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Cost and Returns Analysis of Manure Management Systems Evaluated in 2007 under the North Carolina Attorney General Agreements with Smithfield Foods, Premium Standard Farms, and Front Line Farmers

TECHNOLOGY REPORT: SUPER SOILS "2nd GENERATION" ON-FARM

Prepared as Part of the Full Economic Assessment of Alternative Swine Waste Management Systems Under the Agreement Between the North Carolina Attorney General and Smithfield Foods

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Includes:	Manure Evacuation and Lift Station:	$ 7.29 / 1,000 lbs. SSLW / Yr.
	Homogenization Tank:	$ 37.70 / 1,000 lbs. SSLW / Yr.
	Solids Separator:	$106.84 / 1,000 lbs. SSLW / Yr.
	Separated Effluent Tank:	$ 29.79 / 1,000 lbs. SSLW / Yr.
	Denitrification Tank:	$ 15.73 / 1,000 lbs. SSLW / Yr.
	Nitrification Tank:	$ 25.43 / 1,000 lbs. SSLW / Yr.
	Settling Tank:	$ 23.01 / 1,000 lbs. SSLW / Yr.
	Clean Water Tank:	$ 12.68 / 1,000 lbs. SSLW / Yr.
	Phosphorus Removal Tank:	$ 24.63 / 1,000 lbs. SSLW / Yr.
	Return to Barns:	$ 1.29 / 1,000 lbs. SSLW / Yr.
	Increased Land Application Cost:	$ 15.82 / 1,000 lbs. SSLW / Yr.

Range: Across Farm Sizes and Types (Pit-Recharge): $195.69 To 772.58 / 1,000 lbs. SSLW / Yr.
Across Farm Sizes and Types (Flush): $221.59 To 1,658.71 / 1,000 lbs. SSLW / Yr.

Confidence in Estimates:
Medium
Based on 7 months evaluation, real commercial setting data for solids and liquids collection, electricity and polymer use, electricity and polymer prices, construction and operating performance and expense

Costs by Category:

Direct Construction:	$155.65 / 1,000 lbs. SSLW / Yr.
Contractor Overhead	$ 48.27 / 1,000 lbs. SSLW / Yr.
Total Operating:	$ 80.47 / 1,000 lbs. SSLW / Yr.
Increased Land Application Cost:	$ 15.82 / 1,000 lbs. SSLW / Yr.

- Assumes solids separator is shared by 2.5 farms and operates at 3,600 gallons per hour for 140 hours per week. Total barn effluent (pit recharge liquid plus manure plus spilled water) is assumed to average 28,361 gallons per day on each 4,320 head feeder pig to finish farms or 48.63 gallons per 1,000 pounds SSLW per day. Costs are excluded for labor or other monitoring systems for separator operation in excess of the 60 hours per week when farm personnel are present.

Summary of Results: Modified Actual Model

Retrofit Cost per 1,000 pounds Steady State Live Weight per year: $132.24
Actual Feeder-to-Finish Farm (Tyndall) with 5,145 head (Tables SSII.22- SSII.35)
10-Year Amortization, Pit-Recharge, N-limited Irrigation onto Forage

Includes:	Manure Evacuation and Lift Station:	$ 15.04 / 1,000 lbs. SSLW / Yr.
	Homogenization Tank:	$ 13.81 / 1,000 lbs. SSLW / Yr.
	Solids Separator:	$ 30.78 / 1,000 lbs. SSLW / Yr.
	Separated Effluent Tank:	$ 8.50 / 1,000 lbs. SSLW / Yr.
	Denitrification Tank:	$ 12.09 / 1,000 lbs. SSLW / Yr.
	Nitrification Tank:	$ 26.86 / 1,000 lbs. SSLW / Yr.
	Settling Tank:	$ 7.88 / 1,000 lbs. SSLW / Yr.
	Clean Water Tank:	$ 7.09 / 1,000 lbs. SSLW / Yr.
	Phosphorus Removal Tank:	$ 13.37 / 1,000 lbs. SSLW / Yr.
	Return to Barns:	$ 0.92 / 1,000 lbs. SSLW / Yr.
	Decreased Land Application Cost:	$ (4.10) / 1,000 lbs. SSLW / Yr.

Costs by Category:

	Direct Construction:	$ 75.63 / 1,000 lbs. SSLW / Yr.
	Contractor Overhead	$ 21.96 / 1,000 lbs. SSLW / Yr.
	Total Operating:	$ 38.75 / 1,000 lbs. SSLW / Yr.
	Decreased Land Application Cost:	$ (4.10) / 1,000 lbs. SSLW / Yr.

- Assumes solids separator is shared by 7 farms and operates at 3,600 gallons per hour for 110 hours per week. Total barn effluent (pit recharge liquid plus manure plus spilled water) is assumed to average 8,034 gallons per day on each of seven 5,145 head feeder pig to finish farms or 11.57 gallons per 1,000 pounds SSLW per day. Costs are excluded for labor or other monitoring systems for separator operation in excess of the 60 hours per week when farm personnel are present.

Sensitivity Analysis on Results of the Standardized Model

Effect of Expected Economic Life, Interest Rate, and Overhead Rate on Predicted Annualized Construction and Overhead Cost ($ / 1,000 lbs. SSLW)

Capital Recovery Factor (CRF)		Overhead Rate 20 %	Overhead Rate 43.1 %
Low-Cost Projection (15-year economic life, 6 % interest rate)	0.1030	$126.69	$144.56
Baseline Cost Projection (10-year economic life, 8 % interest rate)	0.1490	$178.05	**$203.92***
High-Cost Projection (7-year economic life, 10 % interest rate)	0.2054	$240.80	$276.45

* This predicted cost was estimated using the assumptions that are applied throughout the report—10-year economic life, 8 % interest rate, and 43.1 % overhead rate.

Effect of Electricity Price on Predicted Annual Operating Cost ($ / 1,000 lbs. SSLW)

Electricity Price ($ / kWh)	Predicted Annual Operating Cost ($ / 1,000 lbs. SSLW)
Low-Cost Electricity ($0.06 / kWh)	$77.02
Baseline Cost of Electricity ($0.08 / kWh)	**$80.47***
High-Cost Electricity ($0.10 / kWh)	$83.92

* This predicted cost was estimated using the assumption that is applied throughout the report--$0.08 / kWh.

Effect of Weekly Flushed Effluent Rate (Gallons of Flushed Effluent / 1,000 Lbs. SSLW / week) and Maximum Weekly Solids Separation Time on Predicted Annualized Separation Cost ($ / 1,000 lbs. SSLW)[1]

Gallons of flushed effluent / 1,000 lbs. SSLW / week	21[2]	60	110	120	140	160
	maximum separation hours / week					
81[3]	$151.77	$48.00	**$30.78[4]**	$29.14	$26.44	$24.42
220	N/A[5]	$128.09	$82.05	$77.39	$70.07	$64.58
340[6]	N/A	$197.46	$126.22	$118.87	**$106.84[7]**	$99.19
402[8]	N/A	$218.23	$148.81	$140.30	$126.92	$116.89

1. This table shows the annualized cost of the solids separation unit process (construction and operating costs) on a standardized 4,320-head finishing farm assuming 3,600 gallons processed per hour of separator operation.
2. Based on the actual weekly separation time at Tyndall Farm during the evaluation of the system (Vanotti).
3. Flushed effluent rate based on actual Super Soils "2nd Generation" data from Tyndall Farm (8,034 gallons / day * 7) / (5,145 head * 0.135 lbs. / head) = 81.0
4. Based on assumed operating conditions in the modified actual model.
5. Requires multiple mobile separators in order to process the weekly barn effluent under these assumptions
6. Flushed effluent rate used in the standardized model for 4,320-head finishing farm with pit-recharge system (28,361 gallons / day * 7) / (4,320 head * 0.135 lbs. / head) = 340.4
7. Based on assumed operating conditions in the standardized model.
8. Flushed effluent rate used in the standardized model for a 4,320-head finishing farm with flush system.

Effect of Processing Rate (Gallons processed by the separator / hour) and Maximum Weekly Solids Separation Time on Predicted Annualized Retrofit Cost ($ / 1,000 lbs. SSLW)

Processing Rate	**21**	**60**	**110**	**120**	**140**	**160**
Modified Actual[1]	maximum separation hours / week					
2,400 gallons / hour	$256 (100%)	$168 (39%)	$142 (21%)	$140 (20%)	$136 (17%)	$133 (15%)
3,600 gallons / hour	$220 (74%)	$149 (26%)	**$132**[2] (14%)	$132 (14%)	$132 (14%)	$132 (14%)
Standardized[3]						
2,400 gallons / hour	N/A[4]	N/A	$354 (75%)	$341 (69%)	$324 (59%)	$324 (52%)
3,600 gallons / hour	N/A	$371 (92%)	$319 (50%)	$312 (46%)	**$300**[5] (39%)	$297 (34%)

Note: The value in parentheses under the cost is the cost share allocated to the mobile separator (e.g., if the mobile separator travels to one farm, the cost share is 100%; if it travels to seven farms, the cost share is 14%).

1. Based on Tyndall Farm data (5,145-head finishing farm with pit-recharge system and a flushed effluent rate of 81 gallons / 1,000 lbs. SSLW). Excludes labor cost for after hours monitoring.
2. Assumptions used to calculate the costs in the modified actual model (110 separation hours / week, 3,600 gallons processed / hour, flushed effluent rate of 81 gallons / 1,000 lbs. SSLW)
3. Based on standardized assumptions (4,320-head finishing farm with pit-recharge system and a flushed effluent rate of 340 gallons / 1,000 lbs. SSLW). Excludes labor cost for after hours monitoring.
4. Requires multiple mobile separators in order to process the weekly barn effluent under these assumptions
5. Assumptions used to calculate the costs in the standardized model (140 separation hours / week, 3,600 gallons processed / hour, flushed effluent rate of 340 gallons / 1,000 lbs. SSLW)

The sensitivity of predicted costs and returns to a few critical assumptions is illustrated above by recalculating **annualized construction and overhead cost** with lower and higher values for amortization rate (cost recovery factor) and for overhead rate. The number in bold face $203.92 is the predicted construction and overhead cost for the Super Soils "2nd Generation" on-farm system on a 4,320 head feeder-to-finish farm with pit-recharge and nitrogen-limited land application to forage. Numbers are recalculated using two overhead rates: 20% and 43.1%, and three combinations of interest rate and maximum expected economic life: 15-year life and 6% interest rate, 10-year life and 8% interest rate, and 7-year life and 10% interest rate. The range of selected parameter values has a significant effect on the predicted value of annual construction and overhead costs.

Similarly, predicted **annual operating costs** of the Super Soils "2nd Generation" on-farm system are recalculated using higher and lower prices for electricity. The 25% increase or decrease in electricity price has a relatively small effect on the predicted annual cost per unit reflecting reduced use of electricity by the nitrification/denitrification system (as compared to the Super Soils "1st Generation" system).

The sensitivity of predicted costs and returns to two critical barn effluent and solids separation assumptions is illustrated above by recalculating **annualized separation cost** with lower and higher values for weekly flushed effluent rate and weekly separation time. The number in bold face $106.84 is the predicted separation cost for the Super Soils "2nd Generation" on-farm system on a 4,320 head feeder-to-finish farm with pit-recharge and nitrogen-limited land application to forage (assuming 140 separation hours per week at 3,600 gallons processed per hour) and a barn effluent rate of 340 gallons / 1,000 lbs. SSLW / week). Numbers are recalculated using four weekly flushed effluent rates: 81, 220, 340, and 402 flushed gallons / 1,000 lbs. SSLW / week, and six weekly separation times: 21, 60, 110, 120, 140, and 160 hours. The range of selected barn effluent and solids separation assumptions has a significant effect on the predicted value of annual construction and overhead costs. It is important to consider how frequently a major overhaul of the separator would be required with various weekly operating schedules. As weekly separation time approaches 160 hours, the separator would need more frequent overhauls than when using a shorter weekly separation schedule. This consideration is not included in the above sensitivity analysis. Furthermore, the sensitivity analysis excludes the cost of labor or other monitoring systems for separator operation in excess of the 60 hours per week when farm personnel are present.

In the final table on page 6, the sensitivity of predicted costs and returns to separator operating time (hours / week) and separator processing rate (gallons of wastewater processed / hour) is illustrated. **Annualized total retrofit costs** of the Super Soils "2nd Generation" system are recalculated using six weekly separation times (21, 60, 110, 120, 140, and 160 hours) and two hourly separation processing rates (2,400 and 3,600 gallons / hour). In both the standardized and modified actual models, a separator processing rate of 3,600 gallons / hour was assumed (Campbell) based on the rated capacity of the separator. However, in the principal investigators' report, it was stated that the separator was operated at a rate of 2,400 gallons / hour on Tyndall Farm (Vanotti). A lower separation rate implies that the mobile separator will not be able to travel to as many farms per week. Therefore, the total share of the separator cost that is borne by any single farm will increase as processing rate decreases (as illustrated by the higher annualized total retrofit costs in the '2,400 gallons / hour' row of the sensitivity table). As in the previous sensitivity analysis, as weekly separation time approaches 160 hours, the separator would need more frequent overhauls than when using a shorter weekly separation schedule. This consideration is not included in the above sensitivity analysis. Furthermore, the sensitivity analysis excludes the cost of labor or other monitoring systems for separator operation in excess of the 60 hours per week when farm personnel are present. It is unclear what, if any, impact the higher processing rate would have on the life of the separator or on the annual maintenance costs associated with the separator. In the above analysis, it is assumed that these variables will stay constant across both processing rates.

Note that the sensitivity analysis is not intended to propose alternative costs and returns estimates. It is solely intended to illustrate the sensitivity of the results to changes in parameter values.

Break-even Analysis on By-product Prices

Breakeven analysis is conducted for systems that produce potentially marketable by-products in order to determine the by-product price required to cover the cost of the system. The Super Soils "2nd Generation" on-farm system produces separated solids as well as liquid effluent. Breakeven analysis is conducted for the separated solids.

Break-even Analysis on Separated Solids: 4,320 Head Feeder to Finish Farm

Cost to be Recovered	**($ / 1,000 lbs. SSLW / Year)**	**Breakeven Price @ 4.300 wet tons / 1,000 lbs. SSLW per Year***
		($ / wet ton)
Cost of lift station, homogenization tank, solid separator, separated effluent tank, installation and operation	$181.62	$42.24
Cost of solids separation plus liquid treatment and phosphorus recovery excluding solids land application	$282.90	$65.79

* Calculated based on separation of 5,015,687 pounds per year of wet solids @ 75.1% moisture.

The table above presents partial and total breakeven prices. The first row of numbers in the table presents the breakeven price of the additional technology necessary to produce the by-product (e.g. the solids separation system to produce separated solids). The bottom line in the table is the price necessary to offset the incremental cost of the entire retrofitted manure management system.

To be economically viable, by-product prices must at least exceed their cost of production. Based on known markets, it does not appear that separated solids can produce sufficient revenue or savings to offset their cost. However, since they are part of a larger system that includes off-farm treatment of solids and since the solids removal is necessary to limit costs of liquid treatment, they are included in the systems analyzed here.

1. Overview of the Super Soil Systems "2^{nd} Generation" Technology

1.1. Experimental Site Overview

This candidate technology, constructed and operated by Super Soil Systems USA, has an on-farm and off-farm component. The full-scale demonstration facility for on-farm treatment of swine manure is located on B&B Tyndall Farm near Clinton in Sampson County, NC. The separated solids from Tyndall Farm receive further treatment at the off-farm solids treatment (composting) site located near Clinton, NC.

B&B Tyndall Farm consists of seven houses (with a total capacity of 5,145 head) and two anaerobic lagoons of equal area (0.58 hectares each). The houses are naturally ventilated and equipped with fully slatted floors and a pit-recharge system for manure removal. In total, the Super Soil Systems technology is treating manure from barns with capacity for 5,145 feeder-to-finisher pigs or 694,575 pounds of SSLW.[1] 2006 farm records reported an average inventory of 653,940 lbs. of SSLW (equivalent to 4,844 head at 135 pounds per head). For the 204 days in which the Super Soils "2^{nd} Generation" technology was evaluated at Tyndall Farm, the estimated average weight in the houses was 549,045 pounds (equivalent to 4,067 head @ 135 lbs.) (Vanotti).

This report only includes the on-farm component. It is assumed here that all separated solids and liquids produced by the technology are land applied (currently the lowest-cost option for handling the solids). During the technology evaluation period, Super Soils was responsible for removing the separated solids from Tyndall Farm. The solids processing (composting) component was analyzed in a separate report released in November 2005. See the previous section on breakeven analysis for discussion of the effects on cost and returns estimates of shipping solids off the farm.

1.2. Technology Overview and Performance Data (Tables SSII.1-SSII.5)

The Super Soil Systems "2^{nd} Generation" on-farm component uses polymer-enhanced liquid-solid separation, nitrification/denitrification, and soluble phosphorus removal modules to treat swine manure.

During the reporting period from December 2006 to June 2007, the pits in seven barns were emptied and recharged once a week at the Tyndall site. For the 204 days in which data was collected for the Super Soils "2^{nd} Generation" technology at the Tyndall site, average daily pit-recharge volumes (for a seven-day week) were reported as 2,002 gallons / day. Average daily fresh manure, urine, and excess water volumes were reported as 5,354 gallons / day, for a total average daily effluent volume (pit-recharge plus fresh manure) of 7,356 gallons/ day. Over this time period, Tyndall had an estimated average monthly pig weight of 549,045 pounds—or the SSLW equivalent of

[1] Based on 135 lbs. of SSLW per head.

4,067 head (Vanotti). See Table SSI.1 for a monthly summary of estimated pig weights and barn effluent volumes.

