Recycling Technical Assistance Project #557
New Wilmington Borough, Lawrence County, PA

Building Efficient, Viable, Durable Hauling Routes from Waste-Generating Businesses and Institutions to Local Composting Farmers

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Prepared by the Pennsylvania Resources Council

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1.0 Introduction

1.1 Purpose

In April, 2014 New Wilmington Borough submitted an application for a Recycling Technical Assistance project to the Pennsylvania Department of Environmental Protection (PA DEP), as project lead on behalf of nearby municipalities in Lawrence and Mercer counties: Volant Borough; Townships of Wilmington, Neshannock, Hickory, Washington, Plain Grove and Pine; and the Cities of New Castle, Grove City, Sharon and Hermitage. The project required the PA Resources Council (PRC) to conduct research with major food-waste-generators within short distances from existing composting farmers in the area for the purpose of designing an initial set of viable hauling routes from these generators to compost sites.

1.2 Background

Seven regional farmers in the region have obtained PA-DEP on-farm composting permits (WMGM017). Five of the farmers, in two clusters, have formed a legal cooperative, *Neshannock Soil Builders Coop* (henceforth 'the Coop'). The Coop has secured regular deliveries of leaves/yard-waste from seven municipalities and two one-year contracts with regional haulers of Wal-Mart/Sam's Club food-waste.[i] Since May 21, 2013, these farmers have accepted roughly 5,490 tons of compostable waste (food-waste, leaves, yard-waste, wood-waste, manure, etc.) and produced over 1,200 tons of finished compost.

The service agreements with Wal-Mart's haulers have provided this initial group of participating farmers with significant tons of material; regular practice in managing compost operations of considerable scale; and significant tipping fee income. However, there are three reasons why local compostable-waste hauling routes are critical to the medium and longer-term success of these farm-based operations and the soil-building frontier which they help open. First, a durable infrastructure is not dependent on any one source of material. Second, the environmental benefits of the infrastructure are greatest when hauling distances are shortest. [ii] Third, given the relatively low value of both compostable waste and compost relative to the cost of other trucked material, *most of the benefits of compost will accrue to areas near waste-generators and composting and compost-applying farmers.* The strong local and regional benefits deserve to be best appreciated and most highly valued among people and institutions near the local waste generators (FWG's), composting farmers, compost-using farmers and other soil-builders. The key relationships in the local routes discussed here are between composting farmers and local FWGs.

1.3 Summary of Approach

The goal is to create compostable-waste hauling systems from local FWGs to composting farmers that are efficient, viable and durable.[iii] This report is divided into two main sections. The first focuses on the physical efficiency of diversion and hauling; the second on the viable pricing of compostable-waste hauling and tipping fees. *The efficiency section* begins with a description of the operational choices that the Coop has made and how these choices affect FWG's. The choices of containers and trucks set the parameters in which physical route efficiency is maximized. Procedures are described for determining realistic rates of easily-divertible compostable-waste generation for each of 50 FWGs near composting farmers. This section ends with a presentation of four physically efficient routes.

The viable pricing section begins with an introduction to hauling and tipping fees, the services they pay for, and questions of standardized per-unit pricing. Estimated costs of hauling the physically-efficient routes are presented, as well as actual capital and operational costs of composting by the farmers over the past year; and two largely potential sources of farmer benefit beyond tipping fees. The section ends with a standardized, volume-unit-based pricing of hauling and tipping that covers these costs, for initial consideration by the composting farmers and the FWGs, to serve as a starting-point for negotiations.

2.0 Maximizing Route Efficiency

2.1 Planned Operations of Compostable Waste Diversion and Hauling

After two years of negotiations among farmers, FWGs and a regional waste hauler, it became apparent that the margins of compostable waste hauling on local routes were likely to be too slim to afford the services of a commercial hauler. A key benefit of local routes is that they can be directly serviced by the farmers themselves. The Coop can own the truck(s), totes and other equipment; plan, amend, execute and manage the routes (hiring drivers or driving themselves); enter into service agreements with FWGs; etc. Operations move material from waste-streams to containers; and from containers to trucks.

<u>Containers.</u> It is assumed that few FWGs would find acceptable a waste-hauling system with less frequent service than at present. Although less frequent service would allow lower hauling costs, composting operators would prefer to receive material that is less putrescent, 'fresher'. Less frequent service would require larger dumpster-type containers which would require a significantly higher capital investment and add a further step to FWG diversion. The ideal container for compostable waste appears to be a tote of durable plastic, wheeled and lidded, which can be moved easily. Upper level managers at a major supermarket chain with diversion experience in Ohio recommend a 65-gallon capacity (27" wide x 33" deep x 41" high) tote.[iv] Cleaned empty totes are placed in appropriate areas of work and waste-generation: prep areas of kitchens; self-busing areas in cafeterias; dishwashing areas; offices and classrooms for mixed paper. Full ones will be staged at the collection point and serviced three times each week.

<u>Liner Bags or Cleaning Totes.</u> Plastic liner bags do not decompose at rates of organic material and require many hours of ripping open and emptying to discard. One popular alternative among organic waste routes with higher margins is compostable liner bags. However, these are roughly five times the cost of plastic liners, and pure food waste is so dense that the risk of ripping is high. It was decided to avoid the cost and work of liner bags altogether and place the burden of cleaning and sanitizing each tote immediately after each pull by the composting/hauling farmers themselves.

