King County Vashon Island Organics Processing Feasibility Study

Final Phase 1 Report

Contract No. 6122178

King County
Department of
Natural Resources and Parks
Solid Waste Division

Waste **Prevention** Resource **Recovery** Waste **Disposal**

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VASHON ISLAND ORGANICS PROCESSING FEASIBILITY STUDY
FINAL PHASE 1 REPORT

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April 2021

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Executive Summary

King County Solid Waste Division (KCSWD) retained HDR Inc. (HDR) to evaluate the feasibility of an on-island organics processing facility (Facility) on Vashon Island. Due to the possible variability of the composition of feedstock, this Phase 1 Report is the first portion of the study focusing on evaluating a low and high range of food waste composition. HDR believes the benefits of providing a facility arrangement for each low and high range of feedstock quantity will become evident in the economic analysis which is second phase of this study.

The study is broken into two phases, with this Phase 1 Report commencing the Review and Explore Organics Processing Operations Phase. During Phase 1, HDR reviewed available organics feedstock, proposed composting methods, available technologies, and siting considerations.

The study presents technology platforms, each of which can accept a range of food waste, each with slightly different benefits as follows:

- **A Pipe-on-grade (POG) positive pressure aerated static pile system :** This technology is ideally suited to operate on a somewhat lower range of food waste/bulking (woody waste). Based on initial planning estimates, the facility may have an operations based on projected quantity of approximately 4,000 tons per year of green/yard waste material received at the existing Vashon Recycling and Transfer Station and assumes the proposed Facility will receive food waste consisting of up to 10 percent of the overall compost stream (this range would be termed an Initial Phase). The Initial Phase strategy uses covered aerated static piles (CASPs), where compost is stored in windrows and process control is provided via pipe-on-grade positive aeration.
- **An Aerated Static Pile (ASP) reversing pressure system with a biofilter :** This technology is ideally suited to operate on the higher range of food waste/bulking agent. Planning estimates indicate an upper range of food waste could be collected (termed an Ultimate Phase of operations) for the proposed Facility is based on the maximum envisioned feedstock volume of combined food and green waste quantity of approximately 6,600 tons per year of up to approximately 34 percent food waste consisting of the overall compost stream. The Ultimate Phase composting strategy assumes feedstock is stored in CASPS in bunkers and utilizes a biofilter for process control.

This Phase 1 Report summarizes the analysis performed to date and develops preliminary sizing assumptions for the phased composting approach. A preliminary sizing analysis was performed for each phase and concluded a site of approximately two acres would be needed for either of the two operating methods. Following acceptance of this Phase 1 Report, HDR will develop a cost estimate of the preferred composting strategy to commence Phase 2 of the feasibility study, the Expanded Analysis phase. Phase 2 proposed Facility will include development of an economical model for the preferred composting approach selected by KCSWD. Phase 2 is anticipated to kick off by spring of 2021.

Contents

Tables

Figures

1 INTRODUCTION

King County Solid Waste Division (KCSWD) retained HDR Inc. (HDR) to evaluate the feasibility of an on-island organics processing facility (Facility) on Vashon Island. KCSWD's primary objective is to explore alternatives to hauling materials (by truck and ferry) to the Cedar Grove Compost facility (Cedar Grove) in order to minimize costs to ratepayers and environmental impacts. Further, the Vashon community represented by Zero Waste Vashon (ZWV) has sought to create a sustainable, resilient waste management system that would include a compost facility on-island. The overall study is the culmination of consideration of available organics feedstock, technologies, site layouts, siting considerations, options for ownership and operation, expected markets for finished compost and other products, and will quantify Greenhouse Gas emissions related to the proposed Facility.

The scope of work is separated into two phases:

- Phase 1 Review and Explore Organics Processing Operations
- Phase 2 Expanded Analysis

The study includes analysis regarding feedstocks, technology, site development, and potential partnerships. This Phase 1 Report (Report) summarizes the work to date and provides next steps to commence Phase 2.

2 PROJECT BACKGROUND

Vashon and Maury Islands are connected by an isthmus and are herein referred to as Vashon Island to refer to the largely rural island on King County's west edge. Vashon Island's municipal solid waste (MSW) stream has evolved from local disposal at the Vashon Landfill for much of the last century, to the current system where residents can either subscribe to Waste Connections' service or self-haul their waste to a transfer station. Waste Connections offers two-bin collection (MSW and commingled recycling) and does not offer organics collection. Waste Connections transfers recycling off-island to Pierce County, and tips MSW on-island at the Vashon Recycling & Transfer Station (VRTS). MSW, recycling, and organics brought to VRTS is transferred off-island to King County.

