

Largo's Beneficial Use of Biosolids

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The city of Largo Wastewater Reclamation Facility (WWRF) Biosolids Facility utilizes advanced heat-drying technology to produce marketable pelletized domestic waste residuals. The facility produces between 16 and 18 dry tons per day of Class AA residuals that are sold for beneficial use as a soil conditioner. The finished product has very little odor, has a high nutrient value and is highly marketable. The city's success follows years of difficulty in developing facility equipment and staff skills for effective plant performance.

The biosolids facility began operation in 1977 as a wastewater residual processing facility.

In 1986, the city shut down its sludge heat-drying facility following several years of operational problems, including chronic odor problems.

The city and the consulting, engineering and construction firm CDM organized a number of facility improvements to allow Largo to restart its sludge pelletizing facility. The improvements were completed in phases responsive to then-Florida Department of Environmental Regulation (FDER) construction grant procedures, to city funding limitations, and to citizen complaints of unacceptable odors related to facility operations.

The improvement project, completed in 1991, included

modified gravity thickeners and aerobic digesters, a new belt press, a parallel heat-drying process, product-storage and truck-loading facilities, rehabilitation of the original sludge-processing train, and installation of new odor-control facilities: high-efficiency, energy-recovery after-burners for process air and wet scrubbers for controlling odors from the thickeners and the drying-building air.

The facility expansion added aerobic digesters, an additional process train to provide assurance of uninterrupted service, venturi air scrubbers to reduce particulate emissions, and a regenerative thermal oxidizer to reduce the emissions of volatile organic compounds. The expansion dramatically reduced odor complaints from the surrounding neighborhood while significantly improving the efficiency of the operation.

The drying process reduces the moisture content of the finished product from approximately 85 percent in the wet cake from the press to approximately 8 percent in the pelletized product. The dramatic reduction in water weight reduces the potential cost of disposal by nearly 78 percent. The heat-drying process also serves to meet the vector reduction and pathogen attraction reduction requirements found in 40 CFR Part 503.

The finished product is sold to a private entity for resale to various agricultural interests throughout the United States. The final product is used directly as a soil conditioner and also is mixed with other ingredients for use as a fertilizer. The sludge-handling process is relatively complex and illustrated in Figure 1:

The biosolids facility is operated and maintained by a team of three two-person biosolids operator crews and one foreman. This team is knowledgeable of the biosolids facility and has consis-

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tently improved the performance and cost effectiveness of the facility. Savings are demonstrated in a 20-percent reduction in electrical consumption and a 31-percent reduction in natural-gas consumption in the past two years. Within this time, production increased by 20 percent.

During the calendar year 2001, the facility production averaged 0.53 dry tons per hour, compared with a design capacity of 0.76 dry tons per hour. The net operating cost for the facility in 2001 was \$574,938.28, or \$254.49 per dry ton. The product is sold for \$38 per ton. The facility continues to operate with good public support and with no odor complaints.

Treatment Plant History

The Largo Wastewater Treatment Plant was originally designed and constructed as a contact stabilization activated-sludge secondary treatment facility. The first 3.0-mgd phase of the plant was completed in 1970 and consisted of a master pump station and control building; grit removal and screening unit; contact stabilization unit, including aerobic digesters; clarifier; effluent holding pond; and related site work.