<u>The Truck.</u> Based on the data developed as part of this report, it was determined that one collection truck is capable of servicing all FWG's in proximity to two clusters of composting farmers. Two basic truck types have been identified that might effectively service these local routes. They differ in price, capacity and operational requirements for the hauler to load, dump, wash and replace totes. The first is a *smaller and less expensive* truck (24' box or stake body), equipped with a power tailgate lift. In this option, the driver would swap out empty for full totes at each collection point. A full load of 24 totes would be transported to the collection site for tipping. Once manually tipped, the totes would be cleaned at the compost site and reloaded as the set of swap out containers for the next collection point. The second option is a *larger and more expensive* truck, a 20 cubic yard capacity self-dumping truck, equipped with a 'candy-cane' style side lift that lifts two totes at a time over the top of the truck bed for tipping. This vehicle would be equipped with an on-board wash system (hot water tank; 'green' sanitizing detergent tank; power-wash hose and nozzle) to allow for the washing of each tote directly into the truck bed.

2.2 Principles of Building Efficient Routes

The most efficient hauling route delivers the greatest amount of material – and through it the greatest income—with the lowest operational costs. Fiscal efficiency here happily coincides with environmental efficiency (minimizing fossil-fuel energy use, air pollutants and greenhouse gas emissions). All three fiscal cost components (diesel, labor, truck use) are obviously affected by miles per route: reducing miles reduces all three. However, each cost component is also affected by the number of stops per route; the amount and speed of traffic; the terrain covered; the average miles-per-gallon achieved under actual route conditions; and the efficiency of the driver in positioning truck, collecting totes, washing totes etc. An additional principle follows from maximizing route density: build routes around the largest stops, for this project the largest food-waste generators within a reasonable hauling distance.

2.3 Estimating weekly weights and volumes of easily-divertible compostable waste

A key goal of this project was to conduct waste-sorts at as many of the major FWGs within a reasonable distance of the composting sites as possible. For these efforts project staff arranged to have access to 24-hours of waste from each participating FWG. All waste was then hand-sorted into two categories: 1) easily divertible compostables and 2) all remaining waste. Weight and volume of each was then extrapolated to provide estimates of weekly generation rates and percent compostables. This data allows estimated volume and weight of material per stop and the design and modeling of specific routes.

Project staff began by developing a list and map of all larger commercial and institutional FWG's. These included supermarkets, schools, universities restaurants, hospitals and nursing homes. Specific attention was given to FWG's with multiple locations: Giant Eagle, Eat n Park, Sheetz, etc. Appendix 1 summarizes primary types of compostable waste found at each type of FWG. From the assembled list, an initial target group of 50 major FWGs in the two areas was identified as the focus of this report. Of this group, waste sorts were conducted at 14 sites. Waste generation data from an additional 6 supermarkets was obtained from corporate-level management. Appendix 2 summarizes experiences with the initial list of major FWGs.[v] The data from these 20 locations was used to establish average generation rates by generator type. These averages allowed for the calculation of estimated generation rates of all other targeted FWG's. Appendix 3 provides estimated generation rates of easily divertible compostable waste, and estimated percentages of all currently non-recycled solid waste at each FWG.

2.4 Modeling Efficient Routes

The four initial route areas are as follows:

- North Beaver 1: Beaver Falls/Darlington/Chippewa
- North Beaver 2: Rochester/Beaver
- Law-Mer 1: Sharon/Hermitage/Grove City
- Law-Mer 2: New Castle/New Wilmington

As the larger, more efficient truck is limited to 20 cubic yards per pull, and the target for this report was two routes per cluster, some cuts were made to select FWGs for inclusion in initial mapping of four routes. All major FWGs were divided into the four potential routes. FWGs that did not meet criteria (relatively high rate of compostable waste generation; waste-sort conducted or data obtained from managers; an expression of some interest; proximity to participating farmers and/or other major FWGs) were deleted until each of the four routes fell below 20 cubic yards. Based on the observed and estimated waste generation rates derived from the waste sorts a simple mapping tool was used to design a routing system which is sensitive to efficiency, compost site locations and operational considerations. From these, hours en route (assuming an average of 45 MPH) and minutes per stop (assuming 3 minutes per tote) were estimated. Appendix 4 presents these four large truck routes considered most efficient using the above criteria. An analysis of routes with the smaller truck revealed that these cannot generate adequate revenue to cover basic hauling costs (Appendix 5).[vi] These small truck routes were not explored further.

3.0 Determining Viable Pricing of Proposed Routes

3.1 Definitions, standardization

Businesses typically pay waste haulers a monthly fee with two major components: a hauling fee, to pay for the costs of hauling the waste, and a tipping-fee, to pay for the costs of operating an environmentally-benign landfill. Local FWGs vary in the size of their financial margins. Based on previous experience, it appears that commercial waste haulers exercise some latitude in pricing among their clients. Sliding-scale pricing was considered, to maximize the affordability of participation. However, it was decided that standardized pricing across all FWGs and municipalities is a simpler approach and one that does not require divulgence of confidential information.

What unit should be used as the basis for pricing? The three obvious choices are per weight (ton), per volume (traditionally per cubic yard) or per tote (another volume measure), all within a given time period (week or month, typically). While landfill tip fees are based per ton, as are most compactor fees, most businesses and institutions pay based on service frequency of dumpsters of specified sizes (cubic yards). A base standardized pricing on a per tote-pull basis was used: a flat fee for each pull of each full tote.[vii]

3.2 Estimating Hauling Costs

The basic operational costs of hauling are diesel fuel and adequate compensation for the drivers of the trucks along the routes. To estimate diesel cost, miles of all legs of each route were totaled; divided by an assumed MPG of 5 to estimate diesel gallons; and multiplied by $4.25 per gallon (assuming a plausible price increase over the coming two years). To estimate driver compensation, time was calculated in two categories: en route, by dividing miles for each leg by an assumed average speed of 45 MPH; at each stop, by multiplying the number of totes pulled at each FWG by 3 minutes and and a final 10 minutes to dump on a farm. The total estimated hours was multiplied by $15 per hour, reasonable compensation, given the range of skills, efficiencies and responsibilities required. For the small truck option, an estimated 2 hours at the end of each route was included, for the driver to hand dump 24 full totes off the back of the tailgate; unload the totes; bring them to a washing area set up at each farm; power wash them out; drip dry; and reload the cleaned totes onto the truck.

