COMPOSTING BIOSOLIDS IN VIRGINIA: CASE STUDIES OF THREE FACILITIES

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ABSTRACT

Composting of biosolids generated from wastewater treatment plants (WWTPs) has continued to increase over the past 16 years. There are approximately 280 biosolids composting facilities currently operating in the United States. The production of an "Exceptional Quality" (EQ) product as outlined in the United States Environmental Protection Agency (USEPA) Part 503 Regulations, system flexibility, and economics are key factors that have led to the continuous increase in the number of operating facilities. This paper will present information on three operating biosolids composting facilities in the Commonwealth of Virginia. The three facilities are the Town of Abingdon facility, the Harrisonburg-Rockingham Regional Sewer Authority (HRRSA) facility in Mt. Crawford, and the Rivanna Water and Sewer Authority (RWSA) in Charlottesville. For each facility, information such as facility design, equipment, capital cost, operating costs, operational experiences, and product marketing programs will be provided.

The Town of Abingdon had been disposing dewatered biosolids in a landfill. Based on a demonstration project and cost analysis, the Town decided to compost and produce an EQ, marketable product. The facility utilizes yard waste collected by the Town as a bulking agent, and composting occurs on an open pad adjacent to the WWTP. The facility composts approximately one dry ton of biosolids per day. The facility markets the finished compost under the name Wolf Creek.

The HRRSA facility was designed to compost 5.5 dry tons of 25 percent solids digested biosolids per day. The facility has been operating since January 1996 and currently composts approximately 2.5 dry tons of biosolids per day, with the remaining 3 dry tons utilized in a liquid land application program. The facility utilizes wood chips as a bulking agent. All materials

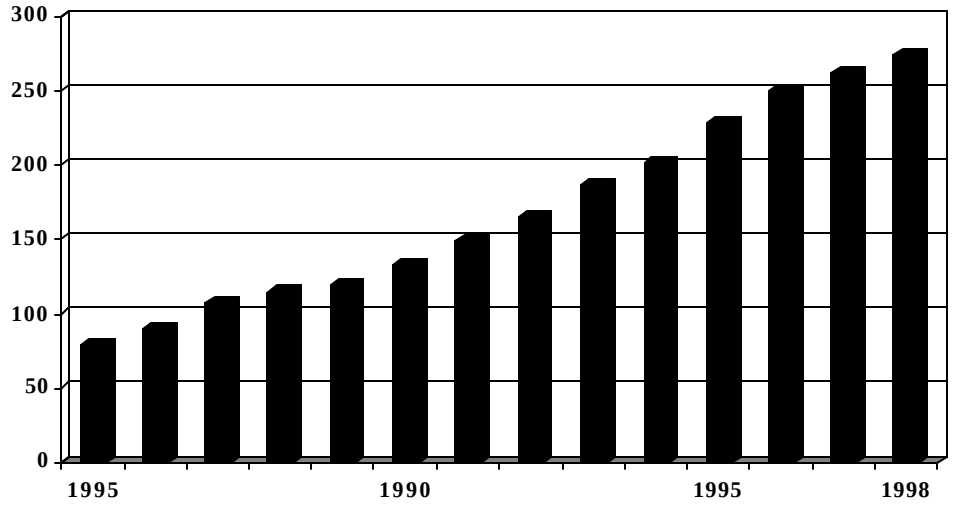
handling processes are conducted on a concrete pad, and curing occurs on asphalt pads. The materials handling, composting, and curing areas are covered. The compost is principally sold to local landscapers and the Virginia Department of Transportation for highway landscaping and wildflower production.

The RWSA facility currently composts approximately 7.7 dry tons of biosolids per day. The facility began operating in 1984 and consists of a covered asphalt composting area and mobile materials handling equipment. The facility utilizes wood chips and shredded pallets as a bulking agent. Based on a recent biosolids management study, RWSA decided to cease landfilling and divert all of the biosolids generated at the WWTP to the composting facility. As such, the facility is currently going through an expansion to 13.5 dry tons of biosolids per day. In the expansion, the composting area and the bulking agent storage area will be increased, and all materials handling will be conducted under cover. The finished compost is sold to local residents and landscapers.