The facility was expanded in 1973 with a second 3.0-mgd con-

Figure 1

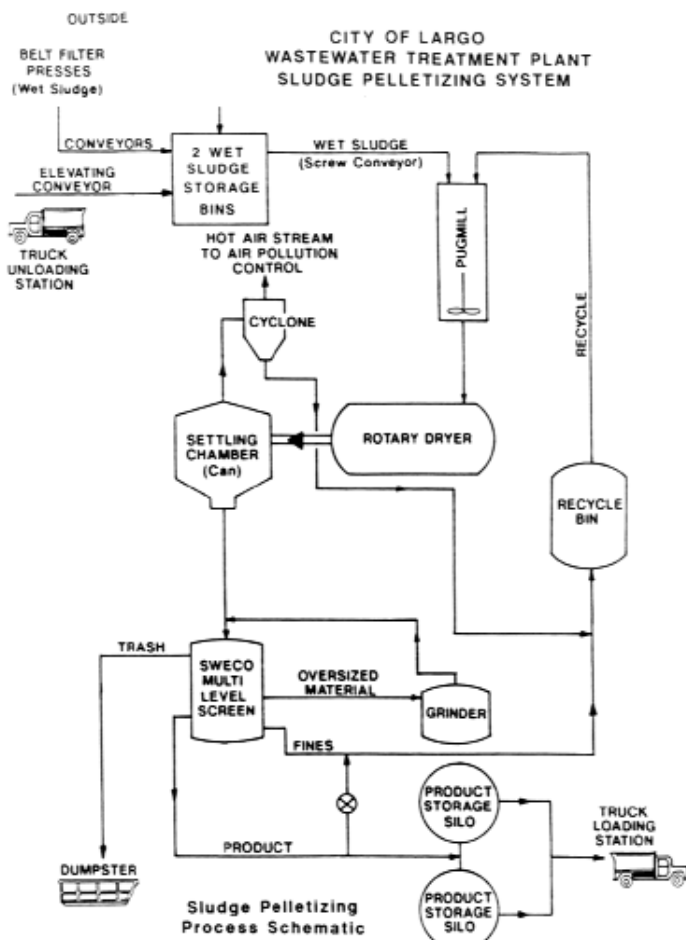
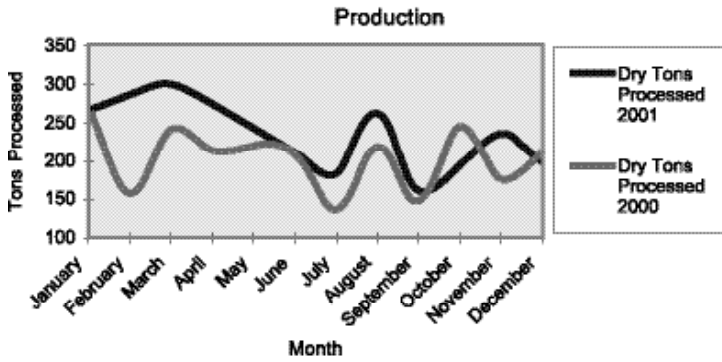


Figure 2



tact stabilization system and secondary clarifier. A third 3.0-mgd contact stabilization process train was completed and placed in operation in December 1977. In addition to the construction of the third contact stabilization unit, the 1977 expansion included the addition of effluent filtration facilities, aerobic sludge digesters, and a sludge pelletizer facility (heat dryer).

Additional comprehensive plant improvements upgraded the existing contact stabilization wastewater treatment plant to a 15.0-mgd advanced treatment facility, with effluent discharge to the Airco Golf Course for irrigation and to the chain of lakes at the Feather Sound Golf Course. Design of the expansion and upgrade was completed in 1981; construction was completed in 1983.

Continued interest in improving the effluent quality by reducing the concentrations of nitrogen and phosphorus in the facility led to a decision to convert the wastewater treatment process to incorporate the A²/O treatment process. The A²/O process modifications converted a portion of the treatment plant to a new process for carbonaceous biological

oxygen demand, nitrogen, and phosphorus removal. The retrofitted plant was to treat raw, dewatered sewage prior to dilution by filter supernatant or other plant sidestreams.

The A²/O process included a covered anaerobic zone equipped with mechanical mixers to prevent solids from settling. Recycled sludge from the secondary clarifier underflow was pumped into the anaerobic

zone using sludge recirculation pumps and was mixed with primary clarifier effluent. The anoxic zone was covered and mixed liquor from the oxalic zone was recycled to the anoxic zone and mixed with anaerobic zone discharge for denitrification. The oxalic zone was also covered and mechanical aerators were used to aerate the mixed liquor.

