Organics Recycling Feasibility Study

Final Report

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Executive Summary

Nelson Engineering, in association with Coker Composting & Consulting, has been retained by Kenai Peninsula Borough (KPB) to evaluate the feasibility of developing an organic wastes recycling facility somewhere in the Borough. The goals of the project were to characterize the organic (biodegradable) components of the municipal and industrial solid wastes generated in the Kenai Peninsula Borough, to evaluate the markets for the products that could be made from these materials (biogas for heating or electricity and/or compost for soil amendments or topsoils) and to evaluate the impact on the solid waste management facilities managed by the Borough.

Feedstocks to a possible organics recycling facility could include source-separated organics (SSO) like food scraps, fish wastes (both from processing and from fishing/cleaning), yard trimmings, garden organics, vegetative clearing debris and woody wastes. Evaluation of the solid wastes handled by KPB Solid Waste indicated that the following SSO could be potentially be diverted:

Estimated Compostable Feedstocks

Year	Population Projections	Food Scrap Wastes	Woody Wastes	Fish Wastes	Sewage Sludge	Total
2012	56,980	10,879.25	1,171.00	44.91	1,777.00	13,872.16
2015	59,073	11,278.87	1,214.00	46.56	1,842.27	14,381.71
2020	62,174	11,870.95	1,277.74	49.00	1,938.98	15,136.67
2025	64,761	12,364.88	1,330.91	51.04	2,019.66	15,766.49
2030	66,700	12,735.10	1,370.75	52.57	2,080.13	16,238.56

It is not clear that there are enough woody wastes in the current solid waste stream to support a composting facility, as preliminary process design suggests an annual demand of almost 7,000 tons/year for composting all of the biodegradable wastes listed above.

Collection alternatives for SSO were also evaluated. The majority of solid waste disposed in KPB is by citizen drop-off at one of the Borough's 21 solid waste management facilities (8 landfills, 5 staffed transfer facilities and 8 unmanned transfer sites) and there is some curbside and commercial waste collection by Alaska Waste in the KPB communities. Should KPB elect to develop a SSO diversion program for organics recycling, there are three basic collection options:

- SSO separated in specially-marked bags and co-collection with trash by Alaska Waste or by KPB Solid Waste
- SSO separated in uniquely-colored roll carts (similar to the 96-gal roll carts currently provided by Alaska Waste) and collected in a separate dedicated truck route by Alaska Waste or by KPB Solid Waste
- SSO separated and delivered to a specially-dedicated collection container at one of KPB's solid waste facilities

Given the likely high cost of setting up a separate collection route for SSO (along with additional traffic, safety and road wear issues), a dedicated drop-off system at KPB transfer stations will likely be the most workable system.

Recycling SSO is different from recycling other commodities insofar as organics recycling results in a product(s) that is typically sold directly to end users (inorganic recycled commodities are usually converted into new products by third party processors). Assessing the feasibility of organics recycling requires an understanding, on a preliminary basis, the nature and size of markets for products recovered from organic wastes. These products can be broadly grouped into compost-based horticultural products and energy products. Outlets for compost products include homeowner and business landscaping, sediment and erosion control, parks and recreation department landscaping, athletic field management, environmental site restoration, storm water management, etc. Outlets for recovered energy products include electrical production, natural gas pipelines and natural gas vehicles.

Compost is an organic matter resource that has the unique ability to improve the chemical, physical, and biological characteristics of soils or growing media. Compost can be utilized directly as a soil amendment, as a topdressing agent for turf, and as a mulch. It is considered a low-grade fertilizer, with a typical Nitrogen-Phosphorus-Potassium (N-P-K) value of 1.5-0.5-0.7. The primary sales market for compost in the Kenai Peninsula Borough is likely residential and commercial landscaping and gardening. This market for compost and compost-based soil products in KPB is largely untested but a survey of likely users concluded that KPB could sell about 2,000 – 3,000 cubic yards (CY) per year.

One of the approaches being considered for recycling SSO is anaerobic digestion (AD). AD, like composting, is a biological conversion process. The primary product from AD is called biogas. How the biogas is handled and processed depends on the end market. Biogas from an anaerobic digester can be used in several ways: as a substitute for natural gas, either in boilers producing hot water and steam for industrial processes, in combined heat and power (CHP) applications to generate electricity (as well as heat for space heating), as a pure natural gas substitute (high-graded for insertion into the natural gas supply), for fueling a fleet of vehicles or as a fuel for fuel cells. Of these, it is believed that electricity production, with the electricity used by KPB Solid Waste "behind the meter" of the Homer Electric Association has the greatest benefit to KPB.

Composting and digestion technologies were evaluated in this project. Preliminary process designs were developed to frame the evaluation. Due to the high costs of trucking organic wastes across the Borough, these initial preliminary process designs assume separate facilities in Seward, Homer and Soldotna, as follows:

- Composting in Seward – 600 tons/year of food scraps combined with 500 tons/year of woody wastes to produce 1,700 cubic yards of finished compost

- Composting in Homer – 1,500 tons/year of food scraps combined with 1,000 tons/year of woody wastes to produce 3,500 cubic yards of finished compost
- Composting in Soldotna – 8,850 tons/year of food scraps and seafood wastes, combined with 5,200 tons/year of woody wastes to produce 19,500 cubic yards of finished compost
- Anaerobic digestion/composting in Soldotna – digesting 8,850 tons/year of mixed food and greenwastes to produce 34 million cubic feet of biogas per year, followed by composting to produce 11,700 cubic yards of finished compost

Composting technologies utilize an aerobic (with oxygen) process to decompose organic materials. It is a self-heating process that destroys pathogens and weeds seeds, and produces a material similar to soil humus. Composting technologies include turned windrow, aerated static pile, enclosed aerated static pile, and in-vessel. The turned windrow system is not recommended for KPB. It takes more space than other composting methods, it would have to be either housed in a building or only done seasonally, and precautions for bears, birds, and other wildlife would have to be taken. Aerated static pile (ASP) composting uses fan-forced aeration, which serves both to maintain aerobic conditions more thoroughly and completely within the static pile. ASP could work in KPB, though using an enclosed ASP composting process has several advantages over open-air methods: elimination of adverse weather effects, better process control, and improved opportunities to manage the air emission and wastewater sidestreams from the process. Containerized aerated static pile compost systems are enclosures that resemble ocean-going shipping containers in size and configuration. . They are usually aerated by low-horsepower centrifugal fans. These systems are provided by private technology companies. Containerized ASP Systems may be suitable for the scale of composting facility contemplated in KPB as the enclosures are insulated for use in cold weather, are scalable to KPB organics quantities and provide resistance to negative impacts such as wildlife, odors, and windblown debris.

Anaerobic digestion is a biological treatment process. The lack of oxygen results in waste stabilization by a different group of microorganisms who produce a usable energy source in the form of biogas (mostly methane). The products of anaerobic digestion are methane, carbon dioxide, trace gases and stabilized solids. Digestion technologies are either aerobic or anaerobic; the former is a method of stabilizing organic wastes, while the latter produces a usable gas byproduct during the stabilization process. Both types of digestion are traditionally "wet" processes and produce both a solid residual and a wastewater effluent that must be further managed. Recent technology changes in Europe have introduced a dry form of anaerobic digestions (known as dry fermentation) which is now being developed in the U.S. Aerobic digestion requires more steps in its process flow and is therefore more expensive, so only anaerobic digestion was evaluated. Anaerobic digestion is a feasible option for KPB. The drawback is extra space needed for the digest to be composted further in windrows or ASPs, but anaerobic digestion is the only process that produces a viable energy byproduct.

The project team evaluated availability of sites to potentially locate an organics recycling facility in the Borough. The KPB owns over 1,500 parcels of land. The site evaluation was limited to those borough-owned lands. The land was evaluated for adequacy regarding size, proximity to sensitive receptors, environmental features, and site topography, with the goal of identifying any issues that might cause permitting or implementation constraints to a proposed site and recommending alternatives to remove those constraints.

Siting a composting (or digestion) facility properly is one of the key factors in ensuring the development of a successful facility. Arguably, poor site selection is the principal cause of many failed composting facilities. Siting must consider factors that include environmental features, such as proximity to sensitive natural and human resources, as well as infrastructure-related issues including availability of utilities, road access, and zoning constraints. The KPB GIS department assisted in analyzing the Borough owned lands by applying search/selection criteria to all such parcels included in the borough's GIS database. Parcels meeting the following criteria were selected for further analysis:

- Minimum parcel size:
    - Soldotna – 5 acres
    - Homer – 1.4 acres
    - Seward – 0.8 acres
- Not in the 100-year floodplain
- Not in "Lowland Wetlands"
- At least 1,000 ft distant of any churches, parks, hospitals, shopping centers, etc.
- At least 1,000 ft distant from any homes
- At Least 50 ft from any property line, well, or stream
- Not located in any "Local Option Zoning" areas
- Not in any KPB Habitat Protection Areas
- Within 20 miles of Soldotna
- Within 10 miles of Seward
- Within 12 miles of Homer

After looking at the Borough's GIS information and applying the criteria, two possible site locations were found in Seward, five in Homer, and six in the Soldotna/Kenai area. Composting facility sites were not considered for remote areas such as Tyonek, English Bay, and Seldovia or for areas such as Hope, Moose Pass, Cooper Landing or other unincorporated communities that are on the road system. Those areas either do not have adequate population to generate enough SSO to justify a small facility, or they are too far away from other sites to make it practical to haul SSO to them from other areas. The evaluation concluded that the following sites were the most suitable:

- Kenai/Soldotna
    - Central Peninsula Landfill

- Kenai Transfer Station
- Kenai "Firewise" site

- Homer
  - Homer Landfill/Transfer Station
- Seward
  - Seward Transfer Station

Discussions with the Alaska Department of Environmental Conservation (ADEC) and local City officials gave clarification on required permit and zoning needs. There is currently no solid waste digestion or source-separated organic solid waste processing regulation in Alaska. Solid waste permit requirements are required per 18 AAC 60.200. Under the list of exemptions 18 AAC 60.200 (a) (9) provides exemptions for 'a reuse, recycling, or resource recovery facility unless the department determines that the facility is causing or is likely to cause excessive odor or other problems such as combustion, blowing litter, water quality degradation, or vermin attraction'.

If site development disturbs more than one acre, construction of the project falls under the EPA's Storm Water Construction General Permit. Preparation of a Storm Water Pollution Prevention Plan (SWPPP) is required as well as filing a Notice of Intent (NOI). Plan review is not required if storm water is not collected or treated. If storm water is collected, a storm water discharge permit is required and plans must be submitted for review per 18 ACC 72.600.

The Kenai Borough 'Firewise site', located on KPB parcel # 04301036 is zoned for Recreation by the City of Kenai and the City will require a Conditional Use Permit (CUP) for an organics recycling facility to be located on the site. The Homer Transfer Station, located on KPB parcels #17367004, #17316056, and #17316057, has been identified as a potential site. As this sites' current function is similar to organics recycling there are no required permits from the City of Homer. The Seward Transfer Site, located on KPB parcel #14424004, has been identified as a potential site. The property does fall in the City Limits, but there are no zoning permits required as the current land use is comparable to organics recycling. If a building is built for the composting facility a building permit is required and may include further permits pertaining to utilities and a floodplain review.

The project team developed preliminary, planning level estimates of capital and operating costs based on costs of similar facilities elsewhere. The capital costs for organics recycling facilities are similar to those for any solid waste management facility: land acquisition, site development, buildings, roadways, fencing and security, and materials handling equipment. As organics recycling involves biological processes to convert wastes to energy and/or soil amendments, there is also a technology cost. Composting and anaerobic digestion, the two processes evaluated in this study, can be done with generic approaches, or with technologies purchased from vendors.

Operating costs for organics recycling facilities will include labor, fuel, electricity, equipment maintenance, disposal of unprocessable materials, product marketing, product sales, and, possibly, acquiring feedstocks. There are possibly not enough woody wastes in the KPB solid waste stream to support a facility and it may be necessary to source wood chips, sawdust, and similar carbonaceous materials. The Anchorage Wood Lot, run by the Anchorage Soil & Water Conservation District is one possible source. Wood chips would be free, but transport costs will likely be high.

In addition to the costs for the facility itself, there will also be costs involved in collecting and transporting organic wastes to the facility. If the dedicated drop-off system is used, KPB citizens and businesses would bring their SSO to a transfer site or station and KPB would have its hauler bring the roll-off to the composting facility. If KPB built a centralized compost facility at, or near, the CPL landfill, the estimated costs for this alternative, the annual costs for hauling would vary from $2,000 to over $47,000 depending on the distances involved (Seward and Homer Transfer Station haul costs are the highest in KPB).

Capital costs for a composting facility to recycle SSO vary widely, depending, in large part, on the need for, and extent of, higher levels of technological process and environmental controls. The project team developed preliminary capital and operating cost estimates for the three aerated compost bin configurations (one for the Seward area, one for the Homer area, and one for the Kenai/Sodotna area). This approach would have all processing steps enclosed in a building, with a generic induced-draft aerated static pile composting approach with air treatment by biofiltration. Similarly, these three alternatives were costed out using vendor-provided technology (Engineered Compost System's "CV" or "SV" composting systems). None of the alternatives include a cost for purchased wood chips as no source could be found in KPB.

Preliminary Capital and Operating Costs for Generic ASP Systems

Facility	Capacity (tons/year)		Capital Cost Estimate ($)	Equipment Cost Estimate	Operating Cost Estimate ($/ton)
	SSO	Greenwaste			
Seward Area	600	500	$1,853,000	$223,400	$31.06
Homer Area	1,400	1,000	$3,025,000	$303,000	$24.14
Kenai/Soldotna Areas	8,500	5,000	$12,125,000	$426,000	$16.02

Preliminary Capital and Operating Costs for ECS CV/SV Systems

Facility	Capacity (tons/year)		Capital Cost Estimate ($)	Equipment Cost Estimate	Operating Cost Estimate ($/ton)
	SSO	Greenwaste			
Seward Area	600	500	$2,265,000	$223,400	$48.29
Homer Area	1,400	1,000	$4,380,000	$303,000	$38.65
Kenai/Soldotna Areas	8,500	5,000	$6,283,500	$426,000	$18.45

Like composting, anaerobic digestion (AD) facilities can be generic or purchased from a vendor. The generic AD designs are traditionally liquid digesters, like those found on farms for livestock manure digestion. Solid waste digesters (also known as dry fermenters) are a late-20th century European technology and are only available from project developers, who offer the technology in a design-build or design-build-operate business model.

One dry fermentation AD project developer, Zero Waste Energy (Lafayette, CA) offers the Eggersmann KompoFerm and SmartFerm combination AD and composting systems. The SmartFerm system is sized in 5,000 ton/year increments. A 5,000 ton/year system has a capital cost estimate of $2,125,000 and estimated operating costs of $15.00 per ton.

The results of initial phases of this study were used to develop a set of nine (9) preliminary conceptual organics recycling alternatives. The alternatives are combinations of feedstocks, sites, technologies, and markets. These alternatives were evaluated using a weighted matrix criteria technique. The weighted criteria matrix is a decision-making tool that was used to evaluate alternatives based on specific evaluation criteria weighted by importance. By evaluating alternatives based on their performance with respect to individual criteria, a value for the alternative was identified. The values for each alternative were then compared to create a rank order of their performance related to the criteria as a whole. This tool is important because it treats the criteria independently, helping avoid the over-influence or emphasis on specific individual criteria. The evaluation criteria were developed by staff and the importance weighing factors assigned by Kenai Peninsula Borough personnel.

Alternatives were defined by the constraints of geography, weather, wildlife and existing solid waste infrastructure. Other constraints included:

- The availability of adequate amounts of carbon (woody material) to support the composting of food and/or seafood wastes. Golden Heart Utilities composting facility in Fairbanks faces this same challenge, but they are able to purchase spruce and birch wood chips from Northland Wood for $24.50/CY.
- The long hauling time from Seward and Homer to the Kenai/Soldotna area.

- The solid waste collection infrastructure is oriented toward drop-off programs at transfer stations or convenience centers more than curbside pickup of commercial and/or residential solid waste.
- The market for compost is currently limited and will need time and effort to stimulate.
- The market for recovered energy is potentially more robust given Homer Electric's net metering program.

The alternatives developed for analysis included:

Alternatives Evaluated

Alt.	Where	Size	Feedstock	Collection	Processing	Technology	Market
1	CPL	10,000 Ton/Yr	All	Private	AD+IVC[1]	SmartFerm + ECS	Electricity +compost
2	CPL	10,000 Ton/Yr	All	Private	IVC only	ECS SV	Compost
3	CPL	10,000 Ton/Yr	All	KPB	AD+IVC	SmartFerm + ECS	Electricity +compost
4	CPL	10,000 Ton/Yr	All	KPB	IVC only	ECS SV	Compost
5	Homer TS	1,500 Ton/Yr	Food only	Drop-off	IVC only	ECS CV, aerated bin	Compost
6	Seward TS	600 Ton/Yr	Food only	Drop-off	IVC only	ECS CV, aerated bin	Compost
7	CPL	8,000 Ton/Yr	All	Drop-off	IVC only	ECS CV, aerated bin	Compost
8	Homer TS	Demo - 170 T/Y	Food only	Drop-off	IVC only	ECS CV, aerated bin	Compost
9	Kenai TS	Demo - 250 T/Y	Seasonal fish waste	Drop-off	IVC only	Aerated Static Pile	Compost

[1]AD = Anaerobic Digestion; IVC = In-Vessel Composting

Each of the evaluation criteria were assigned a "weighting factor" by KPB staff, a numerical value between 1 and 5, where 1 meant it was not an important criterion, 3 meant it was neither an important nor an unimportant criterion and 5 meant it was an important criterion as shown below:

Weighted Matrix Evaluation Criteria

Criteria Class	Evaluation Criteria	Weight Factor
Feedstocks	Flexibility to handle difference feedstocks	4
	Carbon/woody amendment demand	5
Collection and Transport	Participation rate	5
	Contamination prevention	4
	Hauling distance	4
Implementation Criteria	Similar facilities in AK	3
	Time to Implement	3
	Local permits & approvals	4
	State permits & approvals	4
Costs	Capital costs	5
	Operating costs	5
	Maintainability	4
Markets	Recovered energy	3
	Compost	5
Aesthetic/ Environmental	Potential for odor episodes	5
	Proximity to sensitive receptors	5

For each of the evaluation criteria, a raw (i.e. un-weighted) score was assigned. Scoring was from 1 to 5, where 1 meant the alternative was least favorable with respect to the evaluation criterion and 5 meant it was most favorable. Scores were based on best professional judgment.

These weighting factors were multiplied by the raw scores to produce weighted scores. The weighted scores for each alternative were then summed across all evaluation criteria to produce a total weighted score for each alternative. The highest scoring alternatives were:

Alternative	Total Weighted Score
Alt. 8 – Homer Area Demo (170 TPY)	288
Alt. 9 – Kenai/FireWise Demo (250 TPY)	269
Alt. 6 – Seward Transfer Sta. (600 TPY)	268
Alt. 5 – Homer Transfer Station (1,500 TPY)	267

Alternative 8 had the highest score, and the next three highest scoring alternatives were similarly scored. A small-scale demonstration project in the Homer area could accomplish several objectives:

- Provide a mechanism for food scraps diversion from an area of KPB that has high interest in diversion
- Verify that sources of woody carbon material can be sourced for use in composting
- Confirm that enclosed aerated static pile composting technology (such as the ECS CV Composter or the GMT Earth Flow) will work satisfactorily in KPB winter conditions
- Verify that a market exists for the compost in the Homer area

Alternative 9 would also accomplish several objectives, at potentially minor additional cost:

- Solve a seasonal fish waste problem that has potential environmental and tourism impacts
- Confirm that low-technology windrow composting may be suitable for warm season usage
- Verify that a market exists for the compost in the Kenai and Soldotna areas

Based on these evaluations, and due to uncertainties regarding adequate amounts of carbonaceous bulking agent amendment, the participation rate for a drop-off SSO diversion program, and the market demand for a compost product in the KPB, the recommendation is that KPB develop two pilot programs, one for handling food scraps generated in the Homer area, and one for handling seasonal salmon run fish wastes in the Kenai area.

The Homer area demonstration project could be based on a containerized aerated static pile technology, similar to the “CV Composter” sold by ECS. The CV Composter resembles an ocean-going shipping container and operates as a batch system, where a 32-CY container is filled with SSO and carbon amendment and allowed to compost in the reactor for 25 days. After active composting, the material in the reactor would be cured/aged for another 60-90 days, then screened to remove oversized particles from the finished compost.

The goals for the Homer pilot project would be:

1. Determine effectiveness/willingness of local population to separate organics and deliver them to the Compost Facility.
2. Determine effectiveness/willingness of local population to separate organics and deliver them one of several collection facilities, then cost to haul to Compost facility.
3. Determine actual availability of wood fiber delivered to the compost facility and then cost to grind up at the facility.
4. Determine effectiveness and cost to operate the CV Composter units(s).
5. Determine cost recovery, if any, resulting from selling finished compost.

6. Determine other associated costs for marketing, such as possible need to bag the compost vs. loading it into individuals' vehicles for self-delivery.

The proposed demonstration would be based on KPB acquiring two (2) CV Composter units, setting them up at the Homer Transfer Station/Balefill site, and installing dedicated SSO collection units at the Homer Transfer Station, the Anchor Point Transfer Site, the McNeil Canyon Transfer Site, and possibly the Ninilchik Transfer Site. The collection units would be pulled by KPB weekly, delivered to the Homer demonstration site and unloaded. Proportional amounts of SSO and ground-up carbonaceous bulking agent (mostly yard trimmings and wood chips) would be mixed by a combination mixer/reactor loading conveyor.

Estimated capital costs for this Alternative 8 – Homer demonstration project total about $970,000 for site improvements and composting technology and $240,000 for other processing equipment. Operating costs for the demonstration project are estimated at about $52,000 per year, consisting of $15,000 in labor costs, $23,000 in machine costs (fuel, maintenance, etc.), and about $14,000 per year in waste transport costs between the Homer site and the more-distant SSO collection and transfer sites. Detailed cost estimates are included in the Appendix.

The Alternative 9 - Kenai demonstration program would support the City Kenai, which has been tasked with disposal of seasonal dipnetters' fish waste in order to minimize beach contamination. The City estimates that approximately 500,000 lb. (250 tons) of fish waste is generated in July, during the month-long dipnet season. Current practice is to use a front end loader to scrape fish offal off the beach and push it out below the low tideline. The City has expressed willingness to load the fish waste into containers to facilitate offsite composting by others.

The Kenai Borough 'FireWise site', consisting of 31.1 acres located on KPB parcel # 04301036, has been identified as a potential site for an Organics Recycling Facility. The parcel is zoned for Recreation by the City of Kenai and the City will require a Conditional Use Permit (CUP) for an organics recycling facility to be located on the site. If a CUP can be issued for this site, it may be a suitable site for handling both the seasonal fish waste, along with organics collected after the summer fishing season ends.

The composting facility would occupy about 9 acres of the available 31 acres, which would include a waste receipt area, area for the storage of enough ground woody material to handle the entire 250 tons of fish wastes, an active composting area, a curing area, and a product screening and storage area, with the storage area sized to hold one year's worth of compost (about 2,600 CY) and the screened-out overs (about 600 CY).

Estimated capital costs for this demonstration project total about $850,000 for site improvements and $240,000 for other processing equipment. Operating expenses for the

Kenai demonstration project are difficult to project due to the seasonal nature of the feedstock, but most window composting systems operate in the $15-$20 per ton (incoming) range, which would suggest an annual operating cost of $22,500 to $30,000. In addition, there would likely be $10,000 - $15,000 in annual costs to KPB in support of the compost market development program to serve both demonstration sites.

An alternative demonstration project could be set up in partnership with a local non-profit organization, Matti's Ranch, where Blair Martin serves as the Executive Director. Mr. Martin has been working with City of Kenai officials to handle the fish wastes at his 20-acre farm in Kenai. KPB Solid Waste could investigate the possibility of a public-private partnership for this particular demonstration project before committing to improving the FireWise site.

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Introduction

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The project team reached these goals through a series of tasks, the work from each of which was documented in a series of task reports. This report is a compilation from the various task reports, which are available for review at the offices of the KPB Solid Waste Department. The tasks that were completed in this study were:

Task 1 – Feedstock Sourcing and Characterization

Task 2 – Recovered Products Preliminary Market Characterization

Task 3 – Technology Evaluation

Task 4 – Siting Evaluation

Task 5 – Cost Estimates

Task 6 - Permitting Analysis

Task 7 – Evaluation of Alternatives

Task 8 – Final Report

During the project, the scope for Task 5 was modified to include an analysis of collection alternatives. This report includes summaries of each of the task reports prepared during this project.

Chapter 1 –
Feedstocks Characterization

Introduction

Understanding volumes of incoming waste materials (known as "feedstocks") along with tonnages is important, as organics recycling is a volume-based manufacturing operation. The types of recyclable organic wastes generated in the Kenai Peninsula Borough project consist of woody waste, yard trimmings, vegetative clearing debris, fish processing waste, municipal sewage sludge, and food scraps. Collectively, these materials are considered "source-separated organics" (SSO).

Methodology

Quantities for woody waste, yard trimmings, vegetative clearing debris, fish processing waste, municipal sewage sludge and municipal solid waste (MSW) were provided by the Kenai Peninsula Borough (KPB) and are shown in Table 1.0. Supplemental waste characterization reports were supplied by Coker Composting & Consulting.

Table 1.0: Kenai Peninsula Borough Landfill/Transfer Site Monthly Tonnages

Month	Year	Seward Transfer Site*	Homer Landfill	Central Peninsula Landfill	Total
July	2011	372.00	1,065.00	5,623.83	6,688.83
August	2011	372.00	1,030.50	5,850.84	6,881.34
September	2011	360.00	942.00	11,720.57	12,662.57
October	2011	372.00	937.50	8,720.73	9,658.23
November	2011	348.00	757.50	6,542.09	7,299.59
December	2011	360.00	738.00	7,202.58	7,940.58
January	2012	372.00	754.50	3,026.73	3,781.23
February	2012	348.00	651.00	2,407.25	3,058.25
March	2012	372.00	711.00	2,487.96	3,198.96
April	2012	360.00	825.00	3,544.99	4,369.99
May	2012	372.00	1,155.00	4,730.86	5,885.86
June	2012	360.00	1,126.50	5,157.04	6,283.54
Total:	**—**	**4,368.0**	**10,693.5**	**67,015.47**	**77,708.97**

**Seward Transfer Site amounts are based on an estimate of 12 tons per day and are not included in the total column, as they are already included in CPL's numbers.*

The planning period for this study was selected to be 2015 to 2030. Forecasting future quantities was done on the basis of population projections provided by the Alaska Department of Labor and Workforce Development and are presented in Table 1.1. The data[1] for this time period was developed based on current population and historical trends in birth, death and migration levels. The population data was used to define "per capita" generation rates for organic wastes for both present and future conditions.

Table 1.1: Kenai Peninsula Population Projections

Year	Population	Population Change	Growth Rate (Percent)
2010	55,712	—	—
2015	59,073	3,361	5.69
2020	62,174	3,101	4.99
2025	64,761	2,587	3.99
2030	66,700	1,939	2.91

Available Types of Feedstocks

Food Scraps

As KPB does not separately track food scraps, food scrap tonnages were estimated based on an review of food waste percentages found in various Alaskan and national waste characterization studies:

- Kalskag, AK (2010) - 14% of the waste stream was food scraps, 6.3% was cardboard, 1.2% was newspaper, 14.9% was office/mixed paper, and 4.3% was other paper.
- Unalaska/Dutch Harbor, AK (2000) - the organics category contained fish waste, wastewater treatment plant (WWTP) solids, and a portion of "as received" organics, with an estimated percentage of organics at 32%. Because this community is remote and has a year-round fishing industry, this data was considered less representative of KPB conditions.
- Kodiak Island Borough (KIB, 2008) - 14% of the waste was food scraps.
- U.S. Environmental Protection Agency (2010) - 14.1% of all MSW in the U.S. was food scraps, and and 13.7% of MSW was yard trimmings

Upon reviewing these reports in addition to two others done in the states of Maine and Georgia, for supplementary comparison, and removing the outlier found in the Unalaska report, the estimated percentage of food scraps in the KPB waste stream is 14%. Based on the assumed percentages of food scraps in the KPB waste stream, about 10,879 tons of food scraps was generated for the fiscal year of 2012 (see Table 1.2).

[1] "Borough/Census Area." Research and Analysis. 2010. 7 Sep, 2012. State of Alaska Department of Labor and Workforce Development. <http://labor.alaska.gov/research/pop/popproj.htm>

Table 1.2: Kenai Peninsula Borough Food Scraps

Landfill/Transfer Site	Food Waste Tonnage	% of Total Food Waste
Seward Transfer Site*	611.52	—
Homer Landfill	1,497.09	13.8
Central Peninsula Landfill	9,382.16	86.2
Total:	**10,879 Tons**	100.0

**Seward Transfer Site amounts are already included in CPL's numbers and are omitted from the total row.*

Woody Wastes

Woody wastes include yard trimmings and vegetative clearing debris. KPB Solid Waste's Central Peninsula Landfill (CPL) combines these vegetative classes into a single category for their records. Woody wastes are tracked as a volume at the Seward transfer station and the Homer landfill, due to a lack of weigh scales. The estimated weight per cubic yard is about 500 lbs. The Seward transfer site captures about 300 CY or 75 tons of woody wastes per year, the Homer Landfill about 1,000 CY or 250 tons, and CPL about 846 tons annually.

Fish Processing Wastes

While most fish processors grind and discharge their fish waste back into the rivers or Cook Inlet, the general public and some smaller fish processing companies dispose of their fish waste at CPL. Last year, 44.91 tons of fish wastes were discarded at CPL.

Significant quantities of fish waste are also generated as a by-product of the sockeye salmon dipnet fishery which is centered at the mouth of the Kenai River. The City of Kenai has been tasked with disposal of fish waste in ordered o minimize beach contamination. The City estimates that approximately 500,000 lb. (250 tons) of fish waste is generated in July, during the month-long dipnet season. Current practice is to use a front end loader to scrape fish offal off the beach and push it out below the low tideline. The City has expressed willingness to load the fish waste into containers to facilitate offsite composting by others.

Municipal Sewage Sludge

The main suppliers of sewage sludge to CPL are the cities of Kenai and Soldotna. Last year 1,327 tons of sewage sludge was disposed of at CPL. The Homer Landfill receives about 450 tons of sewage sludge annually from the City.

Table 1.3 shows the current feedstock tonnage totals from the main waste collection locations.

Table 1.3: Current Feedstock Amounts in Tons

Feedstock	Seward Transfer Site*	Homer Landfill	Central Peninsula Landfill	Total
Food Scrap Waste	611.52	1,497.09	9,382.16	10,879.25
Woody Waste	75.00	250.00	846.00	1,171.00
Fish Processing Waste	—	—	44.91	44.91
Municipal Sewage Sludge	—	450.00	1,327.00	1,777.00
Total:	**686.52**	**2,197.09**	**11,600.07**	**13,872.16**

**Seward Transfer Site amounts are already included in CPL's numbers and are omitted from the total column with the exception of woody wastes.*

Summary

Table 1.4 contains the results of the projection of future feedstocks production. The projected quantities of organics are about 14,400 tons/year in 2015, increasing to 16,200 tons/year in 2030. However, not all of these organics are considered "capturable" as there is no requirement to divert organics. In those U.S. communities with curbside residential collection of source-separated organics (SSO) participation rates average 35% - 45% and setout quantities average 12-15 lbs/household/week.

About 1.36 pounds of waste is created per person per year in the Borough, and of that waste about 0.25 pounds is potentially compostable, but these waste generation estimates are considered low because not every person who lives in the borough takes waste to the Homer and Central Peninsula Landfills. This is the case for the communities of Beluga, Nanwalek, Port Graham, Seldovia, and Tyonek as they have their own landfills.

Table 1.4: Future Feedstock Production Estimates for KPB

Year	Population Projections	Food Scrap Wastes	Woody Wastes	Fish Wastes*	Sewage Sludge	Total
2012	56,980	10,879.25	1,171.00	44.91	1,777.00	13,872.16
2015	59,073	11,278.87	1,214.00	46.56	1,842.27	14,381.71
2020	62,174	11,870.95	1,277.74	49.00	1,938.98	15,136.67
2025	64,761	12,364.88	1,330.91	51.04	2,019.66	15,766.49
2030	66,700	12,735.10	1,370.75	52.57	2,080.13	16,238.56

**Fish waste is more dependent on fish runs rather than population*

As this information is derived from other studies, it is recommended that the Kenai Peninsula Borough perform its own waste characterization study, similar to the ones performed in Kodiak and Unalaska, to gain more accurate information for the design of any organics recycling facility that might arise from this study.

Chapter 2 –
Collection Alternatives

Introduction

Implementation of any source-separated organics diversion program requires development of some system to collect and transport the separated organics to a processing facility. This chapter examines existing KPB collection infrastructure and explores options for transferring SSO to a new recycling facility.

Existing Collection Infrastructure

The majority of MSW disposed in KPB is by citizen drop-off at one of the Borough's 21 solid waste management facilities (8 landfills, 5 staffed transfer facilities and 8 unmanned transfer sites). Alaska Waste – Kenai Peninsula, LLC (d/b/a Alaska Waste) provides collection services to approximately 1,425 residential accounts and 1,940 commercial accounts in Homer, Kenai, Soldotna, and Seward.

SSO Collection Options

Should KPB elect to develop a SSO diversion program for organics recycling, there are three basic collection options:

- SSO separated in specially-marked bags and co-collection with trash by Alaska Waste or by KPB Solid Waste
- SSO separated in uniquely-colored roll carts (similar to the 96-gal roll carts currently provided by Alaska Waste) and collected in a separate dedicated truck route by Alaska Waste or by KPB Solid Waste
- SSO separated and delivered to a specially-dedicated collection container at one of KPB's solid waste facilities

Co-collection of SSO and trash is a new approach, pioneered in 2012 in Minnesota to cut down on wintertime road damages by solid waste collection trucks. Known as the "Blue Bag Organics" program (www.bluebagorganics.com), it is a subscription program where a residential or commercial customer gets appropriately-sized containers (i.e. 18-gal. or 30-gal. for typical residential accounts) and sixty (60) specially-made compostable plastic bags. The bags have additional plasticizers incorporated into the resin to reduce bag breakage. The bags are filled with SSO and then put out for collection with the trash. When the load arrives at the solid waste management facility, the colored bags of SSO are pulled out of the trash stream and redirected to the organics recycling facility. This separation process is most safely handled at a Materials Recovery Facility or similarly-equipped structure. As KPB has no facility suitable for the safe segregation of SSO from commingled MSW, this alternative may be difficult to implement. Figure 2.0 is an illustration from the Blue Bag Organics program.

Figure 2.0. Blue Bag Organics

Collection of SSO in specially-colored carts is the most common method practiced in the 192 U.S. communities with residential curbside SSO collection programs. Alaska Waste currently offers dark green roll carts, so SSO roll carts would preferably be some distinctive contrasting color to make it visually easier to identify the correct roll cart (Figure 2.1). The SSO roll carts would be placed at curbside in alternate days from regular trash pickup, but this requires a separate dedicated truck route, with its attendant impacts on traffic congestion, road wear and vehicle and pedestrian safety. Similar programs can be put in place for businesses with significant SSO generation (restaurants, grocery stores, etc.), but it requires duplication of the solid waste collection infrastructure.