This total effluent volume at Tyndall was substantially lower than the volume predicted in the standardized model. According to the SF and PSF estimates and published standards reported in Appendix A, average effluent volume for a 4,067-head finishing operation is approximately 26,700 gallons / day (17,346 gallons / day of pit-recharge water plus 9,354 gallons / day of fresh manure). Differences in estimates of barn effluent and recycled liquid used for recharging suggest that a dramatic change in farm management practices occurred when the new technology was installed. The sharp reduction in pit-recharge volume (i.e., 2,002 gallons / day versus 17,346 gallons / day) lowers the projected construction and operating cost of the technology, but also may have an impact on the environment inside the barns. However, preliminary research indicated that the environment inside the houses was not adversely impacted by the reduced usage of pit-recharge water (Vanotti). The "actual" cost model presented later in this document uses the reported experimental average barn effluent volume for one complete cycle of pigs (8,034 gallons / day) to model the technology as actually built and operated on the site (Tables SSII.22–SSII.35). All standardized models use the standard average barn effluent volume (e.g., 26,700 gallons / day for a 4,067-head farm) based on the estimate obtained from SF and PSF and published sources (Appendix A, Table A.5). The effect of assumed effluent volume is discussed in the modeling assumptions and summary sections of this report.

The effluent from the barns was pumped to a homogenization tank and mixed well prior to solids separation. Liquid effluent from the solids separation module was pumped into a separated effluent tank and subsequently to the nitrification/denitrification module. Effluent from the nitrification/denitrification tank flowed by gravity to a settling tank for clarification. Clarified liquid effluent flowed by gravity to a clean water storage tank and was used to recharge the barn pits. Settled solids from the clarification tank were pumped as a thickened liquid to the nitrification tank. Excess nitrification/denitrification tank effluent (not needed for pit recharging) flowed by gravity into the phosphorus removal module (after first being injected with lime). Treated effluent from the phosphorus removal module was used to irrigate crops after first being stored in an existing lagoon. Separated solids were removed periodically from the farm via trailers and transported to the solids processing facility. Settled solids from the phosphorus removal unit were pumped back to the solids separator for additional dewatering before being removed from the farm with the other separated solids.

The Super Soil "2nd Generation" on-farm treatment can be divided into the following unit processes:

(1) Lift Station and Manure Evacuation
(2) Homogenization Tank
(3) Solids Separation
(4) Separated Effluent Tank
(5) Denitrification Tank

(6) Nitrification Tank
(7) Settling Tank
(8) Clean Water Tank
(9) Phosphorus Removal Tank
(10) Return to Barns

The lift station at the site included a 5-HP pump installed to move the effluent from the lift station to the homogenization tank. This pump is capable of pumping approximately 250 gallons/ minute (Campbell). The homogenization tank has a 100,000-gallon capacity, and the manure was mixed using a 3.5-kW submersible mixer. Solids separation uses polymer flocculants to enhance separation of solids from liquids in the swine manure. A 48" dual rotary press separator was used to separate the solids. The separation process also included two 560-gallon polymer preparation tanks, a polymer metering pump, a sludge feed pump, and a flocculator. The final polymer dosage used in the evaluation of the Super Soils "2nd Generation" technology was 128 mg of polymer / L of manure entering the separation module. Separated solids fell into a trailer and were transported off-site to the composting facility. A total of 90 trailers containing 214,580 kg (473,070 lbs.) of separated solids were transported from Tyndall Farm between 12/9/06 and 6/2/07. Tables SSII.2 and SSII.3 report the nutrient content and mass removal associated with the separated solids. Separated effluent was pumped to a 100,000-gallon tank.

Upon removal of solids, the liquid still contains suspended organic material and ammonia that must be treated via a nitrification/denitrification process. This was done in a continuous manner, in which manure entered and exited the module at 9-10 gallons / minute and was recirculated between the dentrification and nitrification tanks at 45-50 gallons / minute. The 60,000-gallon nitrification tank used a 10-HP rotary lobe blower and 128 fine-air diffusers to aerate the wastewater. The 73,000-gallon anoxic denitrification tank contained suspended denitrifying bacteria that used carbon contained in the separated effluent to remove NO_3. Wastewater gravity flowed (at 9-10 gallons/ minute) from the nitrification tank into a 9,653-gallon settling tank. In this tank, the wastewater was clarified and the suspended bacteria were returned to the nitrification tank. The clarified effluent gravity flowed (at 9-20 gallons / minute) into a 73,000-gallon clean water tank and subsequently was used to refill the barn pits (an average of 2,002 gallons / day).

The excess effluent from the nitrification module will flow to a 5,242-gallon phosphorus removal tank. In the phosphorus removal module, phosphorus is recovered in the form of calcium phosphate solid and pathogens were reduced in an alkaline environment. The wastewater first entered a 0.3 m^3 reaction chamber where it was treated with hydrated lime at a rate of 1.178 g of lime / L of treated wastewater. A pH probe kept pH levels at 9.5 throughout the phosphorus removal process. The calcium phosphate precipitate was settled out in a phosphorus settling tank. It was then returned to the solids separation unit for additional dewatering and left the farm along with the other separated solids.

The Super Soils "2nd Generation" technology operated continuously on Tyndall Farm from December 9th through June 30th. Table SSII.1 shows the amount of flushed manure that was being treated by the Super Soils "2nd Generation" technology during its 7-month operational evaluation period. Over the duration of this period, a total of 1.5 million gallons of flushed manure was processed (7,356 gallons per day). Tables SSII.4 and SSII.5 report the treatment efficiency of the technology on both a concentration basis (SSII.4) and a mass basis (SSII.5). About 95% of TKN and 92-94% of the total phosphorus is removed from the liquid effluent by the Super Soils "2nd Generation" system (Vanotti).

The principal investigators' final report (Vanotti) provides a detailed description of the differences between the design of the original Super Soils technology and the Super Soils"2nd Generation" technology.

2. Costs of the Super Soils Technology as Constructed at the Tyndall Farm Demonstrational Facility (Tables SSII.6-SSII.20)

2.1 Invoiced Costs at Tyndall Farm (Tables SSII.6-SSII.18)

Table SSII.6 shows the estimated electrical power requirements necessary to operate the Super Soils "2nd Generation" technology as constructed at Tyndall Farm including all components (assuming an average daily flow rate of 7,356 gallons / day). The system uses an estimated 340.21 kilowatt-hours (kWh) of electricity per day, resulting in a daily operating cost of $27.22 (assuming $0.08 / kWh).[2] Annually, the electricity cost associated with operating the Super Soils "2nd Generation" technology amounts to an estimated $9,940.94.

Tables SSII.7-SSII.17 show the detailed invoiced cost summaries associated with the Super Soils "2nd Generation" technology unit processes. Specifically, the 11 unit processes described in these tables are: manure evacuation and lift station (Table SSII.7), homogenization tank (Table SSII.8), solids separation (Table SSII.9), separated effluent tank (Table SSII.10), denitrification tank (Table SSII.11), nitrification tank (Table SSII.12), settling tank (Table SSII.13), clean water tank (Table SSII.14), phosphorus removal module (Table SSII.15), return to barns (Table SSII.16), and miscellaneous/overhead (Table SSII.17). The costs presented in Tables SSII.7-SSII.17 are actual (invoiced) costs, and represent the Super Soils "2nd Generation" technology as it was originally designed and constructed at Tyndall Farm. Table SSII.18 summarizes the total invoiced costs of the Super Soils "2nd Generation" technology by unit process. In total, the Super Soils "2nd Generation" technology has an invoiced cost of $750,379.95. The majority of Super Soils "2nd Generation" system's costs (~78 %) in Table SSII.18 are borne by its three main modules—solids removal, nitrification/denitrification, and phosphorus removal. Over half of the invoiced costs (56.3%) are associated with the mobile separation unit.

[2] The estimate is based on a conversion formula from horse power (HP) to kilowatt-hours (kWh) assuming 88 % motor and pump efficiency. The result is that 1 HP is assumed to require 0.85 kW.

2.2 Modified Costs at Tyndall Farm (Tables SSII.19-SSII.20)

Table SSII.19 summarizes the modified costs associated with the Super Soils "2nd Generation" technology. Generally, cost modifications are justified reductions associated with unnecessary expenses or unit processes. While invoiced costs include all costs borne by the technology provider, modified costs only include those costs that were deemed necessary to construct and operate the technology. In the case of the Super Soils "2nd Generations" technology, most of the unnecessary costs were related to unused tanks (extra nitrification tank, unused settling and phosphorus removal tanks). An extra pump and costs associated with research-related polymer evaluation were also determined to be unnecessary. Table SSII.20 provides an analogue to Table SSII.18. Instead of Table SSII.18's invoiced costs summary, Table SSII.20 summarizes the modified costs associated with the Super Soils "2nd Generation" technology. In total, the modified Super Soils "2nd Generation" technology has a cost of $725,179.35—a 3.4 % reduction in cost from the invoiced total detailed in Table SSII.18. As in Table SSII.18, Super Soils' three primary modules (solids removal, nitrification/denitrification, phosphorus removal) are the bulk of the technology's total modified costs (~78 %).

3. Cost Modeling (Tables SSII.21-SSII.91)

3.1 Introduction

Original invoiced costs were reported detailing the construction costs of the Super Soils "2nd Generation" technology as it was built on the Tyndall facility. These costs are reported by unit process in Tables SSII.7-SSII.17 and summarized in total in Table SSII.18, where the original Super Soils "2nd Generation" technology costs summed to $750,379.95. Modified construction costs were also determined based on communication between the technology providers and the economic modeling team. The modified costs are reported by unit process in Tables SSII.19 and summarized in Table SSII.20. In the next step, the economic modeling team took the data reported in Tables SSII.7-SSII.17 and examined them for missing components and outdated prices. By doing so, the modeling team created a complete estimate of the construction cost. This estimate is intended to approximate adjusted invoiced cost that can be compared to those for other technologies analyzed under the Agreement. These approximated invoiced costs are summarized in Tables SSII.22-SSII.35. In the next step, estimates of costs that would occur on standard (representative) North Carolina farms were calculated. These costs are presented in Tables SSII.36-SSII.49 for a 4,320-head feeder-to-finish facility using a pit-recharge system of manure removal. Tables SSII.50-SSII.63 present the costs associated with a standard North Carolina feeder-to-finish operation with a head capacity of 4,320 using a flush system of waste removal. A representative NC 8,800-head feeder-to-finish facility with a pit-recharge manure removal system is reported in Tables SSII.64-SSII.77. The final standard NC farm described in these cost tables is a 4,000-sow farrow-to-wean operation using a pit-recharge system of manure removal. Tables SSII.78-SSII.91 list the costs associated with using the Super Soils "2nd Generation" technology at this representative facility.

3.2 Modeling Assumptions—Actual Model

In the actual cost model, the operating conditions and system design were modeled to reflect the conditions during the evaluation to the extent possible. Modeling assumptions were based on data compiled from treating the manure associated with one complete cycle of hogs (data from December 2006 to April 2007). It is assumed that waste is treated from a complete cycle of hogs at Tyndall Farm operating at capacity; 5,145 finishing head. The most important assumption used in the actual model involved using the daily barn effluent volume reported at Tyndall Farm for a single cycle of hogs (8,034 gallons per day—5,732 gallons of manure, urine, and excess water, and 2,302 gallons of pit-recharge liquid, based on data from 12/06 to 4/07). The volume of daily flushed effluent reported at Tyndall Farm was significantly lower than what would be modeled using standardized assumptions. With the baseline (lagoon and sprayfield) model, there are no strong economic incentives for minimizing the amount of pit-recharge liquid used. In a tank-based system (like Super Soils "2nd Generation"), however, economic incentives exist to minimize pit-recharge liquid. This is especially true in the case of the Super Soils "2nd Generation" technology in which it is proposed that a separator will travel between several farms.

In the traveling separator model, it is assumed that the mobile separator will treat as many farms as possible within a seven-day week (with an assumed maximum of one farm per day). A second major assumption is that the separator operates at its rated capacity; a processing rate of 3,600 gallons / hour (Campbell) rather than the 2,400 gallons per hour that it was operated at during the evaluation (Vanotti). The number of farms treated is wholly a function of barn effluent volume and separator processing rate. With an average daily volume of 8,034 gallons (as reported at Tyndall)—or 56,238 gallons / week—the traveling separator can service an average of seven farms (of 5,145 head) per week (a total of 110 separation hours / week at 3,600 gallons per hour with the one farm / day maximum being the binding constraint). When the average daily barn effluent volume increases to 33,777 gallons (as in the standardized model that uses published design parameters) or 236,439 gallons / week, the traveling separator can only service an average of 2.5 5,145-head farms per week (a total of 140 separation hours / week with the 140 hours / week being the binding constraint). The total ownership costs (capital costs, property taxes, and maintenance costs) of the separator can be allocated across more farms (thus reduced per farm) when each farm uses lower pit-recharge volumes.

It is assumed that the solids separator will be operated after normal farm hours (and on weekends) in order to service seven farms per week. Thus, it will be necessary to provide after-hours (and weekend) labor in order to monitor the separation unit (or allow the separator to operate unattended which would be an environmental/spill risk, where the separator operates above ground level). The costs of labor for monitoring after-hours operation are excluded from this study. At $12.50 per hour for wages, benefits, and payroll costs, after-hours labor could cost an additional $625 per week for 110 hours of separator operation ((110 – 60) x $12.50) to $1,250 per week for 160 hours of operation ((160 – 60) x $12.50). These calculations assume that farm personnel are present 60 hours per week and can monitor the separator operation during those hours at no additional cost. The maximum number of head served per week by the separator also depends on the size of the pigs. While the number of pigs served by the separator is modeled based on average barn effluent volumes, the number of farms that can be treated per week using the mobile separator will be cyclical as a function of pig size. For example, the solids separator must operate for 16 hours @ 3,600 gallons per hour to treat the average weekly barn effluent from Tyndall Farm (56,238 gallons / week). During the period when the animals were the heaviest, however, the separator would need to operate for 20 hours in order to treat the weekly barn effluent from Tyndall (72,331 gallons of barn effluent / week (Table SSII.1)).

The second obvious cost category that is affected by barn effluent volume is tank size. Assuming a constant hydraulic retention time (HRT), higher daily barn effluent volumes imply larger (and more expensive) tanks. In an entirely tank-based system like Super Soils "2nd Generation," it is economically advantageous to minimize pit-recharge volume in order to minimize tank sizes and costs. The actual model of the farm during the evaluation uses the amount of pit-recharge liquid that was reported to be used at Tyndall. Tank sizes used in the actual model are based on the actual tank sizes used at Tyndall Farm (as reported in Section 1.2: 100,000-gallon homogenization tank, etc.). Predicted electricity costs for the actual model are detailed in Table SSII.6, and polymer and lime assumptions can be found in Table SSII.21.

Costs by unit process and category for the modified actual model (based on 5,145 head) are summarized on page 3. The modified actual predicted cost / 1,000 lbs. SSLW / year of $132.24 is significantly lower than the standardized model predicted cost / 1,000 lbs. SSLW / year of $291.90 (for a 5,145-head finishing facility with pit-recharge system). As described above, this cost discrepancy is almost wholly a function of the difference in assumed daily barn effluent volume (8,034 in actual vs. 33,777 in standard). This difference manifests itself in the cost of solids separation ($30.78 / 1,000 lbs. SSLW / year in the modified actual model vs. $106.84 in the standardized model) and tank-related unit processes ($89.60 / 1,000 lbs. SSLW / year in the modified actual model vs. $164.18 in the standardized model). It is important to note that these results rest on the assumptions of 3,600 gallons per hour being treated at the efficiency reported in the evaluation and that the separator is being transported between several farms each week such that each farm bears only a fraction of the cost of owning the separator (about 14% in the modified actual model and about 39% in the standardized model). Also keep in mind that the costs of labor and/or other monitoring are excluded from these estimates because they are unknown but could amount to $600 to $1,200 per week. While a lower barn effluent volume (along with the corresponding lower costs) was demonstrated for pit-recharge buildings (based on the data from Tyndall), it is unclear how Super Soils "2nd Generation" technology could be operated as cost effectively on a farm with flush-style houses.

3.3 Modeling Assumptions—Standardized Model

Standardized modeling assumptions are reported in Table SSII.21. As in the costs and returns reports for all EST's, standardized barn effluent volumes were used (despite how the technology was actually operated on Tyndall Farm). All other cost assumptions and design parameters are also identical to those used in earlier economic costs and returns analyses (and outlined in Appendix A of the Combined Appendices Report).

The mobile solids separator is assumed to operate 140 hours per week at a rate of 3,600 gallons processed per hour, and travel to as many farms as possible in that time. It is assumed to take approximately one hour to disconnect the separator, travel to a new farm (assuming within a 10-mile radius of previous farm), and reconnect the separator (Campbell). The cost per trip of hauling the mobile separator unit to a new farm is assumed to be $15. This model assumes around-the-clock separation. Super Soils' operating policy is to run the separator overnight/after hours and on weekends in order to maximize farms treated per week. Based on this policy, it is understood that Super Soils or the farm would need to provide additional labor to monitor the separation unit during the hours when farm personnel are not normally present (or allow the separator to operate unattended). Costs of after-hours monitoring (for example, up to $1,250 per week) are excluded from this analysis. To see how different weekly operating schedules for the separator would affect construction and overhead costs, see the sensitivity table on page 5. Also, provided it will operate 140 hours per week, the system would need to have some excess weekly separation capacity built in. It is unlikely that multiple farms could be operated in such synchrony to allow 140 hours of separation time per week without the safeguard of excess capacity built in to the system. In order to account for this, the homogenization tank and separated effluent tank are modeled to have two days (48 hours) of excess capacity built in.

