COKER
COMPOSTING AND CONSULTING

Food Waste Collection and Processing Feasibility Study

Prepared For:

Environmental Services Department
City of Rolla, MO

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Executive Summary

Coker Composting & Consulting (CC&C) has been retained by the Environmental Services Department (ESD) of the City of Rolla, MO to evaluate the feasibility of developing a food wastes diversion, collection and composting program. It is certainly feasible to implement a voluntary diversion program, collect SSO, compost it with yard waste, and sell the compost. There are hundreds of SSO diversion programs and composting facilities operating in the U.S. and thousands of yard waste composting facilities, many owned and operated by municipalities. Feasibility is tempered by questions about quantities and collection methods, by composting facility siting and approvals, and by economics.

One key question answered in this study was, "How much *capturable* food waste is generated, where is it generated, and how could it be collected?" The project team interviewed several key food waste generators in Rolla and examined how solid waste is now collected, as that has potential impact on the logistical feasibility of food waste diversion and collection. Based on analysis of Rolla solid waste generation and on generation rates from various sources, approximately 2,500 tons per year of food scraps could be diverted to composting, along with the approximately 2,600 tons of yard trimmings the City now handles annually.

Collection of diverted food scraps could be done using a rollcart and/or dumpster system similar to the one the City now uses, so that the same type of collection trucks could be used. Because this would be a voluntary diversion system, initial route densities would be low, raising collection costs.

Composting can be done by using turned windrows or by building a forced aeration system to supply air to the composting piles. Windrows could be turned by a tractor pulling a turner or by a self-propelled turner. Each approach is suitable to the composting of food scraps although the open-air windrows should be covered with fabric covers for odor and process control and to discourage vectors. A composting recipe was developed and that recipe was used to size each step in the compost manufacturing process. This was used to calculate how much area would be needed for composting. Each approach has different area needs, with the tractor-pulled turner alternative needing about 6 acres and the aerated static pile approach needing about 2 acres.

Another key question was, "Where should a composting facility be located to handle food wastes and yard trimmings?" Improper siting of a composting facility handling putrescible solid waste like food wastes is one of the major causes of off-site odor issues, neighbor complaints, and potential adverse impacts. This study evaluated three City-owned sites as possibly suitable for a composting facility: an area just north of the existing Recycling Center, a site west of the Transfer Station, and a site north of the old landfill just east of the City's industrial park. Of the three, the 40-acre site north of the old landfill was considered to be the best site.

The study also analyzed what approvals and permits would be needed, both from the City and from the State of Missouri. For the preferred site north of the landfill, the City would have to rezone it from M-2 (Heavy Manufacturing) to G&I (Government & Institutional). The MO Dept. of Natural Resources (DNR) would permit both solid waste composting and storm water management at a composting facility. The composting approval will be easier to obtain than a storm water permit, which will require a non-discharging runoff management system with storm runoff recycling, land application, or disposal to a sewer.

The most important question to be addressed in this study was, "Can diversion and composting be done cost-effectively, with minimal fiscal impact on City businesses and residents?" To answer that, this study has attempted to analyze the potential costs structure of a collection and composting program. Facility revenues, and capital and operating cost estimates were prepared on a per-ton basis and are summarized below. Costs for collection of diverted food scraps from both commercial and residential sources were estimated assuming no revenues to offset costs and are summarized below.

Per Ton Cost and Revenue Estimates

	Recycle Center Site			Forty-Acre Site		
	Tractor-pulled turner	Straddle turner	ASP	Tractor-pulled turner	Straddle turner	ASP
Capital Cost	n/a	$ 22.84	$ 15.41	$ 38.87	$ 32.95	$ 16.02
Operating Cost	n/a	$ 21.54	$ 26.56	$ 26.01	$ 21.54	$ 26.56
Total		$ 44.39	$ 41.96	$ 64.87	$ 54.49	$ 42.58
Revenue Potential		$ (25.00)	$ (25.00)	$ (25.00)	$ (25.00)	$ (25.00)
Net		$ 19.39	$ 16.96	$ 39.87	$ 29.49	$ 17.58

Proposed Commercial Food Waste Service Monthly Collection Costs

	Rollcart Size (3x/wk service)	
Operating Cost:	90-gal	65-gal
Labor	$ 22.50	$ 22.50
Equipment	$ 5.00	$ 4.92
Composting	$ 102.47	$ 74.01
Subtotal	$ 129.97	$ 101.43
Admin/Overhead	$ 19.50	$ 15.21
Total	**$ 149.47**	**$ 116.64**

Proposed Residential Food Waste Service Monthly Collection Costs

	Low	Medium	High
Number of Participating HHs	748	2245	3742
Labor	$ 0.63	$ 0.63	$ 0.63
Containers:	$ 0.89	$ 0.88	$ 0.87
Equipment:	$ 0.15	$ 0.15	$ 0.15
Composting:	$ 11.07	$ 11.07	$ 11.07
Vehicle R&M:	$ 0.06	$ 0.06	$ 0.06

Fuel:	$ 0.11	$ 0.11	$ 0.11
Subtotal	$ 12.91	$ 12.90	$ 12.89
Program Admin	$ 1.94	$ 1.93	$ 1.93
Total Monthly Cost Per HH =	$ 14.84	$ 14.83	$ 14.82

Conclusions of this study include:

- There are institutional generators of food scraps who are interested in having an opportunity to recycle those wastes, including the Missouri University of Science and Technology and their dining services contractor, Chartwells (also possibly Rolla Public Schools and the Phelps County Regional Medical Center);
- Commercial generators are largely unaware of what is involved in food waste recycling but may be willing to learn, and participate, provided solid waste disposal costs don't go up. At the same time, some commercial generators expressed no interest in participating;
- There may be enough residential generators willing to pay more for solid waste disposal to have an enhanced recycling program for food scraps and SSO collected at curbside, but no confirmative information was obtained in this study;
- There are two suitably-sized City-owned sites where composting of food scraps and ground-up yard trimmings could be done. The Forty-Acre site north of the landfill and east of the Industrial Park is a more suitable site than the current site north of the Recycling Center where ground yard trimmings are currently mulched and composted;
- Composting facilities will require permits from the Missouri DNR, one being an exemption from solid waste composting and the other a no-discharge permit for storm water management. The composting permit exemption should be relatively straightforward, but the storm water permit requirements are a considerable capital cost;
- The preliminary cost estimate for building and operating a composting facility, when expressed on a dollars-per-ton basis, is very similar to the current cost of the contract for the Transfer Station operation ($42.58/ton for composting; $42.56/ton for TS operation). It may be possible to reduce the cost for composting as a result of site analysis and facility design; and
- This cost parity means that diversion and collection of SSO to composting would have to be offset by reduced costs for refuse management to keep overall solid waste management costs stable. It is not known if this is possible.

Should the City elect to continue investigation into the feasibility of this new recycling program, the next steps are recommended:

- Meet with Rolla Public Schools and the Phelps County Regional Medical Center staff to discuss a possible diversion program (neither party was available during this study)
- Conduct an audit of commercial food waste sources- this would include a survey of all generators to identify those willing to participate in a waste audit, selection of 3 to 5 generators to participate in waste audit to determine percent compostable waste vs. percent refuse, conduct the audit using a representative quantity of solid waste, prepare a cost analysis to see if the reduction in refuse container/pickup frequency cost would offset the increase due to food waste collection (using the audit to refine the service cost estimates developed in this study), and a physical survey to see if they have the physical space for separate collection systems. If the results of the audits are positive, share the

audit results with the commercial generators in an outreach program and survey to see how many would be willing to consider implementing food waste diversion

- Survey residential food waste sources- this would include a survey of all Rolla households to see how many might be willing to participate at different price structures (i.e. +$13/month, +$8/month, +$5/month). Based on survey results, develop, using City GIS, a collections routing analysis of willing participants to see if collection system service cost estimates need refining (i.e. size of truck, pickup time, collection operating costs)
- Develop a preliminary design for the composting facility and apply for both the composting permit exemption and the storm water permit – this would include a more detailed examination of the Forty-Acre site with regard to suitability for a storm water management pond and a runoff spray irrigation system, development of a scaled site plan, preparation of more detailed information on composting procedures, operations plans, and product marketing strategies, and refinement of the preliminary cost estimates contained in this study.

Introduction

Coker Composting & Consulting (CC&C) has been retained by the Environmental Services Department (ESD) of the City of Rolla, MO to evaluate the feasibility of developing a food wastes diversion, collection and composting program.

All solid waste collection in the City is handled by the ESD, who operates a fleet of collection trucks that collect refuse and some source-separated recyclables from industrial/commercial/institutional (I/C/I) sources and that collect refuse, recyclables and yard trimmings from residential sources. In 2013, ESD collected slightly above 20,000 tons of refuse and handled (through curbside collection and recycling center drop-off) about 2,800 tons of recyclable commodities, for a 2013 recycling rate of 14%. Most municipal solid waste professionals realize that raising recycling rates in the future will be difficult without a plan to divert and process source-separated organics (SSO) which are mostly food wastes and soiled paper. The purpose of this project was to explore the feasibility of a plan for the diversion and composting of food wastes.

Methodology

The methodology used in this study varied slightly from the series of tasks envisioned in the original Request for Proposals issued by the City in December 2013 in order to reduce the costs of the study.

It is certainly feasible to implement a voluntary diversion program, collect SSO, compost it with yard waste, and sell the compost. There are hundreds of SSO diversion programs and composting facilities operating in the U.S. and thousands of yard waste composting facilities, many owned and operated by municipalities. Feasibility is tempered by questions about quantities and collection methods, by composting facility siting and approvals, and by economics.

One key question to be answered in this study was, "How much *capturable* food waste is generated, where is it generated, and how could it be collected?" The project team interviewed several key food waste generators in Rolla and examined how solid waste is now collected, as that has potential impact on the logistical feasibility of food waste diversion and collection.

Another key question was, "Where should a composting facility be located to handle food wastes and yard trimmings?" Improper siting of a composting facility handling putrescible solid waste like food wastes is one of the major causes of off-site odor issues, neighbor complaints, and potential adverse impacts. This study evaluated three City-owned sites as possibly suitable for a composting facility. The study also analyzed what approvals and permits would be needed, both from the City and from the State of Missouri

The most important question to be addressed in this study was, "Can diversion and composting be done cost-effectively, with minimal fiscal impact on City businesses and residents?" To answer that, this study has attempted to analyze the potential costs structure of a collection and composting program.

Waste Generation and Collection

Generation Estimates

Two different approaches were used to estimate SSO generation in the City of Rolla. One was to take 2012 and 2013 monthly waste tonnage records maintained by ESD and project those tonnages out to the future, then use data on waste composition from Phelps County to project SSO quantities. Future monthly tonnages were projected by averaging the same month's tonnage in 2012 and 2013, then inflating that average by 2% to account for growth as the economic recovery continues. The annual totals were projected to Year 2020 with a 2% annual growth factor. This information is shown in tabular form in Table 1 and graphically in Figure 1.

Table 1. Rolla Solid Waste Tonnage Projections

Year	Month	Tonnage	Totals	Averages	Year	Month	Totals	Tonnage	Averages
2012	Jan-12	1401.2			2014	Mar	1539.2	(Avg 3/12, 3/13) x 2%)	
	Feb	1369.5				Apr	1664.4		
	Mar	1519.0				May	1766.8		
	Apr	1505.0				Jun	1508.1		
	May	1552.4				Jul	1667.8		
	Jun	1436.8				Aug	1705.6		
	Jul	1461.4				Sep	1604.9		
	Aug	1498.1				Oct	1747.8		
	Sep	1297.8				Nov	1518.0		
	Oct	1555.5				Dec	1346.1	18559.53	1546.63
	Nov	1379.6			2015	Jan-15	1324.7		
	Dec	1311.0	17287.3	1440.61		Feb	1506.0		
2013	Jan-13	1331.2				Mar	1549.5		
	Feb	1728.4				Apr	1745.7		
	Mar	1499.0				May	1876.2		
	Apr	1758.6				Jun	1544.5		
	May	1912.0				Jul	1773.1		
	Jun	1520.3				Aug	1811.4		
	Jul	1808.8				Sep	1761.5		
	Aug	1846.2				Oct	1845.9		
	Sep	1849.1				Nov	1588.6		
	Oct	1871.6				Dec	1364.0	19691.11	1640.93
	Nov	1596.9							
	Dec	1328.4	20050.5	1670.88					
2014	Jan-14	1266.2							
	Feb	1224.5							

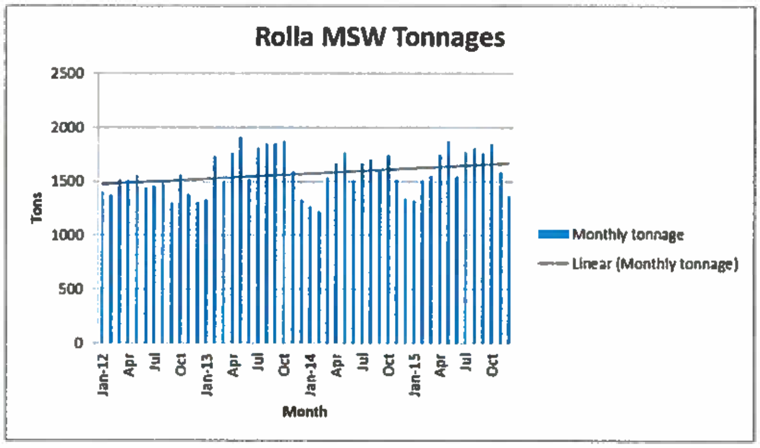


Figure 1. Rolla Solid Waste Tonnage Projections

The waste characterization study done at the Phelps County Transfer Station[1] concluded that "organics" constituted between 32.9% and 33.8% of the refuse processed by the Station. Organics was defined to include: food waste, wood waste, textiles, diapers, and other organics. Both textiles and diapers can be very problematic feedstocks in composting, so the characterization data was adjusted to eliminate those two components. The U.S. Environmental Protection Agency estimates 14.5% of the municipal solid waste (MSW) stream is food waste, and another 13.5% is yard waste[2]. In voluntary diversion programs, only a portion of the total available SSO is ever captured, so Table 2 shows the calculations for various projectioins of capturable SSO in the City. Based on this methodology, a composting facility could be sized for about 2,500 tons/yr of SSO.