INTRODUCTION

Composting of biosolids generated from WWTPs has continued to increase over the past 20 years. Figure 1 shows the growth of biosolids composting in the United States since 1985.

FIGURE 1
Number of Biosolids Composting Facilities Operating in the United States



There are several factors that contributed to this continual growth:

- Federal Regulations – The USEPA encourages beneficial use and production of Class A, EQ products.
- Economics – Composting, after direct land application, is the most economical biosolids management option.
- System Flexibility – Numerous options in system design are available to suit local conditions.
- Product Marketability – The compost produced is widely marketed and accepted.

The growth of biosolids composting should continue and will probably increase as a result of public apprehension over land application of Class B biosolids. Currently, there are local land application bans in areas of California, Virginia, New Hampshire, and Maine.

Biosolids composting produces a Class A product, which has numerous applications in agriculture and horticulture. Income from the sale of the product has often significantly reduced operating costs.

This paper will describe three operating facilities in the Commonwealth of Virginia. The three facilities are the Town of Abingdon facility, the HRRSA facility in Mt. Crawford, and the RWSA facility in Charlottesville.

ABINGDON, VIRGINIA

The Town of Abingdon dewaters anaerobically digested biosolids using a centrifuge to a total solids content of between 16 and 21 percent. As part of a previous WWTP expansion, the facility included a 34,000 square foot asphalt pad for use as a composting area. Due to low tip fees, the Town determined that landfilling biosolids was more cost effective. With tip fees rising and the hauling distance to the nearest landfill increasing, along with a desire to beneficially reuse the biosolids, the Town began to investigate co-composting the biosolids with yard waste and wood waste. Based on their initial investigation, they decided to evaluate a full-scale composting facility. A composting demonstration project was initiated in October 1998. Based on the demonstration study, a conceptual design and economic analysis was conducted. This resulted in implementing the current facility.

Site and System Design

The site is located at the Town's WWTP. The overall site contains the composting area and the yard materials storage area. In addition, a finished compost storage building was located away from the activities of the WWTP. This allows for public access and sales. The composting area is paved and sloped so that run-off is drained and returned to the WWTP. The facility consists of the following elements:

- Three-sided concrete biosolids receiving bin
- Mixing area with batch mixer that discharges mix into two-sided concrete bunker
- Composting pad containing five 5-horsepower blower stations and control building (pad is designed for 28 calendar days of composting)
- Bulking agent storage area

- Screening area located between bulking agent storage area and mixer to minimize materials handling
- Covered aerated curing area with four blowers
- Finished compost storage area

Economics

The capital costs are shown in Table 1. An estimated cost for the composting pad that was previously constructed is approximately $156,000.

TABLE 1 – Capital Costs for the Abingdon Facility

Category	Cost
Curing Building	$60,000
Site Work	$0
Asphalt Pad	$0
Control Building	$2,500
Mixer	$40,000
Compost Blowers	[a]$1,500
Curing Blowers	$500
Miscellaneous Piping	$500
Mobile Equipment	
Front-end Loader	[b]$41,000
Screen	$135,000
Electrical Service	$0
Electrical Connections	$2,000
Temperature Probes & Misc. Equipment	$1,000
Subtotal	$284,000
Engineering, Start-up, Marketing Assistance	$30,000
Total	$314,000

[a]Three 5-horsepower blowers were already on the site.
[b]The front-end loader costs were shared with other public works activities.

Operating costs are shown in Table 2. These costs are based on 293 dry tons per year of 18 percent solids.

