Life Cycle Cost Analysis (LCCA)
Passive Nitrogen Removal Systems
Florida Department of Health
Daniel P. Smith, 6/30/2014

Worksheet

1. LCCA Structure	LCCA objective and structure
2. Input	enter all model inputs
3. Default Design & Cost	ouptuts default design and life cycle costs
4. Default Design Cost Summary	cost summary table for default design
5. Customized Costs	allows user specified override of default design costs
6. Life Cycle Cost Analysis	life cycle cost analysis
7. Design Data	design data

1. LCCA Structure

LCCA performs life cycle cost analysis for passive nitrogen removal systems for onsite wastewater.

LCCA incorporates sixteen process designs of passive nitrogen removal systems.

Input data are the salient design features of the nitrogen removal process and capital and operating costs.

LCCA provides life cycle costs over the project life as Present Worth and Uniform Annual Cost.

LCCA does not predict nitrogen removal performance for the selected design.

PNRS Processes

PNRS System #	Stage 1 → Stage 2 & Stage 1 → Stage 2a/2b						
	Stage 1				Stage 2		Stage 2a /Stage 2b
	Hydraulics		Media		Media		Media
	Single Pass	Recycle	Exp. Clay	Sand	Ligno	Sulfur	Ligno/ Sulfur
1	X		X		X		
2	X		X			X	
3	X		X				X
4	X			X	X		
5	X			X		X	
6	X			X			X
7		X	X		X		
8		X	X			X	
9		X	X				X
10		X		X	X		
11		X		X		X	
12		X		X			X

PNRS System #	Stage 1 /Stage 2a (Single Pass) → Stage 2b			
	Stage 1		Stage 2a	Stage 2b
	Media		Media	Media
	Exp Clay	Sand	Ligno	Sulfur
13	X		X	X
14		X	X	X

PNRS System #	Stage 1 /Stage 2a (Single Pass)		
	Stage 1		Stage 2a
	Media		Media
	Exp Clay	Sand	Ligno
15	X		X
16		X	X

Capital Cost Components

Tankage or In-Ground Biofilter Enclosure							Media						Pump	Control Panel	Piping	Misc. Appurte-nance	Contractor Install Fee
Primary Tank	Pump/ Recycle Tank	Stage 1	Stage 1/ Stage 2a	Stage 2	Stage 2b	Stage 2a/2b	Stage 1 Exp. Clay	Stage 1 Sand	Stage 2 Ligno	Stage 2 Sulfur	Stage 2a Ligno	Stage 2b sulfur					
X		X		X			X		X				X	X	X	X	X
X		X		X			X			X			X	X	X	X	X
X		X				X	X				X	X	X	X	X	X	X
X		X		X				X	X				X	X	X	X	X
X		X		X				X		X			X	X	X	X	X
X		X				X		X			X	X	X	X	X	X	X
X	X	X		X			X		X				X	X	X	X	X
X	X	X		X			X			X			X	X	X	X	X
X	X	X				X	X				X	X	X	X	X	X	X
X	X	X		X				X	X				X	X	X	X	X
X	X	X		X				X		X			X	X	X	X	X
X	X	X				X		X			X	X	X	X	X	X	X

Tankage or In-Ground Biofilter Enclosure							Media						Pump	Control Panel	Piping	Misc. Appurt	Contractor Fees
Primary Tank	Pump/ Recycle Tank	Stage 1	Stage 1/ Stage 2a	Stage 2	Stage 2b	Stage 2a/2b	Stage 1 Exp. Clay	Stage 1 Sand	Stage 2 Ligno	Stage 2 Sulfur	Stage 2a Ligno	Stage 2b sulfur					
X			X		X		X				X	X	X	X	X	X	X
X			X		X			X			X	X	X	X	X	X	X

Tankage or In-Ground Biofilter Enclosure							Media						Pump	Control Panel	Piping	Misc. Appurt	Contractor Fees
Primary Tank	Pump/ Recycle Tank	Stage 1	Stage 1/ Stage 2a	Stage 2	Stage 2b	Stage 2a/2b	Stage 1 Exp. Clay	Stage 1 Sand	Stage 2 Ligno	Stage 2 Sulfur	Stage 2a Ligno	Stage 2b sulfur					
X			X				X				X		X	X	X	X	X
X			X					X			X	X	X	X	X	X	X

