. Review Table 20.2 below to check the remaining crop nutrient demand not satisfied by the LaDePa pellets, and for over-supply of nutrients.
7. The level of nutrient over-supply that can be tolerated will be crop and land dependent.

Nutrient chosen on which to base analysis - code	2		Choose to satisfy the crop demand for one particular nutrient, based on figures calculated in Table 20.1 Not necessarily the highest pellet demand figure, as could result in over-application of the other nutrients - see Table 20.2. 1 - N 2 - P 3 - K
Nutrient chosen on which to base analysis	**P**		
Quantity of LaDePa pellets required to supply required nutrient amount	1690	kg / pellets	

Table 20.2 - Nutrient demand of crop not satisfied by LaDePa pellets:
Negative figures indicate a nutrient is being over-applied

N	24,49	kg N
P	0,00	kg P
K	9,90	kg K

Blend LaDePa pellets with an additional fertiliser
If additional nutrients are required, user may choose to blend LaDePa pellets with a second fertiliser source.
NOTE: In South Africa additional approval is required if adding elements to sewage sludge destined for compost/fertiliser

Table 20.3 - Blend fertiliser nutrient contents and costs

Code	Name	Cost per kg nutrient LCU / kg nutrient	% nutrient in fertiliser %
1	Urea N	10,48	46,00
2	Limestone ammonium nitrate (LAN) - N	18,86	28,00
3	Mono-ammonium phosphate (MAP) - N	67,50	10,00
4	Mono-ammonium phosphate (MAP) - P	25,92	22,00
5	Potassium chloride (KCL) - K	10,50	50,00

6	Incineration ash - K	10,50	0,29

Blend component - code: 6

Choose appropriate code for required blend component:
0 - None
1 - Urea N
2 - Limestone ammonium nitrate (LAN) - N
3 - Mono-ammonium phosphate (MAP) - P
4 - Mono-ammonium phosphate (MAP) - P
5 - Potassium chloride (KCl) - K
6 - Ash - K

Blend component: Incineration ash - K

Nutrient supplied - choose code: 3

Choose based on blend component chosen (shown with the name of the blend component):
1 - N
2 - P
3 - K

Nutrient supplied: K

Delivery distance for LaDePa pellets: 25 km

Spreading costs for LaDePa pellets & blend component (labour, machinery, equipment): 0,50 LCU / kg

Cost of freight & spreading given as 40 USD/tonne (Victora State Government 2013). Use 0.5 ZAR/kg for LaDePa pellets.

Set slightly higher than conventional fertiliser as may have to modify spreading equipment to use pellet form product.

Chosen prices of LaDePa pellets: **3** **-0,83** **0,48** LCU / kg

Sample price 1

Value of pellets based on nutrient content of LaDePa pellets alone

Press to re-calculate after any changes to input parameters

Negative value indicates that LaDePa pellets are never more profitable to use

Partial budget 2 - Replacing a commerical organic fertiliser with LaDePa pellets

Quantity of organic fertiliser needed to supply the mineral nutrient requirements for selected crop

Name of organic fertilisers: Natural Organic (chicken-litter based)

Choose an organic fertiliser comparable to LaDePa - wholesale price, manure/faecal origin

Nitrogen content in organic fertiliser: 0,0343 kg N / kg — KZN Department of Agriculture 2012

Quantity of organic fertiliser need to supply required N: 1093 kg pellets

Phosphorus content in organic fertiliser: 0,0188 kg P / kg — KZN Department of Agriculture 2012

Quantity of organic fertiliser needed to supply required P: 1330 kg pellets

Potassium content in organic fertiliser: 0,0362 kg K / kg — KZN Department of Agriculture 2012

Quantity of organic fertiliser needed to supply required K: 345 kg pellets

Table 20.4 - Quantity of organic fertiliser needed to supply nutrient requirements for chosen crop

1	N	1093	kg fertiliser
2	P	1330	kg fertiliser
3	K	345	kg fertiliser

Partial budget

1. A specific nutrient (N, P or K) must be chosen on which to base the partial budget analysis
2. Review the calculated quanties of organic fertiliser (Table 20.4 above) required to fulfil the crop's requirements for each nutrient.
3. Choosing the nutrient with the highest pellet demand will ensure all the NPK requirements of the crop are met BUT may result in over-application of the other nutrients.
4. Select the appropriate nutrient code below (1 for N, 2 for P or 3 for K) to base the partial budget analysis on.
5. Review Table 20.5 below to check for over-supply of nutrients.
6. The level of nutrient over-supply that can be tolerated will be crop and land dependent.

Nutrient chosen on which to base analysis - code: 2

Choose to satisfy the crop demand for one particular nutrient, based on figures calculated in Table 20.4 Not necessarily the highest fertiliser demand figure, as could result in over-application of the other nutrients - see Table 20.5.

1 - N
2 - P
3 - K

Nutrient chosen on which to base analysis: **P**

Quantity of organic fertiliser required to supply required nutrient amount: 1330 kg / fertiliser

Table 20.5 - Nutrient requirements not met by organic fertiliser

Negative figures indicate over-supply of a nutrient

N	-8,11	kg N
P	0,00	kg P
K	-35,64	kg K

Price of organic fertiliser: 2 LCU / kg

Estimated wholesale price for organic fertiliser - R 2000 / tonne

Delivery distance for organic fertiliser: 25 km

Spreading costs for organic fertiliser (labour, machinery, equipment)	0,40	LCU / kg	Cost of freight & spreading given as 40 USD/tonne (Victora State Government 2013).	unknown - as for conventional fertiliser	
Chosen prices of LaDePa pellets	**3**		**0,18**	**0,48**	LCU / kg
	Sample price 1			Value of pellets based on nutrient content of LaDePa pellets alone	

Press to re-calculate after any changes to input parameters

Negative value indicates that LaDePa pellets are never more profitable to use

Summary table of calculated product values

LaDePa pellets based on inorganic fertiliser nutrient prices	480	LCU / tonne	
LaDePa pellets based on organic fertiliser 1 nutrient content and markup rate	3 578	LCU / tonne	
LaDePa pellets based on organic fertiliser 2 nutrient content and markup rate	2 114	LCU / tonne	
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 competition with inorganic fertilisers. If negative LaDePa pellets are not competitive.
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 competition with organic fertilisers. If negative LaDePa pellets are not competitive.
LaDePa pellets based on their calorific value	102	LCU / tonne	
Ash based on inorganic fertiliser nutrient content prices	359	LCU / dry tonne	
Ash as a construction material		LCU / dry tonne	

Choice of sale prices for LaDePa pellets

Choices of sale prices should be based on the estimated values in table 20.1, and knowledge of the local context.
E.g. LaDePa pellets might be used to fertilise municipal parks and gardens, and sale price set to zero.

Chosen sale price for wholesale LaDePa pellets		LCU / tonne
Chosen sale price for bagged LaDePa pellets (garden centre sales)		LCU / tonne
Chosen sale price for pellets going to combustion		LCU / tonne
Chosen sale price for combustion ash as a fertiliser additive		LCU / dry tonne
Chosen sale price for combustion ash as a construction material		LCU / dry tonne

RESULTS - LOCAL CURRENCY UNITS (LCU)

Currency: LCU

	LaDePa	**Combustion**	**Landfill (base case)**	**Units**	**Comments**	
Number of households served per pit emptying cycle		35000		Total number per pit-emptying cycle		
Sludge removed from pit emptying area during pit emptying cycle		2294,25		Tonnes dry solids / year	Includes detritus	
Planning horizon	10	20	10	years	This is the period that LaDePa & combustion cash flow sheets and the NPV are calculated for.	
Total cost of sludge disposal (emptying, conveyance and processing via chosen route)						
Is the cost of emptying and conveyance included?	Yes	Yes	Yes			
Levelised cost of pit-emptying & sludge disposal per dry tonne FS	11 473	10 947	9 955	LCU / dry tonne FS	Includes managing contractor & service provider costs. Based on mass arriving at storage tanks at the LaDePa / combustion site	
Levelised cost of pit emptying & sludge disposal per pit	3 760	3 588	3 263	LCU / pit	Includes managing contractor & service provider costs	
Levelised cost to produce product	12 262	21 008	N/A	LCU / tonne product	LaDePa pellets (as is - including moisture) or dry tonnes of combustion ash. Includes managing contractor costs	
Total initial capital investment in LaDePa / combustion process (excludes emptying & conveyance)	1 325 000	73 195 000	N/A	LCU	For storage, pre-treatment, LaDePa/combustion process, product & by-product disposal	
NPV	-236 970 668	-482 153 980	-221 733 512	LCU		
Project IRR	#NUM!	#NUM!	#NUM!	%	Array must contain at least one positive and one negative value for IRR to be calculated	
Equity IRR	#NUM!	#NUM!	N/A	%	Array must contain at least one positive and one negative value for IRR to be calculated	
Costs of emptying & conveyance only						
Levelised cost of pit emptying & conveyance per dry tonne FS		4 831		LCU / dry tonne FS	Includes sub-contractor markup	
Levelised cost of pit emptying & conveyance per pit		1 583		LCU / pit	Includes sub-contractor markup	
Product						
Possible fertilizer value of product based on non-organic fertilizer NPK value	480	359	N/A	LCU / tonne	Per wet tonne of LaDePa pellets or dry tonnes of combustion ash.	
Annual quantity of product	2146,67	1 195,43	N/A	tonnes / year	Wet tonnes of LaDePa pellets or dry tonnes of combustion ash. Includes managing contractor costs	0.74 kg fuel / kg sludge dry solids required. 70% mass reduction across incineration. Wet tonnes of LaDePa pellets depend on user-input value for density
Operational parameters						
Percentage reduction in tonnes of waste going to landfill	81,0	63,7	0	%		
Time taken to process sludge from one pit-emptying cycle through LaDePa or combustion	5,00	5,00	N/A	years		
Annual fossil fuel energy used	5699,23	61659,87	1162,35	GJ / year		
Combined mass of NPK produced in product	51,57	19,96		tonnes NPK / year	NOTE: currently not comparable for eThekwini case - based on analysis of pellets and ash, from different sludge sources.	
COD reduction across process				Tonnes COD removed from environment / year	Environmental benefit. To be determined when further testing has been completed.	
Agricultural value of product						
Value based on non-organic fertilizer prices	480	359	N/A	LCU / tonne	Per wet tonne of LaDePa pellets or dry tonnes of combustion ash.	
Value based on organic fertiliser 1 price	3 578	N/A	N/A	LCU / tonne	Per wet tonne of LaDePa pellets or dry tonnes of combustion ash.	
Value based on organic fertiliser 2 price	2 114	N/A	N/A	LCU / tonne	Per wet tonne of LaDePa pellets or dry tonnes of combustion ash.	
Economic feasibility of replacing conventional fertilisers with LaDePa pellets						
Principal nutrient to be supplied to crop (basis for partial budget analysis)	P	N/A	N/A	Nutrient		
Selling price of LaDePa pellets where the costs of using commercial **INORGANIC** fertiliser and LaDePa pellets are equal, for the chosen nutrient	-833	N/A	N/A	LCU / wet tonne	LaDePa pellets must be sold below this price if they are to compete with conventional fertiliser	
Is it economic to use LaDePa pellets instead of the inorganic fertiliser if they are sold at a price that reflects their NPK nutrient content?	No	N/A	N/A			
Principal nutrient to be supplied to crop (basis for partial budget analysis)	P	N/A	N/A	Nutrient		
Selling price of LaDePa pellets where the costs of using commercial **ORGANIC** fertiliser and LaDePa pellets are equal, for the chosen nutrient	175	N/A	N/A	LCU / wet tonne	LaDePa pellets must be sold below this price if they are to compete with conventional fertiliser	
Is it economic to use LaDePa pellets instead of the organic fertiliser if they are sold at a price that reflects their NPK nutrient content?	No	N/A	N/A			
Key model inputs						
Summary of key inputs producing the above outputs						
Emptying method used		Human powered emptying - buckets & shovels				
Conveyance methods used		Pick-up truck with containers of sludge #N/A #N/A #N/A				
Product end use	Wholesale to agricultural industry	General landfill	Hazardous landfill of raw sludge		Two entries for combustion products refer to fly ash and bottom ash respectively	
By-product disposal	Hazardous waste landfill	General landfill Hazardous waste landfill				
Sludge accumulation rate in pits		40		ℓ / person / year		
Sludge dry solids content		30		% DS		
Sludge detritus content		20		% by volume		
Average distance of pits to sludge processing or disposal site		12		km		
Main contractor markup rate		15,0		%		
Main contractor establishment costs		1 000 000		LCU		
Main conractor monthly costs		50 000		LCU / month		

RESULTS - UNITED STATES DOLLARS (USD)

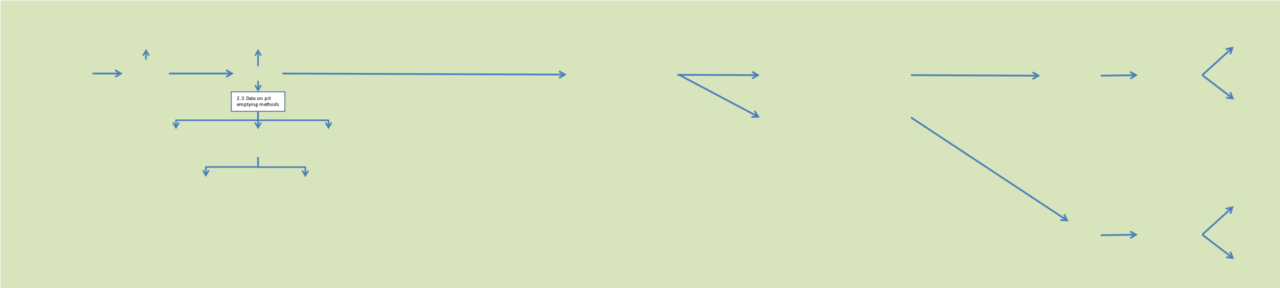
Currency: USD

	LaDePa	Combustion	Landfill (base case)	Units	Comments
Number of households served per pit emptying cycle		35000		Total number per pit-emptying cycle	
Sludge removed from pit emptying area annually		2294,25		Tonnes dry solids / year, including detritus	
Planning horizon	10	20	10	years	This is the period that LaDePa & combustion cash flow sheets and the NPV are calculated for.
Total cost of sludge disposal (emptying, conveyance and processing via chosen route)					
Is the cost of emptying and conveyance included?	Yes	Yes	Yes		
Levelised cost of pit-emptying & sludge disposal per dry tonne FS	1 147	1 095	995	USD / dry tonne FS	Includes managing contractor & service provider costs. Based on mass arriving at storage tanks at the LaDePa / combustion site
Levelised cost of pit emptying & sludge disposal per pit	376	359	326	USD / pit	Includes managing contractor & service provider costs
Levelised cost to produce product	1 226	2 101	N/A	USD / tonne product	LaDePa pellets (as is) or dry tonnes of combustion ash. Includes managing contractor costs
Total initial capital investment in LaDePa / combustion process (excludes emptying & conveyance)	132 500	7 319 500	N/A	USD	For storage, pre-treatment, LaDePa/combustion process, product & by-product disposal
NPV	-23 697 067	-48 215 398	-22 173 351	USD	
Project IRR	#NUM!	#NUM!	#NUM!	%	Array must contain at least one positive and one negative value for IRR to be calculated
Equity IRR	#NUM!	#NUM!	N/A	%	Array must contain at least one positive and one negative value for IRR to be calculated
Costs of emptying & conveyance only					
Levelised cost of pit emptying & conveyance per dry tonne FS		483		USD / dry tonne FS	Includes sub-contractor markup
Levelised cost of pit emptying & conveyance per pit		158		USD / pit	Includes sub-contractor markup
Product					
Possible fertilizer value of product based on non-organic fertilizer NPK value	48,0	35,9	N/A	USD / tonne	
Annual quantity of product	2146,67	1 195,43	N/A	tonnes / year	Wet tonnes of LaDePa pellets or dry tonnes of combustion ash. Includes managing contractor costs
Operational parameters					
Percentage reduction in tonnes of waste going to landfill	81,0	63,7	0	%	
Time taken to process sludge from one pit-emptying cycle through LaDePa or combustion	5,00	5,00	N/A	years	
Annual fossil fuel energy used	5 699	61 660	1 162	GJ / year	NOTE: Combustion supplemental fuel use is based on (i) no energy recovery at the incinerator and (ii) calculation based on feed dry solids content and the consequent minimum feed calorific value required. Further refinement of calculation required.
Combined mass of NPK produced in product	51,57	19,96		tonnes NPK / year	NOTE: currently not comparable for eThekwini case - based on analysis of pellets and ash, from different sludge sources.
COD reduction across process				Tonnes COD removed from environment / year	Environmental benefit. To be determined when further testing has been completed.
Agricultural value of product					
Value based on non-organic fertilizer prices	48	36	N/A	LCU / tonne	Per wet tonne of LaDePa pellets or dry tonnes of combustion ash.
Value based on organic fertiliser 1 price	358	N/A	N/A	LCU / tonne	Per wet tonne of LaDePa pellets or dry tonnes of combustion ash.
Value based on organic fertiliser 2 price	211	N/A	N/A	LCU / tonne	Per wet tonne of LaDePa pellets or dry tonnes of combustion ash.
Economic feasibility of replacing conventional fertilisers with LaDePa pellets					
Principal nutrient to be supplied to crop (basis for partial budget analysis)	P	N/A	N/A	Nutrient	
Selling price of LaDePa pellets where the costs of using commercial **INORGANIC** fertiliser and LaDePa pellets are equal, for the chosen nutrient	-83	N/A	N/A	USD / wet tonne	LaDePa pellets must be sold below this price if they are to compete with conventional fertiliser. If price is negative, LaDePa pellets are not competitive.
Is it economic to use LaDePa pellets instead of the inorganic fertiliser if they are sold at a price that reflects their NPK nutrient content?	No	N/A	N/A		
Principal nutrient to be supplied to crop (basis for partial budget analysis)	P	N/A	N/A	Nutrient	
Selling price of LaDePa pellets where the costs of using commercial **ORGANIC** fertiliser and LaDePa pellets are equal, for the chosen nutrient	18	N/A	N/A	USD / wet tonne	LaDePa pellets must be sold below this price if they are to compete with conventional fertiliser. If price is negative, LaDePa pellets are not competitive.
Is it economic to use LaDePa pellets instead of the organic fertiliser if they are sold at a price that reflects their NPK nutrient content?	No	N/A	N/A		

Key model inputs

Summary of key inputs producing the above outputs

	LaDePa	Combustion	Landfill (base case)	Units	Comments
Emptying method used		Human powered emptying - buckets & shovels			
Conveyance methods used		Pick-up truck with containers of sludge #N/A #N/A #N/A			
Product end use	Wholesale to agricultural industry	General landfill	Hazardous landfill of raw sludge		Two entries for combustion products refer to fly ash and bottom ash respectively
By-product disposal	Hazardous waste landfill	General landfill Hazardous waste landfill			
Sludge accumulation rate in pits		40		ℓ / person / year	
Sludge dry solids content		30		% DS	
Sludge detritus content		20		% by volume	
Average distance of pits to sludge processing or disposal site		12		km	
Main contractor markup rate		15,0		%	
Main contractor establishment costs		100 000		USD	
Main conractor monthly costs		5 000		USD / month	

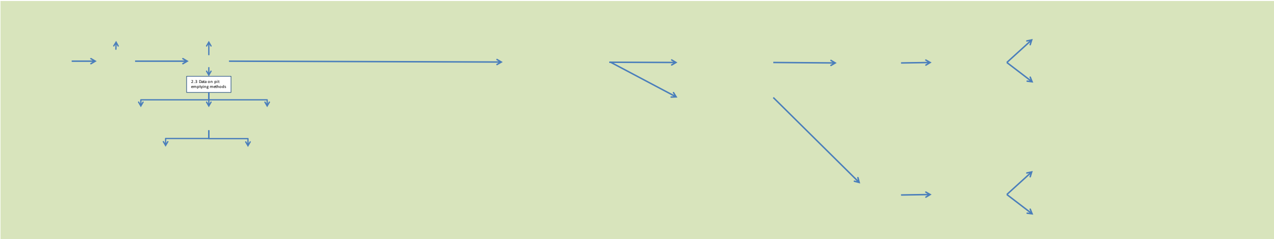


Standard input rates

Parameter	Value	Units	Value	Units	Reference	Notes	User comments
		USD		LCU = local currency unit			
Financial							
Local currency unit (LCU)	South African Rand	ZAR				Name and units are inputs	
Exchange rate LCU-USD	10	LCU / USD					
Escalation rate on O&M costs and revenues, excluding fuel	6	%					
Escalation rate on fuel	12	%					
Interest rate on debt	9	%				Inflation plus 2 - 4% (DS) i.e. 8 - 10 % total	
Debt proportion in debt:equity ratio	70	%				30% equity minimum (DS) is typical for private companies.	
Discount rate	8	%					
Income tax rate	28	%				28% (South Africa). Not applicable for entirely municipal system.	
Lifetime used to calculate depreciation rate for civils	20	years					
Lifetime used to calculate depreciation rate for large mechanical items (e.g. vacuum tanker)	10	years					
Lifetime used to calculate depreciation rate for mechanical items	5	years					
Book depreciation rate - civils	4,5	%					
Book depreciation rate - large mechanical items	9	%					
Book depreciation rate - mechanical items	18	%					
Terminal value of assets	10	% of initial value					
Consumables							
Gasoline	1,29	USD / ℓ	12,88	LCU / ℓ			
Diesel	1,23	USD / ℓ	12,34	LCU / ℓ			
Water	-	USD / ℓ	-	LCU / ℓ			
Vehicle oil		USD / ℓ	26,52	LCU / ℓ	Dept of Ag 2011 with 6% inflation		
Vehicles							
Pick up truck - typical costs							
Pick up truck rental rate	700,00	USD / month	7 000	LCU / month			
Driver labour rate	3,00	USD / hour	30	LCU / hour			
Pick up truck capital cost	17 500,00	USD	175 000	LCU	Department of Agriculture Machinery Guide 2011. 3000 cc 1 tonne club cab diesel pick up truck. 2010-2011 price ZAR 296,265. 2013 price at 6% escalation 332,883. Lower value chosen based on local experience of actual prices available.		
Average travel speed of pick-up truck	50	km / h					
Fuel consumption for pick-up truck	10,53	km / ℓ			Dept. of Agriculture Machinery guide 2010 -2011: 9.5 L/100 km		
Oil consumption for vehicle	1	% of fuel consumption			Dept. of Agriculture Machinery guide 2010 -2011		
Oil consumption for vehicle	1053	km / ℓ					
Price of set of tyres	533,90	USD / set	5 339,00	LCU / set	Dept. of Agriculture Machinery guide 2010 -2011: R4751.75 2011 price, R5339 2013 price		
Distance for which new set of tyres lasts	50 000	km			Dept. of Agriculture Machinery guide 2010 -2011		
Tyre price per km	0,01	USD / km	0,11	LCU / km			
Equipment repair and maintenance cost over lifetime	50	%			Dept. of Agriculture Machinery guide 2010 -2011	Used to calculate repair and maintenance rate per km	
Repair & maintenance cost per km	0,05	USD / km	0,55	LCU / km			
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 rate per km	
Repayment period for debt	3	years				Debt for capital borrowed to buy equipment.	
Vehicle insurance cost	3,5	% of purchase price / year					
Vehicle insurance	612,50	USD / year	6 125,00	LCU / year			
Vehicle license	48,20	USD / year	482,00	LCU / year	Dept. of Agriculture Machinery guide 2010 -2011 price R429, 2013 price R482		
Yearly cost of insurance and licence	660,70	USD / year	6 607,00	LCU / year			
Other costs	-	USD / year	-	LCU / year		Sundries	
Diesel cost per km	0,12	USD / km	1,17	LCU / km			
Oil cost per km	0,00	USD / km	0,0252	LCU / km			
Total equipment maintenance rate per km	0,07	USD / km	0,68	LCU / km			
3 - 5 tonne truck - typical costs							
Truck rental rate	3 000,00	USD / month	30 000,00	LCU / month	Excludes insurance, maintenance etc		
Driver labour rate	3,00	USD / hour	30	LCU / hour			
Truck capital cost	35 000,00	USD	350 000	LCU	Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry		
Average travel speed of truck	50	km / h					
Fuel consumption for truck	6,66	km / ℓ diesel			15 l/100km Dept of Agriculture Machinery guide 2010 - 2011 for 3 - 5 tonne lorry single differential		
Oil consumption for vehicle	2	% of fuel consumption			Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry		
Oil consumption for vehicle	444	km / ℓ					
Price of set of tyres	1 841,80	USD / set	18 418,00	LCU / set	Dept. of Agriculture Machinery guide 2010 -2011 for 3 - 5 tonne lorry single differencial : 2011 price: R16392; 2013 price: R18418		
Distance for which new set of tyres lasts	45 000	km			Dept. of Agriculture Machinery guide 2010 -2011. Price for 3 - 5 tonne lorry		
Tyre price per km	0,04	USD / km	0,41	LCU / km			
Equipment repair and maintenance cost over lifetime	50	%			Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry	Used to calculate repair and maintenance rate per km	
Repair & maintenance cost per km	0,06	USD / km	0,58	LCU / km			
Lifetime of vehicle	10	years				Used to calculate depreciation rate for vehicle	
Vehicle life (distance for accounting purposes)	300 000	km			Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry	Used to calculate repair and maintenance rate per km	
Repayment period for debt	5	years				Debt for capital borrowed to buy equipment.	
Vehicle insurance cost	4,0	% of purchase price / year			Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry		
Vehicle insurance	1 400,00	USD / year	14 000,00	LCU / year			
Vehicle license	81,90	USD / year	819,00	LCU / year	Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry		
Yearly cost of permits and licences	1 481,90	USD / year	14 819,00	LCU / year			
Other costs	-	USD / year	-	LCU / year		Sundries	
Diesel cost per km	0,19	USD / km	1,85	LCU / km			
Oil cost per km	0,01	USD / km	0,0597	LCU / km			
Total equipment maintenance rate per km	0,11	USD / km	1,05	LCU / km			

Fuel properties

			Lower calorific value. Engineering
Diesel lower calorific value	43,4	MJ / kg	Toolbox 2013
Diesel density	833	kg / m3	At 15 deg C. Dieselnet 2013
Coal lower calorific value	31	MJ / kg	Biomass Energy Centre 2013



1.1 Pit conditions & environment

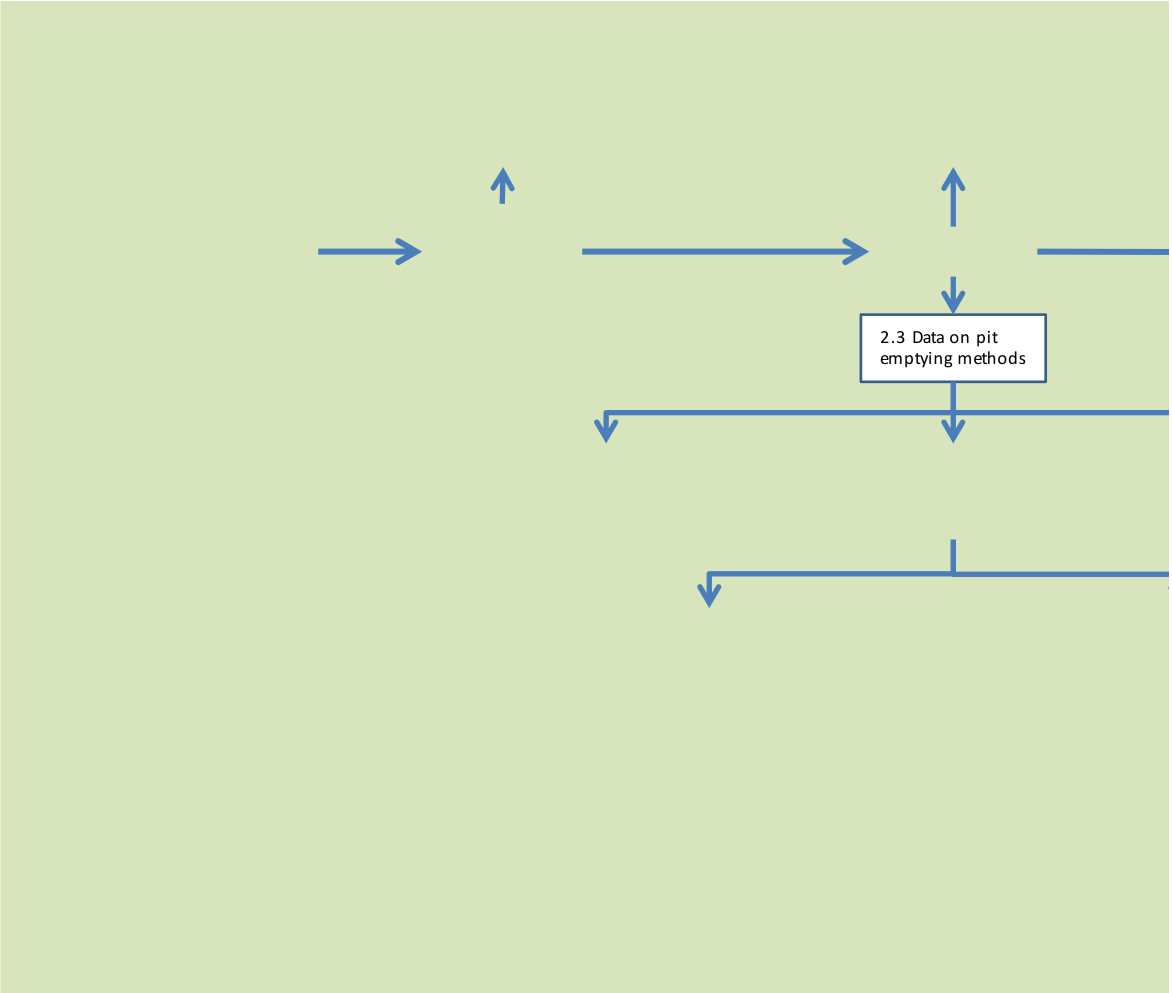
Characterisation of general environment, pit usage and faecal sludge properties in the pit

Parameter	Value	Unit	Reference	Notes	User comments
Area name	Test 1				
Number of households in area	35000				
Average number of people per household	5	No.			
Per capita annual FS accumulation rate	40	ℓ / person / year		Note - this is **accumulation** rate, not **production** rate, i.e. should also take into account soil conditions. Need guidance table of appropriate rates for different soil types.	
Length of pit-emptying cycle	5	years		Time period over which all pits in area are emptied. The pit-emptying cycle could be a fixed length of time, if the municipality has a formal arrangement in place (e.g. one free pit-emptying every 5 years for eThekwini municipality), or the average time between pit-emptyings in that area. This value is used to calculate annualised costs for pit emptying.	
Time between pit-emptying cycles	0	years			
Average time since last desludge	5	years		This value used to calculate the volume of FS now present in the pit	
Average volume of FS to be removed per pit	1 000	ℓ / pit		Assumes one pit per household, on average.	
Average %DS of FS in pit	30	%DS			
Detritus fraction in sludge	20	%		Detritus refers to non-faecal portion of the sludge that may be deposited in a latrine pit, e.g. plastic bags, bottles, rope.	
Average calorific value of FS	12,35	MJ / kg DS			
Average sand/grit fraction of FS	3	%			
Typical density of VIP sludge	1150	kg / m3		linked to landfill sheet	
Total volume of FS to be removed from area per pit-emptying cycle	35 000	m^3 / pit-emptying cycle			
Annualised volume of FS to be removed from area	7 000	m^3 / year		For use in financial calculations	

Data below for information only - data on the changes to sludge composition across the LaDePa process is not currently available. If these factors could be entered into the model the data below could be used to calculate the expected LaDePa pellets composition.

Typical sludge composition data

Parameter	Value	Unit	Notes
Organic content			
COD	-	g COD / g DS	
Nutrient content			
Nitrogen			
Ammonium & urea	-	mg ammoniacal N / g DS	Plant-available form
Nitrate	-	mg NO3- / g DS	Plant-available form
Total nitrogen	-	mg N / g DS	
Phosphorus			
Total phosphate	-	mg P / g DS	Most phosphorus likely to become plant-available after decomposition
Orthophosphate	-	mg ortho-P / g DS	Plant-available form
Potassium	-	mg K / g DS	
Calcium	-	mg Ca / g DS	
Magnesium	-	mg Mg / g DS	
Sulphur	-	mg S / g DS	
Pathogen content			
Ascaris			
Undeveloped eggs	-	No. possible viable Ascaris / 20g DS	
Motile larvae in eggs	-	No. possible viable Ascaris / 20g DS	
Immotile larvae in egg	-	No. possible viable Ascaris / 20g DS	
Trichuris	-	Potentially viable eggs / 20g	
Taenia	-	Potentially viable eggs / 20g	
Faecal coliforms	-	CFU / g DS	



SECTION NOT CURRENTLY LINKED TO MODEL
Questions below provide factors to consider when determining sludge characteristics

1.2 Estimate of faecal sludge characteristics

Characterisation of properties of faecal sludge based on user-input environmental cor

Where faecal sludge property data is not known, context inputs can be entered below
The model will generate a table of estimated parameters, which can be manually inpu

How is greywater (kitchen and washing water) usually disposed of?

Into the latrine pit	0
Elsewhere	0

Is the latrine area used as a washing / showering area, with greywater run-off into the

Yes	0
No	0

Does effective stormwater drainage exist?

Yes	0
No	0

Is the area prone to flooding?

Yes	0
No	0
How high is the water table?	
Very high: 10 - 20 cm below surface	0
Medium: 0.2 - 2 m below surface	0
Below 2m	0
What is the soil type?	
Sand	0
Loamy Sand	0
Sandy Loam	0
Loam	0
Silt	0
Silt Loam	0
Clay Loam	0
Sandy Clay Loam	0
Silty Clay Loam	0
Clay	0
Sandy Clay	0
Silty Clay	0
What is the predominant form of anal cleansing?	
Toilet paper	0
Newspaper / packaging / plant matter	0
Water washing	0
Does an effective solid waste collection service function in the area?	
Yes	0
No	0
How frequently is the pit de-sludged?	
Every few months	0
Every year	0
Every 5 years or more	0
What is the predominant diet in the area?	
Vegetarian	0
Non-vegetarian	0

Estimated input parameters for Module 1

To be reviewed and manually entered into the model above.

Parameter	**Value**
Per capita annual FS accumulation rate	
Average time since last desludge	
Average %DS of FS in pit	
Detritus fraction in sludge	
Average calorific value of FS	
Length of pit-emptying cycle	

Organic content

COD

Nutrient content

Nitrogen

Ammonium & urea

Nitrate

Phosphorus

Total phosphate

Orthophosphate

Potassium

Calcium

Magnesium

Sulphur

Pathogen content

Ascaris

Faecal coliforms

aracteristics to be entered into the model

nmental conditions

tered below.
anually input into the fields in the "1.1 Pit conditions" sheet.

WHO nd (Pit latrine design Annex 5) gives values for FS accumulation in high and low groundwater areas

-off into the pit?

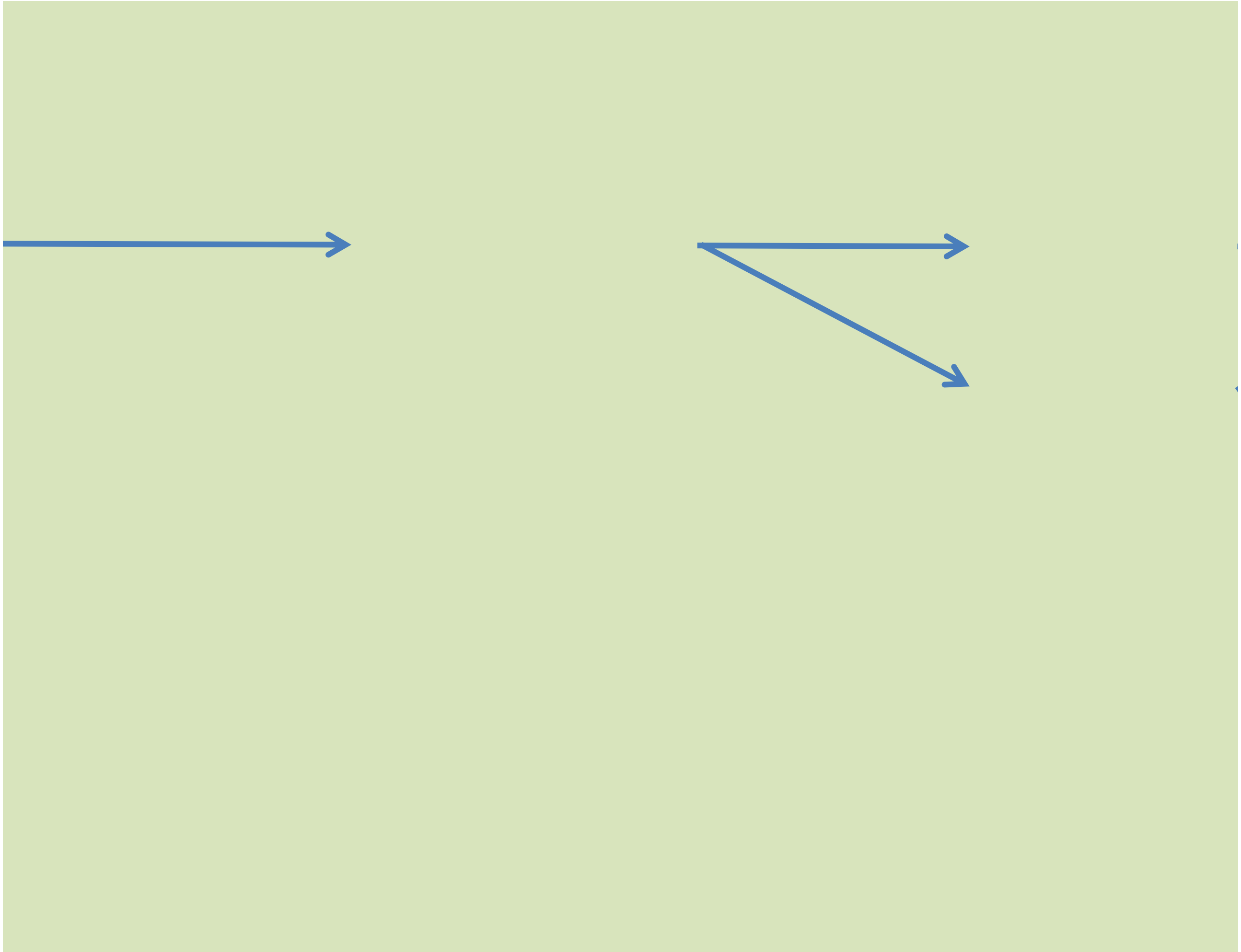
Unit	Reference
ℓ / person / year	
years	
%DS	
%	
MJ / kg DS	
years	

g BOD / g DS

mg ammoniacal N / g DS
mg NO3- / g DS

mg P / g DS
mg ortho-P / g DS
mg K / g DS
mg Ca / g DS
mg Mg / g DS
mg S / g DS

No. viable helminth ova / g DS
CFU / g DS



Link to %DS of sludge in pit

Link to corresponding infiltration rates

Link to detritus content of sludge

Link to detritus content of sludge

Link to calorific value / COD content

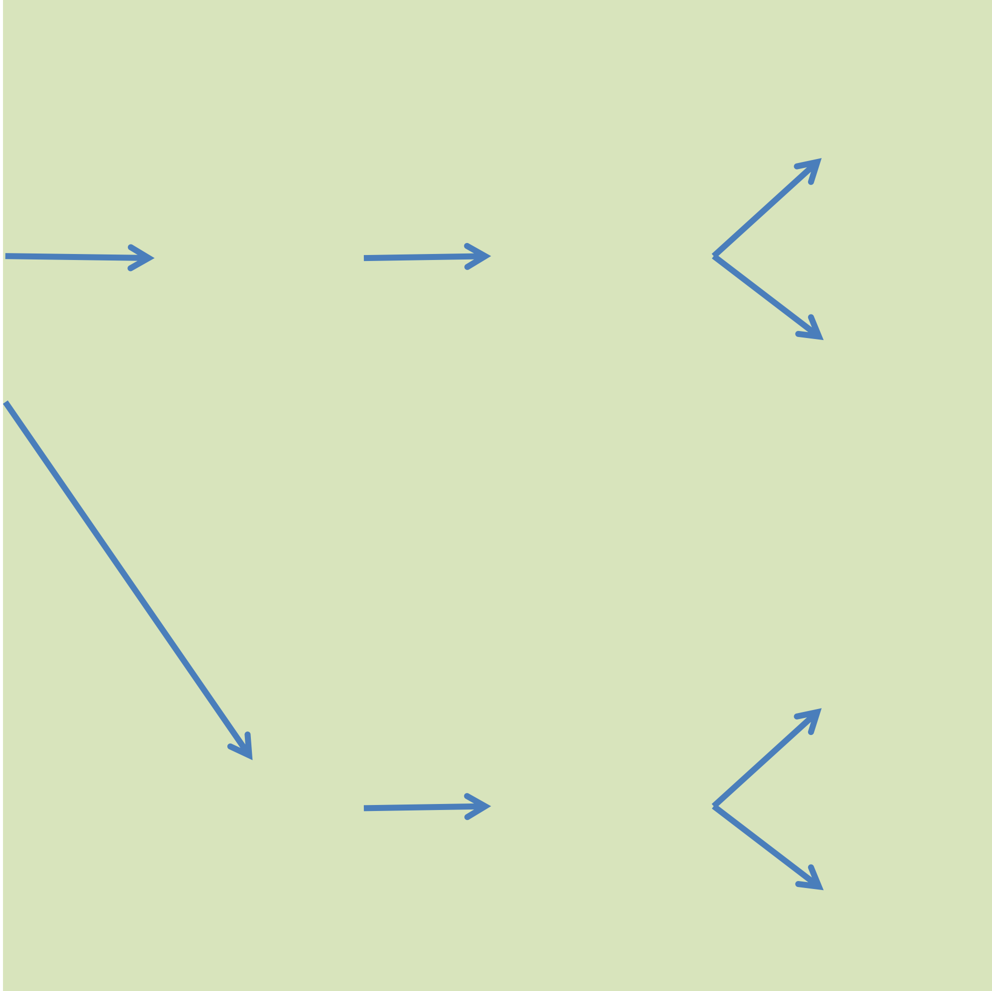
Link to nutrient content / calorific value

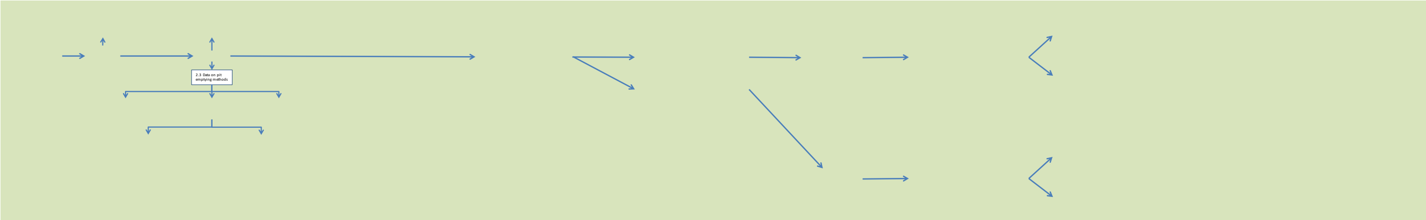
Notes

User comments

Calorific value may not be linked to context data - just a typical suggested value / range of values

Nutrient content may not be linked to context data - just a list of typical suggested values / range of values





2.1 Pit emptying - volume and properties of sludge sent to conveyance

Removal of faecal sludge from pit latrine to a container or transport mechanism situated next to the pit

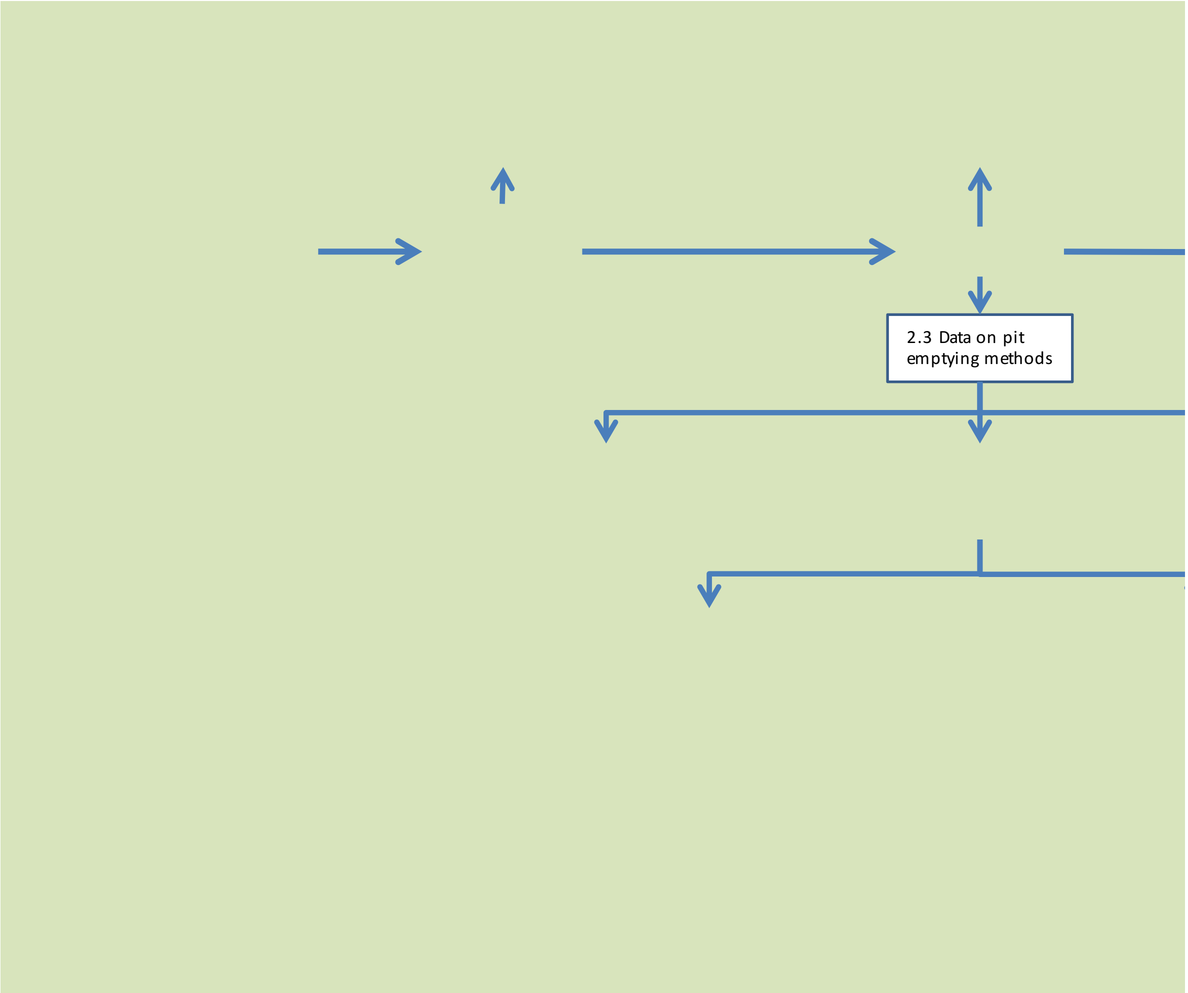
Parameter	Value	Unit	Reference	Notes	User comments
	Area 1				
Area name	Test 1				
No. of households or pits in area	35 000	No.			
Distance E2: Average distance between households	0,3	km		Refer to 'G1 Distances' sheet	
Ease of access to households	1	Rating 1 - 3		Choose a rating: 1, 2 or 3. 1 indicates easiest ease of access to pits (wide streets, smooth road surface, no removal of toilet superstructure required etc). 3 indicates most difficult and time-consuming access to pits. A time is assigned to each of the ratings within the data inputs for each Emptying method (i.e. the extra time spent accessing the pit because of access issues)	
Average time since last desludge	5	years			
Length of pit-emptying cycle	5	years			
Average volume of sludge per pit	1000	ℓ / pit			
Average detritus fraction in sludge in pit	20	%			
Average %DS of FS in pit	30	%DS			
Average FS calorific value	12,35	MJ / kg DS			
Emptying method number	1	Number 1 to 3		Choices are: 1. Human-powered: bucket & shovel or handpump 2. Motorised: small vacuum tanker 3. Motorised: large vacuum tanker	
Emptying method chosen	**Human powered emptying - buckets & shovels**				
Conveyance Stage 1 number	2	Number 1 to 4		Choices are: 1. Handcart with containers of sludge 2. Pick-up truck with containers of sludge 3. Motorised transport - small vacuum tanker 4. Motorised transport - large vacuum tanker Allowable Emptying - Conveyance Stage 1 combinations (need Error indicator) 1 - 1 1 - 2 2 - 3 3 - 4	
Conveyance Stage 1 method chosen	**Pick-up truck with containers of sludge**				
Distance T1: one-way distance for Conveyance Stage 1	12	km		Distance between pit & sludge storage, or pit and the starting point for the next conveyance stage - Refer to 'G1 Distances' sheet	
Conveyance Stage 1 travel speed	50,0	km / h			
Distance E1: to pit emptying area from storage depot	15,0	km		Refer to 'G1 Distances' sheet	
Distance E2: Average distance between pits	0,3	km		Refer to 'G1 Distances' sheet	
Additional water added per pit	0,0	ℓ / pit			
Proportion of total pit contents removed	95	%			
Average actual volume of sludge removed per pit	950,0	ℓ / pit			
Total volume of sludge to be removed from area per pit emptying cycle	33 250,0	m^3 / pit-emptying cycle		Includes additional water added during emptying	
Annualised volume of FS to be removed from area	6 650,0	m^3 / year			
Annualised mass of dry solids to be removed from area	2 294,3	tonnes / year		Includes detritus	
Annualised number of pits to be emptied in area	7 000	pits / year			
Average %DS in sludge to be transported	30,00	%DS			
Average detritus fraction in sludge to be transported	20	%			
Average calorific value of sludge to be transported	12,35	MJ / kg DS			
Number of equipment working days per year required to empty all pits	245	working days / year			
Number of labour working days available per year	252	working days / year			
Number of emptying teams in operation	15	No. teams			
Number of pits emptied per day	30	pits / day			

Links to Emptying method input pages

1 - Human-powered
2 - Small vacuum tanker
3 - Large vacuum tanker

Notes

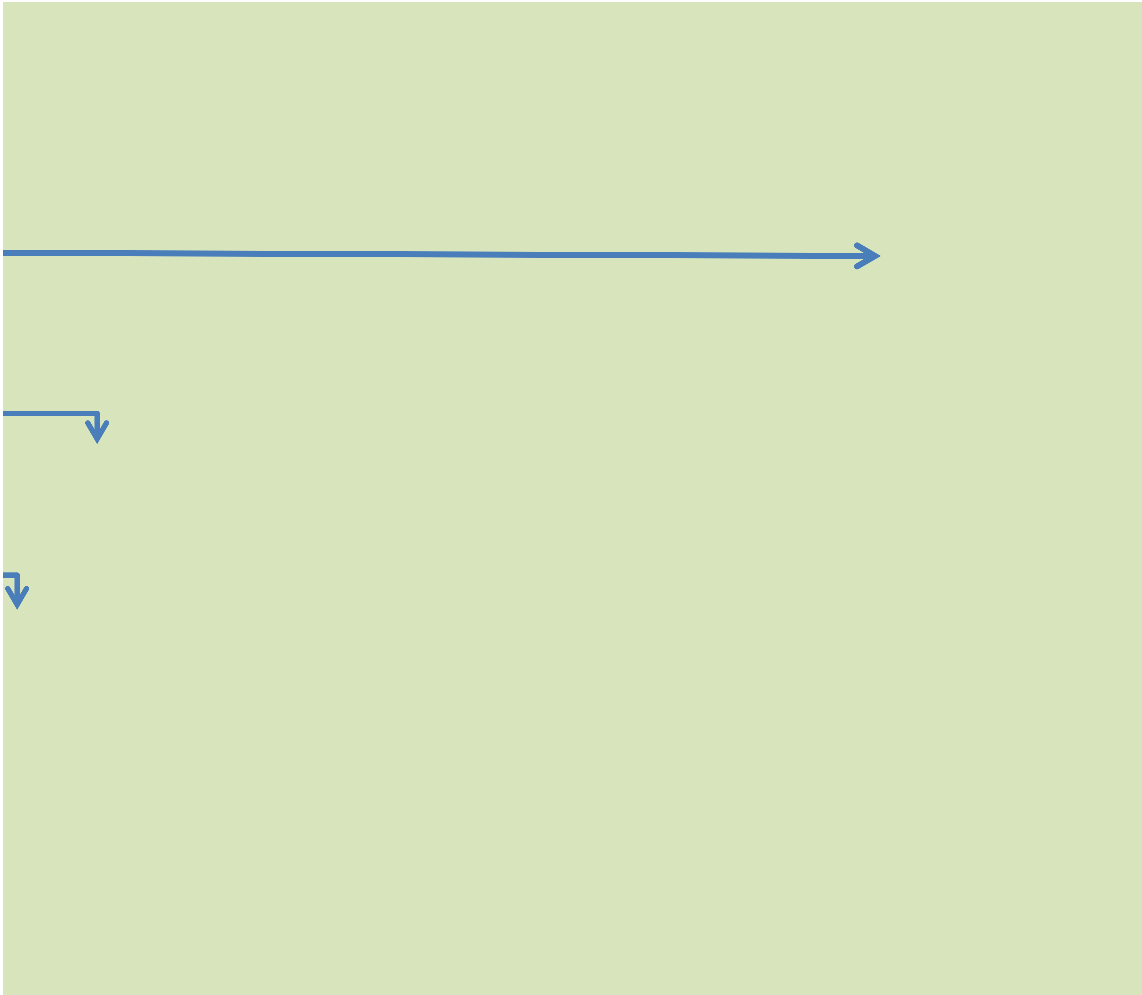
1. The Emptying and Conveyance 1 options chosen on Sheet 2.1 (above) will be those used by the model to calculate the overall cash flows for sludge management
2. You are only required to fill out the data sheets corresponding to the Emptying and Conveyance 1 options chosen above
3. To view the cost comparison of emptying methods on Sheet 2.4 you must also fill out the data sheets for all Emptying methods and their corresponding Conveyance Stage 1 method that you want to compare



2.2 Sub-model: Choosing the appropriate emptying method for the area

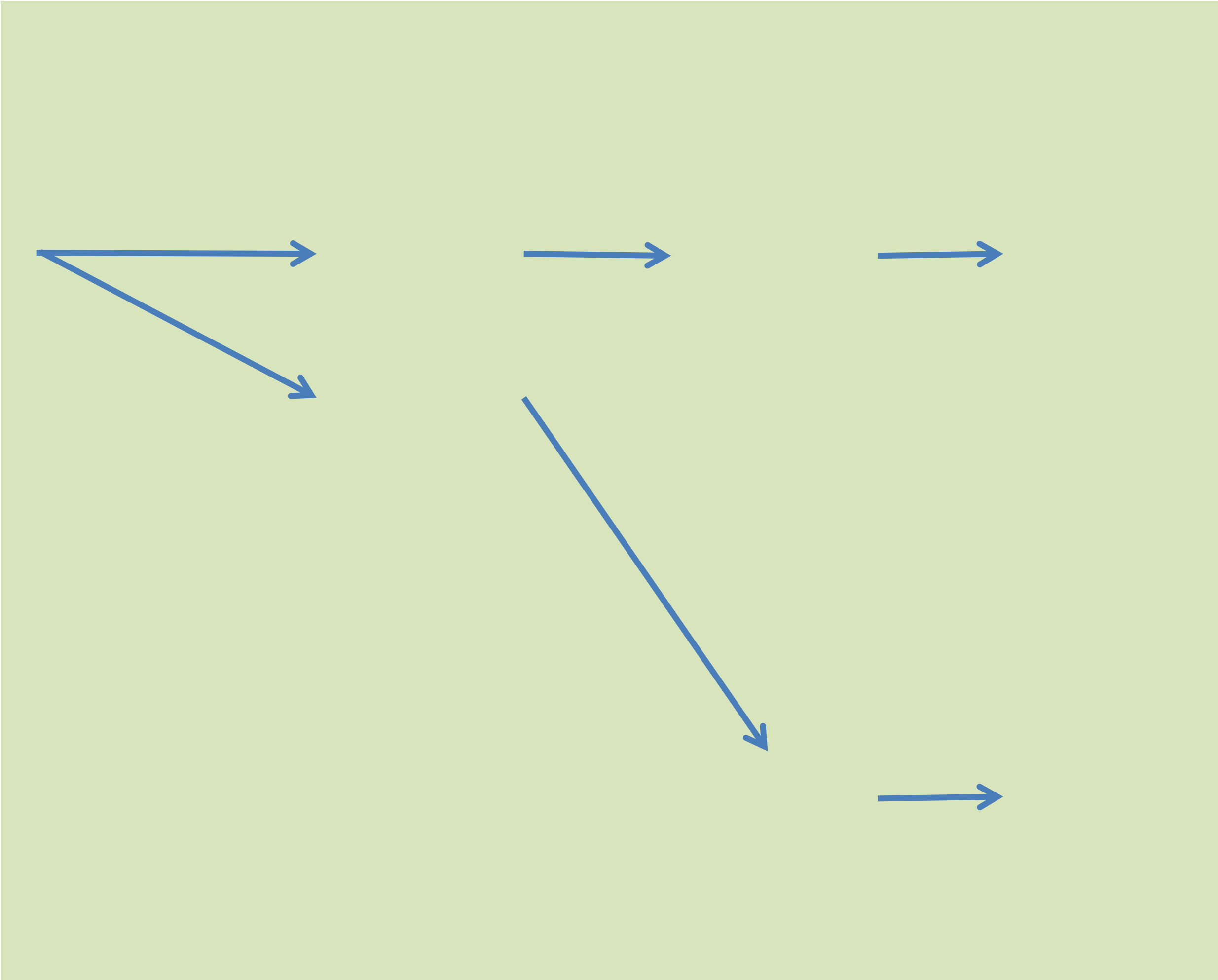
A decision tree to aid the user in choosing the appropriate emptying method for the giv

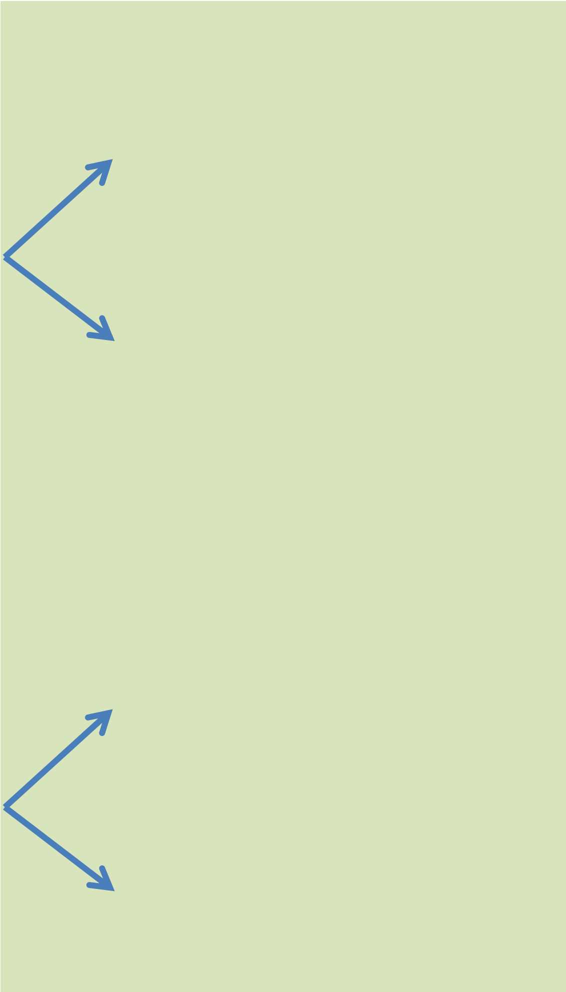
SECTION NOT CURRENTLY LINKED TO MODEL



r the area

d for the given environmental conditions





2.3.1 Human-powered emptying - buckets & shovels and/or hand pump

Cash flows for emptying and Conveyance stage 1

Emptying method chosen (option number)	1		Go to selection for Emptying method
Emptying method	Human-powered emptying: buckets & shovels or handpump		
Stage 1 Conveyance option chosen (option number)	2		Go to selection for Conveyance Stage 1 method.
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 trup (2)

Parameter	Value	Unit	Reference	Notes	User comments
Capital and start-up costs					
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	
Capital and start-up costs					
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, EIAs 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			
O&M costs					
Fee or rental for emptying equipment	-	LCU / year			
Fee or rental for Conveyance Stage 1 vehicles & associated equipment	-	LCU / year			
Fixed yearly costs for Conveyance Stage 1 vehicle & equipment	99 105,00	LCU / year			
Rental for equipment storage facility and office space	115 500,00	LCU / year		Will be set to 0 if a capital cost for office/storage facility is entered above.	
Cost of water	-	LCU / year			
Other costs	175 000,00	LCU / year			
Cost of labour	3 600 000,00	LCU / year			
Cost of emptying equipment & Conveyance Stage 1 equipment maintenance	2 593 124,15	LCU / year			
Yearly cost of health & safety measures, licenses, permitting for ALL teams	100 000,00	LCU / year		Specify the items that make up this cost	
Emptying & Conveyance Stage 1 fuel costs	360 374,68	LCU / year			
Overheads	704 310,38	LCU / year		Calculated as a proportion of total operating costs	
TOTAL OPERATING COSTS	**7 747 414,21**	**LCU / year**			
Total operating costs excluding fuel	7 387 039,53	LCU / year			
Total fuel costs	360 374,68	LCU / year			
Revenues					
Revenue from emptying latrine pits and Conveyance Stage 1	-	LCU / year		This is calculated from revenue per pit OR revenue per litre of FS collected, depending on what inputs are entered below.	
TOTAL REVENUES	-	LCU / year			
Operating parameters					
Number of pits emptied per pit emptying cycle	35000	No. pits / pit emptying cycle			
Annualised number of pits to be emptied in area	7000	No. pits / year			
Average volume of sludge per pit	1000	ℓ / pit			
Ease of access to households	1	Rating 1 - 3			
Average %DS of FS in pit	30	%DS			
Average actual volume of sludge removed per pit	950	ℓ FS / pit			
Annualised volume of sludge removed from pit emptying area	6650	m3 FS / year			
Average %DS in FS removed from pits	30	% DS			
Annualised mass of dry FS solids removed from pit emptying area	2 294	tonnes dry FS / year			
Calculation of number of pit-emptying teams required					
Average proportion of total pit contents removed	95	%			
Morning equipment loading time	0,3	h / day		Time taken to load equipment at the start of each working day, before driving to site	
Distance E1: to pit emptying area from storage depot	15	km		Refer to 'G1 Distances' sheet	
Stage 1 Conveyance option (option number)	2				
Stage 1 Conveyance option (name)	Pick-up truck with containers of sludge				
Average travel speed of pit-emptying team (Conveyance Stage 1 speed)	50	km / h		Taking into account road and traffic conditions	
Time to reach pit emptying area	0,3	h			
Number of return trips made from storage depot to pit emptying area per day	1	No. / day			
Distance E2: Average distance between pits	0,3	km		Refer to 'G1 Distances' sheet	
Average distance travelled per day by pit-emptying team	83,68	km / working day		Return trip from storage depot to pit emptying area + [(number of pits + 1) x distance between pits], + (return trip distance to discharge point x no of discharges required per pit x no. of complete pits per day)	
Access level factor	0,1	h / pit		These times for access level factors 1 -3 are the extra time it takes to actually be able to start emptying the pit - negotiating narrow streeets or having to remove the toilet superstructure before emptying can start.	
1	0,1	h / pit		Access level 1 = easiest access to pit (good roads, low density housing, no superstructure dismantling required)	
2	0,33	h / pit		Access level 2 = medium ease of access to pit	
3	0,75	h / pit		Access level 3 = hardest access to pit (poor roads, high density housing, steep gradients, significant dismantling of latrine superstructure required).	
Travel time between pits	0,106	h / pit		Time to cover distance plus additional time related to ease of access	
Set up time at pit	0,25	h / pit		Time to get machinery in position at the pit so that emptying can start.	
Time taken to remove one kℓ of FS from pit	2	h / kℓ of FS			
Clean up time at pit	0,5	h / pit			
End of day clean-up & equipment store time	0,5	h / day		Time taken to put equipment away when back at the storage depot at the end of the day.	
Total machine time per pit	2,76	h / pit			
Distance T1: One-way distance for Stage 1 conveyance	12,00	km		Refer to 'G1 Distances' sheet	
Time to discharge full load of sludge	0,05	h / load			
Time for discharge and return to pit emptying area (Stage 1 conveyance)	0,53	h / return trip			
Volume of sludge carried per load of Stage 1 Conveyance	864	ℓ / load			
Number of discharges required per pit	1,10	no. discharges / pit		Assumes hand cart or truck is fully loaded on each trip	
Set up and clean up time per day for for Conveyance Stage 1 (no travel)	0,75	h / day			
Set up and clean up time per day for Emptying equipment	0,8	h / day			
Total set up, clean up and travel to pit emptying area	2,15	h / day			
Time available per day to empty pits and take sludge to C1 discharge point	6,85	h / day			
Number of pits possible to empty per day per team	2,05	pits / day / team		Partial pit used in calcs (daily distance travelled by team and number of working days required per year)	
Number of pits emptied per day (optional input - overrides the calculated number of pits possible to empty in a day)	2,0	pits / day / team		Optional input - overrides the calculated number of pits possible to empty in a day	
Number of pits emptied per day per team - used in calculations	2,00	pits / day / team			
Total monthly distance travelled by each team	1 757	km / month			
Total annual distance travelled by each team	21 087	km / year			
Proportion of downtime per year	5	%		To allow for machinery repairs, labour strikes etc.	
Number of equipment working days per year required to empty all pits	3 675	working days / year		Based on machine time, downtime included. Assumes that a pit can be partially emptied one day and finished the next.	
Number of equipment working days per year required to empty all pits (rounded up to nearest whole day)	3 675	complete working days / year			
Number of pit emptying teams required	14,58	No. pit-emptying teams required			
Number of pit-emptying teams in operation	15	No. pit-emptying teams			
Number of working days per year required to empty all pits	245	working days / year			
Personnel numbers, working hours and land area requirements					
Total number of supervisors (managing all teams)	3	No.			
Number of paid months per year for supervisors	12	paid months / year		If labour is retained full-time enter 12.	
Number of labourers per team	6	No. / team			
Total number of labourers	90	No.			
Number of paid months per year for labourers	12	paid months / year		If labour is retained full-time enter 12.	
Working hours per day	9	h / day			
Working days per month	21	days / month			
Available labour working days per year	252	available days / year			
Volume of water required for clean-up per pit	25	ℓ / pit			
Sludge pump fuel consumption	0	ℓ / kℓ sludge pumped			
Area required to store ONE Conveyance Stage 1 vehicle + sludge containers	21	m2			
Storage area for ONE team's emptying equipment (buckets, shovels, clothing)	2	m2			
Total office, ablutions and parking area required at pit emptying company's base	40	m2			
Total property area required for emptying company's base	385	m2		Used to calculate rental rate for office and storage facility.	
Financial parameters					
Conveyance Stage 1 method	Pick-up truck with containers of sludge				
Lifespan of Conveyance 1 vehicle	7,00	years		Used to calculate depreciation rate	
Escalation rate on O&M costs, excluding fuel	6	%			
Escalation rate on fuel	12	%			
Lifetime of Conveyance Stage 1 vehicle - distance	160 000	km			
Calculated lifespan	7,6	years		Compare to lifetime used for accounting	
Time period used for cash flows	5	years		Used for depreciation calculation and length of cash flow series. Currently set to length of pit-emptying cycle - but this is different to LaDePa lifespan	
Residual value at end of equipment life	10	%		Proportion of initial capital cost	
Depreciation rate on equipment	12,9	%			
Residual value of equipment at end of cash flow period	35,7	%			
Discount rate	8	%			
Diesel price	12,88	LCU / ℓ			
Water price	-	LCU / ℓ			
Conveyance 1 vehicle monthly rental rate	250,000	LCU / day			
Monthly cost for consumables	15 000,00	LCU / month			
Other monthly costs	15 000,00	LCU / month		Optional input for any additional costs	
Labour - supervisor rate	10 000,00	LCU / month			
Labour - labourer rate	3 000,00	LCU / month			
Rental rate for one team's emptying equipment, excluding conveyance vehicle	-	LCU / day		Not applicable if emptying equipment purchased	
Fuel cost for Conveyance 1 vehicle	1,172	LCU / km			
Repair and maintenance cost for Conveyance 1 vehicle	50,0	% of purchase price over lifetime			
Repair & maintenance cost for Conveyance 1 vehicle per km	0,6	LCU / km		Calculated based on theoretical vehicle lifetime km	
Maintenance rate for one Conveyance Stage 1 verhicle (tyres & oil)	0,13	LCU / km			
Total monthly maintenance for all Conveyance Stage 1 vehicles	220 767,78	LCU / month			
Monthly maintenance for hand pump	0,00	LCU / month / pump			
Monthly maintenance for other manual emptying equipment per team	100,00	LCU / month / team			
Monthly maintenance for hand pumps and manual emptying equipment, for all teams	1 500,00	LCU / month			
Total monthly equipment maintenance	222 267,78	LCU / month			
Annual costs for Conveyance Stage 1 vehicle (insurance, license etc)	6 607,00	LCU / year			
Total annual costs of insurance & licenses for all Conveyance 1 vehicles	99 105,00				
Revenue generated per pit for emptying & Conveyance Stage 1	-	LCU / pit		Enter a revenue value per pit OR per litre of FS removed. This is total revenue for emptying the pit and transporting the FS away on the first stage of the disposal journey.	
Revenue generated per litre FS removed for emptying and Conveyance Stage 1	-	LCU / kℓ			
Property rental rate	25,00	LCU / m2 / month		Not applicable if property purchased	
Number of months per year office/storage property rented for	12	months / year			
Land purchase price	-	LCU / m2		Applicable if office / storage facility purchased	
Overhead rate (admin, security, bookkeeper, insurance)	10	% of total annual operating costs		Choose dependent on nature of the business - could be zero for small informal business	

Go to Emptying operational data summary
Go to Emptying cash flow summary

Interest and repayment

Parameter	Value	Unit	Notes
Capital cost	3 016 800,00	LCU	
Debt proportion in debt:equity ratio	70	%	
Debt	2 111 760,00	LCU	
Interest	9	%	
Lifespan	5	years	
Repayment period	4	years	Repayment period for debt
Instalment per quarter	131 985,00	LCU / quarter	