Drop-off programs for SSO diversion have traditionally yielded the lowest diversion tonnages as the communities with SSO programs in the U.S. tend to be more densely populated than KPB communities and residents and businesses are used to curbside collection. Given that drop-off

Figure 2.1. Dedicated Roll Carts

of MSW is the basic method of solid waste collection in KPB, a combination of a Blue Bag Organics-type program, with dedicated drop-off collection dumpsters at KPB solid waste facilities, might be more easily implemented. These dumpsters would have to be similar to the bear-proof facilities currently in use at KPB facilities, but they could have different colors or have informational signage and graphics to promote the SSO diversion program. These dedicated dumpsters would be replaced with empty ones weekly and the filled containers hauled to the organics recycling facility.

Chapter 3 –
Recovered Product Markets

Introduction

Assessing the feasibility of organics recycling requires an understanding, on a preliminary basis, the nature and size of markets for products recovered from organic wastes. These products can be broadly grouped into compost-based horticultural products and energy products.

Outlets for compost products include homeowner and business landscaping, sediment and erosion control, parks and recreation department landscaping, environmental site restoration, storm water management, etc. Outlets for recovered energy products include electrical production, natural gas pipelines and natural gas vehicles.

Compost Markets

The primary sales market for compost in the Kenai Peninsula Borough is likely residential and commercial landscaping and gardening, but there are no accepted quantitative “standards” for what the marketplace will buy (it uses qualitative “standards” like color, no objectionable odors, minimal levels of contamination with inert materials, etc.).

Market Overview

Compost is an organic matter resource that has the unique ability to improve the chemical, physical, and biological characteristics of soils or growing media. It is made by the aerobic biological decomposition of organic materials like greenwaste, food scraps, etc. Compost can be utilized directly as a soil amendment, as a topdressing agent for turf, and as a mulch. It is considered a low-grade fertilizer, with a typical Nitrogen-Phosphorus-Potassium (N-P-K) value of 1.5-0.5-0.7. Compost benefits soils from three perspectives: biologically, in that is adds beneficial microorganisms to soils; chemically, in that it creates a pool of organic nitrogen (and other nutrients) in the soil that plants can use for nourishment over several years; and physically, in that it improves soil structure, reduces irrigation demand, and improves water holding capacity. Compost is also an ingredient in specialty soils. Compost-based specialty soils include materials like: golf course putting green rootzone mix, bioretention pond (rain garden) planting media, athletic turf growth media, manufactured topsoil, container mix (for potted plants), and potting soil.

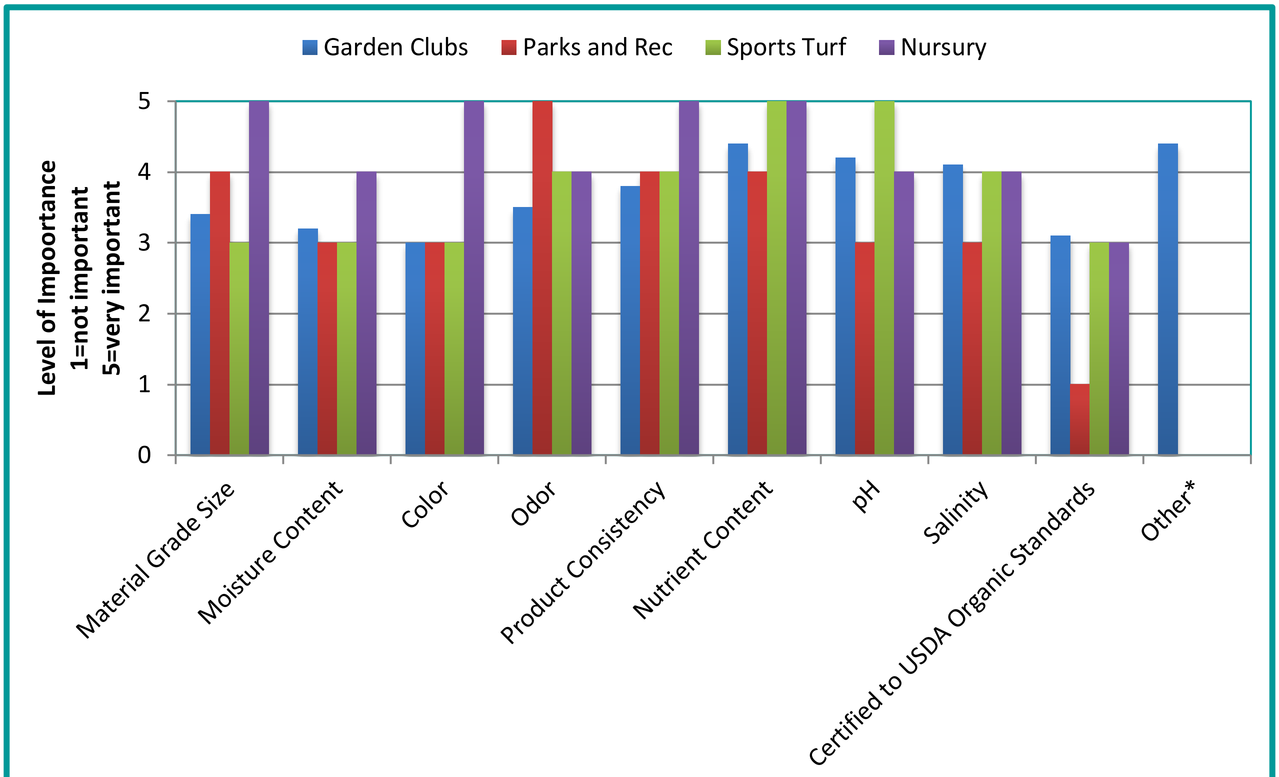
Selling compost and compost-amended soils requires investment in a market development program, which can be a challenge for financially-strapped municipalities. A development program includes traditional marketing tools like branding, logos, informational flyers, advertisements and outreach programs, as well as more tailored programs like demonstration plots, outreach to gardening groups and K-12 schoolchildren, and internal marketing to other Borough departments.

Survey Analysis

To understand the market for compost in KPB, various surveys were given to different types of businesses and clubs to assess their understanding of compost and their potential interest in a KPB-generated product. The following are the results of the various surveys.

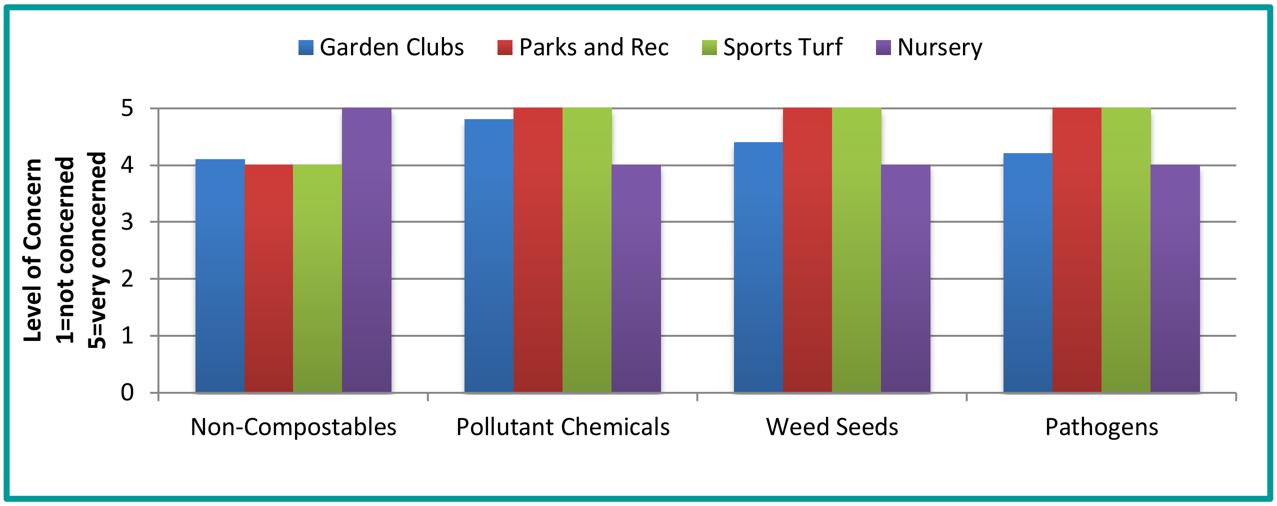
A 10 question survey was distributed to members of the Central Peninsula Garden Club, the Homer Garden Club, and Sustainable Homer. 101 responses were received and of those 98% were familiar with compost products, 96% add organic material/soil amendments to their soil, 86% purchase their soil amendments, and 96% could use more organic material in their soil. When respondents were asked how much compost they would use per year 2% responded with 0 cubic yards (CY), 40% would use 1-5 CY, 33% 6-10 CY, 7% 11-15 CY, 8% 15-20 CY, 4% would use 1-5 tons, 1% 11-15 tons, and 1% more than 20 tons. 70% of respondents felt that delivery was not an important consideration when purchasing compost and 83% would prefer self-hauling their compost. The distance people were willing to travel to get a compost product varied with 54% willing to travel less than 20 miles, 42% willing to travel 20-40 miles, 3% 40-60 miles and 1% willing to travel over 80 miles. Figures 3.0 – 3.2 show the results of the remaining questions asked on the survey.

Figure 3.0: Average importance level of compost characteristics



*Only 5 responses given, “price”, “No pesticide residues - Aminopyralid for ex.”, “Does it work-Fishy Peat does!”, “Trace minerals”, and “Iteration of materials composted”.

Figure 3.1: Average concern level of compost contaminants



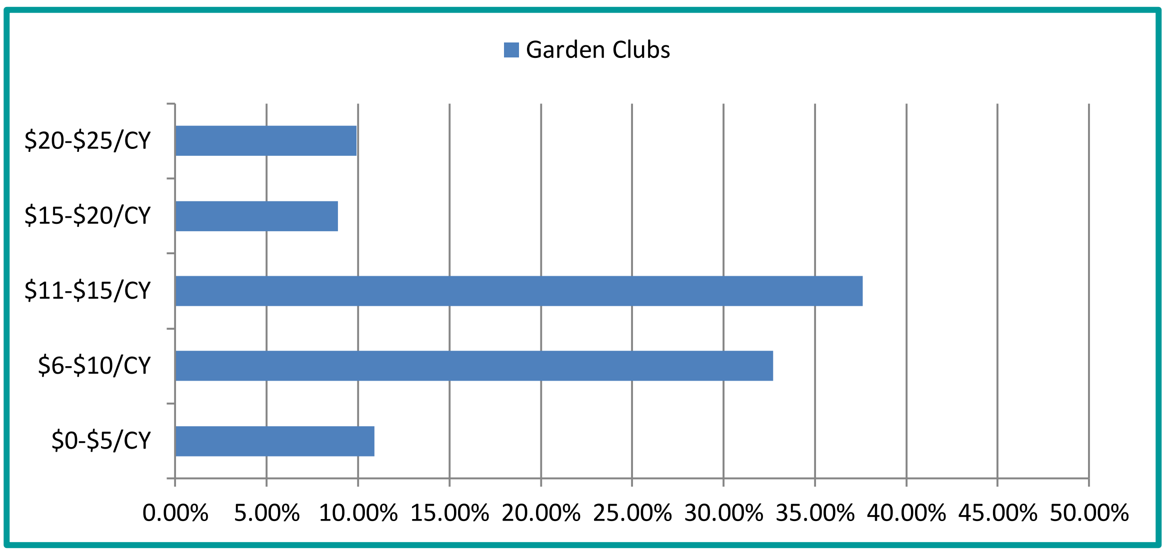


Figure 3.2: The price that respondents are willing to pay per CY of compost

The Parks and Recreation Department of the City of Soldotna filled out a similar survey. They generate 1-10 CY of green waste per week in the summer months, but do not compost it. They use 10-12 yards of wood chips, and about 5 yards of planting mulch per year mainly for maintenance of beds around trees and planter beds. They pay between $11-$15/CY for their soil amendments, which are purchased from a local wholesaler. The Department of Parks and Recreation intends to increase their use of compost and soil amendments, and would be willing to use locally produced compost in addition to, and/or in place of other soil amendments. Being willing to travel less than 20 miles for a compost product, product delivery is an important consideration when purchasing compost to this department and they would want their compost delivered. The parks and recreation department would be willing to try a compost product that met their specifications and would minimize expense risks.

In the sports turf industry, a local golf course was surveyed. They were familiar with compost products and composts use in the sports turf industry. They produce between 1-10 CY of green waste per week and usually compost it. They are currently not using any soil amendments, but when used it is mainly for the maintenance of grass/lawns, planter beds and around trees. Fertilizer is used in addition to organic soil amendments. The golf course owner was not sure if engineered compost would be of any benefit for their business. A reduction in fertilizer cost and increased turf vigor were the seen benefits of soil amendment application. Their undelivered bulk soil amendments are free from the Alaska Garden & Pet Supply. This golf course does add organic amendments to its divot mix. They do not intend to increase their use of compost and/or soil amendments, but would be willing to use locally produced compost in addition to other organic materials. They do not have a specification for turf formulation nor an integrated pest management program. Delivery is an important consideration when making a purchasing decision for them, and they would be willing to travel over 80 miles to acquire a compost product. They would be willing to try a compost product that meets their specifications and would minimize expense risks.

The surveyed nursery was familiar with compost and its use in the nursery industry. They generate 1-10 CY of green waste per week but do not compost it. In their potting mixes they use peat and soil. Reduction in water use, increased plant growth and increased plant survival rates are the benefits seen by this nursery from the application of soil amendments. This nursery purchases “AD Meeks Peat/Topsoil mix” at $25/CY from a local wholesaler. They do not intend to increase their use of compost and/or soil mixes. They would be willing to travel less than 20 miles to obtain a compost product. Delivery is an important factor when making a purchasing decision. They would be willing to try a compost product that meets their specifications and would minimize expense risks. This nursery felt that there is a market for the “home” gardener if the price of compost can be kept low and if the product is easy to transport or can be delivered.

Compost Markets in Alaska

Alaskan compost markets are limited, but appear to have some growth potential. In Anchorage, Green Earth Landworks (in conjunction with Alaska Green Waste Solutions) is a producer of compost. Green Earth Landworks’ main customer is the Alaska Department of

Transportation, and while they are able to move their product, they have about 3,000 CY of compost available for sale. This inventory represents about 2 years of composting. They indicated that the market is stable, but not booming and they sell their compost for $65 - $95/CY[2].

In April 2010, the City of Kodiak published the results of a pilot test looking at composting biosolids with wood chips[3]. The study also examined market conditions and concluded:

> "The City will need to promote its compost to all horticultural businesses on Kodiak Island. In addition, because of its rural location, the City will need to be creative in market development efforts and promote the compost to other Alaska cities and towns as well as local residents. Large, local land managers such as the City Parks and Recreation Department, ADOT&PF, forestry operators, KIB (which manages the landfill), and Kodiak Support Services should also be approached. Application methods that can be marketed include soil incorporation soil blending, topdressing, soil remediation, and erosion control."

The City of Fairbanks, through Utility Services of Alaska, has also successfully marketed biosolids compost. They produce about 9,350 CY/year[4].

Energy Products Markets

One of the technologies being considered in the KPB Organics Recycling Feasibility Study is anaerobic digestion (AD). AD, like composting, is a biological conversion process. The primary product from AD is called biogas. Biogas consists of a mixture of gases, as shown in Table 3.0

Table 3.0: Biogas Composition

Component	Concentration
CH_4	40 ~ 70 Vol%
CO_2	25 ~ 55 Vol%
H_2S	0 ~ 5000 ppm
NH_3	0 ~ 1 Vol%
H_2O	0 ~ 10 Vol%
N_2	0 ~ 5 Vol%
O_2	0 ~ 2 Vol%
H_2	0 ~ 1 Vol%

[2] Personal communication, Mrs. Christina Eneix, Green Earth Landworks, November 6, 2012
[3] CH2M-Hill, "Biosolids Composting Pilot Test", City of Kodiak, AK, April 2010, p. 41
[4] http://www.akwater.com/compost.shtml

How the biogas is handled and processed depends on the end market. Biogas from an anaerobic digester can be used in several ways: as a substitute for natural gas, either in boilers producing hot water and steam for industrial processes, in combined heat and power (CHP) applications to generate electricity (as well as heat for space heating), as a pure natural gas substitute (high-graded for insertion into the natural gas supply), for fueling a fleet of vehicles or as a fuel for fuel cells. It may also be possible to sell Renewable Energy Credits (RECs) based on the type and amount of energy recovered.

Electricity Production

CHP systems are becoming more widely used to generate electricity and recover heat from biogas produced by stand-alone digesters as well as from recovered landfill gas. CHP units can be reciprocating internal combustion (IC) engines, gas turbines, fuel cells and Stirling engines. Of these, the reciprocating IC engine generator is most frequently used. Biogas treatment needs for reciprocating CHPs are particulate (if any) removal and moisture removal. Heat recovery from the engine jacket and exhaust air can range from 3,500 to 6,200 BTU/kWh of shaft power.

This task examined potential recovered energy customers in close proximity to KPB solid waste facilities. Table 3.1 identifies these energy users.

Table 3.1: Electricity and Heat Demands

Location	Energy User	Electricity Consumed	Space Heating Demand	Notes
		(kwh/year)	(million BTUs)	1
Homer	Transfer Station	200,000	3.50	2
	Balefill Building	154,640	None-Electrical	
Kenai/Soldotna	CPL Multipurpose & Baler Bldgs.	No data	No data	
	Skyview HS	1,520,611	11,198	3
	ADOT& PF Hwy Maint Facility	243,478	2,272	4
Seward	Transfer Station	12,660	417	5
Notes				
1. Data for FY 2012 (July 2011-June 2012)				

2. Estimated from project design data
3. Converted from reported usage of 109,034 CCF natural gas
4. Converted from reported usage of 26,987 CCF natural gas
5. Converted from reported usage of 3,000 gallons fuel oil

The two main electric service providers for the energy users in Table 3.1 are the Homer Electric Association (HEA) and the City of Seward Electric Department (Seward Electric). HEA actively encourages net metering[5] and allows interconnections from member-owned sources of renewable energy[6]. The net metering program allows a member to reduce the amount of electricity purchased from Homer Electric by interconnecting on-site generation facilities. Regulations governing net metering were adopted in January 2010 by the Regulatory Commission of Alaska; under these regulations, renewable energy systems with a capacity up to 25 kilowatts (kW) are eligible for net metering. Larger capacity renewable energy systems could negotiate a Purchase Power Agreement (PPA) with HEA; to date, all renewable energy connections fall under the net metering program. HEA has expressed its willingness to negotiate a PPA with KPB Solid Waste[7].

Under either program, it may be possible for KPB Solid Waste to generate its own power for its facilities in Homer and in Soldotna, and sell the excess power (if any) back into the HEA grid under either the net metering rules or under a negotiated Purchase Power Agreement (PPA). Which approach to pursue will depend on the potential power generation level. Alternatively, it may be possible to work out agreements with other major energy users in the vicinity of the CPL to use power generated by KPB Solid Waste.

The City Council of Seward is deliberating a modification to the City Code that would allow interconnections from independent power producers into the Seward Electric grid[8]. Under this proposal, the KPB Solid Waste Department could produce its own power at the Seward Transfer Station but would have to sell it into the Seward Electric grid with one interconnection and buy power from the City through its existing interconnection, with the net charges or credits appearing on the monthly bill.

[5] "Times Change, Values Remain", Homer Electric Association 2011 Annual Report

[6] "Interconnection of Member-Owned Alternate Technology Generation Equipment", Sec. 4.9, Rules and Regulations of Homer Electric Association

[7] Personal Communication, Mr. Brad Hibbert, Homer Electric Association, October 26, 2012

[8] City of Seward, Alaska, Ordinance 2012-010, "An Ordinance Of The City Council Of The City Of Seward, Alaska, Amending Title 14 Of The City's Code Of Ordinances To Provide For Interconnection Of Small Renewable Energy Sources To The City's Electrical Distribution System, introduced September 10, 2012

Natural Gas Augmentation

Natural gas service in Homer and Kenai/Soldotna is provided by Enstar Natural Gas Company. The Seward area does not have natural gas service. Enstar now purchases natural gas from outside sources and is willing to consider recycled natural gas if it were produced by the KPB Solid Waste Department[9]. Enstar's procurement specification requires any purchased gas to meet the following gas quality requirements:

- A Gross Heating Value between 950 and 1,050 BTU per cubic foot
- Less than 4 lbs of water per million cubic feet of gas (<0.0007%)
- Less than 1 grain (0.00014 lbs) of H_2S per one hundred cubic feet of gas
- Less than 3% CO_2 (by volume)
- Less than 1% O_2 (by volume)
- No settleable particulate matter
- Filtered through a 0.3 micron filter to remove condensate

Most biogas produced by AD systems contains a Gross Heating Value of about 550 BTU/cubic foot, so amendment with a higher heating value fuel (i.e. propane) is usually needed.

Given the relatively small volumes of biogas potentially produced by a solid waste AD system in KPB, it is unlikely that the cost of gas clean-up to these specifications will be justified by the potential purchase price.

Vehicle Fleet Fuel

Converting vehicle fleets to run on natural gas or propane is increasing in popularity. There are about 120,000 natural gas vehicles (NGVs) on U.S. roads today and more than 15.2 million worldwide. According to the American Public Transit Association, nearly one-fifth of all transit buses were run by compressed natural gas (CNG) or liquid natural gas (LNG) in 2011. It can cost between $12,000 and $18,000 to convert an existing gasoline powered car to run on natural gas[10], so it is usually more cost-effective to replace retiring vehicles with NGVs. It also requires a compressed gas refueling station.

The Alaska Sustainable Energy Act, Senate Bill 220, an energy policy bill passed in 2010, mandated the Alaska Department of Transportation & Public Facilities (ADOT&PF) to prepare a report on the feasibility of using CNG to power vehicles in the State. That report was published

[9] Personal Communication, Mr. Mark Slaughter, Enstar Natural Gas Co., Oct. 31, 2012
[10] Natural Gas Vehicle Coalition, at http://www.ngvc.org/index.html

in January 2011[11]. Phase 1 of that evaluation was a feasibility study and Phase 2 was the development of a pilot program. The Feasibility Study concluded that "The analysis indicates that CNG is a feasible fuel for certain Alaskan fleets and that an expansion of the CNG program would be beneficial towards Alaska's sustainability efforts." Phase 2 found 571 State vehicles, due for replacement soon, that could be replaced with NGVs.

The two fleets operating in KPB are operated by the School District and all other borough departments. KPB's two fleets consist of approximately 54 vans, pickups and utility vehicles and approximately 9 larger trucks. Of these, 7 are scheduled to be retired in 2013, 6 in 2014, 7 in 2015 and 6 in 2016. Replacing these with NGVs may be feasible if a CNG refueling station could be constructed.

The KPB School District contracts out school bus leasing and operation from a private company (First Student, Cincinnati, OH), but maintains their own fleet of 33 "activity buses" that could potentially be a market for conversion to or replacement with NGVs[12].

Summary

The primary sales market for compost in the Kenai Peninsula Borough is likely residential and commercial landscaping and gardening. Given that 73% of the individuals surveyed indicated they would be willing to purchase up to 10 CY of KPB compost per year, it is reasonable to conclude that with an effective and tailored marketing program, it is likely that KPB could sell between 2,000 and 3,000 CY per year of compost and compost-amended soils.

The recovered energy markets for biogas produced from anaerobic digestion are: electrical production, natural gas pipeline injection, and fleet vehicles running on CNG. Of those, the electrical production alternative appears to be the strongest market, given an active program by Homer Electric Association to encourage net metering for power capacities below 25 kW and a willingness to explore a Power Purchase Agreement for larger power capacities.

[11] Mercury Associates, Inc., "State of Alaska Vehicle Fleet CNG Pilot Program Recommendations/Costs", prepared for ADOT&PF, January 2011, available at http://www.afdc.energy.gov/laws/law/AK/8480

[12] Personal Communication, Ms. Nan Spooner, KPBSD, Nov. 5, 2012

Chapter 4 –
Technology Analysis

Introduction

There are two main categories of organics recycling technologies: aerobic composting, and aerobic/anaerobic digestion. This chapter describes these various technologies and offers project profiles of organics recycling facilities using these technologies in climates and with similar feedstocks similar to KPB.

As part of this work, the project team developed preliminary process designs for both composting and anaerobic digestion to help frame the analysis of suitable technologies in this task and for the analysis of suitable sites. The quantities of food scraps and seafood wastes were derived from the feedstock characterization information presented in Chapter 1. The process design is described below and detailed calculations are contained in the Appendix.

Composting technologies utilize an aerobic (with oxygen) process to decompose organic materials such as food waste, biosolids, yard trimmings, water treatment residuals, animal manures, mortalities, and certain industrial solid wastes. It is a self-heating process that destroys pathogens and weeds seeds, and produces a material similar to soil humus. Well-stabilized (and mature) compost can be stored indefinitely and has a wide variety of product markets in residential and commercial landscaping, sediment and erosion control, agriculture, non-point source water quality management systems, disturbed lands remediation, and commercial horticultural applications. Composting technologies include turned windrow, aerated static pile, enclosed aerated static pile, and in-vessel. These technologies are described in more detail in the Task 3 report and examples of these types of systems are described below.

Digestion technologies are either aerobic or anaerobic; the former is a method of stabilizing organic wastes, while the latter produces a usable gas byproduct during the stabilization process. Both types of digestion are traditionally "wet" processes and produce both a solid residual and a wastewater effluent that must be further managed. Recent technology changes in Europe have introduced a dry form of anaerobic digestions (known as dry fermentation) which is now being developed in the U.S. Aerobic digestion requires more steps in its process flow and is therefore more expensive. Thus, anaerobic digestion (AD) will be the only digestion process further discussed in this task report. Examples of AD systems are presented below; detailed information on AD is presented in the Task 3 report.

Process Design

Due to the high costs of trucking organic wastes across the Borough, the initial preliminary process designs for organics recycling in KPB assume separate facilities in Seward, Homer and Soldotna, as follows:

- Composting in Seward – 600 tons/year of food scraps combined with 500 tons/year of woody wastes to produce 1,700 cubic yards of finished compost

- Composting in Homer – 1,500 tons/year of food scraps combined with 1,000 tons/year of woody wastes to produce 3,500 cubic yards of finished compost
- Composting in Soldotna – 8,850 tons/year of food scraps and seafood wastes, combined with 5,200 tons/year of woody wastes to produce 19,500 cubic yards of finished compost
- Anaerobic digestion/composting in Soldotna – digesting 8,850 tons/year of mixed food and greenwastes to produce 34 million cubic feet of biogas per year (and, potentially, 2 megawatts (MW) of electrical power and 2 MW of thermal energy), followed by composting to produce 11,700 cubic yards of finished compost

The process design recipes include food scraps, woody materials, recycled compost (used as an inoculant) and oversized carbonaceous amendment from the final product screening process. The recipes are based on recommended process design criteria:

- A carbon – nitrogen ratio of between 25:1 and 30:1[13]
- A mix moisture content of 50% - 55%
- Volatile solids content of at least 80%
- A structural porosity (predicted Free Air Space) of between 40% and 60%

The process flow diagrams are daily volumes based on measured bulk density data from other projects, with certain assumptions about volumetric losses in processing. The composting facility alternatives were sized based on aerated static pile composting in concrete block bins (see an example in Figure 4.0). As noted elsewhere in this report, other methods of composting include turned windrows and vendor-supplied in-vessel systems. The anaerobic digestion process flow diagram is mass-based and is based upon European dry fermentation technology followed by aerated static pile composting.

It should be noted that these process designs are preliminary. The Feedstock Characterization report did not identify adequate quantities of woody wastes to support any of the composting alternatives above. It is not clear that enough woody materials could be sourced in the Borough to meet the process design criteria of a C:N ratio of 25:1 to 30:1. In addition, it may not be possible to capture 100% of the food scraps produced in the Borough.

[13] 1 CY of food scraps requires mixing with approximately 2.5 CY of woody waste to achieve the desired C:N ratio
1 CY of fish waste requires mixing with approximately 6.1 CY of woody waste to achieve the desired C:N ratio.

Figure 4.0: Aerated Composting Bin

Technology Alternatives

Composting

Composting technologies include turned windrow, aerated static pile, enclosed aerated static pile, and in-vessel.

Windrow composting is widely practiced and is the predominate method used for composting materials like yard trimmings, but source-separated organics (SSO) can also be composted. When windrow composting, the material is placed in long trapezoidal-shaped windrows approximately six to ten feet high, eight to eighteen feet wide and turned or aerated mechanically using a front-end loader or commercial windrow turner.

Disadvantages to windrow composting of SSO include: a risk of vector attraction (of bears, rodents, birds, etc.) from exposed food scraps on the surface of the windrow, inability to control odors easily, difficulty of separating process leachate from rain-induced storm runoff and reduced composting efficiency in extremely wet and/or cold weather conditions (unless enclosed in a building).

The turned windrow system is not recommended for KPB for a year-round operation. It takes more space than other composting methods, it would have to be either housed in a building or only done seasonally, and precautions for bears, birds, and other wildlife would have to be taken. In Yellowknife, Canada a composting pilot project using the turned windrow process was conducted.

> The City of Yellowknife (62° 26′ N, 114° 24′ W), in collaboration with the local non-profit organization Ecology North, used a turned windrow system for its composting pilot project. The construction and operation of the composting facility (CF) from 2009 to 2011 cost approximately $358,200.00.
>
> There were originally 14 participants in the project, and by the end of 2011 the number had grown to 21 commercial/institutional businesses, condominiums, housing co-operatives, and offices. The key factors in getting participation consisted of businesses/institutions having managers and/or employees interested in composing, and removing any economic barrier by covering the cost of compostable bags, organics bins, and bin collection for the duration of the pilot project.
>
> The (7) two-cubic yard and (9) four-cubic yard organics collection bins were collected on a schedule of once every one, two, or three weeks (depending on waste generation) by a local waste contractor. This contractor used an overhead tip garbage truck to collect the organics waste and deliver it to the CF. Based on the experience of loose organics freezing to the collection container, it was evident that the use of compostable bags was vital to a working organics collection system.
>
> The 2,000 square meter (21,500 SF) CF was constructed within the boundary of the City Solid Waste Facility (SWF). An elevated base pad was constructed out of recycled asphalt and covered with a layer of gravel with a slope of 1.6% to direct surface runoff to the leachate collection pond. The pad was built to be higher in elevation than areas surrounding the landfill to prevent surrounding area leachate from running onto the base pad. The leachate collection pond had an approximate volume of 135 cubic meters (35,600 gallons) and was lined with a layer of non-woven geotextile and one layer of impervious single-textured high density polyethylene liner. The base pad was also enclosed with an electrified bear fence.
>
> The allowed compostables consisted of yard waste (leaves, grass clippings, and plant trimmings), paper products (wet or food soiled boxboard and paper, napkins, facial tissues, wax-coated cardboard and box board), and food waste (fruits, vegetables, dairy products, eggs and egg shells, fish, shellfish, bones, grease and fat, cooked meat, small amounts of raw meat, bread, pasta, rice, cereal, flour, coffee grounds and filters, and tea bags). Many composting facilities don't accept dairy or meat products, but these windrows were able to get to a high enough temperature to make composting such items possible. On average 2 - 3 tonnes (2.2 - 3.3 tons) of food waste were delivered to the CF per week.
>
> Upon food waste delivery to the CF, SWF staff would then combine shredded paper, box board, yard waste, and/or wood chips with the food waste. For ideal composting conditions, these feedstocks were combined to create a carbon to nitrogen (C:N) ratio of 20:1 to 35:1. The newly mixed feedstocks were then added to the end of the newest

windrow on the compost base pad and covered with yard waste and shredded paper to deter wildlife. The windrows were approximately 4 - 6 m (13.1 - 19.7 ft.) wide and 2.5 - 4 m (8.2 - 13.1 ft.) high, reaching 35 m (114.8 ft.) in length.

The windrows were turned once to twice a week between mid-May and mid-October using a front-end loader. The loader was used to pick up the material on one side of the windrow allowing the material to slowly fall back to the ground. This process was then repeated on the other side of each windrow.

The moisture content of the windrows was maintained at 45% to 60% for optimal composting. Windrows were watered each time they were turned. Watering was accomplished using a water pump and fire hose. Leachate from the leachate collection pond was used to water the windrows during active composting, once the leachate had been used, water was transported to the CF. Leachate was never used to water compost in the curing stage to prevent the introduction of pathogens. Roughly 10,000 – 12,000 liters (2,600 – 3,100 gallons) of water and/or leachate was irrigated into the windrows per week in 2011.

The composting time line was collection and windrow formation from August to May, active composting from May to October, Curing from October to August of the following year, with compost screening and sales taking place in August. Temperatures of 55°C (131°F) to 77°C (170°F) were maintained for at least 3 months during active composting. To extend the active composting season into winter, yard waste was placed on top of actively composting windrows for insulation. Areas of the windrows remained at temperatures above 40°C (104°F).

Generally there is a 40% to 60% decrease in volume of composting materials, and a 35% to 55% decrease in mass. After screening out unwanted materials such as non-compostable materials, large pieces of partially composted materials, and bulking agents the amount of Yellowknife Black Gold Compost was in the range of expected decrease in volume and mass. Finished compost was screened using a bobcat and 4' x 8' vibrating Pro-Screen shaker screen owned by the city. Screening 145 tonnes (160 tons) of finished compost took approximately 30 hours.

Wildlife attraction to the CF was a big concern. To prevent bear entry, an electrified fence was erected around the perimeter of the compost base pad (no bears were ever observed at or near the CF). Foxes and wolverines were seen jumping in between the electrified wires of the bear fence. Most problematic of all wildlife were the ravens and gulls. The windrows were covered with non-woven geotextile and eventually 1" galvanized poultry netting, to prevent the birds from pecking holes into the geotextile. This reduced the number of birds, but manually removing and replacing the covers every time the windrows were turned was too labor intensive. The best prevention to ravens and gulls proved to be covering food waste with a layer of yard waste.

The Canadian Council of Ministers of the Environment (CCME) Guidelines for Compost Quality require that turned windrows reach a temperature of 55°C (131°F) or greater for a minimum of 15 days and be turned at least 5 times in that period, the CF windrows met this requirement. The temperature of the windrows was taken twice a week on Tuesdays and Fridays with a ReoTemp compost thermometer with a 36" stem. 10 to 20 temperature measurements were taken from each windrow. Other CCME Compost Quality Guidelines include testing for pathogens, trace elements, foreign matter, and maturity. Yellowknife Black Gold passed all of these tests ranking it as category A compost which can be used for any application.

Yellowknife Black Gold Compost was sold to the public in a two day sale at the CF. The compost was sold by the container or pick-up truck load. Pricing for the compost was based on the current price for soil amendments in Yellowknife and the price of municipally-produced compost in other Canadian communities. The demand for compost in Yellowknife and surrounding areas is high due to a lack of available soil locally.

The most helpful tool in having a successful composting operation proved to be education and communication with the community. CCPP created a variety of educational posters, guides and decals to clarify matters regarding composting to the public. Involving local schools in the CCPP helped raise community awareness, in addition to holding an open house at the CF each year. The City also created a section devoted to "compost" on its website, where detailed information on backyard and centralized composting was posted including all CCPP educational sheets.

