JACOBS

Memorandum

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Subject	**Key West Biosolids Compost Facility Concept**
Project Name	Key West Composting Feasibility Analysis
Attention	John Paul Castro/City of Key West
From	Todd Williams/Jacobs, and Sean McCoy/Jacobs
Date	August 7, 2019
Copies to	John Bartelmo/ OMI-Jacobs; Richard Cleaver/OMI

1. Introduction

The Key West Water Reclamation Facility (WRF) currently produces about 6,000 wet tons per year of dewatered, unstabilized wastewater solids using belt filter presses. The two Ashbrook Winklepresses dewater to about 16 percent total solids on average. Typical operation is for dewatering to run 8 hours per day, 5 to 6 days per week, depending on solids inventory. The dewatered cake is loaded directly into trailers and hauled by a third-party contractor to landfill disposal located approximately 200 miles away, at a current unit cost of $75.22 per ton. In addition, the City of Key West (City) generates about 9,000 tons of yard waste/horticultural debris annually, which is hauled by a third-party contractor to a compost facility located more than 200 miles away, at a cost of approximately $69 per ton. The City has expressed interest in evaluating the potential of composting the wastewater solids as a management method to eliminate the long-distance hauling and disposal costs. Composting wastewater solids achieves U.S. Environmental Protection Agency (EPA) and Florida Department of Environmental Protection (FDEP) requirements for a Class A/Class AA biosolids product. “Class AA biosolids” means biosolids that meet the Class AA pathogen reduction requirements of paragraph 62-640.600(1)(a) of the Florida Administrative Code (F.A.C.), the vector attraction reduction requirements of paragraph 62-640.600(2)(b), F.A.C., and the parameter concentrations of paragraphs 62-640.700(5)(a) and (b), F.A.C. By controlling pile temperatures during the composting stage, the process to further reduce pathogens (PFRP) requirement of 3 days above 131 degrees Fahrenheit (°F) and the vector attraction reduction (VAR) requirement of 14 days above 113 °F are achieved. As long as metal concentrations are below exceptional quality (EQ) limits, the resultant compost product can be utilized as a soil amendment or fertilizer product in Florida. An additional benefit of developing a compost operation would be the potential use of a portion of the currently collected yard waste/horticultural debris as bulking agent for composting the wastewater solids, thereby beneficially reusing these two materials to produce a highly valuable marketable Class AA biosolids compost product for local landscaping and horticultural uses. At the City’s request, Jacobs performed a concept-level evaluation of the potential to jointly compost these materials in an aerated static pile composting operation at the Key West WRF.

This technical memorandum summarizes the results of this evaluation and the three required tasks:

- Task 1 – Feedstock Data Analysis and Materials Quantities
- Task 2 – Conceptual Compost Facility Design
- Task 3 – Conceptual Compost Facility Cost Estimates

2. Feedstock Data Analysis and Material Quantities

Jacobs reviewed the Key West WRF dewatered solids production records and 3 years of analytical data to determine average and peak solids quantities, variations in solids quantities, and the ranges of solids contents produced during the past 3 years (Table 1). Based on this data review, Jacobs selected a maximum monthly design quantity of 3.5 dry tons per day of solids production and solids concentrations of 15 percent total solids (TS) and 20 percent TS to develop a concept-level compost facility layout and estimated costs.

Table 1. Key West WWTP Dewatered Solids Production
Key West Biosolids Compost Facility Concept

	Dry Tons Per Month			Dry Tons Per Day		TS (%)		
	2016	2017	2018	Average	Maximum 17-18	2016	2017	2018
January	104.3	95.5	95.0	3.2	3.1	16.3	16.3	16.0
February	105.3	89.3	98.2	3.5	3.3	16.3	16.0	17.0
March	98.5	100.8	91.2	3.1	3.1	15.5	15.8	15.6
April	94.8	77.2	90.2	2.9	2.7	16.6	15.9	15.7
May	79.5	94.8	91.2	2.9	3.0	16.7	16.2	15.9
June	89.8	91.8	80.9	2.9	2.8	15.7	16.1	17.9
July	81.7	86.0	76.6	2.6	2.6	15.9	16.7	17.3
August	85.5	83.5	49.6	2.4	2.1	16.9	16.9	14.4
September	45.9	23.8	62.4	1.5	1.4	15.9	17.1	15.3
October	64.1	51.0	65.9	1.9	1.9	15.0	16.4	16.0
November	79.0	84.9	60.6	2.5	2.3	13.5	16.6	14.6
December	92.2	80.2	77.2	2.7	2.5	15.8	16.5	15.1
Total	**1,020.7**	**958.8**	**939.0**					
Average				**2.7**	**2.6**	**15.8**	**16.4**	**15.9**

% = percent

Sampling and analysis of dewatered cake was performed to ensure metal concentrations within the solids are acceptable to meet EPA part 503 Exceptional Quality (EQ) and FDEP 62-640.700, FAC requirements for Class AA biosolids once composted. As Table 2 shows, metals concentrations of the solids are well below these standards. Due to the dilution from bulking agent addition for composting, the resultant compost would have lower metals concentrations than the dewatered solids and would, therefore, meet Class AA biosolids standards once composted.