	Opening balance	Interest payable	Repayment at end of quarter	Closing balance
1				
Q1	2 111 760,00	47 514,60	131 985,00	1 979 775,00
Q2	1 979 775,00	44 544,94	131 985,00	1 847 790,00
Q3	1 847 790,00	41 575,28	131 985,00	1 715 805,00
Q4	1 715 805,00	38 605,61	131 985,00	1 583 820,00
2				
Q1	1 583 820,00	35 635,95	131 985,00	1 451 835,00
Q2	1 451 835,00	32 666,29	131 985,00	1 319 850,00
Q3	1 319 850,00	29 696,63	131 985,00	1 187 865,00
Q4	1 187 865,00	26 726,96	131 985,00	1 055 880,00
3				
Q1	1 055 880,00	23 757,30	131 985,00	923 895,00
Q2	923 895,00	20 787,64	131 985,00	791 910,00
Q3	791 910,00	17 817,98	131 985,00	659 925,00
Q4	659 925,00	14 848,31	131 985,00	527 940,00
4				
Q1	527 940,00	11 878,65	131 985,00	395 955,00
Q2	395 955,00	8 908,99	131 985,00	263 970,00
Q3	263 970,00	5 939,33	131 985,00	131 985,00
Q4	131 985,00	2 969,66	131 985,00	-
5				
Q1	-	-	-	-
Q2	-	-	-	-
Q3	-	-	-	-
Q4	-	-	-	-
6				
Q1	-	-	-	-
Q2	-	-	-	-
Q3	-	-	-	-
Q4	-	-	-	-
7				
Q1	-	-	-	-
Q2	-	-	-	-
Q3	-	-	-	-
Q4	-	-	-	-
8				
Q1	-	-	-	-
Q2	-	-	-	-
Q3	-	-	-	-
Q4	-	-	-	-
9				
Q1	-	-	-	-
Q2	-	-	-	-
Q3	-	-	-	-
Q4	-	-	-	-
10				
Q1	-	-	-	-
Q2	-	-	-	-
Q3	-	-	-	-
Q4	-	-	-	-
TOTALS		403 874,10	2 111 760,00	

Debt repayment

Year	1	2	3	4	5	6	7	8	9	10
Interest payable	172 240,43	124 725,83	77 211,23	29 696,63	-	-	-	-	-	-
Principle payable	527 940,00	527 940,00	527 940,00	527 940,00	-	-	-	-	-	-

Cash flows

Parameter	Unit		Year 1	2	3	4	5	6	7	8	9	10
Depreciable cost	LCU	3 016 800,00										
Fixed expenses (do not vary with volume FS)												
Interest on loan	LCU / year		172 240,43	124 725,83	77 211,23	29 696,63	-	-	-	-	-	-
Depreciation	LCU / year		387 874,29	387 874,29	387 874,29	387 874,29	387 874,29	-	-	-	-	-
Variable O&M costs, excluding fuel (dependent on number of pits emptied)	LCU / year		7 387 039,53	7 830 261,90	8 300 077,62	8 798 082,27	9 325 967,21	-	-	-	-	-
Start-up costs (for year 1 only)	LCU / year		2 000,00									
Fuel costs	LCU / year		360 374,68	403 619,64	452 054,00	506 300,48	567 056,54	-	-	-	-	-
Total expenses	**LCU / year**		**8 309 528,92**	**8 746 481,65**	**9 217 217,12**	**9 721 953,66**	**10 280 898,03**	-	-	-	-	-
Salvage value	LCU		-	-	-	-	1 077 428,57	-	-	-	-	-
Revenues (variable)	LCU / year		-	-	-	-	-	-	-	-	-	-
Net expenses	**LCU / year**		**8 309 528,92**	**8 746 481,65**	**9 217 217,12**	**9 721 953,66**	**9 203 469,46**	-	-	-	-	-
Discounted total cost	LCU / year		8 309 528,92	8 098 594,12	7 902 278,06	7 717 600,26	6 764 824,80	-	-	-	-	-
Mass of FS collected	tonnes / year		2 294	2 294	2 294	2 294	2 294	-	-	-	-	-
Number of pits emptied	pits / year		7000	7000	7000	7000	7000	0	0	0	0	0
Levelised cost of pit emptying per tonne FS	**LCU / tonne FS**	**3 381,74**										
Levelised cost of pit emptying per pit	**LCU / pit**	**1 108,07**										

2.3.2 Motorised emptying - Small vacuum tanker (Vacutug)

Cash flows for emptying and Conveyance stage 1

Emptying method (option number)
Emptying method
Stage 1 Conveyance option (option number)
Conveyance 1 method
Error check - highlighted in red when error exists

Parameter

Capital and start-up costs
Capital cost of one vacuum tanker and associated equipment
Total capital cost of all vacuum tankers and associated equipment

Capital cost of land for equipment storage and office

Once-off fees for permits, EIAs etc for emptying and conveyance operation, for ALL teams
TOTAL CAPITAL & STARTUP COSTS

O&M costs
Is vehicle rented?
Fee or rental for vehicle (e.g. for municipal-owned vehicles)

Rental for vehicle storage facility and office space

Cost of diesel
Cost of water
Cost of labour
Cost of vehicle maintenance
Annual cost of insurance & licence
Annual cost of health & safety measures, permitting, licenses
Other costs

Overheads

TOTAL OPERATING COSTS
Total operating costs excluding fuel
Fuel costs

Revenues
Revenue from emptying latrine pits

Operating parameters

Number of pits emptied per pit emptying cycle

Annualised number of pits to be emptied in area
Average volume of sludge per pit
Ease of access to households
Average %DS of FS in pit
Proportion of total original pit contents removed
Average volume of original sludge removed per pit
Additional volume of water added per pit
Total sludge volume removed per pit
Annualised volume of sludge removed from pit emptying area
Average %DS in FS removed from pits
Annualised mass of dry FS solids removed from pit emptying area

Calculation of number of pit-emptying teams required
Vacuum tanker nominal volume
Proportion of tanker volume used
Vacuum tanker working volume
Morning loading time

Distance E1: to pit emptying area from storage depot
Average driving speed of tanker
Time to reach pit emptying area
Number of return trips made from storage depot to pit emptying area per day
Distance E2: Average distance between pits
Stage 1 Conveyance option (option number)
Stage 1 Conveyance option (name)
Average distance travelled per day by vacuum tanker for Emptying and Conveyance Stage 1

Access level factor

1

2

Travel time between pits

Set up time at pit

Machine time per ℓ of FS removed
Extra time for dry pits (water addition and mixing)
Clean up time at pit
End of day clean-up & equipment store time

Total machine time per pit
Distance T1: One-way distance for Stage 1 conveyance
Time to discharge full load of sludge
Time for tanker discharge and return to pit emptying area (Stage 1 conveyance)
Number of tanker discharges per pit

Number of pits possible to empty per day

Number of pits emptied per day (optional input - overrides the calculated number of pits possible to empty in a day)
Number of complete pits possible to empty per day

Proportion of downtime per year
Number of machine working days per year required to empty all pits
Number of machine working days per year required to empty all pits (rounded up to nearest whole day)
Number of pit emptying teams required

Number of tankers in operation
Number of working days per year required to empty all pits

Personnel numbers, working hours and land area requirements
Number of supervisors (total)
Number of paid months per year for supervisors
Number of labourers per tanker team
Total number of labourers
Number of paid months per year for labourers
Working hours per day
Working days per month
Available labour working days per year
Fuel consumption for sludge pump

Fuel consumption for vacuum tanker
Oil consumption for vehicle

Oil consumption for vehicle
Annual distance travelled per tanker
Total annual diesel consumption for all tankers

Volume of water required for clean-up
Total water required per pit
Area required to store ONE small vacuum tanker
Storage area for ONE team's emptying equipment (buckets, shovels, clothing)
Total office, ablutions and parking area required
Total property area required

Special parameters for dry pits
Maximum pumpable dry solids of sludge
Additional water required per pit to achieve pumpability
Additional man and machine time taken to empty pit if water has to be added to make sludge pumpable

Financial parameters
Capital cost of vehicle (for insurance calculation)
Lifespan of Conveyance 1 vehicle
Escalation rate on O&M costs, excluding fuel
Escalation rate on fuel
Equipment lifespan - distance
Calculated lifespan
` Time period used for cash flows
Residual value at end of equipment life
Depreciation rate on vacuum tanker
Residual value of equipment at end of cash flow period
Discount rate
Diesel price
Oil price
Oil cost per km
Water price
Labour - supervisor rate
Labour - labourer rate
Fee or rental rate for vehicle per month (e.g. for municipal-owned vehicles) - if applicable
Vehicle insurance cost

Vehicle insurance
Vehicle license
Annual cost of permits and licences for one vehicle
Total annual cost of permits and license for all vehicles
Repair and maintenance cost for Conveyance 1 vehicle

Repair & maintenance cost for Conveyance 1 vehicle per km

Price of set of tyres
Distance for which new set of tyres lasts
Tyre price per km
Running costs per km (Tyres & oil)

Vehicle maintenance
Revenue generated per pit by tanker company

Revenue generated per litre FS removed by the tanker company
Property rental rate
Number of months per year property rented for
Property/land purchase price
Overhead rate (admin, security, bookkeeper)

Interest and repayment

Parameter
Capital cost
Debt proportion in debt:equity ratio
Debt
Interest
Accounting lifespan
Repayment period
Instalment per quarter

1
Q1
Q2
Q3
Q4
2
Q1
Q2
Q3
Q4
3
Q1
Q2
Q3
Q4
4
Q1
Q2
Q3
Q4
5

Q1
Q2
Q3
Q4
6
Q1
Q2
Q3
Q4
7
Q1
Q2
Q3
Q4
8
Q1
Q2
Q3
Q4
9
Q1
Q2
Q3
Q4
10
Q1
Q2
Q3
Q4

TOTALS

Debt repayment
Year

1
2
3
4
5
6
7
8
9
10

<u>Cash flows</u>
Parameter

Depreciable cost

Fixed expenses (do not vary with volume FS)

Interest on loan

Depreciation

Variable O&M costs, excluding fuel (dependent on number of pits emptied)

Start-up costs (for year 1 only)

Fuel costs

Total expenses

Salvage value

Revenues (variable)

Net expenses

Discounted total cost

Mass of FS collected

Number of pits emptied

Levelised cost of pit emptying per tonne FS

Levelised cost of pit emptying per pit

2
Motorised emptying - Small vacuum tanker
3
Motorised transport - Small vacuum tanker (e.g. Vacutug)
Error!

Value	**Unit**	**Reference**
99 300,00	LCU / tanker	
36 939 600,00	LCU	
-	LCU	
2 000,00	LCU	
36 941 600,00	**LCU**	
No		
-	LCU / year	
476 400,00	LCU / year	
5 573 855,28	LCU / year	
-	LCU / year	
34 584 000,00	LCU / year	
1 165 517,73	LCU / year	
1 292 886,00	LCU / year	
10 000,00	LCU / year	
-	LCU / year	
4 310 265,90	LCU / year	
47 412 924,92	**LCU / year**	
41 839 069,64	LCU / year	
5 573 855,28	LCU / year	

-	LCU / year

35 000	No. pits / pit emptying cycle
7 000	No. pits / year
1 000	ℓ / pit
1	Rating 1 - 3
30	%DS
80	%
800	ℓ FS / pit
1 875	ℓ water / pit
2 675	ℓ FS / pit
18 725 000	ℓ FS / year
12	% DS
1 932	tonnes dry FS / year

700	ℓ
95	%
665	ℓ
0,5	h / day
15	km
5	km / h
3	h
1	No.
0,3	km
3	
Motorised transport	- Small vacuum tanker (e.g. Vacutug)
31,95	km / working day

0,15	h / pit
0,5	h / pit

1	h / pit
0,21	h / pit
0,25	h / pit
0,125	h / kℓ of FS
0,5	h / pit
0,25	h / pit
0,75	h / day
21,25	h / pit
12,0	km
0,1	h / load
4,90	h / return trip
4,02	no. tanker discharges / pit
0,08	pits / day / team
0,00	pits / day / team
0,08	complete pits / day / team
10	%
93 522	working days / year
93 522	complete working days / year
371,12	No. pit-emptying teams required
372	No. tankers
251	working days / year
65	No.
12	paid months / year
2	No. / team
744	No.
12	paid months / year
9	h / day
21	days / month
252	available days / year
0,094	ℓ diesel / kℓ FS pumped
0,15	ℓ diesel / km
1	% of fuel consumption

0,0015	ℓ oil / km
8 032	km / year / tanker
451 690	ℓ diesel / year
50	ℓ / pit
1 925	ℓ / pit
3	m2
1	m2
100	m2
1588	m2
12	% DS
1 875	ℓ / pit
0,5	h / pit
99 300,00	LCU
10,00	years
6	%
12	%
160 000	km
20	years
5	years
10	%
9	%
55,0	%
8	%
12,34	LCU / ℓ
26,52	LCU / ℓ
0,0398	LCU / km
-	LCU / ℓ
10 000,00	LCU / month
3 000,00	LCU / month
2 000,00	LCU / month
3,5	% of purchase price / year
3 475,50	LCU / year
-	LCU / year
3 475,50	LCU / year
1 292 886,00	
50,0	% of purchase price over lifetime
0,3	LCU / km

2 000,00	LCU / set
50 000	km
0,04	LCU / km
0,08	LCU / km

-	LCU / month
-	LCU / pit
-	LCU / kℓ
25,00	LCU / m2 / month
12,00	months / year
-	LCU / m2
10,00	% of total annual operating costs

Value	Unit
36 939 600,00	LCU
70	%
25 857 720,00	LCU
9	%
5	years
5	years
1 292 886,00	LCU / quarter

Opening balance	Interest payable	Repayment at end of quarter
25 857 720,00	581 798,70	1 292 886,00
24 564 834,00	552 708,77	1 292 886,00
23 271 948,00	523 618,83	1 292 886,00
21 979 062,00	494 528,90	1 292 886,00
20 686 176,00	465 438,96	1 292 886,00
19 393 290,00	436 349,03	1 292 886,00
18 100 404,00	407 259,09	1 292 886,00
16 807 518,00	378 169,16	1 292 886,00
15 514 632,00	349 079,22	1 292 886,00
14 221 746,00	319 989,29	1 292 886,00
12 928 860,00	290 899,35	1 292 886,00
11 635 974,00	261 809,42	1 292 886,00
10 343 088,00	232 719,48	1 292 886,00
9 050 202,00	203 629,55	1 292 886,00
7 757 316,00	174 539,61	1 292 886,00
6 464 430,00	145 449,68	1 292 886,00

5 171 544,00	116 359,74	1 292 886,00
3 878 658,00	87 269,81	1 292 886,00
2 585 772,00	58 179,87	1 292 886,00
1 292 886,00	29 089,94	1 292 886,00
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
	6 108 886,35	25 857 720,00

Interest payable	**Principle payable**
2 152 655,19	5 171 544,00
1 687 216,23	5 171 544,00
1 221 777,27	5 171 544,00
756 338,31	5 171 544,00
290 899,35	5 171 544,00
-	-
-	-
-	-
-	-
-	-

Unit

LCU	36 939 600,00	**1**
LCU / year		2 152 655,19
LCU / year		3 324 564,00
LCU / year		41 839 069,64
LCU / year		2 000,00
LCU / year		5 573 855,28
LCU / year		**52 892 144,11**
LCU		-
LCU / year		-
LCU / year		**52 892 144,11**
LCU / year		52 892 144,11
tonnes / year		1932
pits / year		7000
LCU / tonne FS	**24 490,91**	
LCU / pit	**6 759,49**	

If Small vacuum tanker (2) chosen as emptying method, Conveyance 1 method may only be Small vacuum tanker (3)

Notes	**User comment**
User chooses the number of tankers required under operational parameters.	
Set to 0 unless a land purchase price is entered under financial paramaters.	
Specify what makes up this amount	
Set to 0 unless a rental cost for equipment is entered under financial parameters. Equipment rental period set to be equal to period labourers employed for.	
Set to 0 unless a property rental rate is entered under financial parameters.	
For transport and sludge pumping	
Based on retaining all labour for the full year	
Specify in comments what permits are required	
Any other costs in addition to vehicle rental, storage and office rental, fuel, water, labour, vehicle mainteance, insurance, and licenses.	
Calculated as a proportion of total operating costs. Overhead % can be changed under financial parameters	

Calculated from revenue per pit OR revenue per volume of sludge removed depending what input entered under financial parameters

Time taken to load equipment at the start of each working day, before driving to site

Refer to 'G1 Distances' sheet

Taking into account road and traffic conditions.

Time for return trip from storage depot to pit emptying area + [(number of pits + 1) x distance between pits], + (time for return trip to discharge point x no of discharges required per pit x no. of complete pits per day)

See row 20. These times for access level factors 1 -3 are the extra time it takes to actually be able to start emptying the pit - negotiating narrow streeets or having to remove the toilet superstructure before emptying can start.

Access level 1 = easiest access to pit (good roads, low density housing, no superstructure dismantling required)

Access level 2 = medium ease of access to pit

Access level 3 = hardest access to pit (poor roads, high density housing, steep gradients, significant dismantling of latrine superstructure required).

Time to cover distance plus additional time related to ease of access

Time to get machinery in position at the pit so that emptying can start.

Value is populated if dry solids in pit is above pumpable limit.

Time taken to put equipment away when back at the storage depot at the end of the day.

Refer to 'G1 Distances' sheet

Assumes tanker is only emptied once full - i.e. could be less often than once per day

On average - on days where the tanker has to make a trip for discharging sludge fewer pits will be emptied.

Optional input - overrides the calculated number of pits possible to empty in a day

No. pits per day used in calcs (daily distance travelled and number of working days per year required to empty all pits)

To allow for machinery repairs, strikes etc.

Based on machine time, downtime included

If labour is retained full-time enter 12.

If labour is retained full-time enter 12.

Based on number of paid months for labourers

The sludge pump on the vacuum tanker, as opposed to the engine that moves the tanker around.

Consumption of diesel by vacuum pump and truck engine.
Assumes each litre of sludge pumped twice (removal and discharge)

Choose based on total number of staff employed
Used to calculate rental rate for office and storage facility.

Determines how much extra water has to be added to the pit
Water required to bring pit DS% down to pumpable limit
Time required for water collection, addition and mixing

Used to calculate depreciation rate

For repair and maintenance rate calculation

Proportion of initial capital cost

Maintenance rate. Option to enter a monthly amount, rather than an amount per km.

Complete this field OR the revenue generated per litre of FS removed.

Choose dependent on nature of the business - could be nil for small informal business

Repayment period for debt

Closing balance

24 564 834,00
23 271 948,00
21 979 062,00
20 686 176,00

19 393 290,00
18 100 404,00
16 807 518,00
15 514 632,00

14 221 746,00
12 928 860,00
11 635 974,00
10 343 088,00

9 050 202,00
7 757 316,00
6 464 430,00
5 171 544,00

3 878 658,00
2 585 772,00
1 292 886,00
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-

Yea

2	**3**
1 687 216,23	1 221 777,27
3 324 564,00	3 324 564,00
44 349 413,81	47 010 378,64
6 242 717,91	6 991 844,06
55 603 911,96	**58 548 563,98**
-	-
-	-
55 603 911,96	**58 548 563,98**
51 485 103,67	50 195 956,77
1932	1932
7000	7000

r

4	5	6	7	8
756 338,31	290 899,35	-	-	-
3 324 564,00	3 324 564,00	-	-	-
49 831 001,36	52 820 861,44	-	-	-
7 830 865,35	8 770 569,19	-	-	-
61 742 769,02	**65 206 893,99**	**-**	**-**	**-**
-	- 20 316 780,00	-	-	-
-	-	-	-	-
61 742 769,02	**44 890 113,99**	**-**	**-**	**-**
49 013 400,70	32 995 573,88	-	-	-
1932	1932	0	0	0
7000	7000	0	0	0

9	10
-	-
-	-
-	-
-	-
-	**-**
-	-
-	-
-	**-**
-	-
0	0
0	0

2.3.4 Motorised emptying - Large vacuum tanker

Cash flows for emptying and Conveyance stage 1

Emptying method (option number)	3
Emptying method	Motorised emptyir
Stage 1 Conveyance option (option number)	4
Conveyance 1 method	Motorised transpo
Error check - highlighted in red when error exists	Error!

Parameter	**Value**
Capital and start-up costs	
Capital cost of one vacuum tanker and associated equipment	350 000,00
Total capital cost of all vacuum tankers and associated equipment	2 800 000,00
Capital cost of land for equipment storage and office	-
Once-off fees for permits, EIAs etc for emptying and conveyance operation	10 000,00
TOTAL CAPITAL & STARTUP COSTS	**2 810 000,00**
O&M costs	
Is vehicle hired?	No
Fee or rental for vehicle (e.g. for municipal-owned vehicles)	-
Rental for vehicle storage facility and office space	79 800,00
Cost of diesel	135 723,86
Cost of water	0
Cost of labour	816 000,00
Cost of vehicle maintenance	62 632,34
Cost of insurance & license	118 552,00
Cost of health & safety measures for all teams	10 000,00
Other costs	-
Overheads	183 406,23
TOTAL OPERATING COSTS	**1 406 114,43**
Total operating costs excluding fuel	1 270 390,57
Fuel costs	135 723,86

Revenues

Revenue from emptying latrine pits	-

Operating parameters

Number of pits emptied per pit emptying cycle	35 000
Annualised number of pits to be emptied in area	7 000
Average volume of sludge per pit	1 000
Ease of access to households	1
Average %DS of FS in pit	30
Proportion of total original pit contents removed	90
Average volume of original sludge removed per pit	900
Additional volume of water added per pit	1 875
Total sludge volume removed per pit	2 775
Annualised volume of sludge removed from pit emptying area	19 425 000
Average %DS in FS removed from pits	12
Annualised mass of dry FS solids removed from pit emptying area	2 173,5

Calculation of number of pit-emptying teams required

Vacuum tanker nominal volume	10 000
Vacuum tanker working volume	9 500
Morning loading time	0,5
Distance E1: to pit emptying area from storage depot	15
Average driving speed of tanker	50
Time to reach pit emptying area	0,3
Number of return trips made from storage depot to pit emptying area per day	1
Distance E2: Average distance between pits	0,3
Stage 1 Conveyance option (option number)	4
Stage 1 Conveyance option (name)	Motorised transpo
Average distance travelled per day by vacuum tanker for Emptying and Conveyance Stage 1	32,26

Access level factor

1	0,25
2	0,5
3	1
Travel time between pits	0,256
Set up time at pit	0,25
Machine time per ℓ of FS removed	0,0133
Extra time for dry pits (water addition and mixing)	0,5
Clean up time at pit	0,5
End of day clean-up & equipment store time	0,75
Total machine time per pit	1,71
Distance T1: One-way distance for Stage 1 conveyance	12,00
Time to discharge full load of sludge	0,1
Time for tanker discharge and return to pit emptying area (Stage 1 conveyance)	0,58
Number of tanker discharges per pit	0,29
Number of pits possible to empty per day	4,18
Number of pits emptied per day (optional input - overrides the calculated number of pits possible to empty in a day)	0,00
Number of complete pits possible to empty per day	4,18
Proportion of downtime per year	10
Number of machine working days per year required to empty all pits	1 844
Number of machine working days per year required to empty all pits (rounded up to nearest whole day)	1 845
Number of pit emptying teams required	7,32
Number of tankers in operation	8
Number of working days per year required to empty all pits	231

Personnel numbers, working hours and land area requirements

Number of supervisors (total)	2
Number of paid months per year for supervisors	12
Number of labourers per tanker team	2
Total number of labourers	16
Number of paid months per year for labourers	12
Working hours per day	9

Working days per month	21
Available labour working days per year	252
Fuel consumption for sludge pump	0,0533
Fuel consumption for vacuum tanker	0,15
Oil consumption for vehicle	1,5
Oil consumption for vehicle	0,0023
Annual distance travelled per tanker	7 440
Total annual diesel consumption for all tankers	10 999
Volume of water required for clean-up	50
Total water required per pit	1 925
Area required to store ONE Conveyance Stage 1 vehicle	25
Storage area for ONE team's other emptying equipment (buckets, shovels, clothing)	2
Total office, ablutions and parking area required	50
Total property area required	266
Special parameters for dry pits	
Maximum pumpable dry solids of sludge	12
Additional water required per pit to achieve pumpability	1 875
Additional man and machine time taken to empty pit if water has to be added to make sludge pumpable	0,5
Financial parameters	
Capital cost of vehicle (for insurance calculation)	350 000,00
Lifespan of vacuum tanker	10
Escalation rate on O&M costs, excluding fuel	6
Escalation rate on fuel	12
Equipment lifespan - distance	300 000
Calculated lifespan	40
Time period used for cash flows	5
Residual value of equipment at end of equipment life	10
Depreciation rate on vacuum tanker	9
Residual value of equipment at end of cash flow period	55,0
Discount rate	8
Diesel price	12,34
Oil price	26,52
Oil cost per km	0,0597
Water price	-
Labour - supervisor rate	10 000,00
Labour - labourer rate	3 000,00

Fee or rental rate for vehicle per month (e.g. for municipal-owned vehicles)	-
Price of set of tyres	18 418,00
Distance for which new set of tyres lasts	45 000
Tyre price per km	0,41
Vehicle running costs per km (including oil & tyres)	0,469
Equipment repair and maintenance cost over lifetime	50
Repair & maintenance cost for Conveyance 1 vehicle per km	0,6
Vehicle insurance cost	4
Vehicle insurance	14 000,00
Vehicle license	819,00
Yearly cost of permits and licences per vehicle	14 819,00
Vehicle maintenance	-
Revenue generated per pit by tanker company	-
Revenue generated per kilolitre FS removed by the tanker company	-
Property rental rate	25,00
Number of months per year property rented for	12,00
Land purchase price	-
Overhead rate (admin, security, bookkeeper)	15

Interest and repayment

Parameter	**Value**
Capital cost	2 800 000,00
Debt proportion in debt:equity ratio	70
Debt	1 960 000,00
Interest	9
Accounting lifespan	5
Repayment period	5
Instalment per quarter	98 000,00

	Opening balance
1	
Q1	1 960 000,00
Q2	1 862 000,00
Q3	1 764 000,00
Q4	1 666 000,00
2	
Q1	1 568 000,00
Q2	1 470 000,00
Q3	1 372 000,00
Q4	1 274 000,00
3	
Q1	1 176 000,00

Q2		1 078 000,00
Q3		980 000,00
Q4		882 000,00
4		
Q1		784 000,00
Q2		686 000,00
Q3		588 000,00
Q4		490 000,00
5		
Q1		392 000,00
Q2		294 000,00
Q3		196 000,00
Q4		98 000,00
6		
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
7		
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
8		
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
9		
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
10		
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
TOTALS		

Debt repayment

Year		**Interest payable**
	1	163 170,00
	2	127 890,00
	3	92 610,00
	4	57 330,00
	5	22 050,00

6		-
7		-
8	-	0,00
9		-
10		-

<u>Cash flows</u>

Parameter	**Unit**
Depreciable cost	LCU
Fixed expenses (do not vary with volume FS)	
Interest on loan	LCU / year
Depreciation	LCU / year
Variable O&M costs, excluding fuel (dependent on number of pits emptied)	LCU / year
Start up costs (for year 1 only)	LCU / year
Fuel costs	LCU / year
Total expenses	**LCU / year**
Salvage value	LCU
Revenues (variable)	LCU / year
Net expenses	**LCU / year**
Discounted total cost	LCU / year
Mass of FS collected	tonnes / year
Number of pits emptied	pits / year
Levelised cost of pit emptying per tonne FS	**LCU / tonne FS**
Levelised cost of pit emptying per pit	**LCU / pit**

			Go to selection for Emptying method
sed emptying - Large vacuum tanker			
			Go to selection for Conveyance Stage 1 method.
sed transport - Large vacuum tanker			
			If Large vacuum tanker (3) chosen as emptying method, Conveyance 1 method may only be Large vacuum tanker (4)
	Unit	**Reference**	**Notes**
	LCU / tanker		
	LCU		User chooses the number of tankers required under operational parameters.
	LCU		Set to 0 unless a land purchase price is entered under financial paramaters.
	LCU		Specify what makes up this amount
	LCU		
	LCU / year		Set to 0 unless a rental cost for equipment is entered under financial parameters. Equipment rental period set to be equal to period labourers employed for.
	LCU / year		Set to 0 unless a property rental rate is entered under financial parameters.
	LCU / year		For transport and sludge pumping
	LCU / year		
	LCU / year		Based on retaining all labour for the full year
	LCU / year		
	LCU / year		
	LCU / year		Specify in comments what permits are required
	LCU / year		Specify in comments what makes up these costs, e.g. additional consumables
	LCU / year		Calculated as a proportion of total operating costs. Overhead % can be changed under financial parameters
	LCU / year		
	LCU / year		
	LCU / year		

LCU / year	Calculated from revenue per pit OR revenue per volume of sludge removed depending what input entered under financial parameters
No. pits / pit emptying cycle	
No. pits / year	
ℓ / pit	
Rating 1 - 3	
%DS	
%	Consolidated sludge at base of pit often not removed by vacuum tanker
ℓ FS / pit	
ℓ water / pit	
ℓ FS / pit	
ℓ FS / year	
% DS	
tonnes dry FS / year	
ℓ	
ℓ	
h / day	Time taken to load equipment at the start of each working day, before driving to site
km	Refer to 'G1 Distances' sheet
km / h	Taking into account road and traffic conditions.
h	
No.	
km	
sed transport - Large vacuum tanker	
km / working day	Time for return trip from storage depot to pit emptying area + [(number of pits + 1) x distance between pits], + (time for return trip to discharge point x no of discharges required per pit x no. of complete pits per day) See row 20. These times for access level factors 1 -3 are the extra time it takes to actually be able to start emptying the pit - negotiating narrow streeets or having to remove the toilet superstructure before emptying can start.

h / pit	Access level 1 = easiest access to pit (good roads, low density housing, no superstructure dismantling required)
h / pit	Access level 2 = medium ease of access to pit
h / pit	Access level 3 = hardest access to pit (poor roads, high density housing, steep gradients, significant dismantling of latrine superstructure required).
h / pit	Time to cover distance plus additional time related to ease of access
h / pit	Time to get machinery in position at the pit so that emptying can start.
h / kℓ of FS	
h / pit	Value is populated if dry solids in pit is above pumpable limit. User can choose value.
h / pit	
h / day	Time taken to put equipment away when back at the storage depot at the end of the day.
h / pit	
km	Refer to 'G1 Distances' sheet
h / load	
h / return trip	
no. tanker discharges / pit	Assumes tanker is only emptied once full - i.e. could be less often than once per day
pits / day / team	On average - on days where the tanker has to make a trip for discharging sludge fewer pits will be emptied.
pits / day / team	Optional input - overrides the calculated number of pits possible to empty in a day
complete pits / day / team	Pits per day used in calcs
%	Contingency to allow for machinery repairs, strikes etc.
working days / year	Based on machine time, downtime included
complete working days / year	
No. pit-emptying teams required	
No. tankers	
working days / year	
No.	
paid months / year	If labour is retained full-time enter 12.
No. / team	
No.	
paid months / year	If labour is retained full-time enter 12.
h / day	

days / month	
available days / year	Based on number of paid months for labourers
ℓ diesel / kℓ FS pumped	The sludge pump on the vacuum tanker, as opposed to the engine that moves the tanker around.
ℓ diesel / km	
% of fuel consumption	
ℓ / km	
km / year / tanker	
ℓ diesel / year	Consumption of diesel by vacuum pump and truck engine. Assumes each litre of sludge pumped twice (removal and discharge)
ℓ / pit	
ℓ / pit	
m2	
m2	
m2	Choose based on total number of staff employed
m2	Used to calculate rental rate for office and storage facility.
% DS	Determines how much extra water has to be added to the pit
ℓ / pit	Water required to bring pit DS% down to pumpable limit
h / pit	Time required for water collection, addition and mixing
LCU	
years	Used to calculate depreciation rate
%	
%	
km	
years	
years	
%	Proportion of initial capital cost
%	
%	
%	
LCU / ℓ	
LCU / ℓ	
LCU / km	
LCU / ℓ	
LCU / month	
LCU / month	

LCU / month	Not applicable if tanker purchased
LCU / set	
km	
LCU / km	
LCU / km	Maintenance rate. Option to enter a monthly amount, rather than an amount per km.
%	
LCU / km	Calculated over theoretical lifespan distance
% of purchase price / year	
LCU / year	
LCU / year	
LCU / year	
LCU / month	
LCU / pit	Complete this field OR the revenue generated per litre of FS removed.
LCU / kℓ	
LCU / m2 / month	
months / year	
LCU / m2	
% of total annual operating costs	Choose dependent on nature of the business - could be nil for small informal business

Unit	
LCU	
%	
LCU	
%	
years	link to above?
years	Repayment period for debt
LCU / quarter	

Interest payable	**Repayment at end of quarter**	**Closing balance**
44 100,00	98 000,00	1 862 000,00
41 895,00	98 000,00	1 764 000,00
39 690,00	98 000,00	1 666 000,00
37 485,00	98 000,00	1 568 000,00
35 280,00	98 000,00	1 470 000,00
33 075,00	98 000,00	1 372 000,00
30 870,00	98 000,00	1 274 000,00
28 665,00	98 000,00	1 176 000,00
26 460,00	98 000,00	1 078 000,00

	24 255,00	98 000,00		980 000,00
	22 050,00	98 000,00		882 000,00
	19 845,00	98 000,00		784 000,00
	17 640,00	98 000,00		686 000,00
	15 435,00	98 000,00		588 000,00
	13 230,00	98 000,00		490 000,00
	11 025,00	98 000,00		392 000,00
	8 820,00	98 000,00		294 000,00
	6 615,00	98 000,00		196 000,00
	4 410,00	98 000,00		98 000,00
	2 205,00	98 000,00	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
-	0,00	-	-	0,00
-	0,00	-	-	0,00
-	0,00	-	-	0,00
-	0,00	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	-	-	-	0,00
	463 050,00	1 960 000,00		

Principle payable

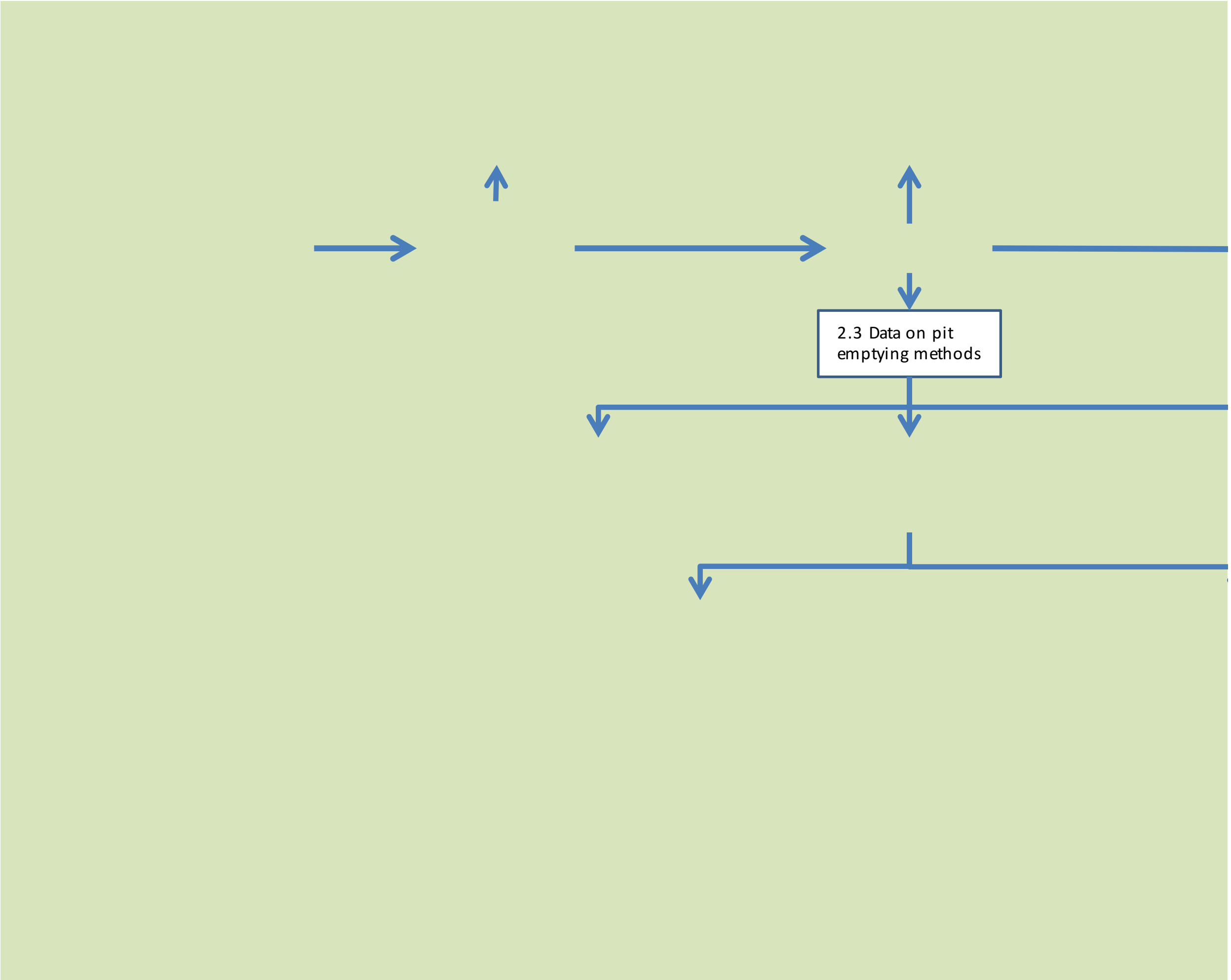
392 000,00
392 000,00
392 000,00
392 000,00
392 000,00

-		
-		
-		
-		
-		
2 800 000,00	**1**	**2**
	163 170,00	127 890,00
	252 000,00	252 000,00
	1 270 390,57	1 346 614,00
	10 000,00	
	135 723,86	152 010,72
	1 831 284,43	**1 878 514,72**
	-	-
	-	-
	1 831 284,43	**1 878 514,72**
	1 831 284,43	1 739 365,48
	2173,5	2173,5
	7000	7000
666,13		
206,83		

User comment

Year			
3	**4**	**5**	**6**
92 610,00	57 330,00	22 050,00	-
252 000,00	252 000,00	252 000,00	-
1 427 410,84	1 513 055,49	1 603 838,82	-
170 252,01	190 682,25	213 564,12	-
1 942 272,85	**2 013 067,74**	**2 091 452,94**	**-**
-	-	- 1 540 000,00	-
-	-	-	-
1 942 272,85	**2 013 067,74**	**551 452,94**	**-**
1 665 185,91	1 598 038,08	405 334,37	-
2173,5	2173,5	2173,5	0
7000	7000	7000	0

	7	8	9	10
	-	-	-	-
	-	-	-	-
	-	-	-	-
	-	-	-	-
	-	**-**	**-**	**-**
	-	-	-	-
	-	-	-	-
	-	**-**	**-**	**-**
	-	-	-	-
	0	0	0	0
	0	0	0	0



2.4 Summary of data for different emptying methods

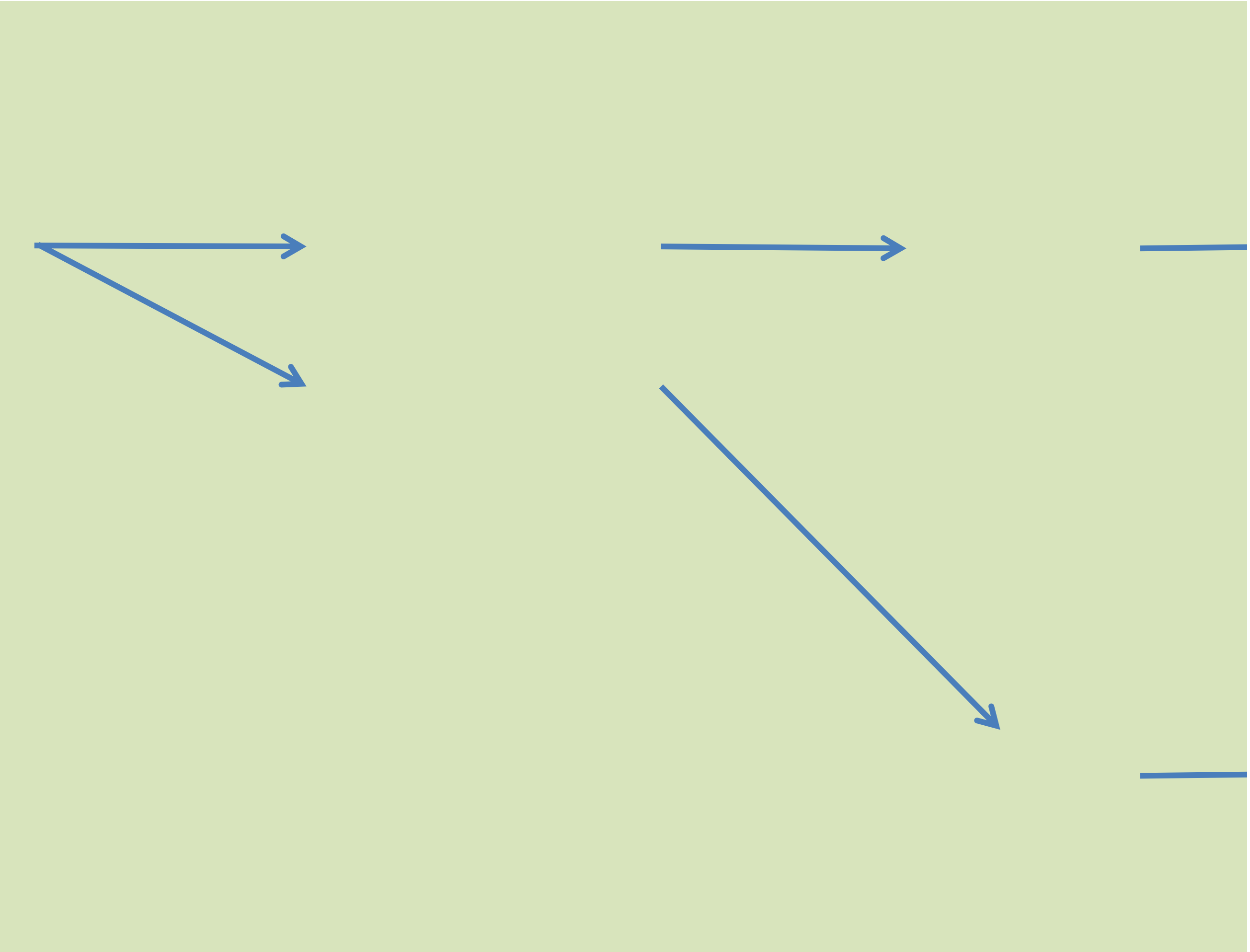
Operational data for different emptying and Conveyance Stage 1 combinations
To use this sheet you must complete inputs for sheets 2.3.1, 2.3.2, 2.3.3 and the relevant Co

VLOOKUP column no.
Options

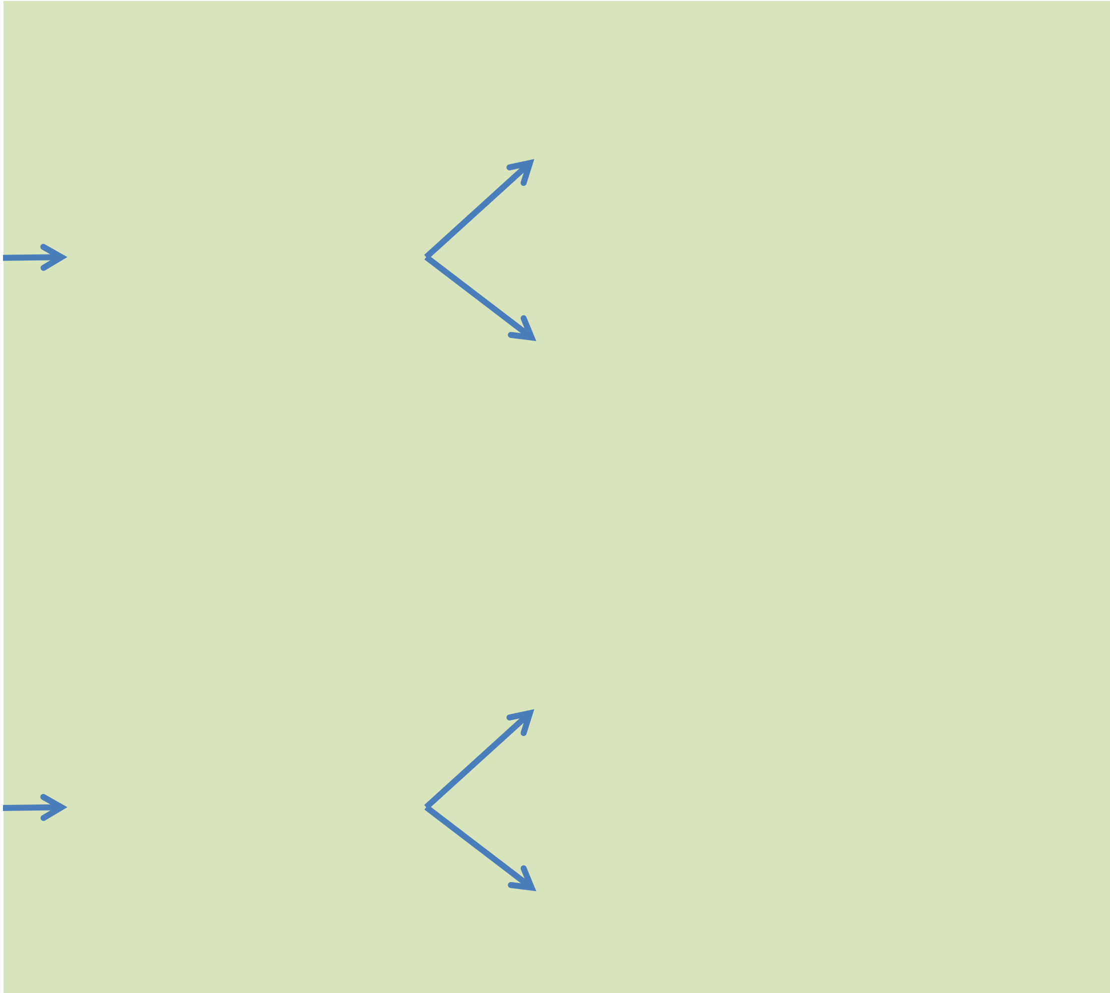
Emptying	Conveyance Stage 1
2.3.1 Human-powered emptying - buckets & shovels	Pick-up truck with containers of sludge
2.3.2 Motorised emptying - Small vacuum tanker (e.g. Vacutug)	Motorised transport - Small vacuum tanker (e.g. Vacutug)
2.3.3 Motorised emptying - Large vacuum tanker	Motorised transport - Large vacuum tanker

relevant Conveyance 1 data sheets

1	2	3
Emptying option number	**Additional water added per pit to achieve pumpable sludge**	**Proportion of original pit contents removed**
	ℓ / pit	%
1	0	95
2	1 875	80
3	1 875	90



4	5	6	7	8
Average volume of sludge removed per pit	**Total capital & start-up costs**	**Total annual O&M costs**	**Number of pits emptied per day**	**Levelised emptying cost per pit**
ℓ FS / pit	LCU	LCU / year	pits / day	LCU / pit
950	3 018 800,00	7 747 414,21	30,00	1 108,37
2 675	36 941 600,00	47 412 924,92	30,63	6 759,49
2 775	2 810 000,00	1 406 114,43	4,18	206,83



9	10	11	12	13
Levelised emptying cost per dry kg FS	**No. equipment working days required per year to empty all pits**	**Total number of staff (excluding admin / security)**	**Number of pit-emptying teams**	**No. of labour working days available per year**
LCU / tonne FS	working days / year	No. staff	No. teams	
3 381,74	245	93	15	252
24 490,91	251	809	372	252
666,13	231	18	8	252

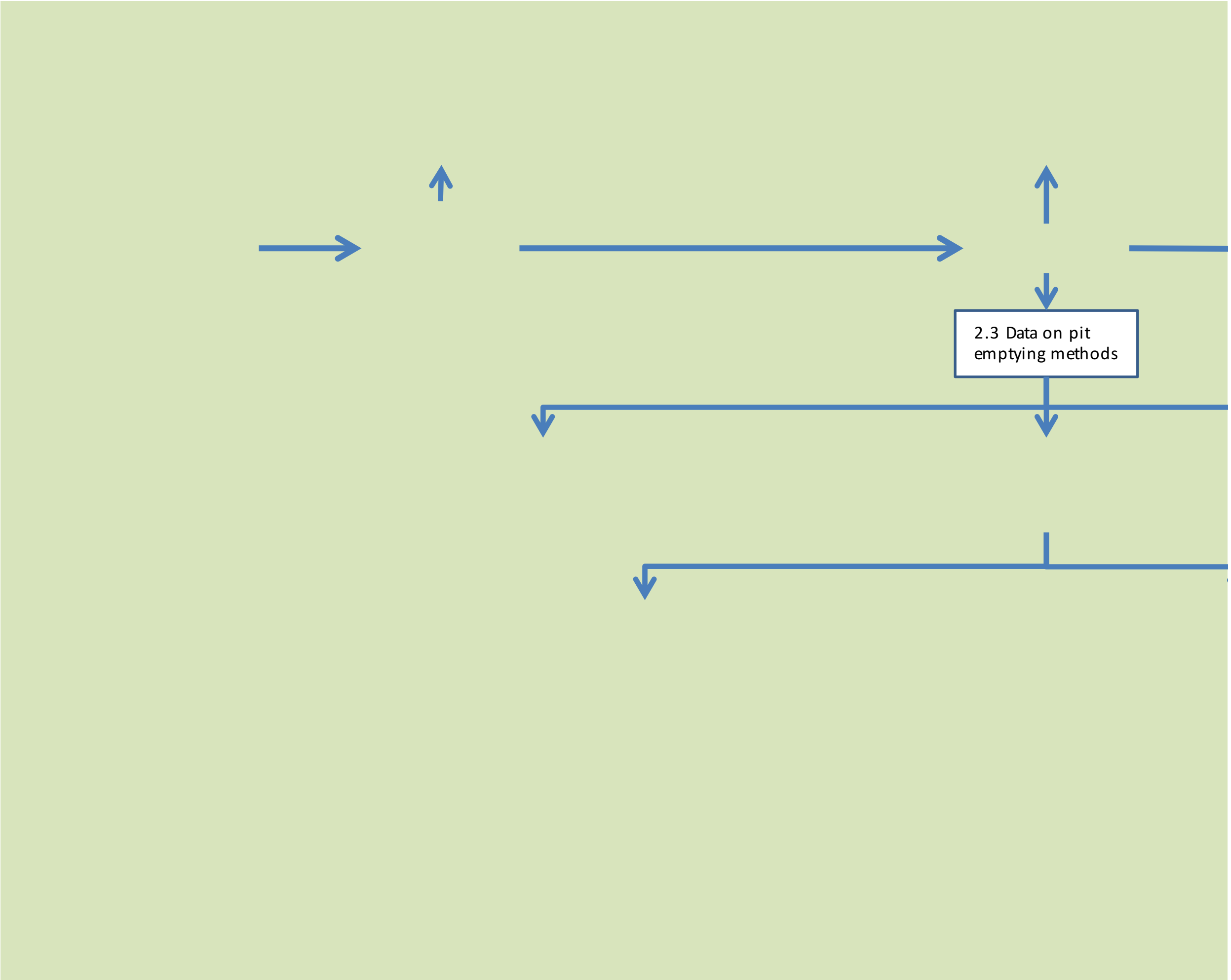
14

Name

Human powered emptying - buckets & shovels

Motorised emptying - small vaccum tanker (Vacutug)

Motorised emptying - large vacuum tanker



2.5 Emptying & Conveyance Stage 1 cash flows

Cash flows for different emptying and Conveyance Stage 1 combinations

<u>2.5.1 Human-powered emptying</u>

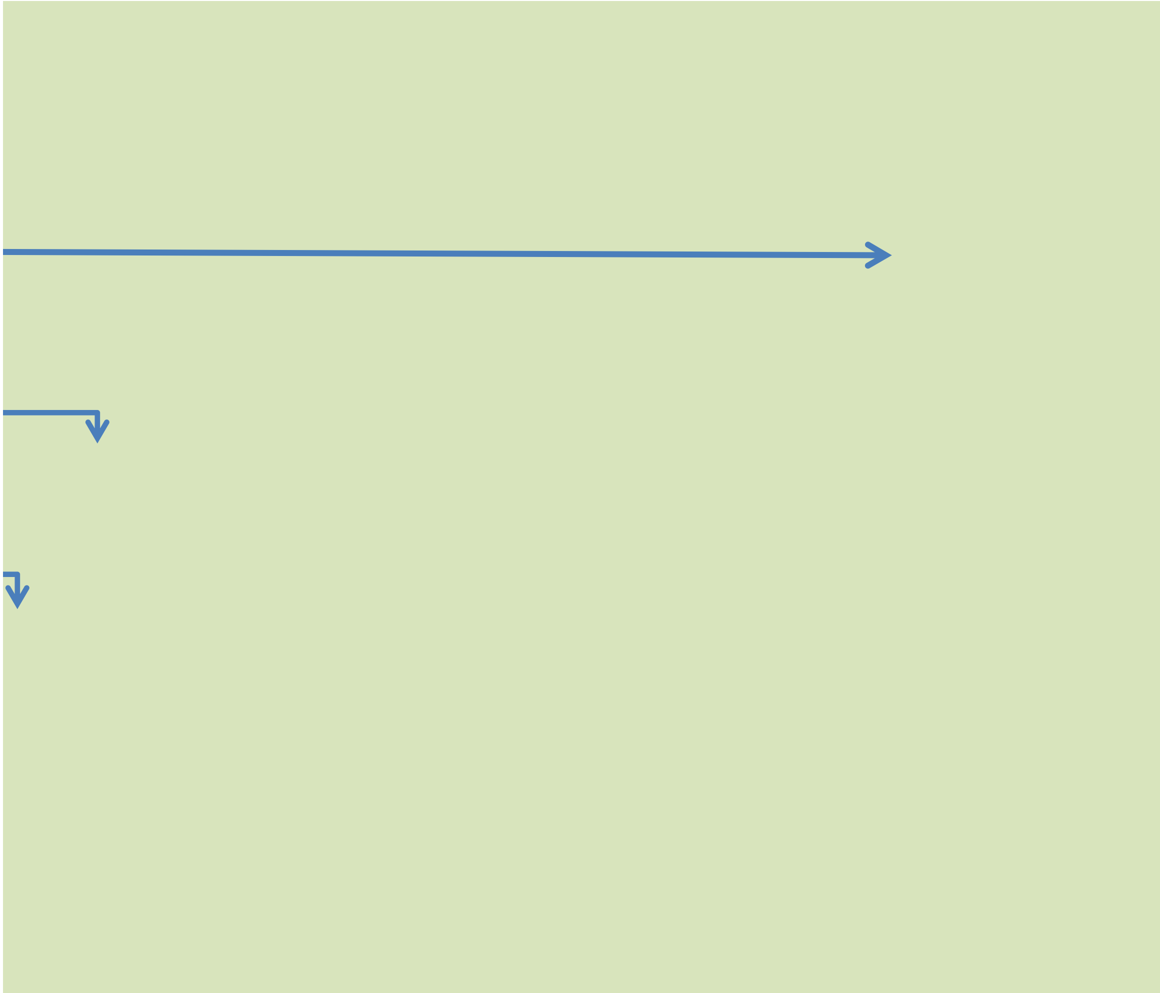
Parameter	**Unit**
Depreciable cost	LCU
Interest on loan	LCU / year
Depreciation	LCU / year
Variable O&M costs, excluding fuel (dependent on number of pits emptied)	LCU / year
Fuel costs	LCU / year
Total expenses	**LCU / year**
Salvage value	LCU
Revenues (variable)	LCU / year
Net expenses	**LCU / year**
Discounted total cost	LCU / year
Mass of FS collected	tonnes / year
Number of pits emptied	pits / year
Levelised cost of pit emptying per tonne FS	**LCU / tonne FS**
Levelised cost of pit emptying per pit	**LCU / pit**

2.5.2 Motorised emptying - Small vacuum tanker (Vacutug)

Parameter	Unit
Depreciable cost	LCU
Interest on loan	LCU / year
Depreciation	LCU / year
Variable O&M costs, excluding fuel (dependent on number of pits empt	LCU / year
Fuel costs	LCU / year
Total expenses	**LCU / year**
Salvage value	LCU
Revenues (variable)	LCU / year
Net expenses	**LCU / year**
Discounted total cost	LCU / year
Mass of FS collected	tonnes / year
Number of pits emptied	pits / year
Levelised cost of pit emptying per tonne FS	**LCU / tonne FS**
Levelised cost of pit emptying per pit	**LCU / pit**

2.5.4 Motorised emptying - Large vacuum tanker

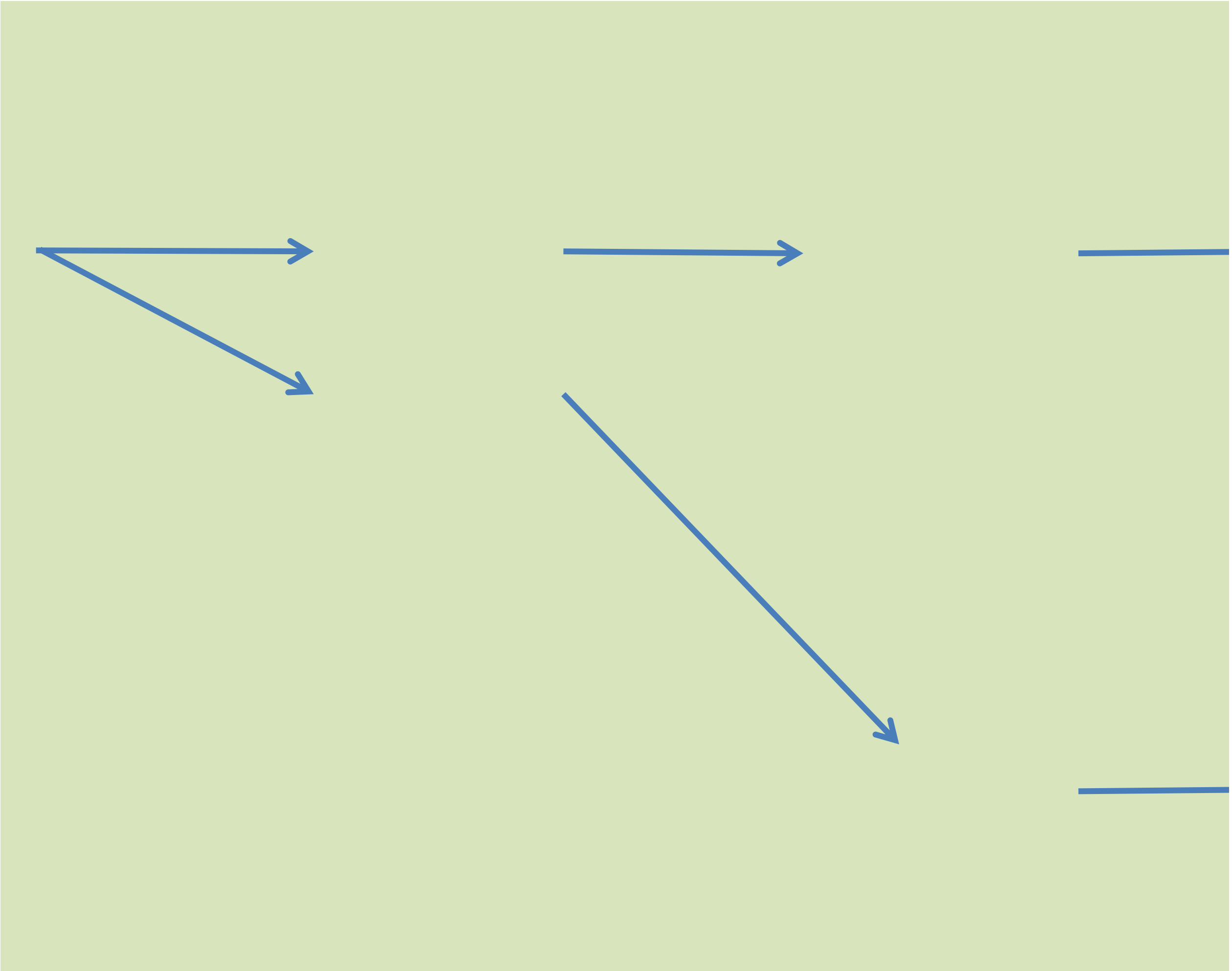
Parameter	Unit
Depreciable cost	LCU
Interest on loan	LCU / year
Depreciation	LCU / year
Variable O&M costs, excluding fuel (dependent on number of pits empt	LCU / year
Fuel costs	LCU / year
Total expenses	**LCU / year**
Salvage value	LCU
Revenues (variable)	LCU / year
Net expenses	**LCU / year**
Discounted total cost	LCU / year
Mass of FS collected	tonnes / year
Number of pits emptied	pits / year
Levelised cost of pit emptying per tonne FS	**LCU / tonne FS**
Levelised cost of pit emptying per pit	**LCU / pit**



	Year	
3 016 800,00	1	2
	172 240,43	124 725,83
	387 874,29	387 874,29
	7 387 039,53	7 830 261,90
	360 374,68	403 619,64
	8 309 528,92	**8 746 481,65**
	-	-
	-	-
	8 309 528,92	**8 746 481,65**
	8 309 528,92	8 098 594,12
	2294,25	2294,25
	7000	7000
3 381,74		
1 108,37		

	Year	
36939600	1	2
	2 152 655,19	1 687 216,23
	3 324 564,00	3 324 564,00
	41 839 069,64	44 349 413,81
	5 573 855,28	6 242 717,91
	52 892 144,11	**55 603 911,96**
	-	-
	-	-
	52 892 144,11	**55 603 911,96**
	52 892 144,11	51 485 103,67
	1932	1932
	7000	7000
24490,90881		
6759,490832		

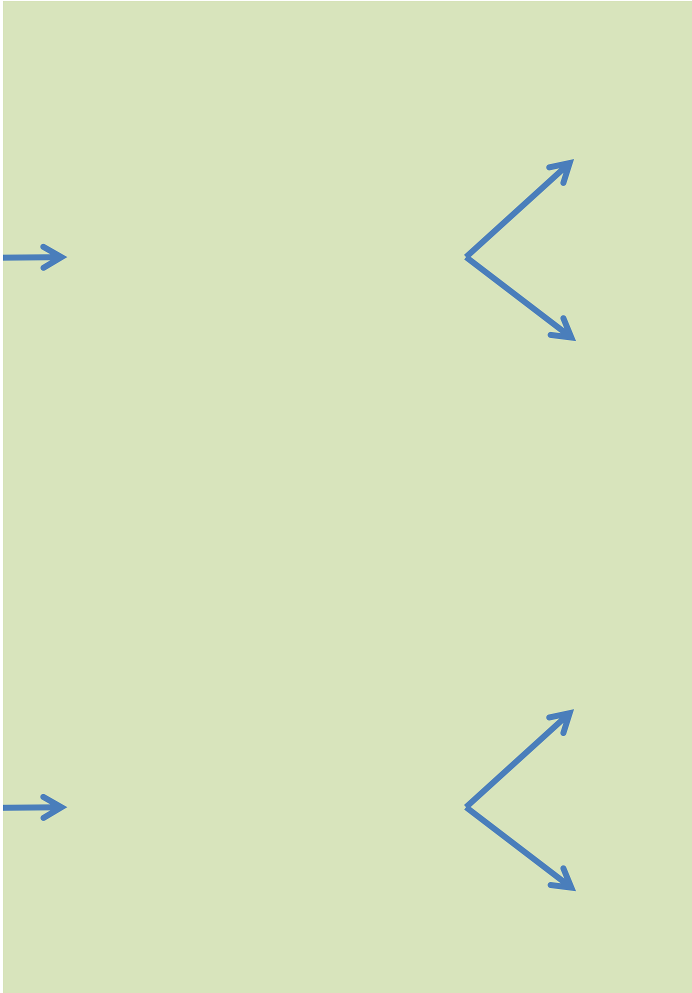
	Year	
2800000	1	2
	163 170,00	127 890,00
	252 000,00	252 000,00
	1 270 390,57	1 346 614,00
	135 723,86	152 010,72
	1 831 284,43	**1 878 514,72**
	-	-
	-	-
	1 831 284,43	**1 878 514,72**
	1 831 284,43	1 739 365,48
	2173,5	2173,5
	7000	7000
666,1337266		
206,8345221		



3	4	5	6	7
77 211,23	29 696,63	-	-	-
387 874,29	387 874,29	387 874,29	-	-
8 300 077,62	8 798 082,27	9 325 967,21	-	-
452 054,00	506 300,48	567 056,54	-	-
9 217 217,12	**9 721 953,66**	**10 280 898,03**	**-**	**-**
-	-	- 1 077 428,57	-	-
-	-	-	-	-
9 217 217,12	**9 721 953,66**	**9 203 469,46**	**-**	**-**
7 902 278,06	7 717 600,26	6 764 824,80	-	-
2294,25	2294,25	2294,25	0	0
7000	7000	7000	0	0

3	4	5	6	7
1 221 777,27	756 338,31	290 899,35	-	-
3 324 564,00	3 324 564,00	3 324 564,00	-	-
47 010 378,64	49 831 001,36	52 820 861,44	-	-
6 991 844,06	7 830 865,35	8 770 569,19	-	-
58 548 563,98	**61 742 769,02**	**65 206 893,99**	**-**	**-**
-	- -	20 316 780,00	-	-
-	-	-	-	-
58 548 563,98	**61 742 769,02**	**44 890 113,99**	**-**	**-**
50 195 956,77	49 013 400,70	32 995 573,88	-	-
1932	1932	1932	0	0
7000	7000	7000	0	0

3	4	5	6	7
92 610,00	57 330,00	22 050,00	-	-
252 000,00	252 000,00	252 000,00	-	-
1 427 410,84	1 513 055,49	1 603 838,82	-	-
170 252,01	190 682,25	213 564,12	-	-
1 942 272,85	**2 013 067,74**	**2 091 452,94**	**-**	**-**
-	- -	1 540 000,00	-	-
-	-	-	-	-
1 942 272,85	**2 013 067,74**	**551 452,94**	**-**	**-**
1 665 185,91	1 598 038,08	405 334,37	-	-
2173,5	2173,5	2173,5	0	0
7000	7000	7000	0	0



8	9	10
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
0	0	0
0	0	0

8	9	10
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
0	0	0
0	0	0

8	9	10
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
0	0	0
0	0	0

Emptying data analysis

Outputs: cost per pit and cost per tonne for 3 emptying methods (without sub-contractor marl

	Results		
Emptying method	LCU/pit		
Manual	1 108,37	3 381,74	
Small vacuum	6 759,49	24 490,91	
Large vacuum	206,83	666,13	
Variable (no of pit)	**Manual-emptying result**		LCU/pit
250	206,83	666,13	8 065,25
500	206,83	666,13	4 044,70
1000	206,83	666,13	2 034,79
1500	206,83	666,13	1 364,81
2000	206,83	666,13	1 029,65
3000	206,83	666,13	694,72
4000	206,83	666,13	527,17
5000	206,83	666,13	541,26
10000	206,83	666,13	340,27
15000	206,83	666,13	273,27
20000	206,83	666,13	239,77
25000	206,83	666,13	219,67
30000	206,83	666,13	206,27
35000	206,83	666,13	196,70

Chart source data

	manual		small vacuum
	LCU/pit	LCU / tonne	LCU/pit
250	8 061,76	27 992,22	80 518,68
500	4 044,70	14 044,08	43 201,87
1000	2 034,79	7 065,23	24 543,46
1500	1 364,81	4 738,94	18 324,19
2000	1 029,65	3 575,16	15 214,41
3000	694,72	2 412,23	12 104,72
4000	527,17	1 830,44	10 444,93
5000	541,26	1 879,37	9 533,02
10000	340,27	1 181,49	7 667,18
15000	273,27	948,86	7 017,24
20000	239,77	832,54	6 713,27
25000	219,67	762,75	6 514,10
30000	206,27	716,23	6 395,31
35000	196,70	683,00	6 298,46

To change variable under analysis
(1) change cell reference in part 1 of macro
(2) change the values in range A13 - A26

tractor markup)

CTL+Q	Create one row of table (relative references)
CTL+W	Create whole table of results for existing formulae on columns B and C
CTL+E	Run the table for manual, small vacuum and large vacuum (formulae in b9

60959703

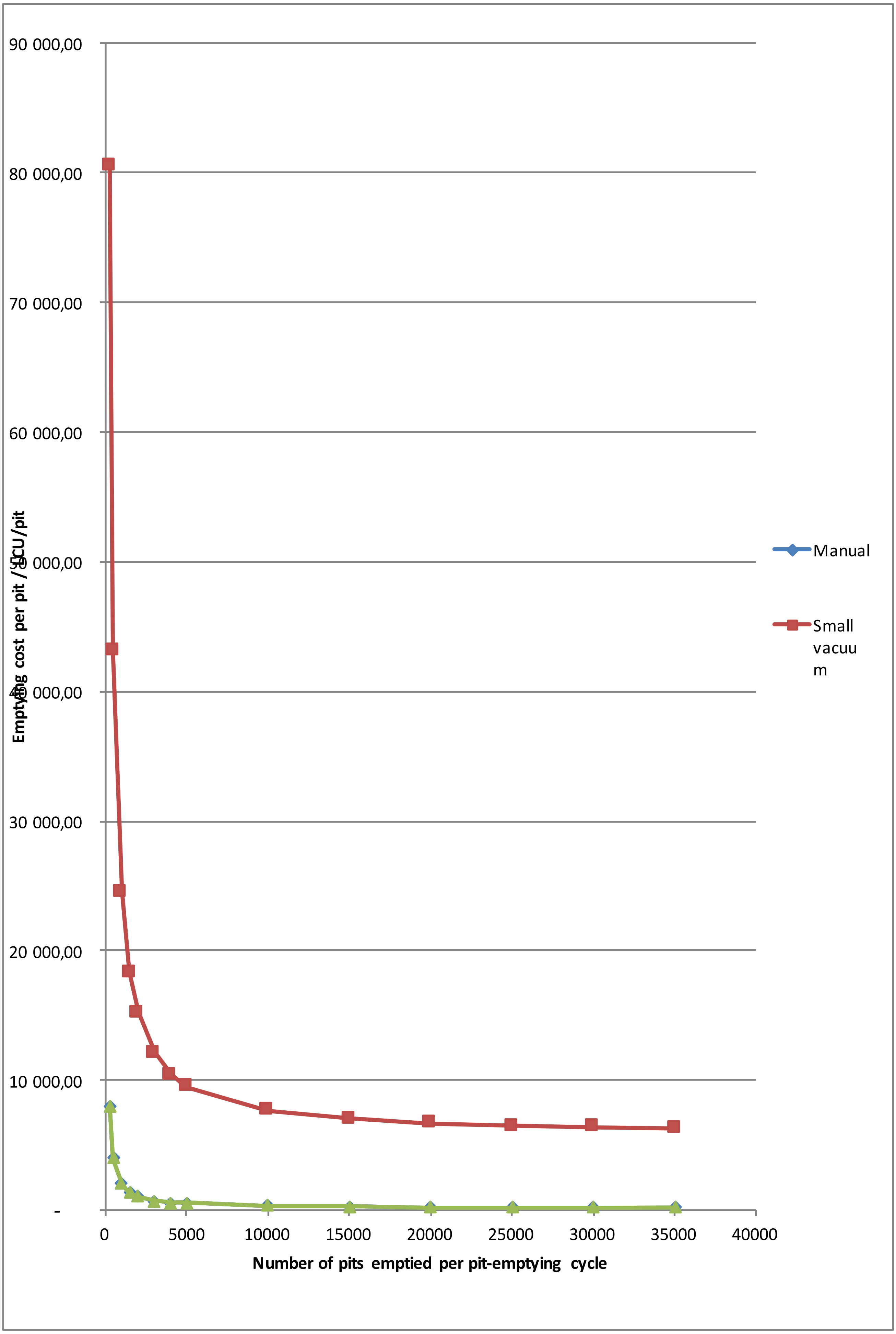
LCU/tonne		**Number sets for number of pits emptied per p**			
		no. pits	no. pits	T1 dist	%DS
28 004,35		1000	250	1	0,5
14 044,08		2000	500	2	1
7 065,23		3000	1000	3	3
4 738,94		4000	1500	4	6
3 575,16		5000	2000	5	9
2 412,23		6000	3000	6	12
1 830,44		7000	4000	7	15
1 879,37		8000	5000	9	18
1 181,49		9000	10000	10	21
948,86		10000	15000	15	25
832,54		11000	20000	20	30
762,75		12000	25000	25	35
716,23		13000	30000	30	40
683,00		14000	35000	35	45

	large vacuum	
LCU / tonne	LCU/pit	LCU / tonne
291 734,34	8 065,25	28 004,35
156 528,51	4 044,70	14 044,08
88 925,60	2 034,79	7 065,23
66 391,98	1 364,81	4 738,94
55 124,66	1 029,65	3 575,16
43 857,68	694,72	2 412,23
37 843,96	527,17	1 830,44
34 539,91	541,26	1 879,37
27 779,62	340,27	1 181,49
25 424,80	273,27	948,86
24 323,43	239,77	832,54
23 601,82	219,67	762,75
23 171,40	206,27	716,23
22 820,51	196,70	683,00