Aerated static pile composting was developed as a composting approach for the beneficial reuse of sewage sludge (biosolids) and is a technology well-suited to wet, heavy materials like sludges and manures. The use of forced aeration in ASP serves both to maintain aerobic conditions more thoroughly and completely within the static pile (provided adequate porosity exists), and to dry out the composting material. As ASP piles are not turned or agitated after forming, the prerequisite of adequate porosity to maintain aerobic conditions is more important.

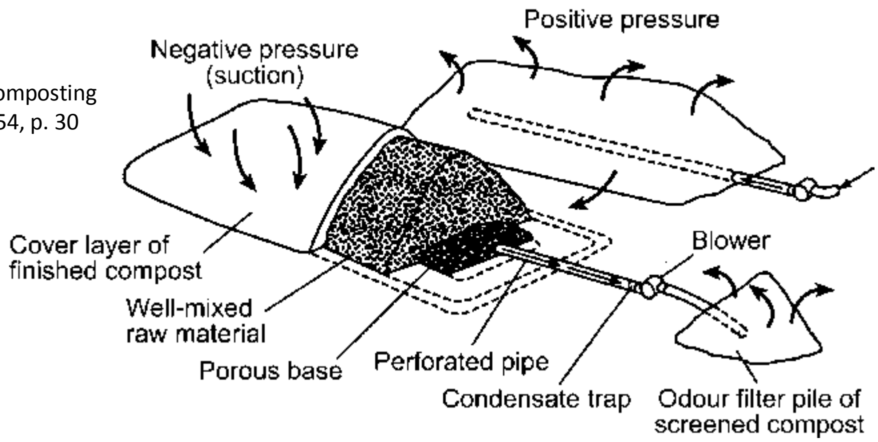
The blowers used in ASP composting are generally "off-the-shelf" units, with horsepower varying from 1 – 2 HP to upwards of 10 HP depending on pile size. Aeration systems are sized to provide a minimum of 500 cubic feet per minute (cfm) of air per dry ton of volatile solids in the mix. Aeration rates are often controlled by simple on-off timers[14]. Aeration systems can be run in either "positive" (blowing air into the pile) or in "negative" (pulling air into the pile) mode. ASP systems in positive air mode can have odor-related issues; and, if inside a building, the entire building air volume may have to be treated with a biofilter. Negative mode aeration reduces the volume of air to be treated, and, in some cases, emissions can be treated with small individual piles of finished compost at each blower. ASP's are often covered after pile

[14] Variable-frequency drives are often used to ensure an ongoing supply of oxygen to the pile; fan speed is dictated by pile temperature.

building with a 6" layer of finished compost, which acts both as an insulation blanket to trap heat and as an *in-situ* biofilter (see Figure 4.1).

Figure 4.1: Aerated Static Pile Layout

Source: "On-Farm Composting Handbook", NRAES-54, p. 30



An advantage of ASP composting is that individual piles can be sized to accommodate daily waste generation quantities. Individual piles are practical where raw materials are available for composting at intervals rather than continuously. A disadvantage is that the aeration piping may not be reusable more than once, depending on aeration system configuration, aeration pipe type (i.e. disposable ABS perforated drain pipe versus reusable perforated PVC pipe), and available labor.

Like turned windrow, ASP could work in KPB, though using an enclosed ASP composting process has several advantages over open-air methods: elimination of adverse weather effects, better process control, and improved opportunities to manage the air emission and wastewater sidestreams from the process. Enclosed static pile composting relies largely on forced aeration. The Western Lake Superior Sanitary District in Duluth, Minnesota has been using an aerated static pile system.

Western Lake Superior Sanitary District (WLSSD) Organic Composting Site
Duluth, Minnesota[15]

The WLSSD composting site in Duluth, MN (46° 47' N, 92° 6' W) processes 3,900 tons of organic matter each year averaging 60 - 75 tons per week. The feedstocks for this CF are SSO and yard waste. Private haulers, paid directly by the customer for collection and hauling, haul SSO from businesses and institutions to the CF. WLSSD operates 6 food waste drop sites for area residents and small business to dispose of their food waste. Each of these sites is overseen by a host business where compostable bags are available for purchase or may be provided. Customers benefit from source separating

[15] Personal Communication, Ms. Heidi Ringhofer, Solid Waste Services Director, September 17, 2012

their organic materials by avoiding a state tax on solid waste, and various management and tipping fees.

The use of forced aeration in aerated static piles maintains aerobic conditions more thoroughly and completely within the static pile. The feedstocks (food waste, yard waste, and wood chips) are ground together using a Schuler mixer and then formed into 7 feet high, 12 feet wide (at base), and 100 - 125 feet long windrows. The piles are generally loose in texture, having 50% - 60% moisture content, and a C:N ratio of 25:1 to 30:1. These piles are placed on aeration pipes that blow air into the piles. The entire composting process takes about 6 months.

The equipment used at the CF includes a loader (3 yd bucket), windrow turner, bobcat, farm tractor, and trommel screen. The WLSSD composting site requires one full-time year-round position for operation and management. WLSSD also invested in a bagging machine so they can bag their own finished compost product, Garden Green®.

The CF is located on a 200 ft. x 300 ft. concrete pad. WLSSD has found that the use of a concrete pad has improved the compost operation. There is better runoff control, less loss of compost material, easier clean-up of litter and waste, and less abuse to the equipment. WLSSD recommends a simple design, such as a concrete pad, similar to their facility. Cold weather conditions at the CF occasionally affect equipment start-up, and cause chunks of food and other material to freeze when screening.

The compost is sold in bulk and in one cubic foot bags under the Garden Green® name. Homeowners and Landscapers are the main consumer of Garden Green®. It is sold for $27 per yard loaded at retail, and $20 at wholesale. WLSSD never makes enough compost to meet the market demand. If they were to recreate their CF today, differences would include designing their CF to be bigger, moving it further out of town and verifying prevailing winds.

There are many subdivisions of composting technologies that fall under enclosed ASP. These include extended ASP, covered ASP, tunnel-type ASP, and containerized ASP. Of these, the containerized ASP system is of greatest applicability to KPB.

Containerized aerated static pile compost systems are enclosures that resemble ocean-going shipping containers in size and configuration. Although usually not agitated (hence "static pile") one vendor offers turning augers inside. They are usually aerated by low-horsepower centrifugal fans. These systems are provided by private technology companies.

One technology provider is Engineered Compost Systems (ECS), based in Seattle, WA (www.compostsystems.com) who offers both in-vessel and ASP compost systems. The ECS systems operate in batch mode. Their container system is the "CV Composter", which is a container-based system using insulated 40 CY vessels with stainless steel interiors. Figure 4.2 is a photograph of ECS' CV Composter. ECS has been in business since 1999, and has over 40 installations of its technologies around the U.S. and Canada (listing 9 CV Composters, 5 SV Composters, 10 AC Composters, and 9 individual ASP facilities).

Figure 4.2: ECS CV Composter

Containerized ASP Systems may be suitable for the scale of composting facility contemplated in KPB as the enclosures are insulated for use in cold weather, are scalable to KPB organics quantities and are vector-resistant. The SV unit is a stationary composting unit similar to the CV unit (Figure 4.3).

Figure 4.3: ECS SV Composter

Livingston, MT Waste Water Treatment Plant (WWTP) Biosolids Composting Facility

The WWTP CF in Livingston, MT (45° 40’ N, 110° 34’ W) uses the ECS CV Composter. The facility consists of four (4) 40 CY CV Composter Vessels, a 475 CY Luck/Now compost mixer, a loading conveyer, Comptroller™ (aeration control and data monitoring system), and a biofiltration system. The staffing level at the CF consists of one full-time employee. Per ECS, these CV vessels are designed for a 20-year service life.

The feedstocks used at Livingston CF are biosolids and wood chips. The approximate compost production is 1,467 CY/year. This approximation comes from an estimated total daily mix volume of 6.7 CY/day or total daily mix weight of 3.11 tons.

Feedstock recipes are developed by weight to achieve the best management practices for aerobic composting methods. The feedstocks are placed into the Luck/Now mixer. The mixer includes scales with large displays for achieving accurate mix ratios, and RF controls so that it can be operated from the front end loader cab. The mixer then discharges its contents onto the vessel loading conveyor and into the CV Vessel. The in-vessel retention time for composting in the CV unit is about 21 days. This process is followed by curing the compost in either passive windrows or small ASP systems. The CV Vessels are moved and unloaded using a roll-off truck.

Another composting technology is rotary drum composting. Rotary drum composting systems are used for MSW, animal mortalities, meat-packing and rendering wastes, and small-scale institutional (i.e. prisons, university dining halls) food wastes. This approach uses a horizontal rotary drum to mix, aerate and move the material through the system. Rotary drum composting for MSW has been practiced since the early 1970's and Bedminister Bioconversion and Conporec are two manufacturers of large, MSW composting systems. Other manufacturers make smaller systems.

The drum is mounted on large bearings and turned through a bull gear. A drum about 6 feet in diameter and 16 feet long has a daily capacity of approximately 4 CY with a residence time of three days. In the drum, the composting process starts quickly; and the highly degradable, oxygen-demanding materials are decomposed. Further decomposition of the material is necessary and is accomplished through a second stage of composting, usually in windrows or aerated static piles. The primary advantage of rotary drum composting is it usually achieves the requisite pathogen kill time-temperature relationship (>55^{o} C for three days), and it can reduce potential odor problems due to rapid decomposition of highly degradable organics, which are often the source of odor problems.

Air is supplied through the discharge end and is incorporated into the material as it tumbles. The air moves in the opposite direction to the material. The compost near the discharge is cooled by the fresh air. In the middle, it receives the warmed air, which encourages the process; and the newly loaded material receives the warmest air to initiate the process. These types of units can also be used as mixers to combine feedstocks prior to the composting process.

Green Earth Landworks with Alaska Green Waste Solutions at Anchorage, Alaska[16,17]

After looking into the possibility of windrow and static pile composting, Alaska Green Waste Solutions in Anchorage decided on using an in-vessel composting method, a rotating BioReactor drum by XACT systems. The small footprint and large capacity was

[16] Personal communication, Ms. Christina Eneix, Green Earth Landworks, November 6, 2012
[17] X-ACT Systems Case Study, BioReactor Composting System, Food Waste

a desirable feature of this system. Alaska Waste purchased a 10' diameter by 30' long vessel and installed it in 2009.

Alaska Green Waste Solutions collects vegetable and fruit waste from grocery stores such as Costco, Fred Meyer, and Carrs/Safeway. Alaska Waste provides grocery stores willing to participate (at a small rental rate) 64-gallon tipper carts to dump their vegetable and fruit waste. Horse stables also contribute their manure to this composting operation. Roll off containers are located at the local stables and picked up weekly. Alaska Waste hauls both the produce waste and manure to its composting system housed in a building on site. The composting system is comprised of the BioReactor, 4 conveyors, and a mixer. The heat off of the BioReactor helps heat the building it is housed in.

The produce waste is loaded into the mixer and allowed to sit over night to allow excess liquid to drain off. The following morning the mixer is started and 2 parts wood chips are added to 2 parts produce waste, and 1 part manure. A proprietary microorganism accelerant is also added to the mix as. After being mixed for 20 minutes, the contents are discharged onto a conveyor that feeds into the BioReactor.

The waste materials take about 7 days to cycle through the BioReactor drum, and about 3 batches of compost are produced each week. It rotates only a few hours each day. According to the operator, with the help of the microbial additive, the temperature of the composting material is kept in the range of 115°F and 145°F. The compost that comes out of the BioReactor has no identifiable particles and is light and fluffy in consistency. The total volume is reduced by about 20%.

The compost is then moved to GEL where it is cured in windrows or static piles. It is then mixed for different projects such as landscaping and erosion control and sold. GEL sells their compost for between $65.00 and $95.00 per cubic yard. Their main consumer of compost is the DOT.

Anaerobic Digestion (AD)

Anaerobic digestion is a biological treatment process. The lack of oxygen results in waste stabilization by a different group of microorganisms who produce a usable energy source in the form of biogas (mostly methane). The products of anaerobic digestion are methane, carbon dioxide, trace gases and stabilized solids. Biogas production ranges from 3,000 to 6,000 cubic feet per ton of incoming SSO, depending on digestion technology. The biogas has an average methane content of 55% - 60%, but pretreatment would be needed to remove impurities before it can be used for energy production[18].

There is a growing interest in the U.S. in the use of anaerobic digestion for recycling SSO.

[18] Van Opstad, B. "Evaluating AD System Performance for MSW Organics", *Biocycle*, Vol. 45, No. 11, November 2006, p. 35-39, and "Managing AD System Logistics for MSW Organics", *Biocycle*, Vol. 45, No. 12, December 2006, p. 39-43.

Anaerobic digestion is a feasible option for KPB. The drawback is extra space needed for the digest to be composted further in windrows or ASPs, but anaerobic digestion is the only process that produces a viable energy byproduct.

High-Solids Anaerobic Digestion Facility at Bad Oeynhausen, Germany

The organics recycling facility in Bad Oeynhausen, Germany (52° 12’ N, 8° 48’ E) uses the Eggersmann/Kompoferm SMARTFERM technology, which is a dry fermentation anaerobic digestion system. The 5,000 SF facility consists of four (4) separate reactors and handles 4,500 tons/year of source-separated “brown bin” wastes (brown bin wastes in Germany consist of kitchen scraps, peels, leftover food, coffee filters, tea bags and garden wastes) and vegetative greenwaste. The mix ratio between brown bin and greenwaste materials is about 50/50, although the brown bins contain vegetative residuals in addition to food scraps.

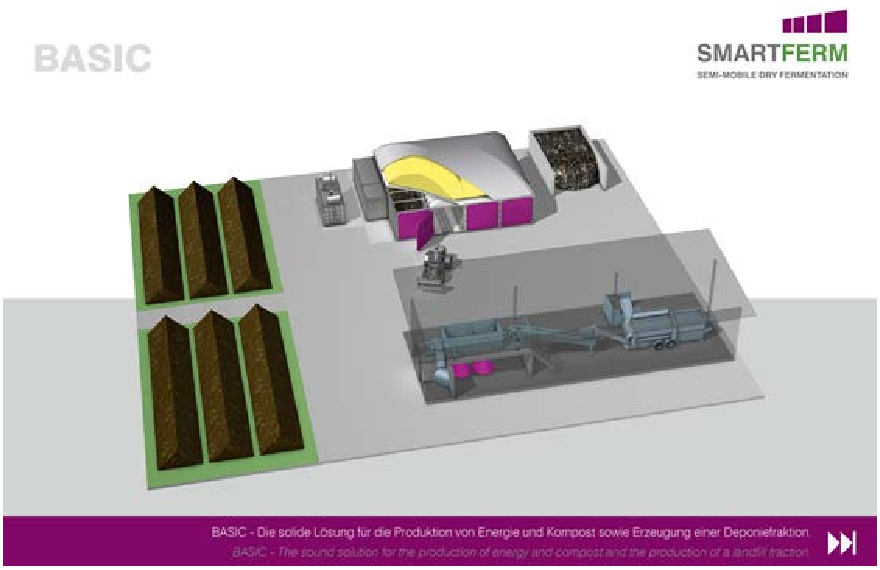
Figure 4.4: SMARTFERM Dry Fermentation Unit

The facility produces 13.6 million cubic feet of biogas per year, which is combusted on-site in a 100 KW Combined Heat and Power (CHP) generator, producing 822,334 kilowatt-hours per year (kWh/yr) of electrical power and recovering 3,818 million British Thermal Units per year (mmBTU/yr) of heat. Electricity is sold into the utility grid at $0.20/kWh and the recovered heat is used for on-site space heating.

Source-separated organic (SSO) wastes are loaded into one of the four reactors with a front-end loader. Once full, the reactor is closed and the 21-day fermentation process begins. The temperature of the SSO is elevated to 131^{o} F. (55^{o} C.) by aerobic composting through air injected via nozzles in the digester floor. This is the required pathogen inactivation temperature threshold. Once the SSO has achieved the targeted temperature, the aeration is stopped and percolation begins. Percolation is a process where a leachate-like liquid is sprayed onto the SSO biomass, filling the biomass pore spaces with liquid, and shifting the bacterial activity from aerobic composting to anaerobic digestion, producing biogas. During the second half of the fermentation period, biogas is recirculated through the aeration nozzles in the floor to enrich the methane content of the biogas. Biogas is collected from all four reactors and the percolate tank below the reactors and stored in a flexible membrane storage bag above the reactors.

At the end of the 21-day cycle, the percolation process is stopped and the aeration system is turned on again. This flushes the methane-rich biogas from the reactor, allowing the reactor to be opened. When the methane content drops below a prescribed level, the exhaust is re-directed to a biofiltration unit, which remains in operation handling reactor air volumes during reactor unloading and reloading. The sanitized digestate (the solid residual left over after fermentation) is arrayed in windrows for compost curing and maturation.

Figure 4.5: SMARTFERM Site Layout



The system was field-assembled from factory-manufactured components. In-field construction took about 30 days.

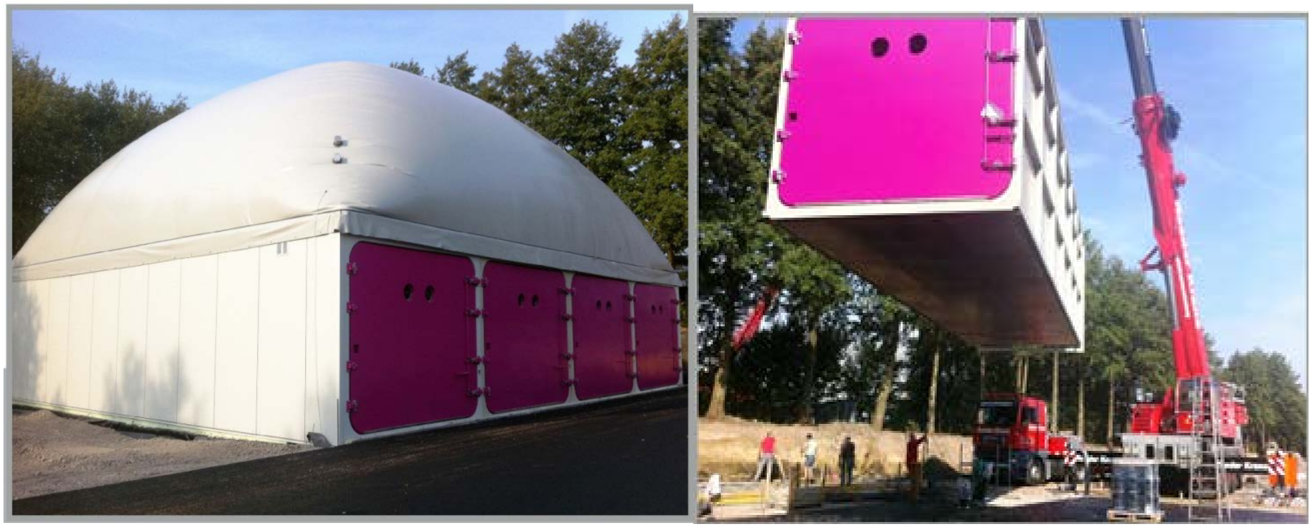


Figure 4.6: Field-assembly of Bad Oeynhausen, Germany Digester

The biogas produced contains about 60% methane and low levels of contaminants. It is combusted without pre-treatment in a 2G Cenergy 100 kW CHP generator. Heat is recovered from both the engine jacket and the exhaust air stream.

The digestate removed from the reactor meets the USEPA standard for the beneficial use of sewage sludge (Process to Further Reduce Pathogens [PFRP] at 40 CFR Part 503) which has become the surrogate measure of pathogen inactivation in many food scraps organics recycling facilities. The digestate is composted in turned windrows for market maturation for a period of several weeks. The finished compost is sold to homeowners and landscaping companies.

The Bad Oeynhausen facility was constructed in 2011 for a capital cost of $2.2 million and has an operating cost of approximately $15/ton. The first American SMARTFERM system is under construction in Monterey, CA and is expected to come on-line in January 2013. The SMARTFERM technology is available from Zero Waste Energy Development in Lafayette, CA (www.zerowasteenergy.com).

Summary

Based on the evaluation of the different organics recycling technologies in this report, it is suggested that KPB use an enclosed ASP system such as the ECS CV Composter. It is cold weather compatible (not season dependent), bear and animal proof, and is suitable for the KPB feedstocks. Table 4.1 on the following page contains a quick reference technology evaluation matrix.

Table 4.1: Technology Evaluation Matrix

Technology Characteristics	Turned Windrow	Aerated Static Pile (ASP)	Enclosed ASP	In-vessel Rotary Drum	Anaerobic Digestion
Cold Weather Compatible	No	No	Yes	Yes	Yes
Bear/Animal Proof	No	No	Yes	Yes	Yes
Suitability for KPB Feedstocks	Poor	High	High	High	High
Batch or Continuous	Continuous	Batch	Batch	Continuous	Either
Seasonal	Yes	Yes	No	No	No
Infrastructure Requirements[19]	Land Area	Land Area	Land Area and/or Building	Building and/or Land Area	Flammable Gas Management
Expansion Ability	Expand Size of Base Pad	Build More Piles	Increase Building Size/Additional Units	Limited Without Multiple Units	Additional Units
Ease of Operation	High	Medium	Medium	Medium	Low
Relative Capitol Cost	Low	Medium	High	High	High
Typical Technology Sizing (Capacity)	4,000 CY /year per acre	4,000 CY /year per acre?	40 CY or 50 CY sized Units	Capacity Starts at 4 CY/day	4,500 tons/year – 73,000 tons/year

Table 4.2: Total Estimated Available Feedstock Tonnage per Year in KPB

Site Location	Tonnage
Seward Transfer Station*	686.52
Homer Transfer Station	2,347.09
Central Peninsula Landfill	11,600.07
Total:	14,022.16

**Seward Transfer Station amounts are already included in CPL's number and are omitted from the total row with the exception of woody wastes.*

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[19] Other than normal infrastructure needs of power, water, sewer, and store water management

Chapter 5 –
Siting Evaluation

Introduction

This chapter focuses on an evaluation of sites to potentially locate an organics recycling facility in the Borough. The Kenai Peninsula Borough (KPB) owns over 1,500 parcels of land within the Borough. The site evaluation was limited to borough owned lands, as it was believed that a suitable site(s) could be found within that inventory of sites. The land was evaluated for adequacy regarding size, proximity to sensitive receptors, environmental features, and site topography, with the goal of identifying any issues that might cause permitting or implementation constraints to a proposed site and recommending alternatives to remove those constraints.

Composting Facility Siting Criteria

Siting a composting facility properly is one of the key factors in ensuring the development of a successful facility. Arguably, poor site selection is the principal cause of many failed composting facilities. Siting must consider factors that include environmental features, such as proximity to sensitive natural and human resources, as well as infrastructure-related issues including availability of utilities, road access, and zoning constraints. The KPB GIS department assisted in analyzing the Borough owned lands by applying search/selection criteria to all such parcels included in the borough's GIS database. Parcels meeting the following criteria were selected for further analysis.

Search/Selection Criteria

- Minimum parcel size:
  - Soldotna – 5 acres
  - Homer – 1.4 acres
  - Seward – 0.8 acres
- Not in the 100-year floodplain
- Not in "Lowland Wetlands"
- At least 1,000 ft distant of any churches, parks, hospitals, shopping centers, etc.
- At least 1,000 ft distant from any homes
- At Least 50 ft from any property line, well, or stream
- Not located in any "Local Option Zoning" areas
- Not in any KPB Habitat Protection Areas
- Within 20 miles of Soldotna

* Within 10 miles of Seward
* Within 12 miles of Homer

Some states in the U.S. require additional criteria such as wind speed and direction, and groundwater proximity and quality. As these are not required in the state of Alaska, these additional criteria were not considered in this siting evaluation.

An important point about siting criteria is that "out-of-sight, out-of-mind" is often true about composting facilities. This is not to suggest that remoteness of a location allows for improper facility operation, but rather that "people smell with their eyes" and a dense buffer surrounding a site is preferable.

Methodology

With the help of the KPB GIS department, multiple site locations were found. These possible locations were found by limiting the searchable area and only considering Borough owned land. The "Overview" maps in the Appendix show the search areas from the Soldotna, Seward, and Homer areas, respectively.

For this study, the Borough GIS group considered any property with improvements valued over $5,000.00 to be a residence to further reduce possible properties and meet the "1,000 ft. distance from homes" criteria. This constraint removed some of the existing transfer stations and landfill sites; subsequently they were added back into the list of site locations under consideration due to the compatibility of the existing land use.

Two possible site locations were found in Seward, five in Homer, and six in the Soldotna/Kenai area. These site possibilities will be further described in the next section. Composting facility sites were not considered for remote areas such as Tyonek, English Bay, and Seldovia or for areas such as Hope, Moose Pass, Cooper Landing or other unincorporated communities that are on the road system. Those areas either do not have adequate population to generate enough SSO to justify a small facility, or they are too far away from other sites to make it practical to haul SSO to them from other areas.

Description of Sites

Kenai/Soldotna

The Kasilof transfer site, Funny River Road transfer site, Sterling transfer site, and the Nikiski transfer site were removed as possibilities due to their remoteness from the main population of the area. Other than their remoteness, these four locations were suitable, and met the criteria.

The Central Peninsula Landfill and the Kenai transfer station were found to be suitable. They both met the criteria of not being in the floodplain; lack of lowland wetlands; adequate land for a composting facility; enough distance from homes, public gathering areas, property lines, wells, and streams; not located in a "Local Option Zoning" area; and not in a habitat protection area. The Kenai transfer site is located in an area that makes it publically accessible to a large portion of the population, as is the case for the Central Peninsula Landfill site.

Homer

In Homer, the Bluegrass Street Parcel, and the North Fork Road Parcel were removed as potential candidates due to their remoteness to the main population.

The Old Sterling Hwy. Parcel in Homer is suitable with the exception of a few reservations. This parcel meets the requirements of minimum acreage, not in the wetlands or floodplain, and zoning, but the adjoining property on the north side contains a residence which is less than 1,000 ft. away. The property itself is only about 660 ft. by 660 ft. consequently building in the most-distant south corner would still not provide the needed 1,000 ft. distance making this property an inadequate site location for a composting facility.

The Diamond Ridge Road Parcel in Homer was also found to be suitable but is not an option owing to the fact that this property is currently reserved for the site of a new fire station. Additionally if residences were to be built on the adjacent properties, the 1,000 ft. minimum setback distance would not be met.

The Homer Landfill/Transfer Site is the most suitable site location in Homer. The challenge with this location is that most of the land that is not in the lowland wetlands is already built on or is part of the old landfill. There is a 3 acre section on the north part of this parcel that is suitable and meets all criteria and would be the optimal location for a composting facility for the Homer area.

Seward

The Old Exit Glacier Road Parcel in Seward was found to not be a suitable location. If properties surrounding this site were developed the 1,000 ft. minimum distance requirement would not be met because of the narrowness of this parcel.

The Seward Transfer Site Parcel is the most suitable location for a composting facility in Seward. This site meets the listed criteria of not being in the floodplain; lowland wetlands; contain enough land for a composting facility; enough distance from homes, public gathering areas, property lines, wells, and streams; not located in a "Local Option Zoning" area; and not in a habitat protection area.

Summary

The above Borough owned sites were reviewed and evaluated with regard to their potential suitability as a site for a composting facility handling yard trimmings, land clearing debris, food scraps, sewage sludge, or a combination of those feedstocks. The use of sewage sludge as a feedstock is only viable for a Borough-wide facility, not for a pilot-scale facility. The sites were evaluated based on the GIS data provided by KPB.

Of the sites that were evaluated, the Central Peninsula Landfill is the most suitable site for a composting facility in the Soldotna/Kenai area, with the Kenai Transfer Station being the second most suitable option. For the Homer area, the Homer Landfill/Transfer Station is the recommended location for a composting facility. For the Seward area, the Seward Transfer Station is the suggested site for a composting facility.

Chapter 6 –
Permits and Approvals

Introduction

This chapter discusses the regulations and permitting required for an organics recycling facility in the KPB. Discussions with the Alaska Department of Environmental Conservation (ADEC) and local City officials gave clarification on required permit and zoning needs. There are currently no solid waste digestion or source-separated organic solid waste processing regulations in Alaska.

ADEC

There are very few regulations related to composting, but composting falls under 18 AAC Chapter 60 – Solid Waste Management, specifically 18 AAC 60.010 (h) which applies to facilities used to store more than 50 tons of solid waste before disposal. Regulations only require the operator of a facility to meet specified requirements if ADEC finds that the facility is causing or contributing to a nuisance.[20] 18 AAC 60.010 (e) allows disposal of organic waste from a commercial slaughterhouse or fish processing waste by applying the waste to agricultural land for soil enhancement purposes with specific conditions of placement. Solid waste permit requirements are required per 18 AAC 60.200. Under the list of exemptions 18 AAC 60.200 (a) (9) provides exemptions for 'a reuse, recycling, or source recovery facility unless the department determines that the facility is causing or is likely to cause excessive odor or other problems such as combustion, blowing litter, water quality degradation, or vermin attraction'. 18 AAC 60.200 (a) (12) provides exemptions for fish waste disposal under 18 AAC 60.010 (e). Excerpts from 18 AAC 60 are attached in appendix A.

If site development disturbs more than one acre, construction of the project falls under the EPA's Construction General Permit. Preparation of a Storm Water Pollution Prevention Plan (SWPPP) is required as well as filing a Notice of Intent (NOI). The NOI must be filed with EPA at least seven days before construction begins. If more than five acres is disturbed, the SWPPP must be submitted to ADEC for review, and a plan review fee is required per 18 ACC 72.995 Table D.

Plan review is not required if storm water is not collected or treated. If storm water is collected, a storm water discharge permit is required and plans must be submitted for review

[20] Phone Interview, Ms. Rebecca Colvin, Program Director, ADEC, Solid Waste Program, February 28, 2013

per 18 ACC 72.600.[21] For example, the Golden Heart Utilities Composting Facility (GHUCF), which composts biosolids, does have a storm water permit. The composting yard is sloped to keep all storm water and leachate on the property. The asphalt composting pads (320'x160') and storage pad (400' long) have a 2 degree slope to keep all leachate and storm water on the property. The pads drain into a centrally located drainage ditch which ties into the wastewater treatment plant via piping. GHUFC uses aerated static piles to compost year round.[22] Depending on the final site(s) selected and the proximity to receiving streams, KPB Solid Waste may wish to include a collected storm water management system in the facility's final design. Runoff from composting facilities handling food wastes can contain significant levels of nutrients, biological oxygen demand (BOD), chemical oxygen demand (COD), and coliform bacteria.

City of Kenai

The Kenai Borough 'Firewise site', located on KPB parcel # 04301036, has been identified as a potential site for an Organics Recycling Facility. The parcel is zoned for Recreation by the City of Kenai and the City will require a Conditional Use Permit (CUP) for an organics recycling facility to be located on the site. To process a CUP through the Commission it takes a minimum of 5 weeks. An application must be submitted 3 weeks prior to a Commission Meeting. Following the Commission Meeting there is a 15 day appeal period. If there is an appeal, it will be put to the Council acting as the Board of Adjustment. This process can take an additional 60+ days.[23]

City of Homer

The Homer Transfer Station, located on KPB parcels #17367004, #17316056, and #17316057, has been identified as a potential site for an organics recycling facility. As this sites' current function is similar to organics recycling there are no required permits from the City of Homer. If the organics recycling facility was to be located elsewhere a Conditional Use Permit might be required.[24]

City of Seward

The Seward Transfer Site, located on KPB parcel #14424004, has been identified as a potential site for an organics recycling facility. The property does fall in the City Limits, but there are no zoning permits required as the current land use is comparable to organics recycling. If a

[21] Phone Interview, Mr. William Ashton, Storm Water & Wetlands Engineer, ADEC, Storm Water Program, March 5, 2013
[22] Phone Interview, Mr. Scott Creel, Composting Facility Foreman, Golden Heart Utilities, March 7, 2013
[23] Personal communication, Ms. Marilyn Kebschull, Planning Administration, City of Kenai, March 4, 2013
[24] Phone Interview, Mr. Travis Brown, Planning Clerk, City of Homer, March 12, 2013

building is built for the composting facility a building permit is required and may include further permits pertaining to utilities and a floodplain review.[25]

[25] Phone Interview, Mr. Dwayne Atwood, Planning Technician, City of Seward, March 12, 2013

Chapter 7 –
Cost Estimates

Introduction

The purpose of this work was to develop preliminary, planning level estimates of capital and operating costs based on costs of similar facilities elsewhere. The capital costs for organics recycling facilities are similar to those for any solid waste management facility: land acquisition, site development, buildings, roadways, fencing and security, and materials handling equipment. As organics recycling involves biological processes to convert wastes to energy and/or soil amendments, there is also a technology cost. Composting and anaerobic digestion, the two processes evaluated in this study, can be done with generic approaches, or with technologies purchased from vendors.

Operating costs for organics recycling facilities will include labor, fuel, electricity, equipment maintenance, disposal of unprocessable materials, product marketing, product sales, and, possibly, acquiring feedstocks. There may not be enough woody wastes in the KPB solid waste stream to support a facility and it may be necessary to purchase wood chips, sawdust, and similar carbonaceous materials.

In addition to the costs for the facility itself, there will also be costs involved in collecting and transporting organic wastes to the facility. This task report explores some of these issues as they relate to the feasibility study and will be explored further in a subsequent task.

Cost Estimates

Collection Costs

There are three main alternative methods for organic wastes (food scraps, soiled paper, yard trimmings, etc.) to get to a new organics recycling facility:

- Citizens and businesses drop off their wastes at KPB transfer sites and stations into dedicated 20-CY roll-offs (or smaller) similar to the ones now used for garbage
- Alaska Waste (the primary private-sector trash hauler in KPB) or KPB Solid Waste expands to offer curbside residential and commercial collection of source-separated organics (SSO)
- Alaska Waste or KPB Solid Waste initiates curbside collection of residential and commercial SSO co-collected with trash in something similar to the "Blue Bag Organics" program in Minnesota.

For the drop-off alternative, KPB citizens and businesses would bring their SSO to a transfer site or station and KPB would have its hauler bring the roll-off to the composting facility. If KPB built a centralized compost facility at, or near, the CPL landfill, the estimated costs for this alternative are shown in Table 7.1. It is assumed that SSO roll-offs would be pulled weekly from the larger transfer facilities, and bi-weekly from the more remote transfer sites.

Table 7.1. Costs for SSO Drop-off

Haul Route	Unit Cost (per pull)	Pulls/Year	Total Annual Cost
Kenai TS to CPL	$65.56	52	$3,409.12
Homer TS to CPL	$787.50	52	$40,950.00
Seward TS to CPL	$900.00	52	$46,800.00
Nikiski TS to CPL	$105.38	52	$5,479.76
Anchor Point to CPL	$700.00	26	$18,200.00
Cooper Landing to CPL	$187.81	26	$4,883.06
Crown Point to CPL	$279.32	26	$7,262.32
Funny River to CPL	$95.59	26	$2,485.34
Hope to CPL	$297.12	26	$7,257.12
Kasilof to CPL	$78.77	26	$2,048.02
McNeil Canyon to CPL	$1,137.50	26	$29,575.00
Ninilchik to CPL	$159.12	26	$4,137.12

Alaska Waste now provides curbside residential and commercial waste collection services in the Borough, concentrated mostly in the areas of Kenai, Soldotna, Seward, and Homer. Their rates vary for weekly residential service from $28.71/month to $33.02/month for "within City limits" to $27.90/month to $32.09/month for "outside City limits". Their rates for commercial pickup vary with collection container size, pickup frequency, and location relative to City limits. For a weekly pickup of a 3 CY container, their fee varies from $96.78/month "within City limits" to $94.05/month "outside City limits"[26].