With standardized barn effluent volumes (28,361 gallons of barn effluent per day for a 4,320 head finishing farm with a pit-recharge system of manure removal) and a separator processing rate of 3,600 gallons/ hour, and assuming 140 hours of separator operation per week, the separator unit can, on average, treat the waste of 10,968 head of finishing hogs per week (or about 2.5 farms with 4,320-head capacity). The costs of the solids separator are therefore assumed to be allocated across the SSLW of 10,968 finishing hogs. For other types of operations (with different standardized barn effluent volumes), the maximum number of animals treated per week is calculated in a similar manner, with the costs again being spread across that number of hogs. If the solids separator will be traveling to three identically-sized farms during each week, the homogenization and separated effluent tanks can be sized accordingly (using a "round-up" function: 7 days – (7 days / 3 farms) = 5 days of HRT + 2 days of excess capacity = 7 days HRT). In the standardized model, homogenization tank and separated effluent tank sizes can range from 3 days of HRT (when the separator treats only one farm) to 8 days of HRT (when the separator treats 7 farms). The current tank sizing/mobile separation model assumes that the separator travels to each farm only once in a given week. For example, if the mobile separator is treating 3 farms per week, it will be disconnected/moved/reconnected three times per week (to move from farm 1 to farm 2, from farm 2 to farm 3, and from farm 3 back to farm 1). An alternative tank sizing/mobile separation model would allow multiple trips to each farm within a given week. This would result in shorter separator stints at each farm, smaller tank sizes (due to more frequent visits), and increased inter-farm transportation/labor costs (since the separator would need to travel more miles per week and be disconnected/reconnected more). In choosing between the two models of mobile separation, one must consider the trade-off between higher homogenization/separated effluent tank costs (with lower inter-farm transportation costs) and higher inter-farm transportation costs (with lower homogenization tank costs). It is also important to consider that, as number of trips increases (as in the second model), the weekly hours available for separation will decrease (since more time will be needed for travel and disconnecting/reconnecting).

Sizes for the nitrification, denitrification, settling, clean water, and phosphorus removal tanks are based on an HRT of one day. At Tyndall Farm (7,356 gallons at 9-10 gallons / minute), an average single day's worth of flushed effluent could be treated in about 14 hours (while achieving the performance results that are detailed in the Vanotti report). Larger daily barn effluent volumes will result in larger tanks (and correspondingly higher daily flow rates through the system), which will enable a day's worth of flushed wastewater to be treated in a single day by the nitrification and phosphorus modules.

Assumptions about aeration and mixing horsepower, lime and polymer usage and cost, separator efficiency, and moisture content of separated solids are reported in Table SSII.21.

3.4 Estimated Adjusted Invoice Costs for Super Soils "2nd Generation" Technology at Tyndall Farm—Actual Model (Tables SSII.22-SSII.35)

Table SSII.22 provides the necessary assumptions (5,145-head finishing facility with pit-recharge system) for the cost estimate calculation and also summarizes annualized costs by land application scenario (nitrogen-based application to forages, nitrogen-based application to row crops, phosphorus-based application to forages, and phosphorus-based application to row crops).[3] Annualized costs for the whole farm and per 1,000 lbs. of SSLW (incremental cost) are reported. Table SSII.22 presents incremental costs for each of the four land application scenarios ranging from $132.24 (nitrogen-based application to forages) to $169.41 (phosphorus-based application to forages). Tables SSII.23-SSII.32 summarize costs associated with individual unit processes of the Super Soils "2nd Generation" technology. Specifically, costs are reported for the following unit processes: manure evacuation and lift station (SSII.23), homogenization tank (SSII.24), separated effluent tank (SSII.25), solids separator (SSII.26), denitrification tank (SSII.27), nitrification tank (SSII.28), settling tank (SSII.29), clean water tank (SSII.30), phosphorus removal module (SSII.31), and return to barns (SSII.32). Table SSII.32 also reports the total costs associated with the unit processes listed above. Total construction costs are reported as $408,747.31 (including a 14% share of the solids separator), while operating costs are estimated as $26,919.54. The total annualized cost of the Super Soils "2nd Generation" technology before land application is estimated to be $94,700.78 for the 5,145-head feeder-to-finish facility at Tyndall Farm. Tables SSII.33 (lagoon effluent) and SSII.34 (solids) report land application costs associated with the Super Soils "2nd

[3] For more on land application, see Appendix B.

Generation" technology. Used in conjunction with the numbers reported at the end of Table SSII.32, the total annualized and incremental cost estimates can be calculated. These numbers are reported in Table SSII.22 for each of the four scenarios of land application. Table SSII.35 details the mass balance of nutrients associated with the Super Soils technology. This table is necessary to derive the numbers found in Tables SSII.33 and SSII.34.

3.5 Standardized Costs for Super Soils "2nd Generation" Technology at a 4,320-Head Feeder-to-Finish Farm (Pit-Recharge System) (Tables SSII.36-SSII.49)

Tables SSII.36- SSII.49 provide estimates of the cost of constructing and operating the Super Soils "2nd Generation" technology on a standard (representative) North Carolina farm. The representative farm reported in this section is a 4,320-head feeder-to-finish facility using a pit-recharge system for waste removal. Table SSII.36 provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for retrofitting the farm with standardized Super Soils "2nd Generation" technology. The standardized incremental costs range from $290.81 (phosphorus-based application to row crops) to $413.20 (phosphorus-based application to forages), with an average incremental cost of $325.84 per 1,000 lbs. SSLW per year across the four land application scenarios. In the standardized Super Soils "2nd Generation" model, it is more costly to land apply to forages than to row crops. Tables SSII.37-SSII.46 are similar to Tables SSII.23-SSII.32. They report standardized costs for the same unit processes as listed in the above section (in the same order). Within certain unit processes (e.g., manure evacuation and lift station), there might be differences in individual components between the actual and standardized models. In these cases, the technology as it was constructed at Tyndall was not indicative of how it would be constructed on a representative NC farm (due to farm-specific factors, etc.). Table SSII.46 summarizes the total costs associated with the standardized Super Soils "2nd Generation" technology for a 4,320-head finishing facility with a pit-recharge system. Total construction costs are estimated at $765,689.49 (including a 39% share of the separator), while total operating costs are reported as $46,931.95. Total annualized costs before land application are estimated at $165,856.76 for this representative farm size and type. Tables SSII.47 (lagoon effluent) and SSII.48 (solids) summarize the land application costs associated with the standardized model for each of four scenarios. Table SSII.49 provides an estimated mass balance of nutrients for this representative NC farm.

3.6 Standardized Costs for Super Soils "2nd Generation" Technology at a 4,320-Head Feeder-to-Finish Farm (Flush System) (Tables SSII.50-SSII.63)

Tables SSII.50- SSII.63 provide estimates of the cost of constructing and operating the Super Soils "2nd Generation" technology on a standard (representative) North Carolina 4,320-head feeder-to-finish facility using a flush system for manure removal. The only difference between the standard farm chosen to estimate the numbers in Tables SSII.50-SSII.63 versus the one chosen to estimate the numbers in Tables SSII.36-SSII.49 is the type of manure removal system used. Table SSII.50 provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized Super Soils "2nd Generation" technology. The standardized incremental costs of retrofitting the farm with the Super Soils "2nd Generation" system range from $333.09 (phosphorus-based application to row crops) to $455.55 (phosphorus-based application to forages)-- with an average incremental cost across the four scenarios of $368.17 per 1,000 lbs. SSLW per year. Forages are more costly than row crops for land application. The use of the flush system of manure removal increases average incremental cost estimates by about 13 % for a 4,320-head finishing facility as compared to using a pit-recharge system on the same facility. Tables SSII.51-SSII.60 detail the costs of individual unit processes in this standardized model. The set of unit processes and components are identical to those in Tables SSII.37-SSII.46, although some of the costs change between the two sets of tables. Table SSII.60 also summarizes the total costs associated with the standardized Super Soils "2nd Generation" technology for a 4,320-head finishing facility with a flush system. Total construction costs are estimated at $882,724.51, while total operating costs are reported as $54,053.89. Total annualized costs before land application are estimated at $190,667.52 for this representative farm size and type. Tables SSII.61 (lagoon effluent) and SSII.62 (solids) summarize the land application costs associated with this standardized model for each of four scenarios. Table SSII.63 provides an estimated mass balance of nutrients for the representative farm modeled in these tables.

3.7 Standardized Costs for Super Soils "2nd Generation" Technology at an 8,800-Head Feeder-to-Finish Farm (Tables SSII.64-SSII.77)

Tables SSII.64- SSII.77 provide estimates of the cost of constructing and operating the Super Soils "2nd Generation" technology on a standard (representative) North Carolina 8,800-head feeder-to-finish facility using a pit-recharge system for manure removal. Table SSII.64 provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for retrofitting a farm with the standardized Super Soils "2nd Generation" technology. The standardized incremental costs for the 8,800-head finishing facility range from $248.06 (phosphorus-based application to row crops) to $370.40 (phosphorus-based application to forages)-- with an average incremental cost of $280.81 per 1,000 lbs. SSLW per year across the four scenarios. This average incremental cost is about 13.8 % less than that of a standardized 4,320-head finishing facility with a pit-recharge system. Based on this finding, the model suggests that slight economies of scale are present for the Super Soils "2nd Generation" technology. Because no economies of scale are present for the mobile separator (the largest cost component)—which is constrained by the amount of waste it can process in 140 hours—the economies of scale for the "2nd Generation" technology are not as great as seen in the original Super Soils system (although it is a more cost-efficient system across all ranges of size and farm type). Tables SSII.65-SSII.74 provide details of the costs of individual unit processes in this standardized model. The set of unit processes and components are identical to those in Tables SSII.37-SSII.46 and SSII.51-SSII.60 although some of the costs change between the sets of tables. Table SSII.74 also summarizes the total costs associated with the standardized Super Soils "2nd Generation" technology for an 8,800-head finishing facility. Total construction costs are estimated at $1,297,559.65, while total operating costs are reported as $88,526.69. Total annualized costs before land application are estimated at $288,670.29 for this representative farm size and type. While these total construction costs are higher than in the standardized 4,320-head model, the costs per unit are lower. That is because the 8,800-head facility contains 1,188,000 pounds of steady-state live weight (SSLW) as compared to the 583,200 pounds of SSLW housed in the 4,320-head facility. Tables SSII.75 (lagoon effluent) and SSII.76 (solids) summarize the land application costs associated with this standardized model for each of four scenarios. Table SSII.77 provides an estimated mass balance of nutrients for the representative farm modeled in these tables.

3.8 Standardized Costs for Super Soils "2nd Generation" Technology at a 4,000-Sow Farrow-to-Wean Farm (Tables SSII.78-SSII.91)

Tables SSII.78- SSII.91 provide estimates of the cost of constructing and operating the Super Soils "2nd Generation" technology on a standard (representative) North Carolina 4,000-sow farrow-to-wean operation using a pit-recharge system for manure removal. This representative farm contains 1,732,000 pounds of SSLW: the largest of any standard farm modeled for the Super Soils "2nd Generation" technology. Table SSII.78 provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized Super Soils "2nd Generation" technology. The standardized incremental costs range from $273.06 (phosphorus-based application to row crops) to $330.77 (phosphorus-based application to forages), with an average incremental cost of $289.98 per 1,000 lbs. SSLW per year across the four scenarios of land application. Forages were estimated as being more costly than row crops for land application. Tables SSII.79-SSII.88 provide details of the costs of individual unit processes in this standardized model. Table SSII.88 summarizes the total costs of the standardized Super Soils "2nd Generation" technology for a 4,000-sow farrow-to-wean operation. Total construction costs are estimated at $1,929,934.43, while total operating costs are reported as $185,169.07. Total annualized costs before land application are estimated at $483,634.98 for this representative farm size and type. Tables SSII.89 (lagoon effluent) and SSII.90 (solids) summarize the land application costs associated with this standardized model for each of four scenarios. Table SSII.91 provides an estimated mass balance of nutrients for the 4,000-sow farrow-to-wean operation modeled for the Super Soils "2nd Generation" technology.

3.9 Extrapolation to Other Farm Types and Sizes (Tables SSII.92-SSII.93)

Table SSII.92 summarizes the per unit incremental costs ($ / 1,000 lbs. SSLW) of retrofitting the Super Soils "2nd Generation" technology onto each of the 25 size of farm / type of operation combinations. This table uses the representative farm size for a permitted North Carolina farm within a size / type combination. Incremental costs are shown for both pit-recharge and flush systems and Table SSII.92's costs assume a nitrogen-based land application to forages is utilized. Table SSII.93 is analogous to Table SSII.92, but uses Smithfield Foods/Premium Standard Farms (SF/PSF) representative farm sizes and farm types only. Incremental costs are again shown for both pit-recharge and flush systems. As in Table SSII.92, the costs in Table SSII.93 assume that a nitrogen-based land application to forages is chosen. Tables SSII.92 and SSII.93 illustrate that predicted incremental costs decrease as the size of the farm increases. Within their farm size categories, wean-to-feeder operations are clearly the most expensive types of farms on which to construct and operate the Super Soils "2nd Generation" technology (on a $ / 1,000 lbs. SSLW / year basis). It is also apparent in Tables SSII.92 and SSII.93 that flush systems of manure removal are generally more costly than pit-recharge systems for most size of farm/type of operation categories.

4. Summary and Conclusions

The on-farm portion of the Super Soils "2nd Generation" technology was installed on an existing feeder-to-finish farm (Tyndall) with a pit-recharge system of waste removal. The original design included 10 components (listed in section 1.2 of this report). The experimental system treated effluent from seven pit-recharge feeder-to-finish buildings with capacity for 5,145 pigs or 694,575 pounds SSLW. During the 7-month evaluation period (December 2006 through June 2007), the average inventory in the buildings was estimated as SSLW of 549,045 pounds (equivalent to 4,067 pigs @ 135 lbs./head). During the 5-month period that constituted a complete cycle, the average inventory in the buildings was estimated at 5,145 pigs with a SSLW of 694,575 pounds. Tables SSII.6 through SSII.20 compare the retrofit installation costs of the original system with the modified system and show cost dropping from $750,379.95 to $725,179.35. One notable feature of the Super Soils "2nd Generation" evaluation was that total barn effluent volume was reported at 8,034 gallons per day (using complete cycle data) versus an expected 33,777 gallons per day that our standardized model predicts for an inventory of 5,145 finishing pigs. The reported effluent volume was used for modeling costs and returns of the actual modified system (Tables SSII.22 – SSII.35) while standardized effluent volume was used for the standardized models (Tables SSII.36 – SSII.93) to allow comparison to other systems. The issue of how much effluent volume can be reduced and what productivity and environmental effects can be expected has been raised by several technology providers. This issue has been addressed (using data from the evaluation period) in the principal investigators' report. The results as reported from the actual model confirm that minimizing barn effluent volume is an economically optimal condition for the Super Soils "2nd Generation" technology (especially when considering a mobile, multi-farm separation unit). The approximated cost of retrofitting the 5,145-head farm with the actual modified system was $408,747.31 (including a 14% share of the separator) in initial investment, $94,700.78 in annualized costs excluding land application costs (and excluding costs of after hours monitoring of the separator), and total costs of $132.24 per 1,000 pounds SSLW per year when effluent is applied on a nitrogen basis to forage. The separator is assumed to operate at its rated capacity of 3,600 gallons per hour rather than the 2,400 gallons per hour rate used during the evaluation. Note that the Super Soils "2nd Generation" technology is effective at separating solids, and solids are assumed to be land applied in these models. As is the case for all technologies, overall costs of the system may fall should an outlet develop for separated solids that is less costly than land application. Super Soils was responsible for removing separated solids during the evaluation.

The standardized model produces a cost estimate of $300.21 per 1,000 pounds SSLW per year (including a 39% share of the separator operating at 3,600 gallons per hour) for the 4,320-head feeder to finish farm with pit-recharge and nitrogen-based land application to forage. Economies of scale are evident in that predicted costs range from $195.69 (for the largest pit-recharge feeder-to-finish farm) to $1,658.71 (for the smallest flush wean-to-feeder farm) per 1,000 pounds SSLW per year.

A critical assumption of the modified actual model and the standardized models is that the separator can be moved weekly between farms and operated for up to 140 hours per week at 3,600 gallons per hour. The separator was operated at 2,400 gallons per hour on one farm for an average of 21 hours per week (Vanotti) during the evaluation. The practical feasibility and cost of sharing and moving the separator between farms has yet to be demonstrated and so the costs remain speculative. For example, the cost of monitoring the separator after hours (beyond the 60 hours per week when farm personnel are assumed to be present) could add $625 to $1,250 per week to the costs predicted in this report (for 50 to 100 hours of monitoring at $12.50 per hour).

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Tables SSII.1 through SSII.21: Actual Pig Inventory and Barn Effluent Volume at Tyndall Farm, System Performance and Mass Balance, Modeling Assumptions, Invoiced Construction Costs for Original (Invoiced) and Modified Super Soils "2nd Generation" Technology, and Estimated Electricity Use for Super Soils "2nd Generation" Technology

Table SSII.1. Total Pig Weight and Liquid Volumes of Raw and Treated Manure at Tyndall Farm (Vanotti)

Month	Days	Pig Weight (AU)	Flushed Manure	Pit Recharge	Fresh Manure	To N Module	System Effluent
					gallons / day		
12/06	23	194	9,840	2,510	7,330	10,247	7,737
1/07	31	423	5,667	3,079	2,588	5,825	2,746
2/07	28	685	5,562	1,465	4,097	5,615	4,150
3/07	31	946	8,390	2,205	6,185	8,545	6,340
4/07	30	1,024	10,333	1,519	8,814	10,399	8,881
5/07	31	156	4,091	1,837	2,255	3,975	2,138
6/07	30	414	8,199	1,443	6,755	8,331	6,888
Avg. (all months)	**29.1**	**559**	**7,356**	**2,002**	**5,354**	**7,468**	**5,466**
Avg. (complete cycle: 12/06-4/07)	**28.6**	**677**	**8,034**	**2,302**	**5,732**	**8,044**	**5,890**

Table SSII.2. Nutrient Content of Separated Solids (Vanotti)

	Avg. Concentration (%)*	Total kg in Solids**
Total Nitrogen	5.18	2,709
Total Phosphorus	3.17	1,663
Potassium	0.82	74

* Dry matter basis
** Based on 214,580 kgs of manure at 24.9% moisture content that left Tyndall Farm from 12/9/06 to 6/2/07 (dry matter basis).