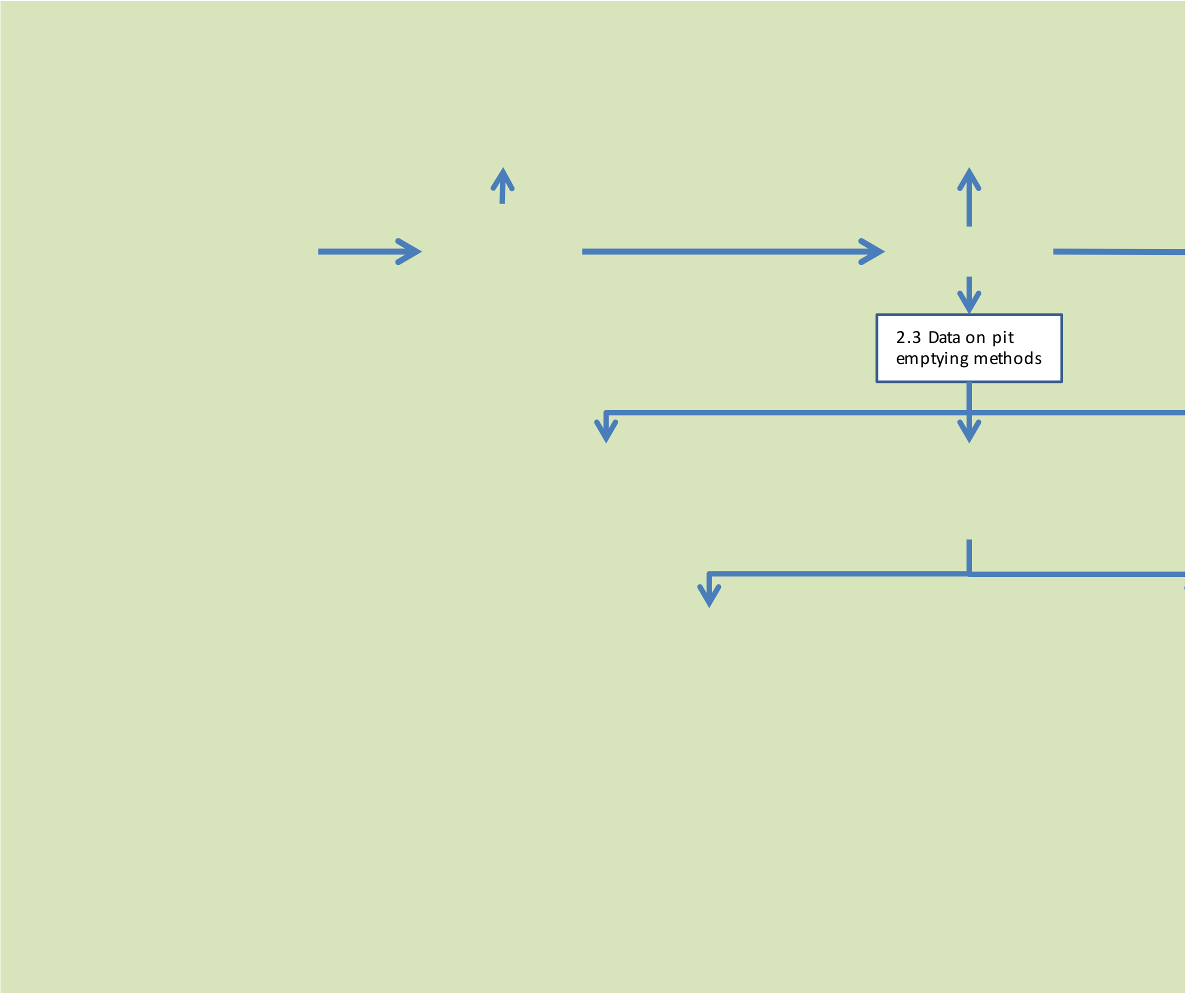
mulae in b9 - c11) & paste results into graph data table

ptied per pit-emptying cycle (paste into A13 - A26)

litre/p/year	pit cycle length/years
15	1
20	2
25	3
30	4
35	5
40	6
45	7
60	8
70	9
80	10
90	
100	
110	
120	



90 000,00
80 000,00
70 000,00
60 000,00
50 000,00
40 000,00
30 000,00
20 000,00
10 000,00
-
0
5000
10000
15000
20000
25000
30000
35000
40000
Emptying cost per pit / SCU/pit
Number of pits emptied per pit-emptying cycle
Manual
Small vacuum



3.1 Conveyance of FS to treatment

Choice of conveyance options for different journey stages

Parameter	**Value**
	Area 1
Area name	Test 1
No. of households or pits in area	35 000
Average distance between households	0,3
Ease of access to households	1
Length of pit-emptying cycle	5
Average volume of sludge removed per pit (including additional water)	950
Emptying method number	1
Emptying method name	Human powered emptying
Total volume of sludge to be removed from area per pit emptying cycle	33 250,0
Annual total volume of sludge removed from pit emptying area	6 650,0
Average %DS in FS to be transported	30,00
Average calorific value of FS to be transported	12,35
Average detritus fraction in FS to be transported	20

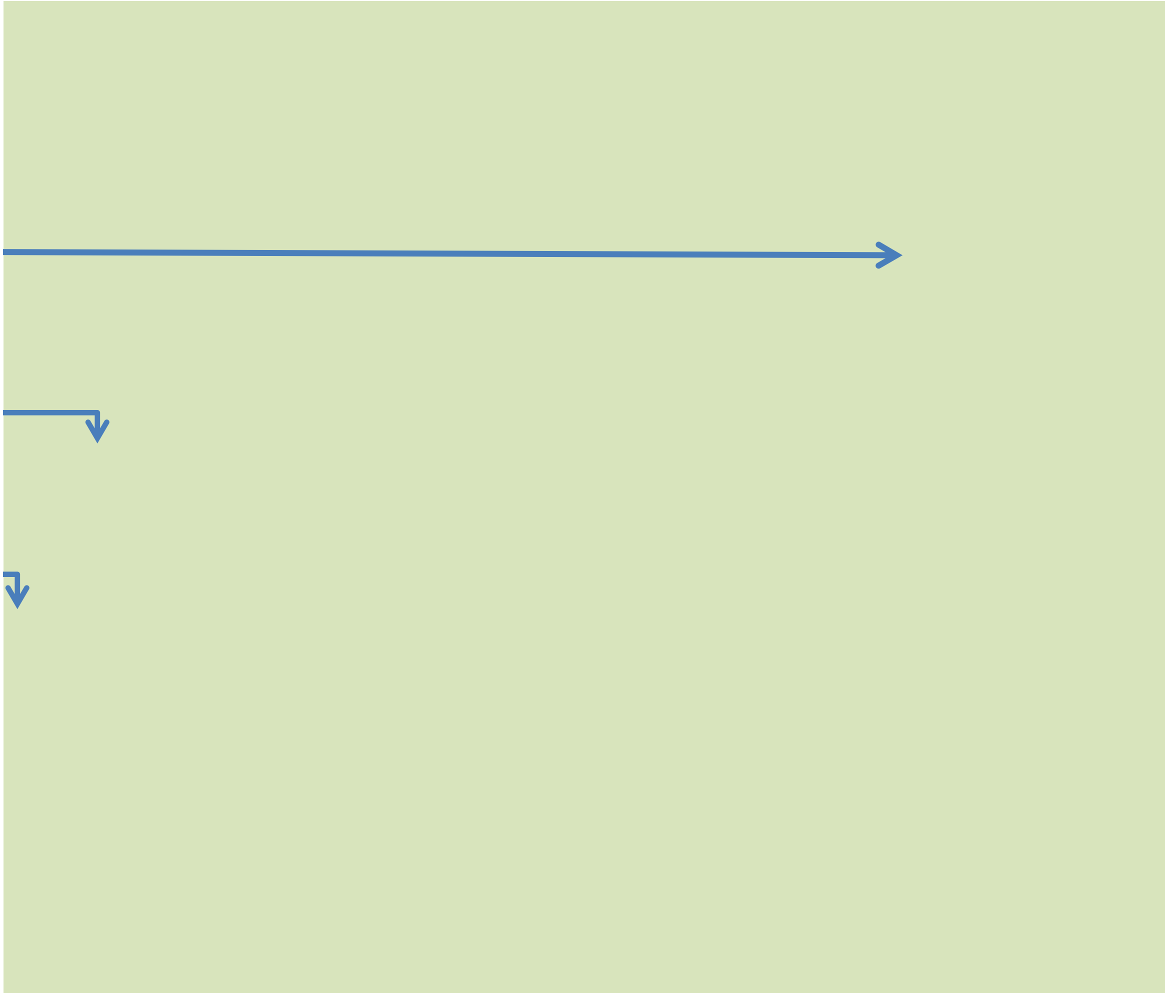
Number of working days per year required to empty all pits	245

Choice of Conveyance methods

Conveyance method choices
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 holding tank later pumped out, no sewer connection
6 - Transfer station with liquid connection to sewer
7 - Sewer discharge station with screening

Conveyance method Stage 1	2
Conveyance method Stage 1	**Pick-up truck with containe**
Distance T1: one-way distance for Conveyance Stage 1	12
Conveyance method Stage 2	0
Conveyance method Stage 2	**#N/A**
Distance T2: one-way distance for Conveyance Stage 2	0
Conveyance method Stage 3	0
Conveyance method Stage 3	**#N/A**
Distance T3: one-way distance for Conveyance Stage 3	0
Conveyance method Stage 4	0
Conveyance method Stage 4	**#N/A**
Distance T4: one-way distance for Conveyance Stage 4	0

Total distance from pit to sludge processing/disposal site (LaDePa, combustion or landfill)	12



Go to schematic showing journey stages

Unit **Reference** **Notes**

No.
km
Rating 1 - 3
years
ℓ / pit

Number
d emptying - buckets & shovels
m^3 / pit-
emptying cycle
m^3 / year

%DS
MJ / kg
%

working days /
year

No. Go to choice of Conveyance method Stage 1

ith containers of sludge

km Refer to 'G1 Distances' sheet

No.

km Refer to 'G1 Distances' sheet

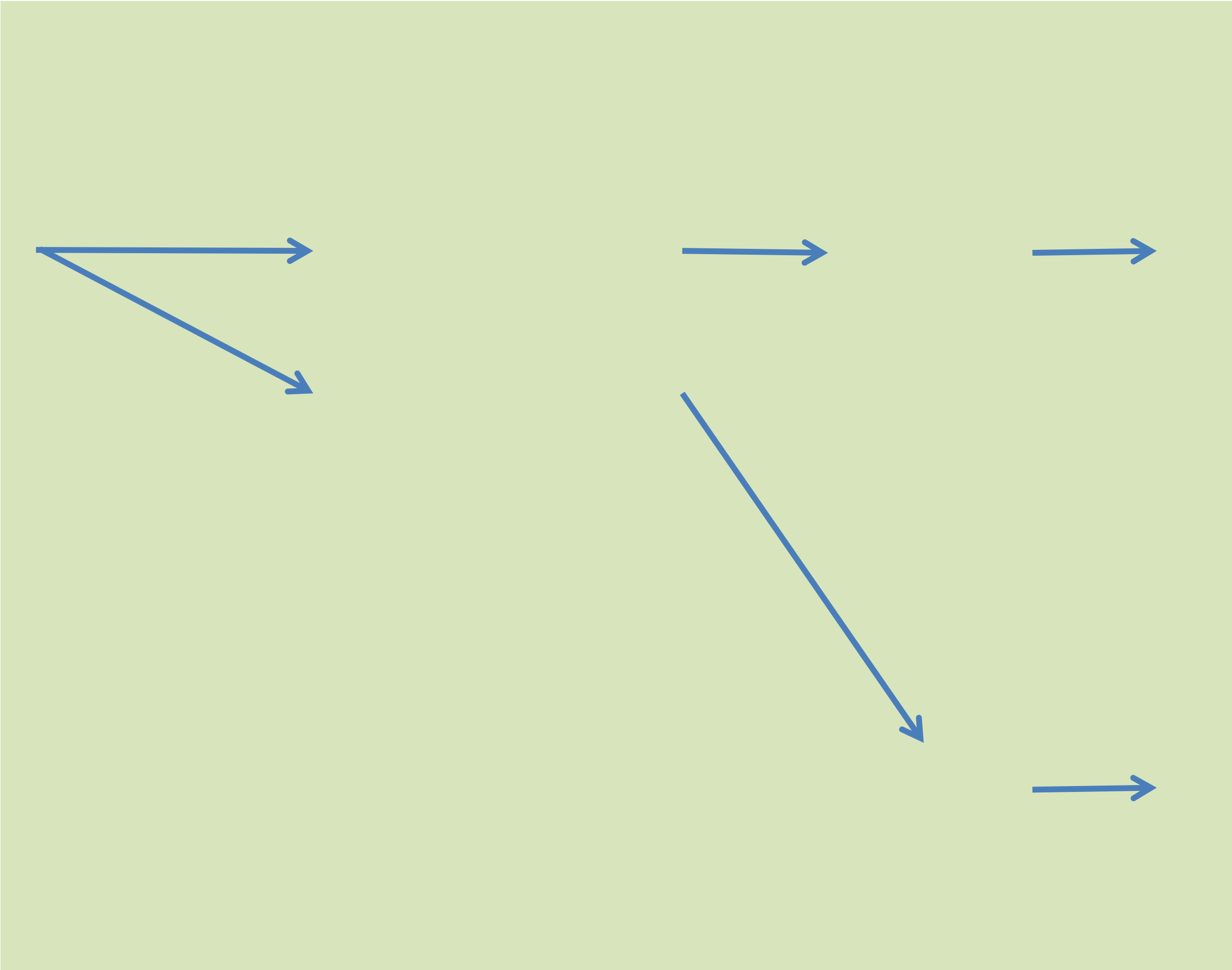
No.

km Refer to 'G1 Distances' sheet

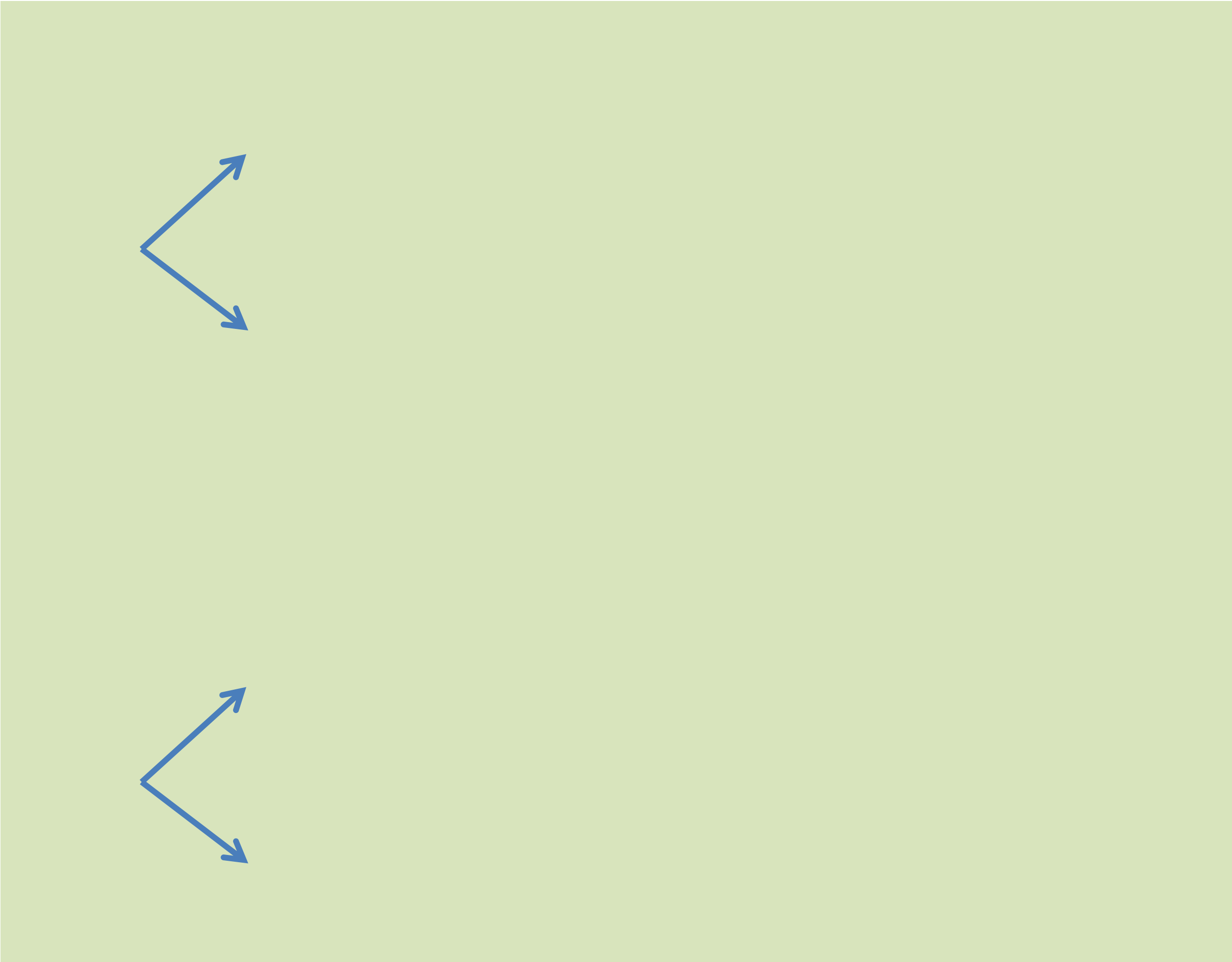
No.

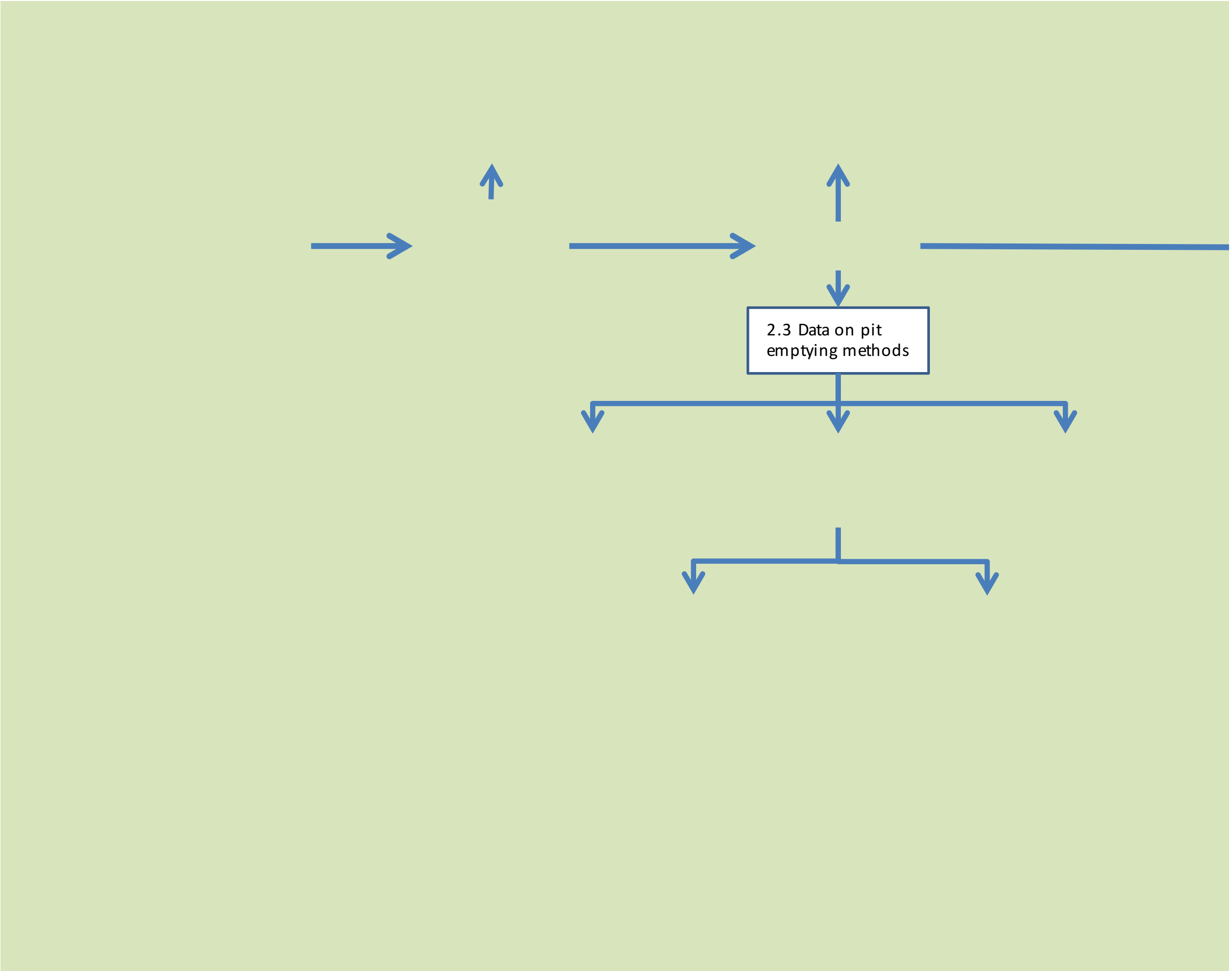
km Refer to 'G1 Distances' sheet

km



User comments

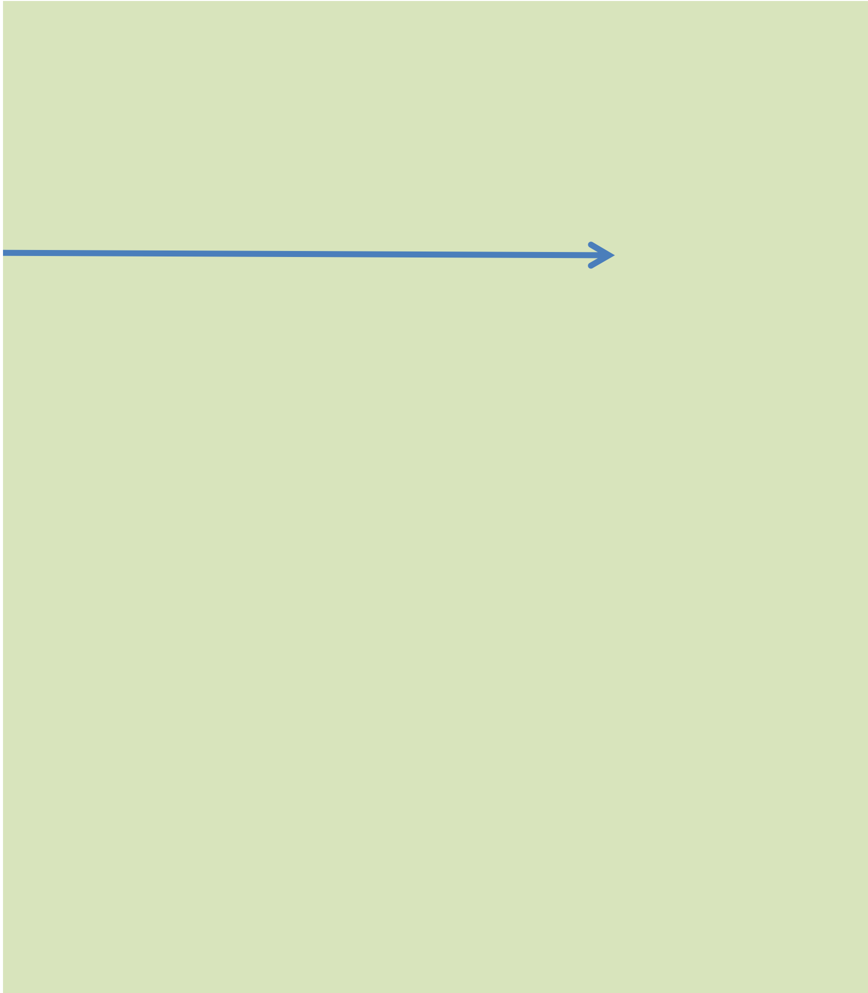




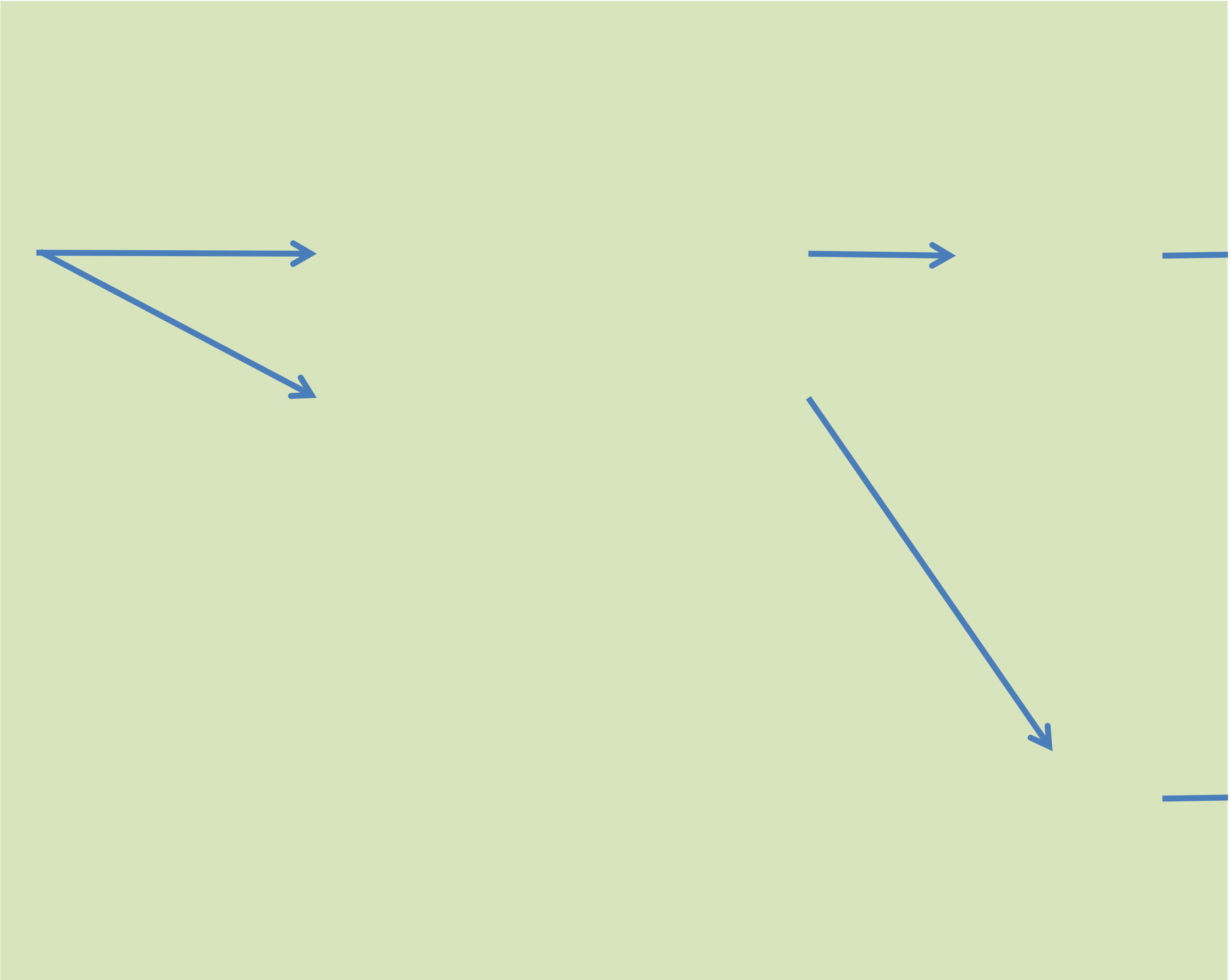
3.2 Sub-model: Choosing the appropriate conveyance method for the area

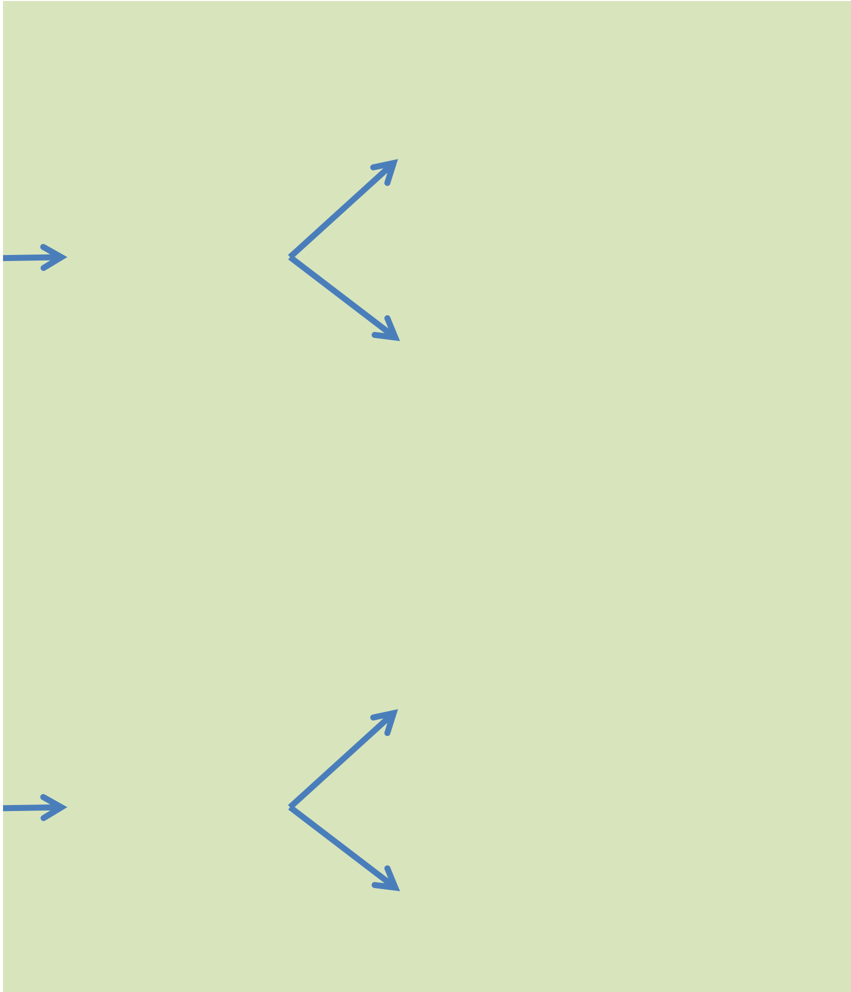
A decision tree to aid the user in choosing the appropriate conveyance method for the given

SECTION NOT CURRENTLY LINKED TO MODEL



r the given environmental conditions





3.3.1 Conveyance - Handcart with containers of sludge

Parameter	Value
Capital costs	
Capital cost of one handcart and sludge containers, capacity as stated below	1 000,00
Once-off start up fees (EIAs, permits etc)	-
O&M costs	
Fixed yearly costs	0
Equipment rental rate per working day per team	-
Total operating costs per km	0,05
Total operating costs per load	
Operating parameters	
Volume of sludge container	20
Number of sludge containers per handcart load	6
Working volume proportion	90
Volume of FS carried per full load	108
Average travel speed of handcart	4
Labourers required per handcart	2
Time to set up transfer of sludge between conveyance stages	0,025
Sludge loading rate	2
Morning loading time	0,25
Evening clean up and storage time	0,5
Total loading and clean up time per day	0,75
Change in volume of FS during conveyance	0
Change in calorific value of FS	0
Change in dry solids of FS	0
Storage area required for ONE handcart and associated equipment	2

Financial parameters

Equipment rental rate	-
Equipment O&M rate	0,05
Lifetime of vehicle	5
Repayment period for debt	2
Other costs	0
Revenue generated per load	5,00
Revenue generated per kilolitre FS removed	-

Unit	Reference	Notes
LCU / unit		Not applicable if equipment hired. Complete rental fee instead (under O&M costs).
LCU		Specify what makes up this cost
LCU / year		
LCU / working day		Labour, rent
LCU / km		Travel costs: fuel, maintenance
LCU / load		Pumping costs, no travel
		Go to schematic showing operating parameters
ℓ / container		
containers / load		
%		
ℓ / load		
km / h		
No. / handcart		
h		Time taken to set up handcart for loading / un-loading
kℓ FS / hour		Rate of loading sludge onto handcart (transfer of containers only, no travel)
h		
h		
h / day		
%		Positive value indicates increase.
%		Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value (enter a negative value)
%		Is water added to or lost from the sludge during conveyance? Negative value indicates reduction.
m2		Used to calculate property rental rate per month

LCU / working day	Not applicable if equipment purchased - complete capital cost (section above) instead. Option for daily equipment rental depending on business model
LCU / km	
years	Used to calculate depreciation rate
years	Debt for capital borrowed to buy equipment.
LCU / year	Specity what constitutes these costs, e.g. additional consumables
LCU / load	Only enter a value here if additional revenue is generated from transporting sludge away from the pit, after it is emptied. This may already be included in any revenue generated by emptying the pit (and therefore accounted for in the Emptying module). Option to enter revenue per pit or per litre of FS removed.
LCU / kℓ	

User comments

3.3.2 Conveyance - Pick-up truck with containers of sludge

Parameter	Value
Capital costs	
Capital cost of one pickup truck	175 000,00
Capital cost of sludge containers to fill pick-up truck, capacity stated below	3 120,00
Capital cost of other equipment, per team	3 000,00
Total capital costs for one team	181 120,00
Once-off start-up costs: environmental permits etc, for all teams	-
O&M costs	
Total yearly operating costs (independent of number of operational days)	6 607,00
Equipment rental rate per working day per team	250,00
Running costs per km (oil & tyres)	0,13
Total operating costs per load	
Diesel cost per km	1,17
Operating parameters	
Volume of sludge container	120
Number of sludge containers per pick-up truck load	8
Working volume proportion	90
Volume of FS carried per full load	864
Average travel speed of pick-up truck	50
Fuel consumption for pick-up truck	10,53
Oil consumption for vehicle	1
Oil consumption for vehicle	1053
Labourers required per pick-up truck team	2

Setup time for transfer of load between conveyance options	0,05
Sludge loading rate	9,00
Morning loading time	0,25
Evening clean up and storage time	0,50
Total loading and clean up time per day	0,75
Change in volume of FS during conveyance	-
Change in calorific value of FS	-
Change in dry solids of FS	-
Storage area required for ONE pick-up truck and associated equipment	21,00
Financial parameters	
Capital cost of vehicle (for insurance calculations)	175 000,00
Equipment rental rate	250,00
Price of set of tyres	5 339,00
Distance for which new set of tyres lasts	50 000
Tyre price per km	0,11
Equipment maintenance rate per km	0,13
Equipment repair and maintenance cost over lifetime	50
Lifetime of vehicle	5
Vehicle life (distance for accounting purposes)	160 000
Repayment period for debt	3
Vehicle insurance cost	3,5
Vehicle insurance	6 125,00
Vehicle license	482,00
Yearly cost of permits and licences	6 607,00
Other costs	-
Diesel cost	12,34
Diesel cost per km	1,17
Oil price	26,52
Oil cost per km	0,0252
Revenue generated per load	-
Revenue generated per kilolitre FS removed	-

Unit	Reference	Notes
LCU / unit		3000 cc 1 tonne club cab diesel pick up truck. 2010-2011 price ZAR 296,265. 2013 price at 6% escalation 332,883
LCU / team		
LCU / team		
LCU / team		
LCU		
LCU / year		Includes vehicle license & insurance
LCU / working day / team		Excludes labour and rent
LCU / km		Excludes repairs & maintenance - calculated separately)
LCU / load		
LCU / km		
		Go to schematic showing operating parameters
ℓ / container		
containers / load		
%		
ℓ / load		
km / h		
km / ℓ		
% of fuel consumption		
km / ℓ		
No. / team		If the pick-up truck is used only for Conveyance Stages 2 - 4. If used for Stage 1 then Emptying labourers will operate and no additional labour will be required.

h	Time taken to set up truck for loading / un-loading
kℓ FS / hour	Rate of loading sludge onto pick up truck (transfer of containers only, no travel)
h	
h	
h / day	
%	Positive value indicates increase.
%	Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value (enter a negative value)
%	Is water added to or lost from the sludge during conveyance? Negative value indicates reduction.
m2	Used to calculate property rental rate per month
LCU	
LCU / working day	
LCU / set	
km	
LCU / km	
LCU / km	
%	Used to calculate repair and maintenance rate per km
years	Used to calculate depreciation rate for vehicle
km	Used to calculate repair and maintenance rate per km
years	Debt for capital borrowed to buy equipment.
% of purchase price / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	Sundries
LCU / ℓ	
LCU / km	
LCU / ℓ	
LCU / km	
LCU / load	Option to enter revenue per pit or per litre of FS removed.
LCU / kℓ	

User comments

3.3.3 Conveyance - Small vacuum tanker

Parameter	Value
Capital and start-up costs	
Capital cost of one vacuum tanker and associated equipment	99 300,00
Once-off fees for permits, EIAs etc for emptying and conveyance operation	2 000,00
O&M costs	
Total yearly operating costs (independent of number of operational days)	2 700,00
Equipment rental rate per working day per team	1 000,00
Total operating costs per km	0,15
Total operating costs per load	
Diesel cost per km	1,85
Diesel cost per kilolitre FS pumped	1,16
Operating parameters	
Vacuum tanker nominal volume	500
Working volume proportion	95
Vacuum tanker working volume	475
Average driving speed of tanker	5
FS removal rate - suction pumping rate	8
Discharge pumping rate	8
Fuel consumption for sludge pump	0,094
Mileage for vacuum tanker	0,15
Oil consumption for vehicle	1
Oil consumption for vehicle	0,0015
Number of labourers per tanker team	2
Set-up time for discharging load of sludge	0,0833
Pumping time for discharging full load of sludge	0,0594
Clean-up time after discharging full load of sludge	0,0833
Time required for changeover of sludge to next conveyance stage, per load	0,100

Morning loading time	0,5
End of day clean-up & equipment store time	0,75
Additional time required per working day	1,25
Change in volume of FS during conveyance	0,0
Change in calorific value of FS	0,0
Change in dry solids of FS	0,0
Storage area required for ONE tanker and associated equipment	3
Financial parameters	
Capital cost of vacuum tanker (for insurance calculations)	20 000,00
Rental rate for vehicle (e.g. for municipal-owned vehicles)	1 000,00
Lifetime of vehicle	10
Vehicle life - distance for accounting purposes	160 000
Other costs	2 000,00
Vehicle running costs per km	0,1466
Price of set of tyres	5 339,00
Distance for which new set of tyres lasts	50 000
Tyre price per km	0,11
Diesel cost per km	1,8510
Diesel cost per kilolitre FS pumped	1,1600
Diesel price	12,34
Oil price	26,52
Oil cost per km	0,0398
Equipment repair and maintenance cost over lifetime	50
Water price	-
Labour - supervisor rate	10 000,00
Labour - labourer rate	3 000,00
Revenue generated per load by tanker company	300,00
Revenue generated per kilolitre FS removed by the tanker company	-

Repayment period for debt	5
Vehicle insurance cost	3,5
Vehicle insurance	700,00
Vehicle license	-
Yearly cost of permits and licences	700,00

Unit	Reference	Notes
LCU / tanker		
LCU		Specify what makes up this amount
LCU / year		
LCU / working day		Labour, rent
LCU / km		Travel costs: fuel, maintenance
LCU / load		
LCU / km		
LCU / kℓ		Sludge pump
ℓ		
%		
ℓ		Assumed 95% of nominal volume
km / h		Taking into account road and traffic conditions.
kℓ FS / h		
kℓ FS / h		
ℓ diesel / kℓ FS pumped		The sludge pump on the vacuum tanker, as opposed to the engine that moves the tanker around.
ℓ / km diesel		
% of fuel consumption		
ℓ / km oil		
No. / team		
h / load		
h / load		
h / load		
h / load		Time to connect / disconnect hoses at start / end of pumping

h / day	Time taken to load equipment at the start of each working day, before driving to site
h / day	Time taken to put equipment away when back at the storage depot at the end of the day.
h / working day	Morning loading and evening clean-up
%	Positive value indicates increase.
%	Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value (enter a negative value)
%	Is water added to or lost from the sludge during conveyance? Negative value indicates reduction.
m2	Used to calculate property rental rate per month
LCU	
LCU / working day	
years	Used to calculate depreciation rate
km	
LCU / year	Sundries
LCU / km	Maintenance rate. Option to enter a monthly amount, rather than an amount per km.
LCU / set	
km	
LCU / km	
LCU / km	
LCU / kℓ	
LCU / ℓ	
LCU / ℓ	
LCU / km	
% of purchase price	
LCU / ℓ	
LCU / month	
LCU / month	
LCU / load	
LCU / kℓ	

years
% of purchase
price / year
LCU / year
LCU / year
LCU / year

User comments

3.3.4 Motorised transport - Large vacuum tanker

Parameter	Value
Capital and start-up costs	
Capital cost of one vacuum tanker and associated equipment	350 000,00
Once-off fees for permits, EIAs etc for emptying and conveyance operation	5 000,00
O&M costs	
Total yearly operating costs (independent of number of operational days)	14 819,00
Equipment rental rate per working day per team	1 000,00
Total operating costs per km	0,47
Total operating costs per load	
Diesel cost per km	1,93
Diesel cost per kilolitre FS pumped	0,69
Operating parameters	
Vacuum tanker nominal volume	10 000
Working volume proportion	95
Vacuum tanker working volume	9 500
Average driving speed of tanker	50
FS removal rate - suction pumping rate	75
Discharge pumping rate	75
Fuel consumption for sludge pump	0,0533
Fuel consumption for vacuum tanker	0,15
Oil consumption for vehicle	1,5
Oil consumption for vehicle	0,00225
Number of labourers per tanker team	2
Set-up time for discharging load of sludge	0,0833
Pumping time for discharging full load of sludge	0,1267
Clean-up time after discharging full load of sludge	0,0833
Total time to discharge full load of sludge	0,293
Morning loading time	0,5
End of day clean-up & equipment store time	0,33

Additional time required per working day	0,83
Change in volume of FS during conveyance	0,0
Change in calorific value of FS	0,0
Change in dry solids of FS	0,0
Storage area required for ONE tanker and associated equipment	25,0
Financial parameters	
Capital cost of vacuum tanker (for insurance calculations)	350 000,00
Rental rate for vehicle (e.g. for municipal-owned vehicles)	1 000,00
Lifetime of vehicle	10,0
Vehicle life - distance for accounting purposes	300 000,00
Price of set of tyres	18 418,00
Distance for which new set of tyres lasts	45 000,0
Tyre price per km	0,41
Other costs	-
Vehicle running costs per km (including tyres & oil)	0,4690
Equipment repair and maintenance cost over lifetime	50,0
Vehicle insurance cost	4,0
Vehicle insurance	14 000,00
Vehicle license	819,00
Yearly cost of permits and licences	14 819,00
Diesel cost per km	1,9320
Diesel cost per kilolitre FS pumped	0,6865
Diesel price	12,88
Oil price	26,52
Oil cost per km	0,0597
Water price	12,34
Revenue generated per load by tanker company	500,00
Revenue generated per kilolitre FS removed by the tanker company	-
Repayment period for debt	5,0

Unit	Reference	Notes
LCU / tanker		
LCU		Specify what makes up this amount
LCU / year		
LCU / working day		Labour, rent
LCU / km		Travel costs: fuel, maintenance
LCU / load		
LCU / km		
LCU / kℓ		Sludge pump
ℓ		
%		
ℓ		Assumed 95% of nominal volume
km / h		Taking into account road and traffic conditions.
kℓ FS / h		
kℓ FS / h		
ℓ diesel / kℓ FS pumped		The sludge pump on the vacuum tanker, as opposed to the engine that moves the tanker around.
ℓ / km diesel		
% of fuel consumption		
km / ℓ		
No. / team		
h / load		
h / load		
h / load		
h / load		
h / day		Time taken to load equipment at the start of each working day, before driving to site
h / day		Time taken to put equipment away when back at the storage depot at the end of the day.

h / working day	Morning loading and evening clean-up
%	Positive value indicates increase.
%	Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value (enter a negative value)
%	Is water added to or lost from the sludge during conveyance? Negative value indicates reduction.
m2	Used to calculate property rental rate per month
LCU	
LCU / working day	
years	
km	
LCU / set	
km	
LCU / km	
LCU / year	
LCU / km	Maintenance rate. Option to enter a monthly amount, rather than an amount per km.
%	
% of purchase price / year	
LCU / year	
LCU / year	
LCU / year	
LCU / km	
LCU / kℓ	
LCU / ℓ	
LCU / ℓ	
LCU / km	
LCU / ℓ	
LCU / load	
LCU / kℓ	
years	

User comments

3.3.5 Transfer station

Intermediate holding tank for FS collected from a local area - later emptied

Parameter	Value
Capital and start-up costs	
Volume of holding tank	20 000,00
Land area occupied by each holding tank	20,00
Cost of land preparation for each holding tank	10 000,00
Civils costs for plinth and bund	10 000,00
Cost of tank	20 000,00
Capital cost of transfer station	40 000,00
Once-off fees for permits, EIAs etc for emptying and conveyance operation	5 000,00
O&M costs	
Total yearly operating costs (independent of number of operational days)	-
Rental rate per working day per facility	200,00
Total operating costs per km	
Total operating costs per load	
Diesel cost per km	
Diesel cost per kilolitre FS pumped	
Operating parameters	
Tank nominal volume	20 000
Working volume proportion	95
Tank working volume	19 000
Number of labourers per facility	0,2
Additional time required per working day	0,50
Proportion of total volume removed as detritus during conveyance	-4

Overall change in volume of FS during conveyance, including detritus removal	-4
Change in calorific value of FS	-15
Change in dry solids of FS	-5
Area required for one tank	20

Financial parameters

Rental rate for tank and/or equipment	200,00
Lifetime of facility	20
Other costs	-
Revenue generated per load accepted by facility	-
Revenue generated per kilolitre of FS accepted by the facility	-
Repayment period for debt	5

Unit	Reference	Notes
ℓ / tank		Carried from Operating Parameters below
m2		Carried from Operating Parameters below
LCU / unit		
LCU / unit		
LCU / unit		
LCU / transfer station		
LCU		
LCU / year		
LCU / working day		
LCU / km		Travel costs: fuel, maintenance
LCU / load		
LCU / km		
LCU / kℓ		
ℓ		
%		
ℓ		
No. / facility		
h / working day		Cleaning etc
%		Is any large detritus screened out manually before the sludge is transferred? E.g. screens at a sewer discharge station? Negative value indicates decrease.

%	Negative value indicates decrease. Accounts for any further loss of sludge or liquid volume, in addition to detritus
%	Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value (enter a negative value)
%	Is water added to or lost from the sludge during conveyance? Negative value indicates reduction.
m2	
LCU / working day	
years	
LCU / year	
LCU / pit	
LCU / kℓ	
years	

User comments

3.3.6 Transfer station with liquid connection to sewer

Settling tank discharge station - liquids discharged to sewer, solids settle and removed periodical

Parameter	Value	Unit
Capital and start-up costs		
Volume of holding tank	25 000,00	ℓ / tank
Land area occupied by each holding tank	20,00	m2
Cost of land preparation for each holding tank	10 000,00	LCU / unit
Civils costs for plinth and bund	10 000,00	LCU / unit
Capital cost of one holding tank (tank only)	100 000,00	LCU / unit
Costs of pump and connection to sewer for all tanks	20 000,00	LCU / unit
Capital cost of sewer discharge station	140 000,00	LCU / station
Once-off fees for permits, EIAs etc for emptying and conveyance operation	5 000,00	LCU
O&M costs		
Total yearly operating costs (independent of number of operational days)	1 000,00	LCU / year
Rental rate per working day per facility	-	LCU / working day
Total operating costs per km		LCU / km
Total operating costs per load		LCU / load
Diesel cost per km		LCU / km
Diesel cost per kilolitre FS pumped		LCU / kℓ
Operating parameters		
Tank nominal volume	25 000	ℓ
Working volume proportion	95	%
Tank working volume	23 750	ℓ
Number of labourers per facility	0,2	No. / facility
Additional time required per working day	0,50	h / working day
Area required for one tank	20,0	m2

Parameters applicable only to Option 2

Proportion of total volume removed as detritus during conveyance	0	%
Overall change in volume of FS during conveyance, including detritus removal	-50	%
Change in calorific value of FS	-15	%
Change in dry solids of FS	90	%

Financial parameters

Rental rate for tank and/or equipment	-	LCU / working day
Lifetime of facility	20	years
Other costs	1 000,00	LCU / year
Revenue generated per load accepted by facility	-	LCU / pit
Revenue generated per kilolitre of FS accepted by the facility	200,00	LCU / kℓ
Repayment period for debt	5	years

d periodically

Reference	Notes
	Carried from Operating Parameters below
	Carried from Operating Parameters below
	Capital costs not applicable if facility is hired - enter a yearly operating cost instead to cover rental fees
	Specify what makes up this amount
	Travel costs: fuel, maintenance
	Cleaning etc
	Used to calculate property rental rate per month. Option 1 - Screening and discharge - will occupy a smaller area than Option 2 - Settling tank

Is any large detritus screened out manually before the sludge is transferred? E.g. screens at a sewer discharge station? Negative value indicates reduction.

Positive value indicates increase. Accounts for loss of liquid portion of sludge to sewer.
Is the sludge stored for a significant period of time (> 1 week)? If so there may be a reduction in calorific value (enter a negative value)
Negative value indicates reduction. Takes into account loss of large amount of water to sewer and a small amount of suspended solids

User comments

3.3.7 Sewer discharge station with screening

Screening and discharge station - solids and liquids discharged to sewer

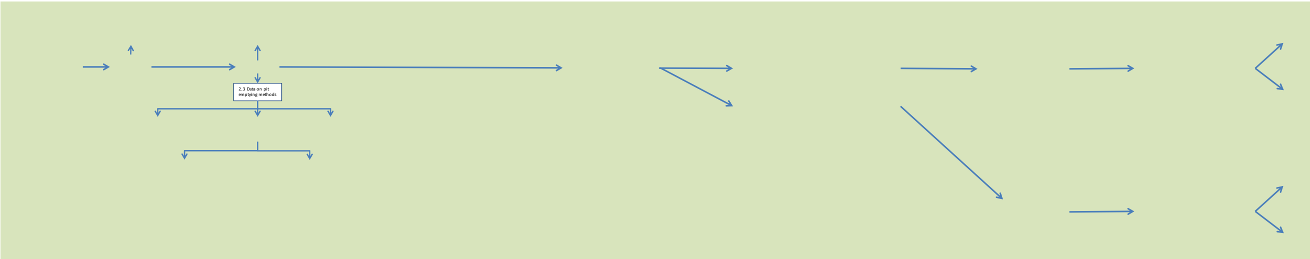
Parameter	Value
Capital and start-up costs	
Cost of land preparation for each discharge station	10 000,00
Civils costs for plinth and bund	10 000,00
Capital cost of screens	10 000,00
Costs of connection to sewer	20 000,00
Capital cost of sewer discharge station	50 000,00
Once-off fees for permits, EIAs etc for emptying and conveyance operation	5 000,00
O&M costs	
Total yearly operating costs (independent of number of operational days)	-
Rental rate per working day per facility	-
Total operating costs per km	
Total operating costs per load	
Diesel cost per km	
Diesel cost per kilolitre FS pumped	
Operating parameters	
Number of labourers per facility	1
Additional time required per working day	0,50
Area required for one screening facility and equipment storage area	8
Change in volume of FS during conveyance	-100
Financial parameters	
Rental rate for equipment	-
Lifetime of facility	20

Other costs	-
Revenue generated per load accepted by facility	-
Revenue generated per kilolitre of FS accepted by the facility	200,00
Repayment period for debt	5

Unit	Reference	Notes
LCU / unit		Capital costs not applicable if facility is hired - enter a yearly operating cost instead to cover rental fees
LCU / unit		
LCU / unit		
LCU / unit		
LCU / station		
LCU		Specify what makes up this amount
LCU / year		
LCU / working day		
LCU / km		Travel costs: fuel, maintenance
LCU / load		
LCU / km		
LCU / kℓ		
No. / facility		
h / working day		Cleaning etc
m2		Used to calculate property rental rate per month. Option 1 - Screening and discharge - will occupy a smaller area than Option 2 - Settling tank
%		All FS disposed of to sewer
LCU / working day		
years		

LCU / year
LCU / pit
LCU / kℓ
years

User comments



3.4 Data tables for conveyance methods

Costs and revenue associated with transfer of sludge from the pit to a storage facility at the treatment site

3.4.1 Summary of Conveyance system

Conveyance method Stage 1	2	No.	
Conveyance method Stage 1	**Pick-up truck with containers of sludge**		
Distance C1: one-way distance for Conveyance Stage 1	12	km	Refer to 'G1 Distances' sheet
Conveyance method Stage 2	0	No.	
Conveyance method Stage 2	**#N/A**		
Distance C2: one-way distance for Conveyance Stage 2	0	km	
Conveyance method Stage 3	0	No.	
Conveyance method Stage 3	**#N/A**		
Distance C3: one-way distance for Conveyance Stage 3	0	km	
Conveyance method Stage 4	0	No.	
Conveyance method Stage 4	**#N/A**		
Distance C4: one-way distance for Conveyance Stage 4	0	km	

3.4.2 Data table

Column number		1	2	3	4	5	6	7	8	9	10	11	12
Conveyance option	**Option number**	**FS volume capacity per load**	**Vehicle speed**	**Number of labourers required per team / per facility**	**Once-off start up fees (EIAs, permits etc)**	**Rental rate per working day per team**	**Operating cost per load**	**Operating cost per km (tyres and oil)**	**Fuel cost per km**	**Fuel cost per kilolitre FS pumped**	**Time required for changeover of sludge to next conveyance stage, per load**	**Revenue per load**	
		ℓ / load	km / h	No.	LCU	LCU / working day / tea	LCU / pit or load	LCU / km	LCU / km	LCU / ℓ	h / load	LCU / pit or load	
3.3.1 Handcart with containers of sludge	**1**	108	4	2	-	-	-	0,05	-	-	0,025	5,00	
3.3.2 Pick-up truck with containers of sludge	**2**	864	50	2	-	250,00	-	0,13	1,17	-	0,05	-	
3.3.3 Motorised transport - Small vacuum tanker (e.g. Vacutug)	**3**	475	5	2	2 000,00	1 000,00	-	0,15	1,85	1,16	0,100	300,00	
3.3.4 Motorised transport - Large vacuum tanker	**4**	9 500	50	2	5 000,00	1 000,00	-	0,47	1,93	0,69	0,293	500,00	
3.3.5 Transfer station - underground holding tank (later pumped out)	**5**	19 000	0	0,2	5 000,00	200,00	-	-	-	-	0	-	
3.3.6 Transfer station with liquid connection to sewer, settled solids removed periodically from tank	**6**	23 750	0	0,2	5 000,00	-	-	-	-	-	0	-	
3.3.7 Sewer discharge station (SDS) - solids and effluent connection to sewer	**7**	0	0	1	5 000,00	-	-	-	-	-	0	-	

3.4 Conveyance stages

Conveyance - Stage 1

Conveyance method for Stage 1 can only be 1, 2, 3 or 4

For stage 1 conveyance, costs are calculated on Emptying sheet unless method 1 or 2 is chosen. For method 1 or 2, additonal costs are linked back to the Emptying sheet.

No. of households or pits in area	#REF!	No.	
Volume of sludge removed per pit	#REF!	ℓ / pit	stage 2 - 4 conveyance will each produce a cash flow sheet
Average dry solids content of FS removed	#REF!	%DS	
Average detritus content of FS removed	#REF!	%	
Average calorific value of FS removed	#REF!	MJ / kg	
Conveyance method number	#REF!		
Conveyance method	#REF!		
One-way distance travelled	#REF!	km	
One-way distance from storage depot to pit	#REF!	km	
Volume of FS carried per full load	#REF!	ℓ / load	
Number of vehicles	#REF!	No.	
Vehicle speed	#REF!	km / h	
Time for sludge discharge per load (excluding travel)	#REF!	h / load	
Travel time per load	#REF!	h / load	
Total time per load	#REF!	h / load	
Additional time required per working day	#REF!	h / working day	link to emptying?
Number of return trips required per pit	#REF!	No. loads / pit	Used to calculate total km travelled per year
Time required per pit	#REF!	h / pit	link to emptying?
Number of pits emptied per day	#REF!	pits / day	
Total time required per day	#REF!	h / day	
Capital costs	#REF!	USD	Will link to emptying cash flows.
Total operating costs per working day	#REF!	USD / working day	Only populated if conveyance method 1 or 2 chosen
Total operating costs per km (excluding fuel)	#REF!	USD / km	Only populated if conveyance method 1 or 2 chosen
Total operating costs per pit	#REF!	USD / pit	Only populated if conveyance method 1 or 2 chosen
Fuel cost per km	#REF!	USD / km	Only populated if conveyance method 1 or 2 chosen
Number of working days per year required to empty pits	#REF!	no. working days required / year	
Number of km travelled per year	#REF!	km / year	
Total operating costs per year	#REF!	USD / year	Will link to emptying cash flows.
Total fuel costs per year	#REF!	USD / year	Will link to emptying cash flows.
Revenue per pit	#REF!	USD / pit	
Revenue per litre of FS conveyed	#REF!	USD / ℓ	
Total revenue per year	#REF!	USD / year	Additional revenue for conveyance, in additional to revenue from emptying - will link to emptying sheet
Reduction in volume of FS during conveyance	#REF!	%	
Reduction in detritus content of FS during conveyance	#REF!	%	
Reduction in calorific value of FS during conveyance	#REF!	%	
Reduction in dry solids content of FS during conveyance	#REF!	%	
Volume of sludge per pit sent to next conveyance stage or storage	#REF!	ℓ / pit	
Detritus content of FS sent to next conveyance stage or storage	#REF!	%	
Calorific value of FS sent to next conveyance stage or storage	#REF!	MJ / kg	
Dry solids of sludge sent to next conveyance stage or storage	#REF!	%DS	

Conveyance - Stage 2

No. of households or pits in area	#REF!	No.	
Volume of sludge received per pit	#REF!	ℓ / pit	
Average detritus content of FS received	#REF!	%	
Average calorific value of FS received	#REF!	MJ / kg	
Average dry solids content of FS received	#REF!	%DS	
Conveyance method number	#REF!		
Conveyance method	#REF!		
One-way distance travelled by vehicle during Stage 2	#REF!	km	
One-way distance from work site to storage depot	#REF!	km	
Volume of FS carried per full load	#REF!	ℓ / load	
Number of vehicles / units	#REF!	No.	
Vehicle speed	#REF!	km / h	
Time for sludge discharge per load (excluding travel)	#REF!	h / load	
Travel time per load	#REF!	h / load	
Total time per load	#REF!	h / load	
Additional time required per working day	#REF!	h / working day	
Number of Conveyance 2 tanks filled by one Conveyance 1 load	#REF!	Conveyance 2 tanks / Conveyance 1 tank	
Number of Conveyance 2 loads per year		loads / year	calculation
Number of working days per year		working days / year	calculation
Number of pits emptied per day	#REF!	pits / day	
Time taken for Conveyance 2 tank to fill	#REF!	days	
Capital costs	#REF!	USD	Linked to cash flows below
Non-depreciable capital	#REF!	USD	Linked to cash flows below
Repayment period for debt	#REF!	years	
Lifespan of equipment	#REF!	years	
Depreciation rate	#REF!	%	Assume 90% straight line depreciation over the lifetime of the component in question to find annual depreciation rate
Total operating costs per working day	#REF!	USD / working day	
Total operating costs per km (excluding fuel)	#REF!	USD / km	
Total operating costs per pit	#REF!	USD / pit	
Total operating costs per year (independent of no. days worked)	#REF!	USD / year	
Fuel cost per km	#REF!	USD / km	
Fuel cost per litre FS pumped	#REF!	USD / ℓ	
Number of km travelled per year	#REF!	km / year	
Total operating costs per year	#REF!	USD / year	Linked to cash flows below
Total fuel costs per year	#REF!	USD / year	Linked to cash flows below
Revenue per pit	#REF!	USD / pit	
Revenue per litre of FS conveyed	#REF!	USD / ℓ	
Total revenue per year	#REF!	USD / year	Linked to cash flows below
Reduction in volume of FS during conveyance	#REF!	%	
Reduction in detritus content of FS during conveyance	#REF!	%	
Reduction in calorific value of FS during conveyance	#REF!	%	
Reduction in dry solids content of FS during conveyance	#REF!	%	
Volume of sludge per pit sent to next conveyance stage or storage	#REF!	ℓ / pit	
Annual volume of sludge sent to next conveyance stage or storage	#REF!	ℓ / year	

Detritus content of FS sent to next conveyance stage or storage	#REF!	%	
Calorific value of FS sent to next conveyance stage or storage	#REF!	MJ / kg	
Dry solids of sludge sent to next conveyance stage or storage	#REF!	%DS	
Annual mass of FS dry solids sent to next conveyance stage or storage	#REF!	kg / year	

Conveyance - Stage 3

No. of households or pits in area	#REF!	No.	
Volume of sludge received per pit	#REF!	ℓ / pit	
Volume of sludge in one load from Conveyance Stage 2	#REF!	ℓ / load	
Average detritus content of FS received	#REF!	%	
Average calorific value of FS received	#REF!	MJ / kg	
Average dry solids content of FS received	#REF!	%DS	
Conveyance method number	#REF!		
Conveyance method	#REF!		
One-way distance travelled during Stage 3 conveyance	#REF!	km	
One-way distance from storage depot to work site	#REF!	km	
Volume of FS carried per full load	#REF!	ℓ / load	
Number of vehicles / units	#REF!	No.	
Vehicle speed	#REF!	km / h	
Time required per load of FS excluding travel	#REF!	h / load	Time for setup, discharge and clean up
Travel time per load of FS	#REF!	h / load	Travel time from pit site to next conveyance stage or storage
Total time per load of FS	#REF!	h / load	
Additional time required per working day	#REF!	h / working day	Travel time from storage depot to pit site, start of day loading, end of day cleaning and storage
Number of Conveyance 3 loads required to transfer one Conveyance 2 load	#REF!	Conveyance 3 loads required to empty Conveyance 2 tank	
Number of times per year Conveyance 2 required to be emptied	#REF!	emptyings / year	
Number of working days required per year for conveyance method 3	#REF!	working days / year	Rounded up - number of times storage tank from conveyance stage 2 needs to be emptied per year. i.e. tanker need to visit the storage tank on x days per year, but will take y loads in total (more than one load on some days). Used to calculate total distance travelled in a year.
Number of Conveyance 3 loads required per working day	2,00	loads / working day	
Number of pits emptied per day	#REF!	pits / day	
Time taken for Conveyance 2 tank to fill	#REF!	days	
CHECK	Error		If Error highlighted red, the number of Conveyance 3 loads required per day must be increased.
Capital costs	#REF!	USD	Linked to cash flows below
Non-depreciable capital	#REF!	USD	Linked to cash flows below
Repayment period for debt	#REF!	years	
Lifespan of equipment	#REF!	years	
Depreciation rate	#REF!	%	Assume 90% straight line depreciation over the lifetime of the component in question to find annual depreciation rate
Total operating costs per working day	#REF!	USD / working day	
Total operating costs per km (excluding fuel)	#REF!	USD / km	
Total operating costs per load	#REF!	USD / load	
Total operating costs per year (independent of no. days worked)	#REF!	USD / year	
Fuel cost per km	#REF!	USD / km	
Fuel cost per litre FS pumped	#REF!	USD / ℓ	
Number of km travelled per year	#REF!	km / year	
Volume of sludge conveyed per year	#REF!	ℓ / year	
Total operating costs per year	#REF!	USD / year	Linked to cash flows below
Total fuel costs per year	#REF!	USD / year	Linked to cash flows below
Revenue per pit	#REF!	USD / pit	
Revenue per litre of FS conveyed	#REF!	USD / ℓ	
Total revenue per year	#REF!	USD / year	Linked to cash flows below
Reduction in volume of FS during conveyance	#REF!	%	
Reduction in detritus content of FS during conveyance	#REF!	%	
Reduction in calorific value of FS during conveyance	#REF!	%	
Reduction in dry solids content of FS during conveyance	#REF!	%	
Volume of sludge per pit sent to next conveyance stage or storage	#REF!	ℓ / pit	
Annual volume of sludge sent to next conveyance stage or storage	#REF!	ℓ / year	
Detritus content of FS sent to next conveyance stage or storage	#REF!	%	
Calorific value of FS sent to next conveyance stage or storage	#REF!	MJ / kg	
Dry solids of sludge sent to next conveyance stage or storage	#REF!	%DS	
Annual mass of FS dry solids sent to next conveyance stage or storage	#REF!	kg / year	

Conveyance - Stage 4

To be completed

3.5 Cash flow sheets for each conveyance stage

3.5.1 Conveyance Stage 2 - cash flows

Interest and repayment

Parameter	Value	Unit	
Capital cost	#REF!	USD	
Debt	#REF!	USD	Uses debt:equity ratio on Rates page
Interest	9	%	
Repayment period	#REF!	years	User must manually extend table to cover this span - put an error check in to alert when cash flow table runs for different number of years
Instalment per quarter	#REF!	USD / quarter	

	Opening balance	Interest payable	Repayment at end of quarter	Closing balance
Year 1				
Q1	#REF!	#REF!	#REF!	#REF!
Q2	#REF!	#REF!	#REF!	#REF!
Q3	#REF!	#REF!	#REF!	#REF!
Q4	#REF!	#REF!	#REF!	#REF!
Year 2				
Q1	#REF!	#REF!	#REF!	#REF!
Q2	#REF!	#REF!	#REF!	#REF!
Q3	#REF!	#REF!	#REF!	#REF!
Q4	#REF!	#REF!	#REF!	#REF!
Year 3				
Q1	#REF!	#REF!	#REF!	#REF!
Q2	#REF!	#REF!	#REF!	#REF!
Q3	#REF!	#REF!	#REF!	#REF!
Q4	#REF!	#REF!	#REF!	#REF!
Year 4				
Q1	#REF!	#REF!	#REF!	#REF!
Q2	#REF!	#REF!	#REF!	#REF!
Q3	#REF!	#REF!	#REF!	#REF!
Q4	#REF!	#REF!	#REF!	#REF!
Year 5				
Q1	#REF!	#REF!	#REF!	#REF!
Q2	#REF!	#REF!	#REF!	#REF!
Q3	#REF!	#REF!	#REF!	#REF!
Q4	#REF!	#REF!	#REF!	#REF!
Year 6				
Q1				
Q2				
Q3				
Q4				
Year 7				
Q1				
Q2				
Q3				
Q4				
TOTALS		#REF!	#REF!	

Debt repayment

Year	Interest payable	Principle payable
1	#REF!	#REF!
2	#REF!	#REF!
3	#REF!	#REF!
4	#REF!	#REF!
5	#REF!	#REF!
6	-	-
7	-	-

Cash flows

Lifespan for cashflows	#REF!	years	User must manually extend table to cover this span - put an error check in to alert when cash flow table runs for different number of years
Number of pit-emptying cycles included in lifespan	#REF!	no. pit-emptying cycles in cash flow sheet	
Escalation on O&M costs and revenues, excluding fuel	6	%	
Escalation on fuel	12	%	

Parameter	Unit		Year 1	2	3	4	5	6	7	8	9	10
Depreciable cost	USD	#REF!										
Interest on loan	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	-	-	0	0	0
Depreciation	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
O&M costs, excluding fuel	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Fuel costs	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!

Total expenses	**USD / year**		**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**
Salvage value	USD											
Revenues (variable)	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Net expenses	**USD / year**		**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**
Discounted total cost	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Mass of FS collected	kg / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Number of pits emptied	pits / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Levelised cost of conveyance per kg FS	**USD / kg FS**	**#REF!**										
Levelised cost of conveyance per pit	**USD / pit**	**#REF!**										

3.5.2 Conveyance Stage 3 - cash flows

Interest and repayment

Parameter	**Value**	**Unit**	
Capital cost	#REF!	USD	
Debt	#REF!	USD	Uses debt:equity ratio on Rates page
Interest	9	%	
Repayment period	#REF!	years	User must manually extend table to cover this span - put an error check in to alert when cash flow table runs for different number of years
Instalment per quarter	#REF!	USD / quarter	

	Opening balance	**Interest payable**	**Repayment at end of quarter**	**Closing balance**
Year 1				
Q1	#REF!	#REF!	#REF!	#REF!
Q2	#REF!	#REF!	#REF!	#REF!
Q3	#REF!	#REF!	#REF!	#REF!
Q4	#REF!	#REF!	#REF!	#REF!
Year 2				
Q1	#REF!	#REF!	#REF!	#REF!
Q2	#REF!	#REF!	#REF!	#REF!
Q3	#REF!	#REF!	#REF!	#REF!
Q4	#REF!	#REF!	#REF!	#REF!
Year 3				
Q1	#REF!	#REF!	#REF!	#REF!
Q2	#REF!	#REF!	#REF!	#REF!
Q3	#REF!	#REF!	#REF!	#REF!
Q4	#REF!	#REF!	#REF!	#REF!
Year 4				
Q1	#REF!	#REF!	#REF!	#REF!
Q2	#REF!	#REF!	#REF!	#REF!
Q3	#REF!	#REF!	#REF!	#REF!
Q4	#REF!	#REF!	#REF!	#REF!
Year 5				
Q1	#REF!	#REF!	#REF!	#REF!
Q2	#REF!	#REF!	#REF!	#REF!
Q3	#REF!	#REF!	#REF!	#REF!
Q4	#REF!	#REF!	#REF!	#REF!
Year 6				
Q1				
Q2				
Q3				
Q4				
Year 7				
Q1				
Q2				
Q3				
Q4				
TOTALS		#REF!	#REF!	