It is not known if they would be willing to start a parallel collection service for SSO, or whether KPB citizens and businesses would be willing to pay a fee for such a service. In other communities that have implemented SSO diversion, residential trash pickup frequencies are often reduced to bi-weekly (with weekly SSO pickup) and commercial accounts can reduce the size and pick-up frequency of their trash dumpster or compactor. These changes in collection frequency and container size can often offset the cost of SSO diversion, but bi-weekly residential trash collection has been reported to cause customer concerns about putrescible wastes like dirty diapers.

If Alaska Waste were not willing to offer SSO collection, KPB Solid Waste could consider offering that service to Borough residents. Based on rate studies of SSO diversion elsewhere, this service could cost approximately $5.53 per participating household per month[27]. If the service were concentrated in the cities of Kenai, Soldotna, Homer and Seward, the potential annual costs for this are shown in Table 7.2.

As noted earlier, a few communities are now opting for co-collection of SSO with trash. In the Blue Bag Organics program in Minnesota, residents pay for the service, and receive a collection container and 60 compostable plastic bags. The cost of the service is a function of the haul distance to the Materials Recovery Facility (MRF). As KPB does not have a MRF where the SSO could be separated and diverted to an organics recycling facility, this option may be difficult to implement.

[26] Rates taken from Alaska Waste website at http://www.alaskawaste.net/

[27] Goldsmith, A., "Source Separated Organics Collection Model – Projecting the Impact in Your Community", presented at the 2012 Southeast Food Waste Reduction Conference

Table 7.2. Annual Cost for Residential SSO Collection

City	Households (2010)	Participating HH (assume 50%)	Cost per Month	Cost per Year
Homer	2,235	1,118	$5.53	$74, 190
Kenai	2,809	1,405	$5.53	$93,240
Seward	928	464	$5.53	$30,790
Soldotna	1,720	860	$5.53	$57,070
Total				$225,290

Total commercial collection costs are difficult to estimate as there are substantial variations in commercial prices charged by haulers depending on location, type of containers leased, type and weight of waste requiring collection, proximity to other generators, collection frequency, length of contracted service, collection fleet available, and the contract terms. Assuming the cost to KPB Solid Waste would be roughly equal to the monthly fee charged by Alaska Waste for weekly pickup of a 3 CY container ($90/month), and assuming that 50% of the approximately 250 businesses in the "Accommodations and Food Service" economic category[28] participate, annual costs for commercial SSO diversion would be about $135,000.

Alaska Waste estimated the cost of a 6 CY bear proof container with shipping at $3,500. The cost for container rental and weekly pick up is $160/month. Alaska Waste could potentially pick up 25, 6 CY containers in one day in the Kenai/Soldotna area. The organic containers would be picked up once per week. An existing truck would be used to haul the source separated organic material (SSO), and would be washed out prior to hauling organics and afterwards. The truck available for use holds 30 CY and achieves between a 3: to 5:1 compaction ratio, making them capable of hauling 90 - 150 bulk CY of SSO[29]. The compaction of SSO is not recommended as the fruit/vegetable/food releases its water and makes a run-off that can be dangerous on the road system. The use of a roll-off truck is recommended over a compaction truck.

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[28] Kenai Peninsula Borough Economic Census, at http://www2.borough.kenai.ak.us/Econ/1s_p%20data/Economic%20Census/AccommodateFood.htm

[29] Personal Communication, Mr. Dennis Smith, Local Alaska Waste Manager, February 8, 2013

Composting Facility Costs

Capital costs for a composting facility to recycle SSO vary widely, depending, in large part, on the need for, and extent of, higher levels of technological process and environmental controls. As noted in the Task 3 Technology Alternatives report, open-air windrow composting is the least expensive form of composting, but is considered unacceptable for implementation in KPB due to weather and wildlife concerns. The recommendation in that task report was for some form of enclosed or containerized composting system.

This type of system can be constructed by KPB using well-proven composting technologies, such as the aerated composting bins pictured in Figure 4.0. Alternatively, KPB can purchase an engineered system from one of several vendors (Engineered Compost Systems, Green Mountain Technologies, XAct Systems, among others). Vendor-supplied technologies can be more expensive than the generic approach. Both alternatives are presented in this report.

The project team developed preliminary capital and operating cost estimates for the three aerated compost bin configurations presented in Chapter 4 (one for the Seward area, one for the Homer area, and one for the Kenai/Sodotna area). This approach would have all processing steps enclosed in a building, with an induced-draft aerated static pile composting approach with air treatment by biofiltration. Operating cost estimates do not include costs for purchased wood chips, as no source of wood chips in KPB could be found. These estimates are summarized in Table 7.3 and detailed calculations are in the Appendix. Similarly, these three alternatives were costed out using Engineered Compost System's CV or SV composting system (see Task 3 report). Those estimates are presented in Table 7.4.

Table 7.3: Preliminary Capital and Operating Costs for Generic ASP Systems

Facility	Capacity (tons/year)		Capital Cost Estimate ($)	Equipment Cost Estimate	Operating Cost Estimate ($/ton)
	SSO	Greenwaste			
Seward Area	600	500	$1,853,000	$223,400	$31.06
Homer Area	1,400	1,000	$3,025,000	$303,000	$24.14
Kenai/Soldotna Areas	8,500	5,000	$12,125,000	$426,000	$16.02

Table 7.4: Preliminary Capital and Operating Costs for ECS CV/SV Systems

Facility	Capacity (tons/year)		Capital Cost Estimate ($)	Equipment Cost Estimate	Operating Cost Estimate ($/ton)
	SSO	Greenwaste			
Seward Area	600	500	$2,265,000	$223,400	$48.29
Homer Area	1,400	1,000	$4,380,000	$303,000	$38.65
Kenai/Soldotna Areas	8,500	5,000	$6,283,500	$426,000	$18.45

KPB Costs

The cost for the KPB solid waste management facilities in FY 2013 were estimated at $2,358,517 for the Central Peninsula Landfill, $616,467 for the Seward Transfer Facility, and $1,396,509 for the Homer Baler. These department totals do not include Solid Waste Debt Service Payments or Solid Waste Capital Projects.[30]

Historically capital projects for KPB Solid Waste are funded from the sale of bonds with the debt service being paid for by the general fund, but they have been successful in obtaining grants for capital construction. Tipping fees and other revenue help offset the operating transfer required from the general fund. Thus, it is currently undeterminable to define how the composting facility will be funded. The impact on tax payers is uncertain as the impact on taxes is figured from the mill rate equivalency, and each fiscal year the Borough determines what the mill rate equivalency for operating transfer from the general fund is for the solid waste department. For Fiscal Year 2013, the mill rate equivalency is 1.20.

Anaerobic Digestion Facility Costs

Previous tasks in this project have examined the potential to extract a renewable energy resource from the SSO prior to producing compost. Like composting, anaerobic digestion (AD) facilities can be generic or purchased from a vendor. The generic AD designs are traditionally liquid digesters, like those found on farms for livestock manure digestion. Solid waste digesters (also known as dry fermenters) are a late-20th century European technology and are only

[30] Personal communication, Mr. Jack Maryott, Solid Waste Director, KPB, February 5, 2013

available from project developers, who offer the technology in a design-build or design-build-operate business model.

One dry fermentation AD project developer, Zero Waste Energy (Lafayette, CA) offers the Eggersmann KompoFerm and SmartFerm combination AD and composting systems. The SmartFerm system is sized in 5,000 ton/year increments. A 5,000 ton/year system has a capital cost of $2,125,000 and estimated operating costs of $15.00 per ton. Equipped with a combined heat-and-power generator to burn biogas, it would produce 650,000 kilowatt-hours/year of electricity.

Chapter 8 –
Alternatives Evaluation

Introduction

This chapter focuses on taking the results of all previous tasks and developing a set of nine preliminary conceptual organics recycling alternatives. The alternatives are combinations of feedstocks, sites, technologies, and markets. These alternatives were evaluated using a weighted matrix criteria technique.

Methodology

The weighted criteria matrix is a decision-making tool that was used to evaluate alternatives based on specific evaluation criteria weighted by importance. By evaluating alternatives based on their performance with respect to individual criteria, a value for the alternative was identified. The values for each alternative were then compared to create a rank order of their performance related to the criteria as a whole. This tool is important because it treats the criteria independently, helping avoid the over-influence or emphasis on specific individual criteria. The evaluation criteria were developed by staff and the importance weighing factors assigned by Kenai Peninsula Borough personnel.

Alternatives

Alternatives were defined by the constraints of geography, weather, wildlife and existing solid waste infrastructure. Other constraints included:

- The availability of adequate amounts of carbon (woody material) to support the composting of food and/or seafood wastes. Golden Heart Utilities composting facility in Fairbanks faces this same challenge, but they are able to purchase spruce and birch wood chips from Northland Wood for $24.50/yd[31].
- The long hauling time from Seward and Homer to the Kenai/Soldotna area.
- The solid waste collection infrastructure is oriented toward drop-off programs at transfer stations or convenience centers more than curbside pickup of commercial and/or residential solid waste.
- The market for compost is currently limited and will need time and effort to stimulate.
- The market for recovered energy is potentially more robust given Homer Electric's net metering program.

[31] Phone interview, Mr. Scott Creel, Composting Facility Foreman, Golden Heart Utilities, March 13, 2013

The list of alternatives is outlined in Table 8.1. The Alternatives were derived from Feedstock (Task 1), Market (Task 2), Technology (Task 3), Siting (Task-4), Cost (Task 5) and Permitting Requirements (Task 6).

Task 1 Feedstock Characterization

Feedstock Characterization was determined in Task 1. Potential feedstocks include food scraps, woody wastes, fish processing wastes and municipal sewage sludge.

Task 2 Market Characterization

A preliminary Market Characterization was defined in Task 2. The most likely primary sales market for compost in the Kenai Peninsula Borough was determined to be relatively small quantity use by individual consumers for residential and commercial landscaping and gardening. There also appears to be a potential market for biogas from anaerobic digestion, where the gas is used as a substitute for natural gas heat buildings or fuel a fleet of vehicles or burned in a generator to produce electricity, which can be fed into the local power grid.

Task 3 Technology Evaluation

Available and Applicable Technology were evaluated in Task 3. An enclosed Aerated Static Pile Technology, similar to the ECS CV system was recommended for this systems suitability for cold climate use, resistance to animal intrusion and scalability. Aerated static piles in the form or windrows were determined to be unsuitable for year round cold climate use.

Since preparation of the Task 3 draft report, a potential limited use of the Windrow or Passive Aerated Static Pile technology has appeared. It is estimated that the Kenai River salmon dip-net fishery generates up to 400,000 lbs. of fish waste (heads & guts) annually during the month of July. Currently the fish waste is discharged into the tidal zone at the mouth of the Kenai River. The concentrated discharge has resulted in an aesthetic and sanitation problem, noted by entities including the City of Kenai and the Alaska Department of Environmental Conservation. One means proposed to mitigate the fish waste problem is to collect the waste from the beach, haul it to an upland location with a ready source of deadwood timber that can be ground into chips, mixed with the fish waste and composted. Since the source of fish waste is seasonal and the composting process could occur during July and August, a Windrow or Passive Aerated Static Pile might be feasible.

Task 4 Siting Evaluation

Potential locations for an Organics Recycling/Composting facility were evaluated in Task 4. The Kenai Peninsula Borough GIS system was used to evaluate potential sites from a list of Borough-owned properties, across the full extent of the Borough.

Task 5 – Cost Estimates

Cost Estimates derived under Task 5 were used to determine relative capital costs, operational costs and hauling costs for various alternatives.

Task 6- Permitting Analysis

Permitting requirements for various types of facilities and for various locations (i.e. inside City Limits vs. outside) were studied in Task 6.

A rigid evaluation against these constraining and defining elements does not adequately differentiate between technologies that should be considered further. Therefore, additional evaluation criteria were selected for use in this project and the rationale for scoring against each criterion is presented below.

Each of these evaluation criteria was assigned a “weighting factor”, a numerical value between 1 and 5, where 1 meant it was not an important criterion, 3 meant it was neither an important nor an unimportant criterion and 5 meant it was a very important criterion. The weighting factors used for each criterion were assigned by KPB staff and are shown in Table 8.2.

Given the constraints above, the potential alternative considerations include:

- Collection alternatives –
    - A pick-up service by a private hauler paid for by a customer-paid service fee or paid for by KPB General Fund
    - A KPB –owned/operated pick-up service paid for by a customer-paid service fee or paid for by KPB General Fund
    - A drop-off system using dedicated appropriate collection containers at the Homer Transfer Station (TS), the Seward TS, the Kenai TS and/or the Central Landfill in Soldotna
- Processing alternatives –
    - # 1 - One facility, in Kenai/Soldotna area, using a combination of AD and in-vessel composting, sized for 10,000 tons/year of source-separated organics
    - # 2 – Same as # 1 but only in-vessel composting
    - # 3 – Smaller composting (only) systems serving Homer (1,500 tons/yr), Seward (600 tons/year) and Kenai/Soldotna (8,000 tons/year) using either invessel or aerated static bin composting
    - # 4 – A demonstration-scale composting project (or projects) that could include one at Homer (170 tons/yr) and/or one in Kenai for seasonal fish waste (50 ton/yr), using aerated static bin composting (either active or passive)
- Technology alternatives –
    - AD – dry fermentation, i.e. Eggessmann’s SmartFerm system
    - Composting – in-vessel with ECS CV or SV system; aerated compost bins
- Siting Alternatives –
    - Homer – Homer TS

- Kenai – Firewise Site
- Soldotna – Central Peninsula Landfill
- Seward – Seward TS

- Product alternatives –
  - Recovered energy – electricity production through CHP generator, electricity used behind-the-meter by KPB Solid Waste, excess sold back to Homer Electric
  - Compost – landscaping/gardening market in KPB, possible use as alternative daily cover in CP landfill until market develops, export to Anchorage market

Alternatives that were evaluated are shown in Table 8.1.

Table 8.1: Alternatives

Alt.	Where	Size	Feedstock	Collection	Processing	Technology	Market
1	CPL	10,000 Ton/Yr	All	Private	AD+IVC	SmartFerm + ECS	Electricity +compost
2	CPL	10,000 Ton/Yr	All	Private	IVC only	ECS SV	Compost
3	CPL	10,000 Ton/Yr	All	KPB	AD+IVC	SmartFerm + ECS	Electricity +compost
4	CPL	10,000 Ton/Yr	All	KPB	IVC only	ECS SV	Compost
5	Homer TS	1,500 Ton/Yr	Food only	Drop-off	IVC only	ECS CV, aerated bin	Compost
6	Seward TS	600 Ton/Yr	Food only	Drop-off	IVC only	ECS CV, aerated bin	Compost
7	CPL	8,000 Ton/Yr	All	Drop-off	IVC only	ECS CV, aerated bin	Compost
8	Homer TS	Demo - 85 T/Y	Food only	Drop-off	IVC only	ECS CV, aerated bin	Compost
9	Kenai TS	Demo - 250 T/Y	Seasonal fish waste	Drop-off	IVC only	Aerated Static Pile	Compost

Evaluation Criteria

All alternatives can reliably produce a stable compost product from SSO, can be expanded to meet increased feedstock quantities, and are capable of cold weather operation. A rigid evaluation against these constraining and defining elements does not adequately differentiate between the alternatives that should be considered further. Therefore, additional evaluation criteria were selected for use in this study. Rational for scoring against each criterion is presented in Table 8.2.

The evaluation criteria selected for use in this assessment of alternatives includes:

Feedstocks

- Flexibility to handle different feedstocks – as noted above, the primary "capturable" feedstocks are food scraps, seafood wastes and sewage sludge, but as there are no composting/AD facilities in KPB, developing the first one may attract other compostable materials not evaluated in this project. An alternative with more flexibility to accept different material from different sources would score higher.

- Carbon/woody amendment demand – as it is unclear if there is enough carbonaceous amendment (i.e. yard trimmings, vegetative clearing debris, agricultural residuals, etc.) available in KPB to support composting, those alternatives needing less amendment would score higher.

Collection and Transport

- Participation rate – as the implementation of a source separated organics diversion program will be voluntary, those alternative that have greater influence over larger numbers of people would score higher.

- Contamination prevention – improperly segregated organics have higher contamination rates with the presence of plastics and inert substances, which cost money to remove. Those alternatives with potentially higher segregation quality would score higher.

- Hauling distances – those alternatives with shorter hauling distances would score higher.

Implementation Criteria

- Similar facilities in AK – alternatives similar in scale and scope to other facilities in Alaska would score higher.

- Time to implement – alternatives that could be implemented more quickly would score higher.

- Local permits and approvals – alternatives that need fewer local permits and approvals would score higher.

- State permits and approvals – alternatives that need fewer state permits and approvals would score higher.

Costs

- Capital costs – alternatives that had less capital cost would score higher.
- Operating costs – alternatives that had less operating cost would score higher.
- Maintainability – alternatives that would be easier to maintain would score higher.

Markets

- Recovered energy – alternatives that returned a financial benefit from the sale of recovered energy would score higher.
- Compost – as the markets for compost sales in KPB are untested, alternatives producing smaller amounts of compost would score higher.

Aesthetic/Environmental

- Potential for odor episodes – alternatives with less potential for odor episodes would score higher
- Proximity to sensitive receptors – alternatives with farther distances to sensitive receptors would score higher.

Each of these evaluation criteria were assigned a "weighting factor", a numerical value between 1 and 5, where 1 meant it was not an important criterion, 3 meant it was neither an important nor an unimportant criterion and 5 meant it was an important criterion as presented in Table 8.2.

Table 8.2: Weighted Matrix Evaluation Criteria

Criteria Class	Evaluation Criteria	Weight Factor
Feedstocks	Flexibility to handle difference feedstocks	4
	Carbon/woody amendment demand	5
Collection and Transport	Participation rate	5
	Contamination prevention	4
	Hauling distance	4
Implementation Criteria	Similar facilities in AK	3
	Time to Implement	3

	Local permits & approvals	4
	State permits & approvals	4
Costs	Capital costs	5
	Operating costs	5
	Maintainability	4
Markets	Recovered energy	3
	Compost	5
Aesthetic/ Environmental	Potential for odor episodes	5
	Proximity to sensitive receptors	5

Alternative Scoring

For each of the evaluation criteria, a raw (i.e. un-weighted) score was assigned. Scoring was from 1 to 5, where 1 meant the alternative was least favorable with respect to the evaluation criterion and 5 meant it was most favorable. Raw scores are presented in Table 8.3. Scores were based on best professional judgment.

KPB staff assigned values between 1 and 5 to reflect a weighting importance for each evaluation criterion. These weighting factors were multiplied by the raw scores to produce weighted scores. The weighted scores for each alternative were then summed across all evaluation criteria to produce a total weighted score for each alternative. Table 8.4 contains the weighted scores.

Table 8.3: Raw Alternatives Evaluation Score

		1	2	3	4	5	6	7	8	9
Criteria Class	**Evaluation Criteria**	CPL 10k, private, IVC + AD	CPL 10k, Private, IVC	CPL 10k, KPB, IVC + AD	CPL 10k, KPB, IVC	Homer 1.5k	Seward 600	CPL 8k	Homer Demo	Fire wise Demo
Feedstocks	Flexibility to handle different feedstocks	4	5	4	5	4	3	4	2	2
	Carbon/woody amendment demand	1	1	1	1	4	4	2	5	5
Collection and Transport	Participation rate	4	4	5	5	3	3	3	3	3
	Contamination prevention	4	4	5	5	3	3	3	3	3
	Hauling distance	3	3	3	3	5	5	4	5	5
Implementation Criteria	Similar facilities in AK	3	3	3	3	5	5	4	5	5
	Time to implement	3	4	3	4	5	5	4	5	5
	Local permits &	5	5	5	5	4	4	5	3	2

	approvals									
	State permits & approvals	3	3	3	3	4	4	4	5	5
Costs	Capital costs	1	1	1	1	4	4	3	5	5
	Operating costs	4	4	4	4	3	2	4	5	5
	Maintainability	2	2	2	2	4	4	3	5	5
Markets	Recovered Energy	5	2	5	2	2	2	2	2	2
	Compost	2	2	2	2	4	5	3	5	5
Aesthetic/ Environmental	Potential for odor episodes	4	4	4	4	5	5	5	5	3
	Proximity to sensitive receptors	5	5	5	5	4	5	5	4	3

Table 8. 4: Weighted Alternatives Evaluation Score

			1	2	3	4	5	6	7	8	9
Criteria Class	**Evaluation Criteria**	**Weight Factor**	CPL 10k, private, IVC + AD	CPL 10k, Private, IVC	CPL 10k, KPB, IVC + AD	CPL 10k, KPB, IVC	Homer 1.5k	Seward 600	CPL 8k	Homer Demo	Fire wise Demo
Feedstocks	Flexibility to handle different feedstocks	4	16	20	16	20	16	12	16	8	8
	Carbon/woody amendment demand	5	5	5	5	5	20	20	10	25	25
Collection and Transport	Participation rate	5	20	20	25	25	15	15	15	15	15
	Contamination prevention	4	16	16	20	20	12	12	12	12	12
	Hauling distance	4	12	12	12	12	20	20	16	20	20
Implementation Criteria	Similar facilities in AK	3	9	9	9	9	15	15	12	15	15
	Time to implement	3	9	12	9	12	15	15	12	15	15
	Local permits &	4	20	20	20	20	16	16	20	12	8

	approvals										
	State permits & approvals	4	12	12	12	12	16	16	16	20	20
Costs	Capital costs	5	5	5	5	5	20	20	15	25	25
	Operating costs	5	20	20	20	20	15	10	20	25	25
	Maintainability	4	8	8	8	8	16	16	12	20	20
Markets	Recovered Energy	3	15	6	15	6	6	6	6	6	6
	Compost	3	10	10	10	10	20	25	15	25	25
Aesthetic/ Environmental	Potential for odor episodes	5	20	20	20	20	25	25	25	25	15
	Proximity to sensitive receptors	5	25	25	25	25	20	25	25	20	15
Total:				**222**	**220**	**231**	**229**	**267**	**268**	**247**	**288**

Summary

The highest scoring alternatives were:

Alternative	Total Weighted Score
Alt. 8 – Homer Area Demo (170 TPY)	288
Alt. 9 – Kenai/FireWise Demo (250 TPY)	269
Alt. 6 – Seward Transfer Sta. (600 TPY)	268
Alt. 5 – Homer Transfer Station (1,500 TPY)	267

Alternative 8 had the highest score, and the next three highest scoring alternatives were similarly scored. A small-scale demonstration project in the Homer area could accomplish several objectives:

- Provide a mechanism for food scraps diversion from an area of KPB that has high interest in diversion
- Verify that sources of woody carbon material can be sourced for use in composting
- Confirm that enclosed aerated static pile composting technology (such as the ECS CV Composter or the GMT Earth Flow) will work satisfactorily in KPB winter conditions
- Verify that a market exists for the compost in the Homer area

Alternative 9 would also accomplish several objectives, at potentially minor additional cost:

- Solve a seasonal fish waste problem that has potential environmental and tourism impacts
- Confirm that low-technology windrow composting may be suitable for warm season usage
- Verify that a market exists for the compost in the Kenai and Soldotna areas

Chapter 9 –
Recommendations

Introduction

The previous chapters of this report have detailed the work of this feasibility study. The evaluation of alternatives was conducted with regard to some of the issues, constraints, and opportunities identified during the course of this project and this chapter is focused on developing recommendations for future steps to be taken by KPB Solid Waste in the development of a SSO diversion strategy with its supporting organics recycling facility.

Due to uncertainties regarding adequate amounts of carbonaceous bulking agent amendment (woody wastes), the participation rate for a drop-off SSO diversion program, and the market demand for a compost product in the KPB, the alternatives analysis recommended that KPB develop two pilot programs, one for handling food scraps generated in the Homer area, and one for handling seasonal salmon run fish wastes in the Kenai area.

Homer Demonstration Project

The Homer area demonstration project would be based on a containerized aerated static pile technology, similar to the "CV Composter" sold by Engineered Compost Systems in Seattle, WA (ECS). The CV Composter resembles an ocean-going shipping container and operates as a batch system, where a 32-CY container is filled with SSO and carbon amendment and allowed to compost in the reactor for 25 days. After active composting, the material in the reactor would be cured/aged for another 60-90 days, and then screened to remove oversized particles from the finished compost.

The goals for the Homer pilot project would be:

1. Determine effectiveness/willingness of local population to separate organics and deliver them to the Compost Facility.
2. Determine effectiveness/willingness of local population to separate organics and deliver them one of several collection facilities, then cost to haul to Compost facility.
3. Determine actual availability of wood fiber delivered to the compost facility and then cost to grind up at the facility.
4. Determine effectiveness and cost to operate the CV Composter units(s).
5. Determine cost recovery, if any, resulting from selling finished compost.
6. Determine other associated costs for marketing, such as possible need to bag the compost vs. loading it into individuals' vehicles for self-delivery.

ECS provided an estimate for a full-scale (1,500 ton/year) composting facility in the Homer area and indicated it would require sixteen (16) CV Composter units to handle the volumes. Figure

4.2 is a photograph of the CV Composter system and Figure 9.1 is a schematic layout of the full-scale system.

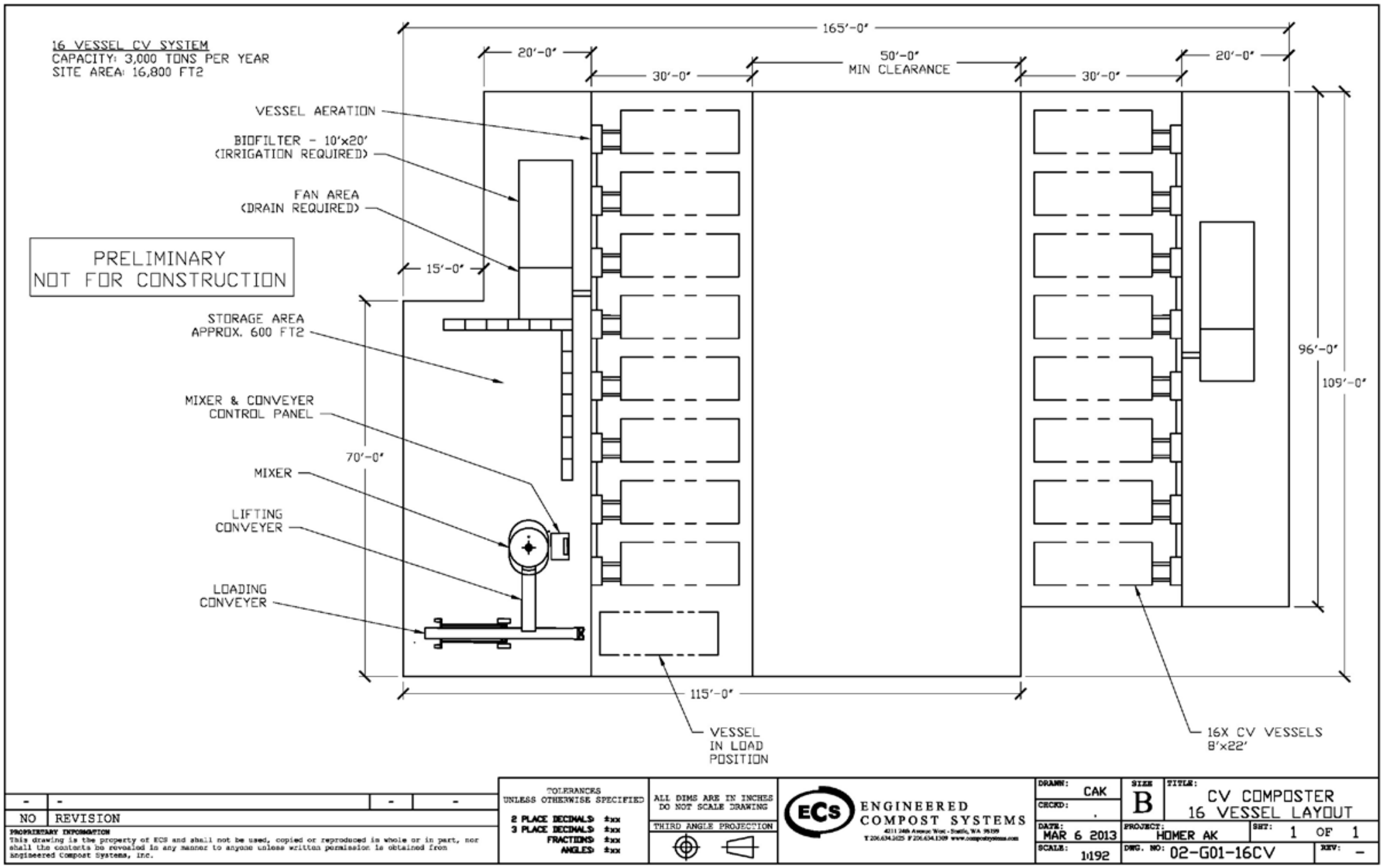
The proposed demonstration would be based on KPB acquiring two (2) CV Composter units, setting them up at the Homer Transfer Station/Balefill site, and installing dedicated SSO collection units at the Homer Transfer Station, the Anchor Point Transfer Site, the McNeil Canyon Transfer Site, and possibly the Ninilchik Transfer Site. The collection units would be pulled by KPB weekly, delivered to the Homer demonstration site and unloaded. Proportional amounts of SSO and ground-up carbonaceous bulking agent (mostly yard trimmings and wood chips) would be mixed by a combination mixer/reactor loading conveyor[32].

The composting recipe would combine SSO with a bulking agent at about a 3:1 ratio (on a volumetric basis), although that could be reduced if there is a lot of soiled paper in the diverted SSO. At a 3:1 ratio, the demonstration facility would need approximately 180 tons of woody material/yard trimmings per year (the recipe should be confirmed with laboratory analysis of representative samples during design). As noted in Chapter 1, the Homer Transfer Station receives approximately 400 tons of woody wastes per year, which could be used in this demonstration project.

Estimated capital costs for this demonstration project are shown in Table 9.1 and total about $900,000 for site improvements and $240,000 for equipment. Operating costs for the demonstration project are estimated at about $52,000 per year, consisting of $15,000 in labor costs, $23,000 in machine costs (fuel, maintenance, etc.), and about $14,000 per year in waste transport costs between the Homer site and the distant transfer sites. Detailed cost estimates are included in the Appendix.

[32] While it is possible to mix feedstocks for composting with mobile front end loaders, in the case of the ECS CV Composter system, the vendor has recommended against manual loading of the reactors with mobile loaders.

Figure 9.1 ECS Layout at Homer Transfer Station



Kenai Demonstration Project

Significant quantities of fish waste are also generated as a by-product of the sockeye salmon dipnet fishery which is centered at the mouth of the Kenai River. The City of Kenai has been tasked with disposal of fish waste in order to minimize beach contamination. The City estimates that approximately 500,000 lb. (250 tons) of fish waste is generated in July, during the month-long dipnet season. Current practice is to use a front end loader to scrape fish offal off the beach and push it out below the low tideline. The City has expressed willingness to load the fish waste into containers to facilitate offsite composting by others.

The Kenai Borough 'FireWise site', consisting of 31.1 acres located on KPB parcel # 04301036, has been identified as a potential site for an Organics Recycling Facility (see Figure 9.1 for an aerial photograph of the site). The parcel is zoned for Recreation by the City of Kenai and the City will require a Conditional Use Permit (CUP) for an organics recycling facility to be located on the site. If a CUP can be issued for this site, it may be a suitable site for handling both the seasonal fish waste, along with organics collected after the summer fishing season ends.

Table 9.1 Homer Demonstration Project Capital Costs

Assumptions						
1. Assume site requires 2' excavation & backfill						
2. Capacity is 170 ton/year food scraps + 210 tons/yr greenwaste						
3. ECS quote is for 2 vessel CV Composter system with mixer						
4. Assume site work for expansion to 8 CV Composter units						
Site size					0.5	ac
	Processing building footprint				0	SF
	ECS system footprint				12,000	SF
	Allowance for access roads, equipment maint.				5,000	SF
	Total area needed				17,000	SF
Components			Quantity	Unit	Unit Cost	Extended Cost
1. Processing Building			Not needed for demonstration project			
2. Services			Assume existing infrastructure can handle			
3. ECS Composting System, mixer & biofilter						
Per budget estimate						$ 384,000
Shipping - Seattle to Homer		estimate				$ 2,000
Installation fee - assume 50% of capital expense						$ 192,000
4. Sitework						
Clearing and Grubbing			0.4	ac	$ 7,000	$ 2,732
Unclassified Excavation			1259	cy	$ 4.00	$ 5,037
Gravel pads for outdoor areas		12" thick, compacted	630	cy	$ 22.00	$ 13,852
Concrete pads for ECS containers			150	SF	$ 12.00	$ 1,800
Asphalt pad for rest of ECS system			16,850	SF	$ 6.00	$ 101,100
Sediment/erosion control			allowance			$ 10,000
					Subtotal	$ 712,521
					Design @ 12%	$ 71,252
					Contingency @ 25%	$ 178,130
					Subtotal	$ 961,903
Equipment						
SSO Collection Containers		6 CY each	4		$ 3,500	$ 14,000
Loader	Volvo L70 (used)		1		$ 79,500	$ 79,500
2nd bucket	3 CY bucket	for product only	1		$ 6,500	$ 6,500
Screen	Trom 406 (used)		1		$ 47,900	$ 47,900
Grinder	Bandit 2600 horiz (used)		1		$ 89,500	$ 89,500
					Subtotal	$ 237,400

Figure 9.1 Kenai "FireWise" Site

A turned windrow composting operation on this site would require about 1,200 tons of woody carbonaceous bulking agents to balance the high nitrogen content of the fish wastes. The Central Peninsula Landfill reports receiving about 850 tons of woody wastes annually, so additional quantities would have to be located (no other sources of wood wastes could be identified during this project, however, Spenard Builders Supply has two large piles of sawdust on their site that might be available). A proposed recipe and sizing analysis is contained in the Appendix. As with the Homer demonstration project, the recipe should be confirmed with laboratory analysis of representative samples during design.

The composting facility would occupy about 9 acres of the available 31 acres, which would include a waste receipt area, area for the storage of enough ground woody material to handle the entire 250 tons of fish wastes, an active composting area, a curing area, and a product screening and storage area, with the storage area sized to hold one year's worth of compost (about 2,600 CY) and the screened-out overs (about 600 CY).

Capital cost estimates for this pilot project are shown in Table 9.2, which includes the same estimate for equipment as shown in Table 9.1 for the Homer project. In reality, that equipment could be shared between the two sites.