Table 2. Key West WRF Dewatered Solids, EPA 503 Metals Concentrations
Key West Biosolids Compost Facility Concept

Parameter	EPA Ceiling Concentration	April 17, 2019	
		Key West	% of Ceiling
METALS (Dry Weight)	mg/kg	mg/kg	mg/kg
Arsenic	41	8.19	20
Cadmium	39	1.35	3

Table 2. Key West WRF Dewatered Solids, EPA 503 Metals Concentrations
Key West Biosolids Compost Facility Concept

Parameter	EPA Ceiling Concentration	April 17, 2019	
		Key West	% of Ceiling
METALS (Dry Weight)	mg/kg	mg/kg	mg/kg
Copper	1,500	204	14
Lead	300	14.7	5
Mercury	17	0.151	1
Nickel	420	17.3	4
Selenium	100	0.0001	0
Zinc	2,800	611	22
% = percent mg/kg = milligrams per kilogram			

Data supplied by the City showed between 8,200 and 9,200 tons of yard waste were produced annually between 2016 and 2018.

3. Conceptual Compost Facility Design

Jacobs defined design criteria for two possible aerated static pile options that were then used to develop concept designs. Option 1 assumed the existing belt filter press dewatering facilities are used to produce dewatered cake at 15 percent TS on average. Option 2 assumed improved dewatering using new centrifuges to produce a dewatered cake of 20 percent TS on average. Design criteria, material balances, and process flow diagrams are provided for each option. These criteria were then used to define the equipment and spatial needs of the aerated static pile process so that cost estimates and preliminary concept layouts could be developed on the existing WRF site.

Table 3 indicates the design criteria used in the sizing of equipment, buildings, pads, and other appurtenances for the Key West Biosolids Composting Facility. Solids and density information for the biosolids, bulking agents, initial mix, and compost are based on field measurements gathered over the past 3 years of operation at the WRF and data from other similar operations.

Table 3. General Design Criteria for Key West Biosolids Compost Facility
Key West Biosolids Compost Facility Concept

Item	Description	Parameter	Units	Minimum	Maximum	Design Value
Materials	Biosolids Quantity	Calendar Days	Dry Tons/ Day			3.5
	Biosolids Characteristics	Solids Content	%TS	15	20	15 and 20
		Volatile Solids	%VS	60	80	75
		Bulk Density	lbs/CY	1,250	1,700	1,600
	New Bulking Agent	Solids Content	%TS	50	65	65
		Bulk Density	lbs/CY	350	650	450
	Recycle Bulking Agent	Solids Content	%TS	55	70	60
		Bulk Density	lbs/CY	500	800	700

Table 3. General Design Criteria for Key West Biosolids Compost Facility
Key West Biosolids Compost Facility Concept

Item	Description	Parameter	Units	Minimum	Maximum	Design Value
	Compost	Solids Content	%TS	55	65	60
		Bulk Density	lbs/CY	800	1,000	900
Mixing	Batch Mixer(s)	Op. Schedule	Hours/day, 5 days/week	4	8	4
Composting	Initial Mix Characteristics	Solids Content	%TS	40	45	40
		Bulk Density	lbs/CY	750	1,000	880-940
	Detention Time	Calendar Days		15	28	21
		Working Days		15	20	15
	Pile Dimensions	Base Depth	Feet	0.5	1	1
		Mix Height	Feet	7	10	10
		Cover Height	Feet	1	2	1
		Total Height	Feet	8.5	13	12
	Aeration	Method	Pos/Neg			Neg
		Capacity	CFH/DT	3,000	5,000	5,000
Screening	Portable Screen	Screening Location		Before Curing	After Curing	Before Curing
	Screen Type	Deck, Trommel or Star				Trommel
	Screen Size		Inches	1/4	1/2	3/8
	Feed Capacity		CY/HR	40	100	40
	Redundant Unit		Yes/No			No
Curing	Detention Time	Calendar Days		21	30	28
		Working Days		15	20	20
	Pile Dimensions	Base Depth	Feet	0	0	0
		Mix Height	Feet	6	12	10
		Cover Height	Feet	0	0	0
		Total Height	Feet	6	12	10
	Aeration	Method	Pos/Neg			Pos
		Capacity	CFH/DT	500	1,200	1,000
Storage	Biosolids Receiving Bunker		Op. Days	0	1	0.5
	Bulking Agent Storage 10 Feet		Op. Days	0	30	10
	Bulking Agent Inside 10 Feet		Op. Days	0	1	0.5
	Recycled Bulking Agent Storage 10 Feet		Op. Days	0	30	5