Table 2. Capturable SSO Tonnage "Top-Down" Projections

Year	Tonnage[1]	% Low[2]	% High[2]	Tonnage Low	Tonnage High	Capture Percentage	Capture Tonnage Low	Capture Tonnage High
2012	17,287.3	23.8%	25.7%	4,114	4,443	--	--	--
2013	20,050.5	23.8%	25.7%	4,772	5,153	--	--	--
Actual 16,687.9 → 2014	18,559.5	23.8%	25.7%	4,417	4,770	--	--	--
16,051.4 → 2015	19,691.1	23.8%	25.7%	4,686	5,061	20%	937	1,012
2016	20,084.9	23.8%	25.7%	4,780	5,162	25%	1,195	1,290
2017	20,486.6	23.8%	25.7%	4,876	5,265	30%	1,463	1,580
2018	20,896.4	23.8%	25.7%	4,973	5,370	35%	1,741	1,880
2019	21,314.3	23.8%	25.7%	5,073	5,478	40%	2,029	2,191
2020	21,740.6	23.8%	25.7%	5,174	5,587	45%	2,328	2,514

Notes:
[1] 2012-2013 actual, 2014-2015 average of monthly values inflated by 2%, 2015-2020 annual values inflated by 2%
[2] Excludes diapers and textiles

[1] Missouri Dept. of Natural Resources, Solid Waste Composition Study, 2006-2007, Appendix IX – Phelps County Transfer Station
[2] U.S. Environmental Protection Agency, "Municipal Solid Waste Generation, Recycling, and Disposal in the United States", February 2014

The second approach used was to look at each potential generator/customer type and apply unit generation rates (derived from other studies). Assumptions about capture rates for commercial sources were tailored to the source type based on experience elsewhere. Estimated tonnages for residential sources were based on an average of 12 lbs per household per week, with varying participation and setout rates[3]. The results of this approach are in general agreement with the previous approach (See Table 3).

Table 3. Capturable SSO Tonnage "Bottom-Up" Projections

Commercial Sources	Meals/day	lbs/meal	lbs/day	Capture %	Tons/yr	Assumptions
Mo S&T	7000	0.228[1]		100%	199	School in session 249 days/yr; only pre-consumer FW included
Rolla Public Schools	3400	0.228		100%	71	School in session 182 days/yr; only pre-consumer FW included
Phelps Co RM Center	581	0.228		100%	24	242 beds, assumed 80% occupancy, 3 meals/day/bed
Grocery Stores (3)			120.82	100%	66	Aldi's, Country Mart, Kroger
Restaurants (55)			138.2	50%	694	includes post-consumer
Fast Food (19)			418.4	30%	435	includes post-consumer
Breakfast-only hotels (2)	120	0.228		100%	5	Holiday Inn (80 rooms) & Hampton Inn (70 rooms); assume avg. 80% occupancy
Subtotal					1,493	

Notes:
[1]Coker Composting & Consulting, Food Waste Audit, Univ. of South Carolina, 2009 – pre-consumer FW only
[2]USDA Food Loss Study, 2004

Residential Sources

2010 housing units = 8,339; 39.9% in multi-unit structures, so assume 8,339 * 60.1% = 5,012 SFDUs

Single Family Dwelling Units	Participation Rate	Weekly Setout Rate	Avg. Lbs/Week	Tons/Yr
5,012	25%	50%	12	195
5,012	30%	55%	12	258
5,012	35%	60%	12	328
5,012	40%	65%	12	407
5,012	45%	70%	12	493

Generator Interviews

During late March, 2014, project team members met with several individuals working for various commercial and institutional sources of food wastes and SSO, including:

[3] Participation rate is the number of households participating in a voluntary diversion program; setout rate is that percentage of participating households who actually set out SSO in any given week.

- Mr. Thomas Dockham and Ms. Joey Roberts, Chartwells (Dining Services contractor for Missouri University of Science and Technology) – they serve about 6,000 meals/day and are very interested in participating in a diversion/composting project
- Ms. Angie Rolufs and Mr. Cory Brennan, MO S&T Recycling Office – they are very interested in participating and are willing to seek grant funding from EPA Region 5 to support the project
- Mr. Josh Stacy, Public Brewing House and Rolla Chamber of Commerce – Mr. Stacy indicated a willingness to learn more about diversion and recycling of food wastes and indicated he thought the Chamber of Commerce could help with outreach
- Mr. Glen Sapaugh, Country Mart Grocery – Mr. Sapaugh indicated all that store's food waste was either going to feed the hungry or going to animal feed

It was not possible to meet with representatives of the Rolla Public Schools or the Phelps County Regional Medical Center due to schedule conflicts, but in many communities, schools are often willing participants in food waste diversion programs. Medical facilities are only allowed to recycle food scraps from kitchen preparation areas.

Neither the Walmart or Kroger grocery stores expressed any willingness to meet or to consider participating in the program if it were launched.

Collection Alternatives

Most voluntary SSO diversion programs start off small and take a few years to expand as businesses, institutions, and residents adapt to a new recycling program. Due to these small volumes, many programs start off with smaller trucks and expand the fleet as the program grows.

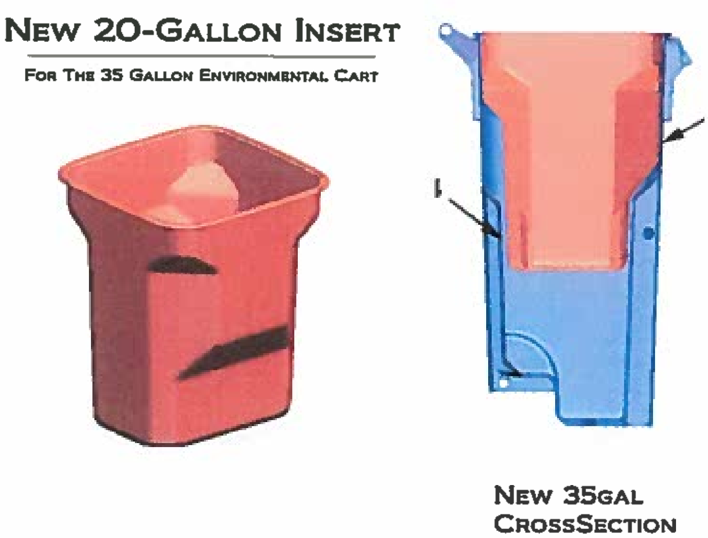
The Rolla ESD uses 20 cubic yard (CY) rear-packer trash trucks made by Loadmaster and indicated a preference for using that same truck for a SSO diversion program, so as to take advantage of the parts inventory and skilled mechanics in the ESD already familiar with that truck. Rear-packer trash trucks have been used frequently in SSO diversion programs but operating experience suggests retrofitting the trucks with stronger gate seals to minimize spillage and with slosh baffles to reduce the impact of shifting liquids on truck handling and safety. The economic analysis done for this project assumed the use of 20 CY Loadmasters.

Rolla commercial waste generators often have their solid waste collection dumpsters located outside the main building in concrete block enclosures protected by lockable doors (see Figure 2). These enclosures also hold the wire bins for recycling cardboard and, in the case of restaurants, often the grease recycling tank. If these generators were to implement food waste diversion, these enclosures would also have to contain the separate food waste collection containers, in many cases several 90-gal or 65-gal rollcarts. Some of these collection enclosures have limited room for any additional infrastructure.

Figure 2. Solid Waste Collection Enclosure

Residential collection alternatives are similar to those used for refuse, but smaller. There are a growing number of smaller organics/SSO collection containers coming onto the market in response to the growing number of residential collection programs (Figure 3). One alternative that is compatible with the City's cart-lifters on its Loadmaster trucks is the Rehrig-Pacific 20-gal insert sized to fit inside its 35-gal cart, many of which are already used by citizens in Rolla.

Figure 3. Residential SSO Collection Container



Preliminary Compost Manufacturing Plan

Composting is a biological manufacturing process that operates at its lowest cost point when materials move through the biological conversion process as efficiently as possible. Irrespective of composting technology selected, all successful composting facilities operate in strict accordance with several key parameters:

- Process design and management that meets carbon:nitrogen, moisture content, volatile solids and free air space (structural porosity) standards
- System design that accommodates acceptable levels of contamination
- Process and material management that moves materials through the system in a linear fashion with the fewest materials handling steps along the way (see illustration below)
- Adequate physical space for managing potentially large volumes of materials at certain times of the year

The primary methods of composting SSO are in turned windrows, in aerated static piles, and bioreactor systems.

Windrow composting involves forming feedstocks into long, narrow, low piles known as windrows (Figure 4) that are about twice as wide as they are high. The length can be as long as the available space. They are built using front-end loaders, skid-steer loaders and excavators. Space requirements for a windrow composting pad vary depending on method of turning, as windrows can be turned with a loader, or with a drum turning machine. These turners are either a pull-behind type towed with a loader or a tractor, or a self-propelled straddle-type machine. Turning with a loader or pull-behind turner requires 15-20 feet of space between each windrow, where straddle-turned windrows can be as close as 2 feet apart.

Actively aerated composting systems use fans and blowers to move air through a compost pile to maintain aerobic conditions in the piles. There are generally three types of aeration systems, positive (or forced-draft), negative (or induced-draft) and bi-directional. In a positive aeration system, air is introduced through perforated pipes at the base of the pile and allowed to migrate up through the pile, carrying entrapped gases and moisture up and out of the pile. In some positively aerated systems, a layer of compost or a fabric cover is used to help manage odors and to retain heat and moisture in the pile. Negatively aerated systems pull air downward through the pile and into the aeration pipes. This "exhaust" air has high temperature and moisture content, so is usually cooled prior to entering an odor control system. Cooling the air condenses the moisture, so condensate management systems are needed. Odor control systems are usually either biofilters or chemical scrubbers. Bidirectional systems have more advance ducting and controls and switch between positive and negative to better control temperatures in the piles. Composting systems using active aeration come in a wide variety of technology

The recipe assumes a capacity of 2,500 tons/year of SSO/food wastes (pre-consumer) and assumes the facility would be open 5 days/week (260 days/year). The proposed recipe is shown in Table 4. As composting is done on a volumetric basis, the recipe calls for mixing (daily) 12 CY of food waste with 28 CY of ground-up yard waste and 13 CY / day of recycled overs (52.5 CY/day total materials entering the composting system).