Organic waste is currently managed on farms, at private residences, through commercial garbage collection programs and by KCSWD through self-haul collection of food waste, yard waste and tree trimmings brought to VRTS. Organic waste collected at VRTS primarily consists of yard waste and tree trimmings, with a small portion of food waste included. KCSWD contracts with Cedar Grove to haul the unprocessed organics off island to a commercial composting facility near Maple Valley, Washington. Hauling and processing organics costs the County's ratepayers an average of $215 per ton, which includes the tip fee at Cedar Grove, ferry fares, and a hauling charge that is assessed by Cedar Grove. Yard and wood waste have been collected at VRTS at a reduced fee of $75/ton (or $12 minimum fee for up to 320 pounds), and food waste is not accepted at VRTS. Through discussions with ZWV, it is understood the quantities of yard waste delivered to VRTS is much lower than the quantity generated on island due to the tip fee. Also, food waste is not collected separately, so there is no historic data on this material source. Approximately half of Vashon Island's residents subscribe to a commercial garbage collection route where food waste is disposed of off island. The engagement of Zero Waste Vashon (ZWV) on this project has led the project team to anecdotally understand that much of the island's yard waste currently ends up in ravines, burn piles or is otherwise contained to the property of origin.

2.1 ZERO WASTE VASHON COLLABORATION

HDR hosted a series of collaborative virtual meetings with the King County Solid Waste Division and ZWV at the project's outset to help guide the direction of the project. Input was solicited at key milestones throughout phase 1 of this project, and a list of potential feedstocks from island generators was prepared by ZWV. This list of potential feedstocks was vetted by the collective team as to whether enough quantity or quality was appropriate for consideration as input into this study. These collaborations led to the resulting effort and benefit analysis discussed later in this report. Further discussion regarding siting considerations, technology selection, and potential partnership opportunities on the island were also discussed during these meetings. This report captures both the input solicited during those discussions, as well as comments received on intermediate draft technical memorandums that directly preceded this report. The memorandums have remained in draft form and the comments have been addressed in this report.

2.2 STUDY INPUTS

In May 2020, KCSWD provided HDR with historic and future projected volumes of organic waste received at the VRTS based on actual yard and wood waste received at VRTS, and the 2019 Draft Waste Characterization Study (Study).

VRTS began accepting disposal of yard and wood waste as separate material in 2015 and received slightly under 1,300 tons in 2019. Year-to-date data from 2020 indicates an approximate 19 percent decrease in yard and wood waste at VRTS from the first five months of 2019 compared to the first five months of 2020. This decrease is believed to be caused by COVID, so was not reflected in the future projections.

The Study indicates that food waste composes approximately 15 percent of the overall waste stream received at King County transfer stations, and yard waste accounts for approximately 2.5 percent of the overall waste stream. Again, it is understood the low quantity of yard waste received at the VRTS is not be reflective of the amount of yard waste on-island due to the cost of service. Consequently, the study assumes more yard waste is available on-island and so included in facility sizing as described in Section 3.2.4 of this report. Projections for future volumes of organic waste assume an annual growth in garbage of 0.6 percent between 2023 and 2030. HDR used projections provided by KCSWD for the year 2030 to inform anticipated feedstock quantities at the VRTS that could be diverted to the proposed Facility, as described in this Report. Projected feedstock available for diversion from VRTS is included in Figure 1 below.