To handle the sludges produced by the A²/O system (primary and waste-activated sludge), plant improvements included the addition of two new final clarifiers, new return activated sludge and waste-activated sludge pumps, two replacement belt filter presses for improved sludge dewatering, and new thickened sludge pumps. Before the conversion to the A²/O process, the sludge heat-drying facility operated economically and provided a reliable sludge disposal alterna-

tive for Largo. After full-scale conversion to the A²/O process in 1983, the facility was the object of numerous complaints of obnoxious odors.

In October 1985 a consent order was issued by the FDER (now the Florida Department of Environmental Protection), and in the fall of 1986 the sludge heat-drying facility was shut down. Subsequently, sludge was treated with lime and truck-hauled for dispersal on agricultural lands, but economics and pending regulations governing land application of dewatered sludge cake made this disposal method unacceptable and insecure for the future. To correct the sludge-processing problems, two major alternatives were evaluated:

- Liquid-stream modifications to another bio-nutrient removal process, biochemical process, or elimination of the primary clarifiers
- Changes in the solid handling

system to accommodate the existing wastewater sludge characteristics

All the associated alternatives were evaluated and the overall accepted plan included the following major components:

- Converting the existing gravity thickener to a gravity thickener for primary sludge and aerated storage tank for waste-activated sludge
- Providing an aluminum plate cover and odor-control facilities for the modified primary sludge thickener
- Constructing an additional 0.5-MG aerated-sludge storage tank
- Providing mechanical belt thickeners
- Providing new anaerobic digestion facilities and replacing one belt filter press

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TABLE 1A

2001 MONTHLY PELLET RESULTS (MG/KG)												
INORGANICS	As	OVER	Cd	OVER	Cr	OVER	Cu	OVER	Pb	OVER	Hg	OVER
CEILING	75		85				4300		840		57	
MONTHLY	41		39				1500		300		17	
DATE												
1/15/01	0.81	N	1.92	N	39.3	N	885	N	40.3	N	0.5965	N
2/12/01	0.17	N	1.58	N	18.7	N	691	N	21.6	N	0.1633	N
3/12/01	0.90	N	2.25	N	26.4	N	871	N	21.4	N	0.6625	N
4/9/01	0.33	N	2.73	N	32.2	N	936	N	40.7	N	0.2441	N
5/7/01	0.58	N	2.54	N	23.8	N	1010	N	30.6	N	0.2728	N
6/11/01	1.34	N	2.45	N	22.5	N	1088	N	29.7	N	0.3438	N
7/9/01	0.48	N	2.16	N	16.7	N	946	N	26.5	N	0.5732	N
8/13/01	0.67	N	2.61	N	20.6	N	1050	N	41.1	N	0.5339	N
9/10/01	1.39	N	2.36	N	17.7	N	895	N	38.7	N	0.1076	N
10/8/01	1.22	N	3.41	N	22.8	N	994	N	35.9	N	0.4468	N
11/12/01	0.80	N	2.71	N	17.2	N	1000	N	30.3	N	0.2417	N
12/10/01	2.50	N	1.90	N	21.0	N	910	N	37.0	N	1.2000	N
AVERAGE	0.94		2.43		21.78		945		32.14		0.4354	
MAXIMUM	2.50		3.41		39.3		1050		41.1		1.2000	
MINIMUM	0.17		1.58		16.7		691		21.4		0.1633	