Operating Cost Components

Primary tank pump out	Electricity	Annual Permit Fee	Inspection and Maintenance	Water Quality Monitoring
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X

Primary tank pumpout	Electricity	Annual Permit Fee	Inspection and Maintenance	Water Quality Monitoring
X	X	X	X	X
X	X	X	X	X

Primary tank pumpout	Electricity	Annual Permit Fee	Inspection and Maintenance	Water Quality Monitoring
X	X	X	X	X
X	X	X	X	X

	A	B	C	D	E
1	Life Cycle Cost Analysis (LCCA)				
2	Passive Nitrogen Removal Systems				
3	Florida Department of Health				
4	Daniel P. Smith, 6/30/2014				
5					
6		Worksheet			
7		1. LCCA Structure			
8		2. Input			
9		3. Default Design & Cost			
10		4. Default Design Cost Summary			
11		5. Customized Costs			
12		6. Life Cycle Cost Analysis			
13		7. Design Data			
14					
15		**2. Input**			
16					
17		**Cell Color Code**			
18		Variables to modify (Input Fields)			
19					
20		**Input Fields**			Effects on Life Cycle Cost
21					
22		No. of Bedrooms	3		Sizing of processes
23					
24		PNRS System Number: Enter 1 to 16	9	-	Required process components
25					
26		Nitrogen Removal Efficiency, %	95		Does not affect life cycle cost. Used to calculate cost per mass of nitrogen removed. The entered nitrogen removal percent should correspond to the specified design.
27					
28		PNRS Stage 1			
29		Media type: enter 1 or 2			
30		1 expanded clay 2 sand	1	-	Process sizing, media quantity
31		Media depth, inch	30		
32					
33		PNRS Ligno media			
34		Surface loading rate, gal/ft^2-day	7.4		Process sizing, media quantity
35		Media depth, inch	42		
36					
37		PNRS Sulfur media			
38		Surface loading rate, gal/ft^2-day	15.7		Process sizing, media quantity
39		Media depth, inch	18		
40					
41		Site layout size: enter 1, 2 or 3			
42		1 Compact 2 Moderate 3 Extensive	1	-	Quantity of piping, installation labor and equipment
43					
44		Energy Consumption			
45		Electrical rate, $/kw-hour	0.145		Energy cost
46					
47		Primary tank pump out			
48		Interval, years	4.0		Maintenance cost
49		Cost, $	300		
50					
51		Annual recurring costs, $/year			
52		Annual inspection & maintenance	150		Compliance and maintenance cost
53		Permit fee	125		
54		Water quality monitoring	120		
55					
56		Life Cycle Cost Analysis			
57		Project life, years	30		Economic analysis
58		Interest rate, %	2.500	-	

Life Cycle Cost Analysis (LCCA)
Passive Nitrogen Removal Systems
Florida Department of Health
Daniel P. Smith, 6/30/2014

Worksheet
1. LCCA Structure
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4. Default Design Cost Summary

	Default Design Cost $
Installation	
Tankage	
Primary tank	800.00
Recycle	558.90
Stage 1	1,111.00
Stage 2	0.00
Stage 2a/Stage 2b	994.63
Stage 1/Stage 2a	0.00
Stage 2b	0.00
Tankage Subtotal	3,464.53
Media	
Expanded Clay	1,080.00
Sand	0.00

Ligno	115.78
Sulfur	666.90
Media Subtotal	1,862.68
Pump	1,053.00
Control Panel	1,161.00
Misc. Appurtenance	1,693.00
Piping	289.60
Contractor Fee	7,370.80
Total Installation Cost	16,894.61
Annual Recurring Cost	
Annual inspection & maintenance	150.00
Annual energy cost	52.43
Permit fee	125.00
Water quality monitoring	120.00
Total	447.43
Recurring Cost > 1 year frequency	
Primary tank pump out	300.00
Interval, years	4.00
Total	300.00

Life Cycle Cost Analysis (LCCA)
Passive Nitrogen Removal Systems
Florida Department of Health
Daniel P. Smith, 6/30/2014