Debt repayment

Year		**Interest payable**	**Principle payable**
	1	#REF!	#REF!
	2	#REF!	#REF!
	3	#REF!	#REF!
	4	#REF!	#REF!
	5	#REF!	#REF!
	6	-	-
	7	-	-

Cash flows

Lifespan for cashflows	#REF!	years	User must manually extend table to cover this span - put an error check in to alert when cash flow table runs for different number of years
Number of pit-emptying cycles included in lifespan	#REF!	no. pit-emptying cycles in cash flow sheet	
Escalation on O&M costs and revenues, excluding fuel	6	%	
Escalation on fuel	12	%	

Parameter	**Unit**		**Year**									
Depreciable cost	USD	#REF!	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Interest on loan	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	-	-	-	-	-
Depreciation	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
O&M costs, excluding fuel	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Fuel costs	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Total expenses	**USD / year**		**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**
Salvage value	USD											#REF!
Revenues (variable)	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Net expenses	**USD / year**		**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**#REF!**
Discounted total cost	USD / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Mass of FS collected	kg / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Number of pits emptied	pits / year		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Levelised cost of conveyance per kg FS	**USD / kg FS**	**#REF!**										
Levelised cost of conveyance per pit	**USD / pit**	**#REF!**										

13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Revenue per unit volume FS	**Change in volume of FS during conveyance**	**Change in detritus content of FS during conveyance**	**Change in calorific value of FS during conveyance**	**Change in dry solids content during conveyance**	**Repayment period for debt**	**Sludge removal rate**	**Lifespan of equipment**	**Yearly total operating costs per year (independent of no. days worked)**	**Vehicle repair & maintenance rate**	**Additional time required per working day (loading, clean up etc, no travel)**	**Storage area required for ONE team's equipment**	**Capital cost of equipment for one team**	**Vehicle life (accounting)**	**Conveyance method name**
LCU / kℓ	%	%	%	%	years	kℓ / hour	years	LCU / year	% purchase price over lifetime	h / working day	m2	LCU	km	
-	0	0	0	0	2	2	5			0,75	2	1000		Handcart with containers of sludge
-	0	0	0	0	3	9	5	6 607,00	50	0,75	21	181 120,00	160 000,00	Pick-up truck with containers of sludge
-	0	0	0	0	5	8,0	10	2 700,00	50	1,25	3	99 300,00	160 000,00	Motorised transport - Small vacuum tanker (e.g. Vacutug)
-	0	0	0	0	5	75,0	10	14 819,00	50	0,83	25	350 000,00	300 000,00	Motorised transport - Large vacuum tanker
-	-4	-4	-15	-5	5	0	20	-		0,50	20	40 000,00		Transfer station - underground holding tank (later pumped out)
200,00	-50	0	-15	90	5	0	20	1 000,00		0,50	20	140 000,00		Transfer station with liquid connection to sewer, settled solids removed periodically from tank
200,00	-100	0	0	0	5	0	20	-		0,50	8	50 000,00		Sewer discharge station (SDS) - solids and effluent connection to sewer

11	12	13	14	15	16	17	18	19	20
0	0	0	0	0	0	0	0	0	0
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
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11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
-	-	-	-	-	-	-	-	-	-
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3.5.1 Conveyance Stage 2 calculations

Parameter	Value
General	
No. of households or pits in area	35000
Volume of sludge received per pit	950
Annual volume of sludge received from Conveyance Stage 1	6650
Annualised mass of dry solids received from Conveyance Stage 1	2294,3
Average detritus content of FS received	20
Average calorific value of FS received	12
Average dry solids content of FS received	30,00
Conveyance Stage 1 data	
Conveyance Stage 1 method number	2
Conveyance Stage 1 method	**Pick-up truck with conta**
Conveyance Stage 1 distance	12,00
Conveyance Stage 1 volume per load	864
Conveyance Stage 1 travel speed	50
Number of Conveyance Stage 1 teams in operation	15
Number of pits emptied per day	30
Volume of FS carried per day by Conveyance 1	28500
Transport time per C1 load	0,48
Changeover setup time: C1 to C2, per C1 load	0,05
C1 sludge loading rate	9,00
C1 sludge loading time	0,10
C1 time (using C1 parameters)	0,63
Conveyance Stage 2 data	
Conveyance Stage 2 method number	0
Conveyance Stage 2 method	**#N/A**
One-way distance travelled by vehicle during Stage 2	0
Distance T5: One-way distance from work site to Conveyance 2 storage depot	0
C2 volume	#N/A
Vehicle speed	#N/A

Number of C1 loads to fill C2 tank	#N/A
Time to fill C2 tank with C1 loads	#N/A
C2 setup time	#N/A
C2 sludge loading rate	#N/A
C2 sludge pumping time	#N/A
C2 travel time	#N/A
C2 time (using C2 parameters)	#N/A
C3 volume	#N/A
C3 time (using C3 parameters)	#N/A
Number of C3 loads to empty C2 tank	#N/A
Time to empty C2 tank	#N/A

Total time to fill and empty one C2 load	#N/A
Additional time required per working day for C2	#N/A
Working hours per day	9,00
If C2 is a vehicle	
Number of C2 loads possible per day per team	#N/A
Number of C1 loads to fill C2 tank	#N/A
Volume of sludge removed per day	27,14
Number of C1 loads produced per day	31,42
Numer of C2 loads required per day	#N/A
Number of C2 teams required in operation	#N/A
Minimum number of C2 teams required in operation (rounded up)	#N/A
If C2 is a storage facility	
Time spent discharging at facility by C1, per load	0,15
Number of discharge points at facility	0,00
Maximum number of C1 loads that can be accepted per day by C2 (time)	#N/A
Number of times per day C2 emptied	1
Time to empty C2	#N/A
Maximum number of C1 loads that can be accepted per day by C2 (volume)	#N/A
Actual maximum number of C1 loads that can be accepted per day by C2	#N/A
Minimum number of C2 facilities required	#N/A
Number of C2 emptyings per year per C2 facility	252

Number of C1 teams in operation	15,00
Chosen number of C2 teams in operation (optional input - overrides calculated minimum figure)	0
Actual number of C2 teams in operation	#N/A

Labour costs

Total number of supervisors required for all C2 teams / facilities	1
Number of labourers per vehicle / facility	#N/A
Total number of labourers required	#N/A
Number of equipment working days per year required	252
Number of labour working days per year for C1	252
Actual number of possible working days per year	252
Working days per month	21
Minimum number of months staff can be employed for per year	12,0
Supervisor salary rate	10 000,00
Number of months supervisor employed for per year	12
Labourer salary rate	3 000,00
Number of months labourers employed for per year	12
Number of labour working days for C2	252
Error check	0
Total labour costs	#N/A

Operating and fuel costs

Equipment rental rate per working day per team	#N/A
Running costs per km (excluding fuel) - oil, tyres	#N/A
Vehicle repair and maintenance rate	#N/A
Total operating costs per load	#N/A
Fuel cost per km	#N/A
Fuel cost per litre FS pumped	#N/A
Vehicle life - distance	#N/A

Repair and maintenance rate per km	#N/A
Number of km travelled per year per C2 team	#N/A
Additional distance factor	0
Total km travelled per year	#N/A
Fuel costs for travel	#N/A
Fuel costs for sludge pumping	#N/A
Equipment and operating costs	#N/A
Property costs	
Number of C2 teams required in operation (rounded up)	#N/A
Storage area required for one vehicle	#N/A
Total area required for sludge vehicles	#N/A
Office and parking area required	15
Total property area required	#N/A
Property rental cost	25
Number of months per year rented	12
Total property rental cost	#N/A
Property purchase cost	-
Capital cost of property	#N/A
Capital costs of equipment	
Capital cost of one Conveyance 2 vehicle and associated equipment	#N/A
Is equipment purchased?	Yes
Capital cost of Conveyance 2 equipment to be used in calculations	#N/A
Total capital costs	#N/A
Operating costs, excluding overhead and fuel	#N/A
Overhead	
Overhead rate	10
Overhead costs	#N/A
Total operating costs	
TOTAL OPERATING COSTS, EXCLUDING FUEL	#N/A
TOTAL FUEL COSTS	#N/A
Revenue per load of FS conveyed	#N/A
Revenue per litre of FS conveyed	#N/A
Total annual revenue	#N/A

Start-up costs: permits, licenses etc payable in year 1	#N/A
Proportion of total volume removed as detritus during conveyance	#N/A
Change in volume of FS during conveyance	#N/A
Change in calorific value of FS during conveyance	#N/A
Change in dry solids content of FS during conveyance	#N/A
Annual volume of sludge sent to next conveyance stage or storage	#N/A
Detritus content of FS sent to next conveyance stage or storage	#N/A
Calorific value of FS sent to next conveyance stage or storage	#N/A
Dry solids of sludge sent to next conveyance stage or storage	#N/A
Annual mass of FS dry solids sent to next conveyance stage or storage	#N/A
Annual mass of detritus removed and to be disposed of	#N/A
Repayment period for debt	#N/A
Lifespan of Conveyance 2 equipment	#N/A
Length of pit emptying cycle	5
Time period used for Emtpying & Conveyance cash flows	5
Terminal value of assets	10
Terminal value of assets at end of cash flow period	#N/A
Depreciation rate	#N/A
Hazardous landfill cost for disposal of detritus	1700
Annual cost of landfill	#N/A

Conveyance Stage 2 expenses and revenues

TOTAL CAPITAL COSTS	#N/A
NON-DEPRECIABLE CAPITAL	#N/A
DEPRECIABLE CAPITAL	#N/A
TOTAL OPERATING COSTS, EXCLUDING FUEL	#N/A
TOTAL FUEL COSTS	#N/A
TOTAL ANNUAL REVENUE	#N/A

Unit	Reference	Notes
No.		
ℓ / pit		
m^3 / year		
dry tonnes / year		
%		
MJ / kg		
%DS		

with containers of sludge

km		
ℓ / load		
km / h		
No. teams		
pits / day		
ℓ / day		
h / C1 load		
h / C1 load		
kℓ / h		Sludge transfer rate between C1 and C2 - e.g. for vacuum tanker will be the pumping rate
h / C1 load		Time to transfer sludge between C1 and C2
h / C1 load		Total time for changeover of sludge load between C1 and C2: C1 travel to and from pit, setup, transfer of sludge between vehicles

km		
km		Refer to 'G1 Distances' sheet
ℓ / load		
km / h		

C1 loads / C2 load	
h / C2 load	Minimum time to fill C2 tank with C1 loads.
h / C2 load	Time to set up / take down connection between C2 and other conveyance stages
kℓ / h	Pumping rate for sludge
h / C2 load	
h / C2 load	Vehicle travel time during Stage C2
h / C2 load	
ℓ / load	
h / C3 load	linked to C3 sheet
C3 / C2	
h / C2 load	If C2 is a vehicle, then use time taken for C2 to empty itself (one load). If C2 is a tank then use C3 time multipled by number of C3 loads required to empty C2. IF C2 is sewer discharge station then fixed time of 0.05 hours/load used.
h / C2 load	
h / working day	
h / working day	
C2 loads / day / team	
C2 volume / C1 volume	
kℓ / day	
C1 loads / day	
C2 loads / day	
C2 teams required	
C2 teams required	Assumes each C2 team is serving more than one C1 team
h at C2 per C1 load	
discharge points	
C2 loads / day	
No. / day	
working days	
C2 loads / day	
C2 loads / day	
No.	
C3 emptyings / year	

No. C1 teams	
C2 teams in operation	Optional override - e.g. if require every C1 team to be attached to a dedicated C2 team
C2 teams in operation	
No.	
No.	
No.	
equipment working days / year	If C2 is a vehicle, must be at least equal to number of days that Conveyance Stage 1 operates. If C2 is a storage facility, must be equal to the labour days per year for C1.
working days / year	
working days / year	Number of days labourers employed for
working days / month	
months / year	
LCU / month	
months / year	
LCU / month	
months / year	
working days / year	
	Highlighted if number of months labourers are employed for is lower than the calculated number of months required
LCU / year	
LCU / working day / team	Includes maintenance, repairs, insurance & license
LCU / km	
% of capital cost over lifespan of vehicle	
LCU / load	
LCU / km	
LCU / ℓ	
km	

LCU / km	
km / year / C2 team	
%	Account for miscellaneous journeys - re-fuelling, repairs etc
km / year	
LCU / year	
LCU / year	Assumes each litre of sludge pumped twice (loading and discharge)
LCU / year	
C2 teams required	
m2 / vehicle	
m2	
m2	Choose based on number of teams in operation
m2	
LCU / m2 / month	Not applicable if property purchased
months / year	
LCU / year	
LCU / m2	Not applicable if property rented
LCU	
LCU / vehicle	
	Enter Yes or No
LCU	
LCU / year	
%	Proportion of total operating costs per year to include admin and security
LCU / year	
LCU / year	
LCU / year	
LCU / load	
LCU / kℓ	
LCU / year	

LCU	
% change	
% change	
% change	
% change	
m3 / year	
%	
MJ / kg	
%DS	
tonnes / year	
tonnes / year	
years	
years	Used to calculate depreciation rate
years	Time period used for cash flows
% of initial value	
% of initial value	
%	Assume straight line depreciation over the lifetime of the component in question to find annual depreciation rate
LCU / tonne	
LCU / year	
LCU	
LCU	
LCU	
LCU / year	
LCU / year	
LCU / year	

User comments

take into account if staff are being used full time by a facility or just a proportion of their time

time taken to empty holding tanks / sewer discharge stations, use the sludge removal rate

3.5.2 Conveyance Stage 3 calculations

Parameter	Value
General	
No. of households or pits in area	35000
Volume of sludge received per pit	950
Annual volume of sludge received from Conveyance Stage 2	#N/A
Average detritus content of FS received	#N/A
Average calorific value of FS received	#N/A
Average dry solids content of FS received	#N/A
Annual mass of FS dry solids received from Conveyance Stage 2	#N/A
Conveyance Stage 2 data	
Conveyance Stage 2 method number	0
Conveyance Stage 2 method	**#N/A**
Conveyance Stage 2 distance	0,00
Conveyance Stage 2 volume per load	#N/A
Conveyance Stage 2 travel speed	#N/A
Number of Conveyance Stage 2 teams in operation	#N/A
Number of pits emptied per day	30
Number of working days per year required for Conveyance Stage 2	252
Conveyance Stage 3 data	
Conveyance Stage 3 method number	0
Conveyance Stage 3 method	**#N/A**
One-way distance travelled by vehicle during Stage 3	0
Distance T6: One-way distance from work site to Conveyance 3 storage depot	0
C3 volume	#N/A
Vehicle speed	#N/A
Time to fill and empty one C2 load	#N/A
Number of C2 loads to fill C3 tank	#N/A
Time to fill C3 with C2 loads	#N/A
C3 setup time	#N/A
C3 sludge loading rate	#N/A
C3 sludge pumping time	#N/A
C3 travel time	0,00
C3 time (using C3 parameters)	#N/A
C4 volume	#N/A
C4 time (using C4 parameters)	#N/A

Number of C4 loads to empty C3 tank	#N/A
Time to empty C3 tank	#N/A
Time to fill and empty C3	#N/A
Additional time required per working day	#N/A
Working hours per day	9,00
If C3 is a vehicle	
Number of C3 loads possible per day per team	#N/A
Number of C2 loads to fill C3 tank	#N/A
Number of C2 loads produced per year	#N/A
Number of C2 loads produced per day	#N/A
Numer of C3 loads required per day	#N/A
Number of C3 teams/facilities required in operation	#N/A
Minimum number of C3 teams/facilities required in operation (rounded up)	#N/A
If C3 is a storage facility	
Time spent discharging at facility by C2, per load	#N/A
Number of discharge points at facility	3,00
Maximum number of C2 loads that can be accepted per day by C3 (time)	#N/A
Number of times per day C3 emptied	1
Time to empty C3	#N/A
Maximum number of C2 loads that can be accepted per day by C3 (volume)	#N/A
Actual maximum number of C2 loads that can be accepted per day by C3	#N/A
Minimum number of C3 facilities required	#N/A
Number of C3 emptyings per year per C3 facility	0
Number of C2 teams / facilities in operation	#N/A
Chosen number of C3 teams/facilities in operation (optional input - overrides calculated minimum figure)	0

Actual number of C3 teams/facilities in operation	#N/A

Labour costs

Number of supervisors required	1
Number of labourers per C3 team/facility	#N/A
Total number of labourers required	#N/A
Minimum number of equipment working days per year required	0
Number of labour working days per year for C2	252
Actual number of working days per year	252
Working days per month	21
Minimum number of months staff can be employed for per year	0,0
Supervisor salary rate	10 000,00
Number of months supervisor employed for per year	12
Labourer salary rate	3 000,00
Number of months labourers employed for per year	12
Number of labour working days for C3	252
Error check	0
Total labour costs	#N/A

Operating and fuel costs

Equipment rental rate per working day per team	#N/A
Total operating costs per km (excluding fuel)	#N/A
Vehicle repair and maintenance rate	#N/A
Total operating costs per load	#N/A
Fuel cost per km	#N/A
Fuel cost per litre FS pumped	#N/A
Vehicle life - distance	#N/A
Repair and maintenance rate per km	#N/A
Number of km travelled per year per C3 team	#N/A
Additional distance factor	5
Total km travelled per year by all teams	#N/A
Fuel costs for travel	#N/A

Fuel costs for sludge pumping	#N/A
Equipment and operating costs	#N/A
Property costs	
Number of C3 teams required in operation (rounded up)	#N/A
Storage area required for one vehicle / facility	#N/A
Total area required for sludge vehicles / facilities	#N/A
Office and parking area required	20
Total property area required	#N/A
Property rental cost	0
Number of months per year rented	0
Total property rental cost	0
Property purchase cost	100,00
Capital cost of property	#N/A
Capital costs of equipment	
Capital cost of one Conveyance 3 vehicle/facility and associated equipment	#N/A
Is equipment purchased?	Yes
Capital cost of Conveyance 3 equipment to be used in calculations	#N/A
Total capital costs	#N/A
Operating costs, excluding overhead and fuel	#N/A
Overhead	
Overhead rate	10
Overhead costs	#N/A
Total operating costs	
Total operating costs, excluding fuel	#N/A
Total fuel costs	#N/A
Revenue per load of FS conveyed	#N/A
Revenue per litre of FS conveyed	#N/A
Total annual revenue	#N/A
Start-up costs: permits, licenses etc payable in year 1	#N/A
Proportion of total volume removed as detritus during conveyance	#N/A
Change in volume of FS during conveyance	#N/A
Change in calorific value of FS during conveyance	#N/A

Change in dry solids content of FS during conveyance	#N/A
Annual volume of sludge sent to next conveyance stage or storage	#N/A
Detritus content of FS sent to next conveyance stage or storage	#N/A
Calorific value of FS sent to next conveyance stage or storage	#N/A
Dry solids of sludge sent to next conveyance stage or storage	#N/A
Annual mass of FS dry solids sent to next conveyance stage or storage	#N/A
Annual mass of detritus removed and to be disposed of	#N/A
Minimum number of working days required for C3	252

Repayment period for debt	#N/A
Lifespan of Conveyance 2 equipment	#N/A
Length of pit emptying cycle	5
Time period used for Emtpying & Conveyance cash flows	5
Terminal value of assets	10
Terminal value of assets at end of cash flow period	#N/A
Depreciation rate	#N/A

Hazardous landfill cost for disposal of detritus	0
Annual cost of landfill	#N/A

Conveyance Stage 3 expenses and revenues

TOTAL CAPITAL COSTS	#N/A
NON-DEPRECIABLE CAPITAL	#N/A
DEPRECIABLE CAPITAL	#N/A
TOTAL OPERATING COSTS, EXCLUDING FUEL	#N/A
TOTAL FUEL COSTS	#N/A
TOTAL ANNUAL REVENUE	#N/A

Unit	Reference	Notes
No.		
ℓ / pit		
m^3 / year		
%		
MJ / kg		
%DS		
tonnes / year		
km		
ℓ / load		
km / h		
No. teams		
pits / day		
working days / year		
km		
km		Refer to 'G1 Distances' sheet
ℓ / load		
km / h		
h / C2 load		
C2 loads		
hours / C3 load		
h / C3 load		
kℓ / h		
h / C3 load		
h / C3 load		Vehicle travel time during Stage C2
h / C3 load		C3 return travel, setup, pumping
ℓ / load		
h / C4 load		Linked to C4 - time for C4 to fill, travel and empty

C4 load / C3 load	
h / C3 load	If C3 is a vehicle, then use time taken for C3 to empty itself (one load). If C3 is a tank then use C4 time multipled by number of C4 loads required to empty C3. If C3 is sewer discharge station then fixed time of 0.05 hours used.
h / C3 load	
h / working day	
h / working day	
C3 loads / day / team	C3 volume accessible in a day due to time constraints
loads	
C2 loads / year	
C2 loads / day	
C3 loads / day	Maximum figure - assumes worst case that all C2 FS enters C3 facility. In practice volume reduction may occurr due to screenings removal etc.
C3 teams/facilities required	Calculated minimum number required, based on timings entered
C3 teams/facilities required	Assumes each C3 team is serving more than one C2 team
h at C3 / C2 load	
discharge points	
C2 loads / day	
No. / day	
working days	
C2 loads / day	
C2 loads / day	
No.	Calculated minimum number required, based on timings entered
C3 emptyings / year	
No. C2 teams	
C3 teams/facilities in operation	Optional override - e.g. if only a fixed number of transfer stations exists. Does not take into account timings above.

C3 teams/facilities in operation	
No.	
No.	
No.	
working days / year	If C3 is a vehicle, must be at least equal to number of equipment days for C2 (i.e. the number of days there is sludge to collect). If C3 is a storage facility, must be equal to the labour days per year for C2.
working days / year	
working days / year	Based on number of labourer days
working days / month	
months / year	
LCU / month	
months / year	
LCU / month	
months / year	
working days / year	
	Highlighted if number of months labourers are employed for is lower than the calculated number of months required
LCU / year	
LCU / working day / team	
LCU / km	
% of capital cost over lifespan of vehicle	
LCU / load	
LCU / km	
LCU / ℓ	
km	
LCU / km	
km / year / C2 team	
%	Account for miscellaneous journeys - re-fuelling, repairs etc
km / year	
LCU / year	

LCU / year	Assumes each litre of sludge pumped twice (loading and discharge)
LCU / year	
C3 teams required	
m2 / vehicle/facility	
m2	
m2	Choose based on number of teams/facilities in operation
m2	
LCU / m2 / month	Not applicable if property purchased
months / year	
LCU / year	
LCU / m2	Not applicable if property rented
LCU	
LCU / vehicle/facility	
LCU	
LCU / year	
%	Proportion of total operating costs per year to include admin and security
LCU / year	
LCU / year	
LCU / year	
LCU / load	
LCU / kℓ	
LCU / year	
LCU	
%	
%	
%	

%	
m3 / year	
%	
MJ / kg	
%DS	
tonnes / year	Does not calculate volume / mass of screenings sent to alternative disposal
tonnes / year	
	If C2 a storage tank, min number for C3 is number of emptyings required per year. If C2 a vehicle, min number is days that C2 vehicle operates
years	
years	
years	
% of initial value	
% of initial value	
%	Assume straight line depreciation over the lifetime of the component in question to find annual depreciation rate
LCU / tonne	
LCU / year	
LCU	
LCU	
LCU	
LCU / year	
LCU / year	
LCU / year	

User comments

3.5.3 Conveyance Stage 4 calculations

Parameter	Value
<u>General</u>	
No. of households or pits in area	35000
Volume of sludge received per pit	950
Annual volume of sludge received from Conveyance Stage 3	#N/A
Average detritus content of FS received	#N/A
Average calorific value of FS received	#N/A
Average dry solids content of FS received	#N/A
Annual mass of FS dry solids received from Conveyance Stage 3	#N/A
<u>Conveyance Stage 3 data</u>	
Conveyance Stage 3 method number	0
Conveyance Stage 3 method	**#N/A**
Conveyance Stage 3 distance	0,00
Conveyance Stage 3 volume per load	#N/A
Conveyance Stage 3 travel speed	#N/A
Number of Conveyance Stage 3 teams in operation	#N/A
Minimum number of working days per year required for Conveyance Stage 3	0
<u>Conveyance Stage 4 data</u>	
Conveyance Stage 4 method number	0
Conveyance Stage 4 method	**#N/A**
One-way distance travelled by vehicle during Stage 4	0
Distance T7: One-way distance from work site to Conveyance 4 storage depot	0
Volume of FS carried per full load	#N/A
Vehicle speed	#N/A
C3 time	#N/A
Number of C3 loads to fill C4 tank	#N/A
Time to fill C4 with C3 loads	#N/A
C4 setup time	#N/A
C4 sludge loading rate	#N/A

C4 sludge pumping time	#N/A
C4 travel time	0,00
C4 time (using C4 parameters)	#N/A
Time to empty C4 tank into Storage	#N/A
Time to fill, travel and empty C4	#N/A
Additional time required per working day for C4	#N/A
Working hours per day	9,00
If C4 is a vehicle	
Number of C4 loads possible per day per team	#N/A
Number of C3 loads to fill C4 tank	#N/A
Number of C3 loads produced per year	#N/A
Number of C3 loads produced per day	#N/A
Numer of C4 loads required per day	#N/A
Number of C4 teams/facilities required in operation	#N/A
Minimum number of C4 teams/facilities required in operation (rounded up)	#N/A
If C4 is a storage facility	
Time spent discharging at facility by C3, per load	#N/A
Number of discharge points at facility	0,00
Maximum number of C3 loads that can be accepted per day by C4 (time)	#N/A
Number of times per day C4 emptied	0
Time to empty C4	#N/A
Maximum number of C3 loads that can be accepted per day by C4 (volume)	#N/A
Actual maximum number of C3 loads that can be accepted per day by C4	#N/A
Minimum number of C4 facilities required	#N/A
Chosen number of C4 teams/facilities in operation (optional input - overrides calculated minimum figure)	0
Actual number of C4 teams/facilities in operation	#N/A
Labour costs	
Number of supervisors required	1
Number of labourers per C4 team/facility	#N/A

Total number of labourers required	#N/A
Minimum number of equipment working days per year required	0
Number of labour working days per year for C3	252
Available number of working days per year for C4	252
Working days per month	21
Minimum number of months staff can be employed for per year	0,0
Supervisor salary rate	10 000,00
Number of months supervisor employed for per year	12
Labourer salary rate	3 000,00
Number of months labourers employed for per year	12
Number of labour working days for C4	252
Error check	0
Total labour costs	#N/A
Operating and fuel costs	
Equipment rental rate per working day per team	#N/A
Total operating costs per km (excluding fuel)	#N/A
Vehicle repair and maintenance rate	#N/A
Total operating costs per load	#N/A
Fuel cost per km	#N/A
Fuel cost per kilolitre FS pumped	#N/A
Vehicle life - distance	#N/A
Repair and maintenance rate per km	#N/A
Number of km travelled per year per C4 team	#N/A
Additional distance factor	5
Total km travelled per year by all teams	#N/A
Fuel costs for travel	#N/A
Fuel costs for sludge pumping	#N/A
Equipment and operating costs	#N/A
Property costs	
Number of C4 teams required in operation (rounded up)	#N/A

Storage area required for one vehicle / facility	#N/A
Total area required for sludge vehicles / facilities	#N/A
Office and parking area required	0
Total property area required	#N/A
Property rental cost	25,00
Number of months per year rented	12
Total property rental cost	#N/A
Property purchase cost	-
Capital cost of property	#N/A
Capital costs of equipment	
Capital cost of one Conveyance 4 vehicle/facility and associated equipment	#N/A
Is equipment purchased?	Yes
Capital cost of Conveyance 4 equipment to be used in calculations	#N/A
Total capital costs	#N/A
Operating costs, excluding overhead and fuel	#N/A
Overhead	
Overhead rate	10
Overhead costs	#N/A
Total operating costs	
Total operating costs, excluding fuel	#N/A
Total fuel costs	#N/A
Revenue per load of FS conveyed	#N/A
Revenue per kilolitre of FS conveyed	#N/A
Total annual revenue	#N/A
Start-up costs: permits, licenses etc payable in year 1	#N/A
Proportion of total volume removed as detritus during conveyance	#N/A
Change in volume of FS during conveyance	#N/A
Change in calorific value of FS during conveyance	#N/A
Change in dry solids content of FS during conveyance	#N/A
Annual volume of sludge sent to next conveyance stage or storage	#N/A
Detritus content of FS sent to next conveyance stage or storage	#N/A
Calorific value of FS sent to next conveyance stage or storage	#N/A
Dry solids of sludge sent to next conveyance stage or storage	#N/A

Annual mass of FS dry solids sent to next conveyance stage or storage	#N/A
Annual mass of detritus removed and to be disposed of	#N/A
Repayment period for debt	#N/A
Lifespan of Conveyance 2 equipment	#N/A
Length of pit emptying cycle	5
Time period used for Emtpying & Conveyance cash flows	5
Terminal value of assets	10
Terminal value of assets at end of cash flow period	#N/A
Depreciation rate	#N/A
Hazardous landfill cost for disposal of detritus	0
Annual cost of landfill	#N/A

Conveyance Stage 4 expenses and revenues

TOTAL CAPITAL COSTS	#N/A
NON-DEPRECIABLE CAPITAL	#N/A
DEPRECIABLE CAPITAL	#N/A
TOTAL OPERATING COSTS, EXCLUDING FUEL	#N/A
TOTAL FUEL COSTS	#N/A
TOTAL ANNUAL REVENUE	#N/A

Unit	Reference	Notes
No.		
ℓ / pit		
m^3 / year		
%		
MJ / kg		
%DS		
tonnes / year		
km		
ℓ / load		
km / h		
No. teams		
working days / year		
km		
km		Refer to 'G1 Distances' sheet
ℓ / load		
km / h		
h / C3 load		Will only show a value if C3 is a vehicle
C4 loads / C3 loads		
h / C4 load		If C3 is a vehicle, C3 time used. If C3 is a tank, C4 setup and pumping time used.
h / C4 load		
kℓ / h		

h / C4 load	
h / C4 load	
h / C4 load	
h / C4 load	Uses the C4 setup, travel and pumping time
h / C4 load	
h / working day	
h / working day	
C4 loads / day / team	Based on time available
loads	
C3 loads / year	
C3 loads / day	
C4 loads / day	Based on the volume of sludge transferred from C3 per year
C4 teams/facilities required	
C4 teams/facilities required	Calculated minimum number required, based on timings entered
h at C4 / C3 load	
discharge points	
C3 loads / day	
No. / day	
working days	
C3 loads / day	
C3 loads / day	
No.	Calculated minimum number required, based on timings entered
C4 teams/facilities in operation	Optional override - e.g. if only a fixed number of transfer stations exists. Does not take into account timings above.
C4 teams/facilities in operation	
No.	
No.	

No.	
working days / year	If C4 is a vehicle, must be at least equal to number of equipment days for C3 (i.e. the number of days there is sludge to collect). If C4 is a storage facility, must be equal to the labour days per year for C3.
working days / year	
working days / year	Based on number of labourer days
working days / month	
months / year	
LCU / month	
months / year	
LCU / month	
months / year	
working days / year	
	Highlighted if number of months labourers are employed for is lower than the calculated number of months required
LCU / year	
LCU / working day / team	
LCU / km	
% of capital cost over lifespan of vehicle	
LCU / load	
LCU / km	
LCU / kℓ	
km	
LCU / km	
km / year / C4 team	
%	Account for miscellaneous journeys - re-fuelling, repairs etc
km / year	
LCU / year	
LCU / year	Assumes each litre of sludge pumped twice (loading and discharge)
LCU / year	
C4 teams required	

m2 / vehicle/facility	
m2	
m2	Choose based on number of teams/facilities in operation
m2	
LCU / m2 / month	Not applicable if property purchased
months / year	
LCU / year	
LCU / m2	Not applicable if property rented
LCU	
LCU / vehicle/facility	
LCU	
LCU / year	
%	Proportion of total operating costs per year to include admin and security
LCU / year	
LCU / year	
LCU / year	
LCU / load	
LCU / kℓ	
LCU / year	
LCU	
%	
%	
%	
%	
m3 / year	
%	
MJ / kg	
%DS	

tonnes / year	
tonnes / year	
years	
years	
years	Normally use length of one pit-emptying cycle
% of initial value	
% of initial value	
%	Assume straight line depreciation over the lifetime of the component in question to find annual depreciation rate
LCU / tonne	
LCU / year	
LCU	
LCU	
LCU	
LCU / year	
LCU / year	
LCU / year	

User comments

3.6.1 Conveyance Stage 2 interest & repayment

Conveyance Stage 2

Parameter	Value
Capital cost	#N/A
Debt proportion in debt:equity ratio	70
Debt	#N/A
Interest	9
Lifespan of equipment	5
Repayment period	#N/A
Instalment per quarter	#N/A

		Opening balance
	1	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	2	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	3	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	4	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	5	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	6	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A

	7	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	8	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	9	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	10	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	11	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	12	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	13	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	14	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	15	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	16	
Q1		#N/A
Q2		#N/A

Q3		#N/A
Q4		#N/A
	17	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	18	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	19	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	20	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A

TOTALS

Debt repayment

Year		**Interest payable**
	1	#N/A
	2	#N/A
	3	#N/A
	4	#N/A
	5	#N/A
	6	#N/A
	7	#N/A
	8	#N/A
	9	#N/A
	10	#N/A
	11	#N/A
	12	#N/A
	13	#N/A
	14	#N/A
	15	#N/A
	16	#N/A
	17	#N/A
	18	#N/A
	19	#N/A
	20	#N/A

Unit
LCU
%
LCU
%
years
years
LCU / quarter

Interest payable	Repayment at end of quarter	Closing balance
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	

Principle payable

#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A

3.6.2 Conveyance Stage 3 interest & repayment

Conveyance Stage 3

Parameter	Value
Capital cost	#N/A
Debt proportion in debt:equity ratio	70
Debt	#N/A
Interest	9
Lifespan of equipment	5
Repayment period	#N/A
Instalment per quarter	#N/A

		Opening balance
	1	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	2	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	3	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	4	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	5	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	6	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A

	7	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	8	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	9	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	10	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	11	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	12	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	13	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	14	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	15	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	16	
Q1		#N/A
Q2		#N/A

Q3		#N/A
Q4		#N/A
	17	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	18	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	19	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	20	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
TOTALS		

Debt repayment

Year		**Interest payable**
	1	#N/A
	2	#N/A
	3	#N/A
	4	#N/A
	5	#N/A
	6	#N/A
	7	#N/A
	8	#N/A
	9	#N/A
	10	#N/A
	11	#N/A
	12	#N/A
	13	#N/A
	14	#N/A
	15	#N/A
	16	#N/A
	17	#N/A
	18	#N/A
	19	#N/A
	20	#N/A

Unit
LCU
%
LCU
%
years
years
LCU / quarter

Interest payable	Repayment at end of quarter	Closing balance
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	

Principle payable

#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A

3.6.3 Conveyance Stage 4 interest & repayment

Conveyance Stage 4

Parameter	**Value**
Capital cost	#N/A
Debt proportion in debt:equity ratio	70
Debt	#N/A
Interest	9
Lifespan of equipment	5
Repayment period	#N/A
Instalment per quarter	#N/A

		Opening balance
	1	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	2	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	3	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	4	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	5	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	6	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A

	7	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	8	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	9	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	10	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	11	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	12	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	13	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	14	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	15	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	16	
Q1		#N/A
Q2		#N/A

Q3		#N/A
Q4		#N/A
	17	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	18	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	19	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
	20	
Q1		#N/A
Q2		#N/A
Q3		#N/A
Q4		#N/A
TOTALS		

Debt repayment

Year		**Interest payable**
	1	#N/A
	2	#N/A
	3	#N/A
	4	#N/A
	5	#N/A
	6	#N/A
	7	#N/A
	8	#N/A
	9	#N/A
	10	#N/A
	11	#N/A
	12	#N/A
	13	#N/A
	14	#N/A
	15	#N/A
	16	#N/A
	17	#N/A
	18	#N/A
	19	#N/A
	20	#N/A

Unit
LCU
%
LCU
%
years
years
LCU / quarter

Interest payable	Repayment at end of quarter	Closing balance
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A

#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	#N/A
#N/A	#N/A	

Principle payable

#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A
#N/A

3.7.1 Conveyance Stage 2 cash flows

#N/A

Repayment period for debt	#N/A
Time period used for cash flows	5
Terminal value of assets	#N/A
Depreciation rate	#N/A
Escalation rate - general	6
Escalation rate - fuel	12
Discount rate	8

Parameter	**Unit**
Depreciable cost	LCU
Interest on loan	LCU / year
Depreciation	LCU / year
O&M costs, excluding fuel	LCU / year
Fuel costs	LCU / year
Start up costs (year 1 only)	LCU / year
Total expenses	**LCU / year**
Salvage value	LCU
Revenues	LCU / year
Net expenses	**LCU / year**
Discounted total cost	LCU / year
Mass of FS collected	tonnes / year
Number of pits emptied	pits / year
Levelised cost of pit emptying per tonne FS	**LCU / tonne FS**
Levelised cost of pit emptying per pit	**LCU / pit**

years
years
% of initial value
%
%
%
%

	Year				
#N/A	**1**	**2**	**3**	**4**	**5**
	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A				
	#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**
	-	-	-	-	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**
	#N/A	#N/A	#N/A	#N/A	#N/A
	2294,25	2294,25	2294,25	2294,25	2294,25
	7000	7000	7000	7000	7000
	#N/A				
	#N/A				

6	7	8	9	10	11	12	13	14
#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

15	16	17	18	19	20
#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
-	-	-	-	-	-
-	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
-	-	-	-	-	-
0	0	0	0	0	0
0	0	0	0	0	0

3.7.2 Conveyance Stage 3 cash flow

3.7.2 Conveyance Stage 3

#N/A	
Repayment period for debt	#N/A
Time period used for cash flows	5
Terminal value of assets	#N/A
Depreciation rate	#N/A
Escalation rate - general	6
Escalation rate - fuel	12
Discount rate	8

Parameter	**Unit**
Depreciable cost	LCU
Interest on loan	LCU / year
Depreciation	LCU / year
O&M costs, excluding fuel	LCU / year
Start up costs (year 1 only)	LCU / year
Fuel costs	LCU / year
Total expenses	**LCU / year**
Salvage value	LCU
Revenues	LCU / year
Net expenses	**LCU / year**
Discounted total cost	LCU / year
Mass of FS collected	tonnes / year
Number of pits emptied	pits / year
Levelised cost of pit emptying per tonne FS	**LCU / tonne FS**
Levelised cost of pit emptying per pit	**LCU / pit**

years
years
% of initial value
%
%
%
%

	Year			
#N/A	**1**	**2**	**3**	**4**
	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A
	#N/A			
	#N/A	#N/A	#N/A	#N/A
	#N/A	**#N/A**	**#N/A**	**#N/A**
	-	-	-	-
	#N/A	#N/A	#N/A	#N/A
	#N/A	**#N/A**	**#N/A**	**#N/A**
	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A
	7000	7000	7000	7000
	#N/A			
	#N/A			

5	6	7	8	9	10
#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	-	-	-	-	-
#N/A	-	-	-	-	-
#N/A	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
#N/A	-	-	-	-	-
#N/A	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
#N/A	-	-	-	-	-
#N/A	0	0	0	0	0
7000	0	0	0	0	0

11	12	13	14	15	16
#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
-	-	-	-	-	-
-	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
-	-	-	-	-	-
0	0	0	0	0	0
0	0	0	0	0	0

17	18	19	20
#N/A	#N/A	#N/A	#N/A
-	-	-	-
-	-	-	-
-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**
-	-	-	-
-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**
-	-	-	-
0	0	0	0
0	0	0	0

3.7.3 Conveyance Stage 4 cash flow

3.7.3 Conveyance Stage 4

#N/A

Repayment period for debt	#N/A
Time period used for cash flows	5
Terminal value of assets	#N/A
Depreciation rate	#N/A
Escalation rate - general	6
Escalation rate - fuel	12
Discount rate	8

Parameter	**Unit**
Depreciable cost	LCU
Interest on loan	LCU / year
Depreciation	LCU / year
O&M costs, excluding fuel	LCU / year
Start-up costs (year 1 only)	LCU / year
Fuel costs	LCU / year
Total expenses	**LCU / year**
Salvage value	LCU
Revenues	LCU / year
Net expenses	**LCU / year**
Discounted total cost	LCU / year
Mass of FS collected	tonnes / year
Number of pits emptied	pits / year
Levelised cost of pit emptying per tonne FS	**LCU / tonne FS**
Levelised cost of pit emptying per pit	**LCU / pit**

years
years
% of initial value
%
%
%
%

	Year					
#N/A		**1**	**2**	**3**	**4**	**5**
		#N/A	#N/A	#N/A	#N/A	#N/A
		#N/A	#N/A	#N/A	#N/A	#N/A
		#N/A	#N/A	#N/A	#N/A	#N/A
		#N/A				
		#N/A	#N/A	#N/A	#N/A	#N/A
		#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**
		-	-	-	-	#N/A
		#N/A	#N/A	#N/A	#N/A	#N/A
		#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**
		#N/A	#N/A	#N/A	#N/A	#N/A
		#N/A	#N/A	#N/A	#N/A	#N/A
		7000	7000	7000	7000	7000
		#N/A				
		#N/A				

6	7	8	9	10	11
#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
-	-	-	-	-	-
-	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
-	-	-	-	-	-
0,00	0,00	0,00	0,00	0,00	0,00
0	0	0	0	0	0

12	13	14	15	16	17
#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
-	-	-	-	-	-
-	-	-	-	-	-
#N/A	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
-	-	-	-	-	-
0,00	0,00	0,00	0,00	0,00	0,00
0	0	0	0	0	0

18	19	20
#N/A	#N/A	#N/A
-	-	-
-	-	-
-	-	-
#N/A	**#N/A**	**#N/A**
-	-	-
-	-	-
#N/A	**#N/A**	**#N/A**
-	-	-
0,00	0,00	0,00
0	0	0

3.8 Levelised costs of Emptying and Conveyance stages

Costs only: mark-ups and managing contractor expenses not includec

Totals

Levelised costs of emptying and conveyance

Emptying

Emptying method	Option No.
Human-powered emptying: buckets & shovels or handpump	1
Motorised emptying - Small vacuum tanker	2
Motorised emptying - Large vacuum tanker	3

Chosen emptying and Conveyance Stage 1 methods

Human powered emptying - buckets & shovels	1

Conveyance

Conveyance Stage

Conveyance Stage 2
Conveyance Stage 3
Conveyance Stage 4

not included here

Levelised cost of emptying & conveyance per dry tonne FS	Levelised cost of emptying & conveyance per pit
LCU / dry tonne FS	LCU / pit
3 382	1 108

Conveyance Stage 1 method	Option No.	Levelised cost of pit emptying per dry tonne FS	Levelised cost of pit emptying per pit
		LCU / dry tonne FS	LCU / pit
Pick-up truck with containers of sludge	2	3 382	1 108
Motorised transport - Small vacuum tanker (e.g. Vacutug)	3	24 491	6 759
Motorised transport - Large vacuum tanker	4	666	207
Pick-up truck with containers of sludge	2	3 382	1 108

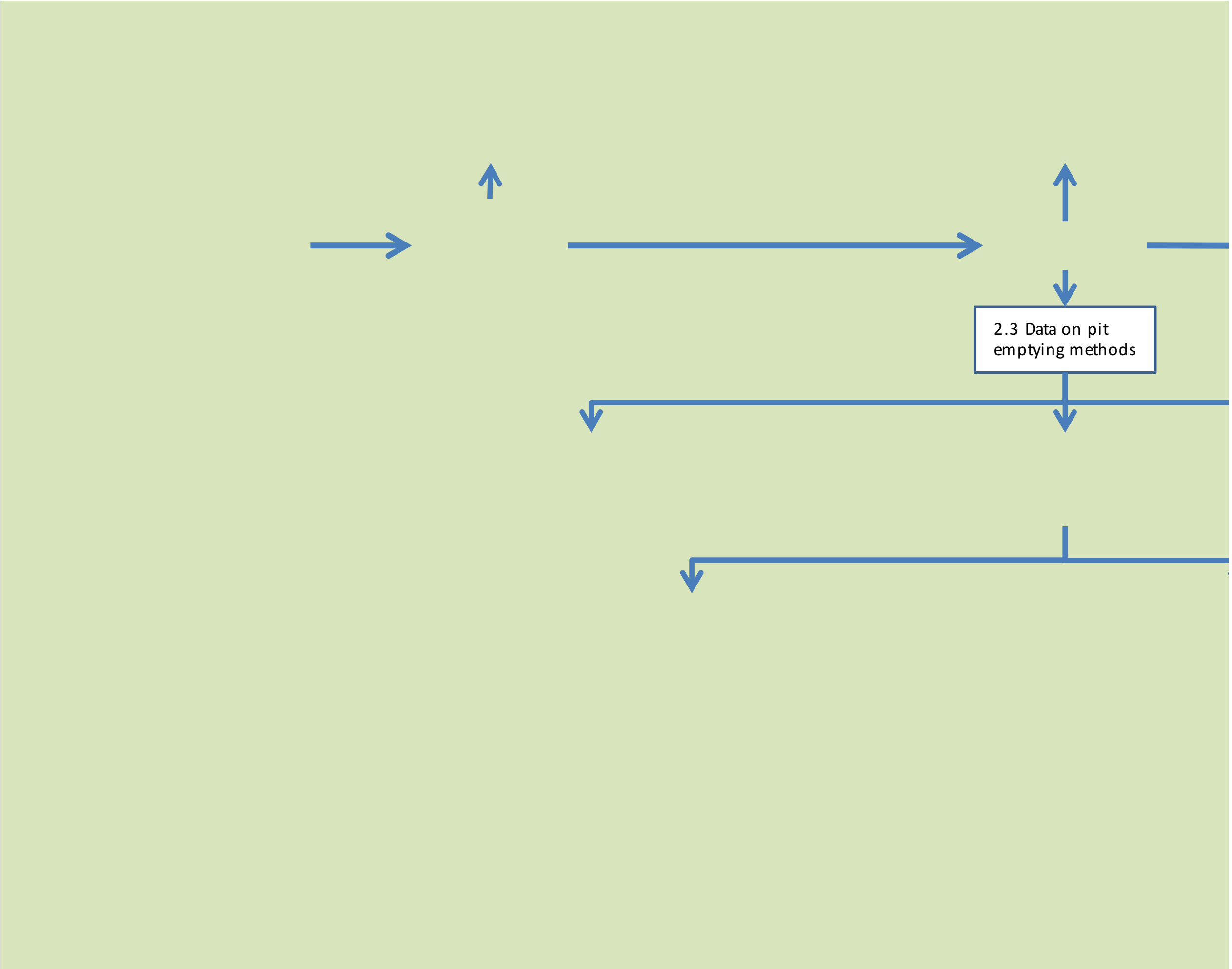
Conveyance method	Option No.	Levelised cost of conveyance per dry tonne FS	Levelised cost of conveyance per pit
		LCU / dry tonne FS	LCU / pit
#N/A	0	0,00	0,00
#N/A	0	0,00	0,00
#N/A	0	0,00	0,00

Dry tonnes FS received by storage per year	**Annual fuel costs (year 1)**
dry tonnes FS / year	LCU / year
2 294	360 375

Includes detritus

Dry tonnes FS removed / year	**Annual fuel costs (year 1)**
dry tonnes FS / year	LCU / year
2 294	360 375
1 932	5 573 855
2 174	135 724
2 294	360 375

Dry tonnes FS removed / year	**Annual fuel costs (year 1)**
0,0	0,0
0,0	0,0
0,0	0,0



3.9 Managing contractor costs

The levelised cost for pit-emptying given in Sheet 3.8 is the the cost amount for the sub-contr
EWS contracting model uses a managing contractor to manage the pit-emptying sub-contract

	Value
<u>Pit-emptying sub-contractors</u>	
Levelised cost of emptying & conveyance per pit	1 108,37
Levelised cost of emptying & conveyance per tonne	3 381,74
Number of pits emptied per year	7 000
Length of pit emptying cycle	5
Total number of pits emptied per cycle	35 000
Total mass of dry solids brought to storage per cycle	11 471
Pit emptying sub-contractor profit margin	30
Amount charged by sub-contractor per pit	1 583,38
Total per cycle	55 418 323,09
Amount charged by sub-contractor per tonne dry solids	4 831,06

Managing contractor

Figures for EWS 2009 - 2010 pit-emptying cycle (31856 pits)

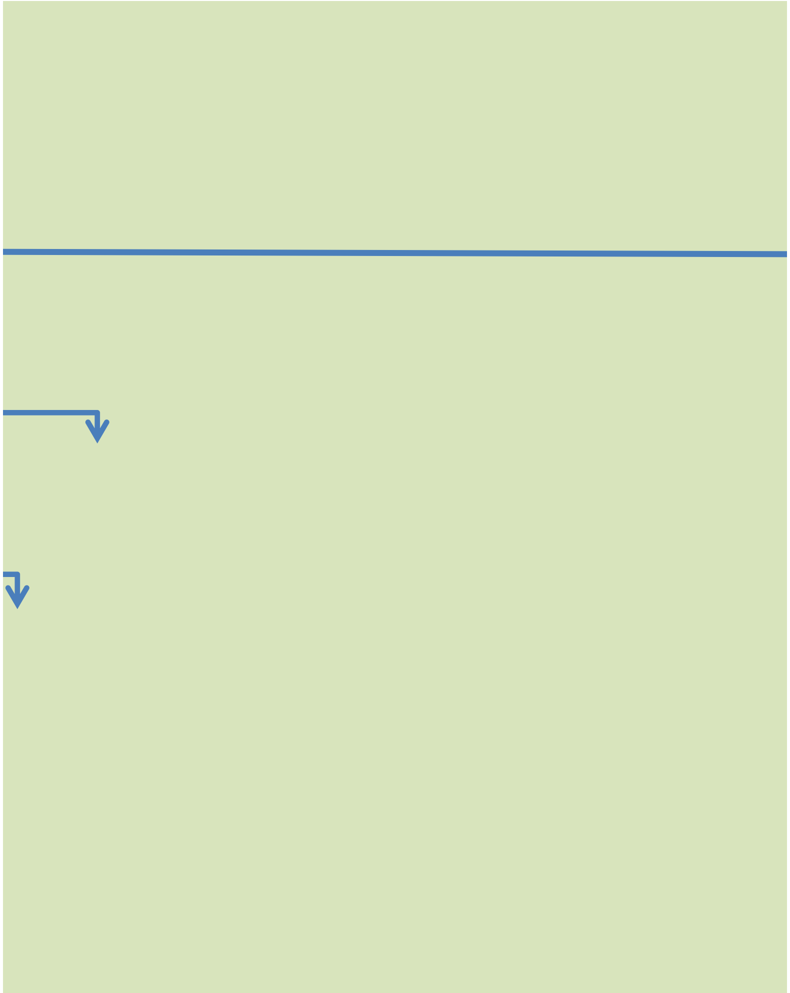
Site establishment	710 000,00
Foreman and accounting	1 511 569,00
Insurance	500 000,00
Health and safety	504 000,00
Environmental management	504 000,00
General costs	248 200,00
Mark-up on sub-contractors' emptying costs	6 834 425,00
Mark-up %	17,4
Sludge screening skips (x2)	135 800,00
Additional plant	204 250,00
Skip transport, maintenance, refuse to landfill	115 969,00
Escalation less retention	918 239,00

Figures for new pit-emptying cycle accounting for escalation

Escalation rate	6
	1,06
Number of years since 2010	3
Site establishment	845 621,36
Foreman and accounting	1 800 302,86
Insurance	595 508,00
Health and safety	600 272,06
Environmental management	600 272,06
General costs	295 610,17
Monthly costs	64 866,09

Managing contractor costs

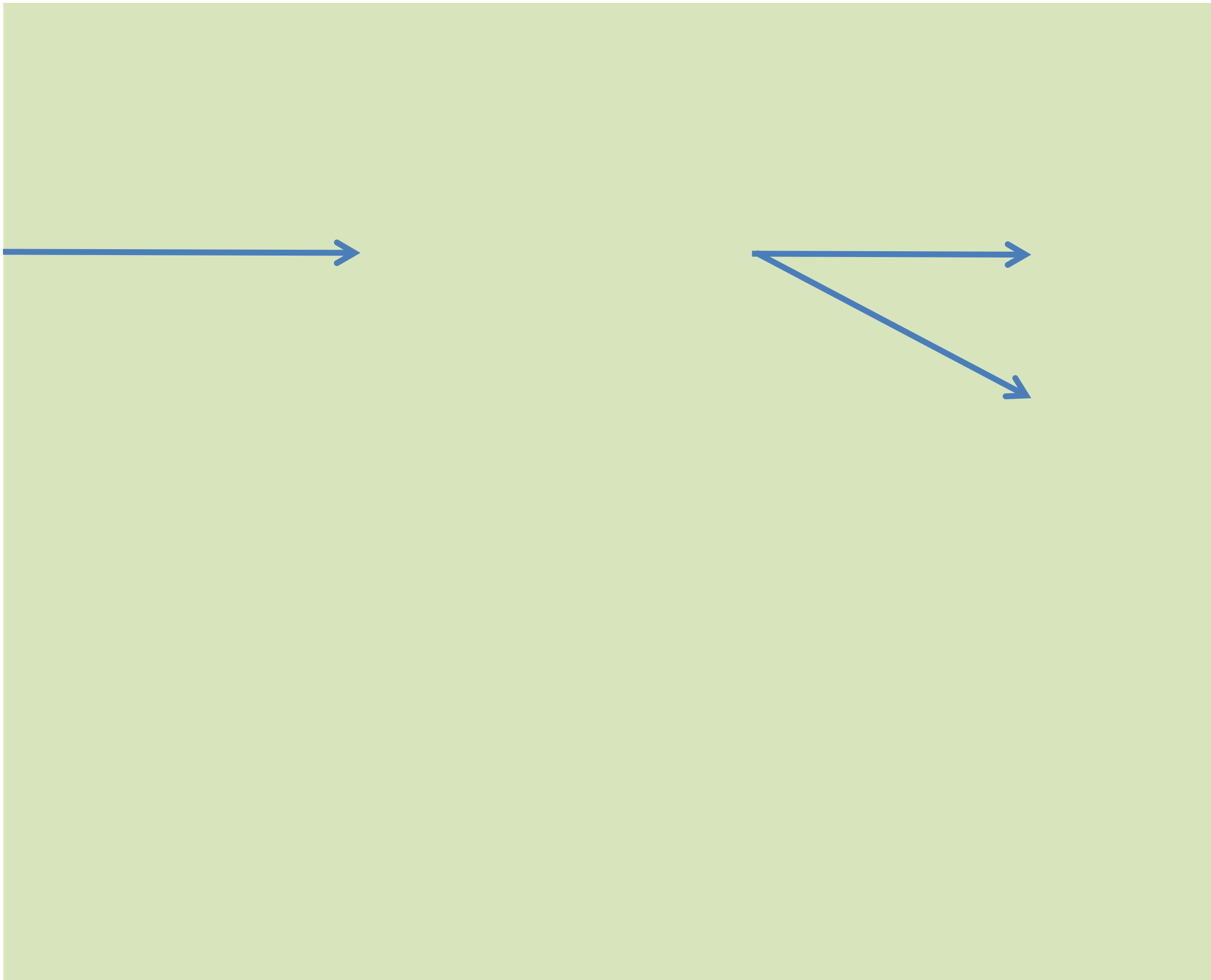
Site establishment	1 000 000,00
Monthly costs	50 000,00
Markup rate	15,00



ne sub-contractor to empty pits and transport sludge to the LaDePa site.
ub-contractors.

Unit	Reference
LCU / pit	
LCU / tonne dry solids	
pits / year	
years	
pits / cycle	
tonnes DS / cycle	
%	
LCU / pit	
LCU / cycle	
LCU / tonne dry mass	

LCU / cycle	Salisbury et al 2011
LCU / cycle	Salisbury et al 2011
LCU / cycle	Salisbury et al 2011
LCU / cycle	Salisbury et al 2011
LCU / cycle	Salisbury et al 2011
LCU / cycle	Salisbury et al 2011
LCU / cycle	Salisbury et al 2011
% of payment to pit-emptying sub-contractors	Calculated from Salisbury et al 2011
LCU	Salisbury et al 2011
LCU	Salisbury et al 2011
LCU	Salisbury et al 2011
LCU	Salisbury et al 2011
%	
years since 2010	
LCU / cycle	
LCU / cycle	
LCU / cycle	
LCU / cycle	
LCU / cycle	
LCU / month	
LCU	
LCU / month	
%	

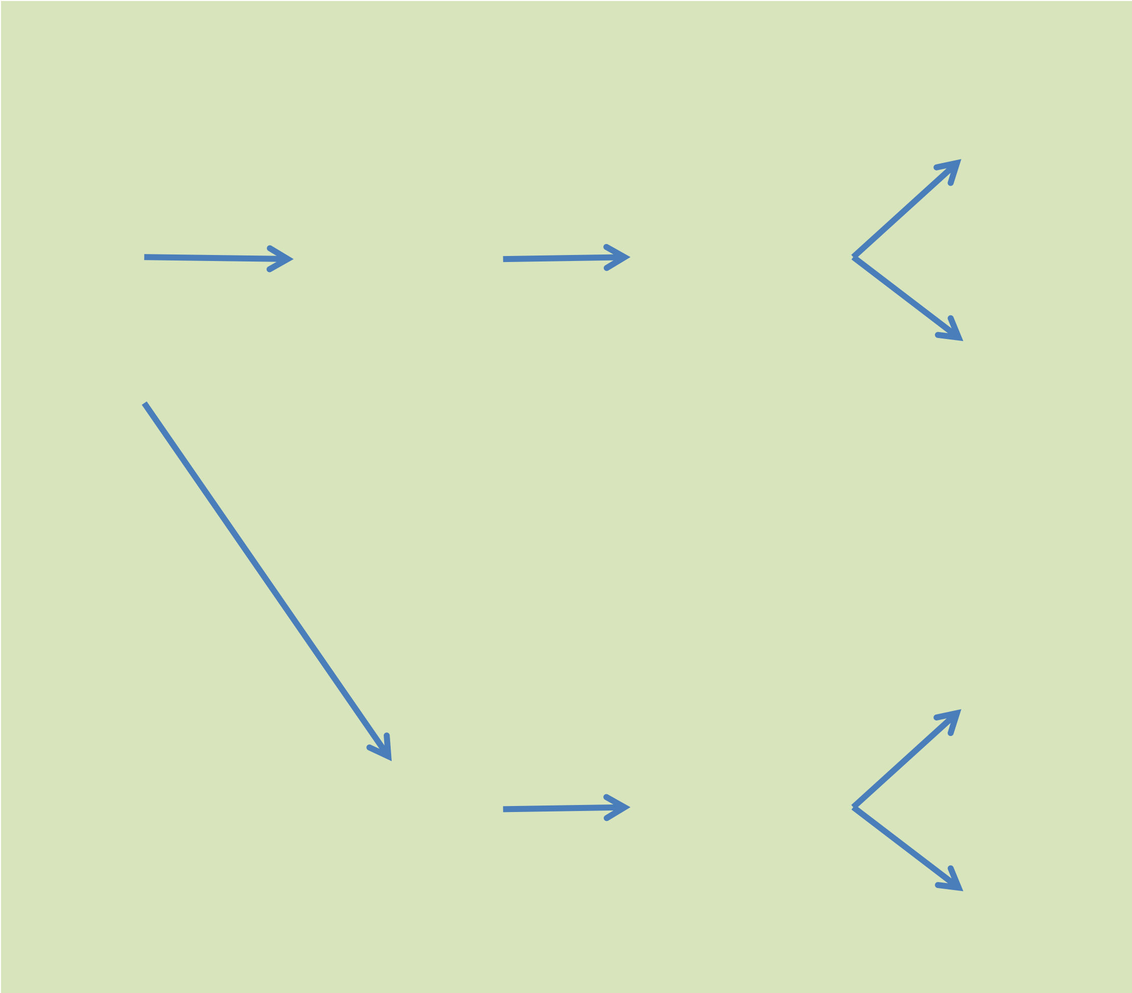


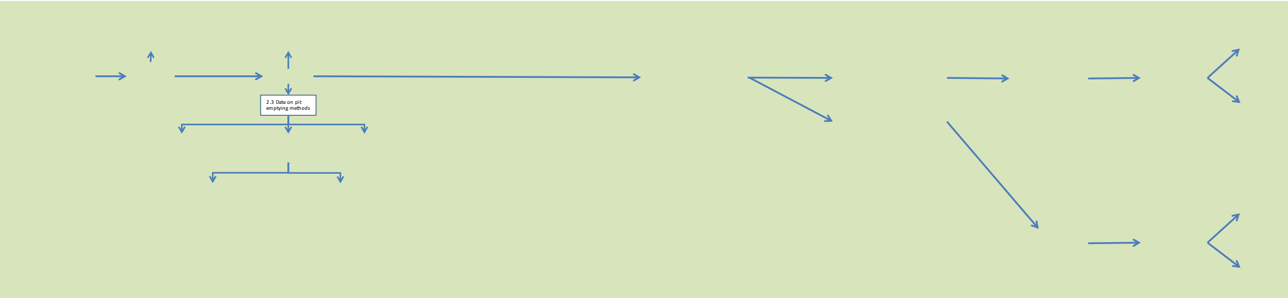
Notes

User comments

c.f. EWS figure for 2009 - 2010 cycle ZAR 39,078,145 in Salisbury et al 2011 (excluding bulk equipment purchases and health interventions)

Mark-up to be applied to all operating costs, including costs
of emptying & conveyance





4. Storage and mixing of FS

Costs and revenue of storage and sludge characteristics at output of storage after mixing of sludge from different sources

4.1 Sludge blend

Parameter	Value	Unit	Reference	Notes	User comments
Area name	Test 1				
Number of households	35000	No.			
Length of pit-emptying cycle	5	years			
Sludge transfer through conveyance stages					
Sludge received by Conveyance Stage 1					
Conveyance Stage 1 number	2				
Annual volume	6650	m^3 / year			
Mass dry solids	2294,25	tonnes / year			
Dry solids content	30	% DS			
Detritus	20	%			
Calorific value	12	MJ / kg			
Minimum number of labour days per year	252	working days / year			
Sludge received by Conveyance Stage 2					
Conveyance Stage 2 number	0				
Annual volume	0	m^3 / year			
Mass dry solids	0	tonnes / year			
Dry solids content	0,00	% DS			
Detritus	0	%			
Calorific value	0	MJ / kg			
Minimum number of labour days per year	0	working days / year			
Sludge received by Conveyance Stage 3					
Conveyance Stage 3 number	0				
Annual volume	0	m^3 / year			
Mass dry solids	0,00	tonnes / year			
Dry solids content	0,00	% DS			
Detritus	0	%			
Calorific value	0	MJ / kg			
Minimum number of labour days per year	0	working days / year			
Sludge received by Conveyance Stage 4					
Conveyance Stage 4 number	0				
Annual volume	0	m^3 / year			
Mass dry solids	0,00	tonnes / year			
Dry solids content	0,00	% DS			
Detritus	0	%			
Calorific value	0,00	MJ / kg			
Minimum number of labour days per year	0	working days / year			
Sludge received by Storage					
Minimum number of working days per year required (defined by final conveyance stage)	252	days / year			
Sludge volume received by Storage per year during pit-emptying cycle	6650	m^3 / year			
Mass of sludge solids received by Storage per year during pit-emptying cycle	2294	tonnes / year			
Length of pit-emptying cycle	5	years			
Time between pit-emptying cycles	0	years			
Available time period during which sludge is processed through pre-treatment & LaDePa, per pit-emptying cycle	5	years			
Annual sludge volume to pre-treatment	6650	m^3 / year		Number of LaDePa plants * volume capacity of one plant * volume factor for pre-treatment	
Annual sludge dry mass to pre-treatment	2294	tonnes / year			
Dry solids content	30,00	% DS			
Detritus	20	%			
Calorific value	12,35	MJ / kg			
Working days per month	21	working days / month			
Number of months per year Storage facility operates	12	months / year			
Number of available working days per year	252	working days / year			
Error check!	0			Highlighted if min number of required working days is higher than available working days	
Average volume of sludge received per day by Storage	26,39	m^3 / day			
Annual pre-treated feed volume to LaDePa	6650	m^3 / year			Volume received by storage goes to pre-treatment, where volume may change - e.g. detritus removal, water addition, water removal. This figures is the modified volume after pre-treatment
Average feed rate to LaDePa	0,667	m^3 / hour		Linked to LaDePa sheet	
LaDePa hours per year required to treat sludge	9975	hours / year		Based on annual pre-treated feed volume, based on number of years available for LaDePa operation	
Hours of LaDePa operation per year	10692	hours / year		Linked to LaDePa sheet - hours per year per plant x downtime x number of plants	
Length of pit-emptying cycle	5	years		Number of years during which sludge is produced	
Calculated volume of buffer storage required.	0	m3		The stockpiled volume of sludge at the end of the pit-emptying cycle. Reflects the difference between the speed of pit-emptying and the speed of sludge processing.	
Minimum storage volume required	0	m^3			
User-specified storage volume	0	m^3		Optional input - overrides the calculated volume requirement	
Actual storage volume available	0	m^3			

4.2 Financial

Parameter	Value	Unit	Reference	Notes	User comments
Capital and start-up costs					
Total storage volume	-	m3			
Number of LaDePa facilities	5	No. LaDePa plants		Each LaDePa facility has a dedicated storage tank(s)	
Number of storage tanks	5	No. tanks			
Volume of each storage tank	-	m3 / tank			
Cost of land preparation for each holding tank	10 000,00	LCU / tank			
Civils costs for plinth and bund	10 000,00	LCU / tank			
Cost of tank per kℓ capacity	2 500,00	LCU / kℓ			
Cost of each tank (calculated)	-	LCU / tank			
Capital cost of other equipment, per tank	-	LCU / tank		Specify what makes up this amount	
Capital cost of storage tanks only	100 000,00	LCU			
Once-off fees for permits, EIAs etc, per tank	-	LCU / tank		Specify what makes up this amount	
TOTAL CAPITAL COSTS	100 000,00	LCU			
START-UP COSTS (YEAR 1 ONLY)	-	LCU			
O&M costs					
Cost of maintenance for all tanks	12 000,00	LCU / year			
Cost of labour for all tanks	-	LCU / year			
Fuel costs for all tanks	-	LCU / year			
Overheads	1 200,00	LCU / year			
TOTAL O&M COSTS, EXCLUDING FUEL	13 200,00	LCU / year			
TOTAL FUEL COSTS	-	LCU / year			
Revenues					
Revenue from operators discharging to storage	-	LCU / year			
Operating parameters					
Number of supervisors per tank	0	No.		May not require staff if storage facility is operated by the LaDePa machine operators	

Number of months per year supervisor employed for	0	months / year	
Number of labourers per tank	0	No.	
Number of months per year labourers employed for	0	months / year	
Number of storage tanks	5,00	No. tanks	
Volume of each storage tank	-	m3 / tank	
Height of tank	2,00	m	
Land area occupied by each holding tank	-	m2	
Land area occupied by each tank + 10%	-	m2	Allows 10% extra area for pipework, bunding etc.
Total facility area required	0,00	m2	

Financial parameters

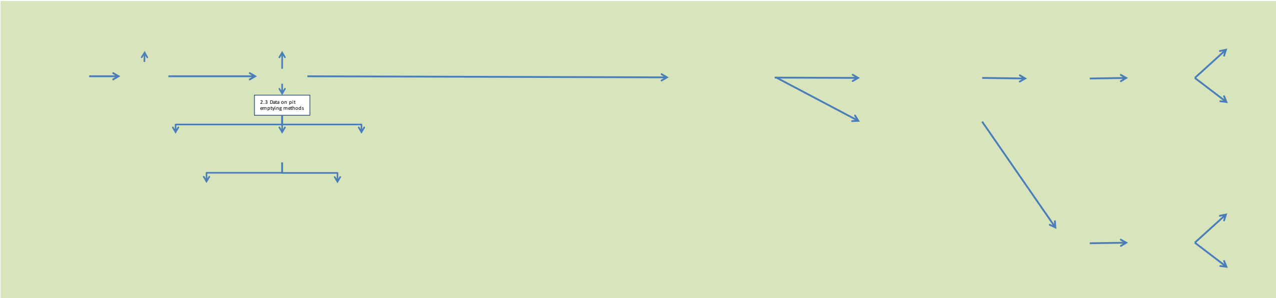
Lifetime of storage tank facility	10	years	
Labour - supervisor rate	10 000,00	LCU / month	
Labour - labourer rate	200,00	LCU / day	
Maintenance rate for facility	200,00	LCU / month	
Consumables cost per month	-	LCU / month	
Overhead rate	10	%	Covers cost of security and admin staff
Revenue generated per kilolitre of FS received at storage	-	LCU / kℓ	A positive value entered here is a gate fee charged to operators dumping sludge at the treatment facility. A negative value entered here is equivalent to the facility paying for sludge to be dumped (incentiviser for correct disposal).