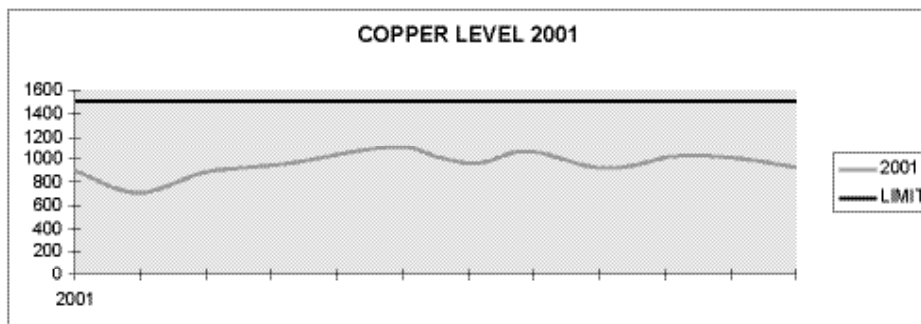
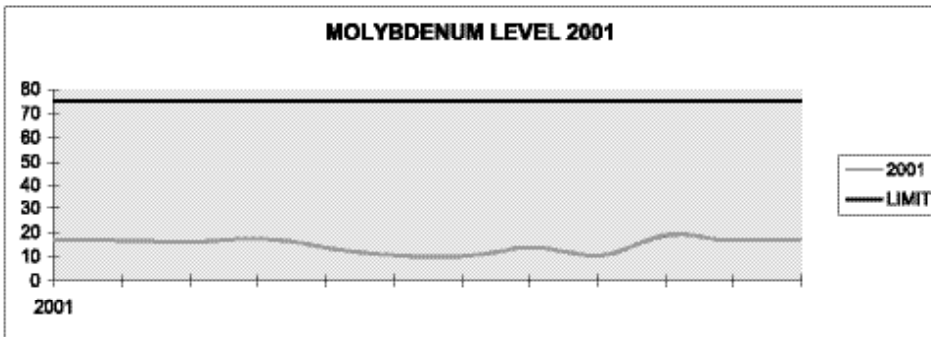


TABLE 1B.

2001 MONTHLY PELLET RESULTS (MG/KG)													
INORGANICS	Mo	OVER	Ni	OVER	Se	OVER	Zn	OVER	K%	PH	N%	P%	SOLIDS
CEILING	75		420		100		7500						<90%
MONTHLY	75		420		100		2800						<90%
DATE													
1/15/01	17.4	N	31.1	N	1.22	N	438	N	0.4818	5.78	7.31	3.39	93.96
2/12/01	17.3	N	21.1	N	0.23	N	389	N	0.7255	6.15	10.0	3.26	91.30
3/12/01	16.3	N	21.6	N	0.74	N	463	N	0.7683	6.72	8.37	3.72	91.96
4/9/01	17.7	N	18.2	N	0.74	N	460	N	0.5609	6.58	4.97	3.52	92.19
5/7/01	14.0	N	21.2	N	>.2	N	496	N	0.6178	6.64	6.70	3.43	92.90
6/11/01	11.3	N	20.5	N	2.22	N	480	N	0.6589	6.48	6.32	2.89	91.79
7/9/01	10	N	18.0	N	1.69	N	398	N	0.6140	6.06	*7.58	*1.17	91.46
8/13/01	14.4	N	26.8	N	1.65	N	530	N	0.5755	6.16	*9.41	*2.63	92.26
9/10/01	10.0	N	19.0	N	1.56	N	413	N	0.6041	7.14	*9.06	*3.43	91.36
10/8/01	18.5	N	20.3	N	0.53	N	499	N	0.5560	6.22	*7.02	*3.78	90.97
11/12/01	17.4	N	16.2	N	2.37	N	398	N	0.5645	6.06	*5.90	*3.04	91.40
12/10/01	17.0	N	22.0	N	12.0	N	540	N	0.8700	6.10	*7.15	*2.95	90.39
AVERAGE	14.9		20.4		2.37		461		0.6469	6.39	7.27	3.36	91.63
MAXIMUM	18.5		31.1		12.0		540		0.8700	7.14	10.00	3.72	93.96
MINIMUM	>10		16		>0.2		389		0.4818	5.78	4.97	2.89	90.39