To estimate the full costs of hauling each of the four larger truck routes, a hybrid strategy was developed based on per-pull data. Estimates of diesel cost and driver compensation, using the methods summarized above, were used in the calculation. The capital costs of the larger truck ($125,000); a power side-arm lift ('candy-cane' style: $8,000); a power-wash system (hot-water tank, detergent tank, high-pressure hose and nozzle: $6,000); and additional totes required ($6,696) were divided by an estimated seven years service-life, for an amortized annual cost of $20,814. The use of a concentrated environmentally-friendly sanitizing detergent was estimated.[viii] Per mile estimates of other hauling cost components (repair and maintenance; insurance premiums; permits and licenses; tires; and tolls) were obtained from a 2013 study by the American Transportation Research Institute (ATRI)[ix] Appendix 6 summarizes these costs and establishes a $ per tote actual hauling cost.

3.3 Estimating Net Composting Costs

This section began by noting that monthly waste fees include a tipping component, to cover the costs of responsible landfilling of waste, meeting all standards for environmental protection. It would appear reasonable to assume that waste generators that recognize some of the public benefits of composting for soil-building might be expected to pay for safe composting and assurance that the bulk of compost is used to build healthy, productive regional soils. The farmers have shown they can compost a wide range of waste safely and efficiently, with unavoidable costs that are significant, especially for most regional farms. At the same time, they can and will derive economic benefits from the compost itself and these should be factored against costs in setting reasonable tipping fees. Capital and operational costs and benefits of on-farm composting, based on costs documented by the facilities, are now summarized.[x]

<u>Capital Costs</u>. Each of the five farmers who are full Coop members have been composting a range of waste material for over a year. Each farmer has expended necessary capital and labor in site preparation (stripping topsoil and grading) and improving access for trucks (grading, gravel). Four of the five have relied on existing equipment (bucket loaders or skid steers) for compost pile management and movement (see below). However, the Coop has purchased some equipment to gain efficiencies and improve their compost production systems including investments in site improvements. Appendix 7 shows capital costs of the five composting farmers over their first full year and includes an additional $8,000 per farmer in improved pad surfacing, expected to be completed over the coming months.

Operational Costs. Operational costs at the compost facilities include: diesel and labor in preparing beds of leaves/wood-waste for receiving food-waste; covering the food-waste with this complementary material; thoroughly mixing materials and forming them into windrows; aerating windrows at least once every two or three weeks (more often in wetter conditions); monitoring temperatures, odors and moisture and adjusting aeration, blending ratios and/or pile size accordingly; reforming windrows; and harvesting finished compost, screening as needed. Finally, while farmers receive regular quantities of needed carbon-rich waste from municipal leaf and yard waste programs, each has had to purchase some supplementary material. Appendix 8 shows the operational costs of the five composting farmers over their first full year.

Estimated Benefits. The farm-based composting business model is predicated on two distinct sources of ongoing financial benefit beyond tipping fee income: production benefits from compost applications on farmers' own fields and sales of surplus compost to other farms nearby. Appendix 9 provides estimated *potential* annual financial benefits from these two sources that all five farmers can reasonably expect over the next couple of years, based on tons of food-waste accepted over their first full year.[xi]

To make the three estimates useful to route pricing, each is calculated as a per-ton of FWG waste accepted. The annual estimates are divided by the tons of waste farmers accepted from existing sources over their first full year. Appendix 10 presents the results. The estimated costs and benefits of on-farm composting are remarkably close, showing a net cost of $5,500 for all 5 farmers together, $1,100/year on average for each. As a per-ton-of-FWG waste rate, this net cost is $2.29.

3.4 Cost of Compostable Waste Collection Services

With solid estimates of route specific hauling costs and of net composting costs established, a minimum cost of providing compostable waste collection services can be determined. The costing presented in Appendix 6 is used to estimate the *net* costs (i.e. including potential benefits) of on-farm composting. First, net costs per ton of FWG waste were multiplied by the estimated tons of FWG waste on each route-pull; the results are included as a new column. When costs per route-pull are divided by totes pulled on each route, the costs per tote-pull are determined. Appendix 11 shows estimated hauling and net composting costs on a per route pull and per tote pull basis. The variation in per tote cost in the last column is the result of route specific factors (e.g. distances to the compost site; overall density).

Table 1: Estimated Cost of Service of Four Efficient Local Routes, each 3 pulls per week

Route	Diesel $4.20/ gallon	Driver $15.00/ hour	Truck & Eqpmnt	Green Sanitiz Detergnt	RIPTT[1]	Composting Costs	Total Cost	Totes	Cost/ Tote
New Castle	$31.44	$64.50	$33.26	$3.50	$10.70	$8.40	$151.80	66	**$2.30**
Hermitage	$70.28	$84.45	$33.26	$3.50	$23.93	$7.82	$223.24	68	**$3.28**
Beaver Falls	$46.12	$61.35	$33.26	$3.50	$15.70	$5.67	$165.60	60	**$2.76**
Rochester	$65.42	$67.50	$33.26	$3.50	$22.27	$6.26	$198.21	58	**$3.42**
Total	$213.26	$277.80	$133.04	$14.00	$72.60	$28.15	$738.85	252	**$2.94**
Total/week	$640	$833	$399	$42	$218	$84	$2,217		

1: RIPTT is the total estimated costs of repair and maintenance; insurance premiums, tires and tolls, based on ATRI mileage-based estimates.