Expenses and revenues summary for all storage tanks at all LaDePa plants

Lifetime of facility	10	years
TOTAL CAPITAL COSTS	100 000,00	LCU
NON-DEPRECIABLE CAPITAL		LCU
DEPRECIABLE CAPITAL	100 000,00	LCU
START-UP COSTS (YEAR 1 ONLY)	-	LCU / year
TOTAL OPERATING COSTS, EXCLUDING FUEL	13 200,00	LCU / year
TOTAL FUEL COSTS	-	LCU / year
TOTAL ANNUAL REVENUE	-	LCU / year
Total land area required	-	m2

Notes

1. Assumed that storage, pre-treatment, LaDePa and product and by-product facilities are co-located and co-operated
2. The land, office and parking facilities for all of these stages are costed on the LaDePa sheet
3. Where additional staff (additional to the team required to operate the LaDePa plant) are required for any treatment stage this is indicated on the individual sheet



5. Pre-treatment of feed to LaDePa process

Costs of pre-treating sludge to a state suitable for input to the LaDePa process

5.1 Properties of feed sludge from storage

Parameter	Value	Unit	Reference	Notes	User comments
Area name	Test 1				
Number of households	35000	No.			
Length of pit-emptying cycle	5	years			
Total volume of storage facility	0	m^3			
Annual volume of sludge available from storage during pit emptying	6650	m^3 / year		Takes account of length of pit emptying cycle (total volume of sludge collected) and time between cycles (time available to process sludge)	
Total dry mass from all storage tanks	2294	tonnes DS / year			
Minimum number of LaDePa plants required	4,66	No. LaDePa plants			
Number of LaDePa plants	5	No. LaDePa plants			

Parameters for ONE pre-treatment facility

Parameter	Value	Unit	Reference	Notes	User comments
Annual volume of sludge from storage to pre-treatment for each LaDePa plant	1330	m^3 / year			
Dry mass of sludge per storage facility / LaDePa plant	459	tonnes DS / year			
Average %DS of sludge	30,00	%DS			
Average detritus fraction in blended sludge	20	%			
Average calorific value of blended sludge	12,35	MJ/kg			
Average sand/grit fraction of blended sludge	3,00	%		Not currently tracked through emptying/conveyance process - assumed to be same as in pit	
Wet sludge density	1150,00	kg / m3			
Number of working days per year for storage facility	252,00	working days / year			
BOD	-	g BOD / g DS			
Nitrogen					
Ammonium & urea	-	mg ammoniacal N / g DS			
Nitrate	-	mg NO3- / g DS			
Total nitrogen	-	mg N / g DS			
Phosphorus					
Total phosphate	-	mg P / g DS			
Orthophosphate	-	mg ortho-P / g DS			
Potassium	-	mg K / g DS			
Calcium	-	mg Ca / g DS			
Magnesium	-	mg Mg / g DS			
Sulphur	-	mg S / g DS			
Ascaris					
Undeveloped eggs	-	No. possible viable Ascaris / 20g DS			
Motile larvae in eggs	-	No. possible viable Ascaris / 20g DS			
Immotile larvae in egg	-	No. possible viable Ascaris / 20g DS			
Trichuris	-	Potentially viable eggs / 20g			
Taenia	-	Potentially viable eggs / 20g			
Faecal coliforms	-	CFU / g DS			

5.2 Required feed spec to LaDePa process

All LaDePa feed specification parameters need to be determined through further testing at the plant. Values given here are estimates.

Parameter	Value	Unit	Reference	Notes
Minimum % DS of feed sludge	20,0	%DS	PSS data sheet on EWS LaDePa plant gives feed as 30 - 35% DS	Sludge of too low dry solids will not form pellets
Maximum % DS of feed sludge	41,0	%DS	PSS data sheet on EWS LaDePa plant gives feed as 30 - 35% DS	Sludge of too high dry solids cannot be efficiently extruded, or crumbles on extrusion.
Maximum allowable detritus content	40,0	% vol		Excessive detritus entering the LaDePa will block the screw feed system, but in practice very large items are manually raked out at the LaDePa hopper.
Maximum allowable sand / gritty solids content	5,0	%		High levels of sand/grit may affect pellet formation.
Minimum volumetric throughput allowable	600	ℓ/hour	Average feed rate to LaDePa 6m3/day (pers. comm. EWS 4 March 2013), 8 hours/day gives average feed rate of 750 l/hour	To be determined through further testing. This will impact on the number of LaDePa plants required
Maximum volumetric throughput allowable (whilst still achieving required drying and pasteurisation)	1000	ℓ/hour		To be determined through further testing. This will impact on the number of LaDePa plants required. Will be determined by the screw feed system and by the required residence time in the LaDePa system.

5.3 Out of spec feed parameters

Parameters highlighted if out of spec

%DS of sludge too high	0
%DS of sludge too low	0
Detritus fraction	0
Average sand / grit fraction	0

5.4 Pre-treatment processes

5.4.1 Water addition

Parameter	Value	Unit	Notes
Is water addition required?	No	m^3	
Does additive addition require more water to be added?	No		
Volume of water required per m3 sludge	0	m3	
Water price	-	LCU / ℓ	
Annual volume of water added	-	m^3 / year	
Annual cost of additional water	0	LCU / year	
Capital cost of facility for water addition and mixing	-	LCU	Small mixing tank, manual mixing
Land area required for mixing tank	0	m^2	
TOTAL CAPITAL COSTS	-	LCU	
TOTAL OPERATING COSTS	-	LCU / year	
Total land area	0	m^2	

5.4.2 Water removal

Parameter	Value	Unit	Notes
Is increase in dry solids required in the stored sludge?	No		
Does additive provide sufficient increase in dry solids content?	Yes		
Volume of water required to be removed per m3 sludge	0,000	m^3	Takes into account the effect of additives
Annual volume of water removed	0	m^3 / year	
Drying bed loading rate	300	kg DS / m2 / year	Uncovered drying beds in Senegal
Dried sludge solids achieved at this loading rate	60	%	
Volume of sludge required to be treated through drying beds	0	m^3 / year	Assumes some sludge is dried and mixed with wetter sludge to achieve required minimum solids for LaDePa feed
Volume of sludge out of drying beds	0	m^3 / year	
Volume of sludge not treated through drying beds	1330	m^3 / year	
Combined volume of dried and feed sludge	1330	m^3 / year	Sludge from drying beds mixed with untreated feed sludge from storage
Annual solids load	0	tonnes DS / year	
Drying bed area required	0	m2 / year	
Area of each drying bed	10	m2	
Number of drying beds required	0,00	No.	
Construction cost of drying bed facility per m2	4 000,00	LCU / m2	
Total construction cost of drying bed facility	-	LCU	

Capital cost of sludge mixing tank	5 000,00	LCU	For mixing of dried and fresh sludge to achieve required blend
TOTAL CAPITAL COSTS	-	LCU	
Additional operational costs			
Assumes the pre-treatment operation is operated by LaDePa plant staff			
Drying bed cleaning costs (required once / month / bed)	50	LCU / 10 m2 / month	
Drying bed cleaning costs for all beds (required once / month / bed)	-	LCU / month	
Drying bed clearing costs per year	-	LCU / year	
Additional labour	0	No. labourers	Labour in addition to LaDePa plant staff. Choose based on drying bed area - assume one 10 m2 bed takes 2 people one day to clear.
Number of months per year drying beds operated for	12	months / year	
Cost of additional labour	-	LCU / year	
TOTAL OPERATING COSTS	-	LCU / year	
Proportion of total solids remaining in dried FS	50	%	Figures for information only - loss of solids, COD and N across drying bed not currently accounted for in calculations
Proportion of total suspended solids remaining in dried FS	95		
Proportion of COD remaining in dried FS	90	%	
Proportion of nitrogen remaining in dried FS			
Ammonium & urea	-	%	
Nitrate	-	%	
Total nitrogen	-	%	
TKN	70	%	
Average dry solids of combined sludge from drying beds and feed sludge	30	%	
TOTAL CAPITAL COSTS	-	LCU	
NON-DEPRECIABLE CAPITAL	-	LCU	
TOTAL OPERATING COSTS	-	LCU / year	
Total land area	0	m2	Allow for 5% extra over total drying bed area

<u>5.4.3 Detritus removal</u>

Is detritus removal required?	No		
Is detritus removed during a dewatering stage?	No		If yes, then assumed that all detritus is removed from sludge during dewatering
Initial detritus content per m3 of FS	0,200	m3 / m3 FS	
Volume of detritus remaining per m3 of feed FS	0,200	m3 / m3 FS	Per m3 of FS in storage tank
Volume of detritus removed per m3 of FS	0,000	m3 / m3 FS	
Detritus content of screened FS	20,00	% vol	Per m3 of FS fed to LaDePa - takes into account water removal, addition, additive addition and detritus removal
Detritus removed per year	0	m^3 / year	
Capital cost of basic screening facility	-	LCU	Zero for EWS case - screening is manual removal of large items from incoming sludge
Land area required	0	m2	
TOTAL CAPITAL COSTS	-	LCU	
TOTAL OPERATING COSTS	-	LCU / year	
Total land area required	0	m2	

<u>5.4.4 Additives</u>

Is an additive to be used?	No		Choose Yes or No
Additive type	0		For example, incineration ash or a nutrient supplement
Additive dry solids content	0	%DS	
Volumetric proportion of additive in sludge - additive mix	0	%	1/(100-proportion additive))*proportion additive is the volume of additive that has to be added per m3 of FS in storage to achieve the desired mix
Volumetric proportion of additive in sludge - additive mix (used for calculations)	0	%	
Wet mass proportion of additive in sludge - additive mix	0	% wt	
Wet mass proportion of sludge in sludge-additive mix	100	% wt	
Calorific value	0	MJ / kg	
Cost of additive by mass	-	LCU / tonne	
Density of additive	0	kg / m3	
Cost of additive by volume	-	LCU / m3	
Cost of additive by volume	-	LCU / m3	
Dry mass of additive added per kg dry solids of sludge	-	kg dry additive / kg dry sludge	1 kg sludge dry solids with y kg of additive, i.e. 1 + y total mass
Volume of additive added to each m3 of sludge in storage	0,00	m3 / m3 FS	
Annual volume of additive used	0	m^3 / year	
Dry solids content of sludge - additive mix	30	%DS	Average solids of the additive + original FS mixture, does not account for water added or removed
Calorific value of sludge - additive mix	12,35	MJ / kg	Average calorific value of the additive + original FS mixture, does not account for any calorific value of detritus content

Additive composition

COD	-	g BOD / g DS	
Nitrogen			
Ammonium & urea	-	mg ammoniacal N / g DS	
Nitrate	-	mg NO3- / g DS	
Total nitrogen	-	mg N / g DS	
Phosphorus			
Total phosphate	-	mg P / g DS	
Orthophosphate	-	mg ortho-P / g DS	
Potassium	-	mg K / g DS	
Calcium	-	mg Ca / g DS	
Magnesium	-	mg Mg / g DS	
Sulphur	-	mg S / g DS	
Ascaris			
Undeveloped eggs		No. possible viable Ascaris / 20g DS	
Motile larvae in eggs		No. possible viable Ascaris / 20g DS	
Immotile larvae in egg		No. possible viable Ascaris / 20g DS	
Trichuris		Potentially viable eggs / 20g	
Taenia		Potentially viable eggs / 20g	
Faecal coliforms		CFU / g DS	

Financial

Capital cost of facility for additive addition and mixing	-	LCU	Type of facility required will depend on additive - could simply be an additional hopper on the feed to the LaDePa plant, or a mixing tank for sludge and additive prior to being fed to the LaDePa.
Land area required for mixing facility	0	m2	
Annual cost of additive	0	LCU / year	
TOTAL CAPITAL COSTS	-	LCU	
TOTAL OPERATING COSTS	-	LCU / year	
Total land area	0	m2	

<u>Additions to stored sludge</u>

Annual water addition to FS	-	m^3 / year	
Additive type used	-		
Annual additive addition to FS - volume	0	m^3 / year	
Annual additive addition - mass	0	tonnes / year	

<u>Feed sludge to LaDePa process</u>

Overall volume change during pre-treatment	0,000	m3 / m3 FS	Change per m3 of sludge from the storage tank
Average %DS of sludge in FS feed to LaDePa	30,00	%DS	Dry solids of the additive-FS mixture, adjusted to take into account water added/removed. Detritus removal is assumed not to significantly affect %DS of the final mixture
Average detritus fraction of FS feed to LaDePa	20,00	%	
Average calorific value of FS feed to LaDePa	12,35	MJ / kg	Calorific value of detritus is not taken into account
Average sand / grit fraction in feed to LaDePa	3,00	%	
Sand/grit fraction error check	0		Highlighted red - indicated sand/grit fraction is too high. No facility for removal - sludge must be blended with other sludge.
Total N	#VALUE!		Blend of sludge and additive - for information only, not carried through to model calculations
Phosphorus	#VALUE!		Blend of sludge and additive - for information only, not carried through to model calculations
Potassium	#VALUE!		Blend of sludge and additive - for information only, not carried through to model calculations
Annual feed volume per LaDePa plant	1330	m^3 / year / plant	
Annual feed dry mass per LaDePa plant	459	tonnes DS / year / plant	Includes remaining detritus

By-products from pre-treatment

Wastewater volume from water removal	0	m^3 / year	
Detritus removed	0	m^3 / year	
Dry solids in detritus removed	0	tonnes DS / year	Uses the average dry solids of LaDePa feed
Wet mass of detritus removed	0,0	wet tonnes / year	Assumes detritus has same density as sludge

Financial parameters

LaDePa number of working days per month	22	working days / month	
LaDepa number of working months per year	12	working months / year	
LaDePa labourer daily rate	135	LCU / day	

Expenses and revenues summary for ONE pre-treatment facility

Lifetime	10	years	Equal to lifetime of LaDePa plant
TOTAL CAPITAL COSTS	-	LCU	
NON-DEPRECIABLE CAPITAL	-	LCU	
DEPRECIABLE CAPITAL	-	LCU	
START-UP COSTS (YEAR 1 ONLY)		LCU / year	
TOTAL OPERATING COSTS, EXCLUDING FUEL	-	LCU / year	
TOTAL FUEL COSTS		LCU / year	
TOTAL ANNUAL REVENUE		LCU / year	
Total land area required	0	m2	

Combined costs and flows for ALL pre-treatment facilities

Additions to stored sludge

Annual water addition to FS	-	m^3 / year	
Additive type used	-		
Annual additive addition to FS - volume	0	m^3 / year	
Annual additive addition - mass	0	tonnes / year	

Feed sludge to LaDePa process

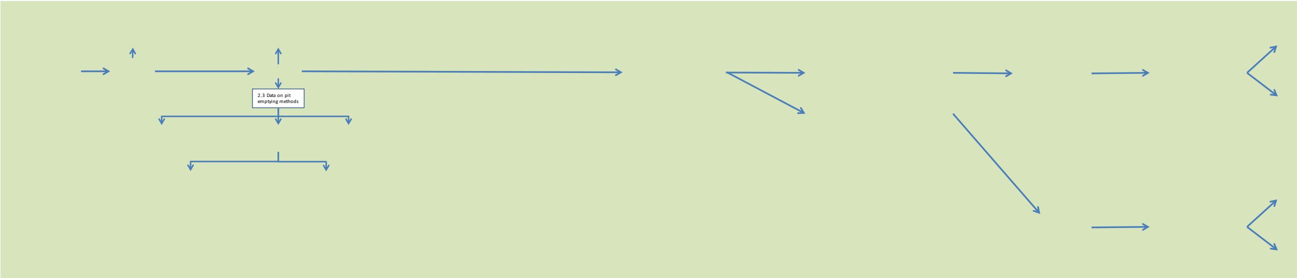
Average %DS of sludge in FS feed to LaDePa	30,00	%DS	Dry solids of the additive-FS mixture, adjusted to take into account water added/removed. Detritus removal is assumed not to significantly affect %DS of the final mixture
Average detritus fraction of FS feed to LaDePa	20,00	%	
Average calorific value of FS feed to LaDePa	12,35	MJ / kg	Calorific value of detritus is not taken into account
Average sand / grit fraction in feed to LaDePa	3,00	%	
Sand/grit fraction error check	0		Highlighted red - indicated sand/grit fraction is too high. No facility for removal - sludge must be blended with other sludge.
Annual feed volume to all LaDePa plants	6650	m^3 / year	
Annual feed dry mass to all LaDePa plants	2294	tonnes DS / year	Includes remaining detritus

By-products from pre-treatment

Wastewater volume from water removal	0	m^3 / year	
Detritus removed	0	m^3 / year	
Dry solids in detritus removed	0	tonnes DS / year	

Financial

Lifetime	10	years	Equal to lifetime of LaDePa plant
TOTAL CAPITAL COSTS	-	LCU	
NON-DEPRECIABLE CAPITAL	-	LCU	
DEPRECIABLE CAPITAL	-	LCU	
START-UP COSTS (YEAR 1 ONLY)	-	LCU / year	
TOTAL OPERATING COSTS, EXCLUDING FUEL	-	LCU / year	
TOTAL FUEL COSTS	-	LCU / year	
TOTAL ANNUAL REVENUE	-	LCU / year	
Total land area required	-	m2	



6. LaDePa FS treatment process

Costs of treating faecal sludge via the LaDePa process

Parameter	Value	Unit	Reference	Notes	User comments
Number of households	35000	No.			
Length of pit-emptying cycle	5	years			
Time between pit-emptying cycles	0	years			
Available years for LaDePa operation	5	years			

6.1 LaDePa feed properties

Parameter	Value	Unit	Reference	Notes	User comments
Allowable LaDePa feed properties					
Minimum % dry solids allowable in feed	20	%DS		TBD at LaDePa	
Maximum % dry solids allowable in feed	41	%DS		TBD at LaDePa	
Maximum % detritus allowable in feed	40	%		TBD at LaDePa	
Maximum allowable sand / gritty solids content	5	%		To be defined better based on LaDePa operation - material that affects the rheology of the sludge - use ash content as an indicator?	
Minimum volumetric throughput allowable	600	ℓ/hour		TBD at LaDePa. Check if vol or mass most appropriate to use	
Maximum volumetric throughput allowable (whilst still achieving required drying and pasteurisation)	1000	ℓ/hour		TBD from min residence time and screw speed	
Actual pre-treated feed properties					
Annual pre-treated FS volumetric feed rate to all LaDePa plants, including detritus	6650	m^3 / year		linked to mass balance	
Annual pre-treatment dry mass feed rate to all LaDePa plants, including detritus	2294	dry tonnes / year			
Average %DS of of pre-treated sludge	30,00	%DS			
Average detritus fraction of pre-treated sludge	20,00	%			
Average calorific value of of of pre-treated sludge sent to LaDePa	12,35	MJ/kg			
Average sand fraction of of pre-treated sludge	3,00	%			
Typical density of VIP sludge	1150	kg / m3		linked to landfill sheet	
Average daily volumetric feed rate per LaDePa plant, including detritus that enters the hopper	6	m^3 / day / plant			
Average volumetric feed rate to LaDePa per plant	666,67	ℓ / hour / plant		TBD at LaDePa	
Dry mass feed rate to LaDePa, including detritus	200,00	dry kg / hour / plant			

6.2 LaDePa operational parameters for one plant running at full capacity

Parameter	Value	Unit	Reference	Notes	User comments
LaDePa annual volumetric capacity	1425,6	m^3 / year		Accounts for downtime	
Years of sludge production per pit-emptying cycle	5	years			
Available number of years for LaDePa operation per pit-emptying cycle	5	years		Includes years between pit-emptying cycles	
Minimum number of LaDePa plants required per year	4,665	No.		Calculated based on volumetric feed of sludge only (detritus removed) & volumetric capacity. Used for operational costs calculation. Assumes that sludge can be processed by LaDePa in the years between pit-emptying cycles	
Number of LaDePa plants in operation	5	No.		Used for royalties, lease rate & capital costs calculation. Select a higher figure if desire to process sludge in a shorter period of time.	
Time taken to process all sludge from one pit-emptying cycle	5,00	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 low, then the time taken to process sludge will be longer than the time available. This may be acceptable if alternative processing is being used in the next pit emptying cycle, for example	
Plant data					
Plant size (design feed rate of sludge)	1000	wet kg / hour		Is it possible in future to correlate throughput to the belt size and array power?	
Design average feed solids	32,5	%DS			
Plant size - belt width	950	mm		For information - PSS gives standard sizes for LaDePa plants in terms of belth length and MIR array power.	
Dryer length	11000	mm		For information	
Area occupied by one plant	160	m2			
Plant size - MIR array power	144	kW		For information	
Operational hours per day	9	hours / day			
Working days per month	22	days / month			
Operational months per year	12	months / year			
Average downtime per year	10	%		This may be the maximum downtime over a year allowed contractually	
Operational days per year	238	days / year			
Operational hours per year	2138	hours / year			
Labour					
Foreman	1	No. / plant			
Labourers	4	No. / plant			
Project manager	0,2	No. / plant			
Commissioning time for new plant	6	months			
Plant lifetime	10	years		Lifespan used for cash flows -Different parts of the plant have different lifetimes, e.g. Generator - 15 years, belt - 1 year, screw conveyer - 9 months	
Power rating for plant (draw at full throughput)	151,75	kW			
Belt drive	0,75	kW		For information	
2 x Screw drives	1,5	kW		For information	
Blower	5,5	kW		For information	
MIR array	144	kW		For information: total figure for 3x arrays	
Power rating of installed diesel engine	310	kW		EWS LaDePa plant only requires a 160 kW engine	
Diesel usage rate	12	ℓ / hour			
Annual LaDePa plant diesel consumption	25661	ℓ / year		Allows for downtime	
Belt apertures	300	micron		For information	
Screw feed (sludge / detritus separation)	-	rpm		For information - to be determined when LaDePa plant testing takes place	
Typical belt rotation cycle length	16	minutes			
Typical belt speed (through drier and MIR)	0,0625	rpm		For wetter sludge, require a slower belt speed (higher drying time). Correlation to be determined when testing can be carried out at LaDePa	
Target depth of sludge on belt	30	mm		Dependent on feed flow of sludge to plant, controlled by eye	
MIR power used	-	kW		MIR power required links to the rate of pre-drying, which is linked to the thermal energy of generator exhaust gases - but not able to quantify at this stage	
Typical residence time of sludge in drier	4	minutes			
Typical residence time of sludge under MIR array	4	minutes			
Product temperature	180 - 220	deg C		For information	
Product average solids content	85,5	%DS			
Product form	Pellets	Description			
Theoretical product rate	300	wet kg / hour		For information	
Theoretical product bagging rate	20	x15kg bags / hour		For information	
Daily volumetric product flow rate	2,21	m^3 / day		Calculated from known dry mass flowrate and measured dry solids of pellets (from 1 m3 of pellets, 855 kg of solids remained - 85.5% DS)	
Annual volumetric product flow rate	524,74	m^3 / year		Accounts for downtime	
Product dry mass flow rate	184,00	dry kg / hour / plant			
Daily product dry mass flow rate	1656,00	dry kg / day / plant			
Annual dry solids flow rate capacity	393 466	dry solids / year / plant		Assumes plant working full time, accounting for downtime	
Product wet density	877,00	kg / m^3			
Hourly product wet mass flow rate	215,20	wet kg / hour / plant		Calculated from dry mass flowrate in & solids content of product	
Daily wet product flow rate	1937	wet kg product / day / plant		c.f. EWS figure 2.5 tonnes/day	
Annual product wet flow rate capacity	460 194	wet kg product / year / plant		Assumes plant workign full time, accounting for downtime	
Product bagging rate	14	x15kg bags / hour / plant			
Evaporation rate	398	ℓ water / h		Based on density of wet VIP sludge, wet product flowrate and wet detritus flowrate	
Evaporation rate	851	m^3 water / year			
Evaporation power use	2,62	ℓ water / kWh			

By-product flow rates

Exhaust gas flowrate	0	m3 / hour	Unknown
Detritus removed at LaDePa	285	m^3 / year / plant at full capacity	Based on volumetric proportion of feed that is detritus. Assumes all remaining detritus removed by screw compactor
Detritus flowrate from LaDePa	0,13	m^3 / working hour / plant	EWS figure 1.2 m3/day - but this does not account for any detritus removal during transit
Detritus dry solids	30,00	% DS	Assumed equal to average FS dry solids
Detritus dry mass flow per year per plant	98,37	dry tonnes / year / plant	
Detritus density	1150	wet kg / m^3	
Detritus dry mass flowrate from LaDePa	40	dry kg / working hour / plant	
Detritus wet mass flowrate from LaDePa	153	wet kg / working hour / plant	
Detritus removed at pre-treatment, for all plants	0	m^3 / year	

Vehicles

Is vehicle purchased?	Yes		
No. pick up trucks	1	No.	
Daily distance travelled	25	km / working day	
Annual distance travelled	6600	km / year	

Facilities

Area required for equipment storage / office	25	m^2	
Parking area	42	m^2	
Additional land area required per LaDePa	67	m^2	
Storage area per LaDePa	-	m^2	
Pre-treatment area per LaDePa	-	m^2	
Product storage area per LaDePa	22,08	m^2	
By-product disposal area per LaDePa	25,00	m^2	

6.3 Financial parameters

Capital and start up costs

			Need a capacity v. capital cost curve for LaDePa plants - information currently not available from PSS
LaDePa plant (152 kW)	-	LCU	Not applicable in SA, where plants are leased from PSS. Capital cost quoted by EWS 4 million ZAR including license
Total site area per LaDePa plant(LaDePa plant, FS storage, pre-treatment, parking, offices, product storage)	274	m2	
Land	-	LCU	
Civils cost for plinth	20 000,00	LCU	
Construction of office / storage area	50 000,00	LCU	
Vehicle - pick up truck	175 000,00	LCU	Populated from Rates sheet if option to purchase vehicle has been chosen
Permitting and legal requirements			
Environmental impact assessment	-	LCU	Cost to EWS of initial EIA LCU 127,000 - likely to be higher than what is routinely required for plants.
Waste licence including EIA	70 000,00	LCU	South Africa: Approx ZAR 50,000 - 70,000 (2013 estimate). Separate EIA not required. However list of waste management activities specifically excludes treatment of sewage - not clear if dedicated treatment of faecal sludge also excluded.
Atmospheric emission licence	-	LCU	Currently plant is below trigger for needing one (EWS 2013)
TOTAL CAPITAL & START-UP COSTS	315 000,00	LCU	
TOTAL CAPITAL COSTS, EXCLUDING LAND	245 000,00	LCU	
NON-DEPRECIABLE CAPITAL	-	LCU	
START-UP COSTS (FOR YEAR 1 ONLY)	70 000,00	LCU	

O&M costs

Labour			
Foremen	120 000,00	LCU / year	
Labourers	142 560,00	LCU / year	
Project manager	84 000,00	LCU / year	
LaDePa plant			
Diesel	316 654,27	LCU / year	EWS figure 21000/m
Lease rate	600 000,00	LCU / year	
Royalties	500 000,00	LCU / year	Includes maintenance contract
Maintenance		LCU / year	EWS model is a separate maintenance contract with PSS.
Other costs	60 000,00	LCU / year	
Vehicle costs			
Vehicle rental	-	LCU / year	
Vehicle maintenance & repair	4 480,35	LCU / year	
Vehicle insurance & license	6 607,00	LCU / year	
Fuel	7 734,47	LCU / year	
Rent of office/storage facilities and land for LaDePa plant	-	LCU / year	
Permitting and legal requirements			
Health and safety	10 000,00	LCU/year	
Monitoring	10 000,00	LCU/year	
Overheads	93 101,80	LCU / year	
TOTAL OPERATING COSTS	1 955 137,89	LCU / year	
TOTAL OPERATING COSTS EXC FUEL	1 630 749,15	LCU / year	
FUEL COSTS	324 388,74	LCU / year	

Revenues from LaDePa plant

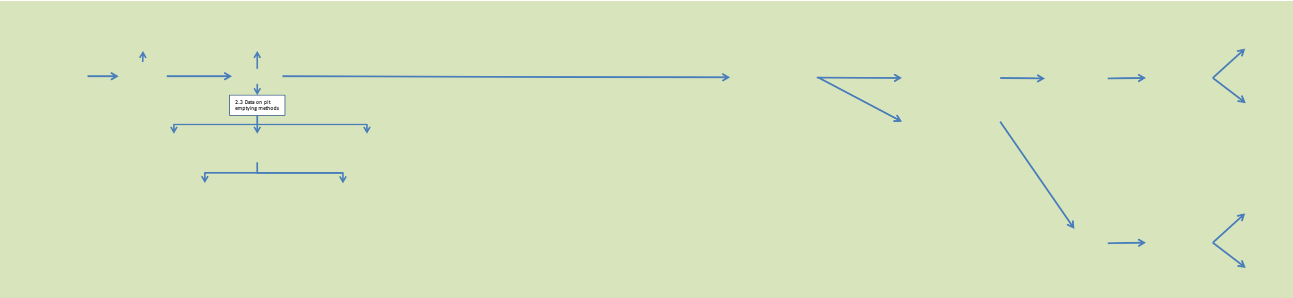
Subsidies	-	LCU/year	
Number of LaDePa plants required	4,66	No.	Used for operational costs calculation
Number of LaDePa plants in operation	5,00	No.	Used for royalties, lease rate & capital costs calculation

Total costs and revenues for all plants

TOTAL CAPITAL & START-UP COSTS	1 575 000,00	LCU	
TOTAL CAPITAL COSTS	1 225 000,00	LCU	
TOTAL CAPITAL COSTS, EXCLUDING LAND	1 225 000,00	LCU	
START-UP COSTS (YEAR 1 OPERATING COSTS)	350 000,00	LCU	
Labour			
Foremen	559 764,31	LCU / year	
Labourers	665 000,00	LCU / year	
Project manager	391 835,02	LCU / year	
LaDePa plant			
Diesel	1 477 098,00	LCU / year	c.f. EWS figure 21000/month/plant
Lease rate	3 000 000,00	LCU / year	Assumed to be paid for complete years
Royalties	2 500 000,00	LCU / year	Assumed to be paid for complete years. Includes maintenance contract
Maintenance		LCU / year	EWS model is a separate maintenance contract with PSS.
Other costs	279 882,15	LCU / year	
Vehicle costs			
Vehicle rental	-	LCU / year	
Vehicle maintenance	20 899,48	LCU / year	
Vehicle insurance & license	33 035,00	LCU / year	
Fuel	36 079,02	LCU / year	c.f. EWS vehicle total costs R7000/month
Rent of office/storage facilities and land for LaDePa plant	-	LCU / year	
Permitting and legal requirements			
Health and safety	46 647,03	LCU/year	
Monitoring	46 647,03	LCU/year	
Overheads	452 844,35	LCU / year	
TOTAL OPERATING COSTS	9 509 731,38	LCU / year	
TOTAL OPERATING COSTS EXC FUEL	7 996 554,36	LCU / year	
FUEL COSTS	1 513 177,02	LCU / year	
TOTAL REVENUE	0	LCU / year	

Financial parameters

Foreman rate	10 000,00	LCU / month	
Labourer daily rate	135,00	LCU / day	Complete only daily rate OR monthly rate
Labourer monthly rate	-	LCU / month	Not applicable if daily rate completed
Project manager rate	35 000,00	LCU / month	
Pick up truck rental rate	7 000,00	LCU / month	
Pick up truck repair & maintenance rate	0,68	LCU / km	
Pick up truck fuel rate	1,17	LCU / km	
Diesel price	12,34	LCU / ℓ	
Pick up truck license & insurance	6 607,00	LCU / year	
Miscellaneous consumables	5 000,00	LCU / month	
Land purchase price	-	LCU / m^2	
Months per year property rented for	12,00	months / year	
Land and property rental price	-	LCU / m^2 / month	Combined rate for buildings and land
Overhead rate	5	%	Covers cost of security and admin staff
Repayment period for debt	5	years	
Escalation rate on O&M costs and revenues, excluding fuel	6	%	
Escalation rate on fuel	12	%	
Debt : equity	70	%	
Depreciation rate	9	%	Straight line depreciation over lifetime of plant
Residual value	10	%	



7. Sale/disposal of LaDePa product

Costs and/or revenue associated with sale/disposal of the LaDePa pellets

Number of LaDePa plants required	4,66	No.	Calculated based on volumetric feed & volumetric capacity	Used for operational costs calculation. Assumes that sludge can be processed by LaDePa in the years between pit-emptying cycles
Number of LaDePa plants in operation	5	No.		Used for royalties, lease rate & capital costs calculation

Product characteristics

Parameter	Value	Unit	Reference	Comment	User notes
Daily product flow rate capacity per plant - mass	1 937	wet kg product / day / plant		Calculated on feed rate to LaDePa, dry solids in, dry solids out	
Actual daily product flow rate from all plants	9 035	wet kg product / day		Calculated based on fractional number of LaDePa plants required	
Annual product flow from all plants	2 146,67	tonnes wet product (pellets) / year			
Annual dry mass product flow from all plants	1 835,40	dry tonnes / year			
Annual volumetric flow of product from all plants					
Figures for one LaDePa plant working at full capacity					
Daily product flow rate - bags	126	x15 kg bags / day			
Annual product flow rate - mass	460 194	wet kg product / year / plant		Number of days LaDePa operation including downtime x daily product flowrate	
Annual product flow rate - bags	30 680	x15 kg bags / year			
Daily volumetric product flow rate	2,208485867	m^3 / day			
Annual volumetric product flow rate	524,736242	m^3 / year			
Product dry solids	85,5	%DS			
Product form	Pellets	Description			
Approximate pellet diameter	5,7	mm			
Physico-chemical properties					
Volatile solids	16,17	%VS			
Calorific value	4,3198	MJ/kg dry solids			
Chemical oxygen demand (COD)	82,2	mg COD / g DS			
Total carbon content	-	mg / g DS			
Nitrogen					
Total N	9,00	mg N / g DS			
TKN	6,00	mg TKN / g DS			
Ammonia	0,00	mg / g DS			
Ammonium & urea	1,82	mg ammoniacal N / g DS			
Nitrate	3,46	mg NO3- / g DS			
Phosphorus					
Total P	17,30	mg P / g DS			
Total phosphate (most of it may become plant-available after decomposition)	1,63	mg P as PO4 / g DS			
Orthophosphate (plant-available)	0,49	mg ortho-P / g DS			
Potassium (K)	1,80	mg K / g DS			
Calcium (Ca)	27,60	mg Ca / g DS			
Magnesium (Mg)	3,00	mg Mg / g DS			
Sulphur (S)	-	mg S / g DS			
Boron (B)	0,0504	mg B / g DS		micro-nutrient	
Copper (Cu)	0,1136	mg Cu / g DS		micro-nutrient	
Molybdenum (Mo)	ND	mg Mo / g DS		micro-nutrient	
Zinc (Zn)	0,5076	mg Zn / g DS		micro-nutrient	
Undesirables					
Pathogen content					
Ascaris					
Undeveloped eggs	1	No. possible viable Ascaris / 20g DS			
Motile larvae in eggs	0	No. possible viable Ascaris / 20g DS			
Immotile larvae in egg	0	No. possible viable Ascaris / 20g DS			
Trichuris	257	Potentially viable eggs / 20g			
Taenia	37	Potentially viable eggs / 20g			
Faecal coliforms	-	CFU / g DS			
Heavy metals					
Heavy metals (*Cr, Be, *As, *Sb, Ba, *Pb, Ag, *Co, *Ni, *Cu, Sn, *V, *Mn)	-				
Heavy metals (*Cd, *Hg, *Tl)	-			Possible lower permit limit applies to these c.f. group above, as more toxic? (it does for air emissions of heavy metals)	
As	0,0063	mg As / g DS			
B	0,0504	mg B / g DS			
Cu	0,1136	mg Cu / g DS			
Co	0,0068	mg Co / g DS			
Ni	ND	mg Ni / g DS			
Mo	ND	mg Mo / g DS			
Pb	0,4000	mg Pb / g DS			
Al	16,8082	mg Al / g DS			
Cr	0,0590	mg Cr / g DS			
Hg	0,0398	mg Hg / g DS			
Zn	0,5076	mg Zn / g DS			

Fertiliser regulation limits

Applicable regulations	Department of Agriculture, Forestry and Fisheries 2012 Regulations regarding fertilisers	
Cd	0,02	mg / g
Co	0,1	mg / g
Cr	1,75	mg / g
Cu	0,75	mg / g
Hg	0,01	mg / g
Mo	0,025	mg / g
Ni	0,2	mg / g
Pb	0,4	mg / g
Zn	2,75	mg / g
As	0,015	mg / g
Se	0,015	mg / g
B	0,08	mg / g
F	0,4	mg / g

Bagging costs

Packaging cost per bag	1	LCU / 15kg bag	
Annual packaging costs	30 679,58	LCU / year	
Storage			
Number of days product storage required on-site	10	working days	
Storage area required	22,08	m2	Assuming maximum height of 1m for product stockpile

General product expenses for one LaDePa plant at full capacity

Total depreciable capital costs		LCU
Total non-depreciable capital costs		LCU
Start up costs (year 1 only)		LCU
Total operating costs, excluding fuel	30 679,58	LCU / year
Total fuel costs		LCU / year
Total land area required	22,08	m2

General product expenses for all LaDePa plants

Number of LaDePa plants required	4,66	No.	Used for operational costs calculation. Assumes that sludge can be processed by LaDePa in the years between pit-emptying cycles
Number of LaDePa plants in operation	5	No.	Used for royalties, lease rate & capital costs calculation
Total depreciable capital costs	0	LCU	
Total non-depreciable capital costs	0	LCU	
Start up costs (year 1 only)	0	LCU	
Total operating costs, excluding fuel	143 111,11	LCU / year	
Total fuel costs	0	LCU / year	
Total land area required	110,42	m2	

Disposal routes - costs per LaDePa plant

Choice of disposal route	1	Choices: 1 - Wholesale to agriculture 2 - Bag sale to general public / garden centres 3 - Landfill 4 - Incineration
Chosen disposal route	Wholesale to agricultural industry	

Financial parameters

Transport costs
Assumes vehicle already owned, insured & licensed - by LaDePa operator, or by buyer. Only maintenace & fuel costs covered here.

Truck capacity - mass	3	tonnes	Complete mass OR volume capacity	
Truck capacity - volume	-	m^3		
Mileage rate	6,66	km / ℓ diesel		
Maintenance costs	1,05	LCU / km		List
Fuel type	2	No.	Choose 1 for Gasoline or 2 for Diesel	1
Gasoline price	12,88	LCU / ℓ		2
Diesel price	12,34	LCU / ℓ		
Vehicle average speed	50	km / hour		
Driver labour rate	30	LCU / hour		

Option 1: Wholesale to agricultural industry

Cost of fertiliser product registration	3 120,00	LCU	
Cost of analysis accompanying fertiliser product registration	3 300,00	LCU	
Delivery distance	0	km	
Number of return trips required	0	No. / year	
Time for one return trip	0,5	hours	
Labour cost per trip	15,0	LCU / return trip	
Fuel cost per trip	0,0	LCU / return trip	
Maintenance cost per trip	0,0	LCU / return trip	
Transport cost per trip	15,0	LCU / return trip	
Total annual transport costs	-	LCU / year	
Total annual costs	6 420,00	LCU / year	
Sale price of product	-	LCU / tonne	Sale prices are selected in section 20 of the model, based on calcuated values for the pellets.
Total capital costs		LCU	
Depreciable capital		LCU	
Total startup costs (year 1 only)	6 420,00	LCU	
Total operating costs, excluding fuel	-	LCU / year	
Total fuel costs	-	LCU / year	
Total revenue	-	LCU / year	

Option 2: Sale to general public / garden centres

Additional packaging costs per bag	1	LCU / 15 kg bag	
Additional packaging costs per year	30 679,58	LCU / year	
Cost of fertiliser product registration	3 120,00	LCU	
Cost of analysis accompanying fertiliser product registration	3 300,00	LCU	
Delivery distance	0	km	
Number of return trips required	0	No. / year	
Time for one return trip	0,5	hours	
Labour cost per trip	15,0	LCU / return trip	
Fuel cost per trip	0,0	LCU / return trip	
Maintenance cost per trip	0,0	LCU / return trip	
Transport cost per trip	15,0	LCU / return trip	
Total annual transport costs	-	LCU / year	
Total annual costs	37 099,58	LCU / year	
Sale price of product	-	LCU / tonne	Sale prices are selected in section 20 of the model, based on calcuated values for the pellets.
Total capital costs		LCU	
Depreciable capital		LCU	
Total startup costs (year 1 only)	6 420,00	LCU	
Total operating costs, excluding fuel	30 679,58	LCU / year	
Total fuel costs	-	LCU / year	
Total revenue	-	LCU / year	

Option 3: General landfill

Landfill cost - by volume	-	LCU / m3	
Landfill cost - by mass	1 300,00	LCU / tonne	
Annual landfill fees	598 251,79	LCU / year	
Distance to landfill site	40	km	
Landfill cost includes transport?	Yes		Enter 1 or 0. 1 = Yes, 0 = No
Number of return trips required	153	No. / year	
Time for one return trip	2,1	hours	
Labour cost per trip	63,0	LCU / return trip	
Fuel cost per trip	148,2	LCU / return trip	
Maintenance cost per trip	84,2	LCU / return trip	
Transport cost per trip	295,4	LCU / return trip	
Total calculated annual transport costs	45 316,25	LCU / year	
Total annual transport costs, excluding fuel	-	LCU / year	
Total annual fuel costs	-		
Total annual cost of disposal	598 251,79	LCU / year	
Total capital costs		LCU	
Depreciable capital		LCU	
Total startup costs (year 1 only)		LCU	
Total operating costs, excluding fuel	598 251,79	LCU / year	
Total fuel costs	-	LCU / year	

Option 4: Incineration

Delivery distance	35	km	
Number of return trips required	153	No. / year	
Time for one return trip	1,9	hours	
Labour cost per trip	57,0	LCU / return trip	
Fuel cost per trip	129,7	LCU / return trip	
Maintenance cost per trip	73,7	LCU / return trip	
Transport cost per trip	260,4	LCU / return trip	
Total annual transport costs	39 939,34	LCU / year	
Total annual fuel costs	20 043,68	LCU / year	
Total annual costs	39 939,34	LCU / year	
Sale price of product	-	LCU / tonne	Sale prices are selected in section 20 of the model, based on calcuated values for the pellets.
Total capital costs		LCU	
Depreciable capital		LCU	
Total startup costs (year 1 only)		LCU	
Total operating costs, excluding fuel	19 895,66	LCU / year	
Total fuel costs	20 043,68	LCU / year	
Total revenue	-	LCU / year	

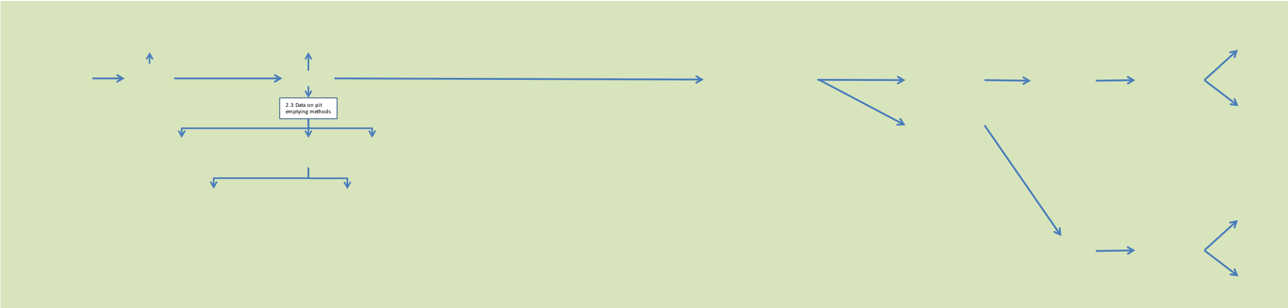
Disposal routes - costs for ALL plants

	1	2	3	4	5	6
Option number		Total startup costs LCU	Total operating costs, excluding fuel LCU / year	Total fuel costs LCU / year	Total revenue	
1	Wholesale to agricultural industry	32 100,00	-	-	-	
2	Sale to general public / garden centres	32 100,00	143 111,11	-	-	
3	General landfill	-	2 790 666,67	-		
4	Incineration	-	92 807,34	93 497,81	-	

Total mass of NPK contained in product

Annual dry mass of pellets	1 835,40	dry tonnes / year

N content	9,00	mg N / g DS
P content	17,30	mg P / g DS
K content	1,80	mg K / g DS
Annual mass of N produced	16 519	kg N / year
Annual mass of P produced	31 752	kg P / year
Annual mass of K produced	3 304	kg K / year
Total annual mass of NPK produced	51,57	tonnes NPK / year



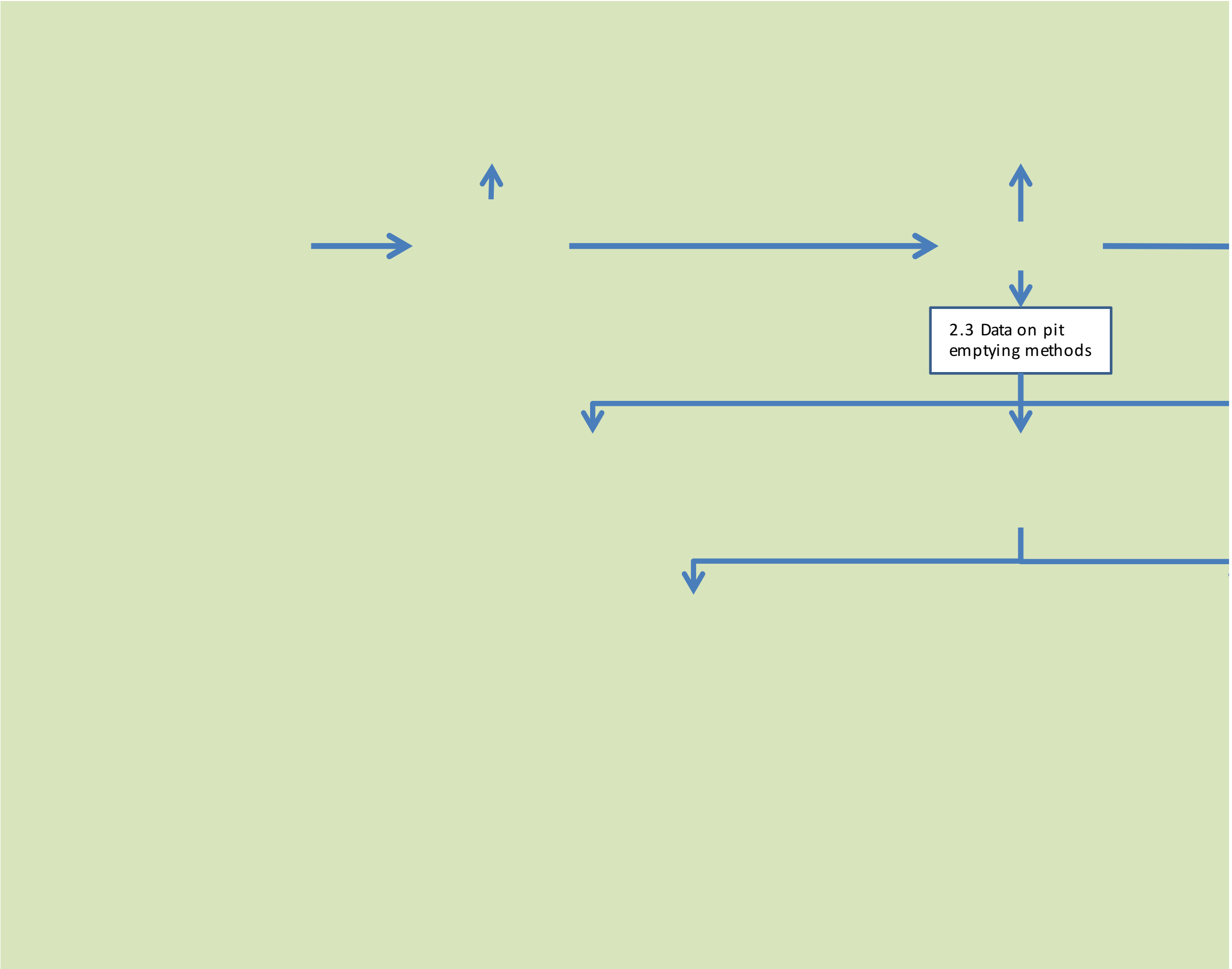
8. Disposal of LaDePa by-products

Costs associated with disposal of LaDePa process by-products
These costs exclude items which are covered under the establishment of the LaDePa plant - e.g. waste and atmospheric emission licence fees.

Parameter	Value	Unit	Reference	Comment	User notes
8.1 By-product characteristics					
Detritus					
Detritus removed during pre-treatment	0	m^3 / year			
Detritus removed per LaDePa plant at full capacity	285	m^3 / year / plant at full capacity			
Land area required per plant for on-site storage of detritus, prior to disposal	25	m2			
Number of LaDePa plants required per year	4,66	No.			
Number of LaDePa plants in operation	5,00	No.			
Total wet detritus flowrate	1 330	m^3 / year		Accounts for partial operation of one of the plants	
Average density of detritus	1 150	kg / m^3			
Mass flowrate	1 530	wet tonnes / year			
Water loss from detritus	5	% of total volume		Evaporation and leaching during storage	
Volumetric flowrate of detritus to disposal	1 264	m^3 / year			
Mass flowrate of detritus to disposal	1 453	wet tonnes / year			
Average calorific value of detritus	-	MJ / kg		Unknown	
Options for disposal					
Hazardous waste landfill	1	Code			
Incineration	2	Code			
Choice of disposal option	1			Choose 1 (Landfill) or 2 (Incineration)	List: 1, 2
Air emissions					
Exhaust gas flowrate	0	m^3 / hour		unknown	
Threshold over which treatment required		m^3 / hour		To be determined	
Constituents & flowrates				To be determined	
Total land area required for all plants for detritus storage prior to disposal	125	m2			
8.2 Financial parameters					
Detritus					
Landfill					
Landfill cost - by volume	-	LCU / m3			
Cost of landfill	1700	LCU / tonne		Transport is often charged by volume, landfill charges by mass. Detritus must go to hazardous landfill.	
Annual landfill fees	2 470 142,50	LCU / year			
Distance to landfill site	40	km			
Landfill cost includes transport?	Yes				
Truck capacity - mass	3	tonnes			
Truck capacity - volume	-	m^3			
Mileage rate	6,66	km / ℓ diesel			
Maintenance costs	1,05	LCU / km			
Fuel type	2	No.		Choose 1 for Gasoline or 2 for Diesel	
Gasoline price - fuel type 1	12,88	LCU / ℓ			
Diesel price - fuel type 2	12,34	LCU / ℓ			
Vehicle average speed	50	km / hour			
Driver labour rate	30	LCU / hour			
Number of return trips required	484	No. / year			
Time for one return trip	2,10	hours			
Labour cost per trip	63,0	LCU / return trip			
Fuel cost per trip	148,2	LCU / return trip			
Maintenance cost per trip	84,2	LCU / return trip			
Transport cost per trip	295,4	LCU / return trip			
Total yearly transport costs	143 082,46	LCU / year			
Total annual fuel costs	71 793,11	LCU / year			
Total annual cost of disposal	2 470 142,50	LCU / year			
Incineration					
Cost of incineration	-	LCU / tonne		Incinerator operator fee	
Annual cost of incineration	#VALUE!	LCU / year			
Distance to incinerator site	25	km			
Incinerator cost includes transport?	Yes			Choose Yes or No	
Truck capacity - mass	3	tonnes			
Truck capacity - volume	0	m^3			
Mileage rate	6,66	km / ℓ diesel			
Maintenance costs	1,05	LCU / km			
Fuel type	2	No.		Choose 1 for Gasoline or 2 for Diesel	
Gasoline price - fuel type 1	12,88	LCU / ℓ			
Diesel price - fuel type 2	12,34	LCU / ℓ			
Vehicle average speed	50	km / hour			
Driver labour rate	30	LCU / hour			
Number of return trips required	484	No. / year			
Time for one return trip	1,50	hours			
Labour cost per trip	45,0	LCU / return trip			
Fuel cost per trip	24,7	LCU / return trip			
Maintenance cost per trip	52,6	LCU / return trip			
Transport cost per trip	122,3	LCU / return trip			
Total annual transport costs	59 233,82	LCU / year			
Total annual fuel costs	11 953,55	LCU / year			
Total annual cost of disposal	#VALUE!	LCU / year			
Chosen disposal option:	Hazardous waste landfill				
Total annual cost of detritus disposal by chosen option, excluding fuel	2 398 349,39	LCU / year			
Total annual fuel cost of detritus disposal by chosen option	71 793,11	LCU / year			
Air emissions					
Costs need further detailing - information not currently available					
Atmospheric emission license	Cost included on LaDePa sheet			Currently plant is below trigger for needing one (EWS 2013). To be determined by EIA currently in progress.	
Routine monitoring					
Treatment system				e.g. scrubber / filter	
Total annual cost of air emissions discharge, excluding fuel		LCU / year			
Total fuel cost of air emissions discharge		LCU / year			

8.3 Total costs of LaDePa by-product disposal

Total capital costs of LaDePa by-product disposal		LCU
Depreciable capital		LCU
Non-depreciable capital		LCU
Start up costs		LCU
Total operating costs of LaDePa by-product disposal	2 470 142,50	LCU / year
Total operating costs of LaDePa by-product disposal, excluding fuel	2 398 349,39	LCU / year
Fuel costs	71 793,11	LCU / year



9.1 LaDePa costs summary (storage, pre-treatment, LaDePa process, product

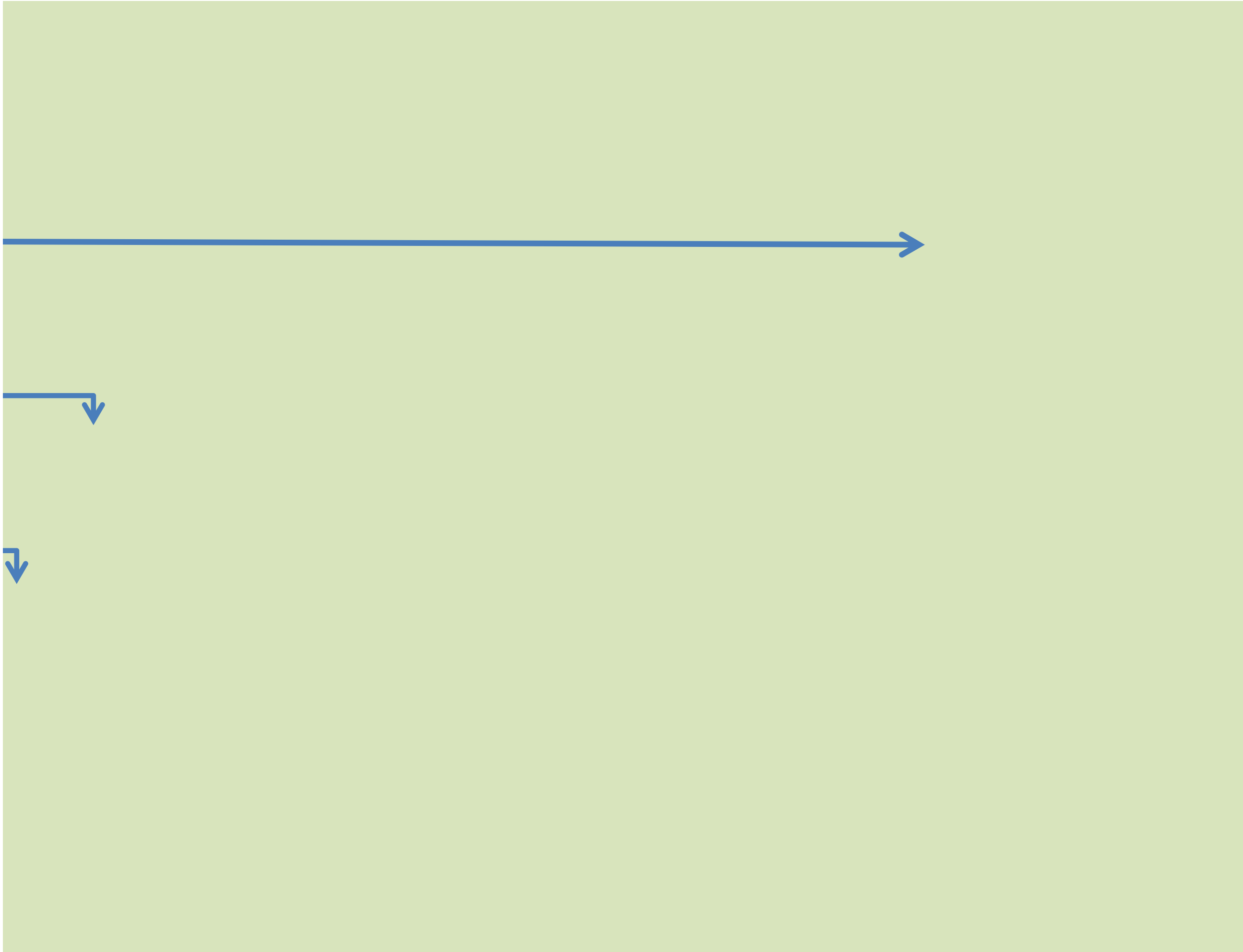
LaDePa process

Is the cost of emptying and conveyance to be included in the LaDePa cash flows?	Yes

	Value
Total capital costs	
Storage	100 000,00
Pre-treatment	-
LaDePa process	1 225 000,00
Product - general	0
By-product disposal	0
Total capital cost	1 325 000,00
Depreciable capital	
Storage	100 000,00
Pre-treatment	-

LaDePa process	1 225 000,00
Product - general	-
By-product disposal	-
Total depreciable capital	1 325 000,00
Non-depreciable capital	
Total non-depreciable capital	-
Startup costs (for year 1 only)	
Managing contractor establishment costs	1 000 000,00
Storage	-
Pre-treatment	-
LaDePa process	350 000,00
Product - general	-
Product - specific to disposal route	32 100,00
By-product disposal	-
Total startup costs	382 100,00
Operating costs, excluding fuel	
Storage	13 200,00
Pre-treatment	-
LaDePa process	7 996 554,36
Product - general	143 111,11
Product - specific to disposal route	-
By-product disposal	2 398 349,39
Managing contractor annual costs	600 000,00
Managing contractor markup rate	15,00
Managing contractor markup	Markup is calculated on cash flow sheet
Total operating costs, excluding fuel	11 151 214,87
Emptying and conveyance costs for sludge	4 831,06
Annual mass FS arriving at Storage	2 294,25
Total annual emptying and conveyance costs	11 083 664,62
Total annual emptying and conveyance costs to be included in LaDePa cash flows	11 083 664,62
Fuel costs	

Storage	-
Pre-treatment	-
LaDePa process	1 513 177,02
Product - general	-
Product - specific to disposal route	-
By-product disposal	71 793,11
Total fuel costs	1 584 970,12
Revenues	
Storage	-
Pre-treatment	-
LaDePa process	-
Product - general	
Product - specific to disposal route	-
By-product disposal	
Total revenues	-
Financial parameters	
Debt proportion in debt:equity ratio	70
Debt	927 500,00
Interest	9
Lifespan of equipment	10
Repayment period	5
Instalment per quarter	46 375,00
Terminal value of assets	10
Depreciation rate	9
Escalation rate - general	6
Escalation rate - fuel	12
Discount rate	8



, product and by-product disposal)

Yes or No

Unit	Reference	Notes
LCU		
LCU		
LCU		
LCU		Only costs that are common to all product sale/disposal routes
LCU		
LCU		
LCU		
LCU		

LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
%	
LCU / year	
LCU / year	Excludes emptying & conveyance costs and managing contractor markup
LCU / tonne dry solids	Price paid to pit-emptying sub-contractor (includes sub-contractor markup)
tonnes dry solids / year	
LCU / year	
LCU / year	

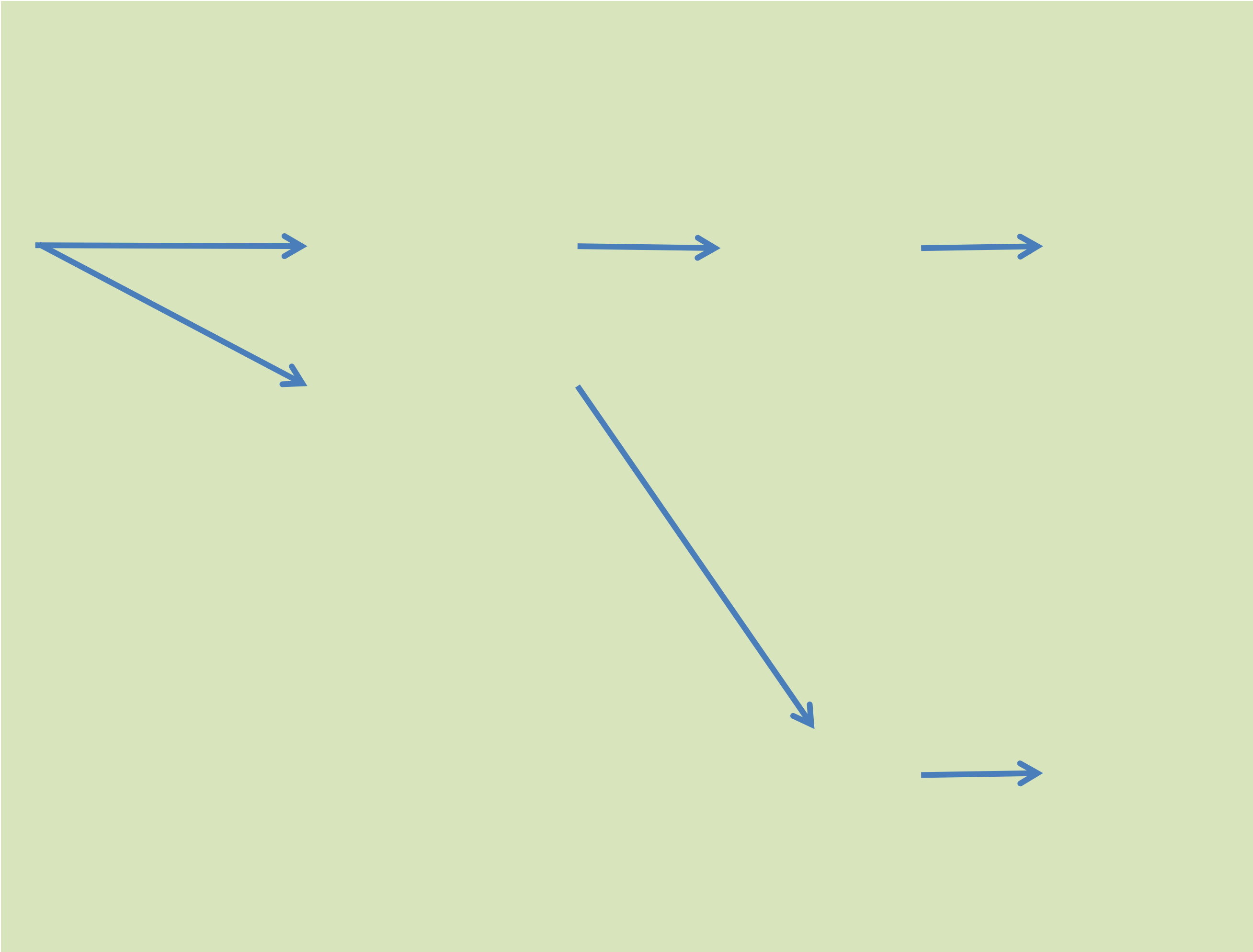
LCU / year
LCU / year
LCU / year
LCU / year
LCU / year
LCU / year

LCU / year

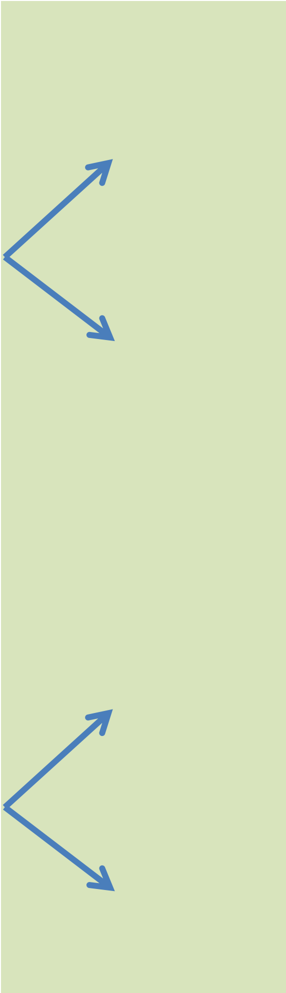
LCU / year
LCU / year
LCU / year
LCU / year
LCU / year
LCU / year

LCU / year

%
LCU
%
years
years
LCU / quarter
% of initial value
%
%
%
%



User comment



9.2 LaDePa interest and repayment

Parameter	Value
Capital cost	1 325 000,00
Debt proportion in debt:equity ratio	70
Debt	927 500,00
Interest	9
Lifespan of equipment	10
Repayment period	5
Instalment per quarter	46 375,00

		Opening balance
	1	
Q1		927 500,00
Q2		881 125,00
Q3		834 750,00
Q4		788 375,00
	2	
Q1		742 000,00
Q2		695 625,00
Q3		649 250,00
Q4		602 875,00
	3	
Q1		556 500,00
Q2		510 125,00
Q3		463 750,00
Q4		417 375,00
	4	
Q1		371 000,00
Q2		324 625,00
Q3		278 250,00
Q4		231 875,00
	5	
Q1		185 500,00
Q2		139 125,00
Q3		92 750,00
Q4		46 375,00
	6	
Q1		- 0,00
Q2		- 0,00
Q3		- 0,00
Q4		- 0,00
	7	
Q1		- 0,00

Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	8	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	9	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	10	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	11	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	12	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	13	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	14	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	15	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	16	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00

	17	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	18	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	19	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
	20	
Q1	-	0,00
Q2	-	0,00
Q3	-	0,00
Q4	-	0,00
TOTALS		

Unit
LCU
%
LCU
%
years
years
LCU / quarter

	Interest payable	Repayment at end of quarter
	20 868,75	46 375,00
	19 825,31	46 375,00
	18 781,88	46 375,00
	17 738,44	46 375,00
	16 695,00	46 375,00
	15 651,56	46 375,00
	14 608,13	46 375,00
	13 564,69	46 375,00
	12 521,25	46 375,00
	11 477,81	46 375,00
	10 434,38	46 375,00
	9 390,94	46 375,00
	8 347,50	46 375,00
	7 304,06	46 375,00
	6 260,63	46 375,00
	5 217,19	46 375,00
	4 173,75	46 375,00
	3 130,31	46 375,00
	2 086,88	46 375,00
	1 043,44	46 375,00
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	219 121,88	927 500,00

Closing balance

	881 125,00
	834 750,00
	788 375,00
	742 000,00
	695 625,00
	649 250,00
	602 875,00
	556 500,00
	510 125,00
	463 750,00
	417 375,00
	371 000,00
	324 625,00
	278 250,00
	231 875,00
	185 500,00
	139 125,00
	92 750,00
	46 375,00
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9.3 LaDePa cash flow

Total depreciable capital	1 325 000,00
Total non-depreciable capital	-
Total operating costs, excluding fuel	11 151 214,87
Emptying & conveyance costs for years where pit emptying occurs	11 083 664,62
Managing contractor markup rate	15,00
Total startup costs	382 100,00
Total fuel costs	1 584 970,12
Total revenue	-
Repayment period for debt	5
Lifespan of equipment	10
Terminal value of assets	10
Depreciation rate	9
Escalation rate - general	6
Escalation rate - fuel	12
Discount rate	8
Income tax rate	28
Does income tax apply?	No
Income tax rate	0

Dry mass of FS going from storage to pre-treatment per year	2294,25
Number of pits emptied per year during pit-emptying cycle	7000,00
Mass of LaDePa pellets produced per year	2146,67

Interest & repayment summary

Year

Interest payable

Principle payable

Cash flows Expenses positive, income

Parameter	**Unit**
Depreciable cost	LCU
Interest on loan	LCU / year
Depreciation	LCU / year
O&M costs, excluding fuel	LCU / year
Emptying & conveyance costs	LCU / year
Managing contractor markup	LCU / year
Start-up costs (year 1 only)	LCU / year
Fuel costs	LCU / year
Total expenses	**LCU / year**

Salvage value	LCU
Revenues	LCU / year
Subsidy	
Net profit before tax (PBT)	**LCU / year**
Tax	LCU / year
Profit after tax (PAT)	LCU / year
Discounted total cost	LCU / year
Mass of FS entering pre-treatment	tonnes / year
Number of pits emptied	pits / year
Mass of LaDePa pellets produced	tonnes / year
Levelised cost of pit-emptying & sludge disposal per dry tonne FS	**LCU / tonne FS**
Levelised cost of pit emptying & sludge disposal per pit	**LCU / pit**
Levelised cost of LaDePa pellets	**LCU / tonne pellets**

Length of pit-emptying cycle	5
Time between pit-emptying cycles	0
Number of pits per cycle	35000
Pits per year during cycle	7000

Pit emptying schedule

No. pits emptied / year

LCU
LCU
LCU / year
LCU / year

%
LCU
LCU / year
LCU / year
years
years
% of initial value
%
%
%
%
%

%

dry tonnes / year Includes detritus

pits / year
wet tonnes / year

0	1	2	3	4
	77 214,38	60 519,38	43 824,38	27 129,38
	185 500,00	185 500,00	185 500,00	185 500,00

tive, income negative

	Year			
1 325 000,00	**1**	**2**	**3**	**4**
	77 214,38	60 519,38	43 824,38	27 129,38
	119 250,00	119 250,00	119 250,00	119 250,00
	11 151 214,87	11 820 287,76	12 529 505,02	13 281 275,33
	11 083 664,62	11 748 684,50	12 453 605,57	13 200 821,90
	3 335 231,92	3 535 345,84	3 747 466,59	3 972 314,58
	382 100,00			
	1 584 970,12	1 775 166,54	1 988 186,52	2 226 768,90
	27 733 645,91	**29 059 254,00**	**30 881 838,07**	**32 827 560,09**

-	-	-	-
-	-	-	-
27 733 645,91	**29 059 254,00**	**30 881 838,07**	**32 827 560,09**
-	-	-	-
27 733 645,91	29 059 254,00	30 881 838,07	32 827 560,09
27 733 645,91	26 906 716,67	26 476 198,62	26 059 575,59
2294,25	2294,25	2294,25	2294,25
7000	7000	7000	7000
2146,67	2146,67	2146,67	2146,67
11 139			
3 651			
11 905			
1	0,925925926	0,85733882	0,793832241
1	**2**	**3**	**4**
7000	7000	7000	7000

5	6	7	8	9
10 434,38 -	0,00 -	0,00 -	0,00 -	0,00
185 500,00	-	-	-	-

5	6	7	8	9
10 434,38 -	0,00 -	0,00 -	0,00 -	0,00
119 250,00	119 250,00	119 250,00	119 250,00	119 250,00
14 078 151,84	14 922 840,96	15 818 211,41	16 767 304,10	17 773 342,34
13 992 871,21	14 832 443,49	15 722 390,10	16 665 733,50	17 665 677,51
4 210 653,46	4 463 292,67	4 731 090,23	5 014 955,64	5 315 852,98
2 493 981,17	2 793 258,91	3 128 449,98	3 503 863,98	3 924 327,66
34 905 342,07	**37 131 086,02**	**39 519 391,72**	**42 071 107,22**	**44 798 450,49**

-	-	-	-	-
-	-	-	-	-
34 905 342,07	**37 131 086,02**	**39 519 391,72**	**42 071 107,22**	**44 798 450,49**
-	-	-	-	-
34 905 342,07	37 131 086,02	39 519 391,72	42 071 107,22	44 798 450,49
25 656 468,44	25 270 793,23	24 903 920,33	24 548 086,98	24 203 208,88
2294,25	2294,25	2294,25	2294,25	2294,25
7000	7000	7000	7000	7000
2146,67	2146,67	2146,67	2146,67	2146,67
0,735029853	0,680583197	0,630169627	0,583490395	0,540268885
5	**6**	**7**	**8**	**9**
7000	7000	7000	7000	7000