Table SSII.3. Mass Removal of Solids and Nutrients during the Solids Separation Process (Vanotti)

	Mass in	Mass out	Mass removal**	% Removed
		(kg)		
Dry Solids*	64,256	7,551	56,705	88.2
Total Nitrogen	10,993	8,213	2,780	25.3
Total Phosphorus	2,637	924	1,713	65.0

* Adjusted to 0% moisture content
** Based on total manure produced at Tyndall Farm from 12/9/06 to 6/30/07.

Table SSII.4. Reduction Concentration of Nutrients, COD, and Solids by the Super Soils "2nd Generation" Technology as Operated at Tyndall Farm (Vanotti)

	TKN	Total P	TSS	VSS	VS	COD
	(mg / L)					
Raw flushed manure	1,910	461	11,230	8,506	17,136	22,708
After solids separation	1,428	184	1,320	937	5,940	8,906
After biological N treatment	101	73	270	174	1,724	1,016
After phosphorus treatment	85	36	325	148	1,732	798
System Efficiency (concentration)	**95.5**	**92.2**	**97.1**	**98.3**	**89.9**	**96.5**

Table SSII.5. Mass Balance Removal of Nutrients, COD, and Solids by the Super Soils "2nd Generation" Technology as Operated at Tyndall Fame (Vanotti)

	TKN	Total P	TSS	VSS	VS	COD
	(kg)					
System influent (raw flushed manure)	10,987	2,637	64,256	48,772	98,552	130,495
Water reuse in barns	148	109	397	260	2,612	1,529
System effluent (after phosphorus treatment	427	153	1,464	709	7,606	3,863
System Efficiency (mass balance)	**96.1**	**94.0**	**97.7**	**98.5**	**92.1**	**97.0**

Table SSII.6. Super Soils "2nd Generation" Estimated Electric Power Requirements

Unit Process / Component	Motorized Component	HP (hp)	Power (kw)	Capacity	Run-time (hrs. / day)*	Daily power requirement (kWh / day)
Lift station	Lift station pump	2.00	1.7	100.0 %	0.31	0.53
Lift station	Lift station pump	2.00	1.7	100.0 %	0.31	0.53
					Lift station subtotal	**1.06**
Homogenization tank	Homogenization tank mixer	4.3	3.66	100.0 %	2.09	7.65
					Homogenization tank subtotal	**7.65**
Solids separator	Polymer mixer	0.34	0.29	100.0 %	0.28	0.08
Solids separator	Polymer mixer	0.34	0.29	100.0 %	0.28	0.08
Solids separator	Polymer heater	0.00	3.50	100.0 %	3.00(during Jan & Feb only)	-
Solids separator	Polymer dosing	0.24	0.20	50.0 %	2.09	0.21
Solids separator	Reacting chamber agitator	0.34	0.29	25.0 %	2.09	0.15
Solids separator	Effluent Pump	1.00	0.85	100.0%	2.09	1.78
Solids separator	Press	10.0	8.5	50.0%	2.09	8.88
Solids separator	Sludge Pump	7.5	6.4	50.0%	2.09	6.69
					Solids separator subtotal	**17.87**
Denitrification tank #1	DN1 mixer	4.30	3.65	100.0 %	23.00	83.95
					Denitrification tank #1 subtotal	**83.95**
Nitrification tank	Re-circulating pump	1.00	0.85	100.0%	23.14	19.67
Nitrification tank	BIOGREEN anti-foam	0.14	0.12	100.0 %	23.22	2.79
Nitrification tank	BIOGREEN blower	10.00	8.50	100.0%	22.77	193.54
					Nitrification tank subtotal	**216.00**
Settling tank	Sludge retention pump	0.33	0.28	100.0 %	22.85	6.40
Settling tank	Sludge return pump	3.00	2.55	100.0 %	0.03	0.08
					Settling tank subtotal	**6.48**
Phosphorus removal	Lime dosing	0.14	0.12	100.0 %	2.00	0.24
Phosphorus removal	Lime Mixer	0.34	0.29	100.0 %	24.0	6.96
					Phosphorus removal subtotal	**7.20**
					Total kWh / day	**340.21**
					Daily operating costs**	**$27.22**
					Annual operating costs	**$9,940.94**

* Daily run-times are based on the average daily treatment volume at Tyndall Farm of 7,356 gallons.
** Operating costs calculations based on a rate of $0.08 / kWh

Table SSII.7. Invoiced Construction Costs of Super Soils "2nd Generation" Manure Evacuation and Lift Station (Creamer, Campbell)

Component	Cost
Lift station tank	$4,590.30
Piping and fittings	$6,252.67
Pipe installation labor	$6,794.73
Pumps and controls	$4,203.96
Pump installation labor	$540.00
Drain pits	$604.07
Drain pit labor and repairs	$1,698.51
Pit foundations	$1,042.18
Drilling equipment rental	$699.98
Crane rental	$747.50
Blades and supplies	$173.66
Fuel	$405.85
Cement and anchors	$343.79
Stone	$1,125.00
Emergency drain (materials and labor)	$3,385.83
Repairs to loading alley	$856.17
Pull plugs	$345.14
Total Cost of Manure Evacuation and Lift Station	**$34,771.05**

Table SSII.8. Invoiced Construction Costs of Super Soils "2nd Generation" Homogenization Tank (Creamer, Campbell)

Component	Cost
Steel tank (100,000 gallons)	$14,674.04
Tank construction	$7,931.10
Tank foundation (labor and materials)	$3,588.65
Mixer	$5,674.02
Mixer panel	$1,500.00
Phase converter for mixer	$1,571.80
Rail system for mixer	$1,635.31
Total Cost of Homogenization Tank	**$36,574.92**

Table SSII.9. Invoiced Construction Costs of Super Soils "2nd Generation" Solids Separator (Creamer, Campbell)

Component	Cost
Mobile solids separator	$415,000.00
Labor to construct mobile unit	$7,200.00
Total Cost of Solids Separator	**$422,200.00**

Table SSII.10. Invoiced Construction Costs of Super Soils "2nd Generation" Separated Effluent Tank (Creamer, Campbell)

Component	Cost
Steel tank (100,000 gallons)	$14,674.04
Tank construction	$7,197.57
Tank foundation (labor and materials)	$3,588.65
Pump and controls	$1,312.18
Piping	$204.48
Safety fence	$29.62
Total Cost of Separated Effluent Tank	**$27,006.54**

Table SSII.11. Invoiced Construction Costs of Super Soils "2nd Generation" Denitrification Tank (Creamer, Campbell)

Component	Cost
Steel tank (73,000 gallons)	$12,920.04
Tank construction	$7,197.57
Tank foundation (labor and materials)	$3,588.65
Mixer	$1,190.86
Mixer rail bracket and hoist base	$184.67
Pipe installation and fittings	$523.34
Feed pump	$728.88
Total Cost of Denitrification Tank	**$26,334.01**

Table SSII.12. Invoiced Construction Costs of Super Soils "2nd Generation" Nitrification Tank (Creamer, Campbell)

Component	Cost
Steel tanks (2- 60,000 gallons)	$24,080.08
Tank construction	$7,197.57
Tank foundation (labor and materials)	$3,603.06
Aeration system/blower package	$11,641.34
Aeration system installation	$2,849.10
Service platform	$269.35
De-foam pump and controls	$472.29
Recycle pump and controls	$824.81
Acclimation system	$189.01
Pipe installation and fittings	$1,562.61
Total Cost of Nitrification Tank	**$52,689.22**

Table SSII.13. Invoiced Construction Costs of Super Soils "2nd Generation" Settling Tank (Creamer, Campbell)

Component	Cost
Steel tank	$5,241.04
Tank construction	$18,898.34
Pump and controls	$1,068.37
Tank piers	$269.64
Pipe installation	$830.13
Total Cost of Settling Tank	**$26,307.52**

Table SSII.14. Invoiced Construction Costs of Super Soils "2nd Generation" Clean Water Tank (Creamer, Campbell)

Component	Cost
Steel tank (73,000 gallons)	$12,920.04
Tank construction	$7,197.57
Tank foundation (labor and materials)	$3,588.65
Pipe installation	$566.70
Total Cost of Clean Water Tank	**$24,272.96**

Table SSII.15. Invoiced Construction Costs of Super Soils "2nd Generation" Phosphorus Removal Tank (Creamer, Campbell)

Component	Cost
Steel tank	$5,241.04
Tank construction	$18,895.61
3-phase sludge pump	$4,082.00
Sludge pump	$1,138.11
Lime injection tank	$1,009.54
Tank piers	$269.64
Mixer	$959.00
Water line	$112.63
Pipe installation, labor, and fittings	$3,896.81
Total Cost of Phosphorus Removal Tank	**$35,604.38**

Table SSII.16. Invoiced Construction Costs of Super Soils "2nd Generation" Return to Barns (Creamer, Campbell)

Component	Cost
Piping and fittings	$504.46
Pipe installation labor and equipment rental	$2,143.44
Total Cost of Return to Barns	**$2,647.90**

Table SSII.17. Invoiced Miscellaneous/Overhead Costs of Super Soils "2nd Generation" Technology (Creamer, Campbell)

Component	Cost
Engineering design	$600.00
Engineering drawings/seal	$1,000.00
Engineering construction review	$44,950.00
Project personnel	$4,285.00
Electrical system (materials and labor)	$5,654.27
Site preparation	$4,720.00
Polymer evaluation and supplies	$317.48
Equipment fuel	$444.70
Total Miscellaneous/Overhead Costs	**$61,971.45**

Table SSII.18. Summary of Invoiced Construction Costs for the Super Soils "2nd Generation" Technology (Creamer, Campbell)

Unit Process	Cost	% of Total Cost
Manure evacuation and lift station	$34,771.05	4.64%
Homogenization tank	$36,574.92	4.87%
Solids separator	$422,200.00	56.27%
Separated effluent tank	$27,006.54	3.60%
Denitrification tank	$26,334.01	3.51%
Nitrification tank	$52,689.22	7.02%
Settling tank	$26,307.52	3.51%
Clean water tank	$24,272.96	3.23%
Phosphorus removal tank	$35,604.38	4.74%
Return to barns	$2,647.90	0.35%
Miscellaneous/overhead costs	$61,971.45	8.26%
Total Invoiced Cost of Super Soils "2nd Generation Technology	**$750,379.95**	**100.00%**

Table SSII.19. Summary of Modified Costs for the Super Soils "2nd Generation" Technology

Unit Process	System Component	Invoiced Cost	Modified Cost	Reason for Modification
Nitrification tank	Steel tanks	$24,080.08	$12,040.04	Invoiced cost includes an extra (unused) tank
Settling tank	Steel tank	$5,241.04	$0.00	Invoiced cost includes an extra (unused) tank
Phosphorus removal tank	Steel tank	$5,241.04	$1,721.00	Invoiced cost includes an oversized tank
Phosphorus removal tank	3-phase sludge pump	$4,082.00	$0.00	Unnecessary equipment cost
Miscellaneous/ overhead costs	Polymer evaluation and supplies	$317.48	$0.00	Research-related cost

Table SSII.20. Summary of Modified Invoiced Construction Costs for the Super Soils "2nd Generation" Technology (Creamer, Campbell)

Unit Process	Cost	% of Total Cost
Manure evacuation and lift station	$34,771.05	4.79%
Homogenization tank	$36,574.92	5.04%
Solids separator	$422,200.00	58.22%
Separated effluent tank	$27,006.54	3.72%
Denitrification tank	$26,334.01	3.63%
Nitrification tank	$40,649.18	5.61%
Settling tank	$21,066.48	2.91%
Clean water tank	$24,272.96	3.35%
Phosphorus removal tank	$28,002.34	3.86%
Return to barns	$2,647.90	0.37%
Miscellaneous/overhead costs	$61,653.97	8.50%
Total Invoiced Cost of Super Soils "2nd Generation Technology	**$725,179.35**	**100.00%**

Table SSII.21. Modeling Assumptions Used in Standardized Costs and Returns Models for the Super Soils "2nd Generation" System

Size of homogenization tank	Based on number of farms treated per week by the traveling separator and including a 2-day excess capacity (if separator travels to 2 farms per week, the homogenization tank will be sized to hold 6 days of barn effluent; if separator travels to 3 farms per week, the homogenization tank will be sized to hold 7 days of barn effluent
Size of separated effluent tank	Same as homogenization tank
Size of nitrification tank	24-hour HRT (daily barn effluent less separated solids)
Size of denitrification tank	24-hour HRT (daily barn effluent less separated solids)
Size of settling tank	24-hour HRT (daily barn effluent less separated solids)
Size of clean water tank	24-hour HRT (daily barn effluent less separated and settled solids)
Size of phosphorus removal tank	24-hour HRT (daily barn effluent less separated and settled solids and pit-recharge liquid)
Separator processing rate	3,600 gallons/ hour (Campbell)
Polymer usage rate	1.069 lbs. / 1,000 gallons of separated wastewater (Vanotti)
Polymer cost	$1.80 / lb. (Campbell)
Separation efficiency	88.25 % of dry solids (mass balance basis) (Vanotti)
Moisture content of separated solids	24.9 % (Vanotti)
Weekly separator usage	140 hours / week (or a maximum of 1 farm / day)
Inter-farm transportation cost	$15 / move
Nitrification tank blower HP	10.14 HP / 60,000 gallons of tank size
Denitrification tank mixer HP	4.3 HP / 73,000 gallons of tank size
Lime slurry usage rate	9.8 lbs. / 1,000 gallons of treated wastewater (Vanotti)
Lime slurry cost	$0.0925 / lb. (Vanotti)

Tables SSII.22. through SSII.35.: Costs and Returns Estimates Based on Actual Cost and Performance Data for Super Soils "2nd Generation" On-Farm System: 4,067-Head Feeder-to-Finish Operation with Pit-Recharge

Table SSII.22. Super Soils Technology Assumptions and Total Annualized Costs—Actual Costs and Performance Data

Number of Animals	**5,145**				
Type of Operation	**Feeder-Finish**				
Barn Cleaning System	**Pit-Recharge System**				
Annualized Cost ($ / Year)					
Total Annualized Cost			Forages		Row Crops
	If Nitrogen-Based Application	**$**	**91,853.71**	**$**	**92,767.09**
	If Phosphorus-Based Application	**$**	**117,664.95**	**$**	**79,681.54**
Per Unit Cost ($ / 1,000 lbs. of SSLW)					
Total Annualized Cost per Unit			Forages		Row Crops
	If Nitrogen-Based Application	**$**	**132.24**	**$**	**133.56**
	If Phosphorus-Based Application	**$**	**169.41**	**$**	**114.72**

Note: Daily volume discharged from barns is 8,034 gallons / day including recharge liquid.
SSLW equals 694,575 pounds.

Table SSII.23. Super Soils ‘2nd Generation” Technology Manure Evacuation and Lift Station Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Pipes/Fittings	$ 10,524.98	$ 1,568.53
Emergency Drain	$ 3,385.83	$ 504.59
Labor (Pipes/Fittings/Pits)	$ 6,794.73	$ 1,012.62
Evacuation Tank	$ 4,590.30	$ 684.09
Drain Pits	$ 3,344.76	$ 498.47
Lift Pumps	$ 4,203.96	$ 1,514.89
Stone Base	$ 1,495.38	$ 222.86
Electric Panel	$ 1,065.38	$ 158.77
Pump Installation Labor	$ 540.00	$ 80.48
Repairs to Loading Alley	$ 856.17	$ 127.59
Pull Plugs	$ 345.14	$ 51.44
Equipment Rental/Fuel	$ 1,853.33	$ 276.20
Cement and Anchors	$ 343.79	$ 51.23
Blades and Supplies	$ 173.66	$ 25.88
Contractor & Engineering Services & Overhead	$ 17,032.00	$ 2,538.27
Total Construction Cost	$ 56,549.41	$ 9,315.91
Electric Power Cost		$ 33.82
Maintenance Cost		$ 895.54
Property Taxes		$ 200.75
Total Operating Costs		$ 1,130.11
TOTAL ANNUALIZED COST OF MANURE EVACUATION AND LIFT STATION		**$ 10,446.02**

Table SSII.24. Super Soils “2nd Generation” Technology Homogenization Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank (100,000 gallons)	$ 14,674.04	$ 2,186.86
Tank Construction	$ 7,931.10	$ 1,181.97
Tank Foundation	$ 3,588.65	$ 534.81
Mixer	$ 5,674.02	$ 2,201.71
Mixer Panel	$ 1,500.00	$ 223.54
Phase Converter	$ 1,571.80	$ 234.24
Rail System	$ 1,635.31	$ 243.71
Contractor & Engineering Services & Overhead	$ 9,439.28	$ 1,406.73
Total Construction Cost	$ 46,014.20	$ 8,213.59
Electric Power Cost		$ 223.53
Maintenance Cost		$ 993.87
Property Taxes		$ 163.35
Total Operating Cost		$ 1,380.76
TOTAL ANNUALIZED COST OF HOMOGENIZATION TANK		**$ 9,594.34**

Table SSII.25. Super Soils "2nd Generation" Technology Mobile Solids Separator Costs—Actual Costs and Performance Data

36,015 HEAD TREATED PER WEEK		
Component	**Total Cost**	**Annualized Cost**
Mobile Separator Unit (.14 share of total unit cost)	$ 59,285.71	$ 8,835.32
Labor to Construct Mobile Unit (.14 share of total unit cost)	$ 1,028.57	$ 153.29
Contractor & Engineering Services & Overhead	$ 25,995,46	$ 3,874.09
Total Construction Cost	$ 86,309.74	$ 12,862.70
Polymer Cost		$ 5,645.35
Electric Power Cost		$ 570.20
Inter-Farm Transportation Cost		$ 780.00
Maintenance Cost (.14 share of total unit cost)		$ 1,206.29
Property Taxes (.14 share of total unit cost)		$ 306.40
Total Operating Cost		$ 8,508.24
TOTAL ANNUALIZED COST OF MOBILE SOLIDS SEPARATOR		**$ 21,370.93**