Table 4. Composting Recipe

MIX RATIO CALCULATIONS- AVERAGE DAILY CONDITIONS

Assumptions:

Facility sized for 2,500 tons/year of food wastes

Facility open 5 days/week (260 days/yr); average daily tonnage = 2,500 / 260 = 9.62 tons/day

INGREDIENTS	Food Wastes	Ground Up Yard Waste	Overs from Screen	TOTAL MIX	TARGET
C (% AS IS)	13.9	46.54	17.2		
N (% AS IS)	1.7	1.03	0.29		
MOISTURE%	71.2	32.3	61.6		
UNITS IN MIX BY WGT (T)	9.6	8.0	3.2	20.8	
UNITS IN MIX BY WGT (LB)	19,240	16,000	6,400	41,640	
UNITS IN MIX BY VOL (CY)	12	28	13	52.5	
DENSITY (LBS/CY)	1634	573.1	500	793.2	
POUNDS OF CARBON	2,674	7,446	1,099	11,220	
POUNDS OF NITROGEN	327	165	19	510	
C:N RATIO	8.18	45.18	59.21	**21.98**	20 TO 30
POUNDS OF MOISTURE	13,699	5,168	3,942	22,809	
NUMBER OF UNITS	19,240	16,000	6,400	41,640	
PERCENT MOISTURE				**54.78**	50 TO 65%
VOLATILE SOLIDS (%)	87.0	98.0	95.0		
VOLATILE SOLIDS (LBS)	8.4	7.8	3.0	19	
NUMBER OF UNITS	9.6	8.0	3.2	21	
MIX VS (%)				**92.5**	> 90%
DENSITY (LBS/CY)	1634	573.1	296.6		
DENSITY (KG/M3)	969.4	340.0	176.0		
% AIR SPACE	12.75	69.40	84.16		
FEEDSTOCK VOLUME (CY)	11.77	27.92	12.80	52.5	
AIR VOLUME (CY)	1.5	19.4	10.8	31.6	
PREDICTED FREE AIR SPACE				**60.3%**	40-55%

The next step was to size the various processing steps in the compost manufacturing system, including feedstock receipt and mixing, ground materials storage, active composting, curing, product screening and product storage. Three composting approaches were evaluated: open-air windrow turning with a tractor-pulled turner, open-air windrow turning with a straddle-type windrow turner, and aerated static pile composting using a forced air system. All alternatives assume a 45-day active composting period, a 75-day curing period, screening with a small trommel screen and 3 months wintertime product storage capacity. Detailed calculations are in the Appendix.

The method of composting has a significant effect on area needed, as shown in Figure 4. With a tractor-pulled turner, one needs 15' (minimum) clearance between the windrows so the tractor can operate. Straddle-turned windrows can be placed 3' apart. Aerated static pile (ASP) systems require no turning as materials are well-mixed (mechanically) then placed on aeration piping for 45 days.

Figure 4. Area Requirements for Different Composting Approaches.

Tractor-pulled turner

Area Summary	Width	Length	Area (sq. ft.)	Area (acres)
On Hardened Pad				
Feedstock Receipt & Mixing	40	40	1,600	0.04
Ground Feedstocks Storage	150	150	22,500	0.52
Composting Pad	360	320	115,200	2.64
Curing Pad	320	320	102,400	2.35
Screening Area	56	70	3,920	0.09
Product Storage Area	75	75	5,625	0.13
		Totals	251,245	5.77

Straddle windrow turner

Area Summary	Width	Length	Area (sq. ft.)	Area (acres)
On Hardened Pad				
Feedstock Receipt & Mixing	40	40	1,600	0.04
Ground Feedstocks Storage	150	150	22,500	0.52
Composting Pad	175	225	39,375	0.90
Curing Pad	150	225	33,750	0.77
Screening Area	56	70	3,920	0.09
Product Storage Area	75	75	5,625	0.13
		Totals	106,770	2.45

Aerated static pile

Area Summary	Width	Length	Area (sq. ft.)	Area (acres)
On Hardened Pad				
Feedstock Receipt & Mixing	40	40	1,600	0.04
Ground Feedstocks Storage	150	150	22,500	0.52
Composting Pad	140	120	16,800	0.39
Curing Pad	130	120	15,600	0.36
Screening Area	56	70	3,920	0.09
Product Storage Area	75	75	5,625	0.13
		Totals	66,045	1.52

These areas are minimums and do not include ancillary features such as access roads, office trailers and equipment maintenance buildings.

Siting Evaluation

There are several objectives a composting site should try to meet:

- The most efficient layout for a composting facility is a linear layout, either in a straight, curved, or rectilinear direction as this minimizes costs by optimizing materials handling.
- Ideally, waste management activities should be uphill (and upwind) of product management activities in order to minimize potential for cross-contamination.
- Buffer zones from non-industrial land uses should be more than 500' in the prevailing wind direction and be densely vegetated to mitigate potential dust and odor problems (the old adage is "people smell with their eyes").

The more a site can meet these objectives, the greater the opportunity to use low-technology composting approaches like open-air turned windrows. Conversely, sites that cannot meet these objectives have to rely on higher technology and/or enclosures to minimize potential for problems.

A desktop and windshield evaluation of two possible sites for food waste composting was conducted, and a desktop evaluation was completed of a third site. The original scope of work for the project envisioned a single site evaluation (the property north of the Recycling Center), but during initial site visits in late March, it became obvious that two other sites should also be evaluated. These other two sites are a small tract immediately west of the Transfer Station (the TS Site) and a 40-acre tract north of the old Landfill (the 40-acre site). Windshield surveys of the Recycle Center site and the TS site were conducted in late March. The 40-acre site is undeveloped and access was not attempted. Figures 5 – 7 illustrate these three sites.

Each site was evaluated using ArcMap 10.0 Geographic Information Systems modelling, using data layers provided by the City of Rolla (parcels, hydrology, land use, transportation, contours, buildings, and aerial photography) and from the Missouri Spatial Data Information Service (caves, sinkholes, sinkhole collapse potential, and DNR-certified wells).

For the Recycle Center site and the Transfer Station site, boundaries were developed based on physical features of the site. For the Recycle Center site, a 5.2 acre parcel was delineated immediately north of the Water Tower and south of the steep dropoff to Burghers Branch largely where the site is already cleared for the existing yard waste mulching yard. For the Transfer Station site, a 1.5 acre parcel was identified that consisted of fill area north of the storm water management system for the old landfill site to the west. As the Forty-Acre Site is not developed, all the acreage was mapped. A 1,000-foot buffer was drawn around each site, which reflects the