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1. LCCA Structure
2. Input
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7. Design Data

5. Customized Costs

User specified cost overides default design cost

Custom Cost Entry Field

set to zero for default costs

	Default Design Cost $	Custom Cost $	Cost for LCCA Analysis $
Installation			
Tankage			
Primary tank	800.00	680.00	680.00
Recycle	558.90	390.00	390.00
Stage 1	1,111.00	800.00	800.00
Stage 2	0.00	0.00	0.00
Stage 2a/Stage 2b	994.63	1,000.00	1,000.00
Stage 1/Stage 2a	0.00	0.00	0.00
Stage 2b	0.00	0.00	0.00
Tankage Subtotal	3,464.53	2,870.00	2,870.00

Media			
Expanded Clay	1,080.00	827.48	827.48
Sand	0.00	0.00	0.00
Ligno	115.78	500.00	500.00
Sulfur	666.90	1,104.96	1,104.96
Media Subtotal	1,862.68	2,432.44	2,432.44
Pump	1,053.00	531.00	531.00
Control Panel	1,161.00	0.00	1,161.00
Misc. Appurtenance	1,693.00	2,414.00	2,414.00
Piping	289.60	240.00	240.00
Contractor Fee	7,370.80	8,765.00	8,765.00
Total Installation Cost	16,894.61	17,252.44	18,413.44
Annual Recurring Cost			
Annual inspection & maintenance	150.00	125.00	125.00
Annual energy cost, $	52.43	0.00	52.43
Permit fee	125.00	150.00	150.00
Water quality monitoring	120.00	100.00	100.00
Total	447.43	375.00	427.43
Recurring Cost > 1 year frequency			
Primary tank pump out	300.00	320.00	320.00
Interval, years	4.00	4.00	4.00
Total	300.00	320.00	320.00

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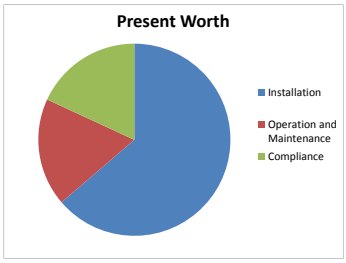
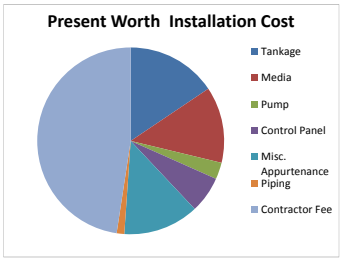
6. Life Cycle Cost Analysis

Cell Color Code

Calculation (do not modify)	
Project life (PL), years	30
Interest rate, %	2.500
Primary tank pump out interval (TI), years	4.0
Pump out life (POL), years	28
Compound Interest Factors	
P/A PL	20.930
A/P PL	0.04778
A/F TI	0.24082
P/A POL	19.965
Nitrogen Removal	
Mass loading/year, lbs.	27.0
Removal efficiency	95.0
Mass removal/year, lbs.	25.7
Present Worth $/lb nitrogen removed	37.54





Life Cycle Cost

Cost Item	Present Worth, $	Uniform Annual Cost, $	% of Total Life Cycle Cost
Installation			
Tankage	2,870.00	137.12	9.9
Media	2,432.44	116.22	8.4
Pump	531.00	25.37	1.8
Control Panel	1,161.00	55.47	4.0
Misc. Appurtenance	2,414.00	115.34	8.4
Piping	240.00	11.47	0.8
Contractor Fee	8,765.00	418.77	30.3
Subtotal	18,413.44	879.75	63.7
Operation and Maintenance			
Annual inspection & maintenance	2,616.29	125.00	9.1
Annual energy cost	1,097.41	52.43	3.8
Primary tank pump out	1,538.53	73.51	5.3
Subtotal	5,252.22	250.94	18.2
Compliance			
Permit fee	3,139.54	150.00	10.9
Water quality monitoring	2,093.03	100.00	7.2
Subtotal	5,232.57	250.00	18.1
Total	28,898.24	1,380.69	100.00