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- Improving the existing sludge heat-drying facility and constructing a new pelletizer train, afterburner, building odor control system, and storage silos and scales
- Providing chemical feeds in the wastewater collection system to control formation and release of hydrogen sulfide odors at the treatment plant

Sludge Processing Facility

In 1987 the recommended sludge processing plan included:

- Sludge lagoon reclamation to provide space for a digester
- Provision for new aerobic digestion facilities
- Replacement of one belt filter press
- Improvements to the existing sludge heat-drying facility and construction of an afterburner, building odor-control system, new pelletizer train, and storage silos and scales
- Provision for chemical feeds in the wastewater collection system to control formation and release of hydrogen sulfide odors at the treatment plant

Combined primary and waste-activated sludge is pumped to the aerobic digestion system. The digesters provide for a minimum 20-

day solids retention time at maximum month loadings. They are equipped with a diffused aeration system comprised of coarse-bubble diffusers supplied from five 4,000-standard-cubic-foot-per-minute centrifugal blowers.

All product produced in 2001 met the pollutant requirements found in 40 CFR, Part 503. The city of Largo takes a proactive approach to monitoring the facility's product to assure that the material produced meets all requirements of Class AA sludge. Facility operators collect samples of the product twice per day for weekly, biweekly, and monthly composite samples. Also, monthly grab samples are collected to comply with vector-reduction monitoring requirements.

Additional samples are collected and reported on a weekly basis for copper and molybdenum. These two metals are monitored closely

to assure that no violations occur. The weekly sampling is analyzed on a rush basis by a contracted laboratory to allow the operators to make immediate decisions on product quality. If a weekly composite sample exceeds the monthly limit, the product can be recycled into the system until the levels are within regulatory limits. If other parameters in the monthly composite demonstrate unusually high levels, those parameters are added to the weekly analyses. The industrial pretreatment staff is also notified so that sources of the pollutant can be tracked.

The following tables demonstrate the facility's compliance with all local, state, and federal requirements:

Table 1A lists the results of monthly composite samples for the metals arsenic, cadmium, chromium, copper, lead, and mercury. The table includes the ceiling and monthly limits contained in the 503 regulations, and the spreadsheet automatically indicates if there is a violation by inserting a "Y" for yes under the "OVER" column. The chart at the bottom tracks the copper levels for the year because of the possibility of approaching the monthly limit for that metal. All levels were below the monthly limit in 2001. Copper in the pellets is due in part to leaching caused by aggressive potable water in plumbing fixtures. The city of Largo does not provide drinking water and has no control over its quality.

Table 1B lists the results of monthly composite samples for the metals molybdenum, nickel, selenium, and zinc, as well as potassium, pH, total nitrogen, total phosphorus, and percent solids. The table includes the ceiling and monthly limits contained in the 503 regulations, and the spreadsheet automatically indicates if there is a violation by inserting a "Y" for yes under the "OVER" column.

TABLE 2

2001 FECAL COLIFORM SAMPLES	
DATE	FECAL
1/16/01	<2
2/27/01	<2
3/13/01	<2
4/10/01	<2
5/15/01	<2
6/13/01	<2
7/17/01	<2
8/14/01	<2
9/11/01	<2
10/16/01	<2
11/20/01	<2
12/11/01	<2

The chart at the bottom tracks the molybdenum levels for the year because of past discharges from an industrial user. All readings in 2001 were below the ceiling limit. The pretreatment section includes a discussion of the molybdenum discharges.