Table SSII.26. Super Soils "2nd Generation" Technology Separated Effluent Tank Costs—Actual Costs and Performance Data

Component	**Total Cost**	**Annualized Cost**
Tank (100,000 gallons)	$ 14,674.04	$ 2,186.86
Tank Construction	$ 7,197.57	$ 1,072.65
Tank Foundation	$ 3,588.65	$ 534.81
Pump and Controls	$ 1,312.18	$ 509.17
Piping	$ 204.48	$ 30.47
Safety Fence	$ 29.62	$ 4.41
Contractor & Engineering Services & Overhead	$ 5,315.31	$ 792.14
Total Construction Cost	$ 32,321.85	$ 5,130.52
Electric Power Cost		$ 80.32
Maintenance Cost		$ 579.50
Property Taxes		$ 114.74
Total Operating Cost		$ 774.56
TOTAL ANNUALIZED COST OF SEPARATED EFFLUENT TANK		**$ 5,905.09**

Table SSII.27. Super Soils "2nd Generation" Technology Denitrification Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank (73,000 gallons)	$ 12,920.04	$ 1,925.47
Tank Construction	$ 7,197.57	$ 1,072.65
Tank Foundation	$ 3,588.65	$ 534.81
Mixer	$ 1,190.86	$ 462.09
Mixer Rail Bracket and Hoist Base	$ 184.67	$ 27.52
Pipe Installation and Fittings	$ 523.34	$ 77.99
Feed Pump	$ 728.88	$ 282.83
Contractor & Engineering Services & Overhead	$ 5,781.42	$ 861.60
Total Construction Cost	$ 32,115.43	$ 5,244.97
Electric Power Cost		$ 2,453.02
Maintenance Cost		$ 584.27
Property Taxes		$ 114.01
Total Operating Cost		$ 3,151.30
TOTAL ANNUALIZED COST OF DENITRIFICATION TANK		**$ 8,396.27**

Table SSII.28. Super Soils "2nd Generation" Nitrification Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank (60,000 gallons)	$ 12,040.04	$ 1,794.32
Tank Construction	$ 7,197.57	$ 1,072.65
Tank Foundation	$ 3,603.06	$ 536.96
Blower Package and Installation	$ 14,490.44	$ 4,941.83
Service Platform	$ 269.35	$ 40.14
Recirculating Pump and Controls	$ 824.81	$ 320.05
De-foam Pump and Controls	$ 472.29	$ 183.26
Acclimation System	$ 189.01	$ 28.17
Pipe Installation and Fittings	$ 1,562.61	$ 232.87
Contractor & Engineering Services & Overhead	$ 12,330.54	$ 1,837.61
Total Construction Cost	$ 52,979.72	$ 10,987.88
Electric Power Cost		$ 6,311.52
Maintenance Cost		$ 1,169.88
Property Taxes		$ 188.08
Total Operating Cost		$ 7,669.48
TOTAL ANNUALIZED COST OF NITRIFICATION TANK		**$ 18,657.36**

Table SSII.29. Super Soils "2nd Generation" Technology Settling Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank Construction (9,653 gallons)	$ 18,898.34	$ 2,816.34
Sludge Pump and Controls	$ 1,068.37	$ 414.56
Tank Piers	$ 269.64	$ 40.18
Pipe Installation	$ 830.13	$ 123.71
Contractor & Engineering Services & Overhead	$ 9,079.65	$ 1,353.14
Total Construction Cost	$ 30,146.13	$ 4,748.01
Electric Power Cost		$ 189.35
Maintenance Cost		$ 431.39
Property Taxes		$ 107.02
Total Operating Cost		$ 727.75
TOTAL ANNUALIZED COST OF SETTLING TANK		**$ 5,475.76**

Table SSII.30. Super Soils "2nd Generation" Technology Clean Water Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank (73,000 gallons)	$ 12,920.04	$ 1,925.47
Tank Construction	$ 7,197.57	$ 1,072.65
Tank Foundation	$ 3,588.65	$ 534.81
Pipe Installation	$ 566.70	$ 84.46
Contractor & Engineering Services & Overhead	$ 4,893.11	$ 729.22
Total Construction Cost	$ 29,166.07	$ 4,346.60
Maintenance Cost		$ 474.13
Property Taxes		$ 103.54
Total Operating Cost		$ 577.66
TOTAL ANNUALIZED COST OF CLEAN WATER TANK		**$ 4,924.27**

Table SSII.31. Super Soils "2nd Generation" Technology Phosphorus Removal Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Steel Tank (5,242 gallons)	$ 1,747.01	$ 260.36
Tank Construction	$ 18,895.61	$ 2,816.00
Sludge Pump	$ 1,138.11	$ 441.62
Lime Injection Tank	$ 1,009.54	$ 150.45
Lime Mixer	$ 959.00	$ 372.12
Tank Piers	$ 269.64	$ 40.18
Water Line	$ 112.63	$ 16.79
Pipe Installation and Fittings	$ 3,896.81	$ 580.74
Contractor & Engineering Services & Overhead	$ 11,327.26	$ 1,688.10
Total Construction Cost	$ 39,355.61	$ 6,366.36
Electric Power Cost		$ 229.74
Lime Slurry Cost		$ 1,932.44
Maintenance Cost		$ 623.48
Property Taxes		$ 139.71
Total Operating Cost		$ 2,925.37
TOTAL ANNUALIZED COST OF PHOSPHORUS REMOVAL TANK		**$ 9,291.74**

Table SSII.32. Super Soils "2nd Generation" Technology Return to Barns Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Piping and Fittings	$ 504.46	$ 75.18
Pipe Installation Labor and Equipment Rental	$ 2,143.44	$ 319.44
Contractor & Engineering Services & Overhead	$ 1,141.24	$ 170.08
Total Construction Cost	$ 3,789.14	$ 564.69
Electric Power Cost		$ 7.89
Maintenance Cost		$ 52.96
Property Tax		$ 13.45
Total Operating Cost		$ 74.30
TOTAL ANNUALIZED COST OF RETURN TO BARNS		**$ 638.99**

TOTAL CONSTRUCTION COST OF SUPER SOILS "2nd GENERATION" TECHNOLOGY	**$ 408,747.31**
TOTAL OPERATING COST OF SUPER SOILS "2nd GENERATION" TECHNOLOGY	**$ 26,919.54**
TOTAL ANNUALIZED COSTS OF SUPER SOILS "2nd GENERATION" TECHNOLOGY WITHOUT LAND APPLICATION	**$ 94,700.78**

Table SSII.33. Super Soils "2nd Generation" Technology Predicted Liquid Application Costs for Four Land Application Scenarios—Actual Costs and Performance Data

Annual Cost of Applying Lagoon Effluent	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 5,795.73	$ 7,486.37
If Phosphorus-Based Application	$ 5,128.29	$ 5,209.50
Acres Needed For Assimilation	**Forages**	**Row Crops**
If Nitrogen-Based Application	5.61	8.29
If Phosphorus-Based Application	12.71	34.74
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 336.78	-
If Phosphorus-Based Application	$ 762.53	-
Irrigation Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 5,458.95	$ 7,668.52
If Phosphorus-Based Application	$ 3,511.20	$ 5,794.41
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (182.16)
If Phosphorus-Based Application	-	$ (584.92)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	-
If Phosphorus-Based Application	$ 854.56	-

Note: 3,053,437 gallons / year of effluent would be land applied at Tyndall Farm.

Table SSII.34. Super Soils "2nd Generation" Technology Predicted Solids Application Costs for Four Land Application Scenarios—Actual Costs and Performance Data

Annual Cost of Applying Solids	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 10,095.62	$ 6,600.50
If Phosphorus-Based Application	$ 40,987.31	$ (2,801.44)
Acres Needed For Application	**Forages**	**Row Crops**
If Nitrogen-Based Application	24.41	79.13
If Phosphorus-Based Application	160.29	428.24
Opportunity Cost of Land	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 1,464.83	-
If Phosphorus-Based Application	$ 9,617.61	-
Application Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 7,264.52	$ 8,119.72
If Phosphorus-Based Application	$ 9,356.07	$ 13,250.24
Savings From Not Having To Buy Fertilizer	**Forages**	**Row Crops**
If Nitrogen-Based Application	-	$ (1,519.22)
If Phosphorus-Based Application	-	$ (16,051.68)
Extra Fertilizer Purchase Costs	**Forages**	**Row Crops**
If Nitrogen-Based Application	$ 1,366.26	-
If Phosphorus-Based Application	$ 22,013.63	-

Note: 1,149,032 lbs. / year of solids would be land applied at Tyndall Farm.

Table SSII.35. Summary and Mass Balance of Generated and Land Applied Nutrients—Actual Costs and Performance Data

Nutrient Balance	Nitrogen (lbs/ year)	Phosphorus (lbs / year)	Potassium (lbs / year)
Generated At Barn	46,799.57	11,295.60	19,377.61
Nutrient Reduction Due to Solids Separation	11,812.21	6,787.53	1,440.84
Entering Nitrification/Denitrification System	34,987.36	4,508.08	17,936.77
Removed in Nitrification/Denitrification System	32,513.75	2,719.72	3,784.66
Remaining after Nitfirication/Denitrification	2,473.61	1,788.35	14,152.11
Entering Phosphorus Removal Module	1,764.84	1,275.93	10,097.08
Removed by Phosphorus Removal Module	279.55	646.64	1,009.71
Remaining in Recycled Effluent	708.77	512.42	4,055.04
Entering Lagoon after Phosphorus Removal	1,485.29	629.29	9,087.37

Tables SSII.36. through SSII.49.: Costs and Returns Estimates Based on Standardized Cost and Performance Data for Super Soils "2nd Generation" On-Farm System: 4,320-Head Feeder-to-Finish Operation with Pit-Recharge

Table SSII.36. Super Soils "2nd Generation" Technology Assumptions and Predicted Total Annualized Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Number of Animals	**4,320**				
Type of Operation	**Feeder-Finish**				
Barn Cleaning System	**Pit-Recharge System**				
Annualized Cost ($ / Year)					
Total Annualized Cost			Forages		Row Crops
	If Nitrogen-Based Application	**$**	**175,081.00**	**$**	**173,889.04**
	If Phosphorus-Based Application	**$**	**240,979.33**	**$**	**170,177.58**
Per Unit Cost ($ / 1,000 lbs. of SSLW)					
Total Annualized Cost per Unit			Forages		Row Crops
	If Nitrogen-Based Application	**$**	**300.21**	**$**	**298.16**
	If Phosphorus-Based Application	**$**	**413.20**	**$**	**291.80**

Note: Daily volume discharged from barns is 28,361 gallons / day including recharge liquid.
SSLW equals 583,200 pounds.

Table SSII.37. Super Soils ‘2nd Generation” Technology Manure Evacuation and Lift Station Costs—Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost	Annualized Cost
Manure Evacuation Modifications	$ 4,555.00	$ 678.83
Concrete Lift Station	$ 604.90	$ 90.15
Pump	$ 1,734.20	$ 672.93
Switches and Brackets	$ 126.50	$ 18.85
Piping	$ 145.67	$ 21.71
Lift Station Accessories	$ 7,715.73	$ 1,149.87
Contractor & Engineering Services & Overhead	$ 6,414.14	$ 955.90
Total Construction Cost	$ 21,296.14	$ 3,588.23
Electric Power Cost		$ 236.18
Maintenance Cost		$ 349.67
Property Taxes		$ 75.60
Total Operating Costs		$ 661.45
TOTAL ANNUALIZED COST OF MANURE EVACUATION AND LIFT STATION		**$ 4,249.68**

Table SSII.38. Super Soils “2nd Generation” Technology Homogenization Tank Costs— Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank	$ 44,649.30	$ 6,654.06
Tank Construction	$ 26,993.28	$ 4,022.79
Tank Foundation	$ 12,213.87	$ 1,820.23
Mixer	$ 5,674.02	$ 2,201.71
Mixer Panel	$ 1,500.00	$ 223.54
Phase Converter	$ 1,571.80	$ 234.24
Rail System	$ 1,635.31	$ 243.71
Contractor & Engineering Services & Overhead	$ 21,372.55	$ 3,185.14
Total Construction Cost	$ 115,610.13	$ 18,585.43
Electric Power Cost		$ 843.42
Maintenance Cost		$ 2,147.13
Property Taxes		$ 410.42
Total Operating Cost		$ 3,400.96
TOTAL ANNUALIZED COST OF HOMOGENIZATION TANK		**$ 21,986.40**

Table SSII.39. Super Soils "2nd Generation" Technology Mobile Solids Separator Costs— Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

10,968 HEAD TREATED PER WEEK		
Component	**Total Cost**	**Annualized Cost**
Mobile Separator Unit (.39 share of total unit cost)	$ 163,469.75	$ 24,361.81
Labor to Construct Mobile Unit (.39 share of total unit cost)	$ 2,836.10	$ 422.66
Contractor & Engineering Services & Overhead	$ 71,677.82	$ 10,682.11
Total Construction Cost	$ 237,983.67	$ 35,466.58
Polymer Cost		$ 19,928.79
Electric Power Cost		$ 1,963.61
Inter-Farm Transportation Cost		$ 780.00
Maintenance Cost (.39 share of total unit cost)		$ 3,326.12
Property Taxes (.39 share of total unit cost)		$ 844.84
Total Operating Cost		$ 26,843.36
TOTAL ANNUALIZED COST OF MOBILE SOLIDS SEPARATOR		**$ 62,309.94**

Table SSII.40. Super Soils "2nd Generation" Technology Separated Effluent Tank Costs— Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Component	**Total Cost**	**Annualized Cost**
Tank	$ 44,649.30	$ 6,654.06
Tank Construction	$ 24,496.73	$ 3,650.74
Tank Foundation	$ 12,213.87	$ 1,820.23
Pump and Controls	$ 1,312.18	$ 509.17
Piping	$ 204.48	$ 30.47
Safety Fence	$ 29.62	$ 4.41
Contractor & Engineering Services & Overhead	$ 16,488.72	$ 2,457.30
Total Construction Cost	$ 99,394.90	$ 15,126.39
Electric Power Cost		$ 196.82
Maintenance Cost		$ 1,697.49
Property Taxes		$ 352.85
Total Operating Cost		$ 2,247.16
TOTAL ANNUALIZED COST OF SEPARATED EFFLUENT TANK		**$ 17,373.55**

Table SSII.41. Super Soils "2nd Generation" Technology Denitrification Tank Costs— Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank	$ 16,406.25	$ 2,445.02
Tank Construction	$ 12,430.01	$ 1,852.44
Tank Foundation	$ 6,197.50	$ 923.61
Mixer	$ 529.13	$ 205.32
Mixer Rail Bracket and Hoist Base	$ 184.67	$ 27.52
Pipe Installation and Fittings	$ 523.34	$ 77.99
Feed Pump	$ 728.88	$ 282.83
Contractor & Engineering Services & Overhead	$ 8,875.81	$ 1,322.76
Total Construction Cost	$ 45,875.60	$ 7,137.49
Electric Power Cost		$ 1,097.84
Maintenance Cost		$ 777.74
Property Taxes		$ 162.86
Total Operating Cost		$ 2,038.44
TOTAL ANNUALIZED COST OF DENITRIFICATION TANK		**$ 9,175.92**

Table SSII.42. Super Soils "2nd Generation" Nitrification Tank Costs— Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank	$ 16,406.25	$ 2,445.02
Tank Construction	$ 12,430.01	$ 1,852.44
Tank Foundation	$ 6,222.39	$ 927.32
Blower Package and Installation	$ 8,021.61	$ 2,431.71
Service Platform	$ 269.35	$ 40.14
De-Foam Pump and Controls	$ 824.81	$ 320.05
Recirculating Pump and Controls	$ 472.29	$ 183.26
Acclimation System	$ 189.01	$ 28.17
Pipe Installation and Fittings	$ 1,562.61	$ 232.87
Contractor & Engineering Services & Overhead	$ 12,926.59	$ 1,926.44
Total Construction Cost	$ 59,324.92	$ 10,387.43
Electric Power Cost		$ 3,141.09
Maintenance Cost		$ 1,090.80
Property Taxes		$ 210.60
Total Operating Cost		$ 4,442.50
TOTAL ANNUALIZED COST OF NITRIFICATION TANK		**$ 14,829.92**

Table SSII.43. Super Soils "2nd Generation" Technology Settling Tank Costs—Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost		Annualized Cost	
Tank Construction	$	52,192.85	$	7,778.27
Sludge Pump and Controls	$	1,068.37	$	414.56
Tank Piers	$	269.64	$	40.18
Pipe Installation	$	830.13	$	123.71
Contractor & Engineering Services & Overhead	$	23,429.59	$	3,491.70
Total Construction Cost	$	77,790.57	$	11,848.43
Electric Power Cost			$	196.35
Maintenance Cost			$	1,097.28
Property Taxes			$	276.16
Total Operating Cost			$	1,569.78
TOTAL ANNUALIZED COST OF SETTLING TANK			**$**	**13,418.21**

Table SSII.44. Super Soils "2nd Generation" Technology Clean Water Tank Costs—Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost		Annualized Cost	
Tank	$	16,406.25	$	2,445.02
Tank Construction	$	12,430.01	$	1,852.44
Tank Foundation	$	6,197.50	$	923.61
Pipe Installation	$	566.70	$	84.46
Contractor & Engineering Services & Overhead	$	8,272.71	$	1,232.88
Total Construction Cost	$	43,873.18	$	6,538.40
Maintenance Cost			$	700.68
Property Taxes			$	155.75
Total Operating Cost			$	856.43
TOTAL ANNUALIZED COST OF CLEAN WATER TANK			**$**	**7,394.82**