Table 9.2 Kenai Salmon Waste Composting Pilot Capital Cost Estimate

Assumptions						
1. Assume site requires no grading						
2. Capacity is 250 ton/year fish wastes + 1,200 tons/yr greenwaste						
3. Assume open-air turned windrow operation						
4. Assume all activities on graveled surface over geotextile fabric						
Site size					31.1	ac
	Composting area footprint				385,506	SF
	Allowance for access roads, equipment maint. (@ 20%)				77,101	SF
	Total area needed				462,607	SF
Components			Quantity	Unit	Unit Cost	Extended Cost
Geotextile Fabric			462,607	SF	$ 0.50	$ 231,304
Gravel pads for processing areas		12" thick, compacted	17,134	cy	$ 22.00	$ 376,939
Sediment/erosion control			allowance			$ 10,000
					Subtotal	**$ 618,243**
					Design @ 12%	**$ 74,189**
					Contingency @ 25%	**$ 154,561**
Equipment						
Loader	Volvo L70 (used)		1		$ 79,500	$ 79,500
2nd bucket	3 CY bucket	for product only	1		$ 6,500	
Screen	Trom 406 (used)		1		$ 47,900	$ 47,900
Grinder	Bandit 2600 horiz (used)		1		$ 89,500	$ 89,500
					Subtotal	**$ 223,400**

Operating expenses for the Kenai demo are difficult to project due to the seasonal nature of the feedstock, but most window composting systems operate in the $15-$20 per ton (incoming) range, which would suggest an annual operating cost of $22,500 to $30,000. In addition, there would likely be $10,000 - $15,000 in annual costs to KPB in support of the compost market development program to serve both demonstration sites.

An alternative demonstration project could be set up in partnership with a local non-profit organization, Matti's Ranch, where Blair Martin serves as the Executive Director. Mr. Martin has been working with City of Kenai officials to handle the fish wastes at his 20-acre farm in Kenai. KPB Solid Waste could investigate the possibility of a public-private partnership for this particular demonstration project before committing to improving the FireWise site.

Appendices

Process Design Calculations

Overview Siting Maps

Capital and Operating Cost Estimates

Recommendations

Process Design Calculations

- Central Peninsula Landfill (CPL) Facility Compost Recipe
- CPL Facility Process Flow Diagram
- CPL Facility Aerated Static Pile (ASP) System Sizing
- CPL Facility with Anaerobic Digestion Mass Balance
- CPL Facility Engineered Compost Systems (ECS) “SV Composter” System Sizing
- Homer Facility Compost Recipe
- Homer Facility Process Flow Diagram
- Homer Facility ASP System Sizing
- Homer Facility ECS “CV Composter” System Sizing
- Seward Facility Compost Recipe
- Seward Facility Process Flow Diagram
- Seward Facility ASP System Sizing
- Seward Facility ECS “CV Composter” System Sizing

COKER
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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	12/2/2012
Analysis	Recipe - CPL Composting Facility		

Assumptions:

1. Estimated current total tonnage of food scraps & seafood waste is	8,850	tons/yr
2. Assume facility is open 5 days/week		
3. Estimated daily tonnage of food scraps	34.0	tons/day

MIX RATIO CALCULATIONS - Daily

INGREDIENTS	Food Scraps	Carbon	Compost Recycle	Overs	TOTAL MIX	TARGET
C (% AS IS)	43.7	49.2	13.2	50.1		
N (% AS IS)	2.2	0.9	1.0	1.0		
MOISTURE%	71.5	40.1	45	45		
UNITS IN MIX BY WGT (T)	34.0	20.0	6.0	4.7	64.7	
UNITS IN MIX BY WGT (LB)	68,077	40,000	12,000	9,400	129,477	
UNITS IN MIX BY VOL (CY)	56.9	76.6	13.3	18.8	165.6	
DENSITY (LBS/CY)	1196	522.5	900	500		
POUNDS OF CARBON	29,750	19,664	1,584	4,709	55,707	
POUNDS OF NITROGEN	1,498	372	120	93	2,083	
C:N RATIO	19.86	52.86	13.20	50.61	**26.75**	20 TO 30
POUNDS OF MOISTURE	48,675	16,040	5,400	4,230	74,345	
NUMBER OF UNITS	68,077	40,000	12,000	9,400	129,477	
PERCENT MOISTURE					**57.42**	50 TO 65%
VOLATILE SOLIDS (%)	87.4%	98.3%	44.2%	98.3%		
VOLATILE SOLIDS (LBS)	59,499	39,320	5,304	9,240	113,363	
TOTAL MASS (LBS)	68,077	40,000	12,000	9,400	129,477	
MIX VS (%)					**87.6%**	> 90%
DENSITY (LBS/CY)	1196	522.5	900	500		
DENSITY (KG/M3)	709.6	310.0	533.9	296.6		
% AIR SPACE	36.14	72.10	51.94	73.30		
FEEDSTOCK VOLUME (CY)	56.9	76.6	13.3	18.8	109	
AIR VOLUME (CY)	20.6	55.2	6.9	13.8	75.9	
PREDICTED FREE AIR SPACE					**69.8%**	40-60%

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	12/2/2012
Analysis	PFD - CPL Composting Facility		

Assumptions:
1. Facility is open 5 days/week, 52 weeks/year
2. Facility will use aerated static pile composting with negative aeration
3. Exhaust air to be treated with biofilter

Waste Generation Quantities

1. Daily quantities

Food Scraps & Seafood Wastes	34.0	tons/day
Carbon	20.0	tons/day
Screened Compost (inoculant)	6.0	tons/day
Screen overs (bulking agent)	4.7	tons/day
Total Daily Tonnage	64.7	tons/day
Total Annual Tonnage	20,198.4	tons/year

2. Daily Volumes (ground up)

Food Scraps & Seafood Wastes	56.9	CY/day
Carbon	76.6	CY/day
Screened Compost (inoculant)	13.3	CY/day
Screen overs (bulking agent)	18.8	CY/day
Total Daily Volumes	165.6	CY/day
Total Annual Volume	51,670	CY/year

Composting Materials Flows

1. Residence times for ASP composting (winter conditions)

	Composting	Curing	Total
ASP	30 days	60 days	90 days

2. Daily Volumes going to composting (assume 10% volume loss in grinding/mixing)

Daily volumes of mixed feedstocks = 149.0 CY/day

3. Volume of material in Primary Composting

	Residence Days	Mixed feedstocks
ASP	30	4,471 CY

4. Daily Volumes going to curing (assume 30% volume shrink in composting)

Daily volumes of composted feedstocks = 104.3 CY/day

5. Volume of material in Curing (Secondary Composting):

	Residence Days	Composted Feedstocks
Windrow	60	6,260 CY

6. Daily Volumes going to screening (assume 10% volume shrink in curing):

Daily volumes of cured feedstocks = 93.9 CY/day

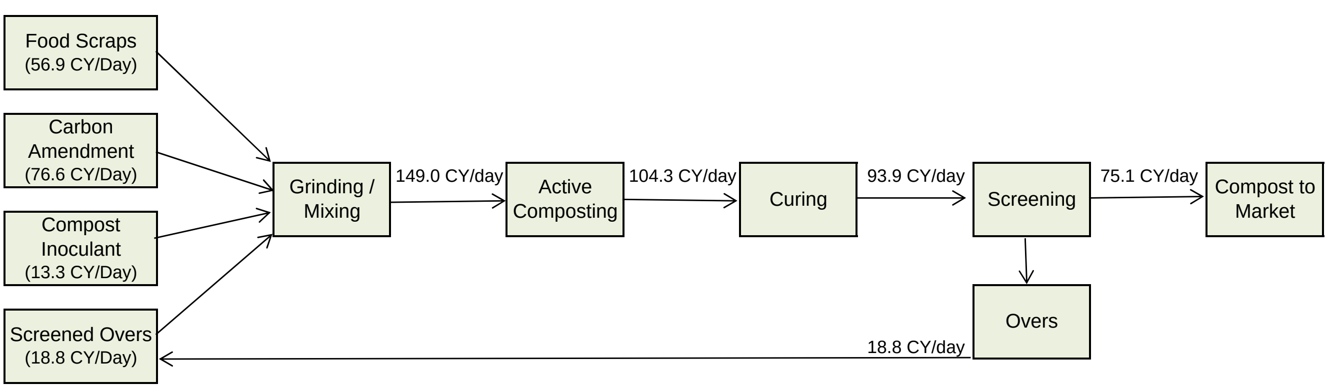
7. Screening

a. Assume approx. 80% finished compost capture rate and 20% going to overs

b. Finished compost production (daily):

Daily volumes of screened compost = 75.1 CY/day

Daily volumes of overs (mulch) = 18.8 CY/day



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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	12/2/2012
Analysis	PFD - CPL Composting Facility		

Assumptions:
1. Facility is open 5 days/week, 52 weeks/year
2. Facility will use aerated static pile composting in concrete block bins with negative aeration
3. Exhaust air to be treated with biofilter

Waste Generation Quantities

1. Daily quantities

Food Scraps & Seafood Wastes	34.0	tons/day
Carbon	20.0	tons/day
Screened Compost (inoculant)	6.0	tons/day
Screen overs (bulking agent)	4.7	tons/day
Total Daily Tonnage	64.7	tons/day
Total Annual Tonnage	20,198.4	tons/year

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Carbon	76.6	CY/day
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Screen overs (bulking agent)	18.8	CY/day
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Total Annual Volume	51,670	CY/year

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ASP	30 days	60 days	90 days

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   Daily volumes of mixed feedstocks = 149.0 CY/day
3. Volume of material in Primary Composting

	Residence Days	Mixed feedstocks
ASP	30	4,471 CY

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	Residence Days	Composted Feedstocks
Windrow	60	6,260 CY

6. Daily Volumes going to screening (assume 10% volume shrink in curing):
   Daily volumes of cured feedstocks = 93.9 CY/day
7. Screening
   a. Assume approx. 80% finished compost capture rate and 20% going to overs
   b. Finished compost production (daily):
   Daily volumes of screened compost = 75.1 CY/day
   Daily volumes of overs (mulch) = 18.8 CY/day

Feedstocks Receipt/Storage Sizing Calculations

1. Feedstock Receipts
   a. Assume daily delivery of feedstocks with 1 day storage capacity
   b. Assume 2 days storage inventory of amendments inside bldg.
   c. Assume all deliveries by SSO collection or dump truck
   Truck Unloading Area = 30 ft. W
   30 ft. L
2. Ground Amendments storage
   a. Volumes - assume 2 days storage

	Daily	Total
Carbon	76.6 CY	153 CY
Screened Compost (inoculant)	13.3 CY	27 CY
Screen overs (bulking agent)	18.8 CY	38 CY
		217 CY

b. Assume amendments stored separately		
c. Assume maximum amendment depth of	8	ft
d. Footprint of carbon storage bin	516.7	SF
Assume bin width of	16	ft
Calculated bin length	32	ft
Carbon Amendments Storage Bin =	16	ft. W
	32	ft. L
	8	ft. D
e. Footprint of compost storage bin	90.0	SF
Assume bin width of	8	ft
Calculated bin length	11	ft
Compost Amendments Storage Bin =	8	ft. W
	13	ft. L
	8	ft. D
f. Footprint of overs storage bin	126.9	SF
Assume bin width of	8	ft
Calculated bin length	16	ft
Overs Amendments Storage Bin =	8	ft. W
	17	ft. L
	8	ft. D
Feedstock Mixing		
1. Daily Mix Volumes		
a. SSO	56.9	CY/day
b. Amendments	108.7	CY/day
Total	165.6	CY/day
2. Daily mixing volume needed	165.6	CY/day
3. Mixing		
a. Assume mixing with small horizontal grinder (Vermeer HG200)		
b. Assume 10% volume loss in mixing		
c. Daily volume going to composting	149	CY/day
4. Footprint of grinder is 20' L x 7' W so area needed =	30	ft W
	80	ft L
Active Composting		
1. Composting residence time	35	days/cycle
2. Total volume in composting during 1 cycle	5,796	CY/cycle
3. Assume one ASP bin filled twice per week		
Bin volume	373	CY/bin
4. Assume ASP bin height =	8	ft
5. Footprint of each ASP =	1,258	SF
6. Assume ASP bin width =	24	ft
7. Calculated ASP bin length =	52	ft
8. Number of ASP bins in each cycle:		
Total volume in cycle/ vol of each bin	16	bins/cycle
9. Area of active composting	20,121	SF
10. Assume 8 bins on each side of open floor in bldg.		
11. Dimensions		
Width: (8 x 24' W) + (9 x 2' W walls)	210	ft W
Length: 52' L x 2 + 50' aisle	154	ft L

Composting Aeration System

1. Volume of each bin	373	CY
2. Assumed bulk density of compostables	1,100	lbs/CY
3. Wet tonnage in each bin	204.9	wet tons
4. Assumed pile moisture content	50	%
5. Dry tonnage in each bin	102.5	dry tons
6. Aeration rate	750	CFH / dry ton
7. Aeration needed for each bin	76,853	CFH
8. Fan Air Flow needed	1,281	CFM/bin
Maximum Air Flow @ 6" W.C.	1,500	CFM/bin

Condensate Removal

1. Assume air stream is 100% saturated		
2. Volume of each bin	373	CY/bin
3. Assumed bulk density	800	lbs/CY
4. Weight of compostables in each bay	298,096	lbs
5. Assume moisture content =	50%	
6. Weight of water in each bay's batch =	149,048	lbs
7. Assumed moisture content at completion	40%	
8. Weight of water in each bay's batch at completion =	119,238	lbs
9. Water loss	29,810	lbs
10. Assume 30% evaporates out of pile when fan off	8,943	lbs
11. Remaining moisture migrating out through aeration system	20,867	lbs
12. Convert to gallons at 8.34 lbs/gal	2,502	gal
13. Daily production assuming a 28-day cycle	89	gal/day/bin

Biofilter System Does not include building air

1. Assume gas retention time =	60	sec
2. Air flow to biofilter from all bins	24,000.0	CFM
3. Required biofilter volume	24,000	CF
4. Assumed biofilter depth =	4	ft
5. Assumed biofilter footprint =	6000	SF
6. Biofilter dimensions =	60	ft W
	100	ft L

Curing System

1. Assumed volume loss in composting	30	%
2. Volume of each ASP bin going to curing	261	CY/bin
3. Number of ASP bins going to curing monthly	16	bins
4. Total volume going to curing monthly	4,173	CY
5. Assumed curing residence time	2	months
6. Total volume in curing per cycle	8,347	CY/cycle
7. Assume cure pile turned with loader with 4 CY bucket		
8. Assumed cure pile height	7	ft
9. Footprint of cure pile	32,194	SF/cycle
10. Assume curing done in static pile in building		
14. Area Needed	150	ft W
	220	ft L

Screening System

1. Assumed volume loss in curing	10	%
2. Monthly volume to screening	3,756	CY/month
3. Assumed percentage of "overs"	20%	
4. Monthly volume of screened compost to storage	3,193	CY/month
5. Monthly volume of overs to storage	563	CY/month
6. Assume use of a 6' x 16' trommel		
a. Dimensions: 50' L x 8' W		
7. Area Needed	25	ft W
	75	ft L

Product Storage

1. Assumed winter storage period	5	months
2. Volume going to storage in winter	15,963	CY
3. Assumed storage pile height	8	ft
4. Storage pile footprint	53,875	SF
5. Assume storage in building		
6. Area Needed	200	ft W
	270	ft L

Area Summary

Process	Width (ft.)	Length (ft.)	Area (sq. ft.)	Area (acres)
Inside Building				
Truck Unloading Area	30	30	900	0.02
Carbon Amendments Storage	16	32	517	0.01
Compost Inoculant Storage	8	13	106	0.00
Overs Storage	8	17	135	0.00
Mixing	30	80	2,400	0.06
Composting Area	210	154	32,340	0.74
Curing Area	150	220	33,000	0.76
Screening Area	25	75	1,875	0.04
Product Storage Area	200	270	54,000	1.24
	Total		125,273	2.88
Outside Behind Building				
Biofilter	60	100	6,000	0.14
	Total		6,000	0.14

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	3/19/2013
Analysis	ASP Sizing - CPL Composting Facility - ECS SV System		rev 3/25/2013

Assumptions:
1. Facility is open 5 days/week, 52 weeks/year
2. Facility will use ECS CV System - 6 vessels
3. Exhaust air to be treated with biofilter

Waste Generation Quantities

1. Daily quantities

Food Scraps (SSO)	34.0	tons/day
Carbon	20.0	tons/day
Screened Compost (inoculant)	6.0	tons/day
Screen overs (bulking agent)	4.7	tons/day
Total Daily Tonnage	64.7	tons/day
Total Annual Tonnage	20,198.4	tons/year

2. Daily Volumes (ground up)

Food Scraps	56.9	CY/day
Carbon	76.6	CY/day
Screened Compost (inoculant)	13.3	CY/day
Screen overs (bulking agent)	18.8	CY/day
Total Daily Volumes	165.6	CY/day
Total Annual Volume	51,670	CY/year

Composting Materials Flows

1. Residence times for ASP composting (winter conditions)

	Composting	Curing	Total
ASP	21 days	69 days	90 days

2. Daily Volumes going to composting (assume 5% volume loss in grinding/mixing)

Daily volumes of mixed feedstocks = 157.3 CY/day

3. Volume of material in Primary Composting

	Residence Days	Mixed feedstocks
ASP	21	3,304 CY

4. Daily Volumes going to curing (assume 20% volume shrink in composting)

Daily volumes of composted feedstocks = 125.9 CY/day

5. Volume of material in Curing (Secondary Composting):

	Residence Days	Composted Feedstocks
Windrow	69	8,685 CY

6. Daily Volumes going to screening (assume 10% volume shrink in curing):

Daily volumes of cured feedstocks = 113.3 CY/day

7. Screening

a. Assume approx. 80% finished compost capture rate and 20% going to overs

b. Finished compost production (daily):

Daily volumes of screened compost = 90.6 CY/day

Daily volumes of overs (mulch) = 22.7 CY/day

Feedstocks Receipt/Storage Sizing Calculations

1. Feedstock Receipts
   a. Assume daily delivery of feedstocks with 1 day storage capacity
   b. Assume 2 days storage inventory of amendments inside bldg.
   c. Assume all deliveries by SSO collection or dump truck

Truck Unloading Area =		30	ft. W
		30	ft. L

2. Ground Amendments storage
   a. Volumes - assume 2 days storage

	Daily		Total	
Carbon	76.6	CY	153	CY
Screened Compost (inoculant)	13.3	CY	27	CY
Screen overs (bulking agent)	18.8	CY	38	CY
			217	CY

   b. Assume amendments stored separately

c. Assume maximum amendment depth of	6	ft
d. Footprint of carbon storage bin	689.0	SF
Assume bin width of	8	ft
Calculated bin length	86	ft
Carbon Amendments Storage Bin =	16	ft. W
	86	ft. L
	6	ft. D
e. Footprint of compost storage bin	120.0	SF
Assume bin width of	8	ft
Calculated bin length	15	ft
Compost Amendments Storage Bin =	8	ft. W
	17	ft. L
	6	ft. D
f. Footprint of overs storage bin	169.2	SF
Assume bin width of	8	ft
Calculated bin length	21	ft
Overs Amendments Storage Bin =	8	ft. W
	22	ft. L
	6	ft. D

Feedstock Mixing
Included in ECS footprint

Active Composting
Included in ECS footprint
11. Dimensions

Width:	166	ft W
Length:	143	ft L

Composting Aeration System
Included in ECS footprint

Condensate Removal
Included in ECS footprint

Biofilter System
Included in ECS footprint

Curing System

1. Assumed volume loss in composting	20	%
2. Volume of each ECS SV reactor going to curing	450	CY/bin
3. Number of ECS SVs going to curing monthly	2	reactors
4. Total volume going to curing monthly	1,035	CY
5. Assumed curing residence time	2	months
6. Total volume in curing per cycle	2,070	CY/cycle
7. Assume cure pile turned with loader with 4 CY bucket inside bldg.		
8. Assumed cure pile height	7	ft
9. Footprint of cure pile	7,984	SF/cycle
10. Assume curing done in static pile in building		
11. Allow extra 50% space for equip, screening, storage	3,992	SF
12. Total building area needed	11,976	SF
13. Area Needed	100	ft W
	120	ft L

Screening System

1. Assumed volume loss in curing	10	%
2. Monthly volume to screening	932	CY/month
3. Assumed percentage of "overs"	20%	
4. Monthly volume of screened compost to storage	792	CY/month
5. Monthly volume of overs to storage	140	CY/month
6. Assume use of a Wildcat 616 trommel		
a. Dimensions: 50' L x 8' W		
7. Area Needed - included in curing building	50	ft W
	35	ft L
	1750	SF

Product Storage

1. Assumed winter storage period	5	months
2. Volume going to storage in winter	3,959	CY
3. Assumed storage pile height	8	ft
4. Storage pile footprint	13,361	SF
5. Assume storage in building		
6. Area Needed - include in curing building	100	ft W
	140	ft L

Area Summary

Process	Width (ft.)	Length (ft.)	Area (sq. ft.)	Area (acres)
Inside Building				
Truck Unloading Area	30	30	900	0.02
Carbon Amendments Storage	16	86	1,378	0.03
Compost Inoculant Storage	8	17	136	0.00
Overs Storage	8	22	177	0.00
Curing Area	100	120	11,976	0.27
Screening Area	50	35	1,750	0.04
Product Storage Area	100	140	14,000	0.32
		Subtotal	30,318	0.70
Outside Behind Building				
ECS CV Compost System	166	143	23,738	0.54
		Total	54,056	1.24

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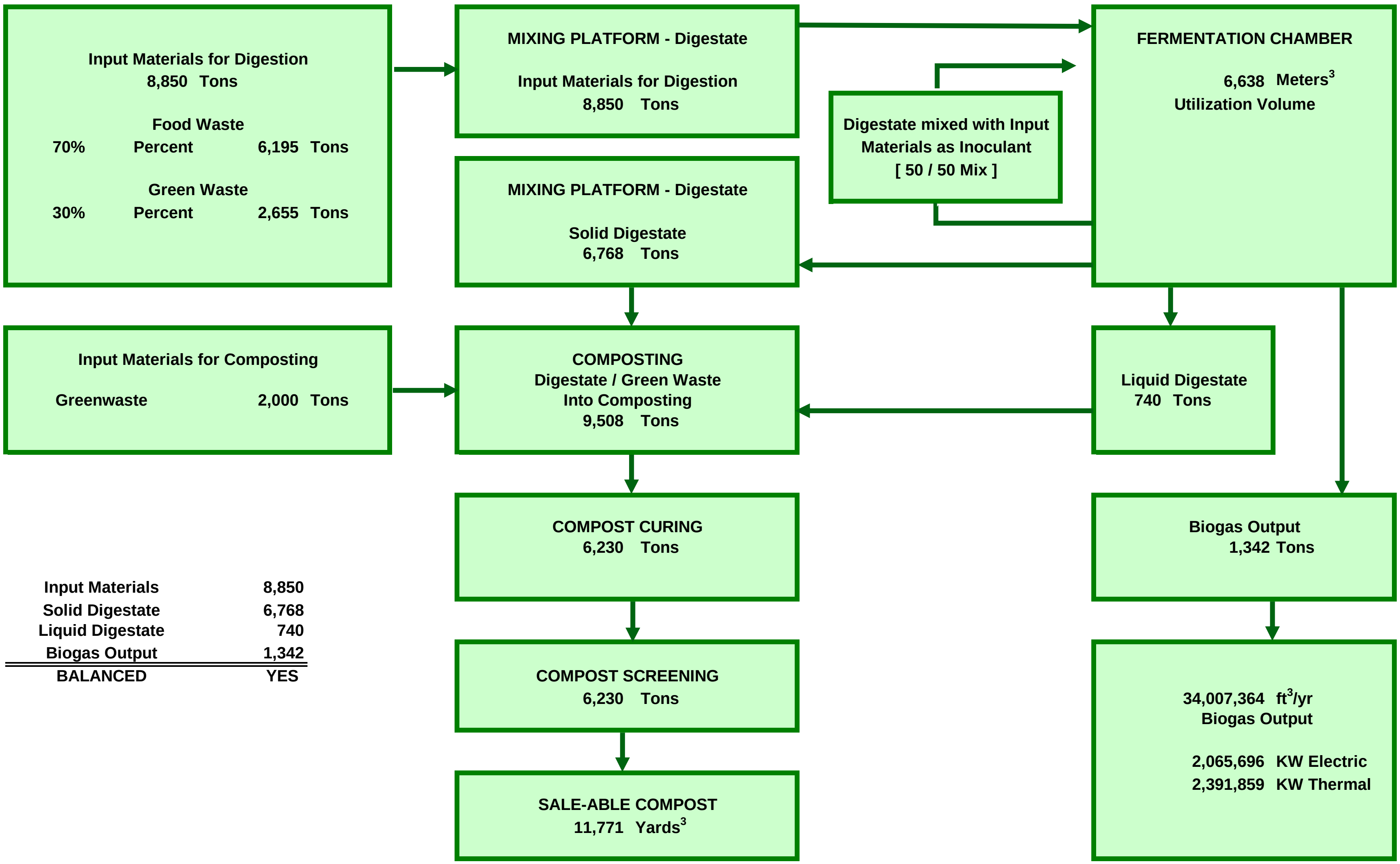
Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	12/2/2012
Analysis	Preliminary Mass Balance - Dry Fermentation AD at CPL		



Input Materials	8,850
Solid Digestate	6,768
Liquid Digestate	740
Biogas Output	1,342
BALANCED	YES

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	12/2/2012
Analysis	Recipe - Homer Composting Facility		

Assumptions:

1. Estimated current total tonnage of food scraps is 1,500 tons/yr
2. Assume facility is open 5 days/week
3. Estimated daily tonnage of food scraps 5.8 tons/day

MIX RATIO CALCULATIONS - Daily

INGREDIENTS	Food Scraps	Carbon	Compost Recycle	Overs	TOTAL MIX	TARGET
C (% AS IS)	43.7	49.2	13.2	50.1		
N (% AS IS)	2.2	0.9	1.0	1.0		
MOISTURE%	71.5	40.1	45	45		
UNITS IN MIX BY WGT (T)	5.8	4.0	1.0	0.9	11.6	
UNITS IN MIX BY WGT (LB)	11,538	8,000	2,000	1,720	23,258	
UNITS IN MIX BY VOL (CY)	9.6	15.3	2.2	3.4	30.6	
DENSITY (LBS/CY)	1196	522.5	900	500		
POUNDS OF CARBON	5,042	3,933	264	862	10,101	
POUNDS OF NITROGEN	254	74	20	17	365	
C:N RATIO	19.86	52.86	13.20	50.61	**27.65**	20 TO 30
POUNDS OF MOISTURE	8,250	3,208	900	774	13,132	
NUMBER OF UNITS	11,538	8,000	2,000	1,720	23,258	
PERCENT MOISTURE					**56.46**	50 TO 65%
VOLATILE SOLIDS (%)	87.4%	98.3%	44.2%	98.3%		
VOLATILE SOLIDS (LBS)	10,085	7,864	884	1,691	20,523	
TOTAL MASS (LBS)	11,538	8,000	2,000	1,720	23,258	
MIX VS (%)					**88.2%**	> 90%
DENSITY (LBS/CY)	1196	522.5	900	500		
DENSITY (KG/M3)	709.6	310.0	533.9	296.6		
% AIR SPACE	36.14	72.10	51.94	73.30		
FEEDSTOCK VOLUME (CY)	9.6	15.3	2.2	3.4	21	
AIR VOLUME (CY)	3.5	11.0	1.2	2.5	14.7	
PREDICTED FREE AIR SPACE					**70.2%**	40-60%

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	12/2/2012
Analysis	PFD - Homer Composting Facility		

Assumptions:
1. Facility is open 5 days/week, 52 weeks/year
2. Facility will use aerated static pile composting with negative aeration
3. Exhaust air to be treated with biofilter

Waste Generation Quantities

1. Daily quantities

Food Scraps (SSO)	5.8	tons/day
Carbon	4.0	tons/day
Screened Compost (inoculant)	1.0	tons/day
Screen overs (bulking agent)	0.9	tons/day
Total Daily Tonnage	11.6	tons/day
Total Annual Tonnage	3,628.3	tons/year

2. Daily Volumes (ground up)

Food Scraps	9.6	CY/day
Carbon	15.3	CY/day
Screened Compost (inoculant)	2.2	CY/day
Screen overs (bulking agent)	3.4	CY/day
Total Daily Volumes	30.6	CY/day
Total Annual Volume	9,554	CY/year

Composting Materials Flows

1. Residence times for ASP composting (winter conditions)

	Composting	Curing	Total
ASP	45 days	30 days	75 days

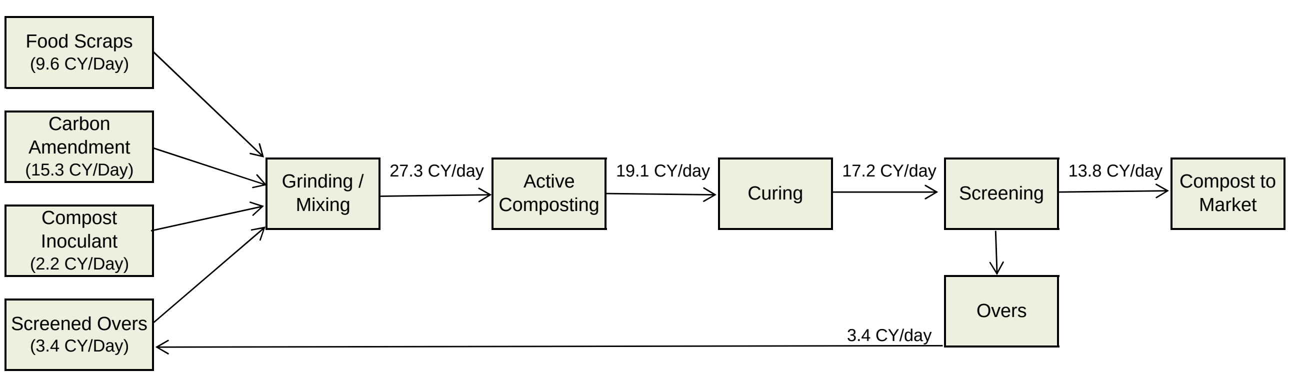
2. Daily Volumes going to composting (assume 10% volume loss in grinding/mixing)
   Daily volumes of mixed feedstocks = 27.6 CY/day
3. Volume of material in Primary Composting

	Residence Days	Mixed feedstocks
ASP	45	1,240 CY

4. Daily Volumes going to curing (assume 30% volume shrink in composting)
   Daily volumes of composted feedstocks = 19.3 CY/day
5. Volume of material in Curing (Secondary Composting):

	Residence Days	Composted Feedstocks
Windrow	30	579 CY

6. Daily Volumes going to screening (assume 10% volume shrink in curing):
   Daily volumes of cured feedstocks = 17.4 CY/day
7. Screening
   a. Assume approx. 80% finished compost capture rate and 20% going to overs
   b. Finished compost production (daily):
      Daily volumes of screened compost = 13.9 CY/day
      Daily volumes of overs (mulch) = 3.5 CY/day



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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	12/2/2012
Analysis	ASP Sizing - Homer Composting Facility		

Assumptions:
1. Facility is open 5 days/week, 52 weeks/year
2. Facility will use aerated static pile composting in concrete block bins with negative aeration
3. Exhaust air to be treated with biofilter

Waste Generation Quantities

1. Daily quantities

Food Scraps (SSO)	5.8	tons/day
Carbon	4.0	tons/day
Screened Compost (inoculant)	1.0	tons/day
Screen overs (bulking agent)	0.9	tons/day
Total Daily Tonnage	11.6	tons/day
Total Annual Tonnage	3,628.3	tons/year

2. Daily Volumes (ground up)

Food Scraps	9.6	CY/day
Carbon	15.3	CY/day
Screened Compost (inoculant)	2.2	CY/day
Screen overs (bulking agent)	3.4	CY/day
Total Daily Volumes	30.6	CY/day
Total Annual Volume	9,554	CY/year

Composting Materials Flows

1. Residence times for ASP composting (winter conditions)

	Composting	Curing	Total
ASP	35 days	60 days	95 days

2. Daily Volumes going to composting (assume 10% volume loss in grinding/mixing)

Daily volumes of mixed feedstocks = 27.6 CY/day

3. Volume of material in Primary Composting

	Residence Days	Mixed feedstocks
ASP	35	965 CY

4. Daily Volumes going to curing (assume 30% volume shrink in composting)

Daily volumes of composted feedstocks = 19.3 CY/day

5. Volume of material in Curing (Secondary Composting):

	Residence Days	Composted Feedstocks
Windrow	60	1,157 CY

6. Daily Volumes going to screening (assume 10% volume shrink in curing):

Daily volumes of cured feedstocks = 17.4 CY/day

7. Screening
   a. Assume approx. 80% finished compost capture rate and 20% going to overs
   b. Finished compost production (daily):

Daily volumes of screened compost = 13.9 CY/day
Daily volumes of overs (mulch) = 3.5 CY/day

Feedstocks Receipt/Storage Sizing Calculations

1. Feedstock Receipts
   a. Assume daily delivery of feedstocks with 1 day storage capacity
   b. Assume 2 days storage inventory of amendments inside bldg.
   c. Assume all deliveries by SSO collection or dump truck

Truck Unloading Area = 30 ft. W
30 ft. L

2. Ground Amendments storage
a. Volumes - assume 2 days storage

	Daily	Total
Carbon	15.3 CY	31 CY
Screened Compost (inoculant)	2.2 CY	4 CY
Screen overs (bulking agent)	3.4 CY	7 CY
		42 CY

b. Assume amendments stored separately		
c. Assume maximum amendment depth of		6 ft
d. Footprint of carbon storage bin		137.8 SF
Assume bin width of		8 ft
Calculated bin length		17 ft
	Carbon Amendments Storage Bin =	8 ft. W
		17 ft. L
		6 ft. D
e. Footprint of compost storage bin		20.0 SF
Assume bin width of		4 ft
Calculated bin length		5 ft
	Compost Amendments Storage Bin =	4 ft. W
		7 ft. L
		6 ft. D
f. Footprint of overs storage bin		31.0 SF
Assume bin width of		4 ft
Calculated bin length		8 ft
	Overs Amendments Storage Bin =	4 ft. W
		9 ft. L
		6 ft. D

Feedstock Mixing

1. Daily Mix Volumes		
a. SSO		9.6 CY/day
b. Amendments		21.0 CY/day
	Total	30.6 CY/day
2. Daily mixing volume needed		30.6 CY/day
3. Mixing		
a. Assume mixing with small horizontal grinder (Vermeer HG200)		
b. Assume 10% volume loss in mixing		
c. Daily volume going to composting		28 CY/day
4. Footprint of grinder is 20' L x 7' W so area needed =		30 ft W
		80 ft L

Active Composting

1. Composting residence time	35 days/cycle
2. Total volume in composting during 1 cycle	1,072 CY/cycle
3. Assume one ASP bin filled every 5 days	
Bin volume	138 CY/bin
4. Assume ASP bin height =	6 ft
5. Footprint of each ASP =	620 SF
6. Assume ASP bin width =	18 ft
7. Calculated ASP bin length =	34 ft
8. Number of ASP bins in each cycle:	
Total volume in cycle/ vol of each bin	8 bins/cycle
9. Area of active composting	4,961 SF
10. Assume 4 bins on each side of open floor in bldg.	
11. Dimensions	
Width: (4 x 18' W) + (5 x 2' W walls)	82 ft W
Length: 34' L x 2 + 50' aisle	118 ft L

Composting Aeration System

1. Volume of each bin	138 CY
2. Assumed bulk density of compostables	1,100 lbs/CY
3. Wet tonnage in each bin	75.8 wet tons
4. Assumed pile moisture content	50 %
5. Dry tonnage in each bin	37.9 dry tons
6. Aeration rate	750 CFH / dry ton
7. Aeration needed for each bin	28,420 CFH
8. Fan Air Flow needed	474 CFM/bin
Maximum Air Flow @ 6" W.C.	500 CFM/bin