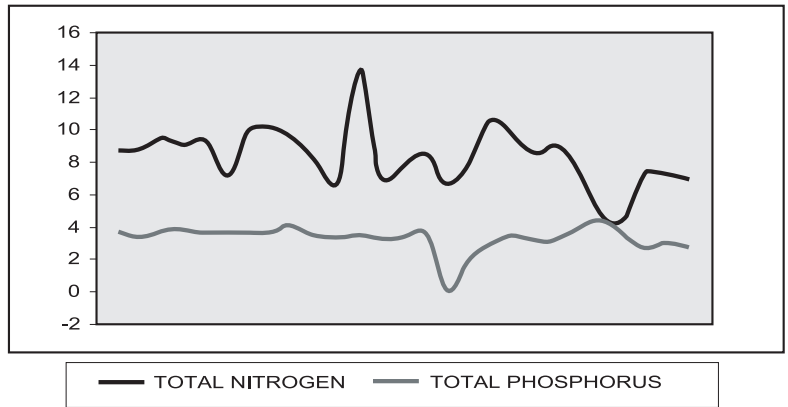
Table 2 lists the results of fecal coliform monitoring for the year. Grab samples are collected on a monthly basis from the process train during operation. Fecal coliform is monitored to demonstrate compliance with the vector-reduction requirements for heat-dried sludge.

Table 3 lists the results of biweekly (every two weeks)

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TABLE 3

2001 BIWEEKLY PELLET RESULTS		
INORGANICS DATE	TOTAL NITROGEN	TOTAL PHOSPHORUS
12/27/00	8.71	3.71
1/8/01	8.81	3.36
1/22/01	9.43	3.73
2/5/01	9.07	3.80
2/19/01	9.27	3.64
3/5/01	7.13	3.70
3/19/01	10.1	3.64
4/2/01	10.07	3.70
4/16/01	9.41	4.17
4/30/01	8.10	3.43
5/14/01	6.71	3.35
5/28/01	13.7	3.52
6/11/01	6.94	3.27
6/25/01	7.84	3.37
7/9/01	8.54	3.60
7/23/01	6.62	0.04
8/6/01	8.11	2.29
8/20/01	10.7	2.96
9/3/01	9.60	3.65
9/17/01	8.52	3.20
10/1/01	9.07	3.07
10/15/01	7.34	3.84
10/29/01	4.65	4.43
11/12/01	4.49	3.47
11/26/01	7.30	2.60
12/10/01	7.30	3.10
12/24/01	7.00	2.80
AVERAGE	8.32	3.19
MAXIMUM	13.7	4.43
MINIMUM	4.49	0.04



over operations from the treatment plant staff, the team was able to save \$137,000 by reducing electrical, gas, and labor costs. The team has found better means to mix the product in the pugmill and to optimize gas usage, allowing the facility to operate more efficiently and providing preventive and predictive maintenance periods while increasing the production of pellets. The hours of opera-

tion and cost per ton have decreased, while total production has increased.

During calendar year 2001, the facility produced 2,256.33 dry tons in 4,197 hours of operation. The hourly production rate averaged 0.53 dry tons. The design capacity for the facility is 0.76 dry tons per hour, for an average operating rate of 70 percent of the design capacity.

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composite samples for total nitrogen and total phosphorus. The samples are composites of samples collected twice a day for two weeks. The sampling is done on a biweekly basis to assure that the holding time of 28 days is not exceeded. This monitoring is performed in compliance with the 503 Regulations.

Table 4 lists the results of emissions tests in 1998 and 2000 and shows a dramatic reduction in volatile organic compound emissions from the regenerative thermal oxidizer after the refurbishment.

Table 5 presents the facility operations results for costs and production.

In December 1999 the biosolids facility operations were organizationally separated from the balance of the treatment plant operations to allow for specialization of the biosolids staff members, who now perform all maintenance of the facility and are intimately knowledgeable of unit operations. The biosolids staff works closely with the treatment plant operations staff, the industrial pre-treatment staff, and maintenance staff for the treatment facility. All processes are on a single site to maximize the ongoing communication among staff members. The biosolids foreman attends weekly departmental staff meetings to coordinate activities with other sections.