10	11	12	13	14
- 0,00	- 0,00	- 0,00	- 0,00	- 0,00
-	-	-	-	-

10	11	12	13	14
- 0,00	- 0,00	- 0,00	- 0,00	- 0,00
119 250,00	-	-	-	-
18 839 742,88	-	-	-	-
18 725 618,16	-	-	-	-
5 634 804,16	-	-	-	-
4 395 246,98	-	-	-	-
47 714 662,18	**- 0,00**	**- 0,00**	**- 0,00**	**- 0,00**

-	132 500,00	-	-	-	-
	-	-	-	-	-
	47 582 162,18 -	**0,00 -**	**0,00 -**	**0,00 -**	**0,00**
	-	-	-	-	-
	47 582 162,18 -	0,00 -	0,00 -	0,00 -	0,00
	23 802 927,49	-	-	-	-
	2294,25	0,00	0,00	0,00	0,00
	7000	0	0	0	0
	2146,67	0,00	0,00	0,00	0,00
	0,500248967				
	10	**11**	**12**	**13**	**14**
	7000	0	0	0	0

15	**16**	**17**	**18**	**19**
- 0,00	- 0,00	- 0,00	- 0,00	- 0,00
-	-	-	-	-

15	**16**	**17**	**18**	**19**
- 0,00	- 0,00	- 0,00	- 0,00	- 0,00
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
- 0,00	**- 0,00**	**- 0,00**	**- 0,00**	**- 0,00**

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-	-	-	-	-
- 0,00	**- 0,00**	**- 0,00**	**- 0,00**	**- 0,00**
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- 0,00	- 0,00	- 0,00	- 0,00	- 0,00
-	-	-	-	-
0,00	0,00	0,00	0,00	0,00
0	0	0	0	0
0,00	0,00	0,00	0,00	0,00

15	**16**	**17**	**18**	**19**
0	0	0	0	0

	20
-	0,00
	-
	20
-	0,00
	-
	-
	-
	-
	-
-	**0,00**

	-
	-
-	**0,00**
	-
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	-
	0,00
	0
	0,00
	20
	0

9.4 LaDePa NPV & IRR calculations

Total depreciable capital	1 325 000,00
Total non-depreciable capital	-
Total operating costs, excluding fuel	11 151 214,87
Emptying & conveyance costs for years where pit emptying occurs	11 083 664,62
Managing contractor markup rate	15,00
Total startup costs	382 100,00
Total fuel costs	1 584 970,12
Total revenue	-
Repayment period for debt	5
Lifespan of equipment	10
Terminal value of assets	10
Depreciation rate	9
Escalation rate - general	6
Escalation rate - fuel	12
Discount rate	8
Income tax rate	28

Dry mass of FS entering pre-treatment	2294,25
Number of pits empties per year	7000
Mass of LaDePa pellets produced	460,19

Interest & repayment summary

Year

Interest payable

Principle payable

Cash flows

Parameter	**Unit**
Depreciable cost	LCU
O&M costs, excluding fuel	LCU / year
Emptying & conveyance costs	LCU / year
Managing contractor markup	LCU / year
Start-up costs (year 1 only)	LCU / year
Fuel costs	LCU / year
Revenues	LCU / year
PBDIT	LCU / year
Depreciation	LCU / year
PBIT	**LCU / year**
Interest on loan	LCU / year

PBT	**LCU / year**
Tax	LCU / year
PAT	**LCU / year**
Salvage value	LCU
Subsidy	LCU
Project cost	LCU
Net cash flow for NPV & IRR	**LCU / year**
Discounted total cost	LCU / year

NPV
IRR

Length of pit-emptying cycle	5
Time between pit-emptying cycles	0
Number of pits per cycle	35000
Pits per year during cycle	7000

Pit emptying schedule
No. pits emptied / year

<u>Equity IRR</u>

Principal repayment
Depreciation
Salvage value
Subsidy
Project equity
Net cash flow

Equity IRR

LCU
LCU
LCU
LCU / year

%
LCU
LCU
LCU
years
years
% of initial value
%
%
%
%
%

tonnes / year
pits / year
tonnes / year

0	1	2	3	4
	77 214,38	60 519,38	43 824,38	27 129,38
	185 500,00	185 500,00	185 500,00	185 500,00

	Year							
0		**1**		**2**		**3**		**4**
1 325 000,00								
	-	11 151 214,87	-	11 820 287,76	-	12 529 505,02	-	13 281 275,33
	-	11 083 664,62	-	11 748 684,50	-	12 453 605,57	-	13 200 821,90
	-	3 335 231,92	-	3 535 345,84	-	3 747 466,59	-	3 972 314,58
	-	382 100,00						
	-	1 584 970,12	-	1 775 166,54	-	1 988 186,52	-	2 226 768,90
		-		-		-		-
	-	**27 537 181,53**	**-**	**28 879 484,63**	**-**	**30 718 763,70**	**-**	**32 681 180,71**
	-	119 250,00	-	119 250,00	-	119 250,00	-	119 250,00
	-	**27 656 431,53**	**-**	**28 998 734,63**	**-**	**30 838 013,70**	**-**	**32 800 430,71**
	-	77 214,38	-	60 519,38	-	43 824,38	-	27 129,38

		-	**27 733 645,91**	**-**	**29 059 254,00**	**-**	**30 881 838,07**	**-**	**32 827 560,09**
			-		-		-		-
		-	**27 733 645,91**	**-**	**29 059 254,00**	**-**	**30 881 838,07**	**-**	**32 827 560,09**
			-		-		-		-
-	1 325 000,00								
-	**1 325 000,00**	**-**	**27 537 181,53**	**-**	**28 879 484,63**	**-**	**30 718 763,70**	**-**	**32 681 180,71**
-	1 325 000,00	-	25 497 390,31	-	24 759 503,28	-	24 385 545,03	-	24 021 643,45
-	**236 970 668,37**								

#NUM! array must contain at least one positive and one negative value for IRR to be cal

			1		**2**		**3**		**4**
			7000		7000		7000		7000
		-	185 500,00	-	185 500,00	-	185 500,00	-	185 500,00
		-	119 250,00	-	119 250,00	-	119 250,00	-	119 250,00
			-		-		-		-
			-		-		-		-
-	397 500								
-	397 500	-	28 038 395,91	-	29 364 004,00	-	31 186 588,07	-	33 132 310,09

#NUM! array must contain at least one positive and one negative value for IRR to be cal

	5		6		7		8		9
	10 434,38	-	0,00	-	0,00	-	0,00	-	0,00
	185 500,00		-		-		-		-

	5		6		7		8		9
-	14 078 151,84	-	14 922 840,96	-	15 818 211,41	-	16 767 304,10	-	17 773 342,34
-	13 992 871,21	-	14 832 443,49	-	15 722 390,10	-	16 665 733,50	-	17 665 677,51
-	4 210 653,46	-	4 463 292,67	-	4 731 090,23	-	5 014 955,64	-	5 315 852,98
-	2 493 981,17	-	2 793 258,91	-	3 128 449,98	-	3 503 863,98	-	3 924 327,66
	-		-		-		-		-
-	**34 775 657,69**	**-**	**37 011 836,02**	**-**	**39 400 141,72**	**-**	**41 951 857,22**	**-**	**44 679 200,49**
-	119 250,00	-	119 250,00	-	119 250,00	-	119 250,00	-	119 250,00
-	**34 894 907,69**	**-**	**37 131 086,02**	**-**	**39 519 391,72**	**-**	**42 071 107,22**	**-**	**44 798 450,49**
-	10 434,38		0,00		0,00		0,00		0,00

-	**34 905 342,07**	**-**	**37 131 086,02**	**-**	**39 519 391,72**	**-**	**42 071 107,22**	**-**	**44 798 450,49**
	-		-		-		-		-
-	**34 905 342,07**	**-**	**37 131 086,02**	**-**	**39 519 391,72**	**-**	**42 071 107,22**	**-**	**44 798 450,49**
	-		-		-		-		-
-	**34 775 657,69**	**-**	**37 011 836,02**	**-**	**39 400 141,72**	**-**	**41 951 857,22**	**-**	**44 679 200,49**
-	23 667 728,29	-	23 323 734,90	-	22 989 604,26	-	22 665 283,10	-	22 350 723,90

RR to be calculated

	5		**6**		**7**		**8**		**9**
	7000		7000		7000		7000		7000
-	185 500,00		-		-		-		-
-	119 250,00	-	119 250,00	-	119 250,00	-	119 250,00	-	119 250,00
	-		-		-		-		-
	-		-		-		-		-
-	35 210 092,07	-	37 250 336,02	-	39 638 641,72	-	42 190 357,22	-	44 917 700,49

RR to be calculated

	10	11	12	13
-	0,00	- 0,00	- 0,00	- 0,00
	-	-	-	-

	10	11	12	13
-	18 839 742,88	-	-	-
-	18 725 618,16	-	-	-
-	5 634 804,16	-	-	-
-	4 395 246,98	-	-	-
	-	-	-	-
-	**47 595 412,18**	**-**	**-**	**-**
-	119 250,00	-	-	-
-	**47 714 662,18**	**-**	**-**	**-**
	0,00	0,00	0,00	0,00

-	**47 714 662,18**	**0,00**	**0,00**	**0,00**
	-	0,00	0,00	0,00
-	**47 714 662,18**	**0,00**	**0,00**	**0,00**
	132 500,00	-	-	-
-	**47 462 912,18 -**	**0,00 -**	**0,00 -**	**0,00**
-	21 984 511,85	-	-	-

	10	11	12	13
	7000	0	0	0
	-	-	-	-
-	119 250,00	-	-	-
	132 500,00	-	-	-
	-	-	-	-
-	47 701 412,18	0,00	0,00	0,00

	14		15		16		17
-	0,00	-	0,00	-	0,00	-	0,00
	-		-		-		-

14	15	16	17
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	**-**	**-**	**-**
-	-	-	-
-	**-**	**-**	**-**
0,00	0,00	0,00	0,00

	0,00	**0,00**	**0,00**	**0,00**
	0,00	0,00	0,00	0,00
	0,00	**0,00**	**0,00**	**0,00**
	-	-	-	-
-	**0,00** **-**	**0,00** **-**	**0,00** **-**	**0,00**
	-	-	-	-

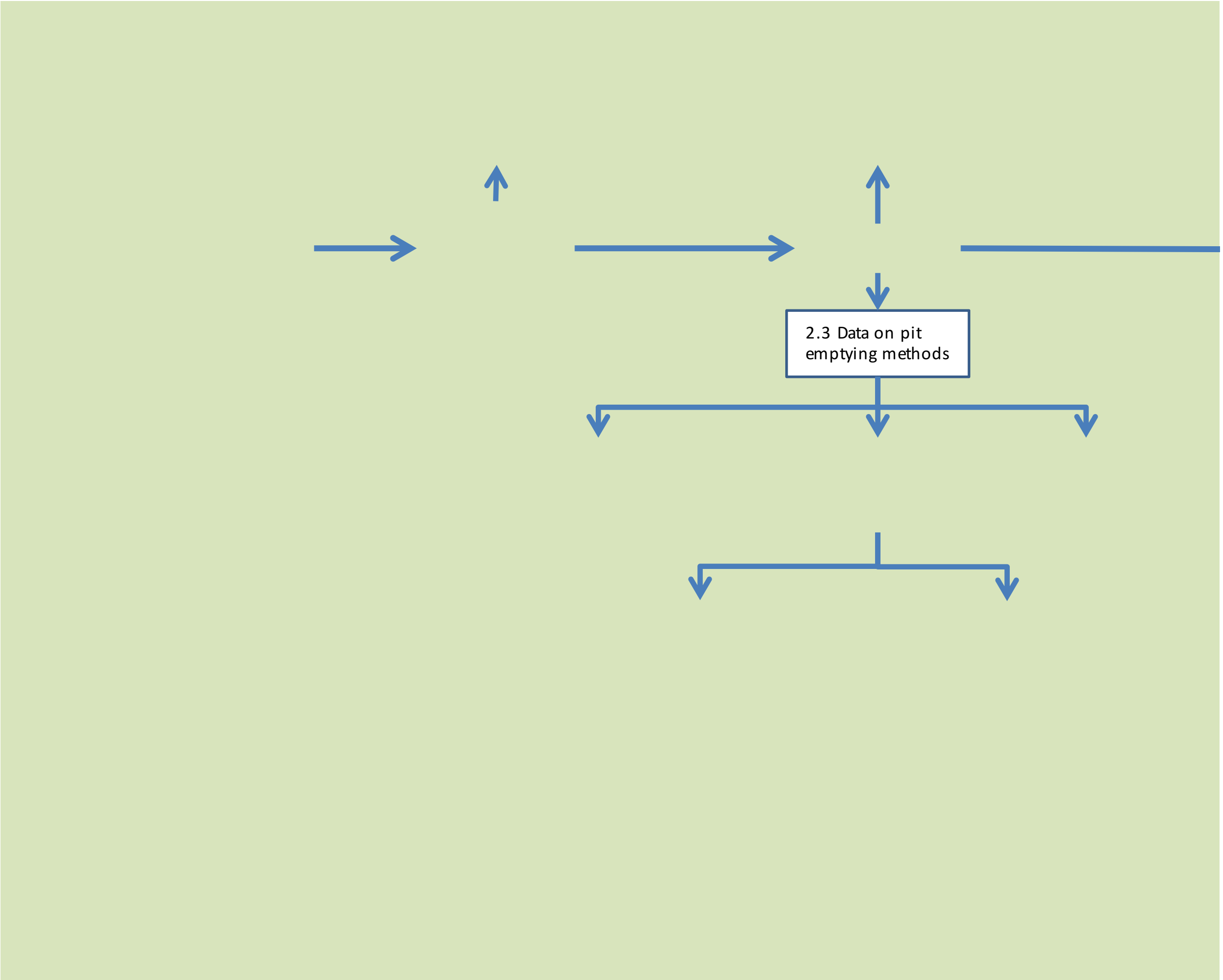
14	**15**	**16**	**17**
0	0	0	0
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
0,00	0,00	0,00	0,00

	18	19	20
-	0,00	- 0,00	- 0,00
	-	-	-

	18	19	20
	-	-	-
	-	-	-
	-	-	-
	-	-	-
	-	-	-
	-	**-**	**-**
	-	-	-
	-	**-**	**-**
	0,00	0,00	0,00

	0,00	**0,00**	**0,00**
	0,00	0,00	0,00
	0,00	**0,00**	**0,00**
	-	-	-
-	**0,00** **-**	**0,00** **-**	**0,00**
	-	-	-

18	**19**	**20**
0	0	0
-	-	-
-	-	-
-	-	-
-	-	-
0,00	0,00	0,00



10. Mass balance

LaDePa mass balance

Pit conditions

Average volume of FS to be removed per pit	1 000	ℓ / pit
Average %DS of FS in pit	30	%DS
Detritus fraction in sludge	20	%
Average sand/grit fraction of FS	3	%
Volume of sludge in pits per year	7 000	m^3 / year
Dry mass in pits per year	2100	tonnes / year

Emptying

Volume proportion of total pit contents removed	95	%
Average actual volume of sludge removed per pit	950,0	ℓ / pit
Average %DS in sludge to be transported	30,00	%DS

Average detritus fraction in sludge to be transported	20	%
Annualised volume of FS removed from area	6 650,0	m^3 / year
Annualised mass of dry solids removed from area	2 294,3	tonnes / year

Arriving at Storage

Sludge volume received by Storage per year	6650	m^3 / year
Mass of sludge solids received by Storage	2294,25	tonnes / year
Dry solids content	30,00	% DS
Detritus	20	%

Pre-treatment

Annual additive addition to FS - volume	0	m^3 / year
Annual additive addition - mass	0	tonnes / year
Annual water addition to FS	-	m^3 / year
Wastewater volume from water removal	0	m^3 / year
Detritus removed	0	m^3 / year
Dry solids in detritus removed	0	tonnes DS / year
Annual feed volume to LaDePa	6650	m^3 / year
Annual feed dry solids to LaDePa	2294	tonnes DS / year

Total volume into pre-treatment	6 650,00
Total volume out of pre-treatment	6650
Total mass into pre-treatment	2294,25
Total mass out of pre-treatment	2294

<u>All LaDePa plants</u>

Volume from pre-treatment	6650	m^3 / year
Mass from pre-treatment	2294,25	dry tonnes / year
Number of LaDePa plants required	4,66	No.
Number of LaDePa plants in operation	5,00	No.
Annual dry solids flow rate for one plant	393 466	dry tonnes / year /
Annual dry solids flow rate for all plants	1 835	dry tonnes / year
Annual detritus mass flow rate for all plants	458,85	dry tonnes / year

Total mass into LaDePa	2294,25	dry tonnes / year
Total mass out of LaDePa	2 294,25	dry tonnes / year

Average dry solids of sludge and detritus

Takes into account some sludge being left in pit, water being added and detritus removed

Takes into account any additioanal water added during emptying

Volume actually removed from pits

Includes detritus - assumed that detritus has same dry solids on average as sludge

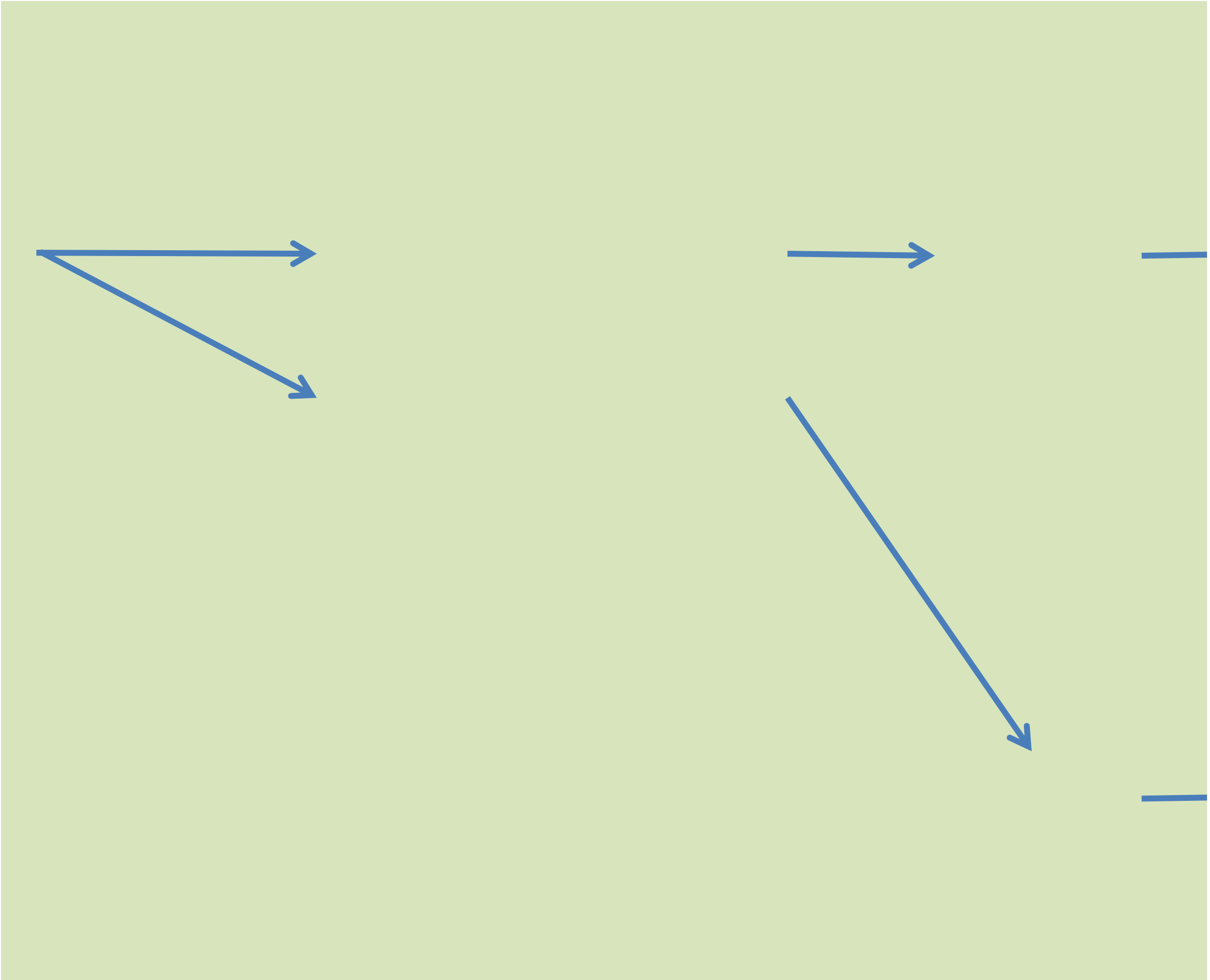
Includes remaining detritus

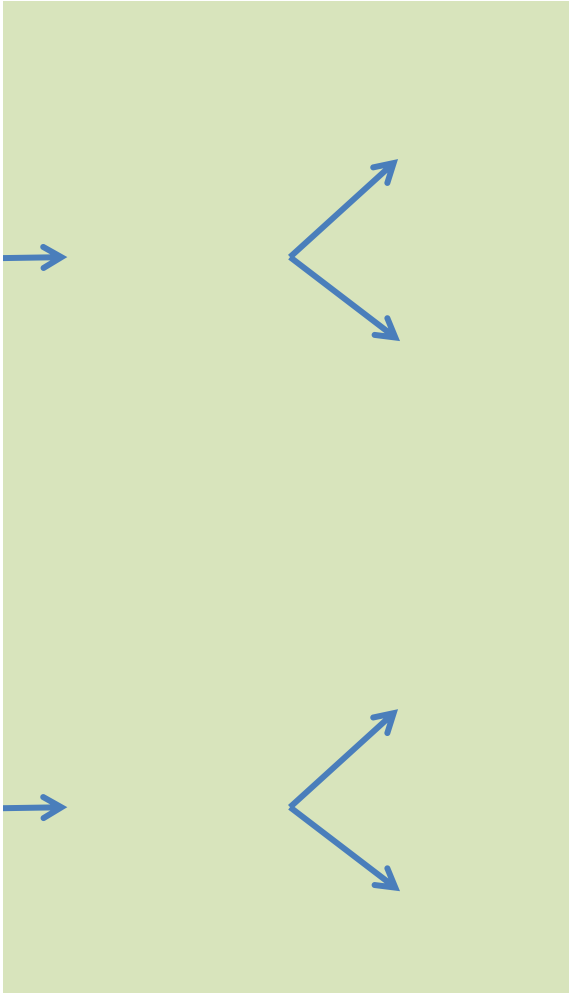
Calculated based on volumetric feed & volumetric capacity

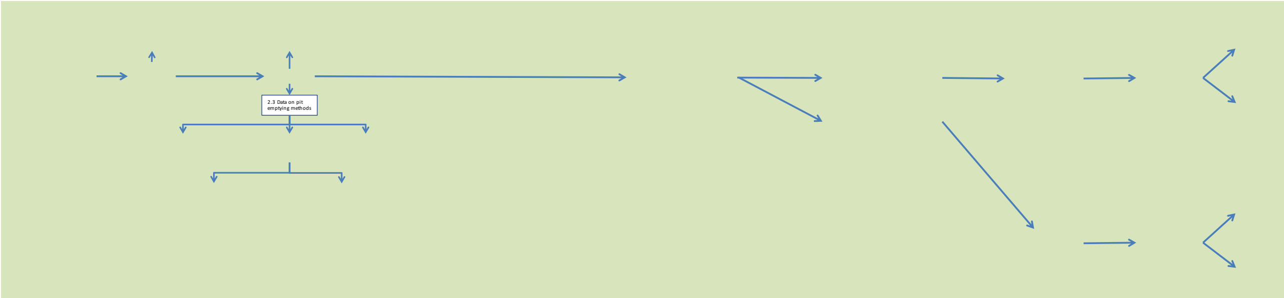
Used for operational costs calculation. Assumes that sludge can be processed by LaDePa in the years between pit-emptying cycles

Used for royalties, lease rate & capital costs calculation

nes / year / plant







11. Storage and mixing of FS for combustion

Costs and revenue of storage and sludge characteristics at output of storage after mixing of sludge from different sources

re-link all input fields

11.1 Sludge blend

Parameter	Value	Unit	Reference	Notes	User comments
Area name	Test 1				
Number of households	35000	No.			
Length of pit-emptying cycle	5	years			
Sludge transfer through conveyance stages					
Sludge received by Conveyance Stage 1					
Conveyance Stage 1 number	2				
Annual volume	6650	m^3 / year			
Mass dry solids	2294,25	dry tonnes / year			
Dry solids content	30	% DS			
Detritus	20	%			
Calorific value	12,35	MJ / kg			
Minimum number of labour days per year	252	working days / year			
Sludge received by Conveyance Stage 2					
Conveyance Stage 2 number	0				
Annual volume	0	m^3 / year			
Mass dry solids	0	dry tonnes / year			
Dry solids content	0,00	% DS			
Detritus	0	%			
Calorific value	0	MJ / kg			
Minimum number of labour days per year	0	working days / year			
Sludge received by Conveyance Stage 3					
Conveyance Stage 3 number	0				
Annual volume	0	m^3 / year			
Mass dry solids	0,00	dry tonnes / year			
Dry solids content	0,00	% DS			
Detritus	0	%			
Calorific value	0	MJ / kg			
Minimum number of labour days per year	0	working days / year			
Sludge received by Conveyance Stage 4					
Conveyance Stage 4 number	0				
Annual volume	0	m^3 / year			
Mass dry solids	0,00	dry tonnes / year			
Dry solids content	0,00	% DS			
Detritus	0	%			
Calorific value	0,00	MJ / kg			
Minimum number of labour days per year	0	working days / year			
Sludge received by Storage					
Minimum number of working days per year required (defined by final conveyance stage)	252	days / year			
Sludge volume received by Storage per year	6650	m^3 / year			
Mass of sludge solids received by Storage	2294	tonnes / year			
Length of pit-emptying cycle	5	years			
Time between pit-emptying cycles	0	years			
Available time period during which sludge is processed through pre-treatment & LaDePa, per pit-emptying cycle	5	years			
Annual sludge volume to pre-treatment	6650	m^3 / year			
Annual sludge dry mass to pre-treatment	2294	dry tonnes / year			
Dry solids content	30,00	% DS			
Detritus	20	%			
Calorific value	12,35	MJ / kg			
Working days per month	21	working days / month			
Number of months per year Storage facility operates	12	months / year			
Number of available working days per year	252	working days / year			
Error check!	0			Highlighted if min number of required working days is higher than available working days	
Average volume of sludge received per day by storage	26,39	m^3 / day			
Annual pre-treated feed volume to combustion	6650	m^3 / year			Volume received by storage goes to pre-treatment, where volume may change - e.g. detritus removal, water addition, water removal
Annual pre-treated dry mass of sludge to combustion	2294	tonnes DS / year			
Average feed rate to combustion	400,000	dry kg / hour / plant		Linked to Combustion sheet	
Combustion hours per year required to treat sludge	5736	hours / year			
Hours of combustion process operation available per year	7884	hours / year		Linked to Combustion sheet - hours per year per plant including downtime x number of plants	
Length of pit-emptying cycle	5	years		Number of years during which sludge is produced	
Calculated volume of buffer storage required	0	m3		Negative value indicates no buffer storage required - combustion plants can process sludge at a higher rate than it is supplied	
Minimum storage volume required	0	m^3			
User-specified storage volume	0	m^3		Optional input - overrides the calculated volume requirement	
Actual storage volume available	0	m^3			

4.2 Financial

Parameter	Value	Unit	Reference	Notes	User comments
Capital and start-up costs					
Total storage volume	-	m3			
Number of combustion process facilities	1	No. combustion plants		Each facility has a dedicated storage tank	
Number of storage tanks	1	No. tanks			
Volume of each storage tank	-	m3 / tank			
Cost of land preparation for each holding tank	10 000,00	LCU / tank			
Civils costs for plinth and bund	10 000,00	LCU / tank			
Cost per kℓ capacity of tank	2 500,00	LCU / kℓ			
Cost of each tank	-	LCU / tank			
Capital cost of other equipment, per tank	-	LCU / tank			
Capital cost of storage tanks only	20 000,00	LCU			
Once-off fees for permits, EIAs etc, per tank	-	LCU / tank		Note that in South Africa waste license is required if more than 34 m3 of sludge is stockpiled. In this case cost has been covered by licensing associated with the LaDePa plant itself.	
TOTAL CAPITAL COSTS	20 000,00	LCU			
START-UP COSTS (YEAR 1 ONLY)	-	LCU			
O&M costs					
Cost of maintenance for all tanks	6 000,00	LCU / year			
Cost of labour for all tanks	-	LCU / year			
Fuel costs for all tanks	-	LCU / year			
Overheads	600,00	LCU / year			
TOTAL O&M COSTS, EXCLUDING FUEL	6 600,00	LCU / year			
TOTAL FUEL COSTS	-	LCU / year			
Revenues					
Revenue from operators discharging to storage	-	LCU / year			
Operating parameters					
Number of supervisors per tank	0	No.		Storage facility operated by LaDePa staff, no additional personnel required	
Number of months per year supervisor employed for	0	months / year			

Number of labourers per tank	0	No.	Storage facility operated by LaDePa staff, no additional personnel required
Number of months per year labourers employed for	0	months / year	
Number of storage tanks	1,00	No. tanks	
Volume of each storage tank	-	m3 / tank	
Height of tank	4,00	m	
Land area occupied by each holding tank	-	m2	
Land area occupied by each tank + 10%	0,00	m2	10% allowance for pipework, bunding etc.
Total facility area required	0,00	m2	

Financial parameters

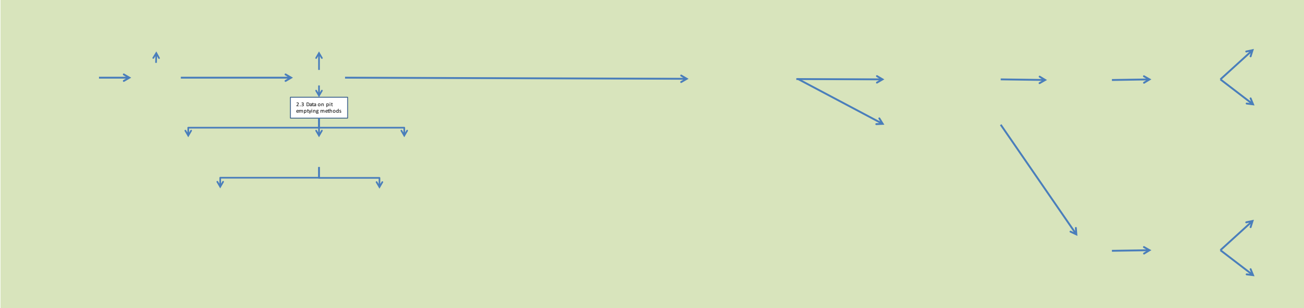
Lifetime of storage tank facility	20	years	Equal to lifetime of incineration plant
Labour - supervisor rate	10 000,00	LCU / month	
Labour - labourer rate	135,00	LCU / day	
Maintenance rate for facility	500,00	LCU / month	
Consumables cost per month	-	LCU / month	
Overhead rate	10	%	Covers cost of security and admin staff
Revenue generated per kilolitre of FS received at storage	-	LCU / kℓ	

Expenses and revenues summary

Lifetime of facility	20	years
TOTAL CAPITAL COSTS	20 000,00	LCU
DEPRECIABLE CAPITAL	20 000,00	LCU
NON-DEPRECIABLE CAPITAL		LCU
START-UP COSTS (YEAR 1 ONLY)	-	LCU / year
TOTAL OPERATING COSTS, EXCLUDING FUEL	6 600,00	LCU / year
TOTAL FUEL COSTS	-	LCU / year
TOTAL ANNUAL REVENUE	-	LCU / year
Total land area required	-	m2

Notes

1. Assumed that storage, pre-treatment, combustion plant and product and by-product facilities are co-located and co-operated
2. The land, office and parking facilities for all of these stages are costed on the Combustion sheet
3. Where additional staff (additional to the team required to operate the combustion plant) are required for any treatment stage this is indicated on the individual sheet



12. Combustion pre-treatment

Costs of pre-treating sludge to a state suitable for input to the combustion process

12.1 Properties of feed sludge from storage

Parameter	Value	Unit	Reference	Notes	User comments
Area name	Test 1				
Number of households	35000	No.			
Length of pit-emptying cycle	5	years			
Total volume of storage facility	0	m^3			
Annual volume of sludge available from storage during pit emptying	6650	m^3 / year			
Total dry mass of sludge sent to storage	2294	tonnes DS / year			
Number of combustin plants required	0,73	No.			
Number of combustion process plants in operation	1	No.			
Parameters for ONE pre-treatment facility					
Annual volume of sludge from storage	6650	m^3 / year			
Total dry mass of sludge sent to storage	2294	tonnes DS / year			
Average %DS of sludge	30,00	%DS			
Average detritus fraction in blended sludge	20,00	%			
Average calorific value of blended sludge	12,35	MJ/kg			
Average sand/grit fraction of blended sludge	3,00	%		Not currently tracked through emptying/conveyance process - assumed to be same as in pit	
Wet sludge density	1150,00	kg / m3			
Number of working days per year for storage facility	252,00	working days / year			
COD	-	g COD / g DS		No input entered for raw sludge	
Nitrogen					
Ammonium & urea	-	mg ammoniacal N / g DS		No input entered for raw sludge	
Nitrate	-	mg NO3- / g DS		No input entered for raw sludge	
Total nitrogen	-	mg N / g DS		No input entered for raw sludge	
Phosphorus					
Total phosphate	-	mg P / g DS		No input entered for raw sludge	
Orthophosphate	-	mg ortho-P / g DS		No input entered for raw sludge	
Potassium	-	mg K / g DS		No input entered for raw sludge	
Calcium	-	mg Ca / g DS		No input entered for raw sludge	
Magnesium	-	mg Mg / g DS		No input entered for raw sludge	
Sulphur	-	mg S / g DS		No input entered for raw sludge	
Ascaris					
Undeveloped eggs	-	No. possible viable Ascaris / 20g DS		No input entered for raw sludge	
Motile larvae in eggs	-	No. possible viable Ascaris / 20g DS		No input entered for raw sludge	
Immotile larvae in egg	-	No. possible viable Ascaris / 20g DS		No input entered for raw sludge	
Trichuris	-	Potentially viable eggs / 20g		No input entered for raw sludge	
Taenia	-	Potentially viable eggs / 20g		No input entered for raw sludge	
Faecal coliforms	-	CFU / g DS		No input entered for raw sludge	

12.2 Required feed spec to incineration process

Further information required on required feed specifications to the combustion process

Minimum % DS of feed sludge	20,0	%DS	The higher the specified minimum %DS, the lower the supplemental fuel requirements for incineration
Maximum % DS of feed sludge	95,0	%DS	Estimated
Maximum allowable detritus content	50	%	Unknown
Maximum allowable sand / gritty solids content	10	%	Unknown
Minimum dry mass throughput allowable	0	kg / hour	Unknown
Maximum dry mass throughput allowable	0	kg / hour	Unknown
Minimum calorific value	20,26	MJ / kg	Calculated on Combustion sheet, based on the dry solids content of the incoming sludge. This will change if additives are added.

12.3 Out of spec feed parameters

Parameters highlighted if out of spec

%DS of sludge too high	0	
%DS of sludge too low	0	
Detritus fraction	0	
Average sand / grit fraction	0	
Calorific value too low	1	Can be corrected by addition of additive here, or by addition of supplemental fuel on Combustion sheet

12.4 Pre-treatment processes

12.4.1 Water addition

Is water addition required to stored sludge?	No		
Does additive addition require more water to be added to the fuel-additive mix?	No		
Volume of water required per m3 sludge	0	m3	
Water price	-	LCU / ℓ	
Annual volume of water added	-	m^3 / year	
Annual cost of additional water	0	LCU / year	
Capital cost of facility for water addition and mixing	0	LCU	Small mixing tank, manual mixing
Land area required	0	m^2	
TOTAL CAPITAL COSTS	-	LCU	
TOTAL OPERATING COSTS	-	LCU / year	
Total land area	0	m^2	

12.4.2 Increase in dry solids

Is increase in dry solids required?	No		
Does additive provide sufficient increase in dry solids content?	Yes		
Volume of water required to be removed per m3 sludge	0,00	m^3	Takes into account the effect of additives
Annual volume of water removed	0	m^3 / year	
Drying beds			
Drying bed loading rate	300	kg DS / m2 / year	Uncovered drying beds in Senegal
Dried sludge solids achieved at this loading rate	60	%	
Volume of sludge required to be treated through drying beds	0	m^3 / year	Assumes some sludge is dried and mixed with wetter sludge to achieve required minimum solids for combustion feed
Volume of sludge out of drying beds	0	m^3 / year	
Volume of sludge not treated through drying beds	6650	m^3 / year	
Combined volume of dried and feed sludge	6650	m^3 / year	Sludge from drying beds mixed with untreated feed sludge from storage
Annual solids load	0	tonnes DS / year	
Drying bed area required	0	m2 / year	
Area of each drying bed	10	m2	
Number of drying beds required	0,00	No.	
Construction cost of drying bed facility per m2	4 000,00	LCU / m2	
Total construction cost of drying bed facility	-	LCU	
Capital cost of sludge mixing tank	5 000,00	LCU	For mixing of dried and fresh sludge to achieve required blend
TOTAL CAPITAL COSTS	-	LCU	
Additional operational costs			
Assumes the pre-treatment operation is operated by incinerator plant staff			
Drying bed cleaning costs (required once / month / bed)	50	LCU / 10 m2 / month	
Drying bed cleaning costs (required once / month / bed)	-	LCU / month	

Drying bed clearing costs per year	-	LCU / year	
Additional labour	0	No. labourers	Labour in addition to combustion plant staff. Choose based on drying bed area - assume one 10 m2 bed takes 2 people one day to clear.
Number of months per year drying beds operated for	12	months / year	
Cost of additional labour	-	LCU / year	
TOTAL OPERATING COSTS	-	LCU / year	
Proportion of total solids remaining in dried FS	50	%	Figures for information only - loss of solids, COD and N across drying bed not currently accounted for in calculations
Proportion of total suspended solids remaining in dried FS	95		
Proportion of COD remaining in dried FS	90	%	
Proportion of nitrogen remaining in dried FS			
Ammonium & urea	0	%	
Nitrate	0	%	
Total nitrogen	0	%	
TKN	70	%	
Average dry solids of combined sludge from drying beds and feed sludge	30	%	
TOTAL CAPITAL COSTS	-	LCU	
NON-DEPRECIABLE CAPITAL	-		
TOTAL OPERATING COSTS	-	LCU / year	
Total land area	0	m2	Allow for 5% extra over total drying bed area

5.4.3 Detritus removal

Is detritus removal required?	No		All detritus goes into the combustion process
Initial detritus content per m3 of FS	0,20	m3 / m3 FS	
Volume of detritus remaining per m3 of feed FS	0,20	m3 / m3 FS	Per m3 of FS in storage tank
Volume of detritus removed per m3 of FS	0,00	m3 / m3 FS	
Detritus content of screened FS	20,00	%	Per m3 of FS fed to combstion - takes into account water removal, addition, additive addition and detritus removal
Detritus removed per year	0	m^3 / year	
Capital cost of basic screening facility	0	LCU	
Land area required	0	m2	
TOTAL CAPITAL COSTS	-	LCU	
TOTAL OPERATING COSTS	-	LCU / year	
Total land area required	0	m2	

5.4.4 Additives

Is an additive to be used?	No		Enter Yes or No
Additive type	0	Name	
Additive dry solids content	0	%DS	
Volumetric proportion of additive in sludge - additive mix	0	%	1/(100-proportion additive))*proportion additive is the volume of additive that has to be added per m3 of FS in storage to achieve the desired mix
Volumetric proportion of additive in sludge - additive mix (used in calculations)	0	%	
Wet mass proportion of additive in sludge - additive mix	0	% wt	
Wet mass proportion of sludge in sludge-additive mix	100	% wt	
Calorific value	0	MJ / kg	
Cost of additive by mass	0	R / tonne	
Density of additive	0	kg / m3	
Cost of additive by volume	0	LCU / m3	
Cost of additive	-	LCU / m3	
Dry mass of additive added per kg dry solids of sludge	-	kg dry additive / kg dry sludge	
Volume of additive added to each m3 of sludge in storage	0,00	m3 / m3 FS	
Annual volume of additive used	0,00	m^3 / year	
Dry solids content of sludge - additive mix	30,00	%DS	Average solids of the additive + original FS mixture, does not account for water added or removed
Calorific value of sludge - additive mix	12,35	MJ / kg	Average calorific value of the additive + original FS mixture, does not account for any calorific value of detritus content
Error check	1		Highlighted if calorific value of mix is lower than minimum required for feed to incinerator. Can be corrected by addition of supplementary fuel (Combustion sheet)

Additive composition

BOD		0	g BOD / g DS
Nitrogen			
	Ammonium & urea	0	mg ammoniacal N / g DS
	Nitrate	0	mg NO3- / g DS
	Total nitrogen	0	mg N / g DS
Phosphorus			
	Total phosphate	0	mg P / g DS
	Orthophosphate	0	mg ortho-P / g DS
Potassium		0	mg K / g DS
Calcium		0	mg Ca / g DS
Magnesium		0	mg Mg / g DS
Sulphur		0	mg S / g DS
Ascaris			
	Undeveloped eggs	0	No. possible viable Ascaris / 20g DS
	Motile larvae in eggs	0	No. possible viable Ascaris / 20g DS
	Immotile larvae in egg	0	No. possible viable Ascaris / 20g DS
Trichuris		0	Potentially viable eggs / 20g
Taenia		0	Potentially viable eggs / 20g
Faecal coliforms		0	CFU / g DS

Capital cost of facility for additive addition and mixing	-	LCU	Type of facility required will depend on additive - could simply be an additional hopper on the feed to the LaDePa plant, or a mixing tank for sludge and additive prior to being fed to the LaDePa.
Land area required for mixing facility	0	m2	
Annual cost of additive	-	LCU / year	
TOTAL CAPITAL COSTS	-	LCU	
TOTAL OPERATING COSTS	-	LCU / year	
Total land area	0	m2	

Additions to stored sludge

Annual water addition to FS	-	m^3 / year
Additive type used	-	
Annual additive addition to FS - volume	0,00	m^3 / year
Annual additive addition to FS - mass	0,00	tonnes / year

Feed sludge to incineration process

Overall volume change during pre-treatment	0,000	m3 / m3 FS	Change per m3 of sludge from the storage tank
Average %DS of FS feed to incineration	30,00	%DS	Dry solids of the additive-FS mixture, adjusted to take into account water added/removed. Detritus removal is assumed not to significantly affect %DS of the final mixture
Average detritus fraction of FS feed to incineration	20,00	%	
Average calorific value of FS feed to incineration	12,35	MJ / kg	Calorific value of detritus is not taken into account
Average sand / grit fraction in feed to incineration	3,00	%	
Sand/grit fraction error check	0		If highlighted, indicates sand/grit fraction of pre-treated sludge is too high. No facility for removal - sludge must be blended with other sludge.
Total nitrogen	#VALUE!	mg N / g DS	Calculated blend of sludge and additive - for information only, not carried through to model calculations. Will be used in a future iteration of the model where pellet composition can be predicted from sludge feed composition.
Total phosphate	#VALUE!	mg P / g DS	
Potassium	#VALUE!	mg K / g DS	
Calcium	#VALUE!	mg Ca / g DS	
Magnesium	#VALUE!	mg Mg / g DS	
Sulphur	#VALUE!	mg S / g DS	

Annual feed volume per combustion plant	6 650	m^3 / year / plant	
Annual feed dry mass per combustion plant	2294	tonnes DS / year / plant	

By-products from pre-treatment

Wastewater volume from water removal	0	m^3 / year	
Detritus removed	0	m^3 / year	
Dry solids in detritus removed	0	tonnes / year	
Wet mass of detritus removed	0,0	wet tonnes / year	Assumes detritus has same density as sludge

Financial parameters

Incinerator number of working months per year	12	working months / year	
Incinerator labourer monthly rate	7000	LCU / month	

Expenses and revenues summary for ONE pre-treatment facility

Lifetime	20	years	Equal to lifetime of incinerator plant
TOTAL CAPITAL COSTS	-	LCU	
NON-DEPRECIABLE CAPITAL	-	LCU	Land costs for pre-treatment are calculated on the incineration sheet and do not appear here
DEPRECIABLE CAPITAL	-	LCU	
START-UP COSTS (YEAR 1 ONLY)		LCU / year	
TOTAL OPERATING COSTS, EXCLUDING FUEL	-	LCU / year	
TOTAL FUEL COSTS		LCU / year	
TOTAL ANNUAL REVENUE		LCU / year	
Total land area required	0	m2	

Combined costs and flows for ALL pre-treatment facilities

Additions to stored sludge

Annual water addition to FS	-	m^3 / year	
Additive type used	-		
Annual additive addition to FS - volume	-	m^3 / year	
Annual additive addition - mass	0,00	tonnes / year	

Feed sludge to combustion processes

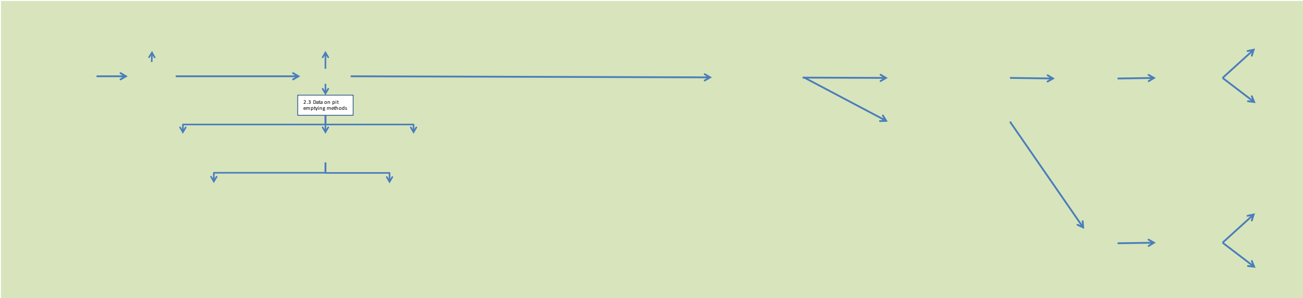
Annual pre-treated feed volume available to all combustion plants	6650	m^3 / year	
Annual dry mass feed to all combustion plants	2294	tonnes DS / year	
Average %DS of FS feed to incineration	30,00	%DS	Dry solids of the additive-FS mixture, adjusted to take into account water added/removed. Detritus removal is assumed not to significantly affect %DS of the final mixture
Average detritus fraction of FS feed to incineration	20,00	%	
Average calorific value of FS feed to incineration	12,35	MJ / kg	Calorific value of detritus is not taken into account
Average sand / grit fraction in feed to incineration	3,00	%	
Sand/grit fraction error check	0		Highlighted red - indicated sand/grit fraction is too high. No facility for removal - sludge must be blended with other sludge.

By-products from pre-treatment

Wastewater volume from water removal	0	m^3 / year	
Detritus removed	0	m^3 / year	
Dry solids in detritus removed	0	tonnes DS / year	

Financial

Lifetime	20	years	Equal to lifetime of LaDePa plant
TOTAL CAPITAL COSTS	-	LCU	
NON-DEPRECIABLE CAPITAL	-	LCU	
DEPRECIABLE CAPITAL	-	LCU	
START-UP COSTS (YEAR 1 ONLY)	-	LCU / year	
TOTAL OPERATING COSTS, EXCLUDING FUEL	-	LCU / year	Accounts for using pre-treatment facility at partial capacity for full cycle, or at full capacity for part of cycle
TOTAL FUEL COSTS	-	LCU / year	
TOTAL ANNUAL REVENUE	-	LCU / year	
Total land area required	-	m2	



13. Combustion FS treatment process

Costs of treating faecal sludge via a total combustion process

Pre-heating of combustion air (energy recovery) is not considered
Energy generation is not considered

Parameter	Value	Unit	Reference	Notes	User comments
Number of households	35000	No.			
Length of pit-emptying cycle	5	years			
Time between pit-emptying cycles	0	years			
Furnace type	**Fluidised bed**				

13.1 Required feed specification to incinerator

Parameter	Value	Unit
Minimum % DS of feed sludge	20,0	%DS
Maximum % DS of feed sludge	95,0	%DS
Maximum allowable detritus content	50,0	%
Maximum allowable sand / gritty solids content	10,0	%
Minimum dry mass throughput allowable	0,0	kg / hour
Maximum dry mass throughput allowable	0,0	kg / hour
Minimum calorific value	20,3	MJ / kg

13.2 Pre-treated sludge feed properties

Parameter	Value	Unit
Average %DS of FS feed to combustion	30,00	%DS
Average detritus fraction of FS feed to combustion	20,00	%
Average calorific value of FS feed to combustion	12,35	MJ / kg
Average sand / grit fraction in feed to combustion	3,00	%
Available annual pre-treated feed volume to all combustion plants during pit emptying cycle	6 650,00	m^3 / year
Available annual pre-treated dry mass to all combustion plants during pit emptying cycle	2 294,25	dry tonnes / year
Available annual pre-treated feed wet mass to all combustion plants during pit emptying cycle	7 647,50	wet tonnes / year
Density of FS feed to combustion	1 150,00	kg / m3

13.3 Number of combustion plants required

Parameter	Value	Unit	Notes
Average dry mass feed rate to one combustion plant	400,00	dry kg / hour / plant	
Average volumetric feed rate to one combustion plant	1,16	m^3 / hour	
Average wet mass feed rate to one combustion plant	1 333,33	wet kg / hour / plant	
Incineration plant working hours per year	7 884	hours / year	
Incineration plant annual mass processing capacity	3 153,60	dry tonnes / year	
Incineration plant annual volumetric capacity	9 140,87	m3 / year	
Incineration plant wet mass annual capacity	10 512,00	wet tonnes / year	
Years of sludge production per pit-emptying cycle	5	years	
Available years for combustion operation per pit-emptying cycle	5	years	
Minimum number of combustion plants required	0,73	No.	Assumes that sludge can be processed by plant in the years between pit-emptying cycles
Number of combustion plants in operation	1	No.	User choice, based on calculated number of plants required - can choose to have more plants than min required and process sludge faster
Time taken to process all sludge from one pit-emptying cycle	5,00	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 low, then the time taken to process sludge will be longer than the time available.

13.4 Combustion operation parameters for one combustion plant working at full capacity

Parameter	Value	Unit	Notes
Annual feed volume capacity per combustion plant	9 140,87	m^3 / year / plant	
Annual sludge dry mass feed capacity to combustion per plant	3 153,60	dry tonnes / year / plant	
Annual sludge wet mass feed rate to combustion per plant	10 512,00	wet tonnes / year / plant	
Average dry mass feed rate to one combustion plant	400,00	dry kg / hour / plant	KwaMashu feeds 2000 wet kg/hour @ 20% DS
Average wet mass feed rate to one combustion plant	1 333,33	wet kg / hour / plant	

13.4.1 Furnace conditions

Parameter	Value	Unit	Notes
Temperature of furnace	760 - 815	˚C	For reference only. Dependent on furnace type and part of furnace.
Residence time of solids in incinerator	1 to 5	minutes	For reference only, furnace-specific
Gas detention time (at high temperature)	6 to 8	seconds	For reference only, furnace-specific
Gas exit temperature	815 - 871	˚C	For reference only, furnace-specific

Combustion air

Further information required

Parameter	Value	Unit	Notes
Excess air requirement	40	%	For reference only, furnace-specific
Combustion air flow required	0	Nm^3/hour	Unknown
Is combustion air pre-heated?	Yes		Choose Yes or No
Energy required to heat combustion air	0	MW	Unknown
Pre-heated temperature of combustion air	0	˚C	Unknown

13.4.2 Supplemental fuel feed

Calculation of target calorific value of combustion feed at the specified dry solids

Supplemental fuel requirements with air pre-heated to 48 deg Celsius (i.e. no significant pre-heating), excess air 40%, feed sludge 453 dry kg/hour
FS calorific value 17.45 MJ / dry kg, supplemental fuel 41.87 MJ / kg

Parameter	Value	Unit	Reference
Hourly mass feed rate to process	453	dry kg / hour	Dangtran et al 2000 p6
Hourly volumetric feed rate to process	1,313	m3 / hour	

FS feed dry solids / %DS	Supplmental fuel requirement / lb/hour	Supplmental fuel requirement / kg/hour	
20	460	208,61	Dangtran et al 2000
21		188,2025	interpolated
22	370	167,795	Dangtran et al 2000
23		149,655	interpolated
24	290	131,515	Dangtran et al 2000
25		117,91	interpolated
26	230	104,305	Dangtran et al 2000
27		91,83375	interpolated
28	175	79,3625	Dangtran et al 2000
29		69,15875	interpolated
30	130	58,955	Dangtran et al 2000
31		49,885	interpolated
32	90	40,815	Dangtran et al 2000
33		31,745	interpolated
34	50	22,675	Dangtran et al 2000
35		15,8725	interpolated
36	20	9,07	Dangtran et al 2000
37		4,535	interpolated
38	0	0	Dangtran et al 2000

Parameter	Value	Unit
Is supplemental fuel required?	Yes	
Feed dry solids	30,00	%DS
Supplemental fuel requirement	58,955	kg / hour

Fuel calorific value	41,87	MJ / kg		
Fuel type	Fuel oil			
Calorific value of sludge - fuel mix	20,26	MJ / kg		Use this figure as the target minimum feed calorific value at the specified minimum % DS

Calculation of chosen supplemental fuel requirements

Note - these figures assume no pre-heating of the combustion air. Supplemental fuel requirements will be lower if air is pre-heated

Is supplemental fuel required?	Yes		
Additional fuel used	Coal	Name	
Is supplemental fuel a fossil fuel?	Yes		
Fuel dry solids content	85	%DS	
Calorific value	31	MJ / kg	
Cost of fuel by mass	729	LCU / tonne	
Density of fuel	900	kg / m3	
Dry mass of fuel required per dry mass of FS feed to achieve minimum targe feed calorific value	0,74	dry kg fuel / dry kg FS	
Wet mass of fuel required per wet mass of FS feed	0,26	wet kg fuel / wet kg FS	
Wet mass of fuel required per dry mass of FS feed	0,87	wet kg fuel / dry kg FS	
Calorific value of sludge - fuel mix	20,26	MJ / kg	
Dry solids of sludge - fuel mix	53,33	% DS	Therefore the quantity of supplemental fuel required could potentially come down - check for a future version.
Supplemental fuel usage rate	346,75	wet kg / hour	
Annual supplemental fuel usage rate per plant	2 733,77	tonnes fuel / year / plant	
Annual volume of supplemental fuel	3 037,53	m3 / year	

13.4.3 Plant operational parameters

Does the plant operate 24/7?	Yes		
Operational months per year	12	months / year	
Operational days per month (excluding downtime)	0	days / month	Only required to complete if not 24/7 operation
Operational hours per day	24	hours / day	
Average downtime per year	10	%	
Operational hours per year	7884	hours / year	
Commissioning time for new plant	6	months	
Plant lifetime	20	years	

13.4.4 Combustion products

Mass reduction across combustion process	70	%	
Volume reduction across combustion process	90	%	
Hourly ash mass flowrate	208,42	dry kg / hour	Estimate only
Annual ash mass flowrate per plant	1643,19	dry tonnes / year / plant	Estimate only
Annual ash volume flowrate per plant	1217,84	m3 / year	Estimate only
Proportion of ash going to bottom ash	20	%	Unknown
Bottom ash			
Bottom ash mass flow rate	41,7	dry kg/hour	
Bottom ash annual mass flow rate per plant	328,6	dry tonnes / year / plant	
Fly ash			
Fly ash mas flow rate	167	dry kg/hour	
Fly ash annual mass flow rate per plant	1315	dry tonnes / year / plant	
Dry solids of hydrated fly ash flow	51,42	%DS	
Flue gases			
Further information needed			
Flue gas flow rate	0	Nm^3/hour	
Flue gas temperature	815 - 871	°C	For reference only - plant-specific
Flue gas water content	0	%	

13.4.5 Polymer use

			Used for ash sedimentation
1998 cost for 60 dry tonne/24h day fluidised bed incinerator	31	USD / dry tonne feed	Better figures required for polymer usage and cost.
Current year	2013		
Escalation rate	6	%	
Scaled cost to current year	74,29	USD / dry tonne feed	
Conversion facotr	10,00	LCU / USD	
Polymer cost	742,93	LCU / dry tonne	Assumed to be dry tonne of sludge feed, not combined sludge and fuel
Annual polymer cost	2 342 913,63	LCU / year	

13.4.6 Sand use

			Sand loss from bed during operation, in ash flow
Sand loss	5	% of bed volume / 300 hours operation	
1998 cost for 60 dry tonne/24h day fluidised bed incinerator	0,48	USD / dry tonne feed	Better figures required for polymer usage and cost.
Current year	2013		
Escalation rate	6	%	
Scaled cost to current year	1,15	USD / dry tonne feed	
Conversion facotr	10,00	LCU / USD	
Sand cost	11,50	LCU / dry tonne feed	
Annual sand cost	36 277,37	LCU / year	

13.4.7 Power use

Electrical power rating for plant (draw at full throughput)	0	MW		Assuming no electricity generation at the combustion plant
Electricity price	0,6551	LCU / kWh	South Africa industrial electricity price 2013	
Annual operational hours	7884	hours / year		
Annual power cost	0	LCU / year		

13.4.8 Vehicle

Pick up truck purchase price	175 000,00	LCU
Pick up truck hire price	7 000,00	LCU / month
Is vehicle purchased?	Yes	
Repair & maintenance cost per km	0,68	LCU / km
Diesel cost per km	1,17	LCU / km
Annual license and insurance	6 607,00	LCU / year
Average distance travelled per working month	210,00	km / month
Annual distance travelled	2 520,00	km / year
Annual operating costs, excluding fuel	8 317,68	LCU / year
Annual fuel costs	2 953,16	LCU / year

13.4.8 Other parameters

Repairs & maintenance

% of capital cost per year	5	% of capital cost / year

Labour

Number of supervisors per plant	2	No. / plant
Number of labourers per plant	16	No. / plant
Number of project managers per plant	0,2	No. / plant
Supervisor rate	10 000,00	LCU / month
Labourer rate	7 000,00	LCU / month
Project manager rate	35 000,00	LCU / month

Land requirements

Incineration plant area	400	m^2	Estimate
Facilities			
Area required for equipment storage / office	10	m^2	
Parking area	60	m^2	
Total additional land area required	70	m^2	
Storage area per plant	-	m^2	
Pre-treatment area per plant	-	m^2	
Product storage area	50,00	m^2	
By-product disposal area	-	m^2	
Total land area per plant	520,00	m^2	

13.5 Financial

13.5.1 Financial parameters

Land purchase price	-	LCU / m^2	Leave blank if land / facility is rented
Land and office property rental price	-	LCU / m^2 / month	Combined rate for buildings and land - leave blank if land and buildings are purchased
Overhead rate	10	%	Covers cost of security and admin staff
Repayment period for debt	5	years	

Escalation rate on O&M costs and revenues, excluding fuel	6	%	
Escalation rate on fuel	12	%	
Debt : equity	70	%	
Depreciation rate	4,5	%	Straight line depreciation over lifetime of plant
Residual value	10	%	

13.5.2 Costs for ONE plant

Capital and start-up costs - one plant			
Combustion plant capacity	400	dry kg / hour	
Capital cost of combustion plant	73 000 000	LCU / plant	More research needed - cost curve of of capital cost v. capacity for fluidised bed plants.
Land	-	LCU / plant	
Vehicle - pick up truck	175 000,00	LCU / plant	Will be set to 0 if hire option was selected
Permitting and legal requirements			
Environmental impact assessment	0	LCU / plant	
Waste licence	100 000,00	LCU / plant	
Atmospheric emission licence	50 000,00	LCU / plant	Estimate
Community consultation	25 000,00	LCU / plant	Estimate
TOTAL CAPITAL COSTS	73 175 000,00	LCU / plant	
DEPRECIABLE CAPITAL COSTS	73 175 000,00	LCU / plant	
NON-DEPRECIABLE CAPITAL COSTS	-	LCU / plant	
START-UP COSTS	175 000,00	LCU / plant	
O&M costs- one plant at FULL capacity			
Labour	1 668 000,00	LCU / year	
Plant O&M			
Maintenance	3 650 000,00	LCU / year	
Sand	36 277,37	LCU / year	
Polymer	2 342 913,63	LCU / year	
Power	-	LCU / year	
Sundries	24 000,00	LCU / year	Estimate. Note that costs associated with consumbles for air pollution control devices are accounted for on the 'Combustion by-product' sheet
Vehicle operating costs	8 317,68	LCU / year	Includes rental cost if purchase option was not selected.
Rent of land & buildings	-	LCU / year	
Permitting and legal requirements			Costs of air emissions monitoring is covered on the Combustion by-product sheet
Health and safety	10 000,00	LCU/year	Estimate
Other	-	LCU/year	
Fuel costs			
Vehicle diesel	2 953,16	LCU / year	
Incinerator supplementary fuel	1 992 920,34	LCU / year	
Overheads	973 538,22	LCU / year	
TOTAL OPERATING COSTS, EXCLUDING FUEL	8 713 046,90	LCU / year	
TOTAL FUEL COSTS	1 995 873,50	LCU / year	
Revenues			
Subsidies	0	LCU/year	
TOTAL REVENUES	-	LCU/year	

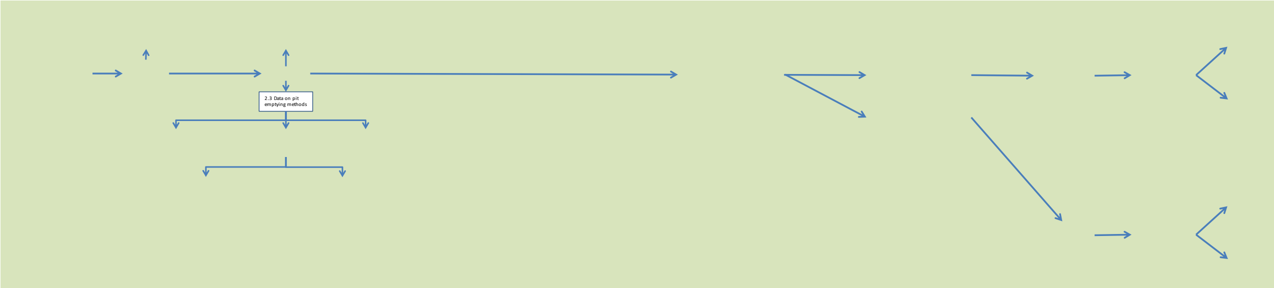
13.5.3 Costs for ALL combustion process plants

Accounts for plant(s) being used at full capacity for less than the whole cycle, or for plants being used at partial capacity for whole cycle

TOTAL CAPITAL COSTS	73 175 000,00	LCU / plant
DEPRECIABLE CAPITAL COSTS	73 175 000,00	LCU / plant
NON-DEPRECIABLE CAPITAL COSTS	-	LCU / plant
START-UP COSTS	175 000,00	LCU / plant
TOTAL OPERATING COSTS, EXCLUDING FUEL	6 338 758,20	LCU / year
TOTAL FUEL COSTS	1 452 001,77	LCU / year
TOTAL REVENUES	-	LCU/year

Flowrates for ALL combustion plants

Dry mass feed rate	2 294,25	dry tonnes / year
Volume feed rate	6650,0	m^3 / year
Wet mass feed rate	7647,5	wet tonnes / year
Supplementary fuel mass feed rate	1988,8	tonnes / year
Supplementary fuel volumetric feed rate	2209,8	m^3 / year
Annual ash mass flowrate per plant	1195,43	dry tonnes / year
Annual ash volume flowrate per plant	885,98	m3 / year
Bottom ash annual mass flow rate per plant	239,09	dry tonnes / year
Fly ash annual mass flow rate per plant	956,34	dry tonnes / year



14. Combustion product

Costs and/or revenue associated with sale/disposal of the combustion ash

Product characteristics

Parameter	Value	Unit	Reference	Comment
Number of combustion plants required	0,73	No.		
Number of combustion plants operating	1	No.		
Hourly ash mass flowrate per plant	208,42	dry kg / hour / plant		Estimate only - based on a 70% dry mass reduction across incinerator
Annual ash mass flowrate per plant at full capacity	1643,19	dry tonnes / year / plant		Estimate only
Annual ash mass flowrate for all plants	1195,43	dry tonnes / year		
Combustion annual operational hours	7884,00	hours / year		
Combustion operational months per year	12	months / year		
Proportion of ash going to bottom ash	20	%		Remainder goes to fly ash

Fly ash

Parameter	Value	Unit	Reference	Comment
Fly ash mas flow rate for one plant at full capacity	1315	dry tonnes / year / plant		
Dry solids of fly ash flow	51,42	%DS		Ash/water mixture at end of process
Volatile solids	5,22	%		Ash/water mixture at end of process
Product form	Hydrated ash	Description		e.g. fine powder, crystals
Particle size	-	µm		important for producing bricks
Carbon content	0	mg C / g DS		
Nitrogen - total	1,90	mg N / g DS		
Phosphorus - total	11,90	mg P / g DS		
Potassium	2,90	mg K / g DS		
Calcium	116,10	mg Ca / g DS		
Magnesium	6,30	mg Mg / g DS		
Zinc	0,46	mg Zn / g DS		
Copper	0,23	mg Cu / g DS		
Manganese	0,32	mg Mn / g DS		
Iron	30,95	mg Fe / g DS		
Aluminium	33,32	mg Al / g DS		
Boron	0,00	mg B / g DS		
Sulphur	0,00	mg S / g DS		
Sodium	1,41	mg Na / g DS		
CaO content	0	%		important for brick manufacture - Hersleman et al 2008: should be under 15% to prevent cracking
Heavy metals (*Cr, Be, *As, *Sb, Ba, *Pb, Ag, *Co, *Ni, *Cu, Sn, *V, *Mn)	0	mg / g DS		
Heavy metals (*Cd, *Hg, *Tl)	0	mg / g DS		Possible lower permit limit applies to these c.f. group above, as more toxic? (it does for air emissions of heavy metals)
Cd	0	mg / g		
Co	0	mg / g		
Cr	0	mg / g		
Cu	0,23	mg / g		
Hg	0	mg / g		
Mo	0	mg / g		
Ni	0	mg / g		
Pb	0	mg / g		
Zn	0	mg / g		
As	0	mg / g		
Se	0	mg / g		
B	0	mg / g		
F	0	mg / g		
Chosen disposal route for fly ash	2 General landfill			Choices: 1 - Addition to LaDePa pellets or other fertiliser product 2 - Landfill 3 - Construction materials

Bottom ash

Parameter	Value	Unit	Reference	Comment
Bottom ash mass flow rate for one plant at full capacity	328,6	dry tonnes / year / plant		
Bottom ash average dry solids	90	%DS		Estimate
Product form	Dry ash	Description		e.g. fine powder, crystals
Particle size	0	µm		important for producing bricks
Chemical properties				
Carbon content	-	mg C / g DS		
Nitrogen (total) (N)	-	mg N / g DS		
Phosphorus (total) (P)	-	mg P / g DS		
Potassium (K)	-	mg K / g DS		
Calcium (Ca)	-	mg Ca / g DS		
Magnesium (Mg)	-	mg Mg / g DS		
Sulphur (S)	-	mg S / g DS		
Zinc	-	mg Zn / g DS		
Copper	-	mg Cu / g DS		
Manganese	-	mg Mn / g DS		
Iron	-	mg Fe / g DS		
Aluminium	-	mg Al / g DS		
Boron	-	mg B / g DS		
Sulphur	-	mg S / g DS		
Sodium	-	mg Na / g DS		
CaO content	-	%		important for brick manufacture - Hersleman et al 2008: should be under 15% to prevent cracking
Heavy metals (*Cr, Be, *As, *Sb, Ba, *Pb, Ag, *Co, *Ni, *Cu, Sn, *V, *Mn)	-	mg / g DS		
Heavy metals (*Cd, *Hg, *Tl)	-	mg / g DS		Possible lower permit limit applies to these c.f. group above, as more toxic? (it does for air emissions of heavy metals)
Cd	-	mg / g		
Co	-	mg / g		
Cr	-	mg / g		
Cu	-	mg / g		
Hg	-	mg / g		
Mo	-	mg / g		
Ni	-	mg / g		
Pb	-	mg / g		
Zn	-	mg / g		
As	-	mg / g		
Se	-	mg / g		
B	-	mg / g		
F	-	mg / g		

Fertiliser regulation limits

Parameter	Value	Unit
Applicable regulations	Department of Agriculture, Forestry & Fisheries 2012 - Regulations regarding fertilisers	
Cd	0,02	mg / g
Co	0,1	mg / g
Cr	1,75	mg / g
Cu	0,75	mg / g
Hg	0,01	mg / g
Mo	0,025	mg / g
Ni	0,2	mg / g
Pb	0,4	mg / g
Zn	2,75	mg / g
As	0,015	mg / g
Se	0,015	mg / g
B	0,08	mg / g
F	0,4	mg / g

Chosen disposal route for bottom ash	2		Choices: 1 - Addition to LaDePa pellets or other fertiliser product 2 - Landfill 3 - Construction materials
	General landfill		

Storage

Number of days product storage required on-site	10	working days	
Storage area required	50	m2	Skips for ash

General product expenses for one combustion plant

Total capital costs		LCU	
Total non-depreciable capital costs		LCU	
Start up costs (year 1 only)		LCU	
Total operating costs, excluding fuel		LCU / year	
Total fuel costs		LCU / year	
Total land area required	50	m2	

General product expenses for all combustion plants

Number of combustion plants required	0,73	No.	Used for operational costs calculation. Assumes that sludge can be processed by combustion in the years between pit-emptying cycles
Number of combustion plants in operation	1	No.	Used for royalties, lease rate & capital costs calculation
Total depreciable capital costs	0	LCU	
Total non-depreciable capital costs	0	LCU	
Start up costs (year 1 only)	0	LCU	
Total operating costs, excluding fuel	-	LCU / year	
Total fuel costs	0	LCU / year	
Annual income (excluding income from product sales)	0	LCU / year	
Total land area required	50	m2	

Disposal routes - per combustion plant

Financial parameters

Transport costs

Truck capacity - mass (3 - 5 tonne range)	3	tonnes	
Truck purchase price	350 000,00	LCU	
Truck rental price	30 000,00	LCU / month	Excludes maintenance & fuel
Repair & maintenance cost per km	1,05	LCU / km	
Diesel cost per km	1,85	LCU / km	
Annual license and insurance	14 819,00	LCU / year	
Vehicle average speed	50	km / hour	
Driver labour rate	30	LCU / hour	
Transport hours available per year	2016	hours / year	Assumes 21 working days/month and 8 hour days