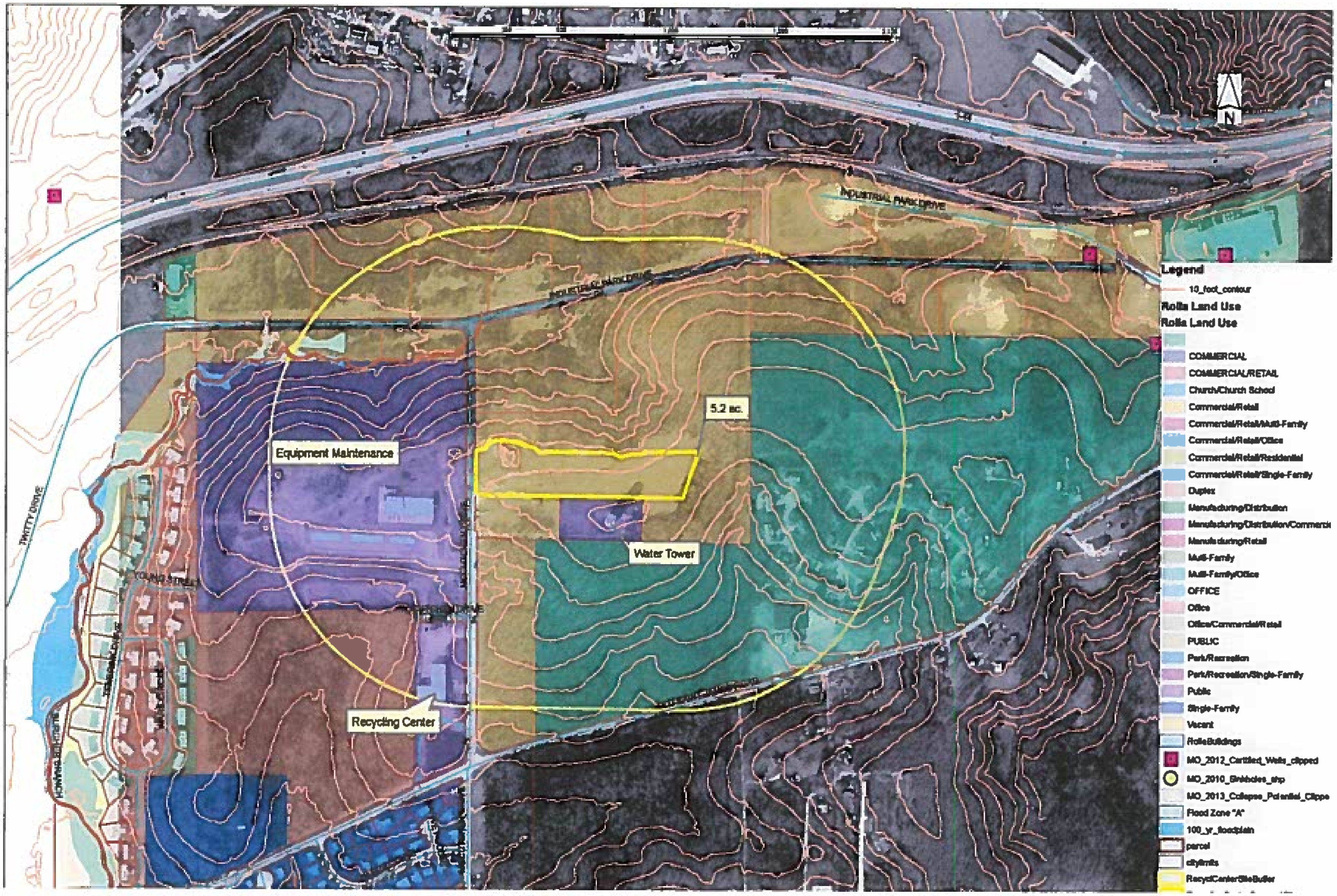


Figure 5. Recycle Center Site

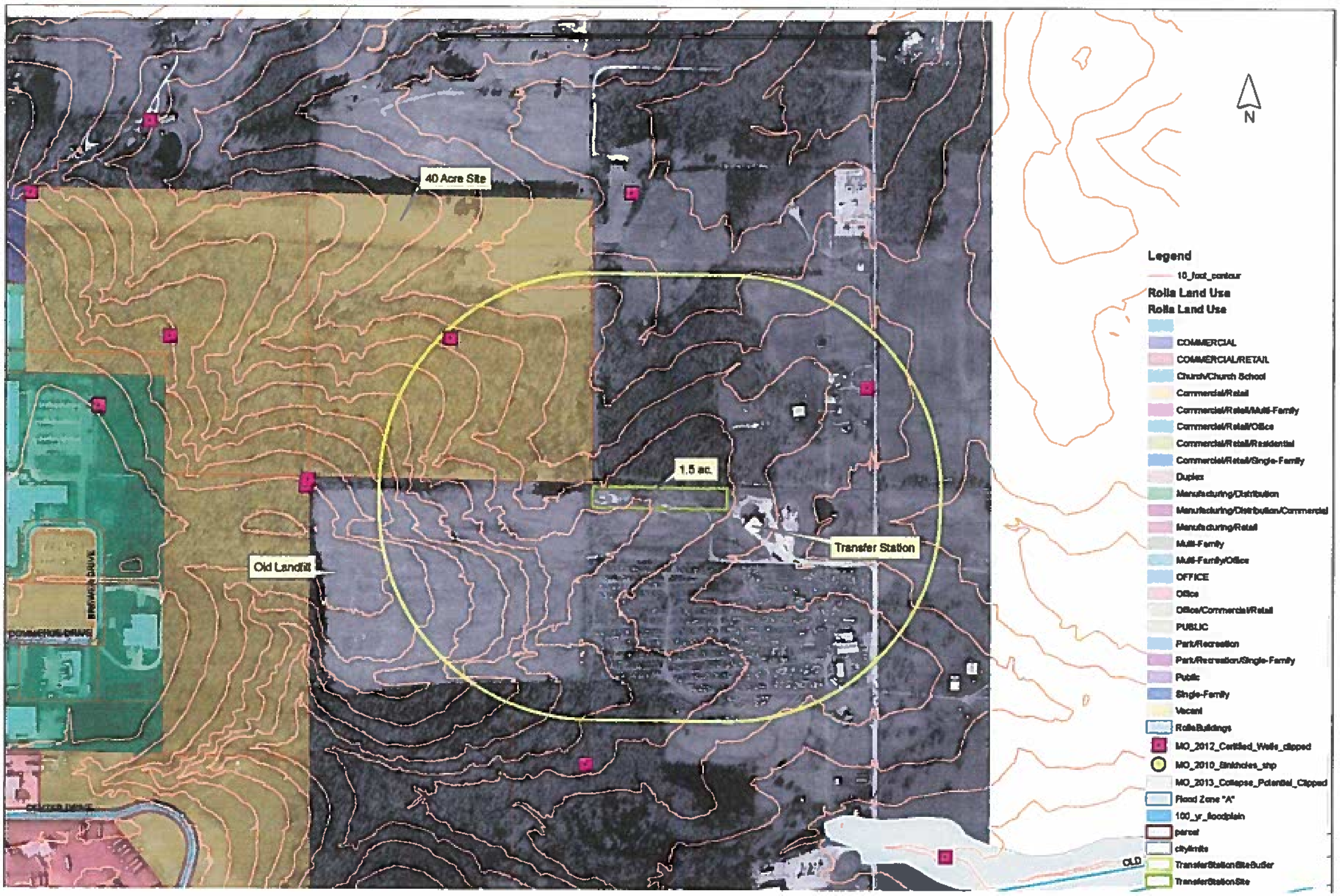


Figure 6. Transfer Station Site

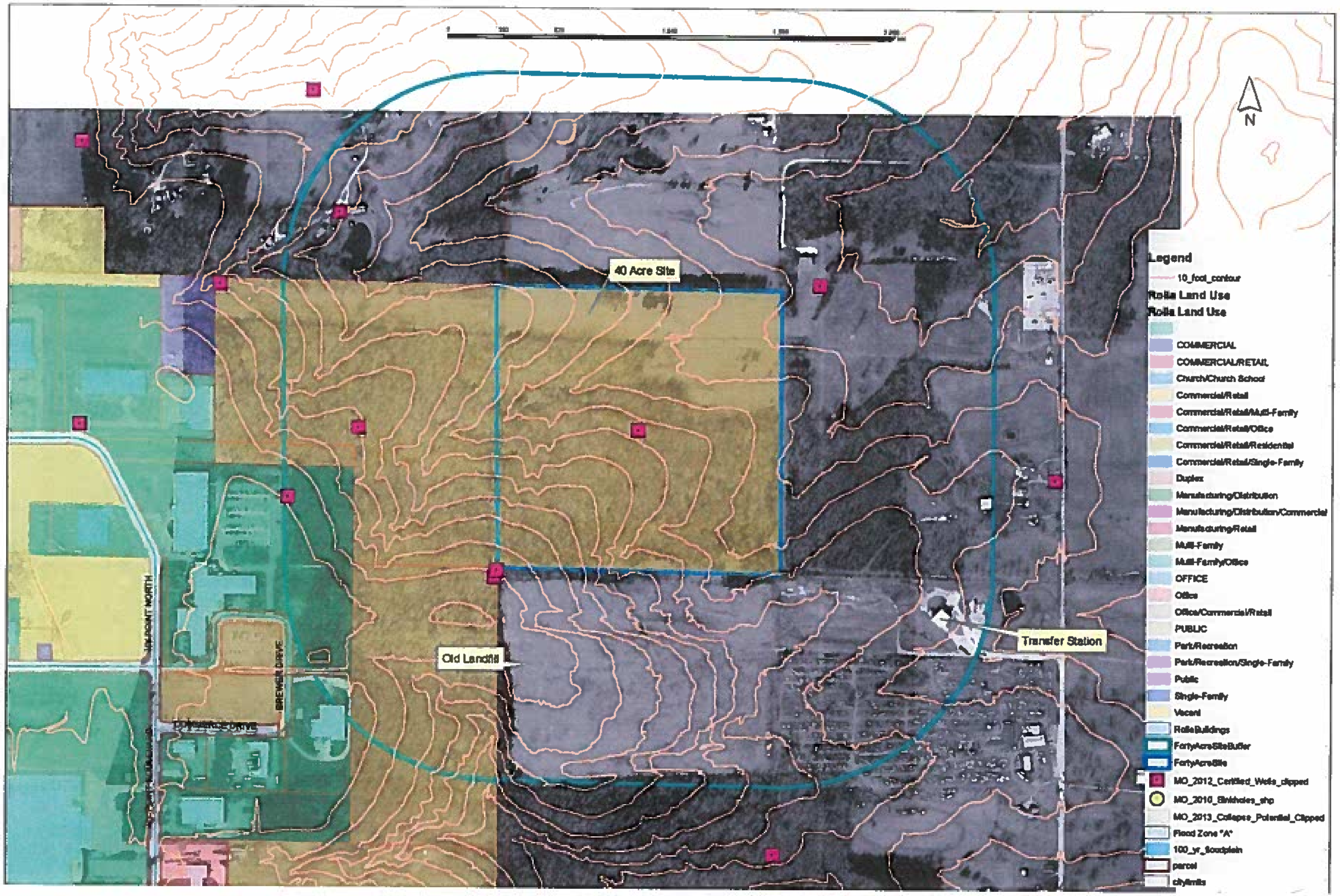


Figure 7. Forty-Acre Site

extent to which Missouri DNR requests information on adjacent land usages and features as part of the solid waste composting approval process.

Based on the Preliminary Manufacturing Plan for the proposed composting facility, various areal extents are needed depending on the composting method chosen:

- Open-air turned windrow with tractor-pulled turner 5.8 acres
- Open-air turned windrow with straddle turner 2.5 acres
- Forced aerated static pile 1.5 acres

Consequently, not all sites are suitable for all technologies, as shown in Table 5:

Table 5. Site Area and Processing Needs Compatibility

Composting Approach	Recycle Center Site	Transfer Station Site	Forty-Acre Site
Pull-behind turner	N	N	Y
Straddle turner	Y	N	Y
Aerated Static Pile	Y	Y	Y

The three sites were also evaluated against several standard Best Management Practices siting criteria and relative to information needed by Missouri DNR in any permit application:

- Topographic grade – generally speaking, grades in excess of 6% are difficult for some motorized equipment to traverse, particularly windrow turners
- Soils – for composting pads, generally try to avoid expansive clays; for spray irrigation sites for storm water, avoid sites with low infiltration rates and intercepting aquitard and aquiclude layers
- Floodplains – siting composting facilities in 100-year floodplains is not recommended
- Caves/Sinkholes/Potential Collapse Areas – this information is sought by MO DNR
- Distance to nearest homes/schools/commercial areas – composting facilities are best kept a considerable distance from sensitive receptors (anywhere public activities occur)
- Distance to nearest wells – wells should be at adequate distance to minimize the potential for groundwater contamination problems
- Adequacy of road network – as most of the incoming feedstocks and outgoing products are transported by trucks, existing road conditions and vehicle traffic are considerations
- Storm water management – can the site handle the no-discharge requirements of MO DNR?

Each site has the following characteristics relative to the evaluation criteria above:

<u>Recycle Center Site</u> – this site is only large enough for two of the composting approaches evaluated, and it is marginal for straddle windrow turning due to the 7% grade running south-to-north in the designated processing area. Most of the soils on-site are a Union silt loam, which is

suitable for construction, and the westernmost 2 acres has been improved with a compacted stone surface beneath the existing mulching site. There are no floodplains on site, nor any caves, sinkholes, or potential collapse areas. There are no wells on-site, and the nearest DNR-certified well is 2,300 feet away to the ENE and has a static water level of 210 ft. There is residential housing less than 500 feet away to the east. The road serving the site is Old St. James Rd., which is now carrying an average annual daily traffic (AADT) of 6,000 vehicles per day. The site is drained by Burgher Branch, which has water quality limitations in development at MO DNR. The only options for storm water runoff management on this site are to reuse it all in the composting process or discharge into the sewer running along Burgher Branch.

Transfer Station Site – this site is only large enough for the aerated static pile composting approach, and there is little room for ancillary facilities other than composting areas. The Transfer Station site is located outside the City on Turner Road (County Road 2170), which serves only small agricultural and large-lot residential areas in Phelps County. As the 1-foot contour interval topography is only available inside the City, it was not possible to determine grade, but a windshield survey revealed the site to be essentially flat. While the native soils are Union silt loams, the site has been built up by fill. There are no floodplains on site, nor any caves, sinkholes, or potential collapse areas. There are no wells on-site, and the nearest DNR-certified well is 810 feet away to the NE and has a static water level of 240 ft. There is one residence about 750 feet away to the NE. The site is drains to Little Prairie Lake (part of a MO DCR Conservation Area) by the same storm water management system serving the old landfill and Transfer Station. It is not known if this system has adequate capacity to meet the no-discharge requirements of MO DNR.

Forty-Acre Site – this undeveloped site is located due north of the old landfill and due west of the Transfer Station site. It has about a 5% grade to the northeast and is in the same watershed as the Transfer Station site. This site is large enough for any of the composting approaches. The eastern side of the site is comprised of a Hartville silt loam soil while the western side is a Beemont-Gatewood Complex (a stoney and clayey colluvium). The USDA Soil Survey for Phelps County lists both soil types as very limited for septic tank absorption fields and for sewage lagoons, so it is not known if spray irrigation of storm water runoff would be feasible for this site (there is no sewer service in this area). There are no floodplains on site, nor any caves, sinkholes, or potential collapse areas. There is one DNR-certified well on-site (a monitoring well for the old landfill) and three more on the property immediately to the southwest. The on-site well has a static water level of 126.0 feet, while the offsite wells have levels between 260.0 and 305.0 feet. There is one residence about 170 feet away from the NE corner of the site and another residence 1,150' away to the east.

The most suitable of the three sites is the Forty-Acre Site. This is remote from any neighbors and is likely to have adequate space for land application of storm water runoff. As it is wooded and undeveloped, construction costs will be higher.

Regulatory Approvals

Composting facilities routinely need approvals on a local level for zoning, building permits and sediment/erosion control plans, while also needing approvals on a State level for waste management and for storm water management.

Local Approvals

The sites being considered by ESD have three separate zoning categories:

- Recycle Center site: M-1, or Light Manufacturing, for the existing Recycling Center; Government & Institutional (G&I) for the area around the water tower, and M-2 Heavy Manufacturing for the remainder.
- Transfer Station site: None as it is in Phelps County
- Forty-Acre site: M-2, or Heavy Manufacturing

The current City Zoning Ordinance does not include a definition of "composting facility" as an allowable land use in any zone, either by right, or subject to a Conditional Use permit. Options for dealing with this could include rezoning the M-2 parcels to G&I District ("Government buildings and uses" are permitted) or adding a composting facility definition to the M-2 list of allowable uses via a zoning text amendment. Rolla Community Development Department believes rezoning to G&I to be the most appropriate action[5].

If the ESD decides to build a structure to enclose the composting facility, a building permit will be needed from Community Development, and as it is probable that more than one acre of land will be disturbed during construction, a Land Disturbance Permit and approval of Erosion and Sediment Control plans will likely be needed from Public Works.

State Approvals

Solid Waste Composting

Missouri DNR regulates solid waste composting under 10CSR80-5.010 as a "solid waste processing facility". Many composting facilities have applied and can apply for exemption under 10CSR80-2.020(9)(D), Exemptions, which allow permit exemptions for:

The department may grant an exemption from having to obtain a solid waste processing facility permit for the composting or co-composting of solid waste not specifically addressed in 10 CSR 80-2.020(9)(A)9. (e.g., food waste) provided that beneficial use of the compost can be demonstrated and provided that the composting and beneficial use activities will not create pollution, a public nuisance or health hazard. In the event a person desires to request an exemption from the requirements to obtain a permit, that person shall submit a written request to the department which includes the following:

[5] Personal Communication, Mr. John Petersen, Rolla Community Development, March 25, 2014

The Composting Exemption Guidelines go on to elaborate on information submittal requirements in 18 different categories regarding the site and the proposed composting operation. The City currently has a Composting Exemption from MO DNR for the woody waste mulching/composting operation north of the Recycle Center.

Project team members reviewed all three sites with MO DNR Solid Waste Management Program staff, along with a fourth site based on locating the facility on top of the old landfill west of the Transfer Station. MO DNR staff indicated that a new composting exemption would be needed for the Recycle Center site, that reuse of the old landfill could be problematic, and that no immediate obstacles to obtaining a Composting Exemption for the Transfer Station site or for the Forty-Acre site were immediately obvious[6].

Storm Water Management

Missouri DNR also regulates storm water discharges from composting facilities, under the EPA Multi-Sector Industrial General Discharge Permit program, MOG-09. This will require preparation of a Storm Water Pollution Prevention Plan and annual benchmark monitoring for pollutants. A permit exemption is possible if all components of the composting facility are under a roofed structure, thus qualifying the facility for a "No-Exposure Exclusion".

The City can obtain a MOG-09 General Discharge Permit (from the regional office at DNR-Poplar Bluff), provided it is for a no-discharge facility, where no-discharge is defined in the permit as no allowable discharge unless an acute storm event occurs of more than the 24-hour, 25-year storm (5.94" in 24-hrs in SW Missouri) or a chronic rainfall event occurs exceeding between 44-63 inches per year. No-discharge options are recycle for moisture control in composting; land apply on appropriate sites; or discharge to sewer[7].

The general permit provides a range of rainfall frequencies for the chronic and catastrophic events. The catastrophic event is based on a 24 hour period and for the Rolla area, use of a 6" rainfall event would be sufficient. The chronic 1 in 10 year rainfall values discussed in the permit are referenced for a 365 day or annual storage holding time. It is costly to construct a storage basin to contain annual storm water flows. The goal of no-discharge is to contain runoff events with sufficient holding times to adequately manage storm water during inclement weather conditions. To reduce construction cost, the City could consider a 90 day holding time, however, maintenance and management increases with a shorter holding time. Storm water may need to be land applied or hauled on a more frequent basis to maintain no-discharge pending rainfall received during a given year or holding period. If a 90 day holding time is chosen, use of an 11 inch rainfall would be the equivalent 1 in 10 year storm value for the chronic event unless you

[6] Personal Communication, Mr. John Boessen, Missouri DNR Solid Waste Management Program, March 27, 2014
[7] Personal Communication, Mr. Mike Hefner, Missouri DNR Water Management Program, March 28, 2014

have other data to present. To be no-discharge the design must collect and contain both events which is a cumulative total (i.e. 6" acute + 11" chronic = 17" total capture needed).