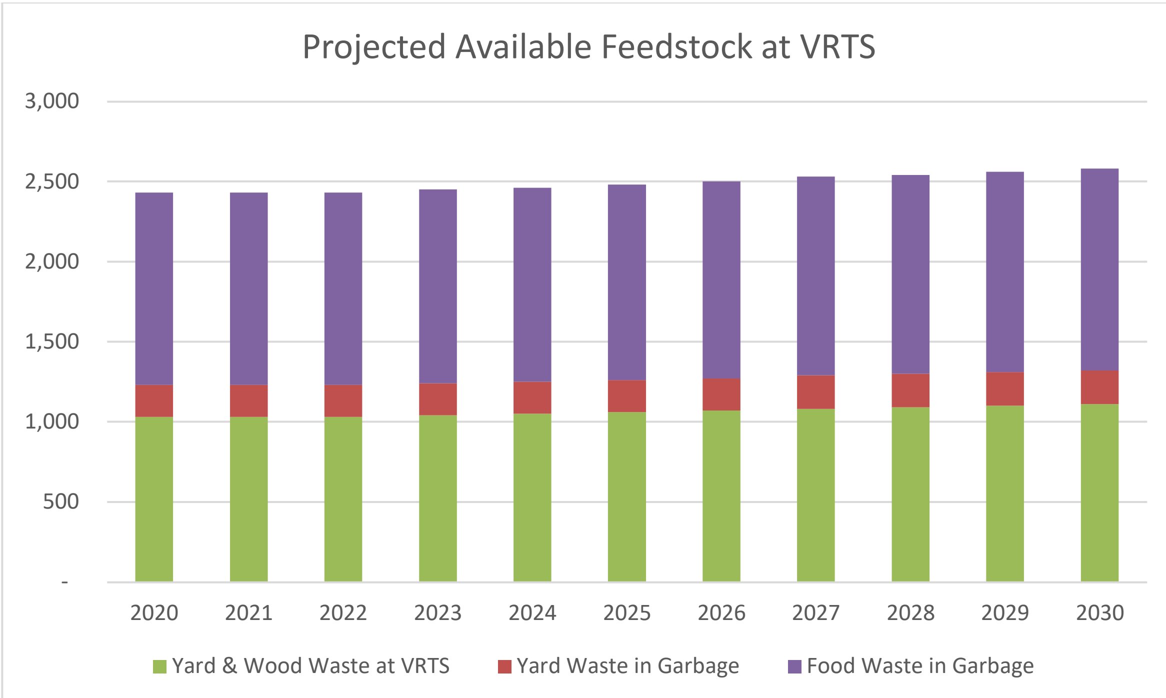

Figure 1. Total Tons of Divertible Organic Waste Received at VRTS (KCSWD, 2020).

3 FEEDSTOCK SOURCES

Anticipated feedstocks available to the proposed Facility have been identified and quantified to inform preliminary sizing and technology considerations. HDR facilitated a discussion of the possible feedstock sources that could be processed at the contemplated organics processing facility. ZWV committee members explored potential feedstocks by communicating with members of the community (business owners, store managers, etc.) to determine the availability of the contemplated feedstocks.

Many of the feedstocks identified in the initial analysis were discovered to being beneficially reused already. HDR submitted a Preferred Feedstocks Memorandum to King County in June 2020, describing the decisions for feedstock considered to be available for the proposed Facility. The Preferred Feedstocks Memorandum is included as an attachment to this Phase 1 Report.

An Effort and Benefit Analysis was developed and attached to the Preferred Feedstocks Memorandum, providing recommendations for whether to pursue various on-island waste streams based on a qualitative and quantitative analysis of feedstock compatibility and availability. Generally, materials that are considered hard to acquire with medium-to-low quality were not considered for pursuit for the proposed Facility, while those that were easy to acquire with medium-to-high quality were included for further consideration. Although availability and identification of these materials may develop in the future, feedstock parameters were identified to inform preliminary sizing, composting strategies, and to develop an initial schematic layout. A summary of materials considered is included in the ensuing section.

3.1 FEEDSTOCKS EXCLUDED FROM STUDY

Feedstock considered in this study but excluded from the anticipated waste stream includes materials already programmed for beneficial reuse, materials that are highly variable or inconsistent to quantify, and materials with sufficient contamination to be deemed infeasible for proper use.

3.1.1 Beneficial Reuse

During the analysis of available feedstocks, ZWV conducted research regarding a variety of potential on-island feedstock providers. Through their research, several potential feedstocks were identified for beneficial reuse in existing operations. Pulp (Okara) obtained from tofu processing is either sent to pig farms or digested at the Vashon Bioenergy Farm for anaerobic digestion however a portion of Okara could reportedly be available for composting. Winery pomace is either composted on-site by vintners or used as pig feed. On-island nurseries compost materials at their own facilities, and on-island farms are understood to maintain strategies for waste produced from livestock and manure bedding, and for waste produced from fruit gleaning. Biosolids produced from wastewater treatment are currently used in a pilot study to evaluate biosolids compost at the King County South Wastewater treatment plant.

3.1.2 Variability of the Feedstock

On-island seasonal and large events were considered as potential sources of organic material; however, it was determined that designing a facility for seasonal peaks at the feasibility phase would not result in a cost-effective economic analysis. Annual events, seasonal camps, and other discrete events are not considered for feedstock quantities for the proposed Facility.

Coffee shops produce highly variable waste streams and were determined to have insufficient volume available to influence size or technologies and were therefore excluded from the Facility feedstock analysis.