Condensate Removal

1. Assume air stream is 100% saturated	
2. Volume of each bin	138 CY/bin
3. Assumed bulk density	800 lbs/CY
4. Weight of compostables in each bay	110,235 lbs
5. Assume moisture content =	50%
6. Weight of water in each bay's batch =	55,117 lbs
7. Assumed moisture content at completion	40%
8. Weight of water in each bay's batch at completion =	44,094 lbs
9. Water loss	11,023 lbs
10. Assume 30% evaporates out of pile when fan off	3,307 lbs
11. Remaining moisture migrating out through aeration system	7,716 lbs
12. Convert to gallons at 8.34 lbs/gal	925 gal
13. Daily production assuming a 28-day cycle	33 gal/day/bin

Biofilter System Does not include building air

1. Assume gas retention time =	60 sec
2. Air flow to biofilter from all bins	4,000.0 CFM
3. Required biofilter volume	4,000 CF
4. Assumed biofilter depth =	4 ft
5. Assumed biofilter footprint =	1000 SF
6. Biofilter dimensions =	20 ft W
	50 ft L

Curing System

1. Assumed volume loss in composting	30 %
2. Volume of each ASP bin going to curing	96 CY/bin
3. Number of ASP bins going to curing monthly	8 bins
4. Total volume going to curing monthly	772 CY
5. Assumed curing residence time	2 months
6. Total volume in curing per cycle	1,543 CY/cycle
7. Assume cure pile turned with loader with 4 CY bucket	
8. Assumed cure pile height	7 ft
9. Footprint of cure pile	5,953 SF/cycle
10. Assume curing done in static pile in building	
14. Area Needed	60 ft W
	100 ft L

Screening System

1. Assumed volume loss in curing	10 %
2. Monthly volume to screening	694 CY/month
3. Assumed percentage of "overs"	20%
4. Monthly volume of screened compost to storage	590 CY/month
5. Monthly volume of overs to storage	104 CY/month
6. Assume use of a TROM 406 trommel	
a. Dimensions: 25' L x 8' W	
7. Area Needed	25 ft W
	35 ft L

Product Storage

1. Assumed winter storage period	5 months
2. Volume going to storage in winter	2,952 CY
3. Assumed storage pile height	8 ft
4. Storage pile footprint	9,961 SF
5. Assume storage in building	
6. Area Needed	100 ft W
	100 ft L

Area Summary

Process	Width (ft.)	Length (ft.)	Area (sq. ft.)	Area (acres)
Inside Building				
Truck Unloading Area	30	30	900	0.02
Carbon Amendments Storage	8	17	138	0.00
Compost Inoculant Storage	4	7	28	0.00
Overs Storage	4	9	35	0.00
Mixing	30	80	2,400	0.06
Composting Area	82	118	9,676	0.22
Curing Area	60	100	6,000	0.14
Screening Area	25	35	875	0.02
Product Storage Area	100	100	10,000	0.23
		Total	30,052	0.69
Outside Behind Building				
Biofilter	20	50	1,000	0.02
		Total	1,000	0.02

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	3/19/2013
Analysis	ASP Sizing - Homer Composting Facility - ECS CV System		

Assumptions:
1. Facility is open 5 days/week, 52 weeks/year
2. Facility will use ECS CV System - 14 vessels
3. Exhaust air to be treated with biofilter

Waste Generation Quantities

1. Daily quantities

Food Scraps (SSO)	5.8	tons/day
Carbon	4.0	tons/day
Screened Compost (inoculant)	1.0	tons/day
Screen overs (bulking agent)	0.9	tons/day
Total Daily Tonnage	11.6	tons/day
Total Annual Tonnage	3,628.3	tons/year

2. Daily Volumes (ground up)

Food Scraps	9.6	CY/day
Carbon	15.3	CY/day
Screened Compost (inoculant)	2.2	CY/day
Screen overs (bulking agent)	3.4	CY/day
Total Daily Volumes	30.6	CY/day
Total Annual Volume	9,554	CY/year

Composting Materials Flows

1. Residence times for ASP composting (winter conditions)

	Composting	Curing	Total
ASP	21 days	69 days	90 days

2. Daily Volumes going to composting (assume 5% volume loss in grinding/mixing)

Daily volumes of mixed feedstocks = 29.1 CY/day

3. Volume of material in Primary Composting

	Residence Days	Mixed feedstocks
ASP	21	611 CY

4. Daily Volumes going to curing (assume 20% volume shrink in composting)

Daily volumes of composted feedstocks = 23.3 CY/day

5. Volume of material in Curing (Secondary Composting):

	Residence Days	Composted Feedstocks
Windrow	69	1,606 CY

6. Daily Volumes going to screening (assume 10% volume shrink in curing):

Daily volumes of cured feedstocks = 20.9 CY/day

7. Screening

a. Assume approx. 80% finished compost capture rate and 20% going to overs

b. Finished compost production (daily):

Daily volumes of screened compost = 16.8 CY/day

Daily volumes of overs (mulch) = 4.2 CY/day

Feedstocks Receipt/Storage Sizing Calculations

1. Feedstock Receipts
   a. Assume daily delivery of feedstocks with 1 day storage capacity
   b. Assume 2 days storage inventory of amendments inside bldg.
   c. Assume all deliveries by SSO collection or dump truck

Truck Unloading Area =	30	ft. W
	30	ft. L

2. Ground Amendments storage
   a. Volumes - assume 2 days storage

	Daily		Total	
Carbon	15.3	CY	31	CY
Screened Compost (inoculant)	2.2	CY	4	CY
Screen overs (bulking agent)	3.4	CY	7	CY
			42	CY

b. Assume amendments stored separately		
c. Assume maximum amendment depth of	6	ft
d. Footprint of carbon storage bin	137.8	SF
Assume bin width of	8	ft
Calculated bin length	17	ft
Carbon Amendments Storage Bin =	8	ft. W
	17	ft. L
	6	ft. D
e. Footprint of compost storage bin	20.0	SF
Assume bin width of	4	ft
Calculated bin length	5	ft
Compost Amendments Storage Bin =	4	ft. W
	7	ft. L
	6	ft. D
f. Footprint of overs storage bin	31.0	SF
Assume bin width of	4	ft
Calculated bin length	8	ft
Overs Amendments Storage Bin =	4	ft. W
	9	ft. L
	6	ft. D

Feedstock Mixing
Included in ECS footprint

Active Composting
Included in ECS footprint
11. Dimensions

Width:	165	ft W
Length:	109	ft L

Composting Aeration System
Included in ECS footprint

Condensate Removal
Included in ECS footprint

Biofilter System
Included in ECS footprint

Curing System

1. Assumed volume loss in composting	20	%
2. Volume of each ECS CV going to curing	36	CY/bin
3. Number of ECS CVs going to curing monthly	16	bins
4. Total volume going to curing monthly	576	CY
5. Assumed curing residence time	2.3	months
6. Total volume in curing per cycle	1,325	CY/cycle
7. Assume cure pile turned with loader with 4 CY bucket inside bldg.		
8. Assumed cure pile height	7	ft
9. Footprint of cure pile	5,110	SF/cycle
10. Assume curing done in static pile in building		
11. Allow extra 50% space for equip, screening, storage	2,555	SF
12. Total building area needed	7,665	SF
13. Area Needed	60	ft W
	128	ft L

Screening System

1. Assumed volume loss in curing	10	%
2. Monthly volume to screening	518	CY/month
3. Assumed percentage of "overs"	20%	
4. Monthly volume of screened compost to storage	441	CY/month
5. Monthly volume of overs to storage	78	CY/month
6. Assume use of a TROM 406 trommel		
a. Dimensions: 25' L x 8' W		
7. Area Needed - included in curing building	25	ft W
	35	ft L
	875	SF

Product Storage

1. Assumed winter storage period	5	months
2. Volume going to storage in winter	2,203	CY
3. Assumed storage pile height	8	ft
4. Storage pile footprint	7,436	SF
5. Assume storage in building		
6. Area Needed - include in curing building	60	ft W
	130	ft L

Area Summary

Process	Width (ft.)	Length (ft.)	Area (sq. ft.)	Area (acres)
Inside Building				
Truck Unloading Area	30	30	900	0.02
Carbon Amendments Storage	8	17	138	0.00
Compost Inoculant Storage	4	7	28	0.00
Overs Storage	4	9	35	0.00
Curing Area	60	128	7,665	0.18
Screening Area	25	35	875	0.02
Product Storage Area	60	130	7,800	0.18
	Subtotal		17,441	0.40
Outside Behind Building				
ECS CV Compost System	165	109	17,985	0.41
	Total		35,426	0.81

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	12/2/2012
Analysis	Recipe - Seward Composting Facility		

Assumptions:

1. Estimated current total tonnage of food scraps is	600	tons/yr
2. Assume facility is open 5 days/week		
3. Estimated daily tonnage of food scraps	2.3	tons/day

MIX RATIO CALCULATIONS - Daily

INGREDIENTS	Food Scraps	Carbon	Compost Recycle	Overs	TOTAL MIX	TARGET
C (% AS IS)	43.7	49.2	13.2	50.1		
N (% AS IS)	2.2	0.9	1.0	1.0		
MOISTURE%	71.5	40.1	45	45		
UNITS IN MIX BY WGT (T)	2.3	2.0	0.5	0.4	5.2	
UNITS IN MIX BY WGT (LB)	4,615	4,000	1,000	800	10,415	
UNITS IN MIX BY VOL (CY)	3.9	7.7	1.1	1.6	14.2	
DENSITY (LBS/CY)	1196	522.5	900	500		
POUNDS OF CARBON	2,017	1,966	132	401	4,516	
POUNDS OF NITROGEN	102	37	10	8	157	
C:N RATIO	19.86	52.86	13.20	50.61	**28.83**	20 TO 30
POUNDS OF MOISTURE	3,300	1,604	450	360	5,714	
NUMBER OF UNITS	4,615	4,000	1,000	800	10,415	
PERCENT MOISTURE					**54.86**	50 TO 65%
VOLATILE SOLIDS (%)	87.4%	98.3%	44.2%	98.3%		
VOLATILE SOLIDS (LBS)	4,034	3,932	442	786	9,194	
TOTAL MASS (LBS)	4,615	4,000	1,000	800	10,415	
MIX VS (%)					**88.3%**	> 90%
DENSITY (LBS/CY)	1196	522.5	900	500		
DENSITY (KG/M3)	709.6	310.0	533.9	296.6		
% AIR SPACE	36.14	72.10	51.94	73.30		
FEEDSTOCK VOLUME (CY)	3.9	7.7	1.1	1.6	10	
AIR VOLUME (CY)	1.4	5.5	0.6	1.2	7.3	
PREDICTED FREE AIR SPACE					**70.1%**	40-60%

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	12/2/2012
Analysis	PFD - Seward Composting Facility		

Assumptions:
1. Facility is open 5 days/week, 52 weeks/year
2. Facility will use aerated static pile composting with negative aeration
3. Exhaust air to be treated with biofilter

Waste Generation Quantities

1. Daily quantities

Food Scraps (SSO)	2.3	tons/day
Carbon	2.0	tons/day
Screened Compost (inoculant)	0.5	tons/day
Screen overs (bulking agent)	0.4	tons/day
Total Daily Tonnage	5.2	tons/day
Total Annual Tonnage	1,624.8	tons/year

2. Daily Volumes (ground up)

Food Scraps	3.9	CY/day
Carbon	7.7	CY/day
Screened Compost (inoculant)	1.1	CY/day
Screen overs (bulking agent)	1.6	CY/day
Total Daily Volumes	14.2	CY/day
Total Annual Volume	4,438	CY/year

Composting Materials Flows

1. Residence times for ASP composting (winter conditions)

	Composting	Curing	Total
ASP	45 days	30 days	75 days

2. Daily Volumes going to composting (assume 5% volume loss in grinding/mixing)
Daily volumes of mixed feedstocks = 13.5 CY/day

3. Volume of material in Primary Composting

	Residence Days	Mixed feedstocks
ASP	45	608 CY

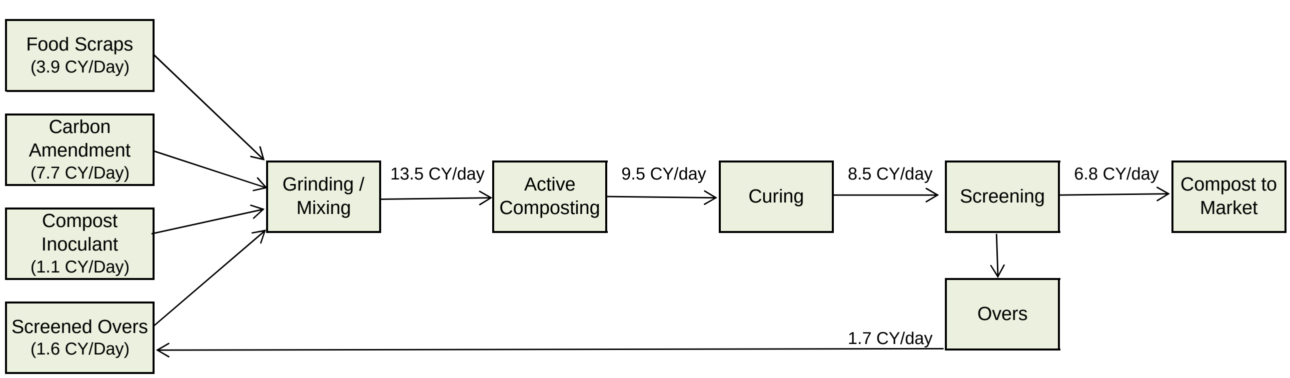
4. Daily Volumes going to curing (assume 30% volume shrink in composting)
Daily volumes of composted feedstocks = 9.5 CY/day

5. Volume of material in Curing (Secondary Composting):

	Residence Days	Composted Feedstocks
Windrow	30	284 CY

6. Daily Volumes going to screening (assume 10% volume shrink in curing):
Daily volumes of cured feedstocks = 8.5 CY/day

7. Screening
a. Assume approx. 80% finished compost capture rate and 20% going to overs
b. Finished compost production (daily):
Daily volumes of screened compost = 6.8 CY/day
Daily volumes of overs (mulch) = 1.7 CY/day



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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	12/2/2012
Analysis	ASP Sizing - Seward Composting Facility		

Assumptions:
1. Facility is open 6 days/week, 52 weeks/year
2. Facility will use aerated static pile composting in concrete block bins with negative aeration
3. Exhaust air to be treated with biofilter

Waste Generation Quantities

1. Daily quantities

Food Scraps (SSO)	2.3	tons/day
Carbon	2.0	tons/day
Screened Compost (inoculant)	0.5	tons/day
Screen overs (bulking agent)	0.4	tons/day
Total Daily Tonnage	5.2	tons/day
Total Annual Tonnage	1,624.8	tons/year

2. Daily Volumes (ground up)

Food Scraps	3.9	CY/day
Carbon	7.7	CY/day
Screened Compost (inoculant)	1.1	CY/day
Screen overs (bulking agent)	1.6	CY/day
Total Daily Volumes	14.2	CY/day
Total Annual Volume	4,438	CY/year

Composting Materials Flows

1. Residence times for ASP composting (winter conditions)

	Composting	Curing	Total
ASP	30 days	60 days	90 days

2. Daily Volumes going to composting (assume 5% volume loss in grinding/mixing)

Daily volumes of mixed feedstocks = 13.5 CY/day

3. Volume of material in Primary Composting

	Residence Days	Mixed feedstocks
ASP	30	405 CY

4. Daily Volumes going to curing (assume 30% volume shrink in composting)

Daily volumes of composted feedstocks = 9.5 CY/day

5. Volume of material in Curing (Secondary Composting):

	Residence Days	Composted Feedstocks
Windrow	60	568 CY

6. Daily Volumes going to screening (assume 10% volume shrink in curing):

Daily volumes of cured feedstocks = 8.5 CY/day

7. Screening

a. Assume approx. 80% finished compost capture rate and 20% going to overs

b. Finished compost production (daily):

Daily volumes of screened compost = 6.8 CY/day

Daily volumes of overs (mulch) = 1.7 CY/day

Feedstocks Receipt/Storage Sizing Calculations

1. Feedstock Receipts

a. Assume daily delivery of feedstocks with 1 day storage capacity

b. Assume 2 days storage inventory of amendments inside bldg.

c. Assume all deliveries by SSO collection or dump truck

Truck Unloading Area = 30 ft. W
30 ft. L

2. Ground Amendments storage
a. Volumes - assume 2 days storage

	Daily	Total
Carbon	7.7 CY	15 CY
Screened Compost (inoculant)	1.1 CY	2 CY
Screen overs (bulking agent)	1.6 CY	3 CY
		21 CY

b. Assume amendments stored separately	
c. Assume maximum amendment depth of	6 ft
d. Footprint of carbon storage bin	68.9 SF
Assume bin width of	8 ft
Calculated bin length	9 ft
Carbon Amendments Storage Bin =	8 ft. W
	9 ft. L
	6 ft. D
e. Footprint of compost storage bin	10.0 SF
Assume bin width of	4 ft
Calculated bin length	3 ft
Compost Amendments Storage Bin =	4 ft. W
	5 ft. L
	6 ft. D
f. Footprint of overs storage bin	14.4 SF
Assume bin width of	4 ft
Calculated bin length	4 ft
Overs Amendments Storage Bin =	4 ft. W
	5 ft. L
	6 ft. D

Feedstock Mixing

1. Daily Mix Volumes	
a. SSO	3.9 CY/day
b. Amendments	10.4 CY/day
Total	14.2 CY/day
2. Daily mixing volume needed	14.2 CY/day
3. Mixing	
a. Assume bucket blending with 4 CY bucket on loader	4 CY
b. Number of mixing loads per day	4 loads/day
c. Assume 5% volume loss in mixing	
d. Daily volume going to composting	14 CY/day
4. Area needed	30 ft W
	30 ft L

Active Composting

1. Composting residence time	35 days/cycle
2. Total volume in composting during 1 cycle	498 CY/cycle
3. Assume one ASP bin filled every 5 days	
Bin volume	68 CY/bin
4. Assume ASP bin height =	6 ft
5. Footprint of each ASP =	304 SF
6. Assume ASP bin width =	12 ft
7. Calculated ASP bin length =	25 ft
8. Number of ASP bins in each cycle:	
Total volume in cycle/ vol of each bin	8 bins/cycle
9. Area of active composting	2,433 SF
10. Assume 4 bins on each side of open floor in bldg.	
11. Dimensions	
Width: (4 x 12' W) + (5 x 2' W walls)	58 ft W
Length: 25' L x 2 + 50' aisle	100 ft L

Composting Aeration System

1. Volume of each bin	68 CY
2. Assumed bulk density of compostables	1,100 lbs/CY
3. Wet tonnage in each bin	37.2 wet tons
4. Assumed pile moisture content	50 %
5. Dry tonnage in each bin	18.6 dry tons
6. Aeration rate	750 CFH / dry ton
7. Aeration needed for each bin	13,937 CFH
8. Fan Air Flow needed	232 CFM/bin
Maximum Air Flow @ 6" W.C.	250 CFM/bin

Condensate Removal

1. Assume air stream is 100% saturated	
2. Volume of each bin	68 CY/bin
3. Assumed bulk density	800 lbs/CY
4. Weight of compostables in each bay	54,057 lbs
5. Assume moisture content =	50%
6. Weight of water in each bay's batch =	27,029 lbs
7. Assumed moisture content at completion	40%
8. Weight of water in each bay's batch at completion =	21,623 lbs
9. Water loss	5,406 lbs
10. Assume 30% evaporates out of pile when fan off	1,622 lbs
11. Remaining moisture migrating out through aeration system	3,784 lbs
12. Convert to gallons at 8.34 lbs/gal	454 gal
13. Daily production assuming a 28-day cycle	16 gal/day/bin

Biofilter System Does not include building air

1. Assume gas retention time =	60 sec
2. Air flow to biofilter from all bins	2,000.0 CFM
3. Required biofilter volume	2,000 CF
4. Assumed biofilter depth =	4 ft
5. Assumed biofilter footprint =	500 SF
6. Biofilter dimensions =	20 ft W
	25 ft L

Curing System

1. Assumed volume loss in composting	30 %
2. Volume of each ASP bin going to curing	47 CY/bin
3. Number of ASP bins going to curing monthly	8 bins
4. Total volume going to curing monthly	378 CY
5. Assumed curing residence time	2 months
6. Total volume in curing per cycle	757 CY/cycle
7. Assume cure pile turned with loader with 4 CY bucket	
8. Assumed cure pile height	7 ft
9. Footprint of cure pile	2,919 SF/cycle
10. Assume curing done in static pile in building	
14. Area Needed	30 ft W
	100 ft L

Screening System

1. Assumed volume loss in curing	10 %
2. Monthly volume to screening	341 CY/month
3. Assumed percentage of "overs"	20%
4. Monthly volume of screened compost to storage	289 CY/month
5. Monthly volume of overs to storage	51 CY/month
6. Assume use of a TROM 406 trommel	
a. Dimensions: 25' L x 8' W	
7. Area Needed	25 ft W
	35 ft L

Product Storage

1. Assumed winter storage period	5	months
2. Volume going to storage in winter	1,447	CY
3. Assumed storage pile height	8	ft
4. Storage pile footprint	4,885	SF
5. Assume storage in building		
6. Area Needed	50	ft W
	100	ft L

Area Summary

Process	Width (ft.)	Length (ft.)	Area (sq. ft.)	Area (acres)
Inside Building				
Truck Unloading Area	30	30	900	0.02
Carbon Amendments Storage	8	9	69	0.00
Compost Inoculant Storage	4	5	18	0.00
Overs Storage	4	5	18	0.00
Mixing	30	30	900	0.02
Composting Area	58	100	5,800	0.13
Curing Area	30	100	3,000	0.07
Screening Area	25	35	875	0.02
Product Storage Area	50	100	5,000	0.11
	Total		16,580	0.38
Outside Behind Building				
Biofilter	20	25	500	0.01
	Total		500	0.01

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	3/8/2013
Analysis	ASP Sizing - Seward Composting Facility - ECS CV System	rev	3/25/2013

Assumptions:
1. Facility is open 5 days/week, 52 weeks/year
2. Facility will use ECS CV System - 7 vessels
3. Exhaust air to be treated with biofilter

Waste Generation Quantities

1. Daily quantities

Food Scraps (SSO)	2.3	tons/day
Carbon	2.0	tons/day
Screened Compost (inoculant)	0.5	tons/day
Screen overs (bulking agent)	0.4	tons/day
Total Daily Tonnage	5.2	tons/day
Total Annual Tonnage	1,624.8	tons/year

2. Daily Volumes (ground up)

Food Scraps	3.9	CY/day
Carbon	7.7	CY/day
Screened Compost (inoculant)	1.1	CY/day
Screen overs (bulking agent)	1.6	CY/day
Total Daily Volumes	14.2	CY/day
Total Annual Volume	4,438	CY/year

Composting Materials Flows

1. Residence times for ASP composting (winter conditions)

	Composting	Curing	Total
ASP	21 days	69 days	90 days

2. Daily Volumes going to composting (assume 5% volume loss in grinding/mixing)

Daily volumes of mixed feedstocks = 13.5 CY/day

3. Volume of material in Primary Composting

	Residence Days	Mixed feedstocks
ASP	21	284 CY

4. Daily Volumes going to curing (assume 20% volume shrink in composting)

Daily volumes of composted feedstocks = 10.8 CY/day

5. Volume of material in Curing (Secondary Composting):

	Residence Days	Composted Feedstocks
Windrow	69	746 CY

6. Daily Volumes going to screening (assume 10% volume shrink in curing):

Daily volumes of cured feedstocks = 9.7 CY/day

7. Screening

a. Assume approx. 80% finished compost capture rate and 20% going to overs

b. Finished compost production (daily):

Daily volumes of screened compost = 7.8 CY/day

Daily volumes of overs (mulch) = 1.9 CY/day

Feedstocks Receipt/Storage Sizing Calculations

1. Feedstock Receipts
   a. Assume daily delivery of feedstocks with 1 day storage capacity
   b. Assume 2 days storage inventory of amendments inside bldg.
   c. Assume all deliveries by SSO collection or dump truck

Truck Unloading Area =		30	ft. W
		30	ft. L

2. Ground Amendments storage
   a. Volumes - assume 2 days storage

	Daily	Total	
Carbon	7.7 CY	15	CY
Screened Compost (inoculant)	1.1 CY	2	CY
Screen overs (bulking agent)	1.6 CY	3	CY
		21	CY

b. Assume amendments stored separately		
c. Assume maximum amendment depth of	6	ft
d. Footprint of carbon storage bin	68.9	SF
Assume bin width of	8	ft
Calculated bin length	9	ft
Carbon Amendments Storage Bin =	8	ft. W
	9	ft. L
	6	ft. D
e. Footprint of compost storage bin	10.0	SF
Assume bin width of	4	ft
Calculated bin length	3	ft
Compost Amendments Storage Bin =	4	ft. W
	5	ft. L
	6	ft. D
f. Footprint of overs storage bin	14.4	SF
Assume bin width of	4	ft
Calculated bin length	4	ft
Overs Amendments Storage Bin =	4	ft. W
	5	ft. L
	6	ft. D

Feedstock Mixing

Included in ECS footprint

Active Composting

Included in ECS footprint

11. Dimensions

Width:	115	ft W
Length:	109	ft L

Composting Aeration System

Included in ECS footprint

Condensate Removal

Included in ECS footprint

Biofilter System

Included in ECS footprint

Curing System

1. Assumed volume loss in composting	20	%
2. Volume of each ECS CV going to curing	36	CY/bin
3. Number of ECS CVs going to curing monthly	7	bins
4. Total volume going to curing monthly	252	CY
5. Assumed curing residence time	2.27	months
6. Total volume in curing per cycle	572	CY/cycle
7. Assume cure pile turned with loader with 4 CY bucket inside bldg.		
8. Assumed cure pile height	8	ft
9. Footprint of cure pile	1,931	SF/cycle
10. Assume curing done in static pile in building		
11. Allow extra 50% space for equip, screening, storage	965	SF
12. Total building area needed	2,896	SF
13. Area Needed	40	ft W
	72	ft L

Screening System

1. Assumed volume loss in curing	10	%
2. Monthly volume to screening	227	CY/month
3. Assumed percentage of "overs"	20%	
4. Monthly volume of screened compost to storage	193	CY/month
5. Monthly volume of overs to storage	34	CY/month
6. Assume use of a TROM 406 trommel		
a. Dimensions: 25' L x 8' W		
7. Area Needed - included in curing building	25	ft W
	35	ft L
	875	SF

Product Storage

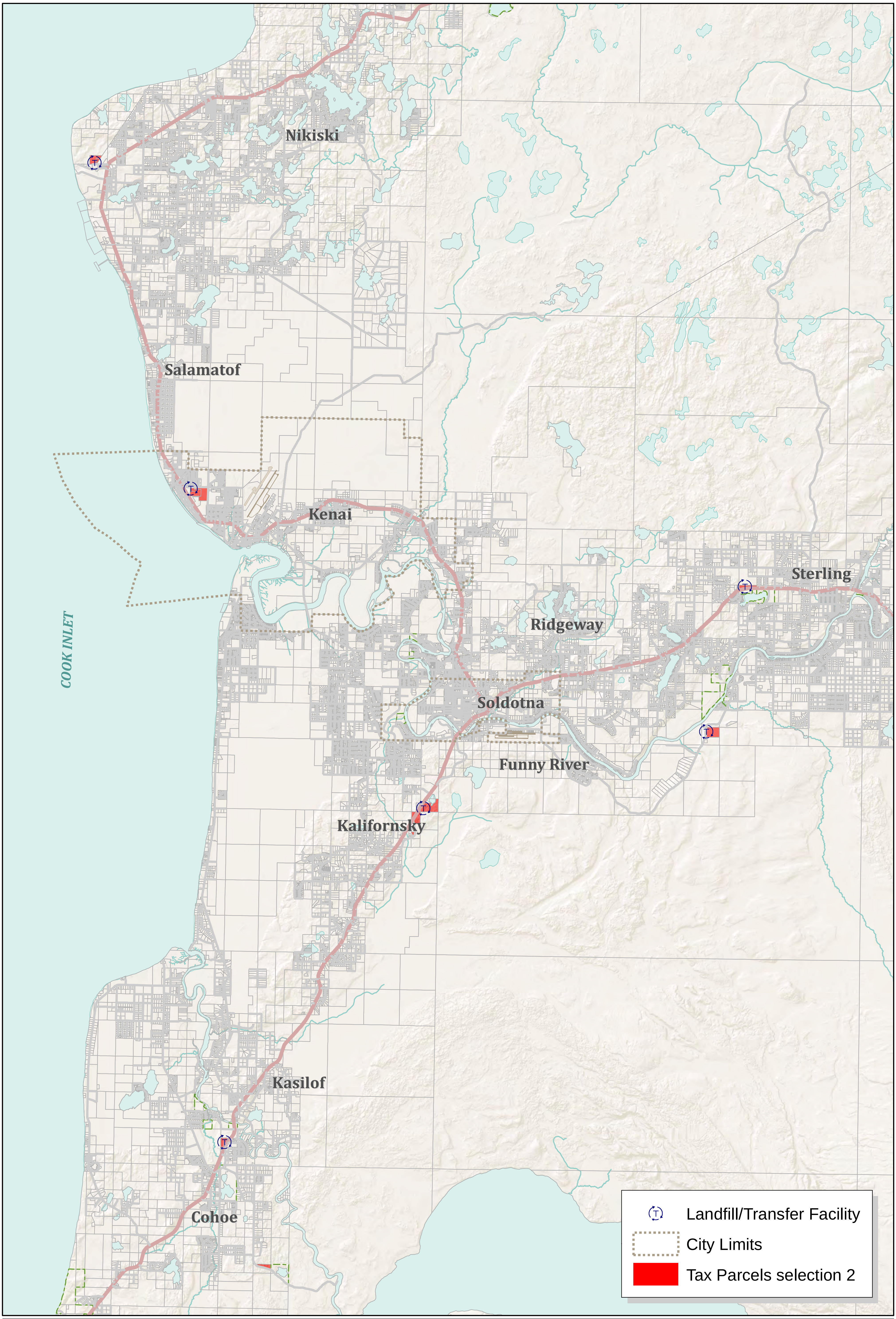
1. Assumed winter storage period	5	months
2. Volume going to storage in winter	964	CY
3. Assumed storage pile height	8	ft
4. Storage pile footprint	3,253	SF
5. Assume storage in building		
6. Area Needed - include in curing building	40	ft W
	90	ft L

Area Summary

Process	Width (ft.)	Length (ft.)	Area (sq. ft.)	Area (acres)
Inside Building				
Truck Unloading Area	30	30	900	0.02
Carbon Amendments Storage	8	9	69	0.00
Compost Inoculant Storage	4	5	18	0.00
Overs Storage	4	5	18	0.00
Curing Area	40	72	2,896	0.07
Screening Area	25	35	875	0.02
Product Storage Area	40	90	3,600	0.08
		Subtotal	8,376	0.19
Outside Behind Building				
ECS CV Compost System	115	109	12,535	0.29
		Total	20,911	0.48

Overview Siting Maps

- Soldotna Area Overview Map of Sites Evaluated
- Homer Area Overview Map of Sites Evaluated
- Seward Area Overview Map of Sites Evaluated



KPB ORGANICS RECYCLING FACILITY
SITE ANALYSIS

Figure 1

0 1.5 3 6 Miles

Date: 1/24/2013

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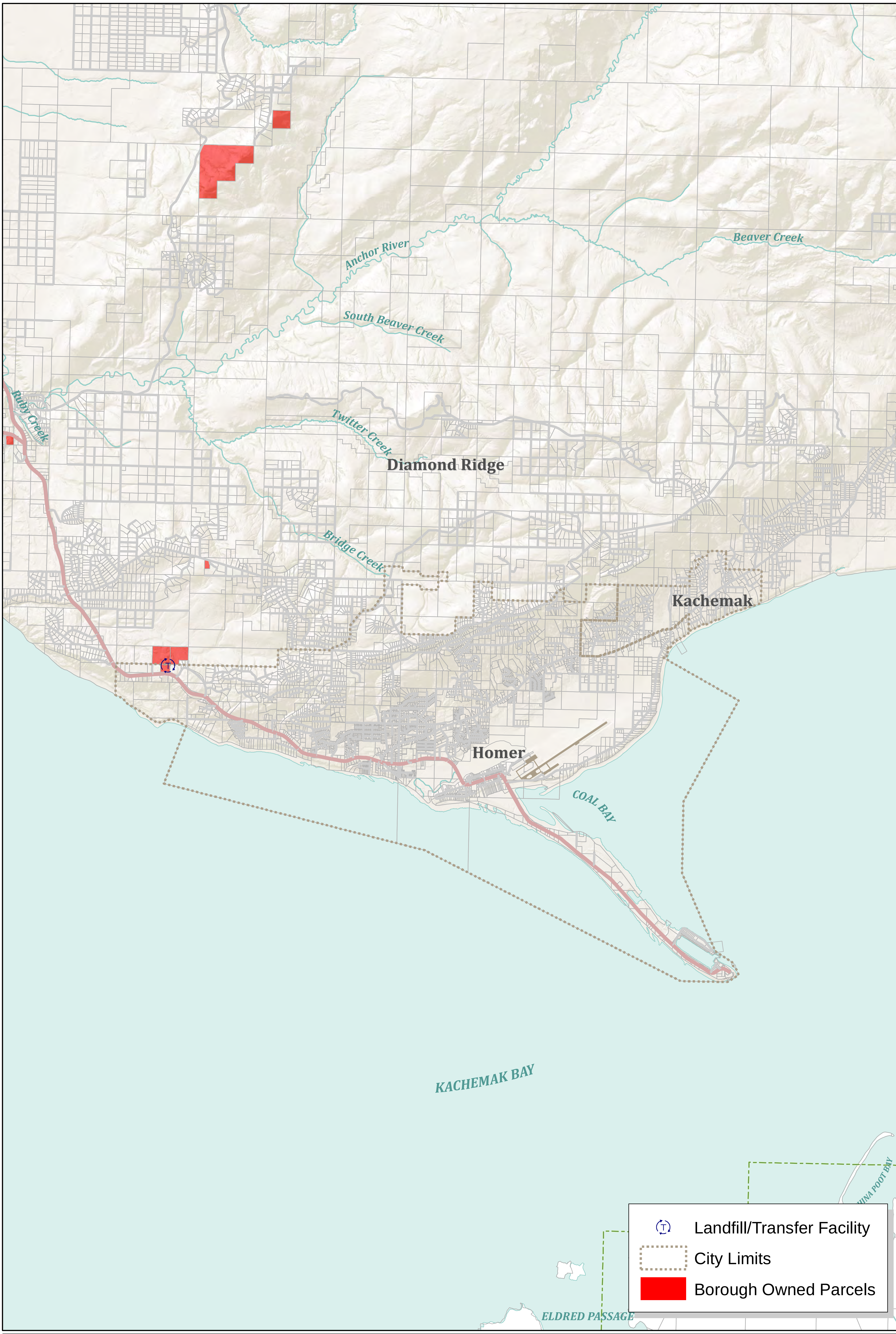