The general permit calls for any storm water management basin to be sealed in accordance with 10 CSR 20-Chapter 8. A compacted clay liner or a synthetic liner may be used. A geologic evaluation for the basin is recommended by MO DNR to ensure the site is suitable to constructing an earthen basin based on site conditions.

The MO DNR storm water management requirements influence the feasibility of the various sites. Due to steepness of terrain from the Recycle Center site down to Burgher Branch, it may be infeasible to construct a storm water management basin although there is a sewer line in Burgher Branch that could possibly convey storm flows down to the Southeast WWTP. The Transfer Station site would have to depend on the existing ponds east of the Transfer Station that were built in the 1990s by Waste Management, Inc. when it built the Transfer Station. It is not known if those ponds have adequate hydraulic capacity to accommodate 17" of rainfall. The Forty-Acre site would have enough room for a pond, and may have geologic suitability. It may also be possible to spray irrigate storm water on unused portions of the Forty-Acre site.

Economic Analysis

The economic feasibility of any new public-sector organics diversion program should be based on a determination that all costs of providing that service are offset by revenues, so there is no net cost to the municipality. A new food waste diversion, collection and composting program in Rolla will have costs associated with construction and operation of a new composting facility and with operation of a new collection program for SSO. It will have revenues from monthly service charges (similar to the current service charge system for solid waste) and, potentially, from product sales. It will also have avoided costs from reduced transfer station charges, which could be viewed as additional revenues.

Industrial/commercial/institutional generators of food scraps and SSO will be unlikely to sign up for a voluntary program that costs more than current services, although some schools and universities have sustainability initiatives that may make them more flexible about costs. Residential customers who could be considered "innovators" or "early adopters"[8] might be willing to pay more for an additional SSO service on top of their existing refuse, recycling and yard waste services. In several U.S. communities with voluntary SSO diversion programs, households are paying $8 - $15/week extra for SSO collection services[9], although these programs tend to be located on East and West Coasts where solid waste costs are higher.

The methodology used in this economic analysis included:

- Develop capital cost estimates for composting facility using any of the three composting approaches at the Recycle Center site and the Forty-Acre site (the Transfer Station site was eliminated due to inadequate area)
- Develop operating cost estimates for all composting alternatives
- Calculate "per-ton" total costs based on total tonnage of material handled by the facility
- Calculate potential revenues from avoided transfer station charges and compost product sales
- Update the Commercial and Residential Refuse Service Charges of the City to 2014 using more current data
- Develop Commercial and Residential Food Waste Service Charge rate sheets based on costs of collection containers and tipping fee at the composting facility

Each of these steps is summarized below; the detailed calculations are in the Appendix.

[8] Rogers, E. M. (2003). *Diffusion of innovations* (5th edition). New York, NY: Free Press.
[9] Coker Composting & Consulting, *ecomaine Food Waste Diversion Study,* Task 2 – Collection Alternatives Report, March 2013

Capital Costs

Capital costs were estimated for site development, composting process management, and mobile equipment at a facility planning level of accuracy (i.e. +50%/-30%). Site development cost components included clearing/grading, stone subbase, asphalt pads for all process areas, security fencing and gating, power/lighting, water, sewer, storm water pond and storm water recycle system. Composting process management costs included windrow covers and hold-downs (for the turned windrow alternatives), bunker walls, floors, aeration blowers and timers, and aeration piping (for the aerated static pile alternatives), process control software, monitoring instruments, uniforms/work shoes, office furniture, and computers. Mobile equipment included a tractor and a pull-behind windrow turner or a self-propelled straddle turner (for the turned windrow alternatives), mechanical mixing equipment (for the aerated static pile alternatives), front-end loaders, and a trommel screen. For all alternatives, the capital costs were assumed to be financed with a debt instrument at 3% interest rate for a 20-year term. Capital costs for the alternatives are summarized in Table 6, and detailed calculations are in the Appendix.

Table 6. Capital Costs Summary

	Recycle Center Site		**Forty-Acre Site**		
	Straddle Turner	Bunker ASP	Tractor-pulled Turner	Straddle Turner	Bunker ASP
Site Development	$1,244,106	$777,376	$2,843,297	$2,065,329	$827,672
Composting Process Management	$27,350	$134,564	$27,350	$27,350	$134,564
Mobile Equipment	$584,900	$339,900	$286,400	$584,900	$339,900
Subtotal	$1,856,356	$1,251,840	$3,158,397	$2,677,579	$1,302,136
Financing Cost	$614,517	$414.402	$1,045,537	$886,370	$431.052
Total Capital Cost	$2,470,873	$1,666,242	$4,203,934	$3,563,949	$1,733,188

The higher capital costs for the tractor-pulled turner alternative reflect the larger land area needed (and, thus, area paved). Similarly, the smaller processing footprint of the aerated static pile alternatives is reflected in the lower capital costs.

Operating Costs

Operating costs were estimated for administrative costs, labor costs, and machine costs. Administrative costs included a rented office trailer, electricity, using contract scales for weighing trucks, and for site administration and product marketing and sales costs. Labor costs were based on a labor rate of $20/hour and the facility being open 5 days per week, 52 weeks per year. Machine costs were based on a repair and fuel usage rate of $50/hour. Time-and-motion estimates were prepared for each step in the compost manufacturing process in order to estimate the number of full-time staff needed for the facility. Operating costs for the alternatives are summarized in Table 7, and detailed calculations are in the Appendix.

Table 7. Operating Costs Summary

	Pull-behind Turner	Straddle Turner	Bunker ASP
Daily Operating Labor (hrs/day)	10.7	10.7	10.2
Full-time Equivalents needed	1.33	1.33	1.27
Annual Operating Cost			
Labor	$37,421	$30,524	$44,245
Machine	$90,376	$73,133	$83,612
Consumables	$12,840	$12,840	$15,765
Total	$140,637	$116,498	$143,622

The higher operating costs for the Bunker ASP option are due to the assumption that curing piles would be turned with a bucket loader, which is relatively slow and inefficient, but is still less than using a windrow turner for a very limited application.

Revenues

Revenues were estimated for compost sales assuming 75% of annual production went to market (the other 25% would be used in-house on City projects) and that the average sales price would be about $8.00 per cubic yard (CY). That is a low price relative to what composters in St. Louis and Kansas City are selling product for, but it is more in line with traditional municipal compost pricing.

Insofar as a composting facility would divert food scraps and SSO away from the Transfer Station, there is an avoided cost that could be considered a form of revenue.

Both of these revenues are considered "potential" revenues. While there has been good demand for the City's mulched yard waste, compost is a different product, and there will need to be a well-thought out compost marketing and sales plan. Also, as this SSO diversion program is intended to be voluntary, there are no assurances that the levels of diversion will reach the amounts forecast in this analysis.

Revenue estimates are presented in Table 8.

Table 8. Revenue Estimates

Revenue Sources			
Avoided Transfer Station Charges:			
Annual tonnage food scraps composted		2501.2	tons/year
Current TS fee	$	42.56	per ton
Avoided cost	$	106,451	per year
Compost Sales			
Annual compost production		5,159	CY/yr
Assume annual sales as % of production		75%	
Annual quantities sold		3,869	
Average sales price	$	8.00	per CY
Revenue from compost sales	$	30,954	per year
Total Revenues Forecast	$	137,405	per year
Per ton (based on all feedstocks)	$	25.00	

There are some uncertainties in these estimates. For example, if the composting facility net tip fee (net of potential revenue) is used ($17.58/ton), the monthly container fee drops to $80.28 and $66.67, respectively. Also, not all generators would need service 3 times per week (although some will need 5 day/week pickup). It was not possible in the scope of this study to do a complete analysis of potential diversion costs for all food waste generators in the City.

As noted above, it is unlikely that a commercial generator will subscribe to a voluntary program that will cost them more per month for solid waste management. If a restaurant or grocery diverts food wastes to composting, then the volumes and weights of residuals that have to go into an existing dumpster or compactor are reduced. This offers the possibility that the dumpster could be down-sized and pickup frequency reduced to reflect the fact that putrescible organics are not going into that dumpster. This process of optimizing solid waste management collection infrastructure for a particular generator is called Resource Management Analysis.

To analyze this hypothetically, the existing 2001 Commercial Dumpster Fees were updated to 2014 conditions and compared to the Food Service Collection Costs in Table 10. For example, a commercial user generates 4 CY per week and has a 2 CY dumpster pulled twice per week (at an updated cost of $130.91/month). If that user diverts one CY per week by using the 90-gal rollcarts picked up three times weekly (at a cost of $149.47), then there are 3 CY of MSW generated weekly that has to be removed. The user could go to a 1 CY dumpster pulled three times per week (updated monthly cost of $128.80) or a 4 CY dumpster pulled once per week (updated cost of $113.61). The savings from reduced pickup frequency or reduced size do not necessarily offset the additional costs of diversion to composting.

A more comprehensive evaluation of commercial food waste/SSO generators is recommended. This would include detailed waste audits of a representative sample of solid waste from several different types of generators, physical weighing and characterization into compostable and non-compostable fractions, and then determination of the optimum number and size of containers for each fraction. This determination could be used to make up a *pro forma* invoice for routine service in a post-diversion timeframe for comparison to each generator's current solid waste management costs invoiced by Rolla Municipal Utilities.

Residential Food Waste Service Collection Costs

Although the City's main interest is in a commercial-sector food waste/SSO diversion program, a similar analysis was done of residential households so that the City would have a more complete picture of the potential for food waste diversion. In January 2013, there were 183 residential curbside collection programs for food wastes in 18 states, serving over 2.55 million households[10] and that number is now thought to be over 200.

[10] Yepsen, R., "Residential Food Waste Collection in the United States – A Survey", *BioCycle*, Vol. 54, No. 3, March 2013, p. 23

According to 2013 data from the Rolla Regional Economic Commission, there were 7,483 single-family households in Rolla. The economic analysis assumed three various levels of voluntary participation: 10%, 30%, and 50%. The analysis included labor time for picking up containers at curbside, capital cost of truck and containers, vehicle fuel, repair and maintenance, composting facility tip fee (gross of potential revenues) and program administration at 15%. The resulting monthly charge would be about $14.84 as shown in Table 11.

Table 11. Residential Food Waste Service Collection Costs

	Low	Medium	High
Number of HHs	748	2245	3742
Labor	$ 0.63	$ 0.63	$ 0.63
Containers:	$ 0.89	$ 0.88	$ 0.87
Equipment:	$ 0.15	$ 0.15	$ 0.15
Disposal:	$ 11.07	$ 11.07	$ 11.07
Vehicle R&M:	$ 0.06	$ 0.06	$ 0.06
Fuel:	$ 0.11	$ 0.11	$ 0.11
Subtotal	$ 12.91	$ 12.90	$ 12.89
Program Admin	$ 1.94	$ 1.93	$ 1.93
Total Monthly Cost Per HH =	$ 14.84	$ 14.83	$ 14.82

Conclusions and Recommendations

This study was a very preliminary investigation into the feasibility of recycling food scraps and other source-separated organics into compost at a site owned by the City of Rolla. Conclusions of this study include:

- There are institutional generators of food scraps who are interested in having an opportunity to recycle those wastes, including the Missouri University of Science and Technology and their dining services contractor, Chartwells (also possibly Rolla Public Schools and the Phelps County Regional Medical Center);
- Commercial generators are largely unaware of what is involved in food waste recycling but may be willing to learn, and participate, provided solid waste disposal costs don't go up. At the same time, some commercial generators expressed no interest in participating;
- There may be enough residential generators willing to pay more for solid waste disposal to have an enhanced recycling program for food scraps and SSO collected at curbside, but no confirmative information was obtained in this study;
- There are two suitably-sized City-owned sites where composting of food scraps and ground-up yard trimmings could be done. The Forty-Acre site north of the landfill and east of the Industrial Park is a more suitable site than the current site north of the Recycling Center where ground yard trimmings are currently mulched and composted;
- Composting facilities will require permits from the Missouri DNR, one being an exemption from solid waste composting and the other a no-discharge permit for storm water management. The composting permit exemption should be relatively straightforward, but the storm water permit requirements are a considerable capital cost;
- The preliminary cost estimate for building and operating a composting facility, when expressed on a dollars-per-ton basis, is very similar to the current cost of the contract for the Transfer Station operation ($42.58/ton for composting; $42.56/ton for TS operation). It may be possible to reduce the cost for composting as a result of site analysis and facility design; and
- This cost parity means that diversion and collection of SSO to composting would have to be offset by reduced costs for refuse management to keep overall solid waste management costs stable. It is not known if this is possible.