Based on analysis, the figure $2.94 per tote-pull is the pricing that just covers the actual cost of service to offer food waste collection services. Several factors may raise this amount: it may take longer to service each stop; not all FWGs that comprise these routes may agree to participate; farmers may take longer to generate cost savings/higher production via applications or to develop markets for surplus compost among neighbors. To provide a wider middle ground for negotiations, a summary of the cost impact of a $4/tote-pull fee for each of the 50 FWGs is presented (Appendix 11) With both per cubic yard and per ton estimates, this allows each FWG to determine the cost of participation relative to current waste hauling.

4.0 Conclusion

Fifty major FWGs were identified in Northern Beaver, Lawrence and Southern Mercer counties and estimated rates of easily divertible compostable waste were derived for them. More than half of the FWG's expressed at least preliminary interest in diversion to composting farms. Four hauling routes were mapped from major FWGs to composting farms in these counties that are dense and efficient in waste-diversion per mile. A range of per-tote hauling-plus-tipping fees was identified that covers the estimated hauling and composting costs and is competitive with current solid-waste hauling, calculated per cubic-yard or per ton. The four routes would divert as much as 1,916 tons of compostable waste each year and would directly create two jobs and contribute to the economic development of the region.

Over the past decade or so, Northern Lawrence and Southern Mercer counties have begun to open some strong bridges between their non-farming and farming citizens. Farmers Markets in New Wilmington, Grove City and New Castle have all grown in participation and sales; local farmers are well represented at the successful market in Slippery Rock. There are a growing number of grass-fed beef growers, many of whom have developed more direct relations to butchers and markets; and several restaurants that source food locally. Hauling routes of compostable-waste from FWGs to composting farmers have strong synergies with the growing interest in supporting local farmers. To maximize the regional environmental and employment benefits of this frontier, New Wilmington Borough and nearby municipalities should encourage the parties in negotiating mutually satisfactory service-agreements, and in planning and launching successful hauling routes. All FWGs in Northern Lawrence and Southern Mercer counties should feel welcome to approach the farmers if they are interested. Other farmers in the area should be informed as more composting farmers will be needed as routes grow. School districts should be encouraged to obtain maximum educational value from participation. Municipalities can assist in expediting the launching of these routes by helping identify and secure economic development funds to support this cooperative enterprise.

A Final Note on Residential Leaves/Yard-Waste. This report has focused on the potential relationships between major food-waste-generators (FWGs) and nearby composting farmers. However, farmers cannot compost food-waste without significant amounts of complementary, Carbon-rich feedstock, e.g. autumn leaves, yard-waste and wood-waste.[xii] There are eight mandated municipalities in Lawrence and Mercer counties relatively close to the composting farmers (i.e. with populations and/or densities that require diversion of residential leaves and yard-waste): the cities of New Castle, Hermitage, Sharon and Farrell; Neshannock and Shenango Townships; and the Boroughs of Grove City and Elwood City. While the composting farmers cannot afford to purchase this material, they are happy to accept it as a feedstock without any charge to municipalities, as long as the material is either vacuumed loose or placed in large paper bags (no plastic). Municipalities can thereby avoid costs of composting themselves or paying others to compost for them. There is then a natural complementarity between the diversion of compostable waste from FWGs and the diversion of residential leaves and yard-waste, one that is likely to be advantageous to a good many nearby municipalities. Appendix 12 provides estimated annual *minimum* volumes of Carbon-rich feedstock required by composting farmers in Lawrence and Mercer counties to service Wal-Mart and local routes over the coming year. This is a mutually-beneficial relationship that should grow over time.

APPENDICES

Appendix 1: Types and Sources of Compostable Waste at Waste-Generating Businesses and Institutions

FWGs	Types of Compostable	Source Areas
Supermarkets	**Food-waste**, paper. Cardboard often baled for recycling.	Produce, Bakery, Butcher, Deli, Prepared Foods, Floral, Bathrooms, Offices
Convenience Stores	**Coffee grounds**, filters; food-waste; paper; cardboard	Prepared foods (e.g. 'made-to-order'); bathrooms
Restaurants	**Food-waste**, paper, cardboard.	Kitchen prep; dishwashing; bathrooms
Schools and colleges	**Food-waste**, paper, cardboard	Kitchen prep; self-bussing areas; bathrooms
Hospitals and Nursing Homes	**Food-waste**, paper. Cardboard often baled for recycling.	Kitchen prep; dishwashing.

Appendix 2: The Initial Sample of Major Food-Waste Generators

	listed	contacted	waste sorted	no sort but some interest	total potentially interested
Northern Beaver	19	18	9	7	16
North Lawrence-South Mercer	31	28	5	20	25
Central Fayette	24	19	6	6	12
Total	74	65	20	33	53

Appendix 3: Estimated Compostable Waste Diversion Potential for the Three Areas
3A) Estimated Compostable Waste Diversion Potential, North Beaver Area

Food-Waste Generator	compostables/week		percent compostable	
	lbs	gallons	% weight	% volume
Beaver Valley Nursing and Rehab Center	672	364		
Blackhawk High School	2019	1540	73%	54%
Highland Middle School	1024	880	74%	56%
Giant Eagle 0066 Chippewa	5294	1629	71%	58%
Sheetz Beaver Falls	513	435	54%	37%
Geneva College	2050	2706	64%	47%
Beaver Falls Middle School	808	614	71%	58%
Beaver Falls High School	1033	785	71%	58%
Beaver Falls Save-a-Lot	910	585	84%	67%
Ellwood City Hospital	479	259		
Rochester Manor	683	370		
Giant Eagle 0062 Rochester	4423	1361	71%	58%
Giant Eagle 0075 Baden	2613	804	71%	58%
Rochester ShopnSave	1460	720	88%	73%
Penn State-Beaver	1084	2909	64%	47%
Heritage Valley Hospital, Beaver	3312	1792		
Beaver Area Middle SchoolHigh School	1881	1275	64%	52%
Tusca Beaver ShopnSave	297	195	66%	38%
Sheetz Rochester	1024	885	53%	35%

Note: Cells without highlighting indicate results of waste-sorts at the FWG.
Cells in blue are data we received from upper-level management at the FWGs.
Cells in green are results of previous waste-sorts conducted at that FWG.
Cells in yellow are estimates based on project staff sorts at FWGs of the same type (see text).