1380.689629

Life Cycle Cost

Cost Item	Present Worth, $	% of Total Life Cycle Cost
Installation	18,413.44	63.7
Operation and Maintenance	5,252.22	18.2
Compliance	5,232.57	18.1
Total	28,898.24	100.0

Installation Cost

Installation Cost Item	Present Worth, $	% of Installation Cost
Tankage	2,870.00	15.6
Media	2,432.44	13.2
Pump	531.00	2.9
Control Panel	1,161.00	6.3
Misc. Appurtenance	2,414.00	13.1
Piping	240.00	1.3
Contractor Fee	8,765.00	47.6
Total	18,413.44	100.0

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7. Design Data

based on installed systems

Variables to modify (Input Fields)

Primary tank (look up table)

No. bedrooms	Flow, gpd	Volume, gal.	$
1	330	1,050	800.00
2	330	1,050	800.00
3	330	1,050	800.00
4	440	1,200	1,200.00
5	550	1,500	1,550.00
6	660	1,800	2,050.00
7	770	2,100	2,550.00

Wastewater Flowrate, gpd 330

Nitrogen Equivalent Wastewater Volume

Nitrogen load, g/cap.-day 11.2

N equiv. Volume, gal/cap-day 60

N conc., mg/L 49.3

Design Volume, gal/cap-day 110

N conc., mg/L	26.9
N Equiv. Volume Adjustment Factor	0.545
TN Loading, gram/day	33.6

Media

	$/ft^3	lbs./ft3	$/lb.
Expanded clay	7.200	40	0.180
Sand	7.140	102	0.070
Ligno	1.360	17	0.080
Sulfur	19.760	76	0.260

Energy Consumption

Stage 1 hydraulics	kW-hour/1000 gal
single pass	0.750
recycle	3.000

B-HS2	0.700
B-HS8	0.800

FONRS Task B
Installation Cost
Breakout

System	Hydraulics	Misc. Appurtenance	Piping	Contractor Fee
B-HS2	Recycle	2,212	240	8,765
B-HS4	Single pass	2,347	555	6,229
B-HS5	Single pass	369	319	12,968
B-HS6	Single pass	742	85	2,365
B-HS7	Single pass	2,795	249	6,527
Mean		1,693	290	7,371

PNRS Features (look up table)

1	2	3	4	5	6	7
PNRS System #						**Media**
	Expanded Clay			Sand		
	Volume, ft^3	Volume, gal	Cost, $	Volume, ft^3	Volume, gal	Cost, $
1	150.0	1,122	1,080.00	0.0	0	0.00

2	150.0	1,122	1,080.00	0.0	0	0.00
3	150.0	1,122	1,080.00	0.0	0	0.00
4	0.0	0	0.00	150.0	1,122	1,071.00
5	0.0	0	0.00	150.0	1,122	1,071.00
6	0.0	0	0.00	150.0	1,122	1,071.00
7	150.0	1,122	1,080.00	0.0	0	0.00
8	150.0	1,122	1,080.00	0.0	0	0.00
9	150.0	1,122	1,080.00	0.0	0	0.00
10	0.0	0	0.00	150.0	1,122	1,071.00
11	0.0	0	0.00	150.0	1,122	1,071.00
12	0.0	0	0.00	150.0	1,122	1,071.00
13	150.0	1,122	1,080.00	0.0	0	0.00
14	0.0	0	0.00	150.0	1,122	1,071.00
15	150.0	1,122	1,080.00	0.0	0	0.00
16	0.0	0	0.00	150.0	1,122	1,071.00

Tankage cost

Recycle, Stage 2b tank

	gal	$
Recycle tank	330	559
Stage 2b	0	0

450

0.33

Task B data	
gallon	$
225	508.00
225	650.00
300	390.00
300	712.00

Equation, M
gallon
200
250
300
400
500
600
700
800

Tankage cost

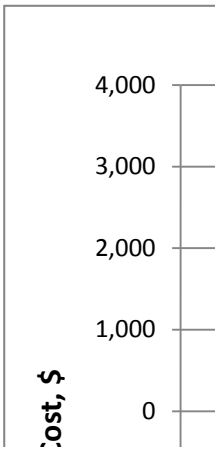
Stage 1, Stage 2, Stage 2a/Stage 2b, Stage 1/Stage 2a tank

	gal	$
Stage 1	1,122	1,111.00
Stage 2	0	0.00
Stage 2a/Stage 2b	889	994.63
Stage 1/Stage 2a	0	0.00