Table SSII.45. Super Soils "2nd Generation" Technology Phosphorus Removal Tank Costs— Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost		Annualized Cost	
Tank Construction	$	35,815.87	$	5,337.62
Sludge Pump	$	1,138.11	$	441.62
Lime Injection Tank	$	1,009.54	$	150.45
Lime Mixer	$	959.00	$	372.12
Tank Piers	$	269.64	$	40.18
Water Line	$	112.63	$	16.79
Pipe Installation and Fittings	$	3,896.81	$	580.74
Contractor & Engineering Services & Overhead	$	11,327.26	$	1,688.10
Total Construction Cost	$	61,821.49	$	9,714.44
Electric Power Cost			$	216.58
Lime Slurry Cost			$	3,289.80
Maintenance Cost			$	926.95
Property Taxes			$	219.47
Total Operating Cost			$	4,652.79
TOTAL ANNUALIZED COST OF PHOSPHORUS REMOVAL TANK			**$**	**14,367.23**

Table SSII.46. Super Soils "2nd Generation" Technology Return to Barns Costs— Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost		Annualized Cost	
Plumbing/Piping	$	1,300.00	$	193.74
Pump	$	600.00	$	216.21
Contractor & Engineering Services & Overhead	$	818.90	$	122.04
Total Construction Cost	$	2,718.90	$	531.99
Electric Power Cost			$	153.44
Maintenance Cost			$	56.00
Property Tax			$	9.65
Total Operating Cost			$	219.09
TOTAL ANNUALIZED COST OF RETURN TO BARNS			**$**	**751.08**

TOTAL CONSTRUCTION COST OF SUPER SOILS "2nd GENERATION" TECHNOLOGY	**$**	**765,689.49**
TOTAL OPERATING COST OF SUPER SOILS "2nd GENERATION" TECHNOLOGY	**$**	**46,931.95**
TOTAL ANNUALIZED COSTS OF SUPER SOILS "2nd GENERATION" TECHNOLOGY WITHOUT LAND APPLICATION	**$**	**165,856.76**

Table SSII.47. Super Soils "2nd Generation" Technology Predicted Liquid Application Costs for Four Land Application Scenarios— Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Annual Cost of Applying Lagoon Effluent		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,141.09	$	8,830.19
If Phosphorus-Based Application	$	5,906.99	$	5,868.82
Acres Needed For Assimilation		**Forages**		**Row Crops**
If Nitrogen-Based Application		7.07		7.61
If Phosphorus-Based Application		13.84		37.84
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	424.40		-
If Phosphorus-Based Application	$	830.57		-
Irrigation Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,716.70	$	8,997.30
If Phosphorus-Based Application	$	4,108.61	$	6,486.84
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(167.11)
If Phosphorus-Based Application		-	$	(618.02)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application		-		-
If Phosphorus-Based Application	$	967.81		-

Note: 3,847,855 gallons / year of effluent modeled to be land applied.

Table SSII.48. Super Soils "2nd Generation" Technology Predicted Solids Application Costs for Four Land Application Scenarios— Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	19,901.39	$	13,447.68
If Phosphorus-Based Application	$	89,575.73	$	13,842.04
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		45.61		147.83
If Phosphorus-Based Application		355.56		949.94
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	2,736.77		-
If Phosphorus-Based Application	$	21,333.86		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	15,397.50	$	16,695.53
If Phosphorus-Based Application	$	19,376.63	$	27,319.83
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(3,247.85)
If Phosphorus-Based Application		-	$	(13,477.79)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	1,767.11		-
If Phosphorus-Based Application	$	48,865.24		-

Note: 5,015,687 lbs. / year of solids modeled to be land applied.

Table SSII.49. Summary and Mass Balance of Generated and Land Applied Nutrients— Standardized 4,320-Head Feeder-to-Finish with Pit-Recharge System

Nutrient Balance	Nitrogen (lbs/ year)	Phosphorus (lbs / year)	Potassium (lbs / year)
Generated At Barn	87,436.80	25,056.00	42,984.00
Nutrient Reduction Due to Solids Separation	22,069.05	15,056.15	6,619.54
Entering Nitrification/Denitrification System	65,367.75	9,999.85	36,364.46
Removed in Nitrification/Denitrification System	60,746.25	6,032.91	7,672.90
Remaining after Nitfirication/Denitrification	4,621.50	3,966.94	28,691.56
Entering Phosphorus Removal Module	1,619.10	1,389.78	10,051.80
Removed by Phosphorus Removal Module	256.46	704.34	1,005.18
Remaining in Recycled Effluent	3,002.40	2,577.16	18,639.76
Entering Lagoon after Phosphorus Removal	1,362.63	685.44	9,046.62

Tables SSII.50. through SSII.63.: Costs and Returns Estimates Based on Standardized Cost and Performance Data for Super Soils "2nd Generation" On-Farm System: 4,320-Head Feeder-to-Finish Operation with Flush System

Table SSII.50. Super Soils "2nd Generation" Technology Assumptions and Total Annualized Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Number of Animals	**4,320**				
Type of Operation	**Feeder-Finish**				
Barn Cleaning System	**Flush System**				
Annualized Cost ($ / Year)					
Total Annualized Cost			Forages		Row Crops
	If Nitrogen-Based Application	**$**	**199,895.36**	**$**	**199,036.71**
	If Phosphorus-Based Application	**$**	**265,673.60**	**$**	**194,255.73**
Per Unit Cost ($ / 1,000 lbs. of SSLW)					
Total Annualized Cost per Unit			Forages		Row Crops
	If Nitrogen-Based Application	**$**	**342.76**	**$**	**341.28**
	If Phosphorus-Based Application	**$**	**455.55**	**$**	**333.09**

Note: Daily volume discharged from barns is 33,505 gallons / day including recharge liquid.
SSLW equals 583,200 pounds.

Table SSII.51. Super Soils '2nd Generation" Technology Manure Evacuation and Lift Station Costs—Standardized 4,320-Head Feeder-to-Finish with Flush System

Component	Total Cost	Annualized Cost
Manure Evacuation Modifications	$ 9,100.00	$ 1,357.66
Concrete Lift Station	$ 604.90	$ 90.15
Pump	$ 1,734.20	$ 672.93
Switches and Brackets	$ 126.50	$ 18.85
Piping	$ 145.67	$ 21.71
Lift Station Accessories	$ 7,715.73	$ 1,149.87
Contractor & Engineering Services & Overhead	$ 8,377.35	$ 1,248.47
Total Construction Cost	$ 27,814.35	$ 4,559.64
Electric Power Cost		$ 279.02
Maintenance Cost		$ 440.77
Property Taxes		$ 98.74
Total Operating Costs		$ 818.53
TOTAL ANNUALIZED COST OF MANURE EVACUATION AND LIFT STATION		**$ 5,378.16**

Table SSII.52. Super Soils "2nd Generation" Technology Homogenization Tank Costs— Standardized 4,320-Head Feeder-to-Finish with Flush System

Component	Total Cost	Annualized Cost
Tank	$ 51,842.13	$ 7,726.01
Tank Construction	$ 31,341.79	$ 4,670.85
Tank Foundation	$ 14,181.48	$ 2,113.46
Mixer	$ 5,674.02	$ 2,201.71
Mixer Panel	$ 1,500.00	$ 223.54
Phase Converter	$ 1,571.80	$ 234.24
Rail System	$ 1,635.31	$ 243.71
Contractor & Engineering Services & Overhead	$ 24,094.80	$ 3,590.84
Total Construction Cost	$ 131,841.32	$ 21,004.36
Electric Power Cost		$ 996.39
Maintenance Cost		$ 2,417.31
Property Taxes		$ 468.04
Total Operating Cost		$ 3,881.74
TOTAL ANNUALIZED COST OF HOMOGENIZATION TANK		**$ 24,886.09**

Table SSII.53. Super Soils "2nd Generation" Technology Mobile Solids Separator Costs— Standardized 4,320-Head Feeder-to-Finish with Flush System

9,284 HEAD TREATED PER WEEK		
Component	**Total Cost**	**Annualized Cost**
Mobile Separator Unit (.47 share of total unit cost)	$ 193,118.18	$ 28,780.30
Labor to Construct Mobile Unit (.47 share of total unit cost)	$ 3,350.48	$ 499.32
Contractor & Engineering Services & Overhead	$ 84,677.99	$ 12,619.52
Total Construction Cost	$ 281,146.65	$ 41,899.14
Polymer Cost		$ 23,543.27
Electric Power Cost		$ 2,319.74
Inter-Farm Transportation Cost		$ 780.00
Maintenance Cost (.47 share of total unit cost)		$ 3,929.37
Property Taxes (.47 share of total unit cost)		$ 998.07
Total Operating Cost		$ 31,570.45
TOTAL ANNUALIZED COST OF MOBILE SOLIDS SEPARATOR		**$ 73,469.60**

Table SSII.54. Super Soils "2nd Generation" Technology Separated Effluent Tank Costs— Standardized 4,320-Head Feeder-to-Finish with Flush System

Component	**Total Cost**	**Annualized Cost**
Tank	$ 47,776.40	$ 7,120.09
Tank Construction	$ 26,212.40	$ 3,906.42
Tank Foundation	$ 13,069.29	$ 1,947.71
Pump and Controls	$ 1,312.18	$ 509.17
Piping	$ 204.48	$ 30.47
Safety Fence	$ 29.62	$ 4.41
Contractor & Engineering Services & Overhead	$ 17,596.86	$ 2,622.45
Total Construction Cost	$ 106,201.23	$ 16,140.73
Electric Power Cost		$ 232.52
Maintenance Cost		$ 1,811.45
Property Taxes		$ 377.01
Total Operating Cost		$ 2,420.98
TOTAL ANNUALIZED COST OF SEPARATED EFFLUENT TANK		**$ 18,561.71**

Table SSII.55. Super Soils "2nd Generation" Technology Denitrification Tank Costs— Standardized 4,320-Head Feeder-to-Finish with Flush System

Component	Total Cost	Annualized Cost
Tank	$ 20,125.00	$ 2,999.22
Tank Construction	$ 15,247.48	$ 2,272.32
Tank Foundation	$ 7,602.27	$ 1,132.96
Mixer	$ 625.09	$ 242.56
Mixer Rail Bracket and Hoist Base	$ 184.67	$ 27.52
Pipe Installation and Fittings	$ 523.34	$ 77.99
Feed Pump	$ 728.88	$ 282.83
Contractor & Engineering Services & Overhead	$ 10,736.96	$ 1,600.12
Total Construction Cost	$ 55,773.90	$ 8,635.53
Electric Power Cost		$ 1,296.96
Maintenance Cost		$ 941.35
Property Taxes		$ 198.00
Total Operating Cost		$ 2,436.31
TOTAL ANNUALIZED COST OF DENITRIFICATION TANK		**$ 11,071.84**

Table SSII.56. Super Soils "2nd Generation" Nitrification Tank Costs— Standardized 4,320-Head Feeder-to-Finish with Flush System

Component	Total Cost	Annualized Cost
Tank	$ 20,125.00	$ 2,999.22
Tank Construction	$ 15,247.48	$ 2,272.32
Tank Foundation	$ 7,632.80	$ 1,137.51
Blower Package and Installation	$ 8,959.75	$ 2,795.74
Service Platform	$ 269.35	$ 40.14
De-Foam Pump and Controls	$ 824.81	$ 320.05
Recirculating Pump and Controls	$ 472.29	$ 183.26
Acclimation System	$ 189.01	$ 28.17
Pipe Installation and Fittings	$ 1,562.61	$ 232.87
Contractor & Engineering Services & Overhead	$ 15,153.14	$ 2,258.26
Total Construction Cost	$ 70,436.24	$ 12,267.56
Electric Power Cost		$ 3,605.94
Maintenance Cost		$ 1,296.64
Property Taxes		$ 250.05
Total Operating Cost		$ 5,152.63
TOTAL ANNUALIZED COST OF NITRIFICATION TANK		**$ 17,420.19**

Table SSII.57. Super Soils “2nd Generation” Technology Settling Tank Costs—Standardized 4,320-Head Feeder-to-Finish with Flush System

Component	Total Cost	Annualized Cost
Tank Construction	$ 61,659.04	$ 9,189.02
Sludge Pump and Controls	$ 1,068.37	$ 414.56
Tank Piers	$ 269.64	$ 40.18
Pipe Installation	$ 830.13	$ 123.71
Contractor & Engineering Services & Overhead	$ 27,509.51	$ 4,099.73
Total Construction Cost	$ 91,336.69	$ 13,867.21
Electric Power Cost		$ 197.79
Maintenance Cost		$ 1,286.60
Property Taxes		$ 324.25
Total Operating Cost		$ 1,808.64
TOTAL ANNUALIZED COST OF SETTLING TANK		**$ 15,675.84**

Table SSII.58. Super Soils “2nd Generation” Technology Clean Water Tank Costs—Standardized 4,320-Head Feeder-to-Finish with Flush System

Component	Total Cost	Annualized Cost
Tank	$ 20,125.00	$ 2,999.22
Tank Construction	$ 15,247.48	$ 2,272.32
Tank Foundation	$ 7,602.27	$ 1,132.96
Pipe Installation	$ 566.70	$ 84.46
Contractor & Engineering Services & Overhead	$ 10,092.49	$ 1,504.08
Total Construction Cost	$ 53,633.95	$ 7,993.04
Maintenance Cost		$ 859.50
Property Taxes		$ 190.40
Total Operating Cost		$ 1,049.90
TOTAL ANNUALIZED COST OF CLEAN WATER TANK		**$ 9,042.94**

Table SSII.59. Super Soils "2nd Generation" Technology Phosphorus Removal Tank Costs— Standardized 4,320-Head Feeder-to-Finish with Flush System

Component		Total Cost		Annualized Cost
Tank Construction	$	35,815.87	$	5,337.62
Sludge Pump	$	1,138.11	$	441.62
Lime Injection Tank	$	1,009.54	$	150.45
Lime Mixer	$	959.00	$	372.12
Tank Piers	$	269.64	$	40.18
Water Line	$	112.63	$	16.79
Pipe Installation and Fittings	$	3,896.81	$	580.74
Contractor & Engineering Services & Overhead	$	11,327.26	$	1,688.10
Total Construction Cost	$	61,821.49	$	9,714.44
Electric Power Cost			$	216.58
Lime Slurry Cost			$	3,289.80
Maintenance Cost			$	926.95
Property Taxes			$	219.47
Total Operating Cost			$	4,652.79
TOTAL ANNUALIZED COST OF PHOSPHORUS REMOVAL TANK			**$**	**14,367.23**

Table SSII.60. Super Soils "2nd Generation" Technology Return to Barns Costs— Standardized 4,320-Head Feeder-to-Finish with Flush System

Component		Total Cost		Annualized Cost
Plumbing/Piping	$	1,300.00	$	193.74
Pump	$	600.00	$	216.21
Contractor & Engineering Services & Overhead	$	818.90	$	122.04
Total Construction Cost	$	2,718.90	$	531.99
Electric Power Cost			$	196.27
Maintenance Cost			$	56.00
Property Tax			$	9.65
Total Operating Cost			$	261.93
TOTAL ANNUALIZED COST OF RETURN TO BARNS			**$**	**793.91**

TOTAL CONSTRUCTION COST OF SUPER SOILS "2nd GENERATION" TECHNOLOGY	**$**	**882,724.51**
TOTAL OPERATING COST OF SUPER SOILS "2nd GENERATION" TECHNOLOGY	**$**	**54,053.89**
TOTAL ANNUALIZED COSTS OF SUPER SOILS "2nd GENERATION" TECHNOLOGY WITHOUT LAND APPLICATION	**$**	**190,667.52**

Table SSII.61. Super Soils "2nd Generation" Technology Predicted Liquid Application Costs for Four Land Application Scenarios— Standardized 4,320-Head Feeder-to-Finish with Flush System

Annual Cost of Applying Lagoon Effluent		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,141.09	$	8,830.19
If Phosphorus-Based Application	$	5,906.99	$	5,868.82
Acres Needed For Assimilation		**Forages**		**Row Crops**
If Nitrogen-Based Application		7.07		7.61
If Phosphorus-Based Application		13.84		37.84
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	424.40		-
If Phosphorus-Based Application	$	830.57		-
Irrigation Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,716.70	$	8,997.30
If Phosphorus-Based Application	$	4,108.61	$	6,486.84
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(167.11)
If Phosphorus-Based Application		-	$	(618.02)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application		-		-
If Phosphorus-Based Application	$	967.81		-

Note: 3,847,855 gallons / year of effluent modeled to be land applied.

Table SSII.62. Super Soils "2nd Generation" Technology Predicted Solids Application Costs for Four Land Application Scenarios— Standardized 4,320-Head Feeder-to-Finish with Flush System

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	19,901.39	$	13,447.68
If Phosphorus-Based Application	$	89,575.73	$	13,842.04
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		45.61		147.83
If Phosphorus-Based Application		355.56		949.94
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	2,736.77		-
If Phosphorus-Based Application	$	21,333.86		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	15,397.50	$	16,695.53
If Phosphorus-Based Application	$	19,376.63	$	27,319.83
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(3,247.85)
If Phosphorus-Based Application		-	$	(13,477.79)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	1,767.11		-
If Phosphorus-Based Application	$	48,865.24		-

Note: 5,015,687 lbs. / year of solids modeled to be land applied.