KPB ORGANICS RECYCLING FACILITY
SITE ANALYSIS

Figure 2

Date: 1/23/2013

0 0.5 1 2 Miles

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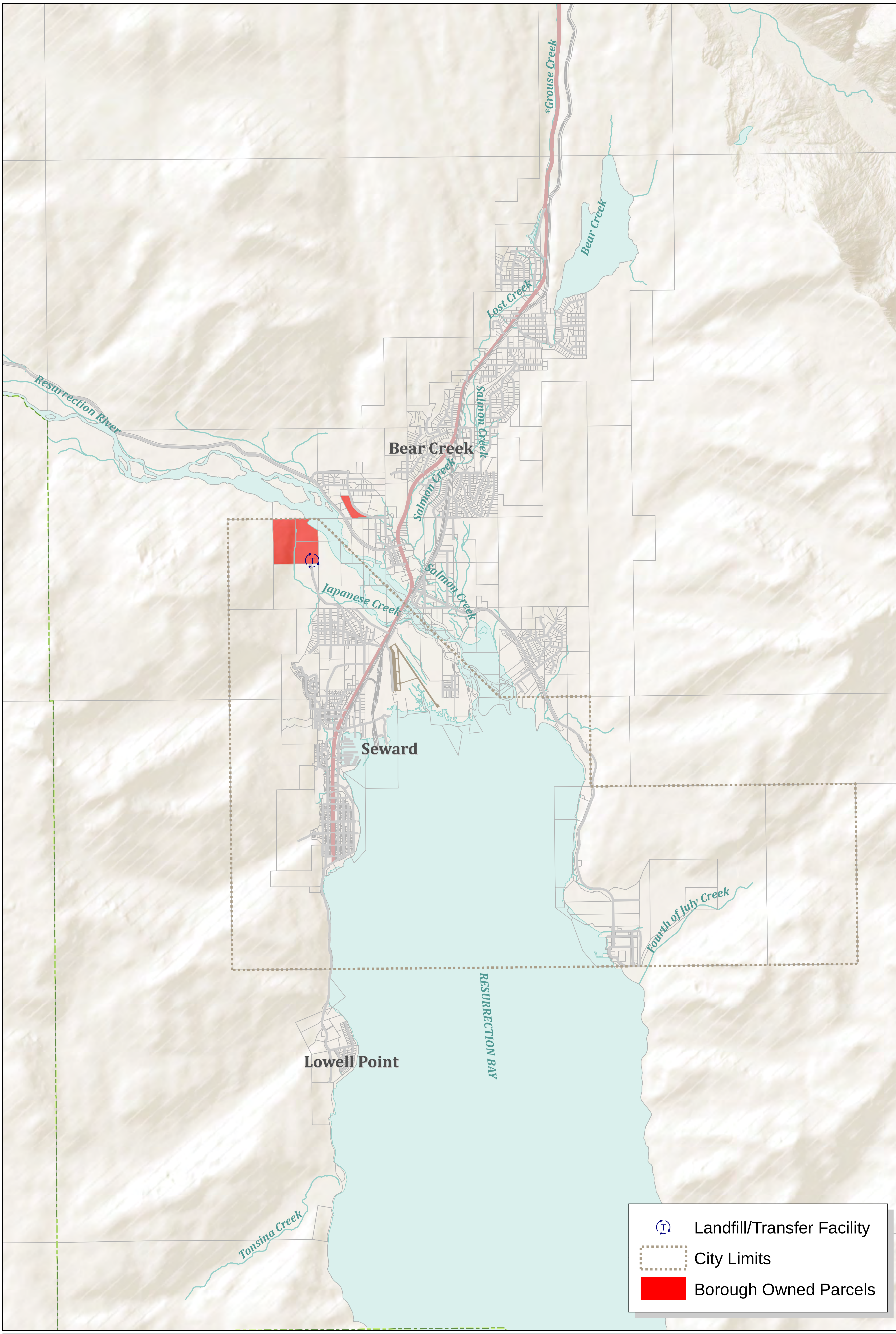

Figure 3

KPB ORGANICS RECYCLING FACILITY
SITE ANALYSIS

0 0.5 1 2 Miles

Date: 1/23/2013

N

Capital and Operating Cost Estimates

- Central Peninsula Landfill (CPL) Aerated Static Pile (ASP) System Capital Cost Estimate
- CPL ASP System Operating Cost Estimate
- CPL Engineered Compost Systems (ECS) “SV Composter” System Capital Cost Estimate
- CPL ECS “SV Composter” System Operating Cost Estimate
- Homer Facility ASP System Capital Cost Estimate
- Homer ASP System Operating Cost Estimate
- Homer ECS “CV Composter” Capital Cost Estimate
- Homer ECS “CV Composter” Operating Cost Estimate
- Seward Facility ASP System Capital Cost Estimate
- Seward ASP System Operating Cost Estimate
- Seward ECS “CV Composter” Capital Cost Estimate
- Seward ECS “CV Composter” Operating Cost Estimate

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	2/22/2013
Analysis	Composting Capital Expense Estimate - CPL		

Assumptions

1. Assume site requires 3 feet of excavation and backfill with Non-Frost-Susceptible gravel inside building and 1' ex& BF ouitside of building
2. Capacity is 8,500 ton/year food scraps + 5,000 tons/yr greenwaste

Site size		5.0	ac
	Processing building footprint	125,273	SF
	Allowance for access roads, biofilter, equipment maint.	125,273	SF
	Total area needed	250,545	SF

		Quantity	Unit	Unit Cost	Extended Cost
Components					
1. Processing Building					
Slab on grade	8" reinforced, w/ vapor barrier and subbase	125,273	SF	$ 12.00	$ 1,503,272
Slab & foundation excavation	after mass excav & fil)	125,273	SF	$ 0.28	$ 35,076
4' foundation wall (push wall)		520	LF	$ 115.00	$ 59,800
Pre-engineered steel building	with insulated panels	125,273	SF	$ 40.00	$ 5,010,906
2. Services					
Exhaust fans/louvers		125,273	SF	$ 0.26	$ 32,571
Fire protection sprinklers		125,273	SF	$ 3.49	$ 437,202
Standpipe and fire pump		125,273	SF	$ 1.88	$ 235,513
Fire Water Storage tank	100,000 g?				$ 250,000
Electrical Service & distribution	200 amp service	125,273	SF	$ 0.48	$ 60,131
Lighting & branch wiring		125,273	SF	$ 5.79	$ 725,329
Comm & security	Alarms, emerg lights	125,273	SF	$ 1.27	$ 159,096
Sewer connection/septic field		allowance			$ 15,000
3. Composting Bins & Biofilter					
Bin walls	16 bins, 128 lf, 8' H, 12" thick	16384	SF	$ 42.00	$ 688,128
Blowers	16, 1,500 cfm each	16	EA	$ 1,500.00	$ 24,000
Aeration piping	3" PVC, 260 LF/bin	2080	LF	$ 3.25	$ 6,760
Exhaust piping	4" - 8" spiral steel	800	LF	$ 3.70	$ 2,960
Biofilter		1000	SF	$ 6.00	$ 6,000
Condensate removal/recycling		allowance			$ 8,000
4. Sitework					
Clearing and Grubbing		5	ac	$ 8,000.00	$ 40,000
Unclassified excavation		23,000	cy	$ 4.00	$ 92,000
NFS gravel backfill for Building	36" thick compacted	14,000	cy	$ 22.00	$ 308,000
Gravel pads for outdoor areas	12" thick, compacted	7,000	cy	$ 22.00	$ 154,000
Sediment/erosion control		allowance			$ 15,000
				Subtotal	**$ 9,699,743**
				Contingency @ 25%	**$ 2,424,936**
				Subtotal	**$ 12,124,678**

Used Equipment

Loader	Volvo L70		3	$ 79,500	$ 238,500
2nd bucket	3 CY bucket	for product only	2	$ 6,500	$ 13,000
Screen	Wildcat 612		1	$ 85,000	$ 85,000
Grinder	Peterson 4400B horiz		1	$ 89,500	$ 89,500
				Subtotal	**$ 426,000**

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	2/26/2013
Analysis	Composting Operating Expense Estimate - CPL		

Assumptions

1. Labor rate (loaded) per hour	$25.00 per hour
2. Machine rate (fuel + maintenance)	$50.00 per hour
3. Electricity rate	$0.09 per kWh
4. Does not include amortized capital	
5. Facility is open 5 days/week, 52 weeks/year (260 days/yr)	

			Annual Costs
Waste Receipt			
Daily incoming tonnage of food scraps	34.0	ton/day	
Assume average of	2	tons/load	
Number of loads	17.02	loads/day	
Time to inspect each load	5	min/load	
Time to push into pile	5	min/load	
Total labor needed daily	170	mins	
	2.8	hrs/day	$18,438
Loader operating cost	2.8	hrs/day	$36,875
Daily incoming tonnage of carbon	20.0	ton/day	
Assume average of 10	2	tons/load	
Number of loads	10	loads/day	
Time to inspect each load	2	min/load	
Time to transfer to storage	5	min/load	
Total labor needed daily	70	mins	
	1.2	hrs/day	$7,583
Loader operating cost	1.2	hrs/day	$15,167
Mixing operations			
Feedstocks to mixing daily	166	CY/day	
Assume use of 3-CY bucket on FEL to blend			
Volume of loader bucket	6	CY	
Number of bucket movements daily	28	buckets/day	
Time to move to mix pad & return	5	min/bucket	
Total labor needed daily	138	min/day	
	2.3	hrs/day	
Loader operating cost	2.3	hrs/day	
Annual labor cost for mixing			$14,951
Annual cost of mixing			$29,902
Pile Building Operations			
Aeration piping			
Assume in-floor permanent piping - both composting and curing bays			
Wood chips for aeration plenum - both bay types			
Area of each bay	1,258	SF	
Depth of plenum	0.667	ft	
Volume of plenum	31	CY each	
Number of bays/year	167	bays/yr	

Total volume of plenum mat'ls.	5,184	CY	
Unit cost of wood chips	$5.00	per CY	
Total cost of plenum materials			$25,919
1. Time to install plenum	0.5	hr	
2. Number of bays built per year	167	piles/yr	
3. Annual cost of labor to install plenum			$2,086
4. Annual machine cost to install plenum			$4,171
5. Daily volume going to composting	149	CY/day	
6. Bucket size on loader	6	CY	
7. Number of bucket trips/day	25	trips/day	
Length of each trip	4	minutes	
Total time needed daily	99	min/day	
	1.7	hrs/day	
8. Annual cost of labor to build piles			$10,765
9. Annual machine cost to build piles			$21,529
Electricity for Composting			
1. Blower horsepower rating	1.5	hp	
Percent full load	75	%	
Motor nameplate efficiency	90	%	
Operating hours/yr (30 min on/30 min off/hr)	4380	hrs/year	
Annual cost of each motor	$465		
2. Annual electricity cost for blowers			$7,440
Biofilter Operations			
1. Assume pile blowers can discharge directly into biofilter			
2. Assume daily inspection of biofilter operations			
Labor to inspect daily	0.25	hrs/day	
3. Annual cost of labor to inspect biofilter			$1,625
Bay Removal to Curing			
1. Daily volume going to curing	104	CY/day	
a. Assume one ASP torn down each day			
2. Bucket size on loader	6	CY	
3. Number of bucket trips/day	17	trips/day	
Length of each trip	3	minutes	
Total time needed daily	52	min/day	
	0.9	hrs/day	
4. Annual cost of labor to empty bays			$5,651
5. Annual machine cost to empty bays			$11,303
Curing Pile Tear-Down			
1. Daily volume going from curing to screening	94	CY/day	
2. Capacity of loader bucket	6	CY	
3. Number of loader trips needed per day	16	trips/day	
4. Assumed time to reach screen	3	minutes	
5. Time needed for windrow tear-down	0.8	hrs/day	
6. Annual cost of labor to empty bays			$5,086
7. Annual machine cost to empty bays			$10,173
Screening			
1. Assume trommel screen with 3/8" screen			
Feed rate	50	CY/hr	
Screening time per CY	0.02	hr/CY	
Screening time needed	1.9	hr/day	
2. Annual cost for labor to screen			$12,207
3. Annual machine cost for screening			$24,414

Moving Materials to Storage

1. Daily overs production	19	CY/day	
2. Daily compost production	75	CY/day	
3. Capacity of loader bucket	6	CY	
4. Number of loader trips needed per day	16	trips/day	
5. Assumed time to reach storage	3	minutes	
6. Time needed weekly for storage	0.8	hrs/day	
6. Annual cost of labor for moving materials			$5,086
7. Annual machine cost for moving materials			$10,173

Loading out Compost to Market

1. Annual compost production estimate	19531.2	CY/yr	
2. Average out-load truck size	40	CY	
3. Annual number of loads	488	loads	
4. Time needed to load truck	1	hr	
5. Annual loading time needed	488	hours/yr	
6. Annual cost of labor for truck load-out			$12,207
7. Annual machine cost for truck load-out			$24,414

Housekeeping

1. Assume 1 hr/day spent on housekeeping	1	hrs/day	
2. Annual time spent housekeeping	260	hrs/yr	
3. Annual cost of labor for housekeeping			$6,500

Subtotals			FTEs	
	Labor	$102,185		2.0
	Machine Usage	$188,120		
	Consumables	$33,359		
Total		$323,664		
	Annual Tonnage	20,198	tons/yr	
	Cost per ton	$16.02	per ton	

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	3/19/2013
Analysis	Composting Capital Expense Estimate - CPL - ECS SV System		rev 3/25/2013

Assumptions

1. Assume site requires 3 feet of excav and backfill with non frost susceptible gravel inside building and 2' ex & bfill outside of building
2. Capacity is 600 ton/year food scraps + 500 tons/yr greenwaste
3. ECS quote is for 8 vessel SV Composter system with mixer

Site size		5.0	ac
	Processing building footprint	30,318	SF
	ECS system footprint	23,738	SF
	Allowance for access roads, equipment maint.	5,000	SF
	Total area needed	59,056	SF

		Quantity	Unit	Unit Cost	Extended Cost
Components					
1. Processing Building					
Slab on grade	8" reinforced, w/ vapor barrier and subbase	30,318	SF	$ 12.00	$ 363,811
Slab & foundation excavation	after mass ex& fill	30,318	SF	$ 0.28	$ 8,489
4' foundation wall (push wall)		650	LF	$ 75.00	$ 48,750
Pre-engineered steel building		30,318	SF	$ 40.00	$ 1,212,705
2. Services					
Exhaust fans/louvers		30,318	SF	$ 0.26	$ 7,883
Fire protection sprinklers		30,318	SF	$ 3.49	$ 105,808
Standpipe and fire pump		30,318	SF	$ 1.88	$ 56,997
Fire water storage tank	50,000 g ?				$ 125,000
Electrical Service & distribution	200 amp service	30,318	SF	$ 0.48	$ 14,552
Lighting & branch wiring		30,318	SF	$ 5.79	$ 175,539
Comm & security	Alarms, emerg lights	30,318	SF	$ 1.27	$ 38,503
Sewer conn./septic field		allowance			$ 10,000
3. ECS Composting System, mixer & biofilter					
Per budget estimate					$ 1,365,000
Installation fee - assume 50% of capital expense					$ 682,500
Biofilter media	30' x 45' x 4'	200	CY	$ 15.00	$ 3,000
4. Sitework					
Clearing and Grubbing		5	ac	$ 7,000	$ 35,000
Unclassified Excavation		23,000	cy	$ 4.00	$ 92,000
NFS Gravel backfill for building		14,000	cy	$ 22.00	$ 308,000
Gravel pads for outdoor areas	12" thick, compacted	7,000	cy	$ 22.00	$ 154,000
Concrete pads for ECS reactors		11132	SF	$ 12.00	$ 133,584
Asphalt pad for rest of ECS system		12,606	SF	$ 6.00	$ 75,636
Sediment/erosion control		allowance			$ 10,000
				Subtotal	**$ 5,026,758**
				Contingency @ 25%	**$ 1,256,690**
				Subtotal	**$ 6,283,448**

Used Equipment					
Loader	Volvo L70		3	$ 79,500	$ 238,500
2nd bucket	3 CY bucket	for product only	2	$ 6,500	$ 13,000
Screen	Trom 406		1	$ 85,000	$ 85,000
Grinder	Peterson 4400B horiz		1	$ 89,500	$ 89,500
				Subtotal	**$ 426,000**

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Client	Nelson Engineering	**Date**	3/19/2013
Analysis	Composting Operating Expense Estimate - CPL - ECS SV System		

Assumptions

1. Labor rate (loaded) per hour	$25.00	per hour
2. Machine rate (fuel + maintenance)	$50.00	per hour
3. Electricity rate	$0.09	per kWh
4. Does not include amortized capital		
5. Facility is open 5 days/week, 52 weeks/year (260 days/yr)		

			Annual Costs
Waste Receipt			
Daily incoming tonnage of food scraps	34.0	ton/day	
Assume average of	6	tons/load	
Number of loads	5.67	loads/day	
Time to inspect each load	5	min/load	
Time to push into pile	5	min/load	
Total labor needed daily	57	mins	
	0.9	hrs/day	$6,146
Loader operating cost	0.9	hrs/day	$12,292
Daily incoming tonnage of carbon	20.0	ton/day	
Assume average of 10	6	tons/load	
Number of loads	3.3	loads/day	
Time to inspect each load	2	min/load	
Time to transfer to storage	5	min/load	
Total labor needed daily	23	mins	
	0.4	hrs/day	$2,528
Loader operating cost	0.4	hrs/day	$5,056
Mixing operations			
Feedstocks to mixing daily	166	CY/day	
Assume use ECS mixer to mix			
Volume of loader bucket	6	CY	
Number of bucket movements daily	28	buckets/day	
Time to move to mixer & return	5	min/bucket	
Total labor needed daily (in ECS estimate)	138	min/day	
	2.3	hrs/day	
Loader operating cost	2.3	hrs/day	
Annual labor cost for mixing (in ECS labor estimate)			$0
Annual loader cost for mixing (mixer cost in ECS estimate below)			$29,902
ECS CV System operating cost			
ECS estimated labor (3.0 FTE)	6240	hrs/yr	
ECS estimated electrical consumption	28	kW	
Annual usage	8760	hrs/yr	
Loader operating hours to load/unload	800	hrs/yr	

Annual cost of labor to manage CV system			$156,000
Annual electrical cost for CV system			$22,075
Annual cost for loaders to load/unload			$40,000
Biofilter Operations			
1. Assume pile blowers can discharge directly into biofilter			
2. Assume daily inspection of biofilter operations			
Labor to inspect daily (in ECS estimate)		hrs/day	
3. Annual cost of labor to inspect biofilter			$0
SV Container Contents Removal to Curing			
1. Daily volume going to curing	126	CY/day	
a. Assume one ASP torn down each day			
2. Bucket size on loader	6	CY	
3. Number of bucket trips/day	21	trips/day	
Length of each trip	3	minutes	
Total time needed daily	63	min/day	
	1.0	hrs/day	
4. Annual cost of labor to empty bays			$6,818
5. Annual machine cost to empty bays			$13,635
Curing Pile Tear-Down			
1. Daily volume going from curing to screening	113	CY/day	
2. Capacity of loader bucket	6	CY	
3. Number of loader trips needed per day	19	trips/day	
4. Assumed time to reach screen	3	minutes	
5. Time needed for windrow tear-down	0.9	hrs/day	
6. Annual cost of labor to empty bays			$6,136
7. Annual machine cost to empty bays			$12,272
Screening			
1. Assume trommel screen with 3/8" screen			
Feed rate	50	CY/hr	
Screening time per CY	0.02	hr/CY	
Screening time needed	2.3	hr/day	
2. Annual cost for labor to screen			$14,726
3. Annual machine cost for screening			$29,452
Moving Materials to Storage			
1. Daily overs production	91	CY/day	
2. Daily compost production	23	CY/day	
3. Capacity of loader bucket	6	CY	
4. Number of loader trips needed per day	19	trips/day	
5. Assumed time to reach storage	3	minutes	
6. Time needed weekly for storage	0.9	hrs/day	
6. Annual cost of labor for moving materials			$6,136
7. Annual machine cost for moving materials			$12,272
Loading out Compost to Market			
1. Annual compost production estimate	1,771	CY/yr	
2. Average out-load truck size	20	CY	
3. Annual number of loads	89	loads	
4. Time needed to load truck	0.5	hr	
5. Annual loading time needed	44	hours/yr	
6. Annual cost of labor for truck load-out			$1,107

7. Annual machine cost for truck load-out			$2,214	

Housekeeping

1. Assume 1 hr/day spent on housekeeping	1	hrs/day		
2. Annual time spent housekeeping	260	hrs/yr		
3. Annual cost of labor for housekeeping			$6,500	

Subtotals			FTEs	
	Labor	$206,096		4.0
	Machine Usage	$139,168		
	Consumables	$40,000		
Total		$385,263		
	Annual Tonnage	20,198	tons/yr	
	Cost per ton	$19.07	per ton	

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	2/22/2013
Analysis	Composting Capital Expense Estimate - Homer		

Assumptions

1. Assume site requires 3 feet of excav and backfill with non frost susceptible gravel inside building and 2' ex & bfill outside of building
2. Capacity is 1400 ton/year food scraps + 1000 tons/yr greenwaste

Site size		1.4	ac
	Processing building footprint	30,052	SF
	Allowance for access roads, biofilter, equipment maint.	30,052	SF
	Total area needed	60,104	SF

		Quantity	Unit	Unit Cost	Extended Cost
Components					
1. Processing Building					
Slab on grade	8" reinforced, w/ vapor barrier and subbase	30,052	SF	$ 12.00	$ 360,621
Slab & foundation excavation	after mass ex&fill	30,052	SF	$ 0.28	$ 8,414
4' foundation wall (push wall)		520	LF	$ 75.00	$ 39,000
Pre-engineered steel building		30,052	SF	$ 40.00	$ 1,202,070
2. Services					
Exhaust fans/louvers		30,052	SF	$ 0.26	$ 7,813
Fire protection sprinklers		30,052	SF	$ 3.49	$ 104,881
Standpipe and fire pump		30,052	SF	$ 1.88	$ 56,497
Fire water storage tank	50,000g ?				$ 125,000
Electrical Service & distribution	200 amp service	30,052	SF	$ 0.48	$ 14,425
Lighting & branch wiring		30,052	SF	$ 5.79	$ 174,000
Comm & security	Alarms, emerg lights	30,052	SF	$ 1.27	$ 38,166
Sewer connection/septic field		allowance			$ 15,000
3. Composting Bins & Biofilter					
Bin walls	8 bins, 86 lf, 6' H, 12" thick	4128	SF	$ 42.00	$ 173,376
Blowers	8, 500 cfm each	8	EA	$ 500.00	$ 4,000
Aeration piping	3" PVC, 135 LF/bin	1080	LF	$ 3.25	$ 3,510
Exhaust piping	4" - 8" spiral steel	400	LF	$ 3.70	$ 1,480
Biofilter		1000	SF	$ 6.00	$ 6,000
Condensate removal/recycling		allowance			$ 4,000
4. Sitework					
Clearing and Grubbing		1.4	ac	$ 7,000.00	$ 9,800
Unclassified Excavation		5,600	cy	$ 4.00	$ 22,400
NFS Gravel backfill for building		3,400	cy	$ 22.00	$ 2,500
Gravel pads for outdoor areas	12" thick, compacted	1,700	cy	$ 22.00	$ 37,400
Sediment/erosion control		allowance			$ 10,000
				Subtotal	**$ 2,420,354**
				Contingency @ 25%	**$ 605,088**
				Subtotal	**$ 3,025,442**

Used Equipment

Loader	Volvo L70		2	$ 79,500	$ 159,000
2nd bucket	3 CY bucket	for product only	1	$ 6,500	$ 6,500
Screen	Trom 406		1	$ 47,900	$ 47,900
Grinder	Peterson 4400B horiz		1	$ 89,500	$ 89,500
				Subtotal	**$ 302,900**

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	2/26/2013
Analysis	Composting Operating Expense Estimate - Homer		

Assumptions

1. Labor rate (loaded) per hour	$25.00	per hour
2. Machine rate (fuel + maintenance)	$50.00	per hour
3. Electricity rate	$0.09	per kWh
4. Does not include amortized capital		
5. Facility is open 5 days/week, 52 weeks/year (260 days/yr)		

			Annual Costs
Waste Receipt			
Daily incoming tonnage of food scraps	5.8	ton/day	
Assume average of	2	tons/load	
Number of loads	2.88	loads/day	
Time to inspect each load	5	min/load	
Time to push into pile	5	min/load	
Total labor needed daily	29	mins	
	0.5	hrs/day	$3,125
Loader operating cost	0.5	hrs/day	$6,250
Daily incoming tonnage of carbon	4.0	ton/day	
Assume average of 10	2	tons/load	
Number of loads	2	loads/day	
Time to inspect each load	2	min/load	
Time to transfer to storage	5	min/load	
Total labor needed daily	14	mins	
	0.2	hrs/day	$1,517
Loader operating cost	0.2	hrs/day	$3,033
Mixing operations			
Feedstocks to mixing daily	31	CY/day	
Assume use of 3-CY bucket on FEL to blend			
Volume of loader bucket	3	CY	
Number of bucket movements daily	10	buckets/day	
Time to move to mix pad & return	5	min/bucket	
Total labor needed daily	51	min/day	
	0.9	hrs/day	
Loader operating cost	0.9	hrs/day	
Annual labor cost for mixing			$5,529
Annual cost of mixing			$11,058
Pile Building Operations			
Aeration piping			
Assume in-floor permanent piping - both composting and curing bays			
Wood chips for aeration plenum - both bay types			
Area of each bay	620	SF	
Depth of plenum	0.667	ft	
Volume of plenum	15	CY each	
Number of bays/year	83	bays/yr	

Total volume of plenum mat'ls.	1,278	CY	
Unit cost of wood chips	$5.00	per CY	
Total cost of plenum materials			$6,390
1. Time to install plenum	0.5	hr	
2. Number of bays built per year	83	piles/yr	
3. Annual cost of labor to install plenum			$1,043
4. Annual machine cost to install plenum			$2,086
5. Daily volume going to composting	14	CY/day	
6. Bucket size on loader	3	CY	
7. Number of bucket trips/day	5	trips/day	
Length of each trip	4	minutes	
Total time needed daily	18	min/day	
	0.3	hrs/day	
8. Annual cost of labor to build piles			$1,952
9. Annual machine cost to build piles			$3,904

Electricity for Composting

1. Blower horsepower rating	1	hp	
Percent full load	75	%	
Motor nameplate efficiency	90	%	
Operating hours/yr (30 min on/30 min off/hr)	4380	hrs/year	
Annual cost of each motor	$310		
2. Annual electricity cost for blowers			$2,480

Biofilter Operations

1. Assume pile blowers can discharge directly into biofilter			
2. Assume daily inspection of biofilter operations			
Labor to inspect daily	0.25	hrs/day	
3. Annual cost of labor to inspect biofilter			$1,625

Bay Removal to Curing

1. Daily volume going to curing	19	CY/day	
a. Assume one ASP torn down each day			
2. Bucket size on loader	3	CY	
3. Number of bucket trips/day	6	trips/day	
Length of each trip	3	minutes	
Total time needed daily	19	min/day	
	0.3	hrs/day	
4. Annual cost of labor to empty bays			$2,090
5. Annual machine cost to empty bays			$4,180

Curing Pile Tear-Down

1. Daily volume going from curing to screening	17	CY/day	
2. Capacity of loader bucket	3	CY	
3. Number of loader trips needed per day	6	trips/day	
4. Assumed time to reach screen	3	minutes	
5. Time needed for windrow tear-down	0.3	hrs/day	
6. Annual cost of labor to empty bays			$1,881
7. Annual machine cost to empty bays			$3,762

Screening

1. Assume trommel screen with 3/8" screen			
Feed rate	50	CY/hr	
Screening time per CY	0.02	hr/CY	
Screening time needed	0.3	hr/day	
2. Annual cost for labor to screen			$2,257
3. Annual machine cost for screening			$4,514

Moving Materials to Storage

1. Daily overs production	3	CY/day	
2. Daily compost production	14	CY/day	
3. Capacity of loader bucket	3	CY	
4. Number of loader trips needed per day	6	trips/day	
5. Assumed time to reach storage	3	minutes	
6. Time needed weekly for storage	0.3	hrs/day	
6. Annual cost of labor for moving materials			$1,881
7. Annual machine cost for moving materials			$3,762

Loading out Compost to Market

1. Annual compost production estimate	3611.3	CY/yr	
2. Average out-load truck size	20	CY	
3. Annual number of loads	181	loads/yr	
4. Time needed to load truck	0.5	hr	
5. Annual loading time needed	90	hours/yr	
6. Annual cost of labor for truck load-out			$2,257
7. Annual machine cost for truck load-out			$4,514

Housekeeping

1. Assume 1 hr/day spent on housekeeping	1	hrs/day	
2. Annual time spent housekeeping	260	hrs/yr	
3. Annual cost of labor for housekeeping			$6,500

Subtotals			FTEs	
	Labor	$31,656		0.6
	Machine Usage	$47,062		
	Consumables	$8,870		
Total		$87,588		
	Annual Tonnage	3,628	tons/yr	
	Cost per ton	$24.14	per ton	

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	3/19/2013
Analysis	Composting Capital Expense Estimate - Homer - ECS CV System		

Assumptions

1. Assume site requires 3 feet of excav and backfill with non frost susceptible gravel inside building and 2' ex & bfill outside of building
2. Capacity is 600 ton/year food scraps + 500 tons/yr greenwaste
3. ECS quote is for 14 vessel CV Composter system with mixer

Site size		0.8	ac
	Processing building footprint	17,441	SF
	ECS system footprint	17,985	SF
	Allowance for access roads, equipment maint.	2,500	SF
	Total area needed	37,926	SF

		Quantity	Unit	Unit Cost	Extended Cost
Components					
1. Processing Building					
Slab on grade	8" reinforced, w/ vapor barrier and subbase	17,441	SF	$ 12.00	$ 209,288
Slab & foundation excavation	after mass ex& fill	17,441	SF	$ 0.28	$ 4,883
4' foundation wall (push wall)		520	LF	$ 75.00	$ 39,000
Pre-engineered steel building		17,441	SF	$ 40.00	$ 697,627
2. Services					
Exhaust fans/louvers		17,441	SF	$ 0.26	$ 4,535
Fire protection sprinklers		17,441	SF	$ 3.49	$ 60,868
Standpipe and fire pump		17,441	SF	$ 1.88	$ 32,788
Fire water storage tank	50,000 g ?				$ 125,000
Electrical Service & distribution	200 amp service	17,441	SF	$ 0.48	$ 8,372
Lighting & branch wiring		17,441	SF	$ 5.79	$ 100,981
Comm & security	Alarms, emerg lights	17,441	SF	$ 1.27	$ 22,150
Sewer conn./septic field		allowance			$ 10,000
3. ECS Composting System, mixer & biofilter					
Per budget estimate					$ 1,297,000
Installation fee - assume 50% of capital expense					$ 648,500
4. Sitework					
Clearing and Grubbing		0.8	ac	$ 7,000.00	$ 5,600
Unclassified Excavation		3100	cy	$ 4.00	$ 12,400
NFS Gravel backfill for building		1850	cy	$ 22.00	$ 40,700
Gravel pads for outdoor areas	12" thick, compacted	1250	cy	$ 22.00	$ 27,500
Concrete pads for ECS containers		6540	SF	$ 12.00	$ 78,480
Asphalt pad for rest of ECS system		11,445	SF	$ 6.00	$ 68,670
Sediment/erosion control		allowance			$ 10,000
				Subtotal	**$ 3,504,342**
				Contingency @ 25%	**$ 876,086**
				Subtotal	**$ 4,380,428**

Used Equipment

Loader	Volvo L70		1	$ 79,500	$ 79,500
2nd bucket	3 CY bucket	for product only	1	$ 6,500	$ 6,500
Screen	Trom 406		1	$ 47,900	$ 47,900
Grinder	Peterson 4400B horiz		1	$ 89,500	$ 89,500
				Subtotal	**$ 223,400**

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	3/19/2013
Analysis	Composting Operating Expense Estimate - Homer - ECS		

Assumptions

1. Labor rate (loaded) per hour	$25.00	per hour
2. Machine rate (fuel + maintenance)	$50.00	per hour
3. Electricity rate	$0.09	per kWh
4. Does not include amortized capital		
5. Facility is open 5 days/week, 52 weeks/year (260 days/yr)		

			Annual Costs
Waste Receipt			
Daily incoming tonnage of food scraps	5.8	ton/day	
Assume average of	2	tons/load	
Number of loads	2.88	loads/day	
Time to inspect each load	5	min/load	
Time to push into pile	5	min/load	
Total labor needed daily	29	mins	
	0.5	hrs/day	$3,125
Loader operating cost	0.5	hrs/day	$6,250
Daily incoming tonnage of carbon	4.0	ton/day	
Assume average of 10	2	tons/load	
Number of loads	2	loads/day	
Time to inspect each load	2	min/load	
Time to transfer to storage	5	min/load	
Total labor needed daily	14	mins	
	0.2	hrs/day	$1,517
Loader operating cost	0.2	hrs/day	$3,033
Mixing operations			
Feedstocks to mixing daily	31	CY/day	
Assume use ECS mixer to mix			
Volume of loader bucket	3	CY	
Number of bucket movements daily	10	buckets/day	
Time to move to mixer & return	5	min/bucket	
Total labor needed daily (in ECS estimate)	51	min/day	
	0.9	hrs/day	
Loader operating cost	0.9	hrs/day	
Annual labor cost for mixing (in ECS labor estimate)			$0
Annual loader cost for mixing (mixer cost in ECS estimate below)			$11,058
ECS CV System operating cost			
ECS estimated labor (1.0 FTE)	2080	hrs/yr	
ECS estimated electrical consumption	10.4	kWh	
Annual usage	8760	hrs/yr	
ECS estimated roll-off truck usage	300	hrs/yr	

Annual cost of labor to manage CV system			$52,000
Annual electrical cost for CV system			$8,199
Annual cost for roll-off truck to empty CV containers			$15,000
Biofilter Operations			
Included in ECS estimate			
Replace biofilter media annually			
Media volume = 2(10' x 20' x 4') = 1600 cf =	60	CY/yr	
Media cost =	$ 15.00	CY	$ 900
CV Container Contents Removal to Curing			
1. Daily volume going to curing	23	CY/day	
a. Assume one ASP torn down each day			
2. Bucket size on loader	3	CY	
3. Number of bucket trips/day	8	trips/day	
Length of each trip	3	minutes	
Total time needed daily	23	min/day	
	0.4	hrs/day	
4. Annual cost of labor to empty bays			$2,521
5. Annual machine cost to empty bays			$5,042
Curing Pile Tear-Down			
1. Daily volume going from curing to screening	21	CY/day	
2. Capacity of loader bucket	3	CY	
3. Number of loader trips needed per day	7	trips/day	
4. Assumed time to reach screen	3	minutes	
5. Time needed for windrow tear-down	0.3	hrs/day	
6. Annual cost of labor to empty bays			$2,269
7. Annual machine cost to empty bays			$4,538
Screening			
1. Assume trommel screen with 3/8" screen			
Feed rate	50	CY/hr	
Screening time per CY	0.02	hr/CY	
Screening time needed	0.4	hr/day	
2. Annual cost for labor to screen			$2,723
3. Annual machine cost for screening			$5,446
Moving Materials to Storage			
1. Daily overs production	4	CY/day	
2. Daily compost production	17	CY/day	
3. Capacity of loader bucket	3	CY	
4. Number of loader trips needed per day	7	trips/day	
5. Assumed time to reach storage	3	minutes	
6. Time needed weekly for storage	0.3	hrs/day	
6. Annual cost of labor for moving materials			$2,269
7. Annual machine cost for moving materials			$4,538
Loading out Compost to Market			
1. Annual compost production estimate	1,771	CY/yr	
2. Average out-load truck size	20	CY	
3. Annual number of loads	89	loads	
4. Time needed to load truck	0.5	hr	
5. Annual loading time needed	44	hours/yr	
6. Annual cost of labor for truck load-out			$1,107