In the first year that the biosolids team took

TABLE 4

**City of Largo
Emission Test Report**

SLUDGE DRYER TRAIN 1 (JULY, 2000)						
Run#	FLOW RATE (SCFM)	CONCENTRATION (PPM C3H8)	INFLUENT VOC RATE (LB/HR) (AS C3H8)	FLOW RATE (SCFM)	CONCENTRATION (PPM C3H8)	EMISSION RATE (LB/HR) (AS C3H8)
	(Qs)	(Cs)	(E)	(Qs)	(Cs)	(E)
1	11,900	14.2	1.16	11,900	0.71	0.06
2	12,000	28.29	2.33	12,000	1.09	0.09
3	11,700	41.67	3.35	11,700	1.21	0.1
AVERAGE	11,867	28.05	2.28	11,867	1	0.08

SLUDGE DRYER TRAIN 1 (JUNE, 1998)					
Run#	FLOW RATE (SCFM)	CONCENTRATION (PPM C3H8)	INFLUENT VOC RATE (LB/HR) (AS C3H8)	CONCENTRATION (PPM C3H8)	EMISSION RATE (LB/HR) (AS C3H8)
	(Qs)	(Cs)	(E)	(Cs)	(E)
1	13,000	11	0.9	3	0.24
2	13,000	12	1.1	3	0.25
3	13,000	11	1	3	0.23

SLUDGE DRYER TRAIN 2 (JULY, 2000)						
Run#	FLOW RATE (SCFM)	CONCENTRATION (PPM C3H8)	INFLUENT VOC RATE (LB/HR) (AS C3H8)	OUTLET		
				FLOW RATE (SCFM)	CONCENTRATION (PPM C3H8)	EMISSION RATE (LB/HR) (AS C3H8)
	(Qs)	(Cs)	(E)	(Qs)	(Cs)	(E)
1	11,100	20.54	1.56	11,100	1.53	0.12
2	11,600	18.52	1.47	11,600	1.29	0.1
3	10,800	18.72	1.39	10,800	1.46	0.11
AVERAGE	11,167	19.26	1.48	11,167	1.43	0.11

SLUDGE DRYER TRAIN 2 (JUNE, 1998)					
Run#	FLOW RATE (SCFM)	CONCENTRATION (PPM C3H8)	INFLUENT VOC RATE (LB/HR) (AS C3H8)	CONCENTRATION (PPM C3H8)	EMISSION RATE (LB/HR) (AS C3H8)
	(Qs)	(Cs)	(E)	(Cs)	(E)
1	12,000	28	2.3	9	0.76
2	13,000	25	2.2	7	0.63
3	13,000	30	2.7	8	0.7
AVERAGE	13,000	27.6	2.4	8	0.7

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The operating cost for the facility in 2001 was \$667,508.76 and the value of product sold was \$92,570.28, for a net cost of \$574,938.28, or \$254.49 per dry ton.

The product is sold for \$38 per ton and would cost \$37.50 per ton to dispose of through land application or incineration. This repre-

sents an additional savings of \$75.50 per ton. Taking into account the cost of disposal, the net cost is \$486,545.91, or \$215.64 per ton.

Biosolids Facility Maintenance

The biosolids staff maintains a rigorous program of preventive and predictive maintenance to keep the facility operating at peak efficiency. The program consists of a weekly agenda for each of the three two-person crews. Each crew maintains a specific section at the facility for two years, after which the sections are rotated so that crew members gain expertise in all areas. Each crew performs all maintenance, including repairs, for its assigned section.

Predictive maintenance includes thermal imaging of control panels, heat measurement of bearings, and vibration analysis of motors and gearboxes. Preventive maintenance includes regular purging and lubrication of all moving parts; checking the torque of all bolts and screws; and inspection of inner surfaces of the burners, drums, and scrubbers. The facility is kept meticulously clean at all times. The operating floor was refinished in May 2002 with an epoxy resin to enhance the aesthetic appearance of the facility.

Public Acceptance

The city of Largo Biosolids Facility produces high-quality, pelletized domestic residuals. The finished product has very little odor and has a beneficial use. The facility staff encourages public acceptance by offering tours to school and civic groups. Recent tours have included the Largo High School Agricultural Club, the Largo Citizens Academy, Largo Middle School, Largo Elementary School, the Florida Water Pollution Control and Operators Association, and the city of Largo Leadership Enrichment Program.