3.1.3 Contamination

Compostable serviceware and packaging may be a suitable feedstock in the future provided proper pre-screening is utilized. However, with the status of existing operations the design team determined this feedstock was not used to develop preliminary sizing or technology for the proposed Facility.

3.2 PREFERRED FEEDSTOCKS

As shown in the Effort and Benefit Analysis, yard waste and commercial food waste are considered feasible sources for the proposed on-island Facility. These materials are separated into several categories for consideration for use at the proposed Facility:

- VRTS Yard and Food Waste
- Yard Waste from Other Sources
- Industrial, Commercial, and Institutional Food Waste
- Other Bulking Materials

3.2.1 VRTS Yard and Food Waste

Yard waste will comprise the majority of the feedstock and is considered an easier material to compost as it usually only requires size reduction through grinding or shredding and does not require a bulking agent or moisture modification. Yard waste sources on the island include materials collected at VRTS and by King County Roads Division, collection by private contractors, and disposal via self-haul by on-island residents.

Values shown in Figure 1 indicate the anticipated volumes of organic waste received at VRTS that could be diverted to the proposed Facility. This material is defined as three separate waste stream categories:

- Yard Waste received as Yard Waste at VRTS
- Yard Waste received in MSW at VRTS which, as noted above is currently comingled with the MSW stream but is assumed to be available in the future as a feedstock for composting.
- Food Waste received in MSW at VRTS. As noted above, could be available from a range of approximately 10 to 34 percent of the MSW stream is assumed to be composed of food waste.

Yard and food waste that has been separated prior to disposal at VRTS is considered compatible feedstock for the proposed on-island Facility (designated as self-haul residential green waste and self-haul residential food waste in the Effort and Benefit Analysis). Yard and food waste collected by transfer vehicles as MSW for disposal at VRTS is not included as potential feedstock (designated as residential green waste and residential food waste in the Effort and Benefit Analysis).

Following discussion with ZWV and review of the nearby Port Townsend Composting Facility (see Preferred Feedstocks Memo), HDR determined approximately 3,700 tons per year of yard waste could be reasonably assumed to be captured at Vashon Island for organics processing facility sizing and modeling purposes. HDR recognizes the Port Townsend Composting Facility is a biosolids composting facility so is quite different than the yard/food waste composting feedstock being considered by this study. However, the example gleaned by the Port Townsend facility is their ability to attract an ample quantity of yard waste as a bulking material by lowering its tip fee. HDR expects a similar response could occur at Vashon Island if additional yard waste is needed to meet the mix requirements of the likely quantity of food waste on-island. Consequently, this underlying assumption assumes that KCSWD can lower its organics fee structure increase the yard debris tonnage at VRTS and is based on the analogous population and demographics of a similar community in Port Townsend. While we understand the issue of lowering tip fees is beyond the scope of this study, we make this observation in light of the similarity between King County and Port Townsend and their respective composting interests.

3.2.2 Yard Waste from Other Sources

Significant sources of yard waste collection and disposal exist on Vashon Island that are not currently disposed of at VRTS. Although these feedstocks are not quantifiable at this stage of study, the below yard waste sources have been considered for additional yard waste feedstock for the proposed Facility.

King County Roads collects fallen trees on the island. Yard waste collected by King County Roads is sent off-island for conversion to landscaping materials pursuant to a contract with Pacific Topsoil. Puget Sound Energy (PSE) contracts with Asplundh to perform vegetative maintenance near its electric lines on Vashon Island, resulting in collection of yard waste by private contractors. Asplundh grinds the resulting yard waste and wood waste into woodchips. Asplundh has indicated an interest in providing the woodchip materials to a facility on the island to an on-island compost facility. Many island residents have voiced an interest in a location to compost yard waste. However, for planning purposes, ground wood from Asplundh is highly sought after and consequently cannot be relied upon for facility sizing purposes. Yard waste from residents has been observed disposed of in ravines or burned in private burn piles.

As food waste volumes increase at the proposed Facility, a bulking agent is necessary to facilitate proper composting. Vashon Island is covered by 70 percent forest, which increases in biomass every year, and requires proper management, including thinning approximately every two to five years. The Vashon Island Forest Stewards have performed forest thinning events over the last several decades resulting in commercial logging as well as clippings available for composting and wood chips, which may be used as a bulking agent at the proposed Facility.

3.2.3 Industrial, Commercial, and Institutional (ICI) Food Waste

Various sources on the island produce food waste that has been considered as feedstock in this analysis, including restaurants, breweries, food processing companies, grocery stores, wholesale retailers, and others, noted as industrial, commercial