Table 3. General Design Criteria for Key West Biosolids Compost Facility
Key West Biosolids Compost Facility Concept

Item	Description	Parameter	Units	Minimum	Maximum	Design Value
	Recycled Bulking Agent Inside 10 Feet		Op. Days	0	1	0.5
	Compost Product Storage 10 Feet		Calendar Days	90	180	20
Odor	Compost Process Exhaust		Continuous	Yes	No	Yes
Control	Biosolids Storage Area		AC/HR	6	12	6
	Mixing Area		AC/HR	6	12	6
	Compost Area		AC/HR	6	12	Passive
	Curing Area (Covered)		AC/HR	0	8	Passive

AC/HR = air changes per hour
CFH/DT = cubic feet per hour per dry ton
lbs/CY= pounds per cubic yard
neg = negative
Op. = operational
pos = positive
CY/HR = cubic yards per hour

3.1 Material Balances

A materials balance is necessary to define the equipment size, space requirements, materials handling, and manpower needs for the biosolids composting facility. The material balances for processing 15 percent TS cake and 20 percent TS cake are shown in Tables 4 and 5, respectively. These material balances are based on the general design criteria provided in Table 3 and a maximum monthly capacity of 105 dry tons, which translates to a calendar day capacity of 3.5 dry tons. Mixing, pile building, and screening activities would typically occur 5 days per week, so the material balances are based on a quantity of 4.9 dry tons per operating day.

Table 4. Key West Compost with 15 Percent TS Cake

Key West Biosolids Compost Facility Concept

DAILY MATERIALS BALANCE FOR: **Key West 15%TS CapEx (MM)**

FOR SCREEN BEFORE CURE

BASED ON:

MASS BALANCE USER WARNINGS/COMMENTS

OPERATING DAYS PER WEEK:	5
BIOSOLIDS DRY TONS PER DAY:	4.9
PERCENT TOTAL SOLIDS (TS):	15.0%

MASS BALANCE SUCCESSFUL

MASS BALANCE SUCCESSFUL

Material	Volume (CY)	Total Weight (Tons)	Dry Weight (Tons)	Volatile Solids (Tons)	Bulk Density (lbs/CY)	Solids Content (%)	Volatile Solids (%)
Biosolids	40.8	33	4.9	3.9	1600	15.0%	80.0%
New Bulking Agent	62.2	14.0	9.1	0.5	450	65.0%	95.0%
Screened Recycled Bulking Agent	66.7	23.3	14.0	12.6	700	60.0%	90.0%
Recycled Active Compost	0.0	0.0	0.0	0.0	800	60.0%	81.8%
Primary Compost Mixture	159.5	70.0	28.0	17.0	878	40.0%	60.8%
Base (Recycled BA)	8.9	3.1	1.9	1.7	700	60.0%	90.0%
Cover (Unscreened)	17.7	7.1	4.3	3.4	800	60.0%	80.0%
Primary Composting Losses		23.1	1.7	1.7			
Cover (Unscreened)	17.7	7.1	4.3	3.4	800	60.0%	80.0%
Screen Feed	117.3	46.9	28.2	17.0	800	60.0%	81.8%
Recycled Bulking Agent	75.4	26.4	15.8	14.3	700	60.0%	90.0%
Curing	45.6	20.5	12.3	2.7	900	60.0%	22.2%
Curing Losses			0.7	0.7			
Compost to Storage	43.0	19.3	11.6	2.0	900	60.0%	17.4%

Table 5. Key West Compost with 20 Percent TS Cake

Key West Biosolids Compost Facility Concept

DAILY MATERIALS BALANCE FOR: **Key West 20%TS CapEx (MM)**

FOR SCREEN BEFORE CURE

BASED ON:

MASS BALANCE USER WARNINGS/COMMENTS

OPERATING DAYS PER WEEK:	5
BIOSOLIDS DRY TONS PER DAY:	4.9
PERCENT TOTAL SOLIDS (TS):	20.0%

MASS BALANCE SUCCESSFUL

MASS BALANCE SUCCESSFUL

Material	Volume (CY)	Total Weight (Tons)	Dry Weight (Tons)	Volatile Solids (Tons)	Bulk Density (lbs/CY)	Solids Content (%)	Volatile Solids (%)
Biosolids	30.6	25	4.9	3.9	1600	20.0%	80.0%
New Bulking Agent	31.1	7.0	4.6	0.5	450	65.0%	95.0%
Screened Recycled Bulking Agent	46.7	16.3	9.8	8.8	700	60.0%	90.0%
Recycled Active Compost	0.0	0.0	0.0	0.0	800	60.0%	81.8%
Primary Compost Mixture	101.9	47.8	19.3	13.2	939	40.2%	68.8%
Base (Recycled BA)	5.7	2.0	1.2	1.1	700	60.0%	90.0%
Cover (Unscreened)	11.3	4.5	2.7	2.2	800	60.0%	80.0%
Primary Composting Losses		16.0	1.3	1.3			
Cover (Unscreened)	11.3	4.5	2.7	2.2	800	60.0%	80.0%
Screen Feed	79.6	31.9	19.1	13.0	800	60.0%	81.8%
Recycled Bulking Agent	52.5	18.4	11.0	9.9	700	60.0%	90.0%
Curing	30.0	13.5	8.1	3.1	900	60.0%	37.9%
Curing Losses			0.5	0.5			
Compost to Storage	28.1	12.7	7.6	2.6	900	60.0%	33.8%

3.2 Process Flow Diagrams

Figure 1 depicts the process flow diagram for composting 15 percent TS cake using the existing belt filter press dewatering.

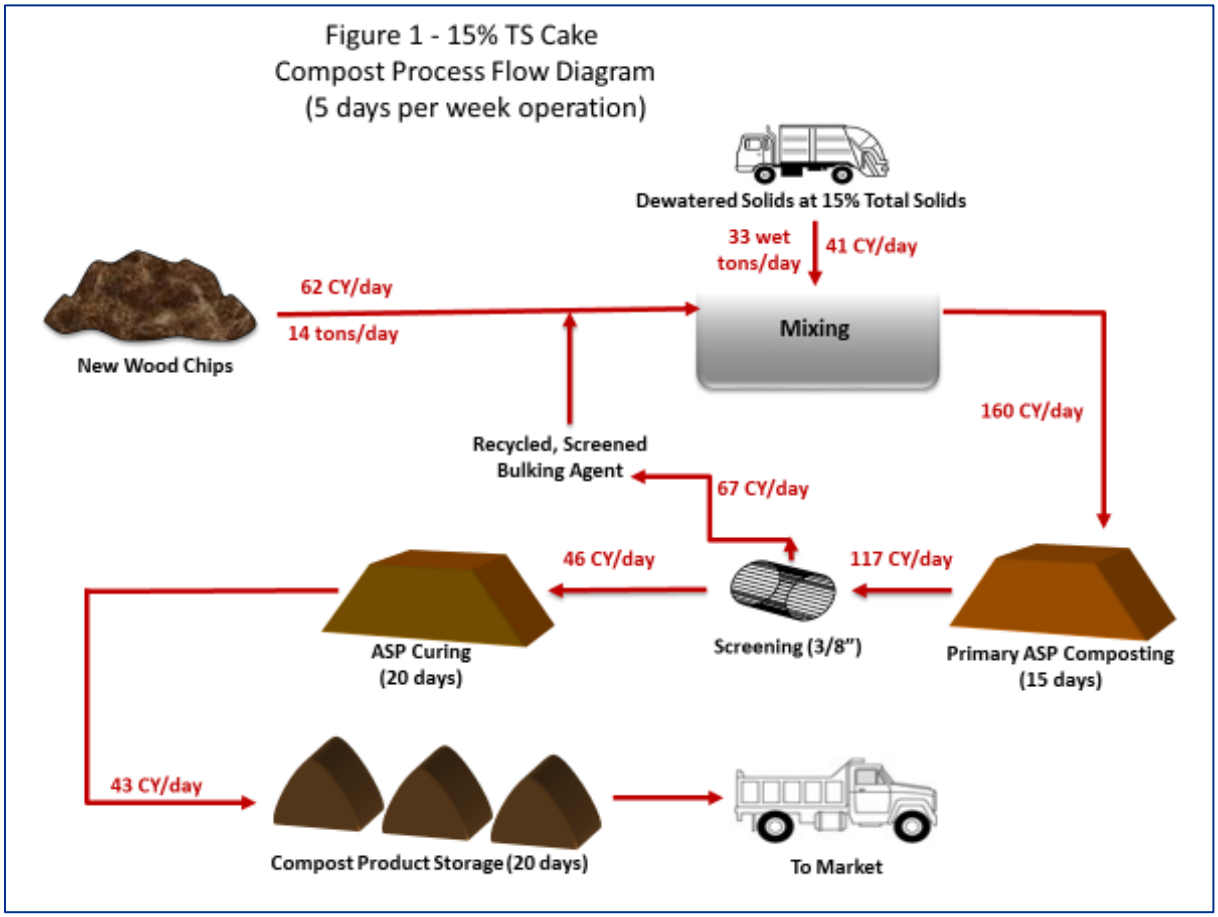

Figure 1. 15 Percent TS Cake Compost Process Flow Diagram (5 days per weeks operation)
Key West Biosolids Compost Facility Concept

Figure 2 shows the process flow diagram for composting 20 percent TS cake using new centrifuge dewatering once the existing belt filter presses reach the end of their useful life.