The Largo Fire Department uses the biosolids facility's silos to practice high rescues. The facility is detailed on the city's Web site at www.largo.com and has been highlighted in a local newspaper, *The Largo Leader*. The city of Largo recreation division regularly uses the pelletized residuals for landscaping purposes.

TABLE 5

BIOSOLIDS YEARLY REPORT FOR 2001				
	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Operation Hours	1290	1078	906	923
Pressed Gallons	17,429,954	15,198,708	12,571,471	13,439,113
Net per Wet Ton (Avg.)	(\$305.00)	(\$210.00)	(\$177.00)	(\$156.00)
Wet Sludge Tons	5210.14	4477.98	3577.88	3847.9
Solids LBS/Hr.(Average)	23,739	19,948	17,266	15,844
Tons Shipped	647.53	740.77	617.39	455.02
Main Consump Therms	150,823	125,248	86,600	112,517
Product Sold	\$24,606.14	\$28,149.26	\$23,460.82	\$17,290.76
Total Operating Cost	\$232,979	\$156,152	\$94,309	\$112,464

BIOSOLIDS YEARLY REPORT FOR 2000				
	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Operation Hours	1175	1047	864	1154
Pressed Gallons	11,529,328	12,883,045	9,727,989	13,997,350
Net per Wet Ton (Avg.)	(\$192.31)	(\$240.34)	(\$244.10)	(\$234.74)
Wet Sludge Tons	3788.88	3771.44	2794.59	3746.3
Solids LBS/Hr.(Average)	24,593	18,610	18,120	17,678
Tons Shipped	654.51	650.36	471.26	539.94
Main Consump Therms	123,566	96,793	88,718	117,611
Product Sold	\$23,582.04	\$24,713.68	\$17,907.88	\$20,517.72
Total Operating Cost	\$133,063.89	\$102,296.15	\$111,440.00	\$141,282

Total for Year 2001	
Operation Hours	4,197
Pressed Gallons	58,639,246
Cost per Wet Ton (Avg.)	(\$214)
Wet Sludge Tons	17,114
Tons Shipped	2,461.00
Main Consump Therms	475,380
Product Sold	\$92,570.28
Total Operating Cost	\$667,508.76
Average cost Per Therm	\$0.81
Polymer cost per Ton	\$2.04

Total for Year 2000	
Operation Hours	4,240
Pressed Gallons	49,137,712
Cost per Wet Ton (Avg.)	(\$228)
Wet Sludge Tons	14,101
Tons Shipped	2,316.00
Main Consump Therms	426,688
Product Sold	\$86,721.32
Total Operating Cost	\$488,082.14
Average cost per Therm	\$0.66
Polymer cost per Ton	\$2.29

Year 2001 Savings		
	Savings	Down by %
Production		(up) 18%
Polymer	\$4,282.90	11%
Operation Hours (electric)	\$648.14	1%
Operation Man Hours	\$1,341.96	1%
Main Consump Therms	\$34,416.90	8%
Product Sold	\$5,848.96	(up) 6%
Total Savings	\$46,548.86	

Looking Ahead

Proposals Sought by Research Foundation

The Awwa Research Foundation has requested proposals for 21 research projects scheduled to be launched in 2004. The projects, with more than \$6 million in funding available, are categorized by the foundation's four strategic

goal areas: efficient and customer-responsive organization, environmental leadership, high-quality water, and infrastructure reliability.

Requests for proposals (RFPs) for the projects are available online at www.awwarf.org. Proposals submitted in response to an RFP must be postmarked by either

May 7 or July 15, as specified in each RFP. Unless otherwise indicated, at least 25 percent of each project budget must be in-kind or cash contributions. In-kind contributions may be labor, materials, or laboratory and other services. They may come from participants such as water utilities, consulting firms, and universities.