TABLE 2 – Operation and Maintenance (O&M) Costs for the Abingdon Facility

Category	Cost
Labor[a]	$0
Maintenance[b]	$9,100
Fuel[c]	$1,500
Electricity[d]	$800
Yard Waste Grinding	$10,000
Monitoring[e]	$2,400
Miscellaneous[f]	$2,500
Total O&M Costs	$26,300

O&M Costs Per Dry Ton of Biosolids[g]	$90

[a]No additional labor was hired.
[b]Based on annual maintenance cost of 3 percent of screen capital, 5 percent of mixer capital, 5 percent of front-end loader capital, purchasing new aeration pipe, and $1,000 maintenance for the asphalt pad.
[c]Based on 3 gallons/hour and 12 hours/week for the front-end loader, 3 gallons/hour and 7 hours/week for the screen, and $0.60/gallon for diesel fuel.
[d]Based on mixer and blower estimated usage rates and $0.05/Kwh.
[e]Based on 12 samples monitored for nutrients and metals.
[f]Miscellaneous includes insurance and licensing fees.
[g]Based on 293 dry tons per year.

Table 3 shows the estimated first year annual costs. These costs include revenue from compost sales and revenue from leaf compost sales. A separate leaf compost is produced in an area adjacent to the biosolids composting area. The leaf composting is part of the overall composting activities of the facility. In the second and following years, additional revenue is expected from biosolids delivered from other communities. In addition, tip fees from yard waste/wood waste are currently $0.

TABLE 3 – Annual Costs for the Abingdon Facility (based on processing 293 dry tons of biosolids)

Category	Cost
Annualized Capital	$38,000
Annual O&M	$26,300
Total Annual Costs	$64,300
Total Annual Cost/Dry Ton of Biosolids	$219
Revenue from Leaf Compost Sales	$9,600
Revenue from Compost Sales	$16,400
Total Annual Costs Minus Revenues	$38,300
Total Annual Costs Minus Revenues/Wet Ton Biosolids	$131

Product Marketing

The product is of excellent quality. It meets USEPA Exceptional Quality criteria. There is a high demand for compost in the Town of Abingdon and the Tri-Cities of Bristol, Johnson City, and Kingsport, Tennessee, which are nearby. The principal markets are nurseries, greenhouses, landscapers, and topsoil blenders. Two different products are being sold. The screened leaf humus is priced at $13 for quantities of 1 to 24 cubic yards. Discounts are provided for larger quantities. One-cubic-foot bags and three-cubic-foot bins are sold at $3 and $5, respectively. Biosolids compost is sold for $15 per cubic yard for quantities up to 24 yards and $11 per cubic yard for quantities of 24 to 100 cubic yards. Bags and bins are sold at $3.50 and $6, respectively.

HRRSA

The HRRSA operates a 16 million gallons per day secondary treatment plant that serves approximately 40,000 persons and accepts a significant amount of industrial wastes from four area poultry processors. The North River Wastewater Plant was recently expanded from 8 to 16 million gallons per day and is currently treating 9.1 million gallons per day of wastewater. Thickened sludge from the treatment plant is anaerobically digested prior to being dewatered with a new high-solids belt filter press. A covered Aerated Static Pile (ASP) composting facility was constructed in 1995 and began operations in 1996.

Site and System Design

Although the design and construction of these facilities included dewatering and composting, this paper will discuss the composting portion of the facility only. The composting facility is designed to process 5.5 dry tons per day of 25 percent total solids digested biosolids cake on a five-day-per-week operating basis. A description of the process flow and equipment features at this facility follows:

- Site Characteristics – The composting facility is located on a two-acre parcel of land immediately adjacent to the existing digesters and dewatering building at the North River Wastewater Plant. Minimal site grading and other preparation activities were required for the construction of the composting facility. All biosolids receiving, mixing, composting, drying, screening, curing, and compost storage activities occur under a 40,000-square-foot pre-engineered metal building.

- Materials Delivery and Processing – Dewatered biosolids are conveyed from the belt filter press to a concrete storage bunker in the composting facility. Wood chips are delivered in dump or live-bottom trailers for use as the primary bulking agent. A portion of the wood chips (up to three operating days' worth) can be stored under cover, with the balance stored outside on an asphalt pad.