Option 1: Addition to fertiliser product or LaDePa pellets

Cost of fertiliser product registration	3 120,00	LCU	
Cost of analysis accompanying fertiliser product registration	3 300,00	LCU	
Delivery distance	30	km	
Mass flow of fly ash	0,00	dry tonnes / year / plant	
Mass flow of bottom ash	0,00	dry tonnes / year / plant	
Total mass flow of ash	0,00	dry tonnes / year / plant	
Annual flow of ash	0	dry tonnes / year / plant	
Average ash dry solids	0	%DS	
Annual wet mass flow of ash per plant	0,0	wet tonnes / year / plant	Assumed that ash-water mixture approximately equal density to water, as water volume unknown
Total wet mass flow of ash for all plants	0,0	wet tonnes / year	
Is vehicle purchased or hired?	Purchased		
Number of return trips required	0	No. / year	
Time for one return trip	1,7	hours	Includes 0.5 hours loading & unloading time
Number of vehicles required	0,0	No.	
Number of vehicles required rounded up	0,0	No.	
Labour cost per trip	51,0	LCU / return trip	
Fuel cost per trip	111,2	LCU / return trip	
Maintenance cost per trip	63,1	LCU / return trip	
Transport cost per trip	225,3	LCU / return trip	
Annual vehicle license & insurance	14819,0	LCU / year	
Vehicle hire cost, if applicable	0,0	LCU / year	
Total annual transport costs	-	LCU / year	
Total annual costs	-	LCU / year	
Sale price of ash	-	LCU / dry tonne	
Total capital costs	-	LCU	
Depreciable capital	-	LCU	
Total startup costs (year 1 only)	-	LCU	
Total operating costs, excluding fuel	-	LCU / year	
Total fuel costs	-	LCU / year	
Total revenues	-	LCU / year	

Option 2: General landfill

Landfill cost - by mass	1 300,00	LCU / tonne	Estimate
Mass flow of fly ash	1314,55	dry tonnes / year / plant	
Mass flow of bottom ash	328,64	dry tonnes / year / plant	
Total mass flow of ash	1643,19	dry tonnes / year / plant	
Annual flow of ash per plant	1643	dry tonnes / year / plant	
Average ash dry solids	59,136	%DS	
Annual wet mass flow of ash per plant	2778,7	wet tonnes / year / plant	Assumed that ash-water mixture approximately equal density to water, as water volume unknown
Total wet mass flow of ash for all plants	2778,7	wet tonnes / year	
Annual landfill fees	3 612 266,08	LCU / year	
Distance to landfill site	50	km	
Landfill cost includes transport?	Yes		
Is vehicle purchased or hired?	Purchased		
Number of return trips required	926	No. / year	
Time for one return trip	2,5	hours	
Number of vehicles required	1,1	No.	
Number of vehicles required rounded up	2,0	No.	
Labour cost per trip	75,0	LCU / return trip	
Fuel cost per trip	185,3	LCU / return trip	
Maintenance cost per trip	105,2	LCU / return trip	
Transport cost per trip	365,5	LCU / return trip	
Annual vehicle license & insurance	14819,0	LCU / year	
Vehicle hire cost, if applicable	0,0	LCU / year	
Total calculated annual transport costs	368 191,14	LCU / year	
Total annual transport costs, excluding fuel	-	LCU / year	
Total annual fuel costs	-		
Total annual cost of disposal	3 612 266,08	LCU / year	
Total capital costs	-	LCU	
Depreciable capital	-	LCU	
Total startup costs (year 1 only)		LCU	
Total operating costs, excluding fuel	3 612 266,08	LCU / year	
Total fuel costs	-	LCU / year	
Total revenues		LCU / year	

Option 3: Production of construction materials

Startup costs	0	LCU	Analysis, any certification requirements
Annual analytical costs	10 000,00	LCU / year	To guarantee suitability of material for construction - e.g. particle size analysis
Mass flow of fly ash	0,00	dry tonnes / year / plant	

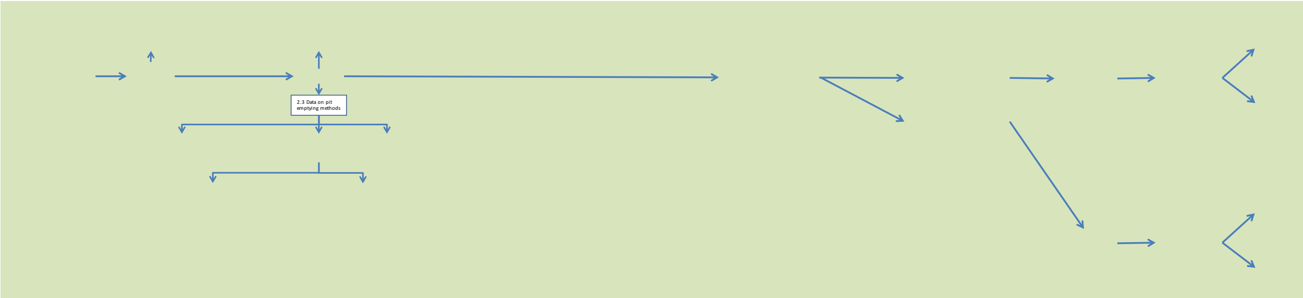
Mass flow of bottom ash	0,00	dry tonnes / year / plant	
Total mass flow of ash	0,00	dry tonnes / year / plant	
Annual flow of ash	0	dry tonnes / year / plant	
Average ash dry solids	0	%DS	
Annual wet mass flow of ash per plant	0,0	wet tonnes / year / plant	Assumed that ash-water mixture approximately equal density to water, as water volume unknown
Total wet mass flow of ash for all plants	0,0	wet tonnes / year	

Distance to end user's site	50	km
Transport costs borne by combustion operator?	Yes	
Is vehicle purchased or hired?	Purchased	
Number of return trips required	0	No. / year
Time for one return trip	2,5	hours
Number of vehicles required	0,0	No.
Number of vehicles required rounded up	0,0	No.
Labour cost per trip	75,0	LCU / return trip
Fuel cost per trip	185,3	LCU / return trip
Maintenance cost per trip	105,2	LCU / return trip
Transport cost per trip	365,5	LCU / return trip
Annual vehicle license & insurance	14819,0	LCU / year
Vehicle hire cost, if applicable	0,0	LCU / year
Total calculated annual transport costs	-	LCU / year
Total annual transport costs, excluding fuel	-	LCU / year
Total annual fuel costs	-	
Total annual cost of disposal	10 000,00	LCU / year
Sale price of ash	-	LCU / dry tonne
Total capital costs	-	LCU
Depreciable capital	-	LCU
Total startup costs (year 1 only)		LCU
Total operating costs, excluding fuel	10 000,00	LCU / year
Total fuel costs	-	LCU / year
Total revenues	-	LCU / year

Option number	2 Capital costs LCU	3 Depreciable capital LCU	4 Total startup costs LCU	5 Total operating costs, excluding fuel LCU/year	6 Total fuel costs LCU /year	7 Total revenues	8
1 Fertiliser	-	-	-	-	-	-	
2 General landfill	-	-	-	3 612 266,08	-	-	
3 Construction	-	-	-	10 000,00	-	-	
	-	-	-	3 622 266,08	-	-	
General costs	0	0	0	-	-	0	
Total per plant	-	-	-	3 622 266,08	-	-	
Total for all plants	-	-	-	2 635 205,46	-	-	

Nutrient content contained in ash

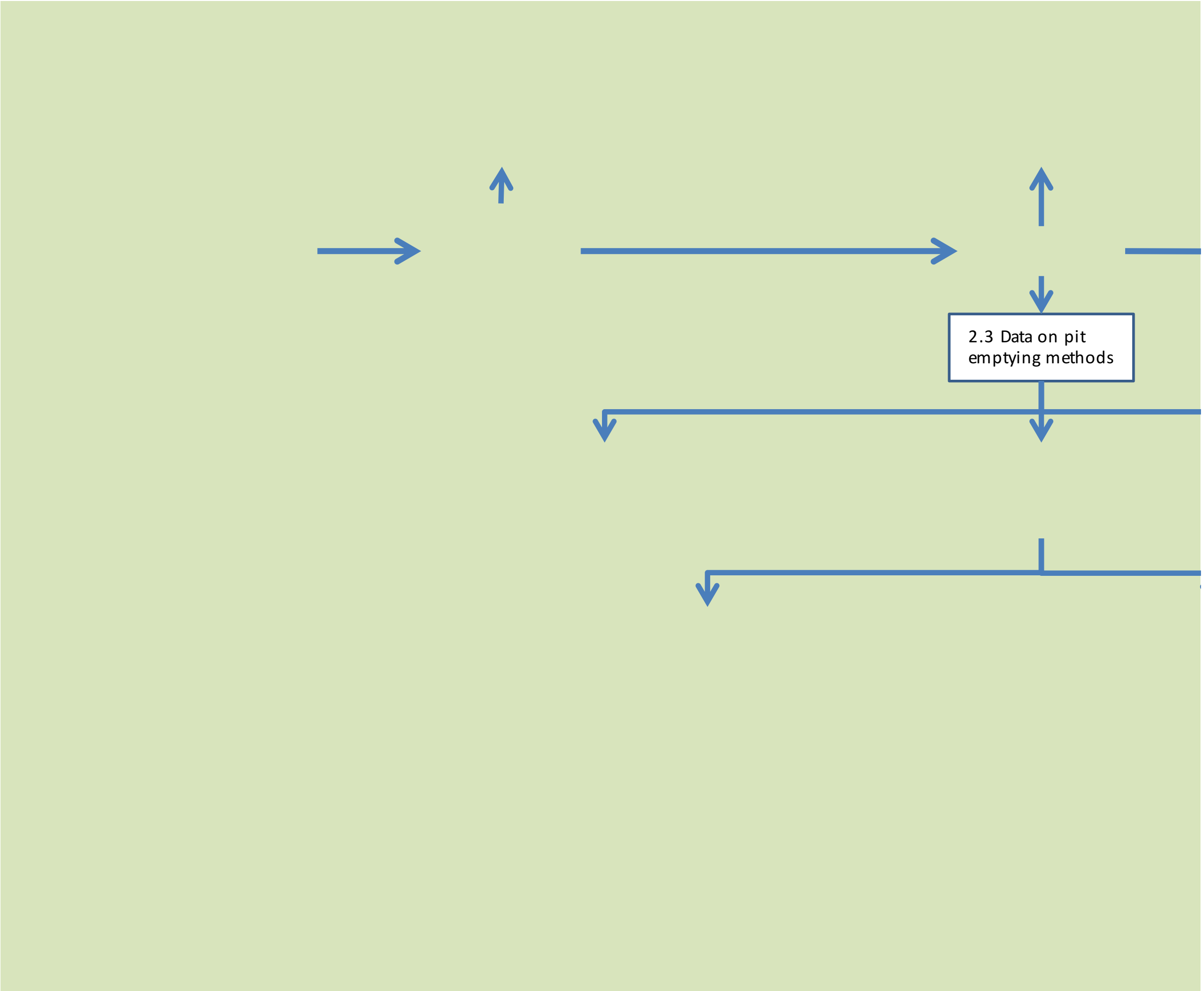
Annual dry mass of ash for all plants	1 195,43	dry tonnes / year
N content	1,90	mg N / g DS
P content	11,90	mg P / g DS
K content	2,90	mg K / g DS
Annual mass of N produced	2 271	kg N / year
Annual mass of P produced	14 226	kg P / year
Annual mass of K produced	3 467	kg K / year
Total annual mass of NPK produced	19,96	tonnes NPK / year



15. Combustion by-products

Costs associated with disposal of combustion process by-products

Parameter	Value	Unit	Reference	Comment
Combustion plant operational months per year	12	months / year		
Number of combustion plants required	0,73	No.		
Number of combustion plants operating	1	No.		
By-product characteristics				
Detritus				
Detritus flowrate per plant at full capacity	0	m3 / year / plant		Any large detritus removed at pre-treatment stage
Detritus density	1100	kg / m3		
Mass flowrate per plant	0	tonnes / year / plant		
Total annual mass flowrate to landfill from all plants	0	wet tonnes / year		
Hazardous landfill cost, including transport	1700	LCU / tonne		
Annual disposal costs	0	LCU / year / plant		
Air emissions -treated off-gas				*starred items are those listed in the Department of Environmental Affairs (DEA) 2009 policy on air emissions from thermal treatment plants
Flowrate	0	Nm^3 / hour		
Constituents				
Inorganic gases				
Carbon dioxide	0			
*Carbon monoxide	0			
Water	0			
*Sulphur dioxide	0			
*Nitrogen oxides	0			
*Hydrogen chloride	0			
*Hydrogen fluoride	0			
*Ammonia	0			
Organic compounds				
*VOC (volatile organic compounds / volatile organic carbon)	0			
*Dioxins (PCDD - polychlorinated dibenzodioxins) & *furans (PCDF - polychlorinated dibenzo-furans)	0			
Odour level	0			units
*TOC (total organic carbon)	0			
Particulates				
*Total particulate matter	0			
Heavy metals (*Cr, Be, *As, *Sb, Ba, *Pb, Ag, *Co, *Ni, *Cu, Sn, *V, *Mn)	0			
Heavy metals (*Cd, *Hg, *Tl)	0			Lower APPA permit limit than other metals above hence grouped separately (Botha et al 2011)
Air pollution control (APC) device				All costs for APC currently assumed to be included under repair & maintenance cost for main combustion plant
Air pollution control device selected	Bag filter			Options could include bag filter, scrubber, bio-filter, electro-static precipitator
Is the capital cost of the air pollution control device included within the capital cost of the combustion plant?	Yes			
Capital cost of air pollution control device	0	LCU		
Maintenance cost of APC	0	LCU / month		
Monthly consumables costs for APC	0	LCU / month		e.g. NaOH for scrubber
Monthly cost of APC residue disposal	0	LCU / month		e.g. fees to discharge wastewater from a scrubber to sewer
Routine monitoring (checking compliance with emissions limits)	0	LCU / month		For requirements in SA: See p 37 onwards of Herselman et al 2008 vol5; DEA 2009 p21 See p 35 of Herselman et al 2008 vol5
	0			
Costs per plant				
Total capital costs	0	LCU		
Depreciable capital		LCU		
Total startup costs (year 1 only)		LCU		
Total operating costs, excluding fuel	0	LCU / year		
Total fuel costs		LCU / year		
Total revenues	0	LCU / year		
Additional land area required	0	m2		
Costs for all plants				
Total capital costs	0	LCU		
Depreciable capital	0	LCU		
Total startup costs (year 1 only)	0	LCU		
Total operating costs, excluding fuel	0	LCU / year		
Total fuel costs	0	LCU / year		
Total revenues	0	LCU / year		
Additional land area required	0	m2		



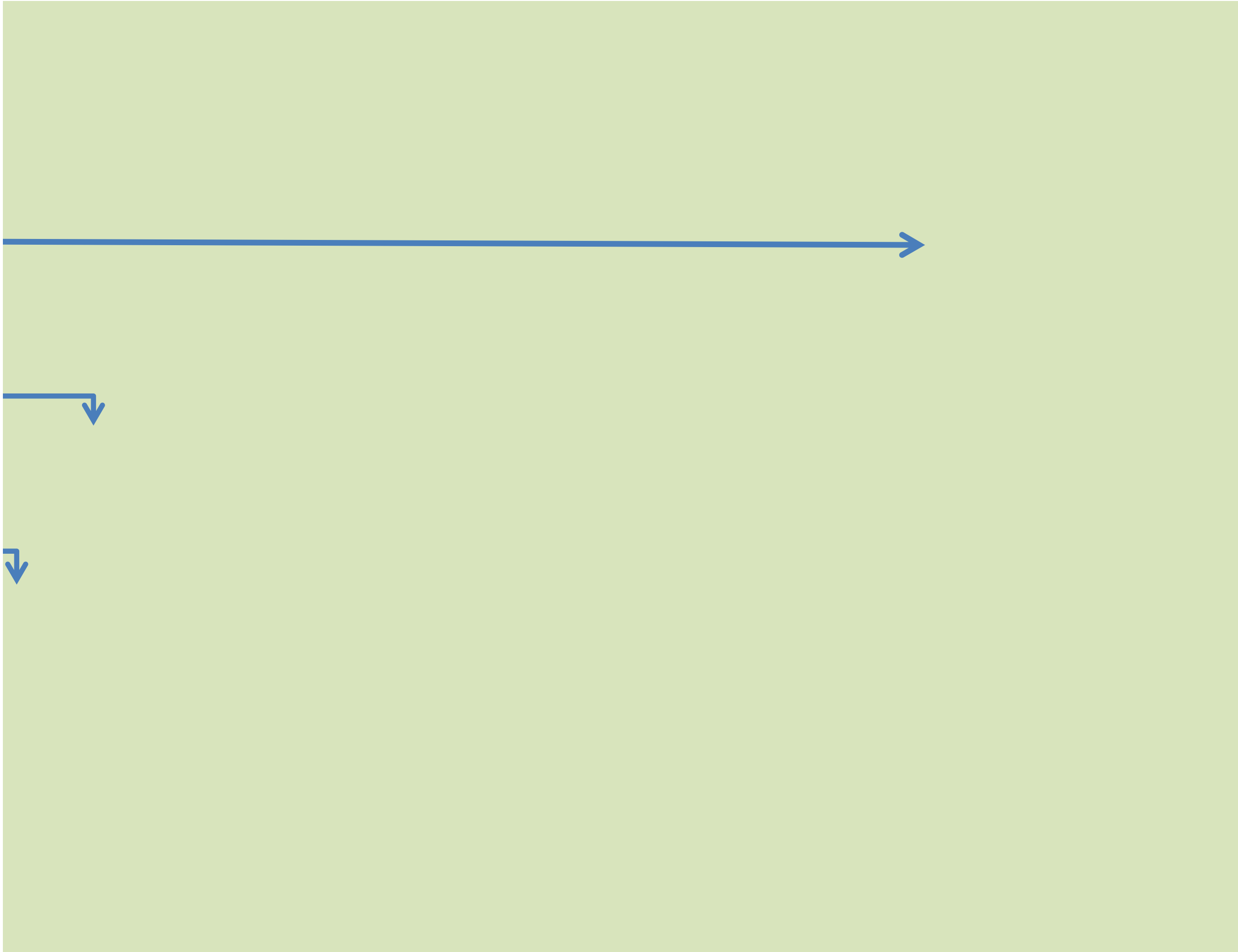
16.1 Combustion costs summary (storage, pre-treatment, combustion pro

Combustion process

Is the cost of emptying and conveyance to be included in the combustion cash flows?	Yes
	Value
Total capital costs	
Storage	20 000,00
Pre-treatment	-
Combustion process	73 175 000,00
Product	-
By-product disposal	0
Total capital cost	73 195 000,00
Depreciable capital	
Storage	20 000,00
Pre-treatment	-

Combustion process	73 175 000,00
Product	-
By-product disposal	-
Total depreciable capital	73 195 000,00
Non-depreciable capital	
Total non-depreciable capital	-
Startup costs (for year 1 only)	
Managing contractor establishment costs	1 000 000,00
Storage	-
Pre-treatment	-
Combustion process	175 000,00
Product	-
By-product disposal	-
Total startup costs	1 175 000,00
Operating costs, excluding fuel	
Storage	6 600,00
Pre-treatment	-
Combustion process	6 338 758,20
Product	2 635 205,46
By-product disposal	-
Managing contractor annual costs	600 000,00
Managing contractor markup rate	15,00
Managing contractor markup	Markup is now calculated on cash flow sheet
Total operating costs, excluding fuel	9 580 563,66
Emptying and conveyance costs for sludge	4 831,06
Annual mass FS arriving at Storage	2 294,25
Total annual emptying and conveyance costs	11 083 664,62
Total annual emptying and conveyance costs to be included in combustion cash flows	11 083 664,62
Fuel costs	
Storage	-
Pre-treatment	-
Combustion process	1 452 001,77
Product	-

By-product disposal	-
Total fuel costs	1 452 001,77
Revenues	
Storage	-
Pre-treatment	-
Combustion process	-
Product	-
By-product disposal	-
Total revenues	-
Financial parameters	
Debt proportion in debt:equity ratio	70
Debt	51 236 500,00
Interest	9
Lifespan of equipment	20
Repayment period	5
Instalment per quarter	2 561 825,00
Terminal value of assets	10
Depreciation rate	4,5
Escalation rate - general	6
Escalation rate - fuel	12
Discount rate	8



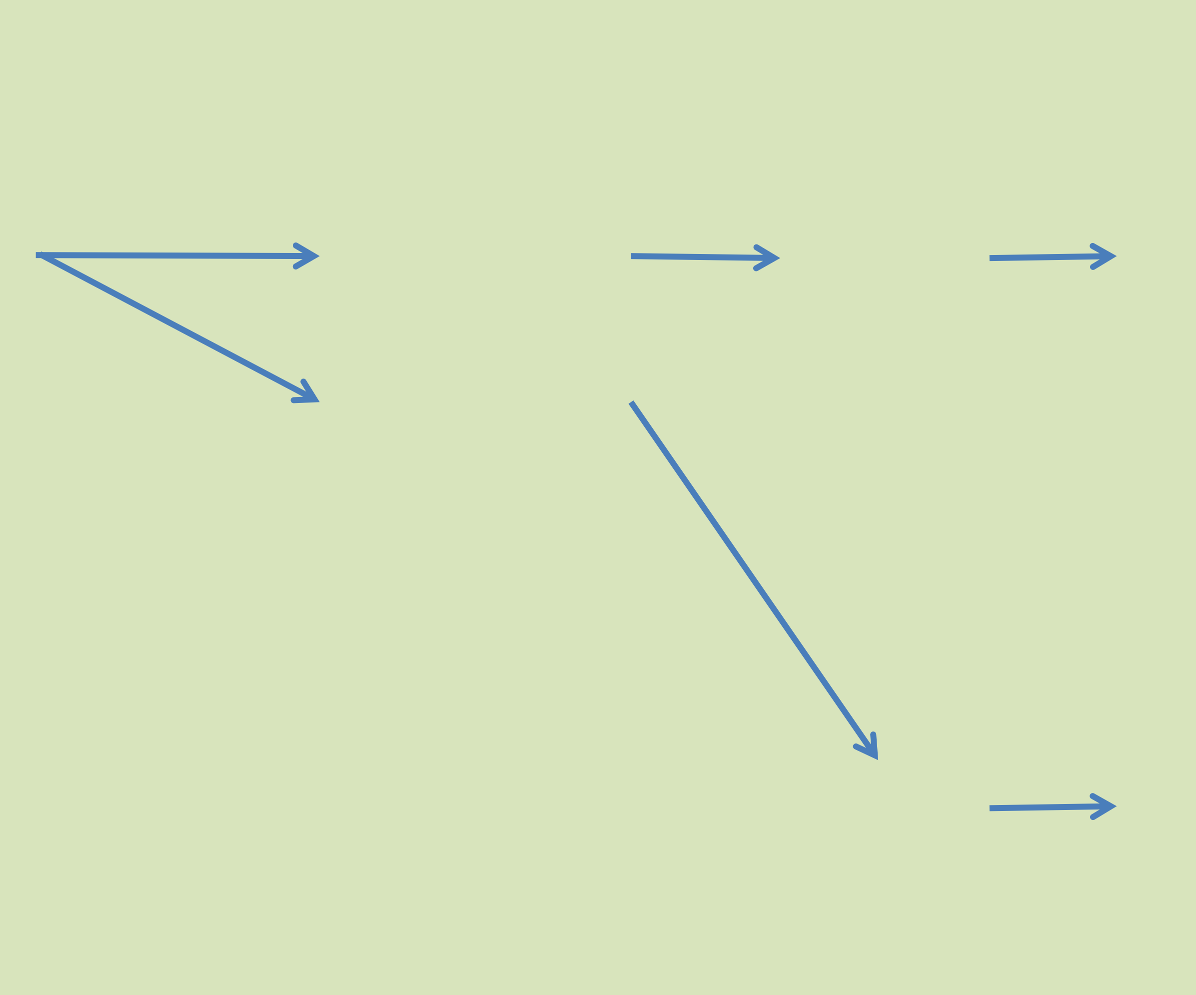
ustion process, product and by-product disposal)

Yes or No

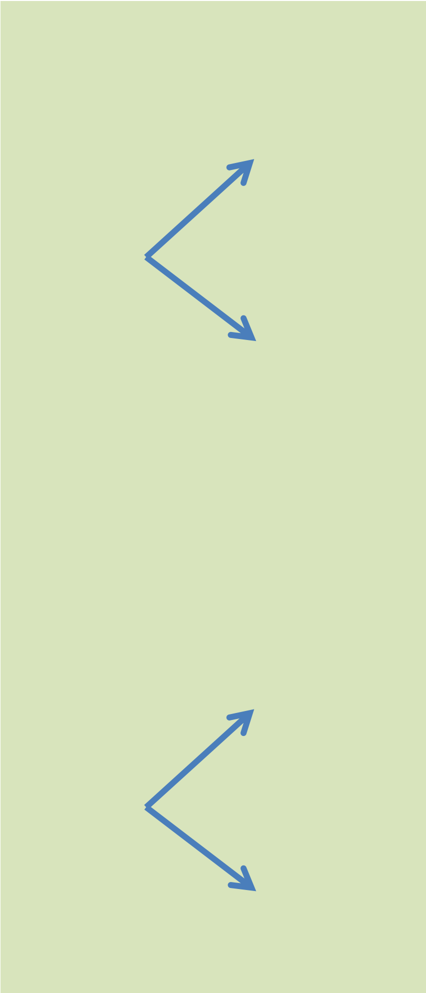
Unit	Reference	Notes
LCU		
LCU		
LCU		
LCU		
LCU		
LCU		
LCU		
LCU		

LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
%	
LCU / year	
LCU / year	
LCU / tonne dry solids	Price paid to pit-emptying sub-contractor (including markup)
tonnes dry solids / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	

LCU / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
LCU / year	
%	
LCU	
%	
years	Combustion plant lifetime
years	
LCU / quarter	
% of initial value	
%	
%	
%	
%	



User comment



16.2 Combustion interest and repayment

Parameter		Value
Capital cost		73 195 000,00
Debt proportion in debt:equity ratio		70
Debt		51 236 500,00
Interest		9
Lifespan of equipment		20
Repayment period		5
Instalment per quarter		2 561 825,00
		Opening balance
	1	
Q1		51 236 500,00
Q2		48 674 675,00
Q3		46 112 850,00
Q4		43 551 025,00
	2	
Q1		40 989 200,00
Q2		38 427 375,00
Q3		35 865 550,00
Q4		33 303 725,00
	3	
Q1		30 741 900,00
Q2		28 180 075,00
Q3		25 618 250,00
Q4		23 056 425,00
	4	
Q1		20 494 600,00
Q2		17 932 775,00
Q3		15 370 950,00
Q4		12 809 125,00
	5	
Q1		10 247 300,00
Q2		7 685 475,00
Q3		5 123 650,00
Q4		2 561 825,00
	6	
Q1		-
Q2		-
Q3		-
Q4		-
	7	
Q1		-

Q2		-
Q3		-
Q4		-
	8	
Q1		-
Q2		-
Q3		-
Q4		-
	9	
Q1		-
Q2		-
Q3		-
Q4		-
	10	
Q1		-
Q2		-
Q3		-
Q4		-
	11	
Q1		-
Q2		-
Q3		-
Q4		-
	12	
Q1		-
Q2		-
Q3		-
Q4		-
	13	
Q1		-
Q2		-
Q3		-
Q4		-
	14	
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Q2		-
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Q1		-
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Q3		-
Q4		-
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Q3		-
Q4		-

	17	
Q1		-
Q2		-
Q3		-
Q4		-
	18	
Q1		-
Q2		-
Q3		-
Q4		-
	19	
Q1		-
Q2		-
Q3		-
Q4		-
	20	
Q1		-
Q2		-
Q3		-
Q4		-
TOTALS		

Unit
LCU
%
LCU
%
years
years
LCU / quarter

Interest payable	Repayment at end of quarter	Closing balance
1 152 821,25	2 561 825,00	48 674 675,00
1 095 180,19	2 561 825,00	46 112 850,00
1 037 539,13	2 561 825,00	43 551 025,00
979 898,06	2 561 825,00	40 989 200,00
922 257,00	2 561 825,00	38 427 375,00
864 615,94	2 561 825,00	35 865 550,00
806 974,88	2 561 825,00	33 303 725,00
749 333,81	2 561 825,00	30 741 900,00
691 692,75	2 561 825,00	28 180 075,00
634 051,69	2 561 825,00	25 618 250,00
576 410,63	2 561 825,00	23 056 425,00
518 769,56	2 561 825,00	20 494 600,00
461 128,50	2 561 825,00	17 932 775,00
403 487,44	2 561 825,00	15 370 950,00
345 846,38	2 561 825,00	12 809 125,00
288 205,31	2 561 825,00	10 247 300,00
230 564,25	2 561 825,00	7 685 475,00
172 923,19	2 561 825,00	5 123 650,00
115 282,13	2 561 825,00	2 561 825,00
57 641,06	2 561 825,00	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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12 104 623,13	51 236 500,00	

16.3 Combustion cash flow

Total depreciable capital	73 195 000,00
Total non-depreciable capital	-
Total operating costs, excluding fuel	9 580 563,66
Emptying & conveyance costs for years where pit emptying occurs	11 083 664,62
Managing contractor markup rate	15,00
Total startup costs	1 175 000,00
Total fuel costs	1 452 001,77
Total revenue	-
Repayment period for debt	5
Lifespan of equipment	20
Terminal value of assets	10
Depreciation rate	4,5
Escalation rate - general	6
Escalation rate - fuel	12
Discount rate	8
Income tax rate	28
Does income tax apply?	No
Income tax rate applied	0

Dry mass of FS entering pre-treatment	2294,25
Number of pits emptied per year	7000
Dry mass of ash produced (bottom and fly ash combined)	1195,43

Interest & repayment summary

Year

Interest payable

Principle payable

Cash flows

Parameter	**Unit**
Depreciable cost	LCU
Interest on loan	LCU / year
Depreciation	LCU / year
O&M costs, excluding fuel	LCU / year
Emptying & conveyance costs	LCU / year
Managing contractor markup	LCU / year
Start-up costs (year 1 only)	LCU / year
Fuel costs	LCU / year
Total expenses	**LCU / year**
Salvage value	LCU

Revenues	LCU / year
Subsidy	
Net profit before tax (PBT)	**LCU / year**
Tax	LCU / year
Profit after tax (PAT)	LCU / year
Discounted total cost	LCU / year
Mass of FS entering pre-treatment	tonnes / year
Number of pits emptied	pits / year
Mass of dry ash produced	dry tonnes / year
Levelised cost of pit emptying per dry tonne FS	**LCU / dry tonne FS**
Levelised cost of pit emptying per pit	**LCU / pit**
Levelised cost of ash production	**LCU / dry tonne ash**

Length of pit-emptying cycle	5
Time between pit-emptying cycles	0
Number of pits per cycle	35000
Pits per year during cycle	7000

Pit emptying schedule

No. pits emptied / year

1	**1,1**
2	**1,2**
3	**2,1**
6	

VLOOKUP result

LCU
LCU
LCU / year
LCU / year

%
LCU
LCU / year
LCU
years
years
% of initial value
%
%
%
%
%

%

tonnes / year
pits / year
dry tonnes / year

0	**1**	**2**	**3**	**4**
	4 265 438,63	3 343 181,63	2 420 924,63	1 498 667,63
	10 247 300,00	10 247 300,00	10 247 300,00	10 247 300,00

	Year			
73 195 000,00	**1**	**2**	**3**	**4**
	4 265 438,63	3 343 181,63	2 420 924,63	1 498 667,63
	3 293 775,00	3 293 775,00	3 293 775,00	3 293 775,00
	9 580 563,66	10 155 397,48	10 764 721,33	11 410 604,61
	11 083 664,62	11 748 684,50	12 453 605,57	13 200 821,90
	3 099 634,24	3 285 612,30	3 482 749,03	3 691 713,98
	1 175 000,00			
	1 452 001,77	1 626 241,98	1 821 391,02	2 039 957,94
	33 950 077,92	**33 452 892,88**	**34 237 166,58**	**35 135 541,05**
	-	-	-	-

-	-	-	-
33 950 077,92	**33 452 892,88**	**34 237 166,58**	**35 135 541,05**
-	-	-	-
33 950 077,92	33 452 892,88	34 237 166,58	35 135 541,05
33 950 077,92	30 974 900,82	29 352 852,00	27 891 725,29
2294,25	2294,25	2294,25	2294,25
7000	7000	7000	7000
1195,43	1195,43	1195,43	1195,43
10 628			
3 483			
20 397			
1	0,925925926	0,85733882	0,793832241
6			
1	**2**	**3**	**4**
7000	7000	7000	7000
7000	0	7000	0
7000	0	0	7000
7000	7000	0	7000
0	0	0	0
0	0	0	0

5	**6**	**7**	**8**	**9**
576 410,63	-	-	-	-
10 247 300,00	-	-	-	-

5	**6**	**7**	**8**	**9**
576 410,63	-	-	-	-
3 293 775,00	3 293 775,00	3 293 775,00	3 293 775,00	3 293 775,00
12 095 240,89	12 820 955,34	13 590 212,66	14 405 625,42	15 269 962,95
13 992 871,21	14 832 443,49	15 722 390,10	16 665 733,50	17 665 677,51
3 913 216,82	4 148 009,82	4 396 890,41	4 660 703,84	4 940 346,07
2 284 752,89	2 558 923,24	2 865 994,03	3 209 913,32	3 595 102,91
36 156 267,44	**37 654 106,89**	**39 869 262,20**	**42 235 751,08**	**44 764 864,44**
-	-	-	-	-

-	-	-	-	-
36 156 267,44	**37 654 106,89**	**39 869 262,20**	**42 235 751,08**	**44 764 864,44**
-	-	-	-	-
36 156 267,44	37 654 106,89	39 869 262,20	42 235 751,08	44 764 864,44
26 575 935,93	25 626 752,45	25 124 398,09	24 644 155,09	24 185 063,38
2294,25	2294,25	2294,25	2294,25	2294,25
7000	7000	7000	7000	7000
1195,43	1195,43	1195,43	1195,43	1195,43
0,735029853	0,680583197	0,630169627	0,583490395	0,540268885
5	**6**	**7**	**8**	**9**
7000	7000	7000	7000	7000
7000	0	7000	0	7000
0	0	7000	0	0
7000	0	7000	7000	0
0	0	0	0	0
0	0	0	0	0

10	11	12	13	14
-	-	-	-	-
-	-	-	-	-

10	11	12	13	14
-	-	-	-	-
3 293 775,00	3 293 775,00	3 293 775,00	3 293 775,00	3 293 775,00
16 186 160,72	17 157 330,37	18 186 770,19	19 277 976,40	20 434 654,99
18 725 618,16	19 849 155,25	21 040 104,57	22 302 510,84	23 640 661,49
5 236 766,83	5 550 972,84	5 884 031,21	6 237 073,09	6 611 297,47
4 026 515,26	4 509 697,09	5 050 860,75	5 656 964,03	6 335 799,72
47 468 835,98	**50 360 930,56**	**53 455 541,72**	**56 768 299,36**	**60 316 188,67**
-	-	-	-	-

-	-	-	-	-
47 468 835,98	**50 360 930,56**	**53 455 541,72**	**56 768 299,36**	**60 316 188,67**
-	-	-	-	-
47 468 835,98	50 360 930,56	53 455 541,72	56 768 299,36	60 316 188,67
23 746 236,17	23 326 855,09	22 926 165,58	22 543 472,73	22 178 137,40
2294,25	2294,25	2294,25	2294,25	2294,25
7000	7000	7000	7000	7000
1195,43	1195,43	1195,43	1195,43	1195,43
0,500248967	0,463193488	0,428882859	0,397113759	0,367697925
10	**11**	**12**	**13**	**14**
7000	7000	7000	7000	7000
0	7000	0	7000	0
7000	0	0	7000	0
7000	7000	0	7000	7000
0	0	0	0	0
0	0	0	0	0

15	16	17	18	19
-	-	-	-	-
-	-	-	-	-

15	16	17	18	19
-	-	-	-	-
3 293 775,00	3 293 775,00	3 293 775,00	3 293 775,00	3 293 775,00
21 660 734,28	22 960 378,34	24 338 001,04	25 798 281,10	27 346 177,97
25 059 101,18	26 562 647,25	28 156 406,09	29 845 790,45	31 636 537,88
7 007 975,32	7 428 453,84	7 874 161,07	8 346 610,73	8 847 407,38
7 096 095,69	7 947 627,17	8 901 342,43	9 969 503,52	11 165 843,94
64 117 681,47	**68 192 881,60**	**72 563 685,63**	**77 253 960,81**	**82 289 742,17**
-	-	-	-	-

-	-	-	-	-
64 117 681,47	**68 192 881,60**	**72 563 685,63**	**77 253 960,81**	**82 289 742,17**
-	-	-	-	-
64 117 681,47	68 192 881,60	72 563 685,63	77 253 960,81	82 289 742,17
21 829 572,60	21 497 240,26	21 180 648,13	20 879 346,98	20 592 928,08
2294,25	2294,25	2294,25	2294,25	2294,25
7000	7000	7000	7000	7000
1195,43	1195,43	1195,43	1195,43	1195,43
0,340461041	0,315241705	0,291890468	0,270268951	0,250249029
15	**16**	**17**	**18**	**19**
7000	7000	7000	7000	7000
7000	0	7000	0	7000
0	7000	0	0	7000
0	7000	7000	0	7000
0	0	0	0	0
0	0	0	0	0

20

-

-

20

-

3 293 775,00

28 986 948,65

33 534 730,15

9 378 251,82

12 505 745,21

87 699 450,83

- 7 319 500,00

-

80 379 950,83

-

80 379 950,83

18 625 004,31

2294,25

7000

1195,43

0,231712064

20

7000

0

0

7000

0

0

16.4 Combustion NPV & IRR calculations

Total depreciable capital	73 195 000,00
Total non-depreciable capital	-
Total operating costs, excluding fuel	9 580 563,66
Emptying & conveyance costs for years where pit emptying occurs	11 083 664,62
Managing contractor markup rate	15,00
Total startup costs	1 175 000,00
Total fuel costs	1 452 001,77
Total revenue	-
Repayment period for debt	5
Lifespan of equipment	20
Terminal value of assets	10
Depreciation rate	4,5
Escalation rate - general	6
Escalation rate - fuel	12
Discount rate	8
Income tax rate	0

Dry mass of FS entering pre-treatment	2294,25
Number of pits empties per year	7000
Dry mass of ash produced (bottom and fly ash combined)	1195,43

Interest & repayment summary

Year

Interest payable

Principle payable

Cash flows

Parameter	**Unit**
Depreciable cost	LCU
O&M costs, excluding fuel	LCU / year
Emptying & conveyance costs	LCU / year
Managing contractor markup	LCU / year
Start-up costs (year 1 only)	LCU / year
Fuel costs	LCU / year
Revenues	LCU / year
PBDIT	LCU / year
Depreciation	LCU / year
PBIT	**LCU / year**
Interest on loan	LCU / year

PBT	**LCU / year**
Tax	LCU / year
PAT	**LCU / year**
Salvage value	LCU
Subsidy	LCU
Project cost	LCU
Net cash flow for NPV & IRR	**LCU / year**
Discounted total cost	LCU / year

NPV
IRR

Length of pit-emptying cycle	5
Time between pit-emptying cycles	0
Number of pits per cycle	35000
Pits per year during cycle	7000

Pit emptying schedule
No. pits emptied / year

1	**1,1**
2	**1,2**
3	**2,1**
6	

VLOOKUP result

<u>Equity IRR</u>

Principal repayment
Depreciation
Salvage value
Subsidy
Project equity
Net cash flow

Equity IRR

LCU
LCU
LCU
LCU / year

%
LCU
LCU
LCU
years
years
% of initial value
%
%
%
%
%

tonnes / year
pits / year
dry tonnes / year

0	1	2	3	4
	4 265 438,63	3 343 181,63	2 420 924,63	1 498 667,63
	10 247 300,00	10 247 300,00	10 247 300,00	10 247 300,00

	Year			
0	**1**	**2**	**3**	**4**
73 195 000,00				
	- 9 580 563,66	- 10 155 397,48	- 10 764 721,33	- 11 410 604,61
	- 11 083 664,62	- 11 748 684,50	- 12 453 605,57	- 13 200 821,90
	- 3 099 634,24	- 3 285 612,30	- 3 482 749,03	- 3 691 713,98
	- 1 175 000,00			
	- 1 452 001,77	- 1 626 241,98	- 1 821 391,02	- 2 039 957,94
	-	-	-	-
	- 26 390 864,29	**- 26 815 936,26**	**- 28 522 466,95**	**- 30 343 098,43**
	- 3 293 775,00	- 3 293 775,00	- 3 293 775,00	- 3 293 775,00
	- 29 684 639,29	**- 30 109 711,26**	**- 31 816 241,95**	**- 33 636 873,43**
	- 4 265 438,63	- 3 343 181,63	- 2 420 924,63	- 1 498 667,63

		-	**33 950 077,92**	**-**	**33 452 892,88**	**-**	**34 237 166,58**	**-**	**35 135 541,05**
			-		-		-		-
		-	**33 950 077,92**	**-**	**33 452 892,88**	**-**	**34 237 166,58**	**-**	**35 135 541,05**
			-		-		-		-
-	73 195 000,00								
-	**73 195 000,00**	**-**	**26 390 864,29**	**-**	**26 815 936,26**	**-**	**28 522 466,95**	**-**	**30 343 098,43**
-	73 195 000,00	-	24 435 985,46	-	22 990 343,16	-	22 642 053,86	-	22 303 083,17
-	**482 153 980,39**								
	#NUM!		array must contain at least one positive and one negative value for IRR to be ca						

6

			1		**2**		**3**		**4**
			7000		7000		7000		7000
			7000		0		7000		0
			7000		0		0		7000
			7000		7000		0		7000
			0		0		0		0
			0		0		0		0
		-	10 247 300,00	-	10 247 300,00	-	10 247 300,00	-	10 247 300,00
		-	3 293 775,00	-	3 293 775,00	-	3 293 775,00	-	3 293 775,00
			-		-		-		-
			-		-		-		-
-	21 958 500								
-	21 958 500	-	47 491 152,92	-	46 993 967,88	-	47 778 241,58	-	48 676 616,05
	#NUM!		array must contain at least one positive and one negative value for IRR to be ca						

5	6	7	8	9
576 410,63	-	-	-	-
10 247 300,00	-	-	-	-

	5		6		7		8		9
-	12 095 240,89	-	12 820 955,34	-	13 590 212,66	-	14 405 625,42	-	15 269 962,95
-	13 992 871,21	-	14 832 443,49	-	15 722 390,10	-	16 665 733,50	-	17 665 677,51
-	3 913 216,82	-	4 148 009,82	-	4 396 890,41	-	4 660 703,84	-	4 940 346,07
-	2 284 752,89	-	2 558 923,24	-	2 865 994,03	-	3 209 913,32	-	3 595 102,91
	-		-		-		-		-
-	**32 286 081,81**	**-**	**34 360 331,89**	**-**	**36 575 487,20**	**-**	**38 941 976,08**	**-**	**41 471 089,44**
-	3 293 775,00	-	3 293 775,00	-	3 293 775,00	-	3 293 775,00	-	3 293 775,00
-	**35 579 856,81**	**-**	**37 654 106,89**	**-**	**39 869 262,20**	**-**	**42 235 751,08**	**-**	**44 764 864,44**
-	576 410,63		-		-		-		-

-	**36 156 267,44**	**-**	**37 654 106,89**	**-**	**39 869 262,20**	**-**	**42 235 751,08**	**-**	**44 764 864,44**
	-		-		-		-		-
-	**36 156 267,44**	**-**	**37 654 106,89**	**-**	**39 869 262,20**	**-**	**42 235 751,08**	**-**	**44 764 864,44**
	-		-		-		-		-
-	**32 286 081,81**	**-**	**34 360 331,89**	**-**	**36 575 487,20**	**-**	**38 941 976,08**	**-**	**41 471 089,44**
-	21 973 364,78	-	21 652 837,53	-	21 341 445,48	-	21 039 137,98	-	20 745 869,66

IRR to be calculated

	5		**6**		**7**		**8**		**9**
	7000		7000		7000		7000		7000
	7000		0		7000		0		7000
	0		0		7000		0		0
	7000		0		7000		7000		0
	0		0		0		0		0
	0		0		0		0		0
-	10 247 300,00		-		-		-		-
-	3 293 775,00	-	3 293 775,00	-	3 293 775,00	-	3 293 775,00	-	3 293 775,00
	-		-		-		-		-
	-		-		-		-		-
-	49 697 342,44	-	40 947 881,89	-	43 163 037,20	-	45 529 526,08	-	48 058 639,44

IRR to be calculated

10	11	12	13	14
-	-	-	-	-
-	-	-	-	-

	10		11		12		13		14
-	16 186 160,72	-	17 157 330,37	-	18 186 770,19	-	19 277 976,40	-	20 434 654,99
-	18 725 618,16	-	19 849 155,25	-	21 040 104,57	-	22 302 510,84	-	23 640 661,49
-	5 236 766,83	-	5 550 972,84	-	5 884 031,21	-	6 237 073,09	-	6 611 297,47
-	4 026 515,26	-	4 509 697,09	-	5 050 860,75	-	5 656 964,03	-	6 335 799,72
	-		-		-		-		-
-	**44 175 060,98**	**-**	**47 067 155,56**	**-**	**50 161 766,72**	**-**	**53 474 524,36**	**-**	**57 022 413,67**
-	3 293 775,00	-	3 293 775,00	-	3 293 775,00	-	3 293 775,00	-	3 293 775,00
-	**47 468 835,98**	**-**	**50 360 930,56**	**-**	**53 455 541,72**	**-**	**56 768 299,36**	**-**	**60 316 188,67**
	-		-		-		-		-

- 47 468 835,98	**- 50 360 930,56**	**- 53 455 541,72**	**- 56 768 299,36**	**- 60 316 188,67**
-	-	-	-	-
- 47 468 835,98	**- 50 360 930,56**	**- 53 455 541,72**	**- 56 768 299,36**	**- 60 316 188,67**
-	-	-	-	-
- 44 175 060,98	**- 47 067 155,56**	**- 50 161 766,72**	**- 53 474 524,36**	**- 57 022 413,67**
- 20 461 600,58	- 20 186 296,26	- 19 919 927,72	- 19 662 471,63	- 19 413 910,34

10	**11**	**12**	**13**	**14**
7000	7000	7000	7000	7000
0	7000	0	7000	0
7000	0	0	7000	0
7000	7000	0	7000	7000
0	0	0	0	0
0	0	0	0	0
-	-	-	-	-
- 3 293 775,00	- 3 293 775,00	- 3 293 775,00	- 3 293 775,00	- 3 293 775,00
-	-	-	-	-
-	-	-	-	-
- 50 762 610,98	- 53 654 705,56	- 56 749 316,72	- 60 062 074,36	- 63 609 963,67

15	16	17	18	19
-	-	-	-	-
-	-	-	-	-

	15		16		17		18		19
-	21 660 734,28	-	22 960 378,34	-	24 338 001,04	-	25 798 281,10	-	27 346 177,97
-	25 059 101,18	-	26 562 647,25	-	28 156 406,09	-	29 845 790,45	-	31 636 537,88
-	7 007 975,32	-	7 428 453,84	-	7 874 161,07	-	8 346 610,73	-	8 847 407,38
-	7 096 095,69	-	7 947 627,17	-	8 901 342,43	-	9 969 503,52	-	11 165 843,94
	-		-		-		-		-
-	**60 823 906,47**	**-**	**64 899 106,60**	**-**	**69 269 910,63**	**-**	**73 960 185,81**	**-**	**78 995 967,17**
-	3 293 775,00	-	3 293 775,00	-	3 293 775,00	-	3 293 775,00	-	3 293 775,00
-	**64 117 681,47**	**-**	**68 192 881,60**	**-**	**72 563 685,63**	**-**	**77 253 960,81**	**-**	**82 289 742,17**
	-		-		-		-		-

-	**64 117 681,47**	**-**	**68 192 881,60**	**-**	**72 563 685,63**	**-**	**77 253 960,81**	**-**	**82 289 742,17**
	-		-		-		-		-
-	**64 117 681,47**	**-**	**68 192 881,60**	**-**	**72 563 685,63**	**-**	**77 253 960,81**	**-**	**82 289 742,17**
	-		-		-		-		-
-	**60 823 906,47**	**-**	**64 899 106,60**	**-**	**69 269 910,63**	**-**	**73 960 185,81**	**-**	**78 995 967,17**
-	19 174 231,98	-	18 943 430,57	-	18 721 506,11	-	18 508 464,69	-	18 304 318,60
	15		**16**		**17**		**18**		**19**
	7000		7000		7000		7000		7000
	7000		0		7000		0		7000
	0		7000		0		0		7000
	0		7000		7000		0		7000
	0		0		0		0		0
	0		0		0		0		0
	-		-		-		-		-
-	3 293 775,00	-	3 293 775,00	-	3 293 775,00	-	3 293 775,00	-	3 293 775,00
	-		-		-		-		-
	-		-		-		-		-
-	67 411 456,47	-	71 486 656,60	-	75 857 460,63	-	80 547 735,81	-	85 583 517,17

20

-
-

20

-	28 986 948,65
-	33 534 730,15
-	9 378 251,82
-	12 505 745,21
	-
-	**84 405 675,83**
-	3 293 775,00
-	**87 699 450,83**
	-

- 87 699 450,83

-

- 87 699 450,83

7 319 500,00

- 77 086 175,83

- 16 538 700,84

20

7000

0

0

7000

0

0

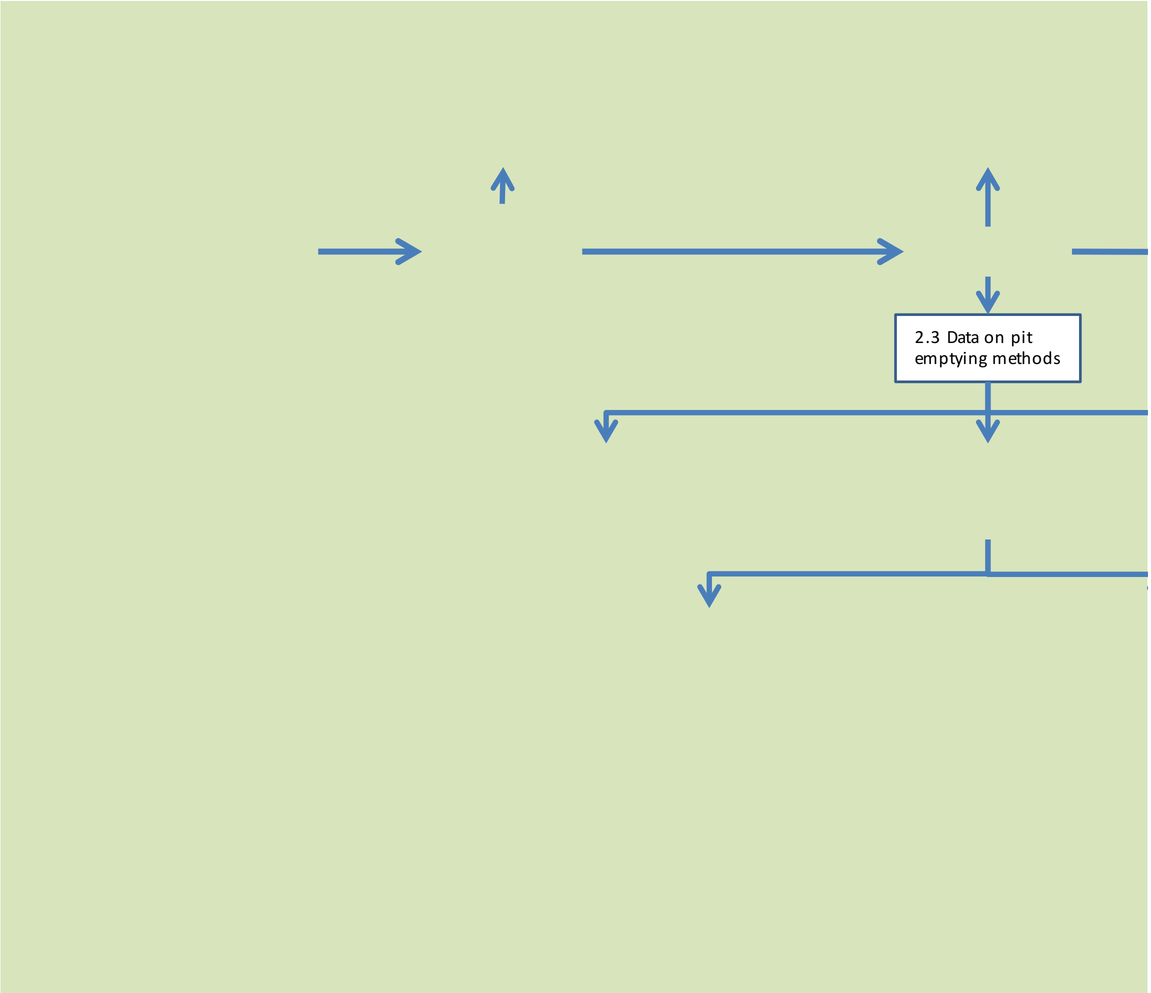
-

- 3 293 775,00

7 319 500,00

-

- 83 673 725,83



17. Landfill disposal costs for unprocessed sludge

Baseline option - pits emptied and sludge conveyed to hazardous landfill

Pits emptied and sludge conveyed to a central point, distance T1 from pits.
Cost of hazardous landfill disposal is calculated from this point.
Excludes the cost of any storage facility.

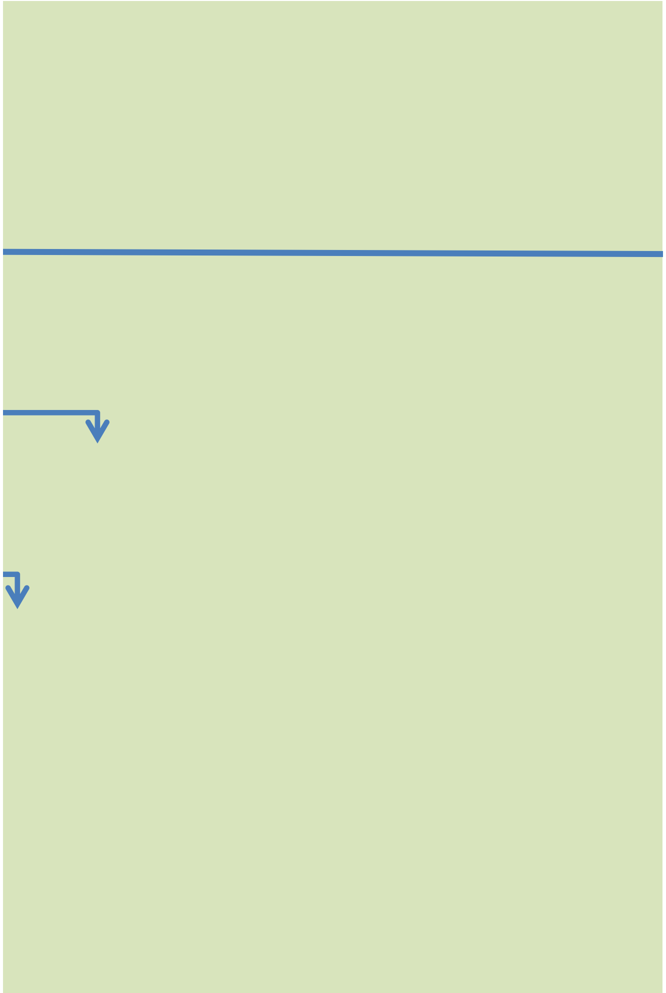
Parameter	Value
Sludge volume received by Storage per year	6650
Mass of sludge solids received by Storage	2294
Sludge dry solids content	30,00
Wet sludge density	1150,00
Average wet mass to be disposed of per year	7648

Length of pit-emptying cycle	5
Time between pit-emptying cycles	0
Distance to landfill site	70
Cost of disposal to hazardous landfill	1700
Annual cost of disposal to hazardous landfill during pit-emptying	13 000 750
Cost of emptying & conveyance, including sub-contractor markup	4 831,06
Annual cost of emptying & conveyance during pit-emptying cycle	11 083 665
Fuel use estimate	
Diesel cost per km	1,85
Number of return trips required, assuming 5 tonne truck	1 530
Fuel cost for all journeys	396 751
Sludge disposal costs	13 000 750,00
Emptying & conveyance costs for years where pit emptying occurs	11 083 664,62
Lifespan for cashflows	10
Escalation rate - general	6
Escalation rate - fuel	12
Discount rate	8
Income tax rate	28
Does income tax apply?	No
Income tax rate	0
Dry mass of FS entering storage	2294
Number of pits emptied per year during pit-emptying cycle	7000

<u>Cash flows</u>	Expenses are positive \
Parameter	**Unit**
Sludge disposal costs	LCU / year
Emptying & conveyance costs	LCU / year
Total expenses	**LCU / year**
Subsidy	
Net profit before tax (PBT)	**LCU / year**
Tax	LCU / year
Profit after tax (PAT)	LCU / year
Discounted total cost	LCU / year
Dry mass of FS to be disposed of per year	tonnes / year

Number of pits emptied	pits / year
Levelised cost of pit-emptying & sludge disposal per dry tonne FS	**LCU / tonne FS**
Levelised cost of pit emptying & sludge disposal per pit	**LCU / pit**
NPV	
IRR	

Length of pit-emptying cycle	5
Time between pit-emptying cycles	0
Number of pits per cycle	35000
Pits per year during cycle	7000
Dry mass to be disposed of per year	2294
No. pits emptied / year	
Dry mass to be disposed of per year	



Units	Reference
m^3 / year	
dry tonnes / year	
% DS	
kg / m3	
wet tonnes / year	

years
years

km
LCU / tonne
LCU / year

LCU / tonne dry solids
LCU / year

LCU / km
return journeys
LCU/ year

LCU / year
LCU / year

years
%
%
%
%

%

dry tonnes / year
pits / year

re positive values, income negative

Year	
	1
	13 000 750,00
	11 083 664,62
	24 084 414,62
	24 084 414,62
	-
	24 084 414,62
	24 084 414,62
	2294

7000

9 665

3 168

- 221 733 511,82

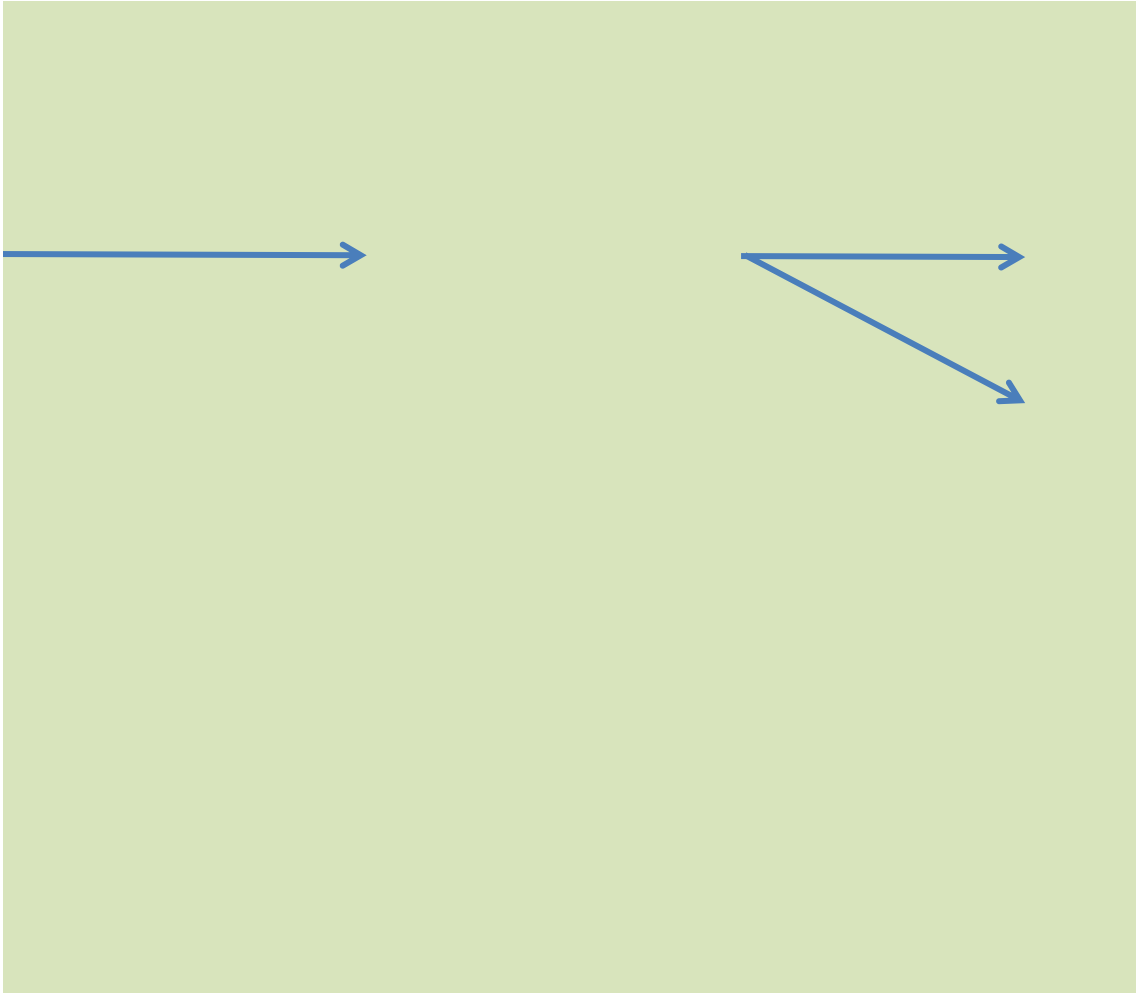
#NUM!