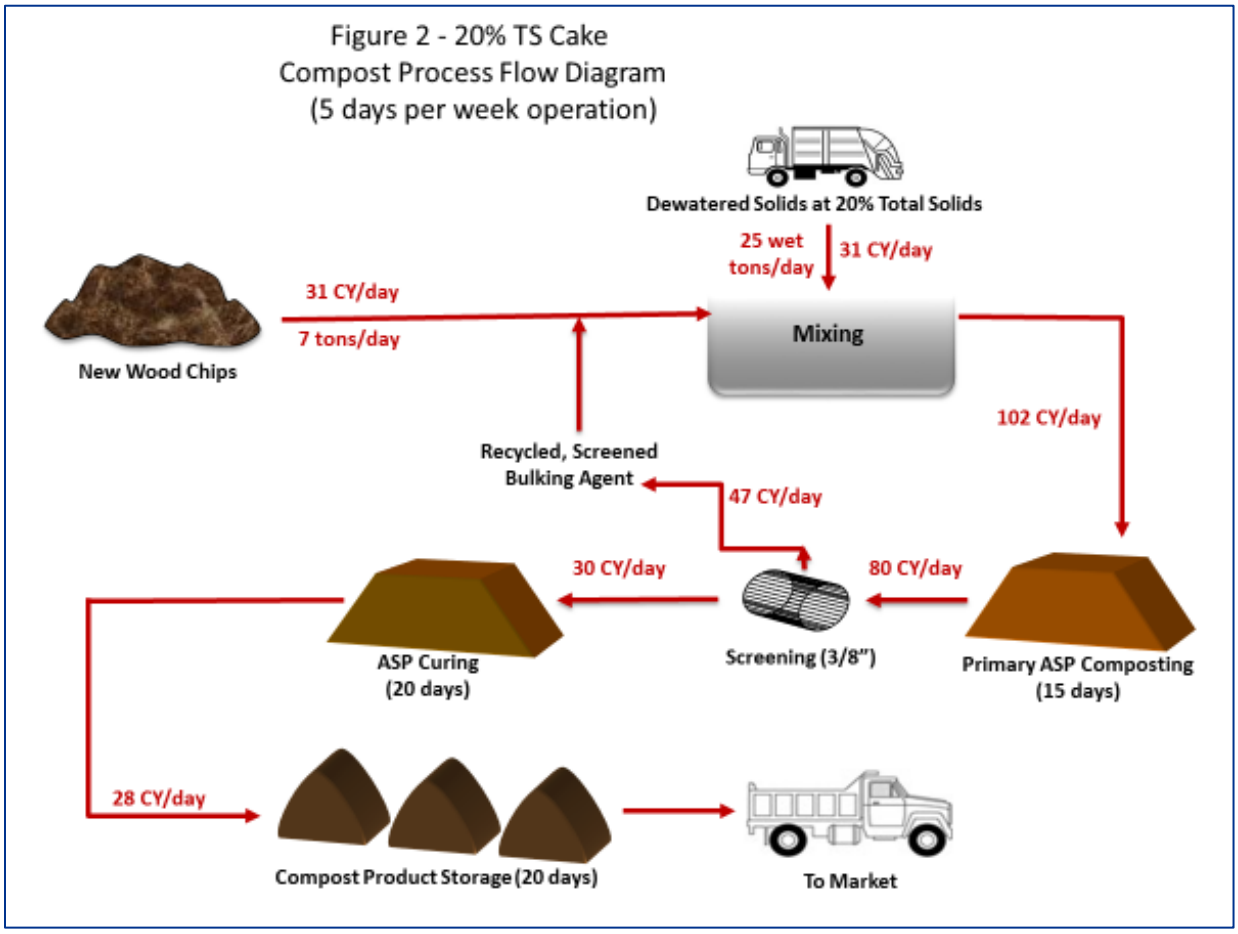

Figure 2. 20 Percent TS Cake Compost Process Flow Diagram (5 days per weeks operation)
Key West Biosolids Compost Facility Concept

Table 6 demonstrates the differences in material quantities on an annual basis for the two options. The City currently generates between 8,200 and 9,000 tons of yard waste/horticultural debris that must be hauled to south Florida for disposal/use at a cost of $69 per ton. As shown in Table 6, between 20 percent and 40 percent of the yard waste would be incorporated into the wastewater solids composting operation, thereby reducing the existing disposal costs accordingly.