7. Annual machine cost for truck load-out $2,214

Housekeeping

1. Assume 1 hr/day spent on housekeeping	1	hrs/day	
2. Annual time spent housekeeping	260	hrs/yr	
3. Annual cost of labor for housekeeping			$6,500

Subtotals			FTEs	
	Labor	$74,030		1.4
	Machine Usage	$50,318		
	Consumables	$15,900		
Total		$140,248		
	Annual Tonnage	3,628	tons/yr	
	Cost per ton	$38.65	per ton	

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	2/22/2013
Analysis	Composting Capital Expense Estimate - Seward		

Assumptions

1. Assume site requires 3 feet of excav and backfill with non frost susceptible gravel inside building and 2' ex & bfill outside of building
2. Capacity is 600 ton/year food scraps + 500 tons/yr greenwaste

Site size		0.8	ac
	Processing building footprint	16,580	SF
	Allowance for access roads, biofilter, equipment maint.	16,580	SF
	Total area needed	33,161	SF

		Quantity	Unit	Unit Cost	Extended Cost
Components					
1. Processing Building					
Slab on grade	8" reinforced, w/ vapor barrier and subbase	16,580	SF	$ 12.00	$ 198,964
Slab & foundation excavation	after mass ex& fill	16,580	SF	$ 0.28	$ 4,642
4' foundation wall (push wall)		520	LF	$ 75.00	$ 39,000
Pre-engineered steel building		16,580	SF	$ 40.00	$ 663,212
2. Services					
Exhaust fans/louvers		16,580	SF	$ 0.26	$ 4,311
Fire protection sprinklers		16,580	SF	$ 3.49	$ 57,865
Standpipe and fire pump		16,580	SF	$ 1.88	$ 31,171
Fire water storage tank	50,000 g ?				$ 125,000
Electrical Service & distribution	200 amp service	16,580	SF	$ 0.48	$ 7,959
Lighting & branch wiring		16,580	SF	$ 5.79	$ 96,000
Comm & security	Alarms, emerg lights	16,580	SF	$ 1.27	$ 21,057
Sewer conn./septic field		allowance			$ 10,000
3. Composting Bins & Biofilter					
Bin walls	8 bins, 62 lf, 6' H, 12" thick	2976	SF	$ 42.00	$ 124,992
Blowers	8, 250 cfm each	8	EA	$ 250.00	$ 2,000
Aeration piping	3" PVC, 75 LF/bin	600	LF	$ 3.25	$ 1,950
Exhaust piping	4" - 8" spiral steel	300	LF	$ 3.70	$ 1,110
Biofilter		500	SF	$ 6.00	$ 3,000
Condensate removal/recycling		allowance			$ 2,000
4. Sitework					
Clearing and Grubbing		0.8	ac	$ 7,000.00	$ 5,600
Unclassified Excavation		3100	cy	$ 4.00	$ 12,400
NFS Gravel backfill for building		1850	cy	$ 22.00	$ 40,700
Gravel pads for outdoor areas	12" thick, compacted	1250	cy	$ 22.00	$ 27,500
Sediment/erosion control		allowance			$ 10,000
				Subtotal	**$ 1,490,433**
				Contingency @ 25%	**$ 372,608**
				Subtotal	**$ 1,863,041**

Used Equipment					
Loader	Volvo L70		1	$ 79,500	$ 79,500
2nd bucket	3 CY bucket	for product only	1	$ 6,500	$ 6,500
Screen	Trom 406		1	$ 47,900	$ 47,900
Grinder	Peterson 4400B horiz		1	$ 89,500	$ 89,500
				Subtotal	**$ 223,400**

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	3/19/2013
Analysis	Composting Operating Expense Estimate - Seward - ECS		

Assumptions

1. Labor rate (loaded) per hour	$25.00	per hour
2. Machine rate (fuel + maintenance)	$50.00	per hour
3. Electricity rate	$0.09	per kWh
4. Does not include amortized capital		
5. Facility is open 5 days/week, 52 weeks/year (260 days/yr)		

			Annual Costs
Waste Receipt			
Daily incoming tonnage of food scraps	2.3	ton/day	
Assume average of	2	tons/load	
Number of loads	1.15	loads/day	
Time to inspect each load	5	min/load	
Time to push into pile	5	min/load	
Total labor needed daily	12	mins	
	0.2	hrs/day	$1,250
Loader operating cost	0.2	hrs/day	$2,500
Daily incoming tonnage of carbon	2.0	ton/day	
Assume average of 10	2	tons/load	
Number of loads	1	loads/day	
Time to inspect each load	2	min/load	
Time to transfer to storage	5	min/load	
Total labor needed daily	7	mins	
	0.1	hrs/day	$758
Loader operating cost	0.1	hrs/day	$1,517
Mixing operations			
Feedstocks to mixing daily	14	CY/day	
Assume use ECS mixer to mix			
Volume of loader bucket	3	CY	
Number of bucket movements daily	5	buckets/day	
Time to move to mixer & return	5	min/bucket	
Total labor needed daily (in ECS estimate)	24	min/day	
	0.4	hrs/day	
Loader operating cost	0.4	hrs/day	
Annual labor cost for mixing (in ECS labor estimate)			$0
Annual loader cost for mixing (mixer cost in ECS estimate below)			$5,137
ECS CV System operating cost			
ECS estimated labor (0.5 FTE)	1040	hrs/yr	
ECS estimated electrical consumption	5.2	kWh	
Annual usage	8760	hrs/yr	
ECS estimated roll-off truck usage	300	hrs/yr	

Annual cost of labor to manage CV system			$26,000
Annual electrical cost for CV system			$4,100
Annual cost for roll-off truck to empty CV containers			$15,000
Biofilter Operations			
1. Assume pile blowers can discharge directly into biofilter			
2. Assume daily inspection of biofilter operations			
Labor to inspect daily (in ECS estimate)		hrs/day	
3. Annual cost of labor to inspect biofilter			$0
4. Annual replacement of biofilter media			
Media volume = 10' x 20' x 4' = 800 cf =	30	CY/yr	
Media cost =	$ 15.00	CY	$450
CV Container Contents Removal to Curing			
1. Daily volume going to curing	9	CY/day	
a. Assume one ASP torn down each day			
2. Bucket size on loader	3	CY	
3. Number of bucket trips/day	3	trips/day	
Length of each trip	3	minutes	
Total time needed daily	9	min/day	
	0.2	hrs/day	
4. Annual cost of labor to empty bays			$1,025
5. Annual machine cost to empty bays			$2,050
Curing Pile Tear-Down			
1. Daily volume going from curing to screening	9	CY/day	
2. Capacity of loader bucket	3	CY	
3. Number of loader trips needed per day	3	trips/day	
4. Assumed time to reach screen	3	minutes	
5. Time needed for windrow tear-down	0.1	hrs/day	
6. Annual cost of labor to empty bays			$922
7. Annual machine cost to empty bays			$1,845
Screening			
1. Assume trommel screen with 3/8" screen			
Feed rate	50	CY/hr	
Screening time per CY	0.02	hr/CY	
Screening time needed	0.2	hr/day	
2. Annual cost for labor to screen			$1,107
3. Annual machine cost for screening			$2,214
Moving Materials to Storage			
1. Daily overs production	2	CY/day	
2. Daily compost production	7	CY/day	
3. Capacity of loader bucket	3	CY	
4. Number of loader trips needed per day	3	trips/day	
5. Assumed time to reach storage	3	minutes	
6. Time needed weekly for storage	0.1	hrs/day	
6. Annual cost of labor for moving materials			$922
7. Annual machine cost for moving materials			$1,845
Loading out Compost to Market			
1. Annual compost production estimate	1,771	CY/yr	
2. Average out-load truck size	20	CY	
3. Annual number of loads	89	loads	

4. Time needed to load truck	0.5	hr		
5. Annual loading time needed	44	hours/yr		
6. Annual cost of labor for truck load-out			$1,107	
7. Annual machine cost for truck load-out			$2,214	

Housekeeping

1. Assume 1 hr/day spent on housekeeping	1	hrs/day		
2. Annual time spent housekeeping	260	hrs/yr		
3. Annual cost of labor for housekeeping			$6,500	

Subtotals			FTEs	
	Labor	$39,592		0.8
	Machine Usage	$23,420		
	Consumables	$15,450		
Total		$78,461		
	Annual Tonnage	1,625	tons/yr	
	Cost per ton	$48.29	per ton	

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	3/19/2013
Analysis	Composting Capital Expense Estimate - Seward - ECS CV System		

Assumptions

1. Assume site requires 3 feet of excav and backfill with non frost susceptible gravel inside building and 2' ex & bfill outside of building
2. Capacity is 600 ton/year food scraps + 500 tons/yr greenwaste
3. ECS quote is for 7 vessel CV Composter system with mixer

Site size		0.8	ac
	Processing building footprint	8,376	SF
	ECS system footprint	12,535	SF
	Allowance for access roads, equipment maint.	2,500	SF
	Total area needed	23,411	SF

		Quantity	Unit	Unit Cost	Extended Cost
Components					
1. Processing Building					
Slab on grade	8" reinforced, w/ vapor barrier and subbase	8,376	SF	$ 12.00	$ 100,515
Slab & foundation excavation	after mass ex& fill	8,376	SF	$ 0.28	$ 2,345
4' foundation wall (push wall)		400	LF	$ 75.00	$ 30,000
Pre-engineered steel building		8,376	SF	$ 40.00	$ 335,050
2. Services					
Exhaust fans/louvers		8,376	SF	$ 0.26	$ 2,178
Fire protection sprinklers		8,376	SF	$ 3.49	$ 29,233
Standpipe and fire pump		8,376	SF	$ 1.88	$ 15,747
Fire water storage tank	50,000 g ?				$ 125,000
Electrical Service & distribution	200 amp service	8,376	SF	$ 0.48	$ 4,021
Lighting & branch wiring		8,376	SF	$ 5.79	$ 48,498
Comm & security	Alarms, emerg lights	8,376	SF	$ 1.27	$ 10,638
Sewer conn./septic field		allowance			$ 10,000
3. ECS Composting System, mixer & biofilter					
Per budget estimate					$ 797,000
Installation fee - assume 50% of capital expense					$ 398,500
4. Sitework					
Clearing and Grubbing		0.8	ac	$ 7,000.00	$ 5,600
Unclassified Excavation		3100	cy	$ 4.00	$ 12,400
NFS Gravel backfill for building		1850	cy	$ 22.00	$ 40,700
Gravel pads for outdoor areas	12" thick, compacted	1250	cy	$ 22.00	$ 27,500
Concrete pads for ECS containers		3270	SF	$ 12.00	$ 39,240
Asphalt pad for rest of ECS system		9265	SF	$ 6.00	$ 55,590
Sediment/erosion control		allowance			$ 10,000
				Subtotal	**$ 2,099,756**
				Contingency @ 25%	**$ 524,939**
				Subtotal	**$ 2,624,695**

Used Equipment					
Loader	Volvo L70		1	$ 79,500	$ 79,500
2nd bucket	3 CY bucket	for product only	1	$ 6,500	$ 6,500
Screen	Trom 406		1	$ 47,900	$ 47,900
Grinder	Peterson 4400B horiz		1	$ 89,500	$ 89,500
				Subtotal	**$ 223,400**

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	3/19/2013
Analysis	Composting Operating Expense Estimate - Seward - ECS		

Assumptions

1. Labor rate (loaded) per hour	$25.00	per hour
2. Machine rate (fuel + maintenance)	$50.00	per hour
3. Electricity rate	$0.09	per kWh
4. Does not include amortized capital		
5. Facility is open 5 days/week, 52 weeks/year (260 days/yr)		

			Annual Costs
Waste Receipt			
Daily incoming tonnage of food scraps	2.3	ton/day	
Assume average of	2	tons/load	
Number of loads	1.15	loads/day	
Time to inspect each load	5	min/load	
Time to push into pile	5	min/load	
Total labor needed daily	12	mins	
	0.2	hrs/day	$1,250
Loader operating cost	0.2	hrs/day	$2,500
Daily incoming tonnage of carbon	2.0	ton/day	
Assume average of 10	2	tons/load	
Number of loads	1	loads/day	
Time to inspect each load	2	min/load	
Time to transfer to storage	5	min/load	
Total labor needed daily	7	mins	
	0.1	hrs/day	$758
Loader operating cost	0.1	hrs/day	$1,517
Mixing operations			
Feedstocks to mixing daily	14	CY/day	
Assume use ECS mixer to mix			
Volume of loader bucket	3	CY	
Number of bucket movements daily	5	buckets/day	
Time to move to mixer & return	5	min/bucket	
Total labor needed daily (in ECS estimate)	24	min/day	
	0.4	hrs/day	
Loader operating cost	0.4	hrs/day	
Annual labor cost for mixing (in ECS labor estimate)			$0
Annual loader cost for mixing (mixer cost in ECS estimate below)			$5,137
ECS CV System operating cost			
ECS estimated labor (0.5 FTE)	1040	hrs/yr	
ECS estimated electrical consumption	5.2	kWh	
Annual usage	8760	hrs/yr	
ECS estimated roll-off truck usage	300	hrs/yr	

Annual cost of labor to manage CV system				$26,000
Annual electrical cost for CV system				$4,100
Annual cost for roll-off truck to empty CV containers				$15,000
Biofilter Operations				
1. Assume pile blowers can discharge directly into biofilter				
2. Assume daily inspection of biofilter operations				
Labor to inspect daily (in ECS estimate)			hrs/day	
3. Annual cost of labor to inspect biofilter				$0
4. Annual replacement of biofilter media				
Media volume = 10' x 20' x 4' = 800 cf =		30	CY/yr	
Media cost =	$	15.00	CY	$450
CV Container Contents Removal to Curing				
1. Daily volume going to curing		9	CY/day	
a. Assume one ASP torn down each day				
2. Bucket size on loader		3	CY	
3. Number of bucket trips/day		3	trips/day	
Length of each trip		3	minutes	
Total time needed daily		9	min/day	
		0.2	hrs/day	
4. Annual cost of labor to empty bays				$1,025
5. Annual machine cost to empty bays				$2,050
Curing Pile Tear-Down				
1. Daily volume going from curing to screening		9	CY/day	
2. Capacity of loader bucket		3	CY	
3. Number of loader trips needed per day		3	trips/day	
4. Assumed time to reach screen		3	minutes	
5. Time needed for windrow tear-down		0.1	hrs/day	
6. Annual cost of labor to empty bays				$922
7. Annual machine cost to empty bays				$1,845
Screening				
1. Assume trommel screen with 3/8" screen				
Feed rate		50	CY/hr	
Screening time per CY		0.02	hr/CY	
Screening time needed		0.2	hr/day	
2. Annual cost for labor to screen				$1,107
3. Annual machine cost for screening				$2,214
Moving Materials to Storage				
1. Daily overs production		2	CY/day	
2. Daily compost production		7	CY/day	
3. Capacity of loader bucket		3	CY	
4. Number of loader trips needed per day		3	trips/day	
5. Assumed time to reach storage		3	minutes	
6. Time needed weekly for storage		0.1	hrs/day	
6. Annual cost of labor for moving materials				$922
7. Annual machine cost for moving materials				$1,845
Loading out Compost to Market				
1. Annual compost production estimate		1,771	CY/yr	
2. Average out-load truck size		20	CY	
3. Annual number of loads		89	loads	

4. Time needed to load truck	0.5	hr		
5. Annual loading time needed	44	hours/yr		
6. Annual cost of labor for truck load-out			$1,107	
7. Annual machine cost for truck load-out			$2,214	

Housekeeping

1. Assume 1 hr/day spent on housekeeping	1	hrs/day		
2. Annual time spent housekeeping	260	hrs/yr		
3. Annual cost of labor for housekeeping			$6,500	

Subtotals			FTEs	
	Labor	$39,592		0.8
	Machine Usage	$23,420		
	Consumables	$15,450		
Total		$78,461		
	Annual Tonnage	1,625	tons/yr	
	Cost per ton	$48.29	per ton	

Recommendations

- Homer Demonstration Project Recipe
- Homer Demonstration Project Capital Cost Estimate
- Homer Demonstration Project Operating Cost Estimate
- Kenai Salmon Waste Demonstration Recipe
- Kenai Salmon Waste Demonstration Windrow Sizing
- Kenai Salmon Waste Demonstration Capital Cost Estimate

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	7/23/2013
Analysis	Recipe - Homer Composting Facility - Demo		

Assumptions:

1. Estimated current total tonnage of food scraps is 170 tons/yr
2. Assume facility is open 5 days/week
3. Estimated weekly tonnage of food scraps 3.3 tons/wk

MIX RATIO CALCULATIONS - Daily

INGREDIENTS	Food Scraps	Carbon	Compost Recycle	Overs	TOTAL MIX	TARGET
C (% AS IS)	43.7	49.2	13.2	50.1		
N (% AS IS)	2.2	0.9	1.0	1.0		
MOISTURE%	71.5	40.1	45	45		
UNITS IN MIX BY WGT (T)	3.3	3.5	0.0	0.0	6.8	
UNITS IN MIX BY WGT (LB)	6,538	7,000	0	0	13,538	
UNITS IN MIX BY VOL (CY)	5.5	13.4	0.0	0.0	18.9	
DENSITY (LBS/CY)	1196	522.5	900	500		
POUNDS OF CARBON	2,857	3,441	0	0	6,299	
POUNDS OF NITROGEN	144	65	0	0	209	
C:N RATIO	19.86	52.86	13.20	50.61	**30.14**	20 TO 30
POUNDS OF MOISTURE	4,675	2,807	0	0	7,482	
NUMBER OF UNITS	6,538	7,000	0	0	13,538	
PERCENT MOISTURE					**55.26**	50 TO 65%
VOLATILE SOLIDS (%)	87.4%	98.3%	44.2%	98.3%		
VOLATILE SOLIDS (LBS)	5,715	6,881	0	0	12,596	
TOTAL MASS (LBS)	6,538	7,000	0	0	13,538	
MIX VS (%)					**93.0%**	> 90%
DENSITY (LBS/CY)	1196	522.5	900	500		
DENSITY (KG/M3)	709.6	310.0	533.9	296.6		
% AIR SPACE	36.14	72.10	51.94	73.30		
FEEDSTOCK VOLUME (CY)	5.5	13.4	0.0	0.0	13	
AIR VOLUME (CY)	2.0	9.7	0.0	0.0	9.7	
PREDICTED FREE AIR SPACE					**72.1%**	40-60%

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	7/22/2013
Analysis	Composting Capital Expense Estimate - Homer - ECS CV Pilot System		

Assumptions

1. Assume site requires 2' excavation & backfill
2. Capacity is 170 ton/year food scraps + 210 tons/yr greenwaste
3. ECS quote is for 2 vessel CV Composter system with mixer
4. Assume site work for expansion to 8 CV Composter units

Site size		0.5	ac
	Processing building footprint	0	SF
	ECS system footprint	12,000	SF
	Allowance for access roads, equipment maint.	5,000	SF
	Total area needed	17,000	SF

Components			Quantity	Unit		Unit Cost		Extended Cost
1. Processing Building			Not needed for demonstration project					
2. Services			Assume existing infrastructure can handle					
3. ECS Composting System, mixer & biofilter								
Per budget estimate							$	384,000
Shipping - Seattle to Homer		estimate					$	2,000
Installation fee - assume 50% of capital expense							$	192,000
4. Sitework								
Clearing and Grubbing			0.4	ac	$	7,000	$	2,732
Unclassified Excavation			1259	cy	$	4.00	$	5,037
Gravel pads for outdoor areas		12" thick, compacted	630	cy	$	22.00	$	13,852
Concrete pads for ECS containers			150	SF	$	12.00	$	1,800
Asphalt pad for rest of ECS system			16,850	SF	$	6.00	$	101,100
Sediment/erosion control			allowance				$	10,000
						Subtotal	**$**	**712,521**
						Design @ 12%	**$**	**71,252**
						Contingency @ 25%	**$**	**178,130**
						Subtotal	**$**	**961,903**
Equipment								
SSO Collection Containers		6 CY each	4		$	3,500	$	14,000
Loader	Volvo L70 (used)		1		$	79,500	$	79,500
2nd bucket	3 CY bucket	for product only	1		$	6,500	$	6,500
Screen	Trom 406 (used)		1		$	47,900	$	47,900
Grinder	Bandit 2600 horiz (used)		1		$	89,500	$	89,500
						Subtotal	**$**	**237,400**

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	7/23/2013
Analysis	Composting Demo Operating Expense Estimate - Homer - ECS		

Assumptions

1. Labor rate (loaded) per hour	$25.00 per hour
2. Machine rate (fuel + maintenance)	$50.00 per hour
3. Electricity rate	$0.09 per kWh
4. Dumpster pull charge	$65.00 per pull
4. Does not include amortized capital	
5. Facility is open 5 days/week, 52 weeks/year (260 days/yr)	

			Annual Costs
Waste Retrieval from Transfer Sites			
Assume 4 dumpsters pulled once/week	208	pulls/yr	
Annual cost for waste transfer			$13,520
Waste Receipt			
Weekly incoming tonnage of food scraps	3.3	ton/week	
Assume average of	0.5	tons/load	
Number of loads	6.54	loads/week	
Time to inspect each load	5	min/load	
Time to push into pile	5	min/load	
Total labor needed daily	65	mins	
	1.1	hrs/week	$1,417
Loader operating cost	1.1	hrs/week	$2,833
Weekly incoming tonnage of carbon	3.5	ton/week	
Assume grinder operated	2	hrs/week	
Total labor needed weekly	2	hrs/week	
	2	hrs/week	$2,600
Loader operating cost	2	hrs/week	$5,200
Grinder operating cost	2	hrs/week	$5,200
Mixing operations			
Feedstocks to mixing weekly	19	:Y/week	
Assume use ECS mixer to mix			
Volume of loader bucket	3	CY	
Number of bucket movements weekly	6	buckets/week	
Time to move to mixer & return	5	min/bucket	
Total labor needed weekly	31	min/week	
	0.5	hrs/week	
Loader operating cost	0.5	hrs/week	
Annual labor cost for mixing			$681
Annual loader cost for mixing			$1,362
Annual mixer operating cost			$1,362
ECS CV System operating cost			
Estimated labor	208	hrs/yr	

ECS estimated electrical consumption		1.3	kWh	
	Annual usage	8322	hrs/yr	
ECS estimated roll-off truck usage		26	hrs/yr	
Annual cost of labor to manage CV system				$5,200
Annual electrical cost for CV system				$974
Annual cost for roll-off truck to empty CV containers				$1,300
Biofilter Operations				
Included in ECS estimate				
Replace biofilter media annually				
Media volume = (10' x 20' x 4') = 800 cf =		30	CY/yr	
Media cost =	Ground on-site	$ -	CY	$ -
CV Container Contents Removal to Curing				
1. Volume going to curing		25	CY/reactor	
2. Number of reactor "cycles" per year		15	per year	
3. Total volume going to curing annually		375	CY/yr	
4. Bucket size on loader		3	CY	
5. Number of bucket trips		125	trips/yr	
Length of each trip		3	minutes	
Total time needed daily		375	min/yr	
		6.3	hrs/yr	
6. Annual cost of labor to empty CVs				$156
7. Annual machine cost to empty CVs				$313
Curing Pile Tear-Down				
1. Volume going from curing to screening		300	CY/year	
2. Capacity of loader bucket		3	CY	
3. Number of loader trips needed		100	trips/yr	
4. Assumed time to reach screen		3	minutes	
5. Time needed for windrow tear-down		5.0	hrs/yr	
6. Annual cost of labor to tear down piles				$125
7. Annual machine cost to tear down piles				$250
Screening				
1. Assume trommel screen with 3/8" screen				
Feed rate		10	CY/hr	
Screening time per CY		0.1	hr/CY	
Screening time needed		30.0	hr/yr	
2. Annual cost for labor to screen				$750
3. Annual machine cost for screening				$1,500
Moving Materials to Storage				
1. Daily overs production		60	CY/yr	
2. Daily compost production		240	CY/yr	
3. Capacity of loader bucket		3	CY	
4. Number of loader trips needed		100	trips/yr	
5. Assumed time to reach storage		3	minutes	
6. Time needed		5.0	hrs/yr	
7. Annual cost of labor for moving materials				$125
8. Annual machine cost for moving materials				$250
Loading out Compost to Market				
1. Annual compost production estimate		240	CY/yr	
2. Average out-load truck size		1	CY	
3. Annual number of loads		240	loads	
4. Time needed to load truck		0.25	hr	
5. Annual loading time needed		60	hours/yr	
6. Annual cost of labor for truck load-out				$1,500
7. Annual machine cost for truck load-out				$3,000

Housekeeping

1. Time spent on housekeeping	0.25	hrs/day			
2. Annual time spent housekeeping	65	hrs/yr			
3. Annual cost of labor for housekeeping			$1,625		

Subtotals			FTEs	
	Labor	$14,179		0.3
	Machine Usage	$37,064		
Total		$51,243		
	Annual Tonnage	352	tons/yr	
	Cost per ton	$145.58	per ton	

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	7/23/2013
Analysis	Recipe - Salmon Composting - Demo		

Assumptions:

1. Estimated current total tonnage of fish wastes is 250 tons/yr

MIX RATIO CALCULATIONS - Annual

INGREDIENTS	Salmon Wastes	Carbon	Water		TOTAL MIX	TARGET
C (% AS IS)	29.9	49.2	0.0			
N (% AS IS)	8.4	0.9	0.0			
MOISTURE%	71.7	40.1	100			
UNITS IN MIX BY WGT (T)	250.0	1,200.0	150.1		1,600.1	
UNITS IN MIX BY WGT (LB)	500,000	2,400,000	300,200		3,200,200	
UNITS IN MIX BY VOL (CY)	749.6	4593.3			5342.9	
UNITS IN MIX BY VOL (GAL)			35,995			
DENSITY (LBS/CY)	667	522.5	900			
POUNDS OF CARBON	149,500	1,179,840	0		1,329,340	
POUNDS OF NITROGEN	42,000	22,320	30		64,350	
C:N RATIO	3.56	52.86	0.00		**20.66**	20 TO 30
POUNDS OF MOISTURE	358,500	962,400	300,200		1,621,100	
NUMBER OF UNITS	500,000	2,400,000	300,200		3,200,200	
PERCENT MOISTURE					**50.66**	50 TO 65%
VOLATILE SOLIDS (%)	60.7%	98.3%	44.2%			
VOLATILE SOLIDS (LBS)	303,500	2,359,200	132,688		2,795,388	
TOTAL MASS (LBS)	500,000	2,400,000	300,200		3,200,200	
MIX VS (%)					**87.4%**	> 90%
DENSITY (LBS/CY)	667	522.5	900			
DENSITY (KG/M3)	395.7	310.0	533.9			
% AIR SPACE	64.39	72.10	51.94			
FEEDSTOCK VOLUME (CY)	749.6	4593.3	0.0		4593	
AIR VOLUME (CY)	482.7	3,311.8	0.0		3,311.8	
PREDICTED FREE AIR SPACE					**72.1%**	40-60%

Data Sources:

Salmon waste - June 2011 lab analysis of wastes from clam processing plant in DE
Carbon - Sept. 2009 lab analysis of yard trimmings from southeastern PA

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	7/24/2013
Analysis	Composting Capital Expense Estimate - Kenai Salmon Pilot		

Assumptions

1. Assume site requires no grading
2. Capacity is 250 ton/year fish wastes + 1,200 tons/yr greenwaste
3. Assume open-air turned windrow operation
4. Assume all activities on graveled surface over geotextile fabric

Site size		31.1	ac
	Composting area footprint	385,506	SF
	Allowance for access roads, equipment maint. (@ 20%)	77,101	SF
	Total area needed	462,607	SF

Components			Quantity	Unit		Unit Cost		Extended Cost
Geotextile Fabric			462,607	SF	$	0.50	$	231,304
Gravel pads for processing areas		12" thick, compacted	17,134	cy	$	22.00	$	376,939
Sediment/erosion control			allowance				$	10,000
						Subtotal	**$**	**618,243**
						Design @ 12%	**$**	**74,189**
						Contingency @ 25%	**$**	**154,561**
Equipment								
Loader	Volvo L70 (used)		1		$	79,500	$	79,500
2nd bucket	3 CY bucket	for product only	1		$	6,500	$	6,500
Screen	Trom 406 (used)		1		$	47,900	$	47,900
Grinder	Bandit 2600 horiz (used)		1		$	89,500	$	89,500
						Subtotal	**$**	**223,400**

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Project	KPB Organics Feasibility Study	**Proj. No.**	12-1125
Client	Nelson Engineering	**Date**	7/23/2013
Analysis	Fish Waste Demo Sizing		

Assumptions:
1. Facility is open 5 days/week, 52 weeks/year (260 days/yr)
2. Facility will use open-air turned windrows
3. Size facility for 250 tons fish wastes during salmon run in July

Waste Volumes (in cubic yards)

	Annual Volume (CY)	
Salmon Wastes	749.6	
Carbon Amendment	4593.3	
Totals	5,342.9	CY/yr

Composting Materials Flows

1. Residence times for windrow composting

	Composting	Curing	Total
Windrow	45 days	75 days	120 days

2. Annual Volumes going to composting
   Annual volumes of mixed feedstocks = 5,343 CY/yr

3. Annual Volumes going to curing (assume 40% volume shrink in composting)
   Annual volumes of composted feedstocks = 3,740 CY/yr

4. Annual Volumes going to screening (assume 10% volume shrink in curing):
   Annual volumes of cured feedstocks = 3,366 CY/yr

5. Screening
   a. Assume approx. 80% finished compost capture rate and 20% going to overs
   b. Annual volumes of screened compost = 2,693 CY/yr
   c. Annual volumes of overs = 673 CY/yr

Feedstocks Receipt

1. Feedstock Receipts
   a. Assume daily delivery of fish wastes and ground woody wastes 5 days/week
   b. Assume all feedstock deliveries by various vehicles (trash trucks, pickups, etc.)
   c. Assume feedstock receipts area cleared off by end of each day

d. Size receipts area		5,343	CY/year
Assume all materials come in during 30-day summer period	=	178	CY/day
	=	4,809	CF/day
e. Assume maximum receipts pile height	=	6	ft
f. Needed receipts area footprint	=	801	SF
g. Allow 50% more area for vehicle and equipment movement	=	401	SF
h. Total Feedstock receipts area	=	1,300	SF

Feedstock Mixing

1. Assume all feedstock mixing done by bucket blending with front-end loader			
2. Daily mixing volume needed	=	178.1	CY/day
3. Assume mixing done in feedstocks receipt area			

Ground Woody Feedstocks Storage

1. Volume of woody material needed annually	=	4,600	CY
2. Assume all material delivered/stored prior to fish run season	=	5342.9	CY
3. Storage volume needed	=	4,600	CY
	=	124,200	CF
4. Assume maximum storage pile size		8	ft
5. Needed storage area footprint		15,525	SF
6. Assume 3-sided storage bunker made of 2' x 2' x 6' blocks			
7. Potential storage bunker dimensions	=	60	ft W
	=	259	ft. L
8. Allow 50' in front of storage bunker for equipment access			
9. Storage area dimensions	=	16,900	SF

Active Composting Windrow Sizing and Layout Calculations

1. Assume use of a tractor-pulled Vermeer 616 windrow turner with 6' x 16' tunnel			
2. Assume trapezoidal windrow shape			
a. Volume per linear foot of windrow:			
A = h x (b-h), where h = height, b = width at base			
Height	=	6	ft
Base	=	16	ft
Cross-sectional area per linear foot	=	60	SF
Volume per linear foot	=	2.22	CY/ LF
3. Linear footage of new windrows daily			
Daily volume from mixing / volume per linear foot	=	80	LF / day
4. Total volume of material in windrows during active composting	=	5,343	CY
5. Total linear footage of material in windrows	=	2,404	LF
6. Total area occupied by windrows	=	38,469	SF
7. Assume each windrow holds 2.5 days worth of mixed material			
80 LF / day x 2.5 days	=	200	LF
8. Volume of material in each windrow	=	445	CY
9. Number of windrows in active composting	=	**12**	**windrows**
10. Assume 20' spacing between windrows and 35' turning radii at each end			
11. Each windrow is			
Length 200 ft + 35 ft + 35ft	=	270	ft
Width 16 ft + 20 ft	=	36	ft
Area of each windrow (gross)	=	9,733	SF
Area of all windrows (gross)	=	116,795	SF
12. Assume pad length is equal to gross windrow length	=	270	ft
Pad width is	=	432	ft
Composting Pad =		**440**	**ft. W**
		300	**ft. L**

Curing Pad Windrow Sizing and Layout Calculations

1. Assume same size windrows as in active composting			
2. Assume 40% volume shrink during composting			
Annual volume to composting	=	5,343	CY/yr
Annual volume to curing	=	3,206	CY/yr
3. Linear footage of new windrows annually	=	1,443	LF / yr
4. Total volume of material in windrows during 75-day curing period	=	3,206	CY
5. Total linear footage of material in windrows	=	1,443	LF
6. Total area occupied by windrows	=	23,081	SF
7. Assume each curing windrow holds two composting windrows			
2 x 200 LF x 2.22 CY/lf x 0.6 shrinkage	=	534	CY
8. Number of windrows in curing	=	**6**	**windrows**
9. Assume 20' spacing between windrows and 35' turning radii at each end			
10. Each windrow is			
Length 200 ft + 35 ft + 35ft	=	270	ft
Width 16 ft + 20 ft	=	36	ft
Area of each windrow (gross)	=	9,733	SF
Area of all windrows (gross)	=	58,456	SF
11. Assume pad length is equal to gross windrow length	=	270	ft
Pad width is	=	216	ft
<u>Curing Pad =</u>		**220**	**ft. W**
		300	**ft. L**

Screening & Product Storage Sizing and Layout Calculations

1. Assume use of a TROM 406 trommel with 3/8" screen			
2. Assume approximately 80%/20% fines/overs split			
3. Plan on one year finished compost storage			
4. Volume going to screening	=	3,366	CY/yr
5. Volume going to storage	=	2,693	CY/yr
6. Volume of overs recycled as bulking agent	=	673	CY/yr
7. Screen size	Length	16	ft
	Width	6	ft
8. Allow 25 ft all sides for equipment movement			
<u>Screening Area =</u>		**56**	**ft. W**
		76	**ft. L**
9. Total Volume in Storage Pile	=	2,693	CY/yr
	=	72,707	CF
10. Assume maximum pile height	=	12	ft
11. Area of storage pile	=	163,590	SF
12. Assume open pile			
13. Width of pile	=	500	ft
14. Length of pile	=	327	ft
<u>Product Storage Area =</u>		**500**	**ft. W**
		330	**ft. L**

Area Summary	<u>Area</u> (sq. ft.)	<u>Area</u> (acres)
<u>On Gravelled Pad</u>		
Feedstock Receipt	1,300	0.03
Ground Feedstocks Storage	16,900	0.39
Composting Pad	132,000	3.03
Curing Pad	66,000	1.52
Screening Area	4,256	0.10
Product Storage Area	<u>165,000</u>	<u>3.79</u>
Total	385,456	8.85