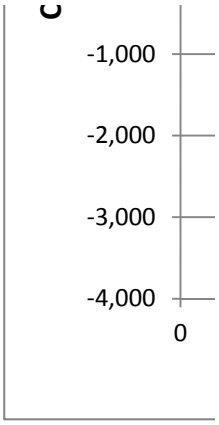
550

0.50

gallon	$	$ equation 1	$ equation 2



200		-3,119.81	650.00
400		-1,456.88	750.00
600		-484.13	850.00
900		488.63	1,000.00
1,200	1,200	1,178.80	1,150.00
1,500	1,740	1,714.15	
1,800	2,050	2,151.55	
2,100	2,550	2,521.38	
2,500	2,980	2,939.67	
2,800	3,250	3,211.56	
3,200	3,500	3,531.91	



Site layout

1	Compact (CU)
2	Moderate (MD)
3	Extensive (EX)

Scaleup factor

Piping	Contractor fee
1.00	1.00
1.10	1.10
1.20	1.20

Pump 1,053.00

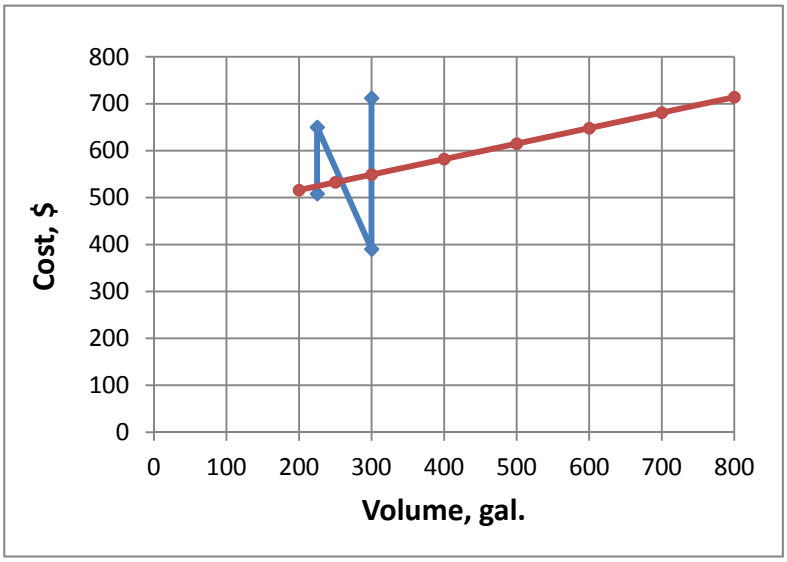
Control Panel 1,161.00

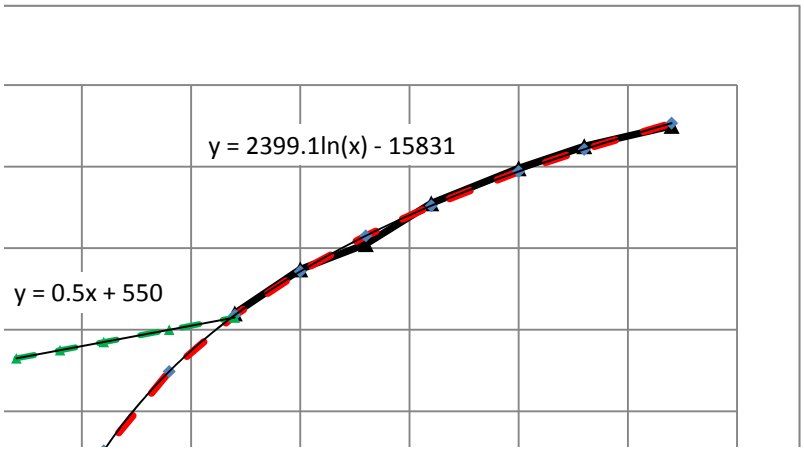
Total
11,217
9,131
13,656
3,192
9,571
9,353