Table 6. Annual Material Quantities for Both Options
Key West Biosolids Compost Facility Concept

Annual Material Quantities	15 Percent TS Cake Feed	20 Percent TS Cake Feed
Tons of Cake	8,490	6,370
Tons of Ground Yard Waste	3,640	1,820
Cubic Yards of Ground Yard Waste	16,200	8,100
Cubic Yards of Input Mix	41,500	26,500
Cubic Yards of Compost	11,200	7,300

3.3 Compost Facility Concept Description

Basic concepts of the assumed composting facility follow. One tensioned membrane structure will be installed to provide a covered area for the mixing operation. This structure will be placed on an asphalt pad and will be supported on a reinforced concrete foundation. The mixing building will be equipped with roll-up doors for vehicle access and man-doors for staff access and code required egress. This building will have capacity for dewatered solids and bulking agent storage for up to half an operating day of capacity. The base of the membrane walls will be mechanically sealed against the asphalt to prevent rain from entering the structure. This structure would need to be rated for hurricane-force winds. Ventilation of the building will be provided by four supply fans and four exhaust fans. A batch mixer will be housed in the building to mix dewatered cake solids and bulking agent. A conveyor system will move the mixed compost feedstock from the fabric structure to a covered compost mix bunker for removal by a front-end loader to the compost building. The conveyor will include an integral cover to prevent rainfall from soaking the mixed compost and to prevent rainfall from running down the conveyor into the mixing machine.

The compost building will be a three-sided, pre-engineered structure (or similar) and will include concrete walls on three sides for containment of the compost piles. An extended compost pile will be built up to a height of 12 feet. Aeration would be provided using perforated high-density polyethylene (HDPE) pipe on-grade, providing negative aeration. Individual compost fans would be located behind the concrete wall with one fan per 2 days of solids production, assuming a 5-day production schedule. Constant negative ventilation will be pulled through the composting piles by eight dedicated fans and this air routed to a wood-chip based biofilter for odor control treatment. The biofilter will have its own dedicated booster fan. After composting , screening using a portable trommel screen outside will allow for recycled bulking agent to reused in the composting process. Curing bays will provide positive aeration through above-ground perforated HDPE pipe with 4 operating days of product being aerated by one fan, or a total of five curing fans. Simple temperature feedback controls will be provided for the active composting fans using variable speed drives to provide the needed ventilation rate for process control. Automated monitoring would be provided in the composting piles to record pile temperatures and demonstrate regulatory (PFRP and VAR) compliance.

Because mixing of wastewater solids and bulking agent occurs inside a building, and both composting and curing operations are under-roof, rainwater will not fall on unprocessed solids. Open roadways and building roof rainwater will be managed as clean stormwater. Condensate from the compost pile exhaust air stream will be collected and piped back to the WRF for treatment.

Ground bulking agent can be delivered to the outside storage area, and finished compost can also be stored there. Grinding yard wastes to supply new bulking agent is assumed to be provided by a third-party offsite. Figure 3 shows a similar site layout for a biosolids compost facility located in Kodiak, Alaska. Many of this facility’s features could be incorporated into a Key West compost facility.

Figure 3. Kodiak, Alaska Compost Facility
Key West Biosolids Compost Facility Concept

3.4 Compost Facility Conceptual Site Layout

Figure 4 shows a conceptual site layout depicting major facility components of a proposed compost facility that could be located on the Key West WRF Site. This site layout is preliminary and developed to show that sufficient space exists in the northwest corner of the WRF site to accommodate the major components of such a compost facility based on 15 percent TS cake solids; optimization of the layout would be done in preliminary design. If 20 percent cake solids were produced, the compost building size would be reduced by about 25 percent. The rest of the site layout would remain largely unchanged.

Figure 4. Concept Compost Site Layout with Major Facility Components (Scale is Approximate)
Key West Biosolids Compost Facility Concept

4. Conceptual Compost Facility Cost Estimates

Jacobs used its internal proprietary composting tool to develop sizing and costing information for the two options previously discussed. Capital, operations and maintenance (O&M), and life-cycle costs for both options were developed to a Class 4 level of accuracy. The capital cost estimates are based on the guidelines provided by the Association for the Advancement of Cost Engineering International and adopted by the American National Standards Institute for a Class 4 level estimate. Class 4 estimates are based on conceptual design when the engineering effort is from 1 to 5 percent complete and includes a 30 percent contingency. Unit costing information from RSMeans, vendor quotes, and construction experience in other communities was used in developing concept-level cost estimates. The expected accuracy ranges for this class capital cost estimate are -30 percent on the low side and +50 percent on the high side. The operating costs consisting of labor, electricity, and fuel were based on prevailing local rates at the time of this work. Bulking agent costs are assumed based on being made available by a third-party processor who would grind the bulking agent for use. Compost pricing is based on a modest revenue of $10 per cubic yard for the sale of the compost product, although pricing tends to be significantly higher for remote locations such as Key West. It is possible that agreements could be explored with a third-party to grind the bulking agent for use and for cost sharing of revenue for compost sales by a third-party as well. These aspects can be evaluated further as part of subsequent efforts/tasks.