- Bulking Agents – Papermill-quality wood chips are used as the primary bulking agent and are supplemented with a limited amount of yard waste available from the Rockingham County Landfill. An asphalt storage pad is provided for storage of new bulking agent as well as recycled bulking agent.

- Mixing – Mixing of the bulking agents with biosolids occurs in an electrically driven 18-cubic-yard batch mixer. The batch mixer is equipped with weigh scales to determine exact quantities of each of the bulking agents as well as the biosolids used in any given mix. A front-end loader is used to load the batch mixer with the biosolids and the bulking agent. After thoroughly mixing these materials, the initial mix is discharged into a 60-cubic-yard three-sided concrete storage bunker, which is also under cover in the composting building.

- Composting – Composting of the biosolids occurs under cover in a 15,000-square-foot area. A front-end loader picks up the mixture from the initial mix discharge bunker and

places it in the static piles in the composting area. The facility is designed to allow a one-foot base of wood chips to be placed over aeration piping, followed by eight feet of mix and a one-foot insulative cover of recycled compost. Compost piles are approximately 90 feet long. Polyethylene pipe is used to supply aeration to the compost piles. Sixteen aeration stations, each capable of providing 630 cubic feet of air per minute at eight inches of water column, service two polyethylene headers spaced approximately four feet apart. Each blower station is capable of operating in the induced draft (negative) or forced (positive) aeration mode, depending on operator preference and the stage of the composting process. Negative aeration allows capture of the odorous exhaust and treatment through a biofilter system. To date, the facility has experienced no odor problems and only practices positive aeration. The aeration rate delivered to the static piles is controlled based on operator adjustments through a central programmable logic controller system. Allowance for up to five days of aerated drying is also provided in the composting building for times when additional drying is necessary.

- Screening – After composting, the material is screened through a deck-type screen. The screening system has a capacity of 40 cubic yards per hour and produces a 3/8-inch minus compost product for curing and use.

- Curing – Aerated curing is provided under cover using portable blower stations and perforated polyethylene pipe. This area is located adjacent to the composting area and is sized to handle 30 days of screened compost production. Six portable aeration stations are provided in the curing area for positive aeration. Cycling timers control aeration rates as necessary in this stage of the process. Upon completion of the curing period, the compost is stored under cover or moved outside to the storage area for marketing. The paved storage area provides up to two months' capacity for the finished compost product.

- Odor Control – Odor control at this composting facility consists of treating process offgas from the most odorous composting process and treatment through a biofilter system. Initial modeling at the facility indicated that the nearest receptors, approximately 1,000 feet from the facility, would not be adversely affected with this type of odor control approach. A 3,150-cubic-feet-per-minute biofilter has been provided to allow a 60-second residence time of odorous gases in the open bed biofilter system for treatment. Moisture control is provided through in-line humidification and surface irrigation. To date, use of the biofilter system has not been required.

Two part-time operators are utilized to operate the composting facility two to three days per week. These operators also perform other plant operations, such as dewatering, land application of liquid biosolids, and other duties within the wastewater plant operation.

Economics

The capital costs for the covered composting facility are shown in Table 4, and the operating costs are shown in Table 5.

TABLE 4 – Capital Costs for the HRRSA Facility[a]

Category	Cost
Total Capital Cost[b]	$1,510,000
Cost per Dry Ton per Day of Capacity	$274,500
Cost per Wet Ton per Day of Capacity	$68,600

[a]HRRSA costs based on 5.5 dry tons per day, 5 days per week, and 25 percent total solids cake.
[b]Includes all facilities, equipment, site work, engineering, permitting, and construction management. Land costs and dewatering costs are not included.

TABLE 5 – Annual O&M Costs for the HRRSA Facility

Category	Cost ($)	% of Total
Labor	$39,500	55
Utilities	$3,600	5
Maintenance	$2,100	3
Bulking Agent	$13,300	19
Fuel	$1,800	2
Miscellaneous	$11,400	16
Total	$71,700	100
Compost Revenue[a]	$16,800	--
Net O&M Costs[a]	$54,900	--
Net O&M Costs/Dry Tons[a]	$120	--

[a]Based on the facility processing 458 dry tons during fiscal year 1999.