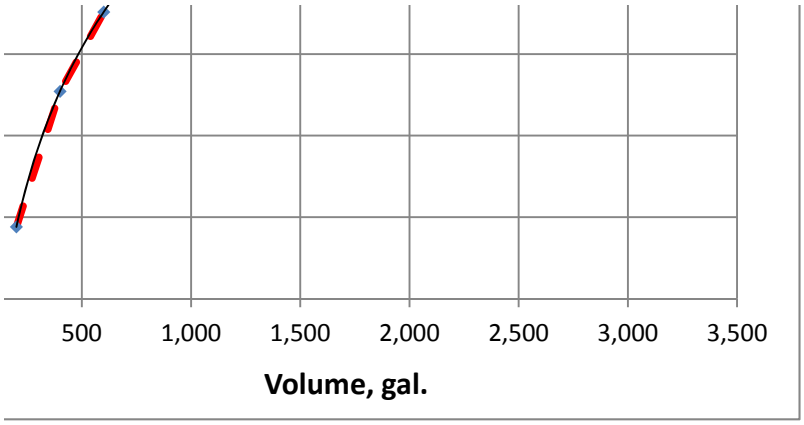
8	9	10	11	12	13	14	15
Stage 1	Ligno			Sulfur			Recycle
Exp. Clay or Sand							
Cost, $	Volume, ft^3	Volume, gal	Cost, $	Volume, ft^3	Volume, gal	Cost, $	Volume, gal
1,080.00	85.1	637	115.78	0.0	0	0.00	0

1,080.00	0.0	0	0.00	33.8	252	666.90	0
1,080.00	85.1	637	115.78	33.8	252	666.90	0
1,071.00	85.1	637	115.78	0.0	0	0.00	0
1,071.00	0.0	0	0.00	33.8	252	666.90	0
1,071.00	85.1	637	115.78	33.8	252	666.90	0
1,080.00	85.1	637	115.78	0.0	0	0.00	330
1,080.00	0.0	0	0.00	33.8	252	666.90	330
1,080.00	85.1	637	115.78	33.8	252	666.90	330
1,071.00	85.1	637	115.78	0.0	0	0.00	330
1,071.00	0.0	0	0.00	33.8	252	666.90	330
1,071.00	85.1	637	115.78	33.8	252	666.90	330
1,080.00	85.1	637	115.78	33.8	252	666.90	0
1,071.00	85.1	637	115.78	33.8	252	666.90	0
1,080.00	85.1	637	115.78	0.0	0	0.00	0
1,071.00	85.1	637	115.78	0.0	0	0.00	0

lin = 200 gal
$
516.00
532.50
549.00
582.00
615.00
648.00
681.00
714.00






500
1,000
1,500
2,000
2,500
3,000
3,500
Volume, gal.

16	17	18	19	20	21	22
Tankage						
Stage 1	Stage 2	Stage 2a/ Stage 2b	Stage 1/ Stage 2a	Stage 2b		
Exp. Clay or Sand	Ligno or Sulfur	Ligno + Sulfur	(Exp. Clay or Sand) + Ligno	Sulfur	Annual energy consumption	Misc. Appurtenance
Volume, gal	Volume, gal	Volume, gal	Volume, gal	Volume, gal	kW-hour	$
1,122	637	0	0	0	90.40	1,693.00

1,122	252	0	0	0	90.40	1,693.00
1,122	0	889	0	0	90.40	1,693.00
1,122	637	0	0	0	90.40	1,693.00
1,122	252	0	0	0	90.40	1,693.00
1,122	0	889	0	0	90.40	1,693.00
1,122	637	0	0	0	361.60	1,693.00
1,122	252	0	0	0	361.60	1,693.00
1,122	0	889	0	0	361.60	1,693.00
1,122	637	0	0	0	361.60	1,693.00
1,122	252	0	0	0	361.60	1,693.00
1,122	0	889	0	0	361.60	1,693.00
0	0	0	1,759	252	90.40	1,693.00
0	0	0	1,759	252	90.40	1,693.00
0	0	0	1,759	0	90.40	1,693.00
0	0	0	1,759	0	90.40	1,693.00

23 **24**

Piping	Contractor Fee
$	$
289.60	7,370.80

289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80
289.60	7,370.80