Table SSII.63. Summary and Mass Balance of Generated and Land Applied Nutrients— Standardized 4,320-Head Feeder-to-Finish with Flush System

Nutrient Balance	Nitrogen (lbs/ year)	Phosphorus (lbs / year)	Potassium (lbs / year)
Generated At Barn	87,436.80	25,056.00	42,984.00
Nutrient Reduction Due to Solids Separation	22,069.05	15,056.15	6,619.54
Entering Nitrification/Denitrification System	65,367.75	9,999.85	36,364.46
Removed in Nitrification/Denitrification System	60,746.25	6,032.91	7,672.90
Remaining after Nitfirication/Denitrification	4,621.50	3,966.94	28,691.56
Entering Phosphorus Removal Module	1,619.10	1,389.78	10,051.80
Removed by Phosphorus Removal Module	256.46	704.34	1,005.18
Remaining in Recycled Effluent	3,002.40	2,577.16	18,639.76
Entering Lagoon after Phosphorus Removal	1,362.63	685.44	9,046.62

Tables SSII.64. through SSII.77.: Costs and Returns Estimates Based on Standardized Cost and Performance Data for Super Soils "2nd Generation" On-Farm System: 8,800-Head Feeder-to-Finish Operation with Pit-Recharge

Table SSII.64. Super Soils "2nd Generation" Technology Assumptions and Total Annualized Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Number of Animals	**8,800**				
Type of Operation	**Feeder-Finish**				
Barn Cleaning System	**Pit-Recharge System**				
Annualized Cost ($ / Year)					
Total Annualized Cost			Forages		Row Crops
	If Nitrogen-Based Application	**$**	**303,616.32**	**$**	**296,036.00**
	If Phosphorus-Based Application	**$**	**440,033.75**	**$**	**294,698.04**
Per Unit Cost ($ / 1,000 lbs. of SSLW)					
Total Annualized Cost per Unit			Forages		Row Crops
	If Nitrogen-Based Application	**$**	**255.57**	**$**	**249.19**
	If Phosphorus-Based Application	**$**	**370.40**	**$**	**248.06**

Note: Daily volume discharged from barns is 57,772 gallons / day including recharge liquid.
SSLW equals 1,188,000 pounds.

Table SSII.65. Super Soils ‘2nd Generation” Technology Manure Evacuation and Lift Station Costs—Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost	Annualized Cost
Manure Evacuation Modifications	$ 9,110.00	$ 1,357.66
Concrete Lift Station	$ 1,209.80	$ 180.30
Switches and Brackets	$ 253.00	$ 37.70
Pumps	$ 3,468.40	$ 1,345.86
Piping	$ 291.34	$ 43.42
Lift Station Accessories	$ 15,431.46	$ 2,299.74
Contractor & Engineering Services & Overhead	$ 12,828.28	$ 1,911.79
Total Construction Cost	$ 42,592.28	$ 7,176.47
Electric Power Cost		$ 481.11
Maintenance Cost		$ 699.33
Property Taxes		$ 151.20
Total Operating Costs		$ 1,331.65
TOTAL ANNUALIZED COST OF MANURE EVACUATION AND LIFT STATION		**$ 8,508.11**

Table SSII.66. Super Soils “2nd Generation” Technology Homogenization Tank Costs— Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank	$ 54,050.95	$ 8,055.19
Tank Construction	$ 32,677.16	$ 4,869.86
Tank Foundation	$ 14,785.70	$ 2,203.51
Mixer	$ 5,674.02	$ 2,201.71
Mixer Panel	$ 1,500.00	$ 223.54
Phase Converter	$ 1,571.80	$ 234.24
Rail System	$ 1,635.31	$ 243.71
Contractor & Engineering Services & Overhead	$ 24,930.76	$ 3,715.42
Total Construction Cost	$ 136,825.71	$ 21,747.18
Electric Power Cost		$ 1,718.08
Maintenance Cost		$ 2,500.27
Property Taxes		$ 485.73
Total Operating Cost		$ 4,704.09
TOTAL ANNUALIZED COST OF HOMOGENIZATION TANK		**$ 26,451.27**

Table SSII.67. Super Soils "2nd Generation" Technology Mobile Solids Separator Costs— Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

10,968 HEAD TREATED PER WEEK		
Component	**Total Cost**	**Annualized Cost**
Mobile Separator Unit (.80 share of total unit cost)	$ 332,993.93	$ 49,625.91
Labor to Construct Mobile Unit (.80 share of total unit cost)	$ 5,777.24	$ 860.98
Contractor & Engineering Services & Overhead	$ 146,010.37	$ 21,759.85
Total Construction Cost	$ 484,781.54	$ 72,246.75
Polymer Cost		$ 40,595.69
Electric Power Cost		$ 3,999.94
Inter-Farm Transportation Cost		$ 780.00
Maintenance Cost (.80 share of total unit cost)		$ 6,775.42
Property Taxes (.80 share of total unit cost)		$ 1,720.97
Total Operating Cost		$ 53,872.02
TOTAL ANNUALIZED COST OF MOBILE SOLIDS SEPARATOR		**$ 126,118.77**

Table SSII.68. Super Soils "2nd Generation" Technology Separated Effluent Tank Costs— Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Component	**Total Cost**	**Annualized Cost**
Tank	$ 54,050.95	$ 8,055.19
Tank Construction	$ 29,654.92	$ 4,419.46
Tank Foundation	$ 14,785.70	$ 2,203.51
Pump and Controls	$ 1,312.18	$ 509.17
Piping	$ 204.48	$ 30.47
Safety Fence	$ 29.62	$ 4.41
Contractor & Engineering Services & Overhead	$ 19,820.36	$ 2,953.82
Total Construction Cost	$ 119,858.22	$ 18,176.03
Electric Power Cost		$ 400.93
Maintenance Cost		$ 2,040.12
Property Taxes		$ 425.50
Total Operating Cost		$ 2,866.55
TOTAL ANNUALIZED COST OF SEPARATED EFFLUENT TANK		**$ 21,042.57**

Table SSII.69. Super Soils "2nd Generation" Technology Denitrification Tank Costs— Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank	$ 26,602.80	$ 3,964.60
Tank Construction	$ 20,155.32	$ 3,003.74
Tank Foundation	$ 10,049.28	$ 1,497.64
Mixer	$ 1,077.85	$ 418.24
Mixer Rail Bracket and Hoist Base	$ 184.67	$ 27.52
Pipe Installation and Fittings	$ 523.34	$ 77.99
Feed Pump	$ 728.88	$ 282.83
Contractor & Engineering Services & Overhead	$ 14,102.03	$ 2,101.62
Total Construction Cost	$ 73,424.17	$ 11,374.18
Electric Power Cost		$ 2,236.35
Maintenance Cost		$ 1,240.64
Property Taxes		$ 260.66
Total Operating Cost		$ 3,737.65
TOTAL ANNUALIZED COST OF DENITRIFICATION TANK		**$ 15,111.83**

Table SSII.70. Super Soils "2nd Generation" Nitrification Tank Costs— Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank	$ 26,602.80	$ 3,964.60
Tank Construction	$ 20,155.32	$ 3,003.74
Tank Foundation	$ 10,089.63	$ 1,503.65
Blower Package and Installation	$ 13,385.69	$ 4,513.15
Service Platform	$ 269.35	$ 40.14
De-Foam Pump and Controls	$ 824.81	$ 320.05
Recirculating Pump and Controls	$ 472.29	$ 183.26
Acclimation System	$ 189.01	$ 28.17
Pipe Installation and Fittings	$ 1,562.61	$ 232.87
Contractor & Engineering Services & Overhead	$ 20,234.90	$ 3,015.60
Total Construction Cost	$ 93,786.41	$ 16,805.24
Electric Power Cost		$ 5,799.00
Maintenance Cost		$ 1,794.79
Property Taxes		$ 332.94
Total Operating Cost		$ 7,926.73
TOTAL ANNUALIZED COST OF NITRIFICATION TANK		**$ 24,731.97**

Table SSII.71. Super Soils "2nd Generation" Technology Settling Tank Costs—Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Component		Total Cost		Annualized Cost
Tank Construction	$	106,318.76	$	15,844.63
Sludge Pump and Controls	$	1,068.37	$	414.56
Tank Piers	$	269.64	$	40.18
Pipe Installation	$	830.13	$	123.71
Contractor & Engineering Services & Overhead	$	46,757.86	$	6,968.30
Total Construction Cost	$	155,244.76	$	23,391.39
Electric Power Cost			$	204.61
Maintenance Cost			$	2,179.79
Property Taxes			$	551.12
Total Operating Cost			$	2,935.52
TOTAL ANNUALIZED COST OF SETTLING TANK			**$**	**26,326.91**

Table SSII.72. Super Soils "2nd Generation" Technology Clean Water Tank Costs—Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Component		Total Cost		Annualized Cost
Tank	$	26,602.80	$	3,964.60
Tank Construction	$	20,155.32	$	3,003.74
Tank Foundation	$	10,049.28	$	1,497.64
Pipe Installation	$	566.70	$	84.46
Contractor & Engineering Services & Overhead	$	13,262.43	$	1,976.49
Total Construction Cost	$	70,636.52	$	10,526.93
Maintenance Cost			$	1,136.15
Property Taxes			$	250.76
Total Operating Cost			$	1,386.91
TOTAL ANNUALIZED COST OF CLEAN WATER TANK			**$**	**11,913.83**

Table SSII.73. Super Soils "2nd Generation" Technology Phosphorus Removal Tank Costs— Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Component		Total Cost		Annualized Cost
Tank Construction	$	72,958.25	$	10,872.93
Sludge Pump	$	1,138.11	$	441.62
Lime Injection Tank	$	1,009.54	$	150.45
Lime Mixer	$	959.00	$	372.12
Tank Piers	$	269.64	$	40.18
Water Line	$	112.63	$	16.79
Pipe Installation and Fittings	$	3,896.81	$	580.74
Contractor & Engineering Services & Overhead	$	34,628.26	$	5,160.63
Total Construction Cost	$	114,972.24	$	17,635.47
Electric Power Cost			$	229.76
Lime Slurry Cost			$	6,701.45
Maintenance Cost			$	1,669.79
Property Taxes			$	408.15
Total Operating Cost			$	9,009.16
TOTAL ANNUALIZED COST OF PHOSPHORUS REMOVAL TANK			**$**	**26,644.43**

Table SSII.74. Super Soils "2nd Generation" Technology Return to Barns Costs— Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Component		Total Cost		Annualized Cost
Plumbing/Piping	$	2,600.00	$	387.48
Pump	$	1,200.00	$	432.42
Contractor & Engineering Services & Overhead	$	1,637.80	$	244.08
Total Construction Cost	$	5,437.80	$	1,063.98
Electric Power Cost			$	625.12
Maintenance Cost			$	112.00
Property Tax			$	19.30
Total Operating Cost			$	756.42
TOTAL ANNUALIZED COST OF RETURN TO BARNS			**$**	**1,820.40**

TOTAL CONSTRUCTION COST OF SUPER SOILS "2nd GENERATION" TECHNOLOGY	**$**	**1,297,559.65**
TOTAL OPERATING COST OF SUPER SOILS "2nd GENERATION" TECHNOLOGY	**$**	**88,526.69**
TOTAL ANNUALIZED COSTS OF SUPER SOILS "2nd GENERATION" TECHNOLOGY WITHOUT LAND APPLICATION	**$**	**288,670.29**

Table SSII.75. Super Soils "2nd Generation" Technology Predicted Liquid Application Costs for Four Land Application Scenarios— Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Annual Cost of Applying Lagoon Effluent		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	7,840.31	$	9,993.54
If Phosphorus-Based Application	$	10,275.13	$	8,440.21
Acres Needed For Assimilation		**Forages**		**Row Crops**
If Nitrogen-Based Application		14.26		15.49
If Phosphorus-Based Application		28.20		77.08
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	855.49		-
If Phosphorus-Based Application	$	1,691.90		-
Irrigation Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,984.81	$	10,333.96
If Phosphorus-Based Application	$	6,611.77	$	9,699.14
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(340.41)
If Phosphorus-Based Application		-	$	(1,258.93)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application		-		-
If Phosphorus-Based Application	$	1,971.46		-

Note: 7,756,472 gallons / year of effluent modeled to be land applied.

Table SSII.76. Super Soils "2nd Generation" Technology Predicted Solids Application Costs for Four Land Application Scenarios— Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	34,347.50	$	21,253.61
If Phosphorus-Based Application	$	176,597.80	$	24,036.32
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		92.92		301.14
If Phosphorus-Based Application		724.30		1,935.06
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,574.91		-
If Phosphorus-Based Application	$	43,457.87		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	25,172.92	$	27,869.60
If Phosphorus-Based Application	$	33,599.63	$	51,491.09
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(6,615.99)
If Phosphorus-Based Application		-	$	(27,454.77)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	3,599.67		-
If Phosphorus-Based Application	$	99,540.30		-

Note: 10,217,140 lbs. / year of solids modeled to be land applied.

Table SSII.77. Summary and Mass Balance of Generated and Land Applied Nutrients Standardized 8,800-Head Feeder-to-Finish with Pit-Recharge System

Nutrient Balance	Nitrogen (lbs/ year)	Phosphorus (lbs / year)	Potassium (lbs / year)
Generated At Barn	178,112.00	51,040.00	87,560.00
Nutrient Reduction Due to Solids Separation	44,955.47	30,669.94	13,484.24
Entering Nitrification/Denitrification System	133,156.53	20,370.06	74,075.76
Removed in Nitrification/Denitrification System	123,742.36	12,289.26	15,629.99
Remaining after Nitfirication/Denitrification	9,414.17	8,080.80	58,445.77
Entering Phosphorus Removal Module	3,298.16	2,831.03	20,475.90
Removed by Phosphorus Removal Module	522.43	1,434.77	2,047.59
Remaining in Recycled Effluent	6,116.01	5,249.77	37,969.88
Entering Lagoon after Phosphorus Removal	2,775.73	1,396.26	18,428.31

Tables SSII.78. through SSII.91.: Costs and Returns Estimates Based on Standardized Cost and Performance Data for Super Soils "2nd Generation" On-Farm System: 4,000-Sow Farrow-to-Wean Operation with Pit-Recharge

Table SSII.78. Super Soils Technology Assumptions and Total Annualized Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Number of Animals	**4,000**				
Type of Operation	**Farrow-Wean**				
Barn Cleaning System	**Pit-Recharge System**				
Annualized Cost ($ / Year)					
Total Annualized Cost			Forages		Row Crops
	If Nitrogen-Based Application	**$**	**482,520.39**	**$**	**480,634.31**
	If Phosphorus-Based Application	**$**	**572,900.99**	**$**	**472,937.23**
Per Unit Cost ($ / 1,000 lbs. of SSLW)					
Total Annualized Cost per Unit			Forages		Row Crops
	If Nitrogen-Based Application	**$**	**278.59**	**$**	**277.50**
	If Phosphorus-Based Application	**$**	**330.77**	**$**	**273.06**

Note: Daily volume discharged from barns is 142,682 gallons / day including recharge liquid.
SSLW equals 1,732,000 pounds.

Table SSII.79. Super Soils '2nd Generation" Technology Manure Evacuation and Lift Station Costs—Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Component	Total Cost	Annualized Cost
Manure Evacuation Modifications	$ 6,377.00	$ 950.36
Concrete Lift Station	$ 1,209.80	$ 180.30
Switches and Brackets	$ 253.00	$ 37.70
Pumps	$ 3,468.40	$ 1,345.86
Piping	$ 291.34	$ 43.42
Lift Station Accessories	$ 15,431.46	$ 2,299.74
Contractor & Engineering Services & Overhead	$ 11,650.36	$ 1,736.25
Total Construction Cost	$ 38,681.36	$ 6,593.63
Electric Power Cost		$ 1,188.21
Maintenance Cost		$ 644.67
Property Taxes		$ 137.32
Total Operating Costs		$ 1,970.21
TOTAL ANNUALIZED COST OF MANURE EVACUATION AND LIFT STATION		**$ 8,563.83**

Table SSII.80. Super Soils "2nd Generation" Technology Homogenization Tank Costs— Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank	$ 82,443.36	$ 12,286.49
Tank Construction	$ 49,842.14	$ 7,427.95
Tank Foundation	$ 22,552.48	$ 3,360.98
Mixer	$ 5,674.02	$ 2,201.71
Mixer Panel	$ 1,500.00	$ 223.54
Phase Converter	$ 1,571.80	$ 234.24
Rail System	$ 1,635.31	$ 243.71
Contractor & Engineering Services & Overhead	$ 35,676.35	$ 5,316.83
Total Construction Cost	$ 200,895.46	$ 31,295.46
Electric Power Cost		$ 4,243.20
Maintenance Cost		$ 3,566.76
Property Taxes		$ 713.18
Total Operating Cost		$ 8,523.13
TOTAL ANNUALIZED COST OF HOMOGENIZATION TANK		**$ 39,818.59**

Table SSII.81. Super Soils "2nd Generation" Technology Mobile Solids Separator Costs— Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

4,037 SOWS TREATED PER WEEK		
Component	**Total Cost**	**Annualized Cost**
Mobile Separator Unit (.99 share of total unit cost)	$ 411,202.06	$ 61,281.23
Labor to Construct Mobile Unit (.99 share of total unit cost)	$ 7,134.11	$ 1,063.19
Contractor & Engineering Services & Overhead	$ 180,302.89	$ 26,870.45
Total Construction Cost	$ 598,639.05	$ 89,214.87
Polymer Cost		$ 100,260.27
Electric Power Cost		$ 9,878.75
Inter-Farm Transportation Cost		$ 780.00
Maintenance Cost (.99 share of total unit cost)		$ 8,366.72
Property Taxes (.99 share of total unit cost)		$ 2,125.17
Total Operating Cost		$ 121,410.91
TOTAL ANNUALIZED COST OF MOBILE SOLIDS SEPARATOR		**$ 210,625.78**

Table SSII.82. Super Soils "2nd Generation" Technology Separated Effluent Tank Costs— Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Component	**Total Cost**	**Annualized Cost**
Tank	$ 82,443.36	$ 12,286.49
Tank Construction	$ 45,232.35	$ 6,740.95
Tank Foundation	$ 22,552.48	$ 3,360.98
Pump and Controls	$ 1,312.18	$ 509.17
Piping	$ 204.48	$ 30.47
Safety Fence	$ 29.62	$ 4.41
Contractor & Engineering Services & Overhead	$ 29,881.71	$ 4,453.26
Total Construction Cost	$ 181,656.18	$ 27,385.74
Electric Power Cost		$ 990.18
Maintenance Cost		$ 3,074.85
Property Taxes		$ 644.88
Total Operating Cost		$ 4,709.91
TOTAL ANNUALIZED COST OF SEPARATED EFFLUENT TANK		**$ 32,095.66**