Table 7 shows the estimated capital cost for the 15 percent TS cake option and the 20 percent TS cake option. These estimates show appropriate contractor markups, contingency, engineering, and services during construction using a standard design-bid-build project development model. The range of capital costs expected to develop an aerated static pile composting facility to process all dewatered cake and a portion of the City's yard wastes is expected to range between $5.4 million and $5.9 million. These costs

could vary by as much as 30 percent lower, on the low side, to 50 percent higher, on the high side, based on the level of project definition at this stage in development.

Tables 8 and 9 show pro forma costs for each option inclusive of operating costs and capital costs assuming a 20-year project life on structures and a 10-year life on moving stock. The operating cost is expected to range from $59 to $62 per ton of dewatered solids processed. After product sales, the net operating cost would drop to $45 to $50 per ton of dewatered cake solids processed. Additionally, a net savings in yard waste haulage of approximately $40 per ton can be expected (assuming a private company grinds and delivers the required 1,800 to 3,600 tons each year to the compost facility for a net cost of $28 per ton), which could reduce the annual cost of yard waste collection and landfilling by as much as $150,000. It is expected that two operators would be needed to run the 15 percent TS facility with half-time maintenance operator support and quarter-time supervisor support. Only 1.5 operators would be needed for the 20 percent TS facility option.

Table 7. Key West Compost Concept Capital Cost Estimate

Key West Biosolids Compost Facility Concept

	15 Percent TS Total Cost	20 Percent TS Total Cost
Site Work		
Earthwork	$98,000	$79,000
Miscellaneous Site Work	$98,000	$79,000
Site Work Total	**$196,000**	**$158,000**
Compost Pre-engineered Building		
Building Pad	$132,000	$101,000
Building, 24-foot Clear Height	$674,000	$539,000
Compost Bunkers and Pushwalls	$836,000	$784,000
Compost Building Total	**$1,642,000**	**$1,424,000**
Composting Process System		
Compost and Biofilter Piping	$110,000	$102,000
Biofilter	$90,000	$90,000
Process Equipment	$472,000	$471,000
Electrical and Instrumentation	$374,000	$343,000
Composting Process System Total	**$1,046,000**	**$1,006,000**
Mobile Equipment		
Front End Loaders (Cat 950H with 7 CY Ejector)	$325,000	$325,000
Screen, 40 CY/HR Screen USA	$140,000	$140,000
Wireless Compost Temperature Probes	$ 58,500	$58,500
Horizontal Grinder	$0	$0
Mobile Equipment Total	**$523,500**	**$523,500**
Total Construction Cost (Direct Costs Only, Without Mobile Equip.)	***$2,884,000***	***$2,588,000***
Contractor Home Office	$288,400	$258,800

Table 7. Key West Compost Concept Capital Cost Estimate
Key West Biosolids Compost Facility Concept

	15 Percent TS Total Cost	20 Percent TS Total Cost
Contractor Fee	$285,516	$256,212
Project Bond/Insurance	$89,906	$80,678
Mobilization/Demobilization	$106,435	$95,511
Contingency	$1,096,277	$983,760
Engineering	$380,043	$341,037
Construction Services	$285,032	$255,778
Total Project Cost	**$5,940,000**	**$5,384,000**

Table 8. Pro-Forma Estimated Costs for Composting 15 percent TS Cake
Key West Biosolids Compost Facility Concept