Product Marketing

A compost marketing assessment was performed in mid-1994 to determine potential demand for a compost product. Currently, the HRRSA is initiating a program to market the compost using in-house personnel. The product is sold for $15 per cubic yard. One of the biggest users of the product in the past has been the Virginia Department of Transportation. They use a considerable amount on intermediate highway strips for wildflower vegetation.

RIVANNA WATER AND SEWER AUTHORITY

The Rivanna Water and Sewer Authority (the RWSA) currently operates a 7.7 dry ton per day composting facility to handle most of the biosolids produced by the Moores Creek Wastewater Treatment Plant. The WWTP is designed to handle 15 million gallons per day (MGD) and is currently treating an average of 11 MGD. The existing composting facility processes about 78 percent of the biosolids currently produced at the WWTP. The RWSA is currently constructing an expansion to the existing composting facility that will increase the capacity to 13.5 dry ton per day. This will provide sufficient capacity to process all the biosolids produced at the WWTP at the full design flow of 15 MGD.

Site and System Design

The facility is an aerated static pile composting operation located at the site of the WWTP. The existing facility consists of a 90 X 293 foot roof only structure and an asphalt pad for final product storage. The expansion will include an additional 70 X 293 foot roof only building and a new asphalt pad to provide delivery access to the expanded facility. The existing building will house the aerated static piles. Capacity for 18 days of composting will be available. The new structure will house the mixing, biosolids, and bulking agent receiving and storage areas. The facility will consist of the following elements:

- Three-sided concrete bunker that will provide two operating days storage of biosolids.
- Stationary batch mixer that will discharge to a three-sided concrete bunker.
- Two two-sided concrete bunkers that will provide up to 17 operating days storage of recycled bulking agent and four days storage of new bulking agent.
- Screening area located under the roof adjacent to the recycled bulking agent storage bunker.
- 22 computer-controlled blowers will provide aeration to the compost based on a temperature and an adjustable time cycle. The composting piles are designed for a seven foot mix height. This allows future increases in capacity by increasing the mix height of the piles.
- All of the new floor space will be asphalt with no concrete floors.
- No odor control system is provided.

Economics

The total capital cost for the composting expansion is estimated at $1,000,000. Table 6 outlines the capital cost.

Table 6 – Capital Costs for the Rivanna Composting Facility

Category	
Site Work	$58,300
Pads & Walls	$117,200
Structures	$468,900
Blowers & Mixer	$150,000
Electrical & Controls	$55,600
Engineering & Contingency	$150,000
Total	$1,000,000

Table 7 – Estimated O&M Cost for Expanded Facility Handling 13.5 DTPD

Category	Cost
Labor	$113,670
Bulking Agent	$65,000
Equipment Maintenance	$37,650
Site Maintenance	$8,091
Fuel	$34,632
Electricity	$16,500
Product Monitoring	$2,000

License Fees	$900
Miscellaneous	$1,460
Total O&M Cost	$279,903
Compost Revenue (@ $13 per cubic yard)	$212,900
Net O&M Cost	$67,003
Net O&M Cost Per Dry Ton	$19.08

Table 7 Total Annualized Cost Based on a 7% Discount Rate

Category	Cost
Amortized Capital (Existing Facility)[1]	$70,600
Amortized Capital (Expansion)	$101,600
O&M	$279,900
Total Annual Cost	$452,100
Compost Revenue	$212,900
Net Annual Cost	$239,200
Net Annual Cost per Dry Ton	$68.15

[1] From the RWSA Records

PRODUCT MARKETING

The compost product is of excellent quality and meets US EPA Exceptional Quality criteria. Demand is good for the product and the RWSA currently charges $13 per cubic yard for the finished compost. Since a detailed marketing study has not been performed it is not known if the increased compost production will effect the cost given the current market.