Should the City elect to continue investigation into the feasibility of this new recycling program, the next steps are recommended:

- Meet with Rolla Public Schools and the Phelps County Regional Medical Center staff to discuss a possible diversion program (neither party was available during this study)
- Conduct an audit of commercial food waste sources- this would include a survey of all generators to identify those willing to participate in a waste audit, selection of 3 to 5 generators to participate in waste audit to determine percent compostable waste vs.

percent refuse, conduct the audit using a representative quantity of solid waste, prepare a cost analysis to see if the reduction in refuse container/pickup frequency cost would offset the increase due to food waste collection (using the audit to refine the service cost estimates developed in this study), and a physical survey to see if they have the physical space for separate collection systems. If the results of the audits are positive, share the audit results with the commercial generators in an outreach program and survey to see how many would be willing to consider implementing food waste diversion

- Survey residential food waste sources- this would include a survey of all Rolla households to see how many might be willing to participate at different price structures (i.e. +$13/month, +$8/month, +$5/month). Based on survey results, develop, using City GIS, a collections routing analysis of willing participants to see if collection system service cost estimates need refining (i.e. size of truck, pickup time, collection operating costs)
- Develop a preliminary design for the composting facility and apply for both the composting permit exemption and the storm water permit – this would include a more detailed examination of the Forty-Acre site with regard to suitability for a storm water management pond and a runoff spray irrigation system, development of a scaled site plan, preparation of more detailed information on composting procedures, operations plans, and product marketing strategies, and refinement of the preliminary cost estimates contained in this study.

Appendix

COKER COMPOSTING AND CONSULTING

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Vinton VA 24179
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cscoker@verizon.net
www.cokercompost.com

Project	Rolla Food Waste Diversion Study	**Proj. No.**	14-160
Client	City of Rolla	**Date**	5/2/14
Analysis	Windrow Facility Capital Cost Estimate		

Area Needs

	Alt. 1 - Tractor-Pulled Turner				
Area Summary	Width	Length		Area (sq. ft.)	Area (acres)
On Hardened Pad					
Feedstock Receipt & Mixing	40	40		1,600	0.04
Ground Feedstocks Storage	150	150		22,500	0.52
Composting Pad	360	320		115,200	2.64
Curing Pad	320	320		102,400	2.35
Screening Area	56	70		3,920	0.09
Product Storage Area	75	75		5,625	0.13
			Totals	251,245	5.77
Allowance for roadways, equip. maintenance, etc. @ 20%				301,494	6.92

	Alt. 2 - Self-propelled Straddle Turner				
Area Summary	Width	Length		Area (sq. ft.)	Area (acres)
On Hardened Pad					
Feedstock Receipt & Mixing	40	40		1,600	0.04
Ground Feedstocks Storage	150	150		22,500	0.52
Composting Pad	175	225		39,375	0.90
Curing Pad	150	225		33,750	0.77
Screening Area	56	70		3,920	0.09
Product Storage Area	75	75		5,625	0.13
			Totals	106,770	2.45
Allowance for roadways, equip. maintenance, etc. @ 20%				128,124	2.94

Available Site Areas

Composting Approach	Recycle Center Site	Transfer Station Site	Forty-Acre Site
Pull-behind turner	N	N	Y
Straddle turner	Y	N	Y
Aerated Static Pile	Y	Y	Y

	Recycle Center Site Alt. 2	Forty-Acre Site Alt. 1	Forty-Acre Site Alt. 2
Site Development			
Clearing/Grading			
Clearing @ $3,000/ac	$ -	$ 20,764	$ 8,824
Assume sites level enough so no fill needed	$ -	$ -	$ -
Cut 12" deep @ $3.00/CY			
Area x 1' deep = CF / 27 cf/cy = CY	$ 14,236	$ 33,499	$ 14,236
Subbase			
6" rock subbase $20/ton, 0.56 tons/SY			
Area / 9 sf/sy = SY x 0.56 tons/SY = tons x $20	$ 159,443	$ 375,193	$ 159,443
Asphalt Pads			
Area / 9 sf/sy = SY x $40/SY	$ 569,440	$ 1,339,973	$ 569,440
Security (fencing)			
SQRT Area x 4 = LF x $25/LF	$ 35,794	$ 54,908	$ 35,794
Extend power/Lighting			
110/220V service to trailer + 2-3 area lights, allowance	$ 2,500	$ 5,000	$ 5,000
Water & Sewer			
Recycle Center site - allowance for hookup	$ 5,000		
Forty-Acre Site - well & septic allowance		$ 20,000	$ 20,000
Storm Water Pond			
DNR will require retention of 24-hr, 25-yr storm = 6.3"			
V = Runoff Vol. = 6.3" x 75% runoff ratio x area, in ft^3	605,386	1,424,559	605,386
Pond Cost equation: $C = 23.5 V^{0.705}$	$ 110,000	$ 202,000	$ 110,000
Source: SMRC, www.stormwatercenter.net			
Pond Liner - 2' compacted clay @ $32,000/acre, assume 8' D	$ 55,591	$ 130,814	$ 55,591
Storm Water Recycle System			
Trash pump & hose to fill water wagon, allowance	$ 5,000	$ 5,000	$ 5,000
Subtotal	$ 957,005	$ 2,187,151	$ 1,588,714
Design Fee at 5%	$ 47,850	$ 109,358	$ 79,436
Contingency at 25%	$ 239,251	$ 546,788	$ 397,179
Total	$ 1,244,106	$ 2,843,297	$ 2,065,329

Composting Process Management			
Windrow Covers (CV Compost, Charlotte, VT, (877) 406-2398)			
ComposTex Fabric Covers			
Alt. 1 - 15 covers, 15' W x 225' L		$ 14,700	
Alt. 2 - 9 covers, 22' W x 225' L	$ 13,350		$ 13,350
Cover Hold-Downs (EnTire Recycling, Rock Port, MO (660) 744-2252)			
Bunker Rings, est. 300 @ $2.00 each	$ 600	$ 600	$ 600
Process Software http://www.compostsoftware.com/			
Ascht Compost Management Software	$ 10,000	$ 10,000	$ 10,000
Monitoring Instruments http://www.reotemp.com/composting-products.html			
Reotemp 36" Compost Thermometers (2)	$ 250	$ 250	$ 250
Microwave Oven	$ 100	$ 100	$ 100
Uniforms/Work Shoes			
Allowance	$ 200	$ 200	$ 200
Office Furniture			
Allowance	$ 350	$ 350	$ 350
Computers			
PC/printer/modem - allowance	$ 2,500	$ 2,500	$ 2,500
Subtotal	$ 27,350	$ 28,700	$ 27,350
Mobile Equipment			
Rubber-tired loaders			
Alt. 1 - 1 FEL + bucket on tractor			
John Deere 524K with 5 CY bucket		$ 125,000	
Alt. 2 - 2 FEL			
2 JD 524Ks	$ 250,000		$ 250,000
Tractor (Donald Farm & Lawn, Rolla, MO, (573) 368-2011)			
John Deere 5100M w/ 16F/16R Creeper Gear		$ 74,000	
Pull-behind turner (Global Repair, Toronto, Ontario, Canada (866) 271-0719)			
Sittler Model 509 windrow turner		$ 25,000	
Sittler Water Wagon/Injection System		$ 12,500	
Straddle turner (Resource Recovery Systems, (970) 522-0663			
RRSKW Model 616	$ 285,000		$ 285,000
Trommel Screen (Screen USA, Smyrna, GA (770) 433-2440)			
TROM 406 Trommel Screen	$ 49,900	$ 49,900	$ 49,900
Subtotal	$ 584,900	$ 286,400	$ 584,900
Total	$ 1,856,356	$ 3,158,397	$ 2,677,579
Cost of money (at 3% for 20 yrs)	$ 614,517	$ 1,045,537	$ 886,370
Capital Cost Estimate	$ 2,470,873	$ 4,203,934	$ 3,563,949
Annual Tonnage 5,408			
Tonnage over 20 yrs 108,160			
Capital Cost Per Ton	$ 22.84	$ 38.87	$ 32.95

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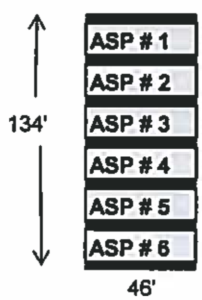
Project	Rolla Food Waste Diversion Study	**Proj. No.**	14-160
Client	City of Rolla	**Date**	5/2/14
Analysis	ASP Capital Cost Estimate		

Area Summary	Width	Length		Area (sq. ft.)	Area (acres)
On Hardened Pad					
Feedstock Receipt & Mixing	40	40		1,600	0.04
Ground Feedstocks Storage	150	150		22,500	0.52
Composting Pad	140	120		16,800	0.39
Curing Pad	130	120		15,600	0.36
Screening Area	56	70		3,920	0.09
Product Storage Area	75	75		5,625	0.13
			Totals	66,045	1.52
Allowance for roadways, equip. maintenance, etc. @ 20%				79,254	1.82



Bunker size: 20' W x 46' L

	Recycle Center Site	Forty-Acre Site
Site Development		
Clearing/Grading		
Clearing @ $3,000/ac	$ -	$ 5,458
Assume sites level enough so no fill needed	$ -	$ -
Cut 12" deep @ $3.00/CY		
Area x 1' deep = CF / 27 cf/cy = CY	$ 8,806	$ 8,806
Subbase		
6" rock subbase $20/ton, 0.56 tons/SY		
Area / 9 sf/sy = SY x 0.56 tons/SY = tons x $20	$ 98,627	$ 98,627
Asphalt Pads		
Area / 9 sf/sy = SY x $40/SY	$ 352,240	$ 352,240
Security (fencing)		
SQRT Area x 4 = LF x $25/LF	$ 28,152	$ 28,152
Extend power/Lighting		
110/220V service to trailer + 2-3 area lights, allowance	$ 2,500	$ 5,000
Water & Sewer		
Recycle Center site - allowance for hookup	$ 5,000	
Forty-Acre Site - well & septic allowance		$ 20,000
Storm Water Pond		
DNR will require retention of 24-hr, 25-yr storm = 6.3"		
V = Runoff Vol. = 6.3" x 75% runoff ratio x area, in ft3	374,475	374,475
Pond Cost equation: C = 23.5 V 0.705	$ 69,000	$ 79,000
Source: SMRC, www.stormwatercenter.net		
Pond Liner - 2' compacted clay @ $32,000/acre, assume 8' D	$ 28,656	$ 34,387
Storm Water Recycle System		
Trash pump & hose to fill water wagon, allowance	$ 5,000	$ 5,000
Subtotal	$ 597,981	$ 636,671
Design Fee at 5%	$ 29,899	$ 31,834
Contingency at 25%	$ 149,495	$ 159,168
Total	$ 777,376	$ 827,672
Composting Process Management		
Bunker Walls		
ASP bunkers made of 8' L x 12' H x pre-cast bunker silos		
Hanson Silo, Lake Lillian, MN (320) 664-4171	$ 82,073	$ 82,073
134 LF of 8'6" high L-wall panels		
424 LF of 8'6" high T-wall panels		
Bunker Floors		
Concrete slab: 6 bunkers x 20' w x 50' L @ $5.00/SF	$ 30,000	$ 30,000
Aeration Piping:		
Manifolds, Tees, Reducers		
20 l.f. per bunker Allowance $ 250.00 per bunker		
4" HDPE DR-11 perf pipe on slab		
4 x 46' each bunker 184 lin. Ft./bunker		
Unit cost $ 0.80 Pipe subtotal $ 147.20 per bunker		
Aeration piping subtotal $ 397.20 per bunker		
all bunkers	$ 2,383	$ 2,383

Aeration Blowers					
ASP blowers from New York Blower Co.					
12" General Industrial Fans with Acoustafoil blades (single phase)					
750 cfm into 6" S.P.					
Unit cost: $ 958.00 each					
Dynamic Bulk Systems, Fenton, MO (636) 343-4300					
	all blowers	$	5,748	$	5,748
ASP blower timers					
Intermatic ET1125CPD82 Double Pole timer (Farm-Tek, p. 336)		$	960	$	960
Process Software http://www.compostsoftware.com/					
Aschl Compost Management Software		$	10,000	$	10,000
Monitoring Instruments http://www.reotemp.com/composting-products.html					
Reotemp 36" Compost Thermometers (2)		$	250	$	250
Microwave Oven		$	100	$	100
Uniforms/Work Shoes					
Allowance		$	200	$	200
Office Furniture					
Allowance		$	350	$	350
Computers					
PC/printer/modem - allowance		$	2,500	$	2,500
	Subtotal	$	134,564	$	134,564
Mobile Equipment					
Rubber-tired loaders					
2 JD 524Ks		$	250,000	$	250,000
Mixing System					
Kuhn Knight Model 3142 Mixer		$	40,000	$	40,000
http://www.tractorhouse.com/list/list.aspx?catid=1146&Manu=KUHN+KNIGHT					
Trommel Screen (Screen USA, Smyrna, GA (770) 433-2440)					
TROM 406 Trommel Screen		$	49,900	$	49,900
	Subtotal	$	339,900	$	339,900
	Total	$	1,251,840	$	1,302,136
	Cost of money (at 3% for 20 yrs)	$	414,402	$	431,052
	Capital Cost Estimate	$	1,666,242	$	1,733,188
Annual Tonnage 5,408					
Tonnage over 20 yrs 108,160					
	Capital Cost Per Ton	$	15.41	$	16.02