Pro Forma in $ USD for 15% TS Option				
Type of System	ASP with biofiltration, piping only (no grates)			
System Cost	$	5,415,608		
Rolling Equipment Cost	$	523,500		
Annual Tons Biosolids Processed				8,493
Capital Cost		**Total**		**Annual**
System Cost	$	5,415,608	$	381,000
Mobile Equipment Cost	$	523,500	$	62,900
Total Capital	$	5,939,108	$	443,900
Annual O&M Costs				
Annual Tons Biosolids Cake				8,493
Operations and Maintenance Expenses				
Hauling biosolids cake			$	-
Mixing			$	21,728
Front end loaders maintenance and repair			$	23,400
Diesel consumption all equipment			$	59,168
Electrical consumption all equipment			$	44,857
Screening			$	6,101
Staff Labor Cost			$	237,360
General repair and replacement			$	23,600
Bulking agent			$	36,400
Biofilter media replacement (every 2 years)			$	3,250
Miscellaneous			$	41,621
Total Operation and Maintenance			**$**	**497,486**
Unit O&M Cost Per Ton Biosolids Processed			**$**	**58.57**
Revenues from Product Sales			$	111,756
Operation and Maintenance after Product Sales			$	385,730
Unit O&M Cost Per Ton Biosolids After Product Sales				**$45.42**
Net Annual Expense			$	830,000
Unit Cost ($/wet ton of annualized Capital and O&M)			**$**	**97.72**

Table 9. Pro-Forma Estimated Costs for Composting 20 percent TS Cake
Key West Biosolids Compost Facility Concept

Pro Forma in $ USD for 20% TS Option				
Type of System	ASP with biofiltration, piping only (no grates)			
System Cost	$	4,859,776		
Rolling Equipment Cost	$	523,500		
Annual Tons Biosolids Processed				6,370
Capital Cost		**Total**		**Annual**
System Cost	$	4,859,776	$	341,900
Mobile Equipment Cost	$	523,500	$	62,900
Total Capital	$	5,383,276	$	404,800
Annual O&M Costs				
Annual Tons Biosolids Cake				6,370
Operations and Maintenance Expenses				
Hauling biosolids cake			$	-
Mixing			$	13,878
Front end loaders maintenance and repair			$	15,600
Diesel consumption all equipment			$	39,700
Electrical consumption all equipment			$	40,773
Screening			$	4,142
Staff Labor Cost			$	199,280
General repair and replacement			$	23,550
Bulking agent			$	18,200
Biofilter media replacement (every 2 years)			$	3,250
Miscellaneous			$	33,692
Total Operation and Maintenance			**$**	**392,065**
Unit O&M Cost Per Ton Biosolids Processed			**$**	**61.55**
Revenues from Product Sales			$	73,129
Operation and Maintenance after Product Sales			$	318,936
Unit O&M Cost Per Ton Biosolids After Product Sales				**$50.07**
Net Annual Expense			$	724,000
Unit Cost ($/wet ton of annualized Capital and O&M)			**$**	**113.66**

5. Summary

This analysis demonstrates that a full-scale aerated static pile compost facility capable of managing the entire Key West WRF cake solids output can fit on the existing WRF site. An aerated static pile facility with covered processing areas and full odor control of the composting process is included in the facility that has been sized and costed. The range of capital costs expected to develop an aerated static pile composting facility to process all dewatered cake and a portion of the City's yard wastes is expected to range between $5.4 million and $5.9 million. These costs could vary by -30 percent on the low side to +50 percent on the high side, based on the level of project definition at this stage in development. Operating costs are expected to range from $59 to $62 per ton of dewatered solids processed. After product sales, however, the net operating cost would range from $45 to $50 per ton of dewatered cake solids processed. This compares against a current cost of more than $75 per ton to haul and landfill the solids cake, and that cost will most certainly escalate. Additionally, a net savings in yard waste haulage of approximately $40 per ton can be expected (assuming a private company grinds and delivers the material to a new Key West compost operation for $28 per ton), which could reduce the annual cost of yard waste collection and landfilling by as much as $150,000. Taking both these cost savings into consideration using the enclosed assumptions, the net annual O&M cost (not including amortized capital) to manage the dewatered solids would be reduced from the current cost of $637,000 to between $236,000 and $246,000 for the two scenarios evaluated. This O&M cost savings would result in a payback period for the capital outlay of between 13.5 and 14.75 years. As these numbers are based on a preliminary, concept-level development for this project, more specific design criteria and cost analysis can be performed once a preliminary design is developed.

A market study/analysis of the potential types and costs of bulking agents available and the potential value of the compost produced by a compost facility may indicate better economics. Evaluations to explore potential partnerships with private enterprises to develop a composting facility at another nearby location could yield additional economic opportunities for the City. A compost pilot study to demonstrate the efficacy of the process on Key West cake solids and yard wastes can also be a very useful next step to allow for stakeholder buy-in from operations personnel, City staff, the public, regulators, and potential third-party partners. Additional benefits from performing a pilot study include the opportunity to evaluate available bulking agents and to more accurately determine market interest and value for the compost that would be produced. Sampling and testing of the compost produced in a compost pilot study would demonstrate Class AA standards are achieved and allow evaluation of any emerging contaminants of concern to regulators or stakeholders. Odor sampling and testing can also be performed as part of a pilot study to allow more accurate odor dispersion modeling of the planned facility design.