3B) Estimated Compostable Waste Diversion Potential, Northern Lawrence/Southern Mercer Area

Food-Waste Generator	compostable/week		percent compostable	
	lbs	gallons	% weight	% volume
Wilmington Area High School	963	732	71%	58%
Wilmington Area Middle School	911	693	71%	58%
Westminster College	1566	2067	64%	47%
Springfield Grille:	1956	974	68%	45%
Iron Bridge Restaurant :	1956	974	68%	45%
Rachel's Roadhouse:	2445	1218	68%	45%
Hickory High School:	1820	1383	71%	58%
Delahunty Middle School:	682	518	71%	58%
Giant Eagle 4012 Hermitage:	8067	2482	71%	58%
Sharon Middle School/High School:	1919	1459	71%	58%
Sharon Reg. Hospital:	2046	1107		
PSU-Shenango:	884	1167	64%	47%
Sharon Save-a-Lot:	1460	720	89%	73%
UPMC Farrel:	1338	724	64%	47%
Neshannock Junior High/High School	1352	1028	71%	58%
Giant Eagle 4077 Wilmington Road	7035	2165		
Sheetz New Castle	815	427	46%	19%
Jameson Memorial Hospital	1881	1018		
New Castle JHigh School/High School	1766	1342	71%	58%
Giant Eagle 6386 Butler Road	6119	1883	71%	58%
Laurel Area Middle School/High School	1463	1112	71%	58%
Grove City Middle School	1113	697	73%	57%
Grove City High School	1692	1075	66%	54%
Grove City College	2474	3266	64%	47%
Orchard Manor Nursing Home	678	367		
Sheetz Butler Pike Grove City	1024	885	53%	35%
Sheetz West Main St Grove City	1024	885	53%	35%
Sheetz US 422 New Castle	1024	885	53%	35%
Sheetz South Hermitage	1024	885	53%	35%
Sheetz North Hermitage	1024	885	53%	35%
New Castle ShopnSave	878	458	77%	56%

Note: Cells without highlighting indicate results of waste-sorts at the FWG.
Cells in blue are data we received from upper-level management at the FWGs.
Cells in green are results of waste-sorts program staff conducted at that FWG several years ago.
Cells in yellow are estimates based on program staff sorts at FWGs of the same type (see text).

3C) Estimated Compostable Waste Diversion Potential, Central Fayette Area

Food-Waste Generator	compostable/week		percent compostable	
	lbs	gallons	% weight	% volume
Sheetz Uniontown	1743	1792	59%	50%
Giant Eagle Uniontown	4550	1400	71%	58%
Mt Macrina Manor	778	421		
Sheetz Save-a-Lot Salem Rd Utown	1024	885	53%	35%
Uniontown Hospital	1989	1077	24%	7%
Uniontown JHigh School/High School	1890	1436	71%	58%
Penn State- Fayette	1597	2108	64%	47%
Laurel Highlands High School	3290	2993	86%	77%
Walnut Hill ShopnSave	878	458	77%	56%
Walnut Hill Save-a-Lot	1185	653	87%	70%
Penn Blvd Save-a-Lot	1185	653	87%	70%
Laurel Highlands Middle School	1958	1593	70%	60%
Ben Franklin Elem/Middle School	1078	819	71%	58%
Golden Living Center	672	364		
Albert Gallitin High School	1470	1060	69%	53%
Albert Gallitin North Middle School	941	705	63%	56%
Brownsville Area Middle School	851	646	71%	58%
Brownsville Area High School	1168	887	71%	58%
Fairchance ShopnSave	878	458	77%	56%
Connellsville Area Jr High School	1739	1322	71%	58%
Connellsville Area High School	2707	2057	71%	58%
Sheetz Connellsville	1024	885	53%	35%
Connellsville ShopnSave	878	458	77%	56%
Masontown ShopnSave	878	458	77%	56%

Note: Cells without highlighting indicate results of waste-sorts at the FWG.
Cells in blue are data we received from upper-level management at the FWGs.
Cells in green are results of waste-sorts program staff conducted at that FWG several years ago.
Cells in yellow are estimates based on program staff sorts at FWGs of the same type (see text).

Appendix 4: Four Efficient Routes with the Larger Truck, all figures for a single pull, based on three-pulls per week

4A) North Beaver 1 (Beaver Falls/Darlington/Chippewa)

FWG	Miles	est hours en route	est Mins/ stop	lbs	gallons	totes	totes rounded	cu yds
DEPOT	0							
Sheetz Beaver Falls	16.46	0.37	9	171	145	2.4	3	0.7
Geneva College	0.28	0.01	45	683	902	15.0	15	4.5
Beaver Falls MS	1.46	0.03	12	269	205	3.4	4	1.0
Beaver Falls HS	0.04	0.00	15	344	262	4.4	5	1.3
Beaver Falls Save-a-Lot	1.05	0.02	12	303	195	3.3	4	1.0
Highland MS	4.78	0.11	15	341	293	4.9	5	1.5
Blackhawk HS	2.23	0.05	27	673	513	8.6	9	2.5
Brighton Hot Dog Shoppe	2.06	0.05	9	183	157	2.6	3	0.8
Giant EagleChippewa	0.29	0.01	27	1765	543	9.0	9	2.7
Harry's Place	6.16	0.14	9	217	153	2.6	3	0.8
Anderson FARM	6.6	0.15	10					
DEPOT	13.5							
TOTAL	54.91	0.92	190	4950	3368	56.133	60	16.7

4B) North Beaver 2 (Rochester/Monaca/Beaver)

FWG	Miles	est hours en route	est Mins /stop	lbs	gallons	totes	totes rounded	cu yds
DEPOT								
Giant Eagle Rochester	23.98	0.53	24	1474	454	7.6	8	2.2
Rochester Sheetz	0.7	0.02	15	341	295	4.9	5	1.5
Rochester Manor	0.22	0.00	6	228	123	2.1	2	0.6
Rochester ShopnSave	0.71	0.02	12	487	240	4.0	4	1.2
Giant Eagle Baden	3.81	0.08	15	871	268	4.5	5	1.3
Penn State-Beaver	6.54	0.15	48	361	970	16.2	16	4.8
Heritage Valley Hospital	5.08	0.11	30	976	582	9.7	10	2.9
Beaver Area MSHS	1.59	0.04	21	627	425	7.1	7	2.1
Tusca Beaver ShopnSave	5.71	0.13	3	99	65	1.1	1	0.3
Anderson FARM	16.04	0.36	10					
DEPOT	13.5							
TOTAL	77.88	1.43	174	5464	3421	57.0	58	16.9

4C) Law-Mer 1 (Sharon/Hermitage/Grove City)

FWG	Miles	est hours en route	est Mins/ stop	lbs	gallons	totes	totes rounded	cu yds
DEPOT								
Sharon Save-a-Lot	23.88	0.53	12	487	240	4.0	4	1.2
PSU-Shenango	0.37	0.01	21	295	389	6.5	7	1.9
Sharon Reg. Hospital	0.79	0.02	18	682	369	6.2	6	1.8
Giant Eagle Hermitage	1.56	0.03	42	2689	827	13.8	14	4.1
Hickory HS	1.47	0.03	24	607	461	7.7	8	2.3
Springfield Grille	17.44	0.39	15	611	305	5.1	5	1.5
Grove City HS	9.58	0.21	18	564	358	6.0	6	1.8
Grove City MS	2.39	0.05	12	371	232	3.9	4	1.1
Grove City College	2.04	0.05	54	519	685	11.4	12	3.4
McKinley FARM	14.24	0.32	10					
DEPOT	9.91	0.22	0					
TOTAL	83.67	1.86	226	6824	3866.6	64.427	66	19.2

4D) Law-Mer 2 (New Castle)

FWG	Miles	est hours en route	est Mins/ stop	Lbs	Gallons	totes	totes round-ed	cu yds
DEPOT	0							
Laurel Area MS/HS	3.24	0.07	18	488	371	6.2	6	1.8
New Castle JHS/HS	5.72	0.13	24	589	447	7.5	8	2.2
Giant Eagle Butler Road	4.98	0.11	33	2040	628	10.5	11	3.1
Giant Eagle Wilmington Rd	3.8	0.08	36	2345	722	12.0	12	3.6
Sheetz New Castle	0.73	0.02	9	272	142	2.4	3	0.7
Neshannock Twp JHS/HS	0.82	0.02	18	451	343	5.7	6	1.7
Westminster College	5.28	0.12	36	522	689	11.5	12	3.4
Wilmington Area HS	0.39	0.01	12	321	244	4.1	4	1.2
Wilmington Area MS	0.06	0.00	12	304	231	3.8	4	1.1
Moose FARM	1.09	0.02	10					
DEPOT	11.32	0.25						
TOTAL	37.43	0.83	208	7330	3816	63.6	66	18.9

Appendix 5: Basic hauling cost 'reality test' of Smaller-Truck Routes:
Per pull estimates based on $2.50/tote fee

Routes	Pounds	Cu Yds	Miles	Hours	Diesel	Driver Salary	HT Fee	Income minus diesel+driver
LM North	1760	8.3	32.2	3.72	$27.08	$55.75	$60.00	($22.83)
LM South	1418	6.5	12.2	3.42	$10.25	$51.32	$57.50	($4.07)
NB BF	2779	6.7	19.4	3.58	$16.31	$53.72	$57.50	($12.53)
NB Roch	3077	7.2	36.9	4.07	$30.97	$61.04	$62.50	($29.51)

Appendix 6: Estimated Hauling Costs and Costs per Tote, Larger-Truck Routes
All data as per-pull, based on three pulls per week.

	$4.20/ gallon	$15.00/ hour						
Route	Diesel	Driver	Truck & Eqpmnt	Green Sanitiz Detergnt	RIPTT[1]	Total Cost	Totes	Cost/ tote
New Castle	$31.44	$64.50	$33.26	$3.50	$10.70	$143.40	66	$2.17
Hermitage	$70.28	$84.45	$33.26	$3.50	$23.93	$215.42	68	$3.17
Beaver Falls	$46.12	$61.35	$33.26	$3.50	$15.70	$159.93	60	$2.67
Rochester	$65.42	$67.50	$33.26	$3.50	$22.27	$191.95	58	$3.31
Total	$213.26	$277.80	$133.04	$14.00	$72.60	$710.70	252	**$2.83**

1: RIPTT is the total estimated costs of repair and maintenance; insurance premiums, tires and tolls, based on ATRI mileage-based estimates.

Appendix 7: Capital Costs of On-Farm Composting, based on first full year (May 2013-May 2014)

	5 farms	avg/farm
Labor[1]	$4,800	$960
Diesel[2]	$2,209	$442
Materials[3]	$61,000	$12,200
Equipment[4]	$14,700	$2,940
Total Capital Costs	$82,709	$16,542
Capital Costs prorated over 7 years	$11,816	$2,363

NOTES
1 Labor: Average of 48 hours/farm in clearing, grading, surfacing pad, improving access, calculated at $20 per hour. Includes both hired labor and farmer's own labor.
2 Diesel: used in above.
3 Materials: Gravel; crushed limestone; clay binding agents for pad surfacing
4 Equipment: Grinder; Screen; Rotator Attachment

Appendix 8: Operational Costs of On-Farm Composting, May 2013-May 2014

	5 farms	avg/farm
Labor[1]	$15,600	$3,120
Diesel[2]	$6,362	$1,272
Materials[3]	$7,500	$1,500
Miscellaneous[4]	$6,230	$1,246
Total Operational Costs	$35,692	$7,138

NOTES:
1: Labor: Average of 156 hours/farm/year in preparing beds for food-waste, covering food-waste with complementary material; thorough mixing; forming windrows; aerating windrows; monitoring temperature, moisture, odors; moving and harvesting windrows.
2: Diesel: used in above tasks.
3: Materials: Supplemental purchases of Carbon-rich feedstock; hauling of manure from other farms.
4: Miscellaneous: Insurance; lab tests of compost; equipment rental

Appendix 9: Estimated potential annual benefits to the 5 composting farmers, based on their rates of waste acceptance over the first full year of operation

Cubic Yards Compost Produced[1]	5044.3
Cu Yds applied to own field[2]	3363
Acres Covered[3]	420
Estd Fertilizer Savings/year[4]	$8,407
Cu Yds sold to nearby farmers[5]	1680
Price per cubic yard[6]	$20.00
Income from sale to farmers	$33,595
Total Benefit	$42,002

NOTES:
1: Assumes 50% loss over composting
2: Assumes 2/3 of compost applied to own fields
3: Assumes application rate of 8 cu yds per acre
4: Assumes $20/acre/year savings in fertilizer use, beginning after 2 or 3 years
5: Assumes 1/3 of compost is sold to nearby farmers
6: This is a reasonable, discounted, bulk rate that does not include delivery.

Appendix 10: Composting Costs and Potential Benefits as Rates per Ton of Food-Waste Accepted

	Over 1st Full year	**per ton of Food Waste Accepted**
Operational Costs	$ 35,692	$ 14.86
Capital Costs prorated over 7 years	$ 11,816	$ 4.92
Total Costs	$ 47,508	$ 19.78
Estimated/potential Benefits	$ 42,002	$ 17.49
Net Costs	$ 5,505	**$ 2.29**

Appendix 11: Assessing the Affordability of a $4 per tote-pull Hauling+Tipping Fee

	FWG	lbs/ wk	cu yds/wk	totes/ pull	HT/ week	HT/ month	HT/ cu yd	HT/ ton
New Castle	Laurel Area MS/HS	1463	5.5	6	$72	$313	$13.09	$98.46
	New Castle JHS/HS	1766	6.6	8	$96	$417	$14.45	$108.70
	Giant Eagle Butler Rd	6119	9.3	11	$132	$574	$14.16	$43.15
	Giant Eagle Wilm. Rd	7035	10.7	12	$144	$626	$13.44	$40.94
	Sheetz New Castle	815	2.1	3	$36	$156	$17.03	$88.37
	Neshannock JHS/HS	1352	5.1	6	$72	$313	$14.15	$106.51
	Westminster College	2343	10.2	12	$144	$626	$14.07	$122.92
	Wilmington Area HS	963	3.6	4	$48	$209	$13.25	$99.69
	Wilmington Area MS	911	3.4	4	$48	$209	$14.00	$105.35
South Mercer	Sharon SaL	1460	3.6	4	$48	$209	$13.47	$65.78
	PSU-Shenango	884	5.8	7	$84	$365	$14.54	$190.03
	Sharon Reg. Hospital	2046	5.5	6	$72	$313	$13.13	$70.37
	Giant Eagle Hermit	8067	12.3	14	$168	$730	$13.67	$41.65
	Hickory HS	1820	6.8	8	$96	$417	$14.02	$105.48
	Springfield Grille:	1834	4.5	5	$60	$261	$13.27	$65.43
	Grove City HS	1692	5.3	6	$72	$313	$13.53	$85.11
	Grove City MS	1113	3.4	4	$48	$209	$13.92	$86.26
	Grove City College	2474	16.2	18	$216	$939	$13.36	$174.61
Beaver Falls	Sheetz Beaver Falls	513	2.2	3	$36	$156	$16.72	$140.35
	Geneva College	2050	13.4	15	$180	$782	$13.44	$175.58
	Beaver Falls MS	808	3.0	4	$48	$209	$15.79	$118.85
	Beaver Falls HS	1033	3.9	5	$60	$261	$15.44	$116.19
	Beaver Falls SaL	910	2.9	4	$48	$209	$16.57	$105.49
	Highland MS	1024	4.4	5	$60	$261	$13.77	$117.19
	Blackhawk HS	2019	7.6	9	$108	$469	$14.17	$106.98
	Brighton Hot Dog	550	2.3	3	$36	$156	$15.47	$130.91
	Giant EagleChippewa	5294	8.1	9	$108	$469	$13.39	$40.80
	Harry's Place	650	2.3	3	$36	$156	$15.81	$110.77
Beaver-Rochest	Giant EagleRochester	4423	6.7	8	$96	$417	$14.25	$43.41
	Rochester Sheetz	1024	4.4	5	$60	$261	$13.70	$117.23
	Rochester Manor	683	1.8	2	$24	$104	$13.11	$70.26
	Rochester SnS	1460	3.6	4	$48	$209	$13.47	$65.78
	Giant Eagle Baden	2613	4.0	5	$60	$261	$15.08	$45.93
	Penn State-Beaver	1084	14.4	16	$192	$834	$13.33	$354.24
	Heritage Valley Hosp	2928	8.6	10	$120	$521	$13.88	$81.97
	Beaver Area MSHS	1881	6.3	7	$84	$365	$13.31	$89.34
	Tusca Beaver SnS	297	1.0	1	$12	$52	$12.43	$80.81

Appendix 12: Est Minimum Annual Carbon Feedstock Required by Composting Farms in Lawrence and Mercer Counties

	Per Farm	3 Farms
FW Tons/farm/yr[1]	500	1500
est cu yds max FW/farm/yr[2]	900	2700
est cu yds paper+CB/farm/yr[3]	300	900
cu yds autumn leaves required[4]	600	1800
cu yds wood chips required[4]	300	900

1: Permitted DEP maximum per farm per year
2: Assuming avg density of 1.8 cubic yards/ton
3: Assuming FW is 75% of FWG waste, by volume
4: Using Cornell University's Feedstock Calculator tool, to achieve overall C:N ratio of 27.

End Notes

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[i] The Coop has also billed externally and distributed tipping fee income internally; managed and monitored composting operations; established baseline soil conditions through analytic testing; and set up demonstration farm trials of compost application on three farms, in consultation with Penn State research faculty.

[ii] Fewer miles hauling waste and hauling compost mean less energy use, fewer emissions of air pollutants and greenhouse gases.

[iii] An *efficien*t system for FWGs is one that requires only modest shifts in daily operations of relevant staff, rather than additional hours; maintains ongoing high standards of safety and hygiene; and is serviced by timely, reliable, safe, hygienic pulls. For farmers and haulers, an efficient system provides the most material at the least cost. A *viable* system is based on pricing of waste hauling+tipping that at once provides adequate income to pay for the safe, efficient and reliable hauling of compostable waste from waste-generators to composting farmers; provides adequate compensation to farmers for the work and expense of composting, alongside other direct benefits to them; and is affordable for the great majority of business and institutional waste generators, alongside any other costs they might bear in diverting organic waste, and any other cost-mitigating activities (cost saving and/or income generating) offered by the program to participating waste generators. Finally a *durable* system is one in which all parties continue to perceive their own ongoing net benefits of participating; and knowledge of, interest in, appreciation of and support for the program continues to expand—among farmers, FWGs and the general public as neighbors, consumers, employees and citizens. If the system meets these goals of efficiency, viability and durability, we can reasonably expect that it will divert a significant and growing portion of our region's compostable waste towards farm and degraded-land soil-building and their various benefits.

[iv] The Coop already owns 82 new totes of this size. The program has received $6,987 from DEP Recycling Program Grant (in partnership with Jerry Zona, Recycling Coordinator for Lawrence and Mercer Counties) for the purchase of an estimated additional 97 totes (at $72/tote including delivery), for a total of 179 totes. This number would be ample for the small-truck routes, with their maximum of 24 totes per pull. However, the four initial large-truck routes require a total of 252 totes. Factoring in 20 replacements, this requires the purchase of an additional 93 totes, at an estimated cost of $6,696.

[v] At some FWGs we determined that only a fraction of all compostables would be sorted and included in our estimates. A major supermarket chain said they would not divert bathroom paper towels. We decided

not to include bathroom waste at hospitals and nursing homes, given the likelihood of high levels of contamination (bodily fluids, plastic medicine bottles, perhaps sharps). At other FWGs, it became clear that some waste streams would require too much effort for the return. At a major hospital we noted that post-consumer cafeteria waste included far too many non-compostables to expect staff and guests to sort at bussing-stations, so we included all of these bags in the waste category.

[vi] Appendix 5 shows summary results of an initial pricing 'reality check' for smaller-truck versions of the four routes. Results clearly show that the smaller truck routes are not viable. While the miles, en-route hours and diesel cost are all significantly lower than the larger-truck routes, they provide much lower hauling+tipping fees and require significant additional time (per volume or ton) in the end-of-route tasks (hand-dump totes; unload each, etc).

[vii] FWGs may fill them as high as they wish. However, we recommend that staff are mindful of the high density of pure food-waste (particularly sauces, meats, prepared foods, some raw vegetable scraps), and limit the height to which they fill totes with these materials. This will avoid back-sprain in moving totes.

[viii] Time did not permit an adequate review of products, their efficacy, concentration and pricing. We estimate that $2190 should be adequate for a full year service of these four routes.

[ix] American Transportation Research Institute (ATRI). 2013. An Analysis of the Operational Costs of Trucking: A 2013 Update.

[x] It should be noted that the bulk of the development of the farm based composting facilities has been funded by a USDA program of rural economic development, and this program requires systematic accounting of ongoing costs and benefits, to farmers and all participants.

[xi] Several things should be noted here. First, three of the farmers have agreed to participate in multi-year field trials in which they apply compost in strips alternating with strips of no-compost, following the guidance of several Penn State faculty. While the hopes are that these trials, if conducted rigorously and communicated effectively, will help build a compost market among nearby farmers, this striped pattern of application is likely to have lower overall production benefits than straight areal applications. Second, Penn State faculty have advised the farmers that it may take two or even three years to see significant and lasting improvement in yields and/or fertilizer requirements. Finally, none of the farmers have yet to sell significant amounts of compost.

[xii] Efficient, environmentally-benign, no-nuisance composting requires sustained *aerobic* decomposition: performed by microbes that require oxygen. On its own, food-waste is too moist, too dense and too high in Nitrogen to serve as an effective feedstock for aerobic composting.