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Project	Rolla Food Waste Diversion Study	**Proj. No.**	14-160
Client	City of Rolla	**Date**	4/21/14
Analysis	Windrow Facility Operating Cost Estimate		

Assumptions

1. Labor rate (loaded) per hour	$20.00	per hour
2. Machine rate (fuel + maintenance)	$50.00	per hour
3. Facility is open 5 days/week, 52 weeks/yr	260	days/yr
4. Assume labor & machine costs equal between both turner alternatives		
5. Neglects any overlap of labor functions between tasks		

Administrative Costs

Office Trailer		$	500	per month
	=	$	6,000	per year
Electricity (including security lighting) – allowance		$	15	per month
	=	$	180	per year
Truck weigh scale usage				
Assume 2 trucks/day @ $8.00 per weigh-in		$	16	per day
	=	$	192	per year
Site admin/Product marketing and sales				
Direct costs (printing, mailing, ads, etc.)		$	2,500	per year
Labor - 16 hrs/week @ $20/hr		$	320	per week
	=	$	16,000	per year
	Admin cost/year	$	**12,840**	
	Labor cost/year	$	**16,000**	

Processing Volumes

	Average Daily Volume
Food Scraps	11.8
Ground Yard Waste/Clearing Debris	27.9
Overs	12.8
Totals	52.5 CY/day

Materials Handling Assumptions

1. Assume wastes & products handled by two separate loaders
   a. Bucket capacity of each loader — 5 CY/loader
2. Grinding done by contractor
3. Mixing done by straddle or pull-behind turner
4. Materials moved to composting and curing with yard truck
5. Materials moved to screening and storage (overs and compost) by loaders

Materials Handling - Waste Receipt

1. Daily volumes coming into facility			52.5	CY/day
2. Number of loader "bucket-movements" to keep piles "pushed up"				
a. Daily volume / capacity of loader bucket			10	buckets/day
3. Assume time spent per loader movement (push up)			1	minutes
4. Time spent handling feedstocks			10	minutes/day
	Convert to hours		0.2	hours/day
	Convert to days		0.01	days
	Labor cost/year	$	910	
	Machine cost/year	$	2,275	

Materials Handling - Transport To Composting Pad

1. Assume volume capacity of transport truck		10.0 CY
2. Number of truck trips/day		5 trips/day
3. Time for RT from receipt area to compost pad (plus load/unload) per trip		10.0 minutes
4. Total time for feedstocks transport		52.5 minutes/day
	Convert to hours	0.9 hours/day
	Labor cost/year	$ 4,549
	Machine cost/year	$ 11,374

Building Composting Windrows

1. Assume all windrows built with loader		5.0 CY/bucket
2. Daily volume coming to composting pad		52.5 CY/day
3. Number of buckets per day		10 buckets/day
4. Time needed to move feedstocks from unload site to windrow		5.0 minutes/bucket
5. Time needed to build windrows		52.5 minutes/day
	Convert to hours	0.9 hours/day
	Labor cost/year	$ 4,549
	Machine cost/year	$ 11,374

Materials Handling - Windrow Mixing & Turning - Straddle Turner

1. Number of turner passes to mix		1 pass/windrow
2. Number of turner passes while composting		2 passes/week/windrow
3. Total number of windrow passes		3 passes/windrow
4. Number of windrows		9 windrows
5. Windrow length =		118 linear ft/ windrow
6. Turner speed = 0.25 mph =		22 ft/min.
7. Time to make one windrow pass =		5.4 minutes/windrow
8. Time to turn around =		2.0 minutes/turn
9. Time to travel down pad to another windrow =		2.0 minutes
10. Total time needed per windrow		11.4 minutes
11. Time needed to mix windrows		102.3 minutes
12. Time needed to turn windrows per week		204.6 minutes/week
13. Total time spent mixing/turning windrows		307.0 minutes
	Convert to hours	5.1 hours
	Convert to per day equiv	1.0 $hours/day_{equiv}$
	Labor cost/year	$ 5,321
	Machine cost/year	$ 13,301

Materials Handling - Windrow Mixing & Turning - Straddle Turner

1. Number of turner passes to mix		1 pass/windrow
2. Number of turner passes while composting		2 passes/week/windrow
3. Total number of windrow passes		3 passes/windrow
4. Number of windrows		15 windrows
5. Windrow length =		213 linear ft/ windrow
6. Turner speed = 0.25 mph =		22 ft/min.
7. Time to make one windrow pass =		9.7 minutes/windrow
8. Time to turn around =		2.0 minutes/turn
9. Time to travel down pad to another windrow =		2.0 minutes
10. Total time needed per windrow		15.7 minutes
11. Time needed to mix windrows		235.0 minutes
12. Time needed to turn windrows per week		469.9 minutes/week
13. Total time spent mixing/turning windrows		704.9 minutes
	Convert to hours	11.7 hours
	Convert to per day equiv	2.3 $hours/day_{equiv}$
	Labor cost/year	$ 12,218
	Machine cost/year	$ 30,544

Windrow Irrigation - based on pull-behind turner

	Formula	Units	Value
Windrow Dimensions			
Length		Ft.	213
Width		Ft.	9
Height		Ft.	5
Volume per linear foot	A = h x (b - h)	CY/LF	0.74
Volume of material in windrow	Vol/LF x linear feet	CY	158
Bulk density of mix	assumed	lbs/CY	800
Weight of windrow	bulk density x volume	lbs	126,222
Moisture content of sample	assumed	%	40%
Desired moisture content		%	50%
Weight of water in windrow	weight x moisture %	lbs	50,489
Desired weight of water	weight x 50%	lbs	63,111
[illegible]	[illegible]	[illegible]	[illegible]

Amt added by rain	48"/yr / 52 weeks =	in./week	0.92		
		gal/wk	1,103		
Net shortfall		gal	410		
Irrigation Rate	Based on windrow speed	gal/min	36		
Irrigation/Pump Running Time		min	42		

1. Assume irrigation weekly by hose reel connected to turner				
2. Assumed time to connect/disconnect reel from standpipes			5.0	minutes/windrow
3. Number of windrows			15	windrows
4. Total irrigation labor time per week			75.0	minutes/week
	Convert to hours		1.3	hours/week
	Labor cost/year	$	1,300	
5. Total pump running time per week			42	minutes/week
	Convert to hours		0.7	hours/week
	Pump O&M Cost	$	2.00	$ per hour
	Machine cost/year	$	73	

Materials Handling - Moving Compost to Curing

1. Daily volume going to curing (assume 30% shrink)			37	CY/day
2. Number of loader bucket movements			6	buckets/day
3. Time to tear down, pick up, transport and load truck			5	min/bucket
4. Total time needed to move compost to transport truck			30.6	minutes/day
5. Assume volume capacity of transport truck			10	CY
6. Number of truck trips/day			4	trips/day
7. Transport time to curing area			5	minutes/trip
8. Total time needed to move compost by truck			18	minutes/day
9. Total time needed to load and move			49	minutes/day
	Convert to hours		0.8	hours/day
	Labor cost/year	$	4,246	
	Machine cost/year	$	10,615	

Managing Curing Piles

1. Assume curing windrows built with loader			5	CY/bucket
2. Daily volume coming to curing			36.7	CY/day
3. Number of buckets per day			7	buckets/day
4. Time needed to move feedstocks from unload site to windrow			4.0	minutes/bucket
5. Time needed to build windrows			29.4	minutes/day
6. Assume turner used to turn windrows once/week			1	pass/week
7. Number of windrows			15	windrows
8. Windrow length =			118	linear ft/ windrow
9. Turner speed = 0.25 mph =			22	ft/min.
10. Time to make one windrow pass =			5.4	minutes/windrow
11. Time to turn around =			1.0	minutes/turn
12. Time to travel down pad to another windrow =			2.0	minutes
13. Total time needed per windrow			8.4	minutes
14. Time needed to turn windrows per week			125.5	minutes/week
13. Total time spent building/turning windrows			272.5	minutes
	Convert to hours		4.5	hours
	Convert to per day equiv		0.9	$hours/day_{equiv}$
	Labor cost/year	$	4,724	
	Machine cost/year	$	11,809	

Materials Handling - Cured Compost to Screening

1. Daily volume going to screening (assume 20% shrink in curing)			29	CY/day
2. Number of loader bucket movements			6	buckets/day
3. Time to tear down, pick up & transport to screen area			2.0	minutes/bucket
4. Total time needed to move cured compost to screen			11.8	minutes/day
	Convert to hours		0.2	hours/day
	Labor cost/year	$	1,019	
	Machine cost/year	$	2,548	

H. Materials Handling - Screening & Product Storage

1. Daily volume going to screening		29	CY/day
2. Assume screen hopper capacity = loader bucket capacity		6	CY
3. Number of bucket movements to keep hopper filled		5	buckets/day
4. Round-trip time to pick up and load hopper		2	min/bucket
5. Time needed to load screen		10	minutes/day
6. Volume of finished compost produced by screen (80% yield)		24	CY/day
7. Number of loader buckets needed to move compost to storage		5	buckets/day
8. Round-trip time needed to move compost to storage		5	minutes/day
9. Time needed to clear compost from screen		24	minutes/day
10. Volume of overs produced by screen (20%)		6	CY/day
11. Number of loader buckets needed to move overs to storage		1	buckets/day
12. Round-trip time to move from screen to overs storage		10	minutes/day
13. Time needed to clear overs from screen		11.8	minutes/day
14. Total time needed with screening		45.1	minutes/day
	Convert to hours	0.8	hours/day
	Labor cost/year	$ 3,906	
	Machine cost/year	$ 9,766	

Labor Summary

Process	Hrs/Day
Administrative	3.2
Waste Receipt	0.2
Transport to pad	0.9
Building windrows	0.9
Windrow Mixing & Turning	1.0
Windrow Irrigation	0.3
Moving Compost to Curing	0.8
Managing Curing Piles	0.9
Moving Cured Compost to Screening	0.2
Screening & Product Storage	0.8
TOTALS	9.1

Assume 85% efficiency of site workers		
Number of work-hours needed	10.7	hrs/day
FTE's in a 8-hour day	1.3	FTEs

Operating Expenses Summary

	Straddle Turner			Pull-behind Turner		
	Labor Cost	Machine Cost	Consumables	Labor Cost	Machine Cost	Consumables
Administrative	$ 16,000		$ 12,840	$ 16,000		$ 12,840
Waste Receipt	$ 910	$ 2,275		$ 910	$ 2,275	
Transport to pad	$ 4,549	$ 11,374		$ 4,549	$ 11,374	
Building windrows	$ 4,549	$ 11,374		$ 4,549	$ 11,374	
Windrow Mixing & Turning	$ 5,321	$ 13,301		$ 12,218	$ 30,544	
Windrow Irrigation	$ 1,300	$ 73		$ 1,300	$ 73	
Moving Compost to Curing	$ 4,246	$ 10,615		$ 4,246	$ 10,615	
Managing Curing Piles	$ 4,724	$ 11,809		$ 4,724	$ 11,809	
Moving Cured Compost to Screening	$ 1,019	$ 2,548		$ 1,019	$ 2,548	
Screening & Product Storage	$ 3,906	$ 9,766		$ 3,906	$ 9,766	
Subtotals	$ 30,524	$ 73,133	$ 12,840	$ 37,421	$ 90,376	$ 12,840
	Total	$ 116,498		Total	$ 140,637	
	Annual Tons	5,408		Annual Tons	5,408	
	Per Ton	$ 21.54		Per Ton	$ 26.01	

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Project	Rolla Food Waste Diversion Study	**Proj. No.**	14-160
Client	City of Rolla	**Date**	4/21/14
Analysis	ASP Operating Cost Estimate		

Assumptions

Labor rate (loaded) per hour	$20.00	per hour
Machine rate (fuel + maintenance)	$50.00	per hour
Cost of electricity	$0.10	per kWh
Facility is open 5 days/week, 52 weeks/yr	260	days/yr
Neglects any overlap of labor functions between tasks		