Table SSII.83. Super Soils "2nd Generation" Technology Denitrification Tank Costs— Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank	$ 39,853.90	$ 5,939.41
Tank Construction	$ 30,194.87	$ 4,499.93
Tank Foundation	$ 15,054.92	$ 2,243.63
Mixer	$ 2,661.99	$ 1,032.94
Mixer Rail Bracket and Hoist Base	$ 184.67	$ 27.52
Pipe Installation and Fittings	$ 523.34	$ 77.99
Feed Pump	$ 728.88	$ 282.83
Contractor & Engineering Services & Overhead	$ 21,269.28	$ 3,169.75
Total Construction Cost	$ 110,471.84	$ 17,273.99
Electric Power Cost		$ 5,523.18
Maintenance Cost		$ 1,885.78
Property Taxes		$ 392.18
Total Operating Cost		$ 7,801.13
TOTAL ANNUALIZED COST OF DENITRIFICATION TANK		**$ 25,075.12**

Table SSII.84. Super Soils "2nd Generation" Nitrification Tank Costs— Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank	$ 39,853.90	$ 5,939.41
Tank Construction	$ 30,194.87	$ 4,499.93
Tank Foundation	$ 15,115.37	$ 2,252.64
Blower Package and Installation	$ 28,871.61	$ 10,522.21
Service Platform	$ 269.35	$ 40.14
De-Foam Pump and Controls	$ 824.81	$ 320.05
Recirculating Pump and Controls	$ 472.29	$ 183.26
Acclimation System	$ 189.01	$ 28.17
Pipe Installation and Fittings	$ 1,562.61	$ 232.87
Contractor & Engineering Services & Overhead	$ 33,402.46	$ 4,977.95
Total Construction Cost	$ 150,756.28	$ 28,996.63
Electric Power Cost		$ 13,472.28
Maintenance Cost		$ 3,135.41
Property Taxes		$ 535.18
Total Operating Cost		$ 17,142.88
TOTAL ANNUALIZED COST OF NITRIFICATION TANK		**$ 46,139.51**

Table SSII.85. Super Soils "2nd Generation" Technology Settling Tank Costs—Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank Construction	$ 262,587.33	$ 39,131.91
Sludge Pump and Controls	$ 1,068.37	$ 414.56
Tank Piers	$ 269.64	$ 40.18
Pipe Installation	$ 830.13	$ 123.71
Contractor & Engineering Services & Overhead	$ 114,105.73	$ 17,005.12
Total Construction Cost	$ 378,852.20	$ 56,715.49
Electric Power Cost		$ 228.44
Maintenance Cost		$ 5,304.99
Property Taxes		$ 1,344.93
Total Operating Cost		$ 6,878.36
TOTAL ANNUALIZED COST OF SETTLING TANK		**$ 63,593.85**

Table SSII.86. Super Soils "2nd Generation" Technology Clean Water Tank Costs—Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank	$ 39,853.90	$ 5,939.41
Tank Construction	$ 30,194.87	$ 4,499.93
Tank Foundation	$ 15,054.92	$ 2,243.63
Pipe Installation	$ 566.70	$ 84.46
Contractor & Engineering Services & Overhead	$ 19,746.90	$ 2,942.87
Total Construction Cost	$ 105,417.29	$ 15,710.28
Maintenance Cost		$ 1,702.07
Property Taxes		$ 374.23
Total Operating Cost		$ 2,076.31
TOTAL ANNUALIZED COST OF CLEAN WATER TANK		**$ 17,786.59**

Table SSII.87. Super Soils “2nd Generation” Technology Phosphorus Removal Tank Costs— Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Component	Total Cost	Annualized Cost
Tank Construction	$ 103,814.11	$ 15,471.36
Sludge Pump	$ 1,138.11	$ 441.62
Lime Injection Tank	$ 1,009.54	$ 150.45
Lime Mixer	$ 959.00	$ 372.12
Tank Piers	$ 269.64	$ 40.18
Water Line	$ 112.63	$ 16.79
Pipe Installation and Fittings	$ 3,896.81	$ 580.74
Contractor & Engineering Services & Overhead	$ 47,927.13	$ 7,142.56
Total Construction Cost	$ 159,126.97	$ 24,215.83
Electric Power Cost		$ 240.72
Lime Slurry Cost		$ 9,535.65
Maintenance Cost		$ 2,286.91
Property Taxes		$ 564.90
Total Operating Cost		$ 12,628.19
TOTAL ANNUALIZED COST OF PHOSPHORUS REMOVAL TANK		**$ 36,844.01**

Table SSII.88. Super Soils “2nd Generation” Technology Return to Barns Costs— Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Component	Total Cost	Annualized Cost
Plumbing/Piping	$ 2,600.00	$ 387.48
Pump	$ 1,200.00	$ 432.42
Contractor & Engineering Services & Overhead	$ 1,637.80	$ 244.08
Total Construction Cost	$ 5,437.80	$ 1,063.98
Electric Power Cost		$ 1,896.75
Maintenance Cost		$ 112.00
Property Tax		$ 19.30
Total Operating Cost		$ 2,028.06
TOTAL ANNUALIZED COST OF RETURN TO BARNS		**$ 3,092.03**

TOTAL CONSTRUCTION COST OF SUPER SOILS “2nd GENERATION” TECHNOLOGY	**$ 1,929,934.43**
TOTAL OPERATING COST OF SUPER SOILS “2nd GENERATION” TECHNOLOGY	**$ 185,169.07**
TOTAL ANNUALIZED COSTS OF SUPER SOILS “2nd GENERATION” TECHNOLOGY WITHOUT LAND APPLICATION	**$ 483,634.98**

Table SSII.89. Super Soils "2nd Generation" Technology Predicted Liquid Application Costs for Four Land Application Scenarios— Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Annual Cost of Applying Lagoon Effluent		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	9,462.69	$	11,655.04
If Phosphorus-Based Application	$	10,302.94	$	7,662.56
Acres Needed For Assimilation		**Forages**		**Row Crops**
If Nitrogen-Based Application		21.12		21.12
If Phosphorus-Based Application		21.12		32.23
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	1,267.10		-
If Phosphorus-Based Application	$	1,267.10		-
Irrigation Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	8,195.59	$	11,783.88
If Phosphorus-Based Application	$	8,195.59	$	8,180.71
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(128.84)
If Phosphorus-Based Application		-	$	(518.14)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application		-		-
If Phosphorus-Based Application	$	840.25		-

Note: 11,488,356 gallons / year of effluent modeled to be land applied.

Table SSII.90. Super Soils "2nd Generation" Technology Predicted Solids Application Costs for Four Land Application Scenarios— Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	22,710.28	$	14,668.38
If Phosphorus-Based Application	$	127,176.15	$	15,569.96
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		61.04		197.82
If Phosphorus-Based Application		525.63		1,404.28
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	3,662.10		-
If Phosphorus-Based Application	$	31,537.60		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	17,283.66	$	19,014.36
If Phosphorus-Based Application	$	23,277.81	$	35,394.80
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(4,345.98)
If Phosphorus-Based Application		-	$	(19,824.84)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	1,764.52		-
If Phosphorus-Based Application	$	72,360.73		-

Note: 5,698,093 lbs. / year of solids modeled to be land applied.

Table SSII.91. Summary and Mass Balance of Generated and Land Applied Nutrients— Standardized 4,000-Sow Farrow-to-Wean with Pit-Recharge System

Nutrient Balance	Nitrogen (lbs/ year)	Phosphorus (lbs / year)	Potassium (lbs / year)
Generated At Barn	117,000.00	37,040.00	77,000.00
Nutrient Reduction Due to Solids Separation	29,530.80	22,257.34	11,858.00
Entering Nitrification/Denitrification System	87,469.20	14,782.66	65,142.00
Removed in Nitrification/Denitrification System	81,285.13	8,918.38	13,744.96
Remaining after Nitfirication/Denitrification	6,184.07	5,864.28	51,397.04
Entering Phosphorus Removal Module	1,248.24	1,183.69	10,374.35
Removed by Phosphorus Removal Module	197.72	599.89	1,037.44
Remaining in Recycled Effluent	4,935.83	4,680.59	41,022.69
Entering Lagoon after Phosphorus Removal	1,050.52	583.80	9,336.92

Tables SSII.92. and SSII.93.: Predicted Costs of Retrofitting Various Representative Farm Sizes and Farm Types with the Standardized Super Soils "2nd Generation" On-Farm System: DWQ Permitted Farms and SF/PSF Owned Farms

Table SSII.92. Predicted Costs ($ / 1,000 Pounds of Steady-State Live Weight (SSLW) per Year) of Retrofitting DWQ Permitted Representative Farm Type / Farm Size Combinations—Standardized Super Soils "2nd Generation" Technology

	Farm Size (1,000 pounds SSLW)				
	0-500	**500-1000**	**1000-1500**	**1500-2000**	**> 2000**
Farm Type					
Farrow-wean					
Rep. # of sows	752	1,540	2,400	4,000	6,000
Pit-recharge system	$486.13	$394.52	$351.38	$278.59	$253.83
Flush system	$524.19	$427.98	$335.66	$298.99	$273.23
Farrow-feeder					
Rep. # of sows	500	1,200	2,000	3,600	5,500
Pit-recharge system	$506.89	$407.53	$320.54	$278.47	$256.28
Flush system	$676.00	$519.29	$417.32	$362.62	$332.58
Farrow-finish					
Rep. # of sows	150	500	1,000	1,200	2,000
Pit-recharge system	$509.49	$332.09	$276.44	$236.19	$210.67
Flush system	$564.48	$398.01	$292.74	$285.41	$257.56
Wean-feeder					
Rep. head capacity	3,840	20,000	N/A	N/A	N/A
Pit-recharge system	$683.76	$344.60	N/A	N/A	N/A
Flush system	$1,505.58	$861.76	N/A	N/A	N/A
Feeder-finish					
Rep. head capacity	2,448	5,280	8,800	12,240	17,136
Pit-recharge system	$371.86	$290.49	$255.57	$241.57	$195.69
Flush system	$388.22	$327.05	$283.43	$237.70	$221.59

Table SSII.93. Predicted Costs ($ / 1,000 Pounds of Steady-State Live Weight (SSLW) per Year) of Retrofitting Smithfield Foods/Premium Standard Farms Representative Farm Type / Farm Size Combinations—Standardized Super Soils "2nd Generation" Technology

	Farm Size (1,000 pounds SSLW)				
	0-500	**500-1000**	**1000-1500**	**1500-2000**	**> 2000**
Farm Type					
Farrow-wean					
Rep. # of sows	650	1,700	2,400	4,000	7,000
Pit-recharge system	$513.25	$386.69	$351.38	$278.59	$243.96
Flush system	$547.74	$411.72	$335.66	$298.99	$261.26
Farrow-feeder					
Rep. # of sows	675	1,200	2,000	3,419	5,500
Pit-recharge system	$482.66	$407.53	$320.54	$284.74	$256.28
Flush system	$621.06	$519.29	$417.32	$369.48	$332.58
Farrow-finish					
Rep. # of sows	N/A	500	1,000	1,200	2,000
Pit-recharge system	N/A	$332.09	$276.44	$236.19	$210.67
Flush system	N/A	$398.01	$292.74	$285.41	$257.56
Wean-feeder					
Rep. head capacity	2,808	N/A	N/A	N/A	N/A
Pit-recharge system	$772.58	N/A	N/A	N/A	N/A
Flush system	$1,658.71	N/A	N/A	N/A	N/A
Feeder-finish					
Rep. head capacity	1,240	5,100	8,800	12,246	17,136
Pit-recharge system	$548.95	$293.52	$255.57	$241.51	$195.69
Flush system	$607.00	$326.51	$283.43	$237.67	$221.59

APPENDIX 1: Technology Providers' Response to Costs and Returns Report

Observations on Economic Report
Super Soils "2nd Generation" Technology
Super Soil Systems USA, Inc.

We appreciate the opportunity to review and comment on the NCSU Economic Study. A good accounting of costs has been made; clearly a standardized model is needed so technologies can be compared on a level playing field. **The conversion of Super Soil's technology to a standardized model must consider details concerning performance, sizing, and water conservation to be accurate.** We have provided these insights absent from the economic report in order to ensure the truest picture of performance and cost of the Super Soil Technology.

The treatment system for the Tyndall Farm was actually designed for a 5,600 head-count (756 1000 lb sslw). This was based on early feedback from the grower concerning animal populations. The Tyndall Farm is actually permitted to house an average of 5,145 animals (694.58 1000 lb sslw) over a one-year inventory. Assuming a certain level of mortality, the farm can be populated to account for this loss, thus minimizing economic impact.

During the evaluation period, December, 2006 – June, 2007 (204 days), one complete cycle of hogs was produced plus 2 months of a second cycle. The economic report indicates the average population during the entire evaluation period was 4,067 based on animal weight (549,045 lb) and the assumption of 135 lb/animal (according to standard procedures for calculating sslw). Basing the economic evaluation on the average population during one complete cycle of hogs is much more accurate than using the average population (4,067) during the entire evaluation period.

During the evaluation period, we confirmed that two of the tanks in the waste treatment system can be decreased in size. The De-nitrification Tank can be reduced to one-half the Second Generation Project size. The Clean-water Storage Tank, which provides water to refill the waste collection pit, can be reduced by two-thirds. These findings should be reflected in the economic report.

Solids are removed from the waste stream during the first stage of the treatment process. During this single process, approximately 50% of the nitrogen, 75% of the phosphorus, and 98% of the copper and zinc are removed with the solids and taken off the farm to a central processing facility. This one process is invaluable in ensuring permit compliance and protecting long-term sustainability of the farm. This also significantly reduces the risk of environmental impact. The solids are composted and used to manufacture value-added products such as container mix and soil amendment.

The economic analysis includes the actual project cost and operational expenses in one of the models (Actual). Even though this model shows actual equipment and labor costs, it still includes 43.1 % overhead, which results in a significant increase in cost. **Super Soil overhead for the Tyndall Farm project was considerably less than 20%.**

To demonstrate the impact of these items on projected cost of the treatment system, we have constructed the table below that shows the calculated reductions in total cost (construction and operation) and $/ 1000 lb sslw when we account for tank size modification, solids removal, and reduction in overhead. For clarity, the reductions in cost are shown incrementally for tank size, solids removal, design capacity, and overhead.

Comparison of Actual Super Soil Technology Model and Modified Models Accounting for Design Capacity, Solids Removal, and Reduced Overhead

	Annualized Cost	**Capacity**	**Annualized Cost**
	Total	1000 lb sslw	Cost/1000 lb sslw
NCSU Economic Evaluation (Actual Model)	$94,700.78	694.58 (Permitted)	$132.24
Adjusted for Oversized Tanks	$87,454.15	694.58 (Permitted)	$125.91
Adjusted for Solids Removal	$87,454.15	694.58 (Permitted)	$111.38
Adjusted for Design Capacity	$87,454.15	756 (Design)	$101.15
Adjusted for 20% Overhead	$80,116.54	756 (Design)	$91.44

Water savings are an important advantage to using the Super Soil treatment technology and must be accounted for in the economic evaluation. These savings have been confirmed in both the Generation I and Generation II evaluations by USDA-ARS. Even with less water use, the treatment system has been verified by USDA-ARS to reduce mortality (57%), increase average daily gain (10.5%), and reduce condemnation rate (38.1%).

The model of “Actual Costs and Performance Data” comes closer to providing an unbiased evaluation of the Super Soil Technology. With an adjustment for oversized tanks, and capacity, this model would provide a clearer view of the actual cost. Reduction of overhead to 20% would also be more realistic. Since no land application of waste is required, it is appropriate to omit this expense from the model.

Inclusions of cost savings resulting from reductions in mortality and condemnation, along with improved gain would also provide a clearer economic picture of the treatment system. These advantages provide returns that will help pay for the treatment system and should be accounted for in the calculation of cost/ 1000 lb sslw. Both the integrator and producer benefit from these improvements. Such benefits are documented in Table 13 on page 31 of the USDA-ARS report “Evaluation of Environmental Superior Technology Contingent Determination - Second Generation Super Soil Technology”. The investigators found an improvement of $91,920 in annual return ($120.15/1000 lb sslw/yr) when comparing pre-treatment and post-treatment performance. If this additional return is subtracted from annualized cost of the technology ($91.44 for Actual Model after adjustments), there is **an increased return of $28.71/1000 lb sslw after paying all expenses.** Without accounting for any of the adjustments ($132.24 - $120.15), the cost of the treatment system (Actual Model) is only $12.09/1000 lb sslw.

Still unaccounted for are significant benefits derived from the fact that the existing lagoon is cleaned up over time at no additional cost to the farmer or citizens of North Carolina. After just 4-6 months, USDA-ARS measured a 50% reduction in TKN and 20-30% reductions in COD, VSS, and salinity. These results are consistent with those of the first generation project in which lagoon ammonia emissions were reduced by 90%.

In conclusion, the economic evaluation must account for advantages such as water conservation and solids removal that are inherent in the Super Soil technology and must be based on proper equipment sizing and design for maximum treatment capacity to ensure an equitable and unbiased assessment of costs. In the case of the Tyndall Farm, adjustments must be made for reductions in tank sizes that became evident during the evaluation period. It is also important to report cost summaries based on maximum treatment capacity as opposed to animal weight and numbers during the evaluation period. Even after these adjustments, consideration must be given to realistic overhead and production advantages that the treatment system provides. Inclusion of economic returns resulting from reduced mortality and condemnation rate along with improved rate of gain is essential. The economic advantage to producers and the people of North Carolina from cleaning up existing lagoons and reducing environmental impact must also be recognized.