1

1

7000

2294,25



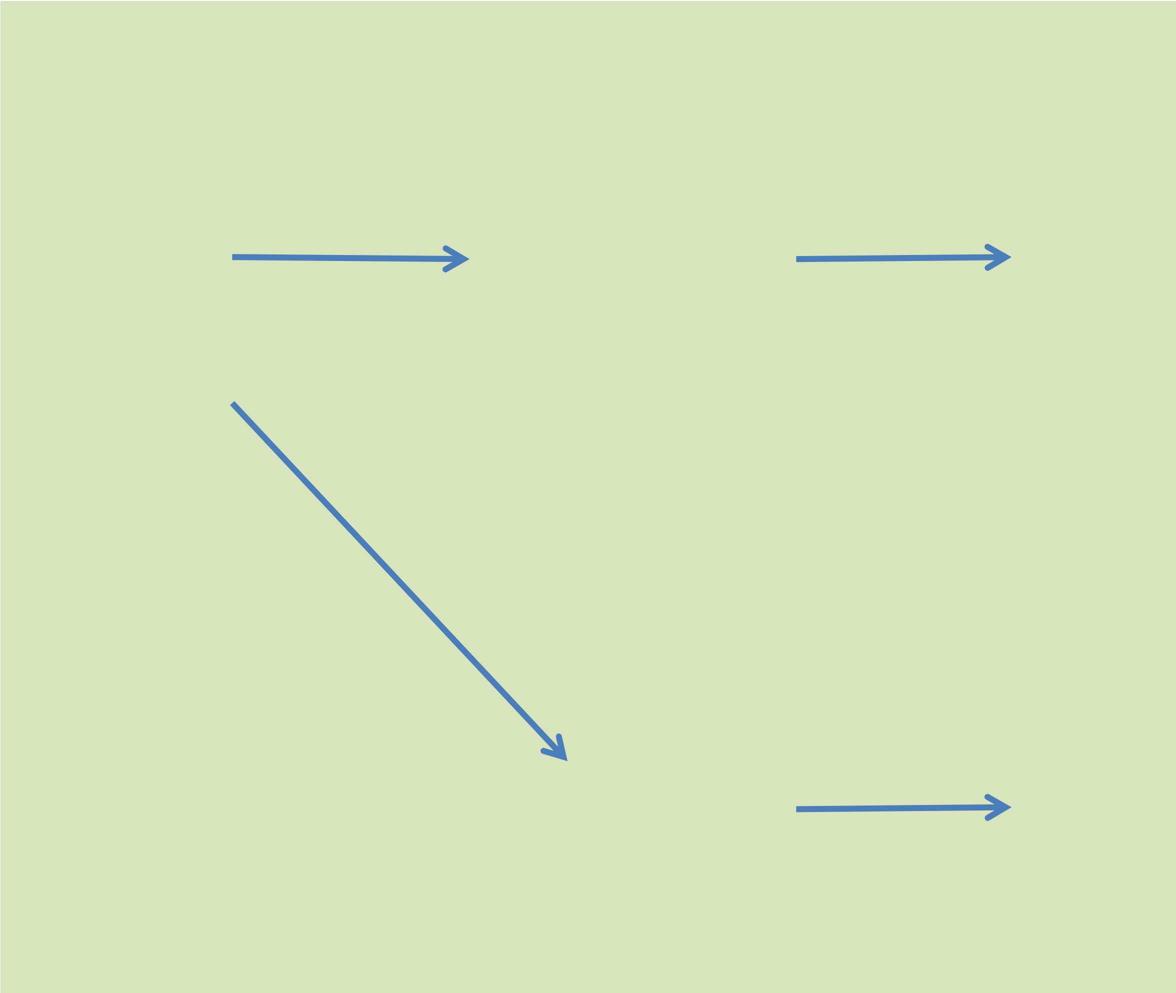
Notes

User comments

May include transport

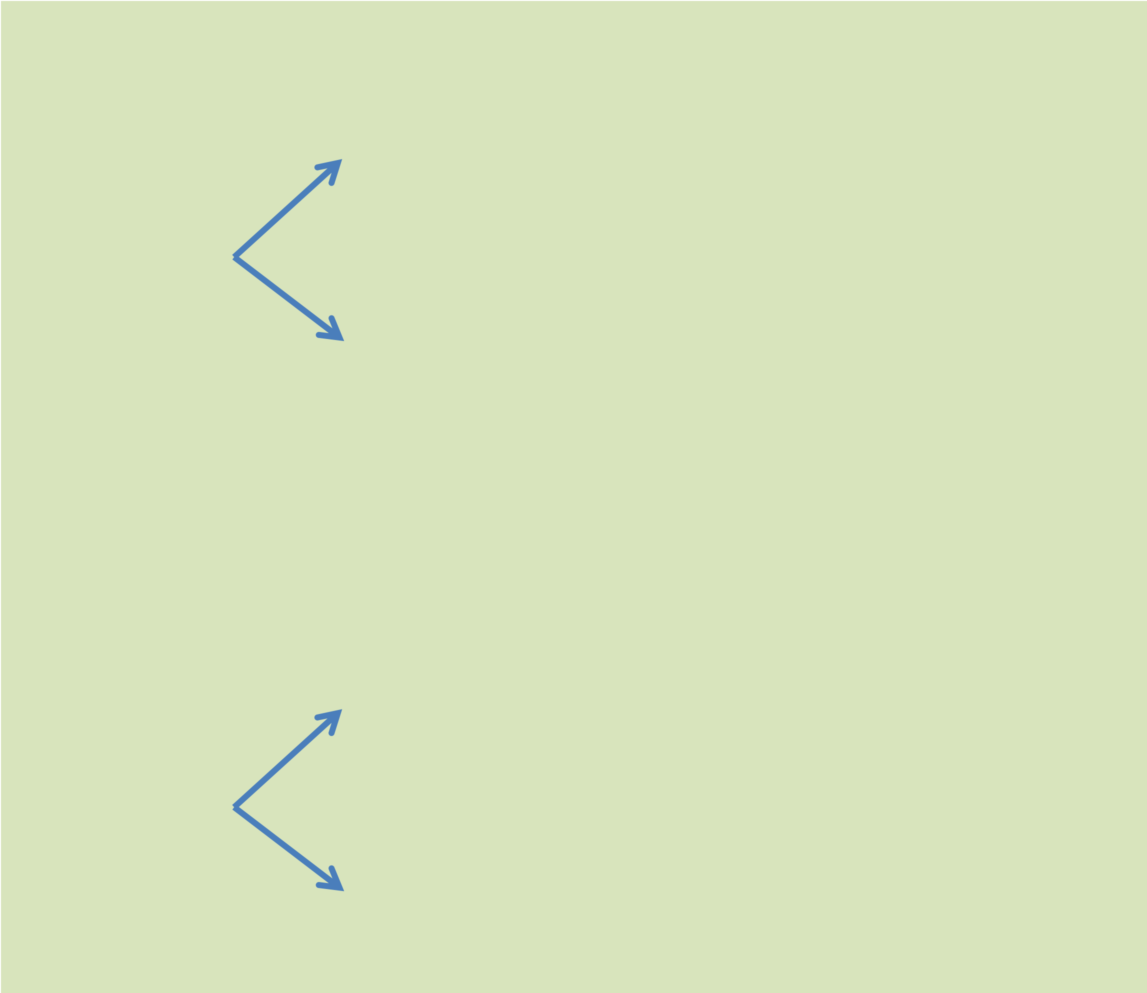
	2	3
	13 780 795,00	14 607 642,70
	11 748 684,50	12 453 605,57
	25 529 479,50	**27 061 248,27**
	25 529 479,50	**27 061 248,27**
	-	-
	25 529 479,50	27 061 248,27
	23 638 406,94	23 200 658,66
	2294	2294

7000	7000
0,925925926	0,85733882
2	**3**
7000	7000
2294,25	2294,25



4	5	6	7	8
15 484 101,26	16 413 147,34	17 397 936,18	18 441 812,35	19 548 321,09
13 200 821,90	13 992 871,21	14 832 443,49	15 722 390,10	16 665 733,50
28 684 923,16	**30 406 018,55**	**32 230 379,66**	**34 164 202,44**	**36 214 054,59**
28 684 923,16	**30 406 018,55**	**32 230 379,66**	**34 164 202,44**	**36 214 054,59**
-	-	-	-	-
28 684 923,16	30 406 018,55	32 230 379,66	34 164 202,44	36 214 054,59
22 771 016,84	22 349 331,34	21 935 454,83	21 529 242,71	21 130 553,03
2294	2294	2294	2294	2294

7000	7000	7000	7000	7000
0,793832241	0,735029853	0,680583197	0,630169627	0,583490395
4	**5**	**6**	**7**	**8**
7000	7000	7000	7000	7000
2294,25	2294,25	2294,25	2294,25	2294,25



9	10	11	12	13
20 721 220,35	21 964 493,58	-	-	-
17 665 677,51	18 725 618,16	-	-	-
38 386 897,87	**40 690 111,74**	**-**	**-**	**-**
38 386 897,87	**40 690 111,74**	**-**	**-**	**-**
-	-	-	-	-
38 386 897,87	40 690 111,74	-	-	-
20 739 246,49	20 355 186,37	-	-	-
2294	2294	0	0	0

7000	7000	0	0	0

0,540268885	0,500248967

9	**10**	**11**	**12**	**13**
7000	7000	0	0	0
2294,25	2294,25	0	0	0

14	15	16	17	18
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
0	0	0	0	0

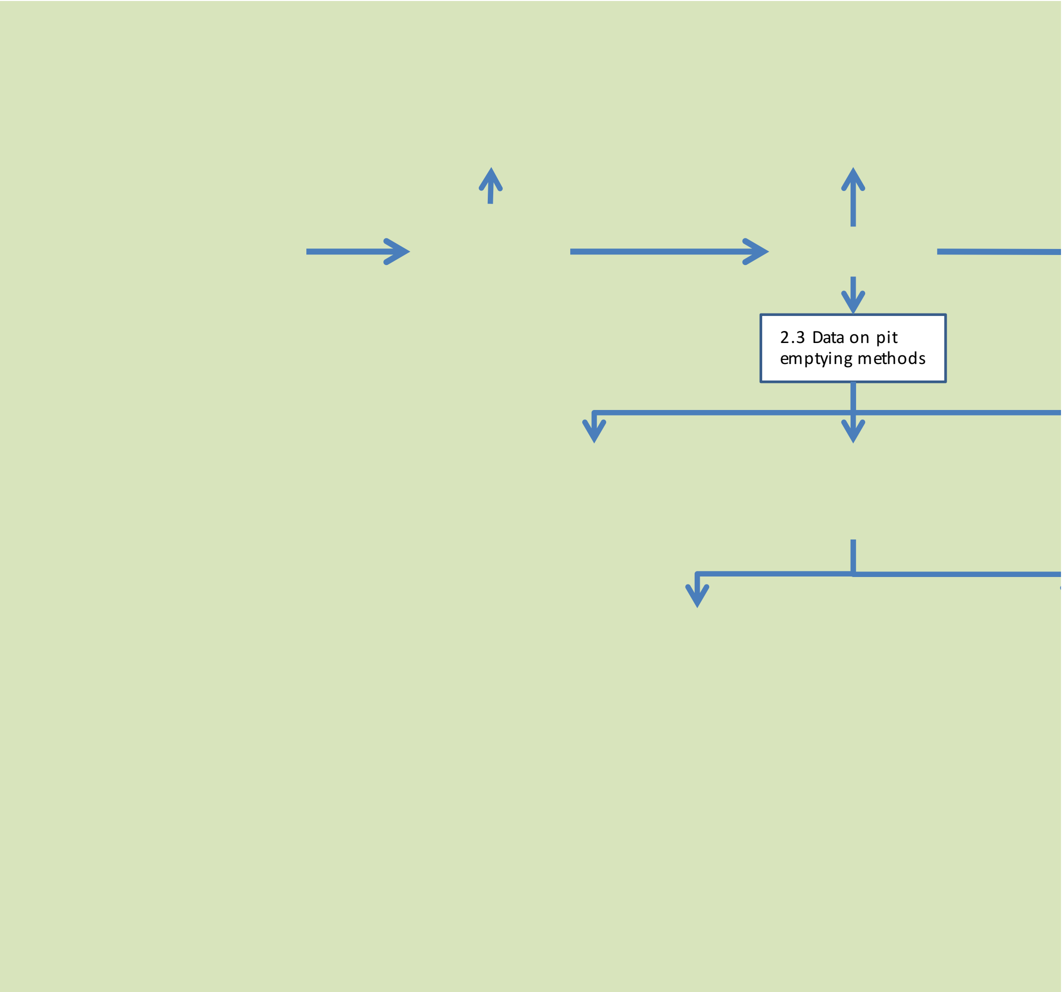
0	0	0	0	0

14	15	16	17	18
0	0	0	0	0
0	0	0	0	0

19	20
-	-
-	-
-	-
-	-
-	-
-	-
-	-
0	0

0	0

19	**20**
0	0
0	0



18. Service provider costs

Costs to municipality or company providing sanitation services, as a percentag

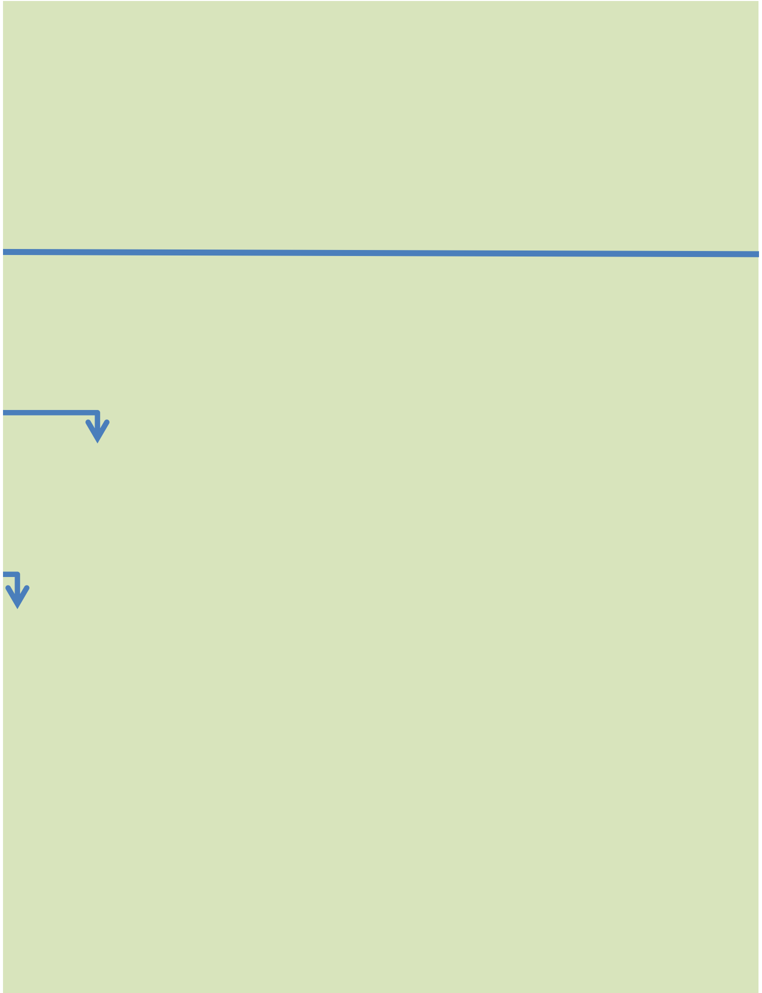
	LaDePa
Levelised cost of pit-emptying & sludge disposal per dry tonne FS	11 139
Levelised cost of pit emptying & sludge disposal per pit	3 651
Levelised cost to produce product	11 905

Service provider cost	3

Total levelised costs, including costs to service provider

	LaDePa

Levelised cost of pit-emptying & sludge disposal per dry tonne FS	11 473
Levelised cost of pit emptying & sludge disposal per pit	3 760
Levelised cost to produce product	12 262



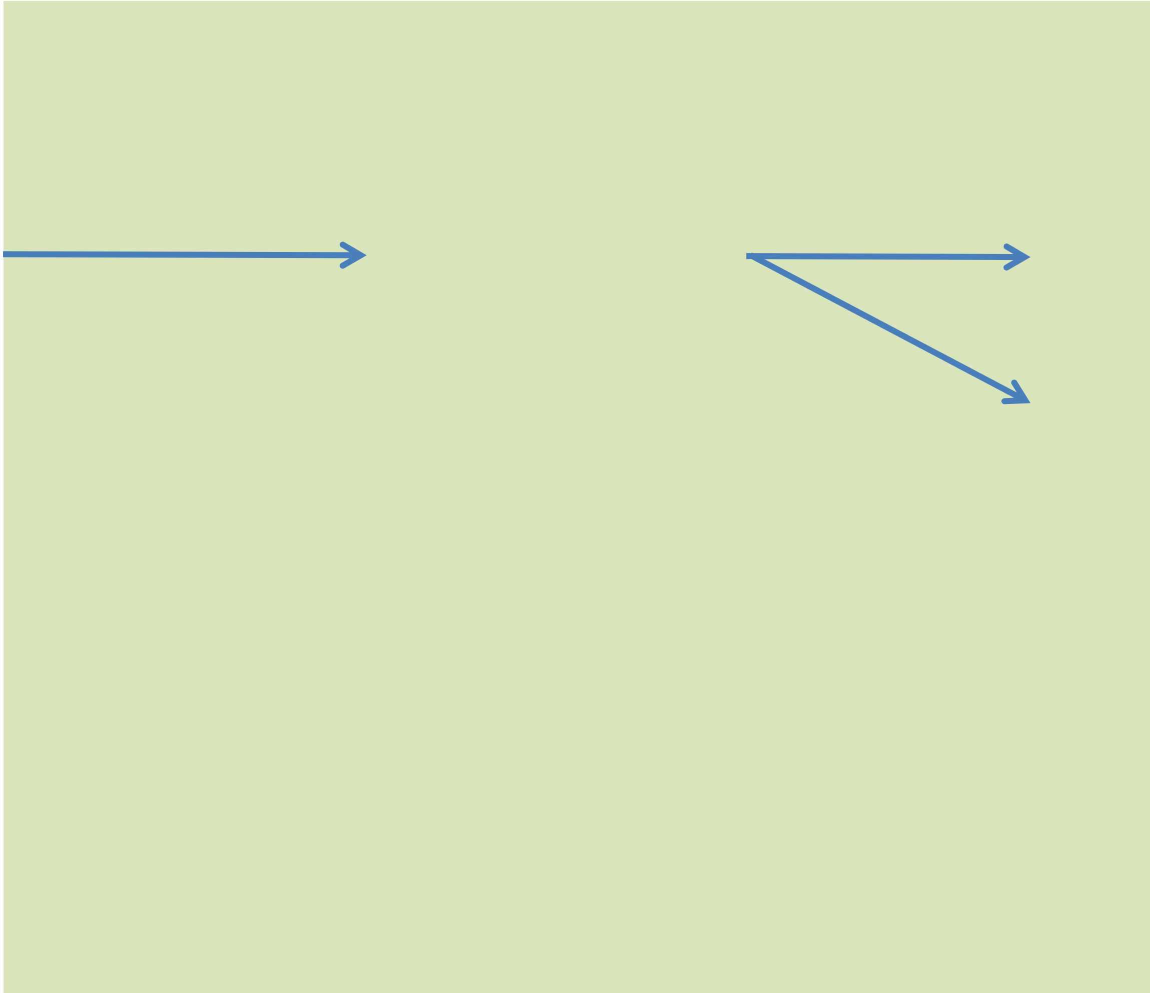
a percentage of levelised costs

Combustion	Landfill
10 628	9 665
3 483	3 168
20 397	

% markup on cost

Combustion	Landfill

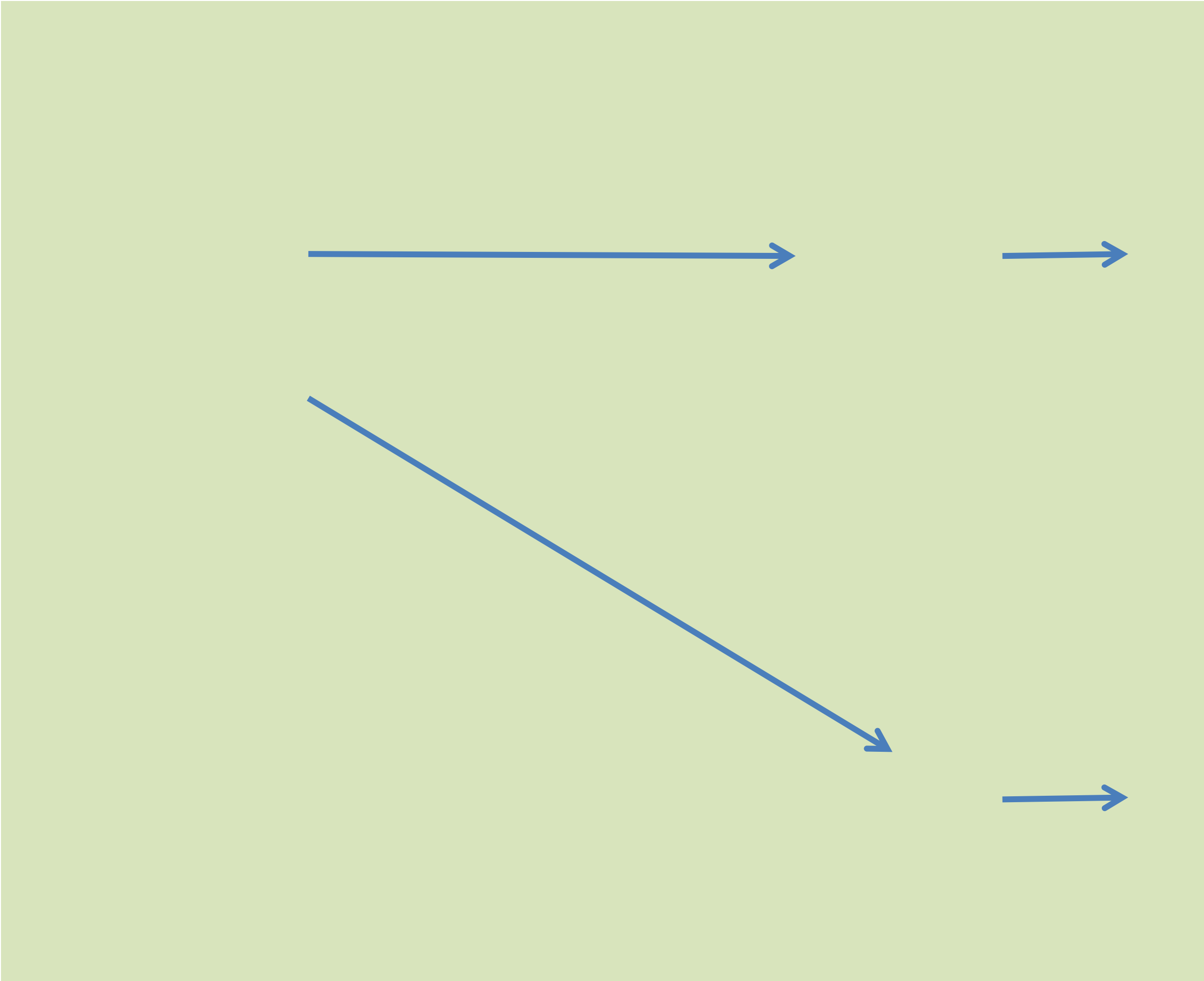
10 947	9 955
3 588	3 263
21 008	



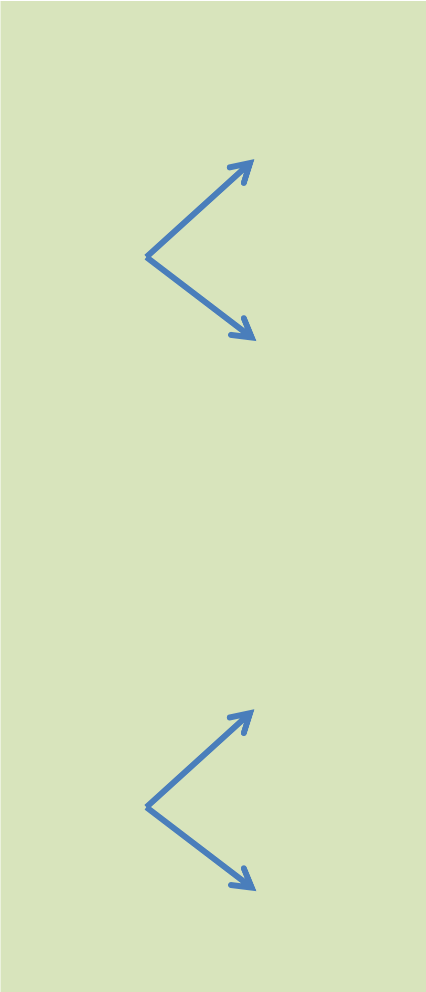
Units	Notes
LCU / dry tonne FS	
LCU / pit	
LCU / tonne product	Per wet tonne LaDePa pellets & per dry tonne combustion ash

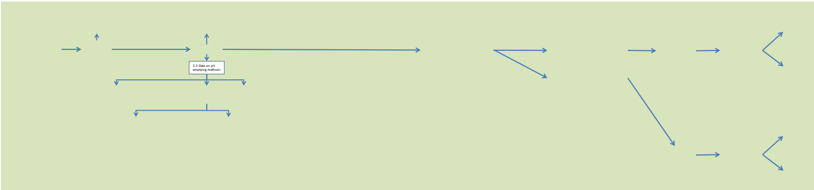
Units

LCU / dry tonne FS	
LCU / pit	
LCU / tonne product	Per wet tonne LaDePa pellets & per dry tonne combustion ash



User comments





19. Product valuation

Valuation of LaDePa pellets and combustion ash based on nutrient content and wholesale prices of commercially-available fertilisers

LaDePa pellets composition

	Value	Units	Reference	Notes	User comments
Dry solids	85,5	%DS			
Total carbon content	-	mg / g DS			
Nitrogen					
Total N	9	mg N / g DS			
TKN	6	mg TKN / g DS			
Ammonia	0	mg / g DS			
Ammonium & urea	1,82	mg ammoniacal N / g DS			
Nitrate	3,46	mg NO3- / g DS			
Phosphorus					
Total P	17,3	mg P / g DS			
Total phosphate (most of it may become plant-available after decomposition)	1,63	mg P as PO4 / g DS			
Orthophosphate (plant-available)	0,49	mg ortho-P / g DS			
Potassium (K)	1,8	mg K / g DS			
Calcium (Ca)	27,6	mg Ca / g DS			
Magnesium (Mg)	3	mg Mg / g DS			
Sulphur (S)	-	mg S / g DS			
Boron (B)	0,0504	mg B / g DS			
Copper (Cu)	0,1136	mg Cu / g DS			
Molybdenum (Mo)	ND	mg Mo / g DS			
Zinc (Zn)	0,5076	mg Zn / g DS			

% composition of LaDePa pellets

			approx ratio
N	0,900	%	5
P	1,73	%	10
K	0,18	%	1
Ca	2,76	%	
Mg	0,3	%	
S	#VALUE!	%	
B	0,005	%	
Cu	0,011	%	
Mo	ND	%	
Zn	0,051	%	

Commercial fertiliser compositions and prices

Nutrient content

	N	P	K	Price	Reference
	%	%	%	LCU / tonne	
Urea	46			4820	12 June 2013 Kokstad Agricultural Cooperative (RSA)
Limestone ammonium nitrate (LAN)	28			5280	12 June 2013 Kokstad Agricultural Cooperative (RSA)
Mono-ammonium phosphate (MAP)	10	22		6750	12 June 2013 Kokstad Agricultural Cooperative (RSA)
Potassium chloride (KCL)			50	5250	12 June 2013 Kokstad Agricultural Cooperative (RSA)

Price per unit nutrient

	N	P	K
	LCU / kgN	LCU / kgP	LCU / kgK
Urea	10,48		
Limestone ammonium nitrate (LAN)	18,86		
Mono-ammonium phosphate (MAP)	67,50	25,92	
Potassium chloride (KCL)			10,50

Commercial organic fertilisers

Organic Fertiliser 1

Neutrog Bounce Back			8750	LCU / tonne	LCU / wet tonne fertilizer for specified nutrient
	g/kg	mg/kg	%	kg/m3	
Water	120		12		
N	30		**3**		**314,35**
P	11		**1,1**		**285,11**
K	10		**1**		**105,00**
Ca	25		2,5		
S	6		0,6		
Mg	8		0,8		
Zn	0,443	443	0,0443		
Product density				655	
Organic matter				655	
TOTAL					704,46

Organic Fertiliser 2

Natural Organic pellet from chicken litter			9000	LCU / tonne	LCU / wet tonne fertilizer for specified nutrient
	g/kg		%	kg/m3	
Water	0		0		
N	34,3		3,43		**359,40**
P	18,8		1,88		**487,28**
K	36,2		3,62		**380,10**
Ca	0		0		
S	0		0		
Mg	0		0		
Zn	0	0	0		
Product density				0	
Organic matter				0	
					1 226,78

Incinerator ash (KwaMashu)

	%	LCU / wet tonne fertilizer for specified nutrient
N	0,19	**19,91**
P	1,19	**308,44**
K	0,29	**30,45**
Ca	11,61	
Mg	0,63	
S	0	
B	0	
Cu	0,0234	
Mo	0	
Zn	0,0456	
		358,79

LaDePa pellet valuation

LaDePa pellet value based on NPK content and non-organic fertilizer NPK prices

N	94,30	LCU / dry tonne for N content
P	448,40	LCU / dry tonne for P content
K	18,90	LCU / dry tonne for K content
Total price per dry tonne	561,60	LCU / dry tonne
Total price per wet tonne	480,17	LCU / wet tonne pellets

LaDePa pellet value based on organic fertilizer 1 price

Ca, Mg and Zn values of Organic Fertiliser 1 and LaDePa pellets comparable

NPK value of Organic Fertiliser 1 organic fertilizer	704,46	LCU / wet tonne for NPK content
Sale price of Organic Fertiliser 1 organic fertilizer	8750	LCU / wet tonne
Dry solids content of Organic Fertiliser 1	88	% DS
NPK value of Organic Fertiliser 1 organic fertilizer per dry tonne	800,52	LCU / dry tonne for NPK content
Sale price of Organic Fertiliser 1 per dry tonne	9 943,18	LCU / dry tonne
Markup on sale price	40	%
Sale price per dry tonne minus markup	5 965,91	LCU / dry tonne
Proportional increase (nutrient value to sale price minus markup)	745	%
LaDePa NPK value scaled by same increase	4 185,37	LCU / dry tonne
Price per wet tonne	3 578,49	LCU / wet tonne pellets

LaDePa pellet value based on organic fertilizer 2 price

NPK value of Natural Organic fertilizer	1 226,78	LCU / wet tonne for NPK content
Sale price of Natural Organic fertilizer	9000	LCU / wet tonne
Dry solids content of Natural Organic	100	% DS
NPK value of Natural Organic fertilizer per dry tonne	1 226,78	LCU / dry tonne for NPK content
Sale price of Natural Organic per dry tonne	9 000,00	LCU / dry tonne
Markup on sale price	40	%
Sale price per dry tonne minus markup	5 400,00	LCU / dry tonne
Proportional increase (nutrient value to sale price minus markup)	440	%
LaDePa NPK value scaled by same increase	2 472,04	LCU / dry tonne
Price per wet tonne	2 113,60	LCU / wet tonne pellets

LaDePa pellet value based on calorific value

Calorific value of pellets	4,32	MJ / kg dry solids	
Dry solids content of pellets	85,50	%DS	
Calorific value of incinerator supplemental fuel	31,00	MJ / kg	
Cost of supplemental fuel	729,00	LCU / tonne	
Dry solids content of supplemental fuel	85,00	%DS	
Scaled value of LaDePa pellets	102,18	LCU / tonne	Scaled according to calorific value and dry solids content

Combustion ash valuation

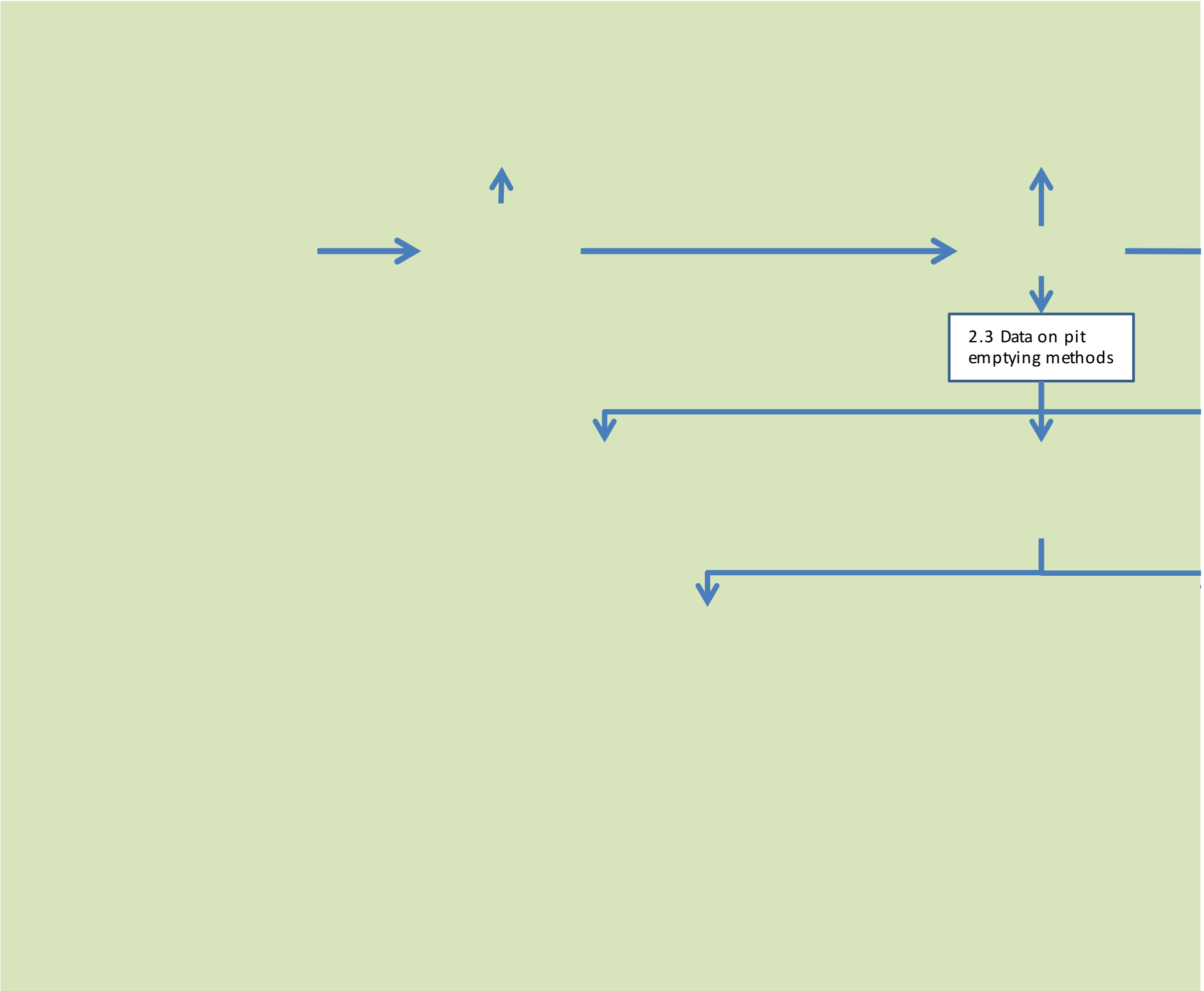
Ash (kwaMashu - primary sludge)	**% composition**
N	0,19
P	1,19
K	0,29
Ca	11,61
Mg	0,63
S	0
B	0
Cu	0,0234
Mo	0
Zn	0,0456

Ash value based on NPK content and non-organic fertilizer NPK prices

N	19,91	LCU / dry tonne for N content
P	308,44	LCU / dry tonne for P content
K	30,45	LCU / dry tonne for K content
Total price per dry tonne	358,79	LCU / dry tonne ash

Summary table of product values

LaDePa pellets based on inorganic fertiliser nutrient prices	480	LCU / tonne
LaDePa pellets based on organic fertiliser 1 nutrient content and markup rate	3 578	LCU / tonne
LaDePa pellets based on organic fertiliser 2 nutrient content and markup rate	2 114	LCU / tonne
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
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
LaDePa pellets based on their calorific value	102	LCU / tonne
Ash based on inorganic fertiliser nutrient content prices	359	LCU / dry tonne



20. Application rates of sludge products for different crops

Partial budget analysis to evaluate the profitability of using LaDePa pellets as an altern

Objective: Comparing the use of LaDePa with inorganic and organic fertilisers

Methodology

Step 1: Determine the additional cost which will result from the change of fertiliser
Step 2: Determine what income will be lost as a result of the change of fertiliser
Step 3: Determine the cost which will be saved as a result of the change of fertiliser
Step 4: Determine the additional income that will be obtained as a result of the change o

Partial budget

Existing practice

(i) Redduced income:	a
(ii) Reduced cost:	b
Difference (i) - (ii)	a - b

Analysis

If change is positive (> 0) the change is desirable; if change is negative (< 0) the change is

Reference

Finance & Farmers - A Financial management guide for farmers. Standard Bank (1981)

Partial budget 1 - Replacing a commercial conventional fertiliser with LaDePa pellets

Commercial fertiliser to be replaced:	Compound fertiliser 3:2:1 (25) + 0.5% Zn
Ratio N	3
Ratio P	2
Ratio K	1
Total % NPK	25
Fertiliser requirements for the production of:	Dry beans
Application rate	300
Mineral nutrient content in:	**100 kg**
Nitrogen	12,5
Phosphorus	8,3
Potassium	4,2
Cost	4,775
Cost for 300kg	**1432,5**

Transport costs

Assumes vehicle already owned, insured & licensed - by LaDePa operator, or by buyer. O

Truck capacity - mass	3
Mileage rate	6,66
Maintenance costs	1,05
Diesel price	12,34
Vehicle average speed	50
Driver labour rate	30

Delivery distance for conventional fertiliser	25
Number of return trips required	0,10
Time for one return trip	1,5
Labour cost per trip	45,0
Fuel cost per trip	92,6
Maintenance cost per trip	52,6
Transport cost per trip	190,3
Total operating costs, excluding fuel	9,76
Total fuel costs	9,26
Application costs for conventional fertiliser (labour, machinery, equipment)	0,40
Total cost per ha	1572

Quantity of LaDePa pellets needed to supply nutrient requirements for chosen crop

Dry solids content of LaDePa pellets	85,5
Nitrogen content in LaDePa pellets (kg N / kg)	0,009
Quantity of LaDePa pellets needed to supply required N	**4873**
Phosphorus content in LaDePa (kg P / kg)	0,0173
Quantity of LaDePa pellets needed to supply required P	**1690**
Potassium content in LaDePa (kg K/kg)	0,0018
Quantity of LaDePa pellets needed to supply required K	**8122**

1	N	4873
2	P	1690
3	K	8122

Partial budget - LaDePa pellets

Nutrient chosen on which to base analysis	2
Nutrient chosen on which to base analysis	**P**
Quantity of LaDePa pellets required to supply required nutrient amount	1690

Blend LaDePa pellets with an additional fertiliser

		Cost per kg nutrient LCU / kg nutrient
1	Urea N	10,48
2	Limestone ammonium nitrate (LAN) - N	18,86
3	Mono-ammonium phosphate (MAP) - N	67,50
4	Mono-ammonium phosphate (MAP) - P	25,92
5	Potassium chloride (KCL) - K	10,50
6	Incineration ash	10,5

	6
Blend component	
Nutrient supplied	3
Nutrient supplied	K
Cost per kg of nutrient	10,50
Quantity of N supplied by LaDePa pellets alone	13,01
Quantity of P supplied by LaDePa pellets alone	25,00

	Quantity of K supplied by LaDePa pellets alone	2,60
	Nutrient demand of crop not satisfied by LaDePa pellets:	
1	N	24,49
2	P	0,0
3	K	9,9
	Cost of blend component to satisfy chosen nutrient demand	103,9
	Quantity of blend component to satisfy chosen nutrient demand	3413,4
	Total mass of LaDePa + blend component	5103,55

Transport costs

Assumes vehicle already owned, insured & licensed - by LaDePa operator, or by buyer. O

Truck capacity - mass	3
Mileage rate	6,66
Maintenance costs	1,05
Diesel price	12,34
Vehicle average speed	50
Driver labour rate	30
Delivery distance for LaDePa pellets	25
Number of return trips required	1,70
Time for one return trip	1,5
Labour cost per trip	45,0
Fuel cost per trip	92,6
Maintenance cost per trip	52,6
Transport cost per trip	190,3
Total operating costs, excluding fuel	166,07
Total fuel costs	157,60
Application costs for LaDePa pellets & blend component (labour, machinery, equipment)	0,50
Chosen prices of LaDePa pellets	**3**
	Sample price 1

Cost of quantity of pellets required	5070
Cost of blend component	103,9
Transport costs	323,67
Application costs (labour, machinery, equipment)	2 551,78
Total costs	**8050**

Partial budget (I)

3:2:1 (25) with 0.5% Zn	
(i) Reduced income:	0
(ii) Reduced cost:	1572
Difference	-1572

Expected change in income

Partial budget 2 - Replacing a commerical organic fertiliser with LaDePa pellets

Quantity of organic fertiliser needed to supply the mineral nutrient requirements for s

Name of organic fertiliser	Natural Organic (chicken-litter based)
Nitrogen content in organic fertiliser	0,0343
Quantity of organic fertiliser need to supply required N	1093
Phosphorus content in organic fertiliser	0,0188
Quantity of organic fertiliser needed to supply required P	1330
Potassium content in organic fertiliser	0,0362
Quantity of organic fertiliser needed to supply required K	345

1	N	1093
2	P	1330
3	K	345

Partial budget

Nutrient chosen on which to base analysis	2
Nutrient chosen on which to base analysis	**P**
Quantity of organic fertiliser required to supply required nutrient amount	1330
Nutrient requirements not met by organic fertiliser	
Negative figure indicates over-supply of nutrient	
N	-8,11
P	0,00
K	-35,64
Price of organic fertiliser	2
Cost of quantity required	2 660
Transport costs	
Assumes vehicle already owned, insured & licensed - by LaDePa operator, or by buyer. O	
Truck capacity - mass	3
Mileage rate	6,66
Maintenance costs	1,05
Diesel price	12,34
Vehicle average speed	50
Driver labour rate	30
Delivery distance for organic fertiliser	25
Number of return trips required	0,44
Time for one return trip	1,5
Labour cost per trip	45,0
Fuel cost per trip	92,6
Maintenance cost per trip	52,6
Transport cost per trip	190,3
Total operating costs, excluding fuel	43,27
Total fuel costs	41,07
Application costs for organic fertiliser (labour, machinery, equipment)	0,40

Total costs	3 276

Chosen prices of LaDePa pellets	**3**
	Sample price 1

Cost of quantity of pellets required	5070
Cost of blend component	103,9
Transport costs	323,67
Application costs (labour, machinery, equipment)	2 551,78
Total costs	**8050**

Partial budget (II)

Organic fertiliser		
(i) Reduced income:		0
(ii) Reduced cost:		3 276
Difference	-	3 276

Expected change in income

as an alternative mineral nutrient source to conventional fertilisers

he change of fertiliser

Alternative
(i) Additional income:

(ii) Additional cost

Difference ((i) - (ii)

he change is is detrimental and therefore undesirable

%

Enter crop name

kg / ha

kg application rate per ha

37,5	kg
25,0	kg
12,5	kg

LCU / kg

LCU / 300 kg

by buyer. Only maintenace & fuel costs covered here.

tonnes
km / ℓ diesel
LCU / km
LCU / ℓ
km / hour
LCU / hour

km	
No. / ha demand	
hours	includes 0.5h loading and unloading time
LCU / return trip	
LCU / return trip	
LCU / return trip	
LCU / return trip	
LCU / ha demand	
LCU / ha demand	
LCU / kg	unknown
LCU / ha	
%DS	
kg N / kg	
kg pellets	
kg P / kg	
kg pellets	
kg K / kg	
kg pellets	
kg pellets	
kg pellets	
kg pellets	

Choose to satisfy the crop demand for one particular nutrient, based on figures calculated above. Not necessarily the highest pellet demand figure, as could result in over-application of the other nutrients

1 - N
2 - P
3 - K

kg / pellets

NOTE: In South Africa additional approval is required if adding elements to sewage sludge destined for compost/fertiliser

% in fertiliser
%
46,0
28,0
10,0
22,0
50,0
0,29

0 - None
1 - Urea N
2 - Limestone ammonium nitrate (LAN) - N
3 - Mono-ammonium phosphate (MAP) - P
4 - Mono-ammonium phosphate (MAP) - P
5 - Potassium chloride (KCl) - K
6 - Incineration ash - K

1 - N
2 - P
3 - K

LCU / kg nutrient

kg N
kg P

kg K

kg N
kg P
kg K

LCU / ha
kg / ha

kg / ha

by buyer. Only maintenace & fuel costs covered here.

tonnes
km / ℓ diesel
LCU / km
LCU / ℓ
km / hour
LCU / hour

km
No. / ha demand
hours includes 0.5h loading and unloading time
LCU / return trip
LCU / return trip
LCU / return trip
LCU / return trip

LCU / ha demand
LCU / ha demand

LCU / kg unknown - as for conventional fertiliser

-0,83	**0,48**	LCU / kg
Price where cost of LaDePa and conventional is equal (use goal seek on INPUTS)	Calculated value based on nutrient content of LaDePa pellets alone	

-1408	812	LCU / ha
103,9	103,9	LCU / ha
323,67	323,67	LCU / ha
2 551,78	2 551,78	LCU / ha
1572	**3791**	

LaDePa	**3**
(i) Additional income:	0
(ii) Additional cost	8050
Difference ((i) - (ii)	-8050
	-6478

ements for selected crop

kg N / kg
kg pellets

kg P / kg
kg pellets

kg K / kg
kg pellets

Choose to satisfy the crop demand for one particular nutrient, based on figures calculated above. Not necessarily the highest pellet demand figure, as could result in over-application of the other nutrients

1 - N
2 - P
3 - K

kg / fertiliser

kg N
kg P
kg K

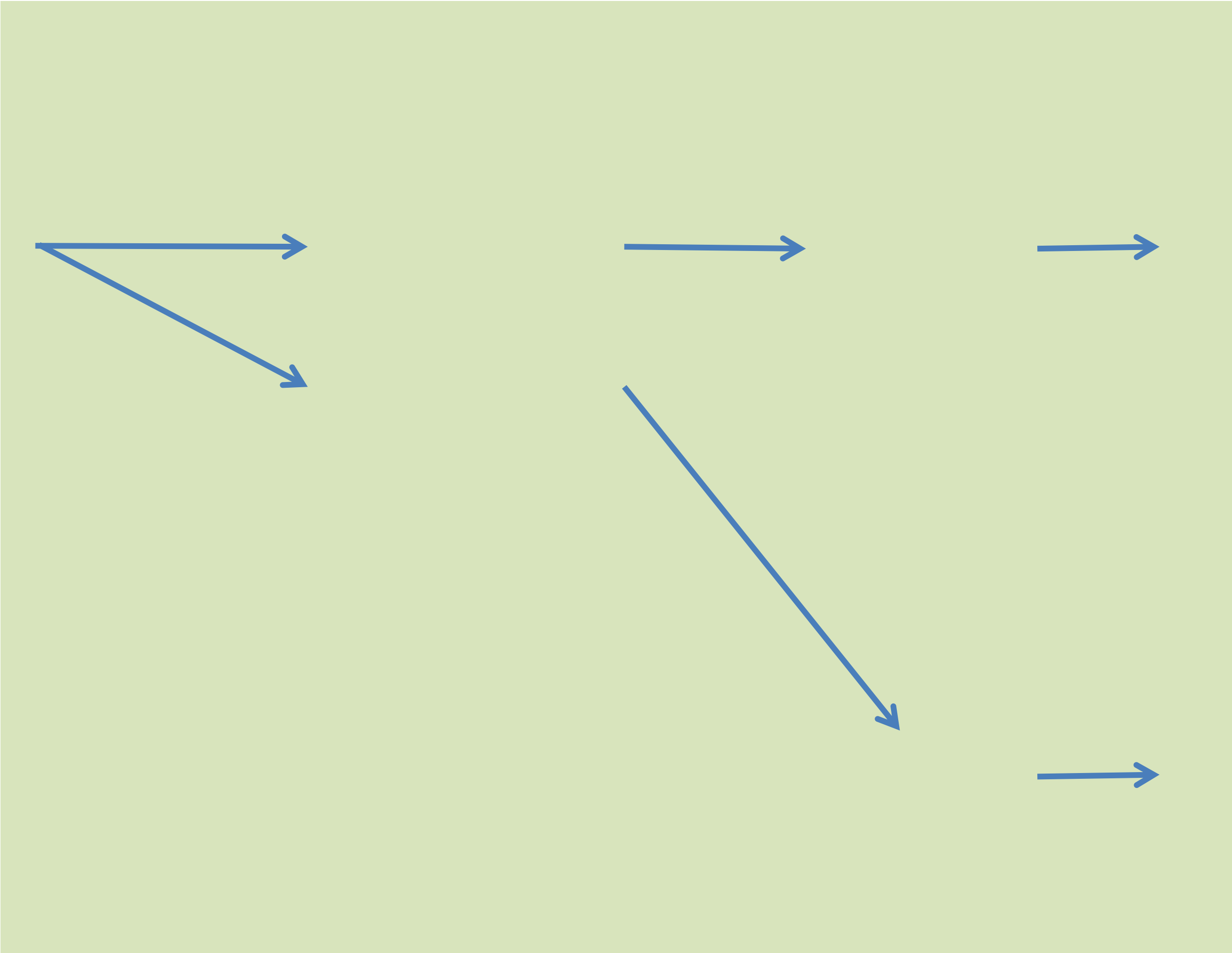
LCU / kg
LCU / ha

by buyer. Only maintenace & fuel costs covered here.

tonnes	
km / ℓ diesel	Rates
LCU / km	Rates
LCU / ℓ	Rates
km / hour	Rates
LCU / hour	
km	
No. / ha demand	
hours	includes 0.5h loading and unloading time
LCU / return trip	
LCU / return trip	
LCU / return trip	
LCU / return trip	
LCU / ha demand	
LCU / ha demand	
LCU / kg	unknown - as for conventional fertiliser

		LCU / ha
0,18	**0,48**	LCU / kg
Price where cost of LaDePa and conventional is equal (use goal seek)	Calculated value based on nutrient content of LaDePa pellets alone	
296	812	LCU / ha
103,9	103,9	LCU / ha
323,67	323,67	LCU / ha
2 551,78	2 551,78	LCU / ha
3276	**3791**	

LaDePa	**3**
(i) Additional income:	0
(ii) Additional cost	8050
Difference ((i) - (ii)	-8050
	-4774



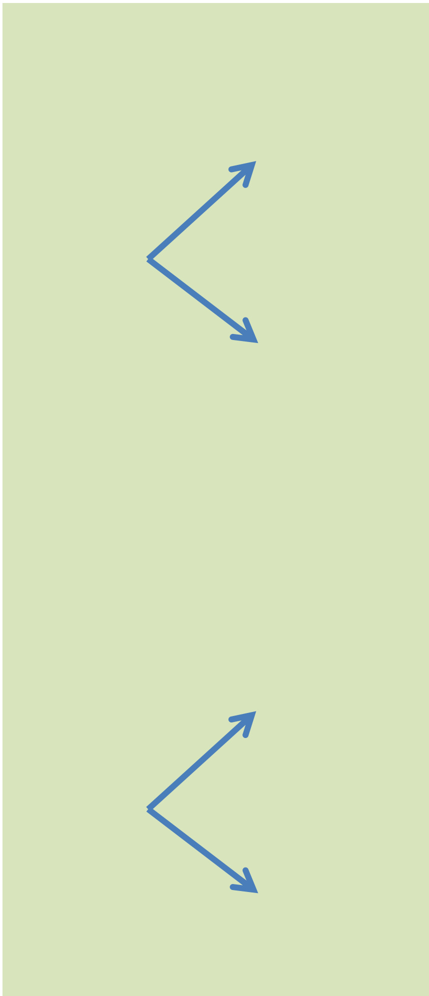
c

d

c - d

	-0,83	**0,48**	**LCU / kg**
	0	0	
	1572	3791	
	-1572	-3791	
	0	**-2219,4**	

	0,18	**0,48**	LCU / kg
	0	0	
	3276	3791	
	-3276	-3791	
	0	**-515**	



Other calculations

Fossil fuel energy used

Total fuel costs for year 1		
Emptying & conveyance	360 375	LCU / year
LaDePa	1 584 970,12	LCU / year
Combustion	1 452 001,77	LCU / year
Supplementary fuel value	1 449 853,34	LCU / year
Supplementary fuel type	Coal	
Is supplmentary fuel a fossil fuel?	Yes	
Supplementary fuel use	1 988,82	tonnes / year
Diesel value	2 148,43	LCU / year
Landfill	396 751	LCU / year
Majority of fuel used is diesel (excluding supplementary fuel for combustion)		
Diesel price	12,34	LCU / ℓ
Diesel lower calorific value	43,40	MJ / kg
Diesel density	833	kg / m3
Supplementary fuel lower calorific value	31,00	MJ / kg
LaDePa fuel cost	1 945 345	LCU / year
LaDePa diesel use	157 645	ℓ / year
LaDePa diesel use - mass	131 319	kg / year
Fossil fuel energy	5 699	GJ / year
Combustion diesel cost	2 148,43	LCU / year
Combustion diesel use	174	ℓ / year
Combustion diesel use - mass	145,03	kg / year
Diesel fossil fuel energy	6	GJ / year
Combustion supplementary fuel use	1 988,82	tonnes / year
Supplementary fuel fossil fuel energy	61 653,57	GJ / year
Combustion total fossil fuel energy use	61 659,87	GJ / year
Landfill diesel cost	396 751	LCU / year
Landfill diesel use	32 152	ℓ / year
Landfill diesel use - mass	26 782,33	kg / year
Fossil fuel energy	1 162	GJ / year

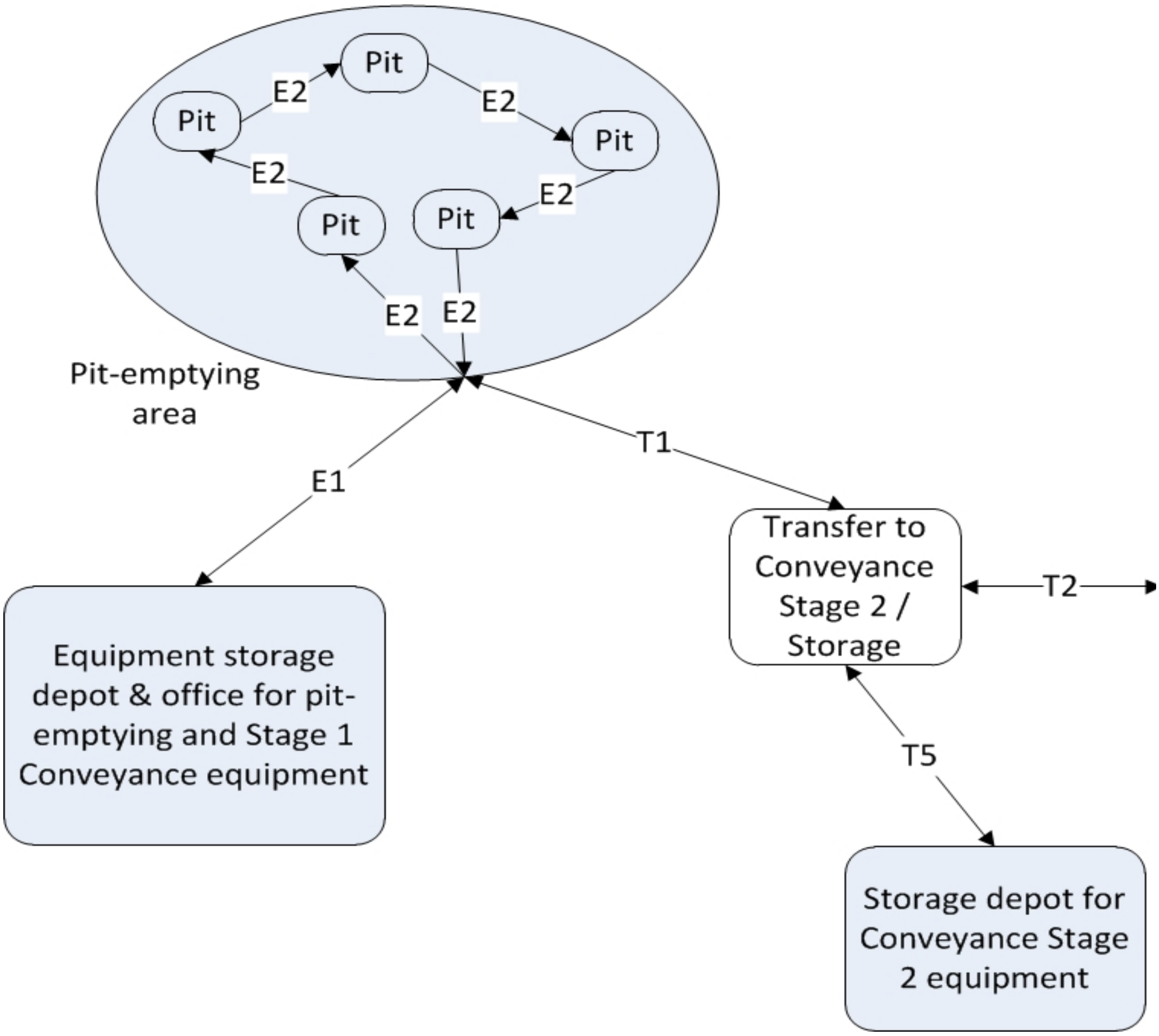
Model validation

EWS pit emptying cost 2009 - 2010	1450	ZAR / pit	2010 price.
	1726,9732	ZAR / pit	2013
Overall cost per pit for entire programm	2088	ZAR / pit	2010
	2486,841408	ZAR / pit	2013

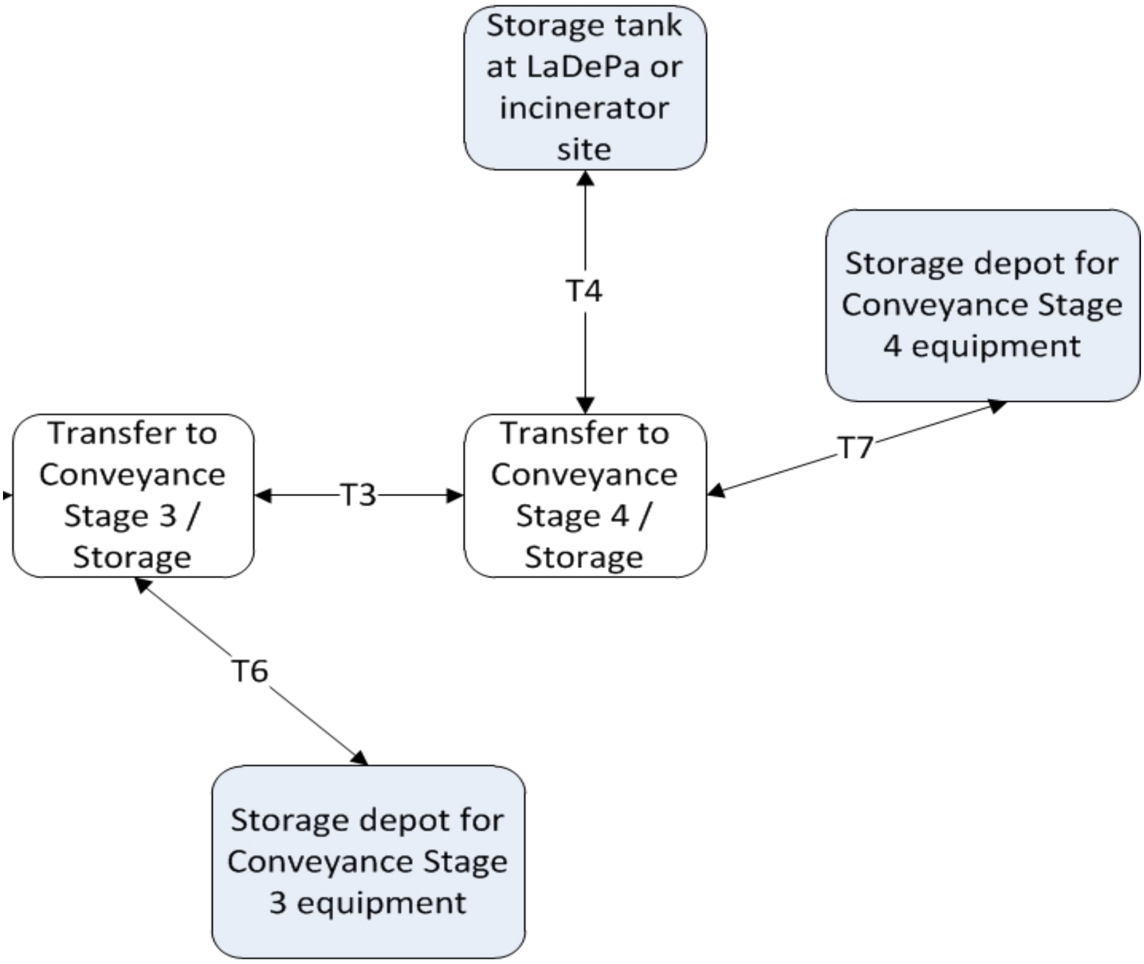
2010 price. Includes medical, bulk purchase and equipment hire

G1. Distances between sites

Refer to graphic for distance references used in the input fields



Go to Main Menu



Links to:
2.1 Emptying

Abbreviations

DS	Dry solids
FS	Faecal sludge
IRR	Internal rate of return
LaDePa	Latrine Dehydratrion Pasteurisation process
LCU	Local currency unit
NPV	Net present value
O&M	Operation and maintenance
USD	United States Dollar
VIP	Ventilated Improved Pit (latrine)
VOC	Volatile organic compound

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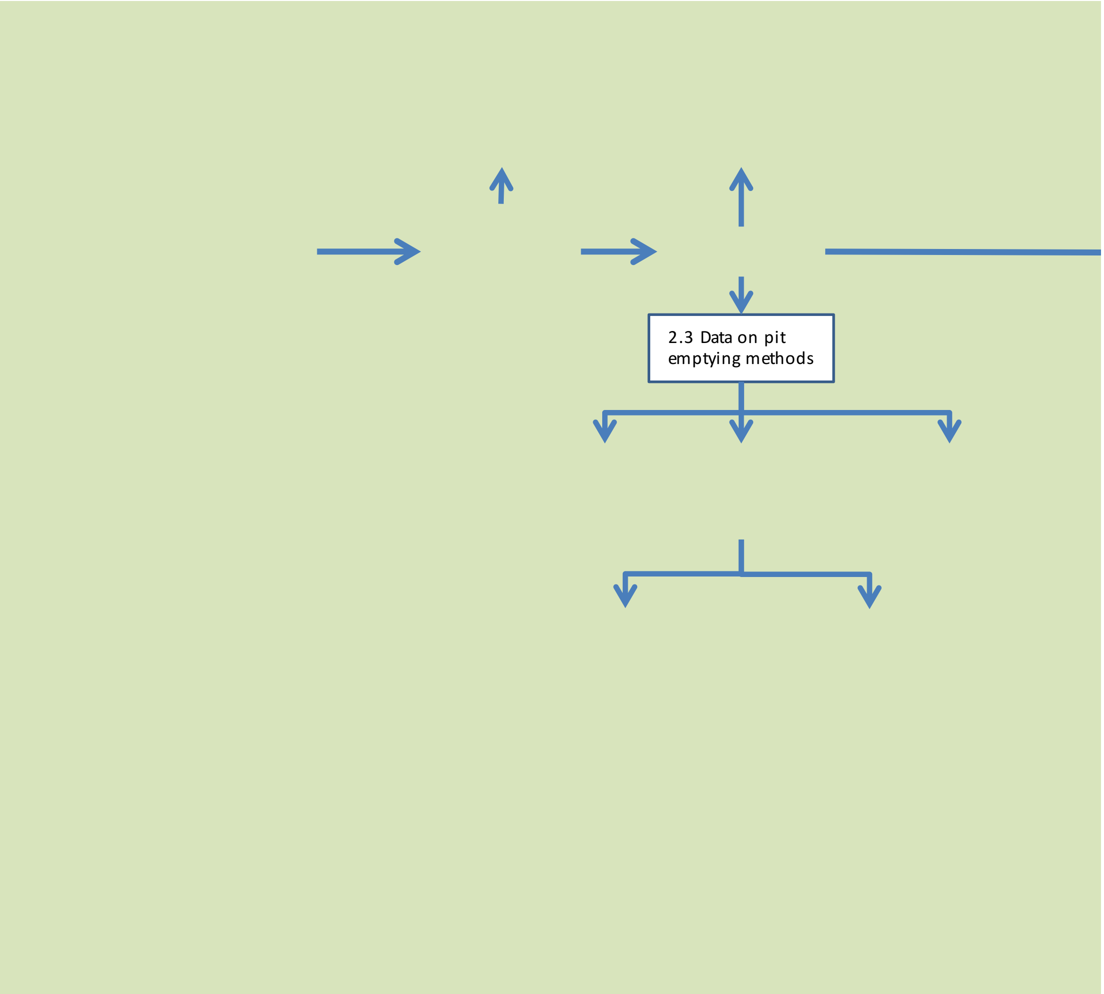

Suggested values for inputs where data is unavailable

Vehicles

Pick up truck - typical costs

Pick up truck rental rate	700,00	USD / month
Pick up truck capital cost	17 500	USD
Fuel consumption for pick-up truck	10,53	km / ℓ
Oil consumption for vehicle	1	% of fuel consumption
Price of set of tyres	534,00	USD / set

Distance for which new set of tyres lasts	50 000	km
Equipment repair and maintenance cost over lifetime	50	%
Lifetime of vehicle	5	years
Vehicle life (distance for accounting purposes)	160 000	km
Vehicle insurance cost	3,5	% of purchase price / year
Vehicle licence	48,00	USD / year

3 - 5 tonne truck - typical costs

Truck rental rate	3 000,00	USD / month
Truck capital cost	35 000	USD
Fuel consumption for truck	6,66	km / ℓ diesel
Oil consumption for vehicle	2	% of fuel consumption
Price of set of tyres	1 842,00	USD / set
Distance for which new set of tyres lasts	45 000	km
Equipment repair and maintenance cost over lifetime	50	%
Lifetime of vehicle	10	years
Vehicle life (distance for accounting purposes)	300 000	km
Repayment period for debt	5	years
Vehicle insurance cost	4,0	% of purchase price / year
Vehicle licence	82,00	USD / year

Working hours

Number of working days per month	21	working days / month

Number of working hours per day	8	working hours / day

Labour

Labourer - private company	13,5	USD / day
Municipal employee	8 000	USD / year
Supervisor	1 000	USD / month
Driver	30	USD / hour
Project manager	6 000	USD / month

Property

Rental rate - industrial area	2,5	USD / m2 / month
Purchase rate - industrial area	10	USD / m2

Landfill

Hazardous landfill, including approx 50km transport	170	USD / tonne

	Source (indication of applicability to another context)
	South Africa
Department of Agriculture Machinery Guide 2011. 3000 cc 1 tonne club cab diesel pick up truck. 2010-2011 price ZAR 296,265. 2013 price at 6% escalation 332,883. Lower value chosen based on local experience of actual prices available.	South Africa
Dept. of Agriculture Machinery guide 2010 -2011: 9.5 L/100 km	South Africa
Dept. of Agriculture Machinery guide 2010 -2011	South Africa
Dept. of Agriculture Machinery guide 2010 -2011: R4751.75 2011 price, R5339 2013 price	South Africa

Dept. of Agriculture Machinery guide 2010 -2011	South Africa
Dept. of Agriculture Machinery guide 2010 -2011	South Africa
	South Africa
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	South Africa
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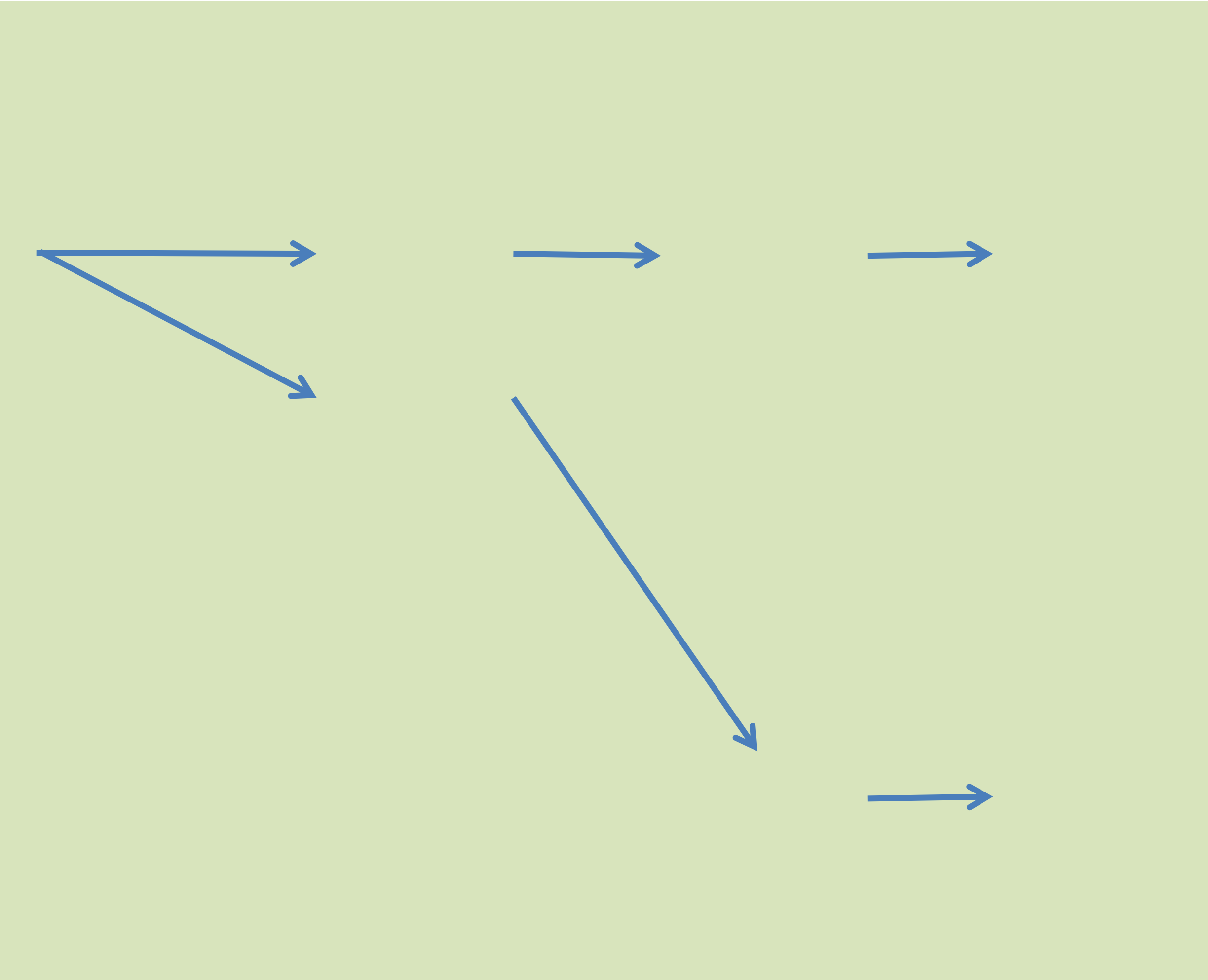
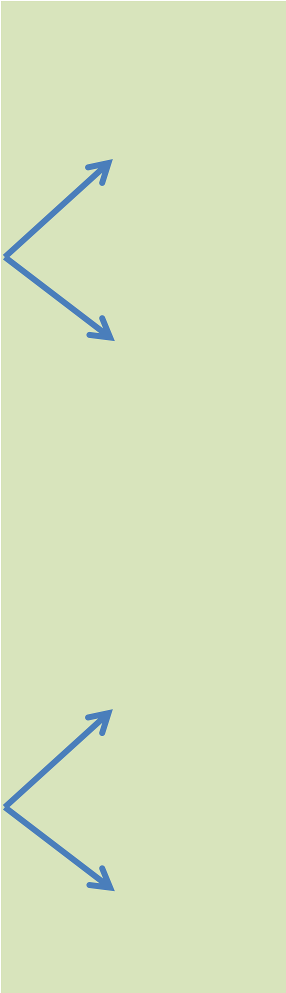
Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry	South Africa
	South Africa
Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry	South Africa
	South Africa
Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry	South Africa
Dept. of Agriculture Machinery guide 2010 -2011. Distance for 3 - 5 tonne lorry	South Africa
	On average, taking into account public holidays

Labour rates should be cost to employer, not the amount the employee receives
South Africa - private company
South Africa - R80000/year cost to company minimum for municipality = R 317/day
South Africa - private company
South Africa - casual rate
South Africa - private company

South Africa
South Africa

Durban, South Africa





Full cost analysis

Results

	LCU/pit	LCU / tonne	
LaDePa	3 760,41	12 262,19	
Combustion	3587,72	21008,46	
Landfill	3262,65	N/A	
Variable			LCU/pit
250	3262,65	N/A	20978,01
500	3262,65	N/A	11 900,83
1000	3262,65	N/A	7 362,23
1500	3262,65	N/A	5 856,18
2000	3262,65	N/A	5 098,04
3000	3262,65	N/A	4 661,22
4000	3262,65	N/A	4 137,07
5000	3262,65	N/A	4 085,12
10000	3262,65	N/A	3 560,48
15000	3262,65	N/A	3 378,76
20000	3262,65	N/A	3 286,20
25000	3262,65	N/A	3 230,03
30000	3262,65	N/A	3 192,31
35000	3262,65	N/A	3 165,23

Chart source data

	LaDePa		Combustion
	LCU/pit	LCU / tonne	LCU/pit
250	173168,88	443391,16	80839,41
500	87 739,96	224 654,24	41 845,62
1000	45 025,50	115 285,78	22 348,72
1500	30 795,18	78 849,68	15 856,92
2000	23 674,15	60 616,59	12 605,64
3000	16 922,62	43 329,60	9 692,38
4000	13 195,25	33 785,85	7 914,12
5000	11 260,75	28 832,66	7 123,34
10000	6 907,92	17 687,41	5 099,20
15000	5 449,11	13 952,19	4 417,29
20000	4 717,74	12 079,55	4 074,54
25000	4 278,20	10 954,13	3 868,23
30000	3 984,85	10 203,03	3 730,40
35000	3 775,15	9 666,11	3 631,80

To change variable under analysis
(1) change cell reference in vary_input_part1 macro
(2) change the values in range A13 - A26 and A31 - A44

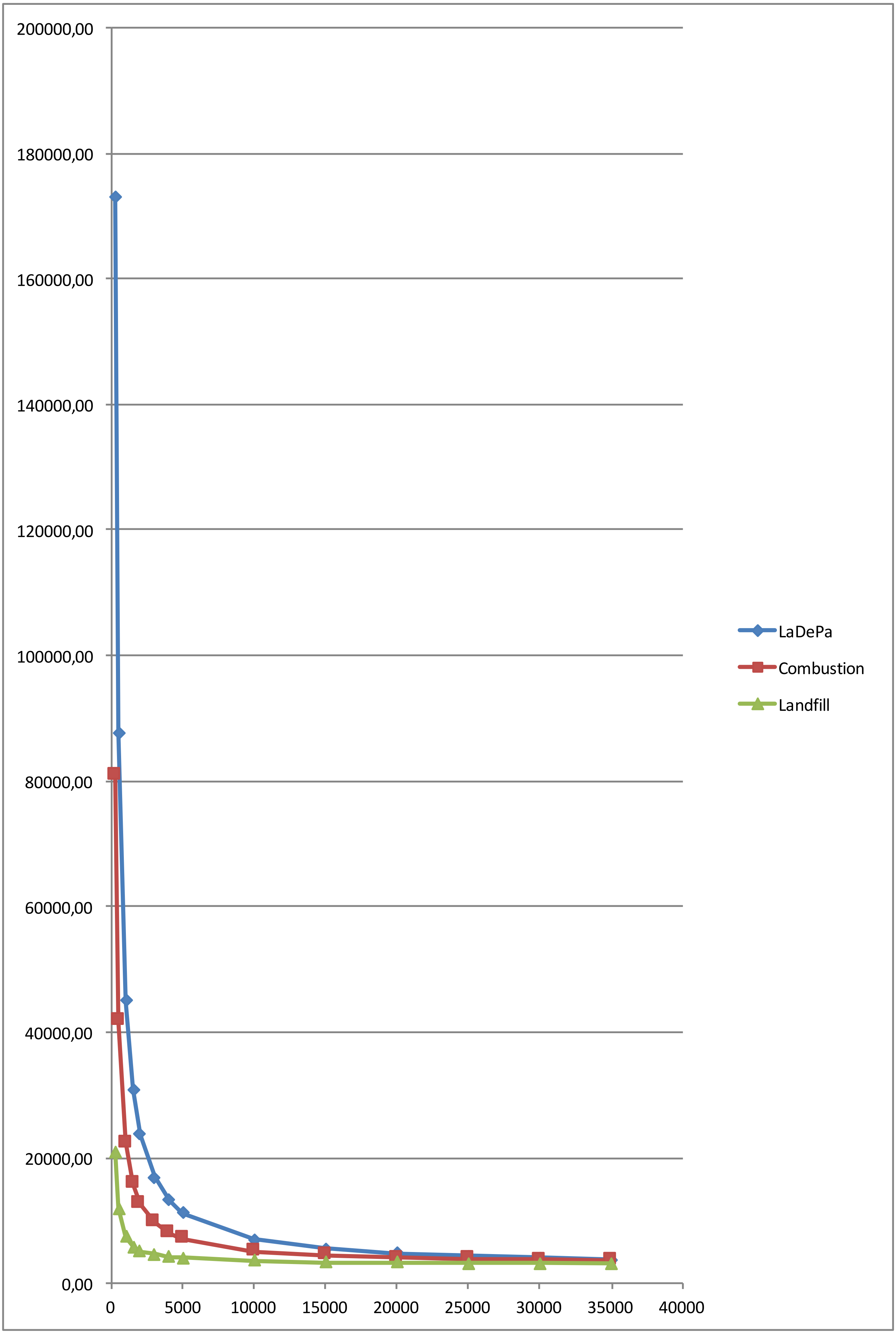
CTL+o	Create one row of table (relative references)
CTL+y	Create whole table of results for existing formulae on columns B and C
CTL+p	Run the table for the formulae in b9 - c11 & paste results into graph data ta

LCU/tonne	no. pits	no. pits	T1 dist	%DS
N/A	1000	250	1	0,5
N/A	2000	500	2	1
N/A	3000	1000	3	3
N/A	4000	1500	4	6
N/A	5000	2000	5	9
N/A	6000	3000	6	12
N/A	7000	4000	7	15
N/A	8000	5000	9	18
N/A	9000	10000	10	21
N/A	10000	15000	15	25
N/A	11000	20000	20	30
N/A	12000	25000	25	35
N/A	13000	30000	30	40
N/A	14000	35000	35	45

LCU / tonne	Landfill LCU/pit	LCU / tonne
457958,60	20978,01	N/A
237 057,14	11 900,83	N/A
126 606,42	7 362,23	N/A
89 830,09	5 856,18	N/A
71 411,49	5 098,04	N/A
54 907,71	4 661,22	N/A
44 833,79	4 137,07	N/A
40 354,03	4 085,12	N/A
28 887,17	3 560,48	N/A
25 024,13	3 378,76	N/A
23 082,43	3 286,20	N/A
21 913,70	3 230,03	N/A
21 132,89	3 192,31	N/A
20 574,31	3 165,23	N/A

raph data table

litre/p/year	pit cycle length/years
15	1
20	2
25	3
30	4
35	5
40	6
45	7
60	8
70	9
80	10
90	
100	
110	
120	


200000,00
180000,00
160000,00
140000,00
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60000,00
40000,00
20000,00
0,00
0
5000
10000
15000
20000
25000
30000
35000
40000
LaDePa
Combustion
Landfill