Administrative Costs

Office Trailer		$	500	per month
	=	$	6,000	per year
Electricity (including security lighting) -- allowance		$	15	per month
	=	$	180	per year
Truck weigh scale usage				
Assume 2 trucks/day @ $8.00 per weigh-in		$	16	per day
	=	$	192	per year
Site admin/Product marketing and sales				
Direct costs (printing, mailing, ads, etc.)		$	2,500	per year
Labor - 16 hrs/week @ $20/hr		$	320	per week
	=	$	16,000	per year
	Admin cost/year	$	12,840	
	Labor cost/year	$	16,000	

Processing Volumes

	Average Daily Volume
Food Scraps	11.8
Ground Yard Waste/Clearing Debris	27.9
Overs	12.8
Totals	52.5 CY/day

Materials Handling Assumptions

1. Assume wastes & products handled by two separate loaders
   a. Bucket capacity of each loader — 5 CY/bucket
2. Mixing done by mechanical mixer
3. Materials moved to composting and to curing with 10 CY dump truck
4. Curing piles "flipped" with loader
5. Materials moved to screening and storage (overs and compost) by loader

Materials Handling - Mixing

1. Daily volumes coming into facility			52.5	CY/day
2. Number of loader "bucket-movements" to load mixer			10	buckets/day
3. Assume time spent per loading event			2	minutes/bucket
4. Assume time spent to load transport truck			2	minutes/bucket
5. Time spent handling feedstocks			42	minutes/day
	Convert to hours		0.7	hours/day
6. Mixer run time			1	hours/day
	Total time		1.7	hours/day
	Labor cost/year	$	3,640	
	Machine cost/year	$	22,099	

Materials Handling - Transport To Composting Pad

1. Assume volume capacity of transport truck			10.0	CY
2. Number of truck trips/day			5	trips/day
3. Time for RT from mixing area to compost pad (plus load/unload) per trip			10.0	minutes
4. Total time for feedstocks transport			52.5	minutes
	Convert to hours		0.9	hours/day
	Labor cost/year	$	4,549	
	Machine cost/year	$	11,374	

Building Aerated Static Piles

1. Assume all ASPs built with loader			5.0	CY/bucket
2. Daily volume coming to composting bunkers			52.5	CY/day
a. Daily volume of wood chip air plenum (1/2 bunker area x 6")			8.5	CY/day
3. Number of buckets per day			12	buckets/day
4. Time needed to move feedstocks from unload site to bunkers			2.0	minutes/bucket
5. Time needed to fill bunkers			24.4	minutes/day
	Convert to hours		0.4	hours/day
	Labor cost/year	$	2,115	
	Machine cost/year	$	5,288	

Aerated Static Pile Composting Cost

1. Size of blower			1.7	hp
Assume 10 min on/20 min off; hours running per day			8.0	hrs/day
Percent full load			75	%
Motor nameplate efficiency			90	%
Annual cost of each motor		$	390	
2. Annual electricity cost for six blowers		$	2,339	

Materials Handling - Moving Compost to Curing

1. Daily volume going to curing (assume 30% shrink)			37	CY/day
2. Number of loader bucket movements			7	buckets/day
3. Time to tear down, pick up, and load truck			2	min/bucket
4. Number of truckloads			4	loads/day
4. Transit time from composting to curing area			2	min/load
4. Total time needed to move compost to curing			22.0	minutes/day
	Convert to hours		0.4	hours/day
	Labor cost/year	$	1,911	
	Machine cost/year	$	4,777	

Building Curing Piles

1. Assume all ASPs built with loader			5.0	CY/bucket
2. Daily volume coming to curing piles			36.7	CY/day
		=	992.1	CF/day
3. Number of buckets per day			7	buckets/day
4. Time needed to build piles			2.0	minutes/bucket
Daily time needed			14.7	minutes/day
	Convert to hours		0.2	hours/day
	Labor cost/year	$	1,274	
	Machine cost/year	$	3,185	

Managing Curing Piles

1. Volume of material in curing during 75-day curing period			2,934	CY
2. Assume 2 turns with loader during first 60 days			2.0	turns/period
3. Total volume of material to be handled in turning			5,868	CY
4. Number of bucket loads			1,174	buckets
5. Time needed per load to move pile			0.50	minute
6. Time needed to flip curing piles			587	minues
	Convert to hours		9.8	hours
	Convert to per day equiv		2.0	hours/day equiv

Materials Handling - Cured Compost to Screening

1. Daily volume going to screening (assume 20% shrink in curing)	29	CY/day
2. Number of loader bucket movements	6	buckets/day
3. Time to tear down, pick up & transport to screen area	2.0	minutes/bucket
4. Total time needed to move cured compost to screen	11.8	minutes/day
Convert to hours	0.2	hours/day
Labor cost/year	$ 1,019	
Machine cost/year	$ 2,548	

Materials Handling - Screening & Product Storage

1. Daily volume going to screening	29	CY/day
2. Assume screen hopper capacity = loader bucket capacity	5	CY
3. Number of bucket movements to keep hopper filled	6	buckets/day
4. Round-trip time to pick up and load hopper	2	min/bucket
5. Time needed to load screen	12	minutes/day
6. Volume of finished compost produced by screen (80% yield)	24	CY/day
7. Number of loader buckets needed to move compost to storage	5	buckets/day
8. Round-trip time needed to move compost to storage	5	minutes/day
9. Time needed to clear compost from screen	24	minutes/day
10. Volume of overs produced by screen (20%)	6	CY/day
11. Number of loader buckets needed to move overs to storage	1	buckets/day
12. Round-trip time to move from screen to overs storage	5	minutes/day
13. Time needed to clear overs from screen	5.9	minutes/day
14. Total time needed with screening	41.2	minutes/day
Convert to hours	0.7	hours/day
Labor cost/year	$ 3,567	
Machine cost/year	$ 8,917	

Labor Summary / **Operating Expenses Summary**

Process	Hrs/Day		Labor Cost	Machine Cost	Consumables
Administrative	3.2		$ 16,000		$ 12,840
Waste Receipt	0.7		$ 3,640	$ 22,099	
Transport to pad	0.9		$ 4,549	$ 11,374	
Building ASPs	0.4		$ 2,115	$ 5,288	
Electricity for ASPs	0				$ 2,925
Moving Compost to Curing	0.4		$ 1,911	$ 4,777	
Building Curing ASPs	0.2		$ 1,274	$ 3,185	
Managing Curing Piles	2.0		$ 10,170	$ 25,426	
Moving Cured Compost to Screening	0.2		$ 1,019	$ 2,548	
Screening & Product Storage	0.7		$ 3,567	$ 8,917	
TOTALS	8.6	Subtotals	**$ 44,245**	**$ 83,612**	**$ 15,765**

Assume 85% efficiency of site workers		Total	$ 143,622
Number of work-hours needed	10.2 hrs/day	Annual tons	5,408
FTE's in a 8-hour day	**1.3 FTEs**	**Per Ton**	**$ 26.56**

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Project	Rolla Food Waste Diversion Study	**Proj. No.**	14-160
Client	City of Rolla	**Date**	5/2/14
Analysis	Revenues Forecast		

Revenue Source:

Avoided Transfer Station Charges:				
	Annual tonnage food scraps composted		2501.2	tons/year
	Current TS fee	$	42.56	per ton
	Avoided cost	$	106,451	per year
Compost Sales				
	Annual compost production		5,159	CY/yr
	Assume annual sales as % of production		75%	
	Annual quantities sold		3,869	
	Average sales price	$	8.00	per CY
	Revenue from compost sales	$	30,954	per year
Total Revenues Forecast		$	137,405	per year
	Per ton (based on all feedstocks)	$	25.00	

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Project	Rolla Food Waste Diversion Study	**Proj. No.**	14-160
Client	City of Rolla	**Date**	5/2/14
Analysis	Commercial Food Waste Service Collection Costs		

Assumptions:

1. Most collection done in 65-gal or 90-gal roll-carts, 3 times per week					
a. If dumpsters, use comm'l refuse service rates					
2. Labor: 1-man crew including fringe			$	18.75	per hour
3. Bulk density				900	lbs/CY
	=			33.3	lbs/CF
a. Volume conversion, 1 CF =				7.48	gal dry
b. Vol. of 90 gal rollcart				12	ft3 dry
c. Vol. of 65 gal rollcart				9	ft3 dry
4. Average Service Time per collection:				3	minutes
5. Truck purchase price			$	145,000	
6. Tipping Fee at composting facility			$	42.58	per ton
	=		$	0.021	per lb
7. Roll-cart prices (assume 5-yr life)					
90-gal	$	55.00	$	0.92	per month
65-gal	$	50.00	$	0.83	per month
8. Admin/overhead				15%	
a. Additional costs for program development					
9. Generators responsible for in-store containers					

Cost Breakdown (based on 90-gal roll-cart):

Labor:				
1 man @ $18.75/hr each		$	37.50	per hour
	=	$	0.63	per minute
1 man for 3 minutes	=	$	1.88	per pull
	=	$	5.63	per week
	=	$	22.50	per month
Equipment (truck/fuel/repair/maint.):				
Truck (assume 10-yr life)		$	14,500.00	per year
Fuel		$	7,000.00	per year
R&M:		$	4,000.00	per year
	Subtotal	$	25,500.00	per year
	=	$	12.26	per hour (2,080 hrs/yr)
	=	$	0.20	per minute
	=	$	4.09	per month

Disposal (assume 3x/wk disposal)

Vol.	Wgt.	Cost/Disposal		
90 gal	401	$ 8.54	$ 102.47	per month
65 gal	290	$ 6.17	$ 74.00	per month

Commercial Food Waste Service Costs

Operating Cost:	Rollcart Size (3x/wk service) 90-gal	65-gal
Labor	$ 22.50	$ 22.50
Equipment	$ 5.00	$ 4.92
Disposal	$ 102.47	$ 74.00
Subtotal	$ 129.97	$ 101.42
Admin/Overhead	$ 19.50	$ 15.21
Total	**$ 149.46**	**$ 116.64**

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Project	Rolla Food Waste Diversion Study	**Proj. No.**	14-160
Client	City of Rolla	**Date**	5/2/14
Analysis	Residential Food Waste Service Collection Costs		

Residential Food Waste Service Collection Costs

Assumptions

		Low	Medium	High
1. No. of Single-Family HH (RREC, 2013)			7,483	
2. Participating Households		Low	Medium	High
	Percent	10%	30%	50%
	Number	748	2245	3741.5
	Time per stop (min)	2	2	2
3. Average FW weight per HH			10 lbs/HH/week	
Assume once per week collection				
		Low	Medium	High
	Weight collected (lbs/week)	7,483	22,449	37,415
4. Labor (including fringe):			$ 18.75 per hour	
		Low	Medium	High
	Labor cost/HH/week	$ 0.63	$ 0.63	$ 0.63
5. Bulk density			600 lbs/CY	
6. Truck purchase price			$ 145,000	
7. Compost facility tipping fee			$ 42.58 per ton	
	=		$ 0.021 per lb	
8. Container prices (assume 5-yr life)		Low	Medium	High
35-gal cart w/ 20-gal insert	$ each	$ 53.35	$ 52.85	$ 52.35
	$/month	$ 0.89	$ 0.88	$ 0.87
9. Admin/overhead (incl. program devel. & maint.)			15%	

	Low Participation 35-gal/wk	Med. Participation 35-gal/wk	High Participation 35-gal/wk
Labor	$ 0.63	$ 0.63	$ 0.63
Containers:	$ 0.89	$ 0.88	$ 0.87
Equipment:			
((1 truck @ $140,000 ea. / 120 mos.) 7,483 HH)	$ 0.15	$ 0.15	$ 0.15
Disposal:			
((10 lbs/wk x 52 wks/yr) * tip fee)	$ 11.07	$ 11.07	$ 11.07
Vehicle R&M			
(($5,000/yr / 12 mos) / 7,483 HH)	$ 0.06	$ 0.06	$ 0.06
Fuel			
(($10,000/yr / 12 mos) / 7,483 HH)	$ 0.11	$ 0.11	$ 0.11
Subtotal	$ 12.91	$ 12.90	$ 12.89
Program Admin	$ 1.94	$ 1.93	$ 1.93
Total Monthly Cost Per HH =	$ 14.84	$ 14.83	$ 14.82

	Low	Medium	High
Number of Participating HHs	748	2245	3742
Labor	$ 0.63	$ 0.63	$ 0.63
Containers:	$ 0.89	$ 0.88	$ 0.87
Equipment:	$ 0.15	$ 0.15	$ 0.15
Disposal:	$ 11.07	$ 11.07	$ 11.07
Vehicle R&M:	$ 0.06	$ 0.06	$ 0.06
Fuel:	$ 0.11	$ 0.11	$ 0.11
Subtotal	$ 12.91	$ 12.90	$ 12.89
Program Admin	$ 1.94	$ 1.93	$ 1.93
Total Monthly Cost Per HH =	$ 14.84	$ 14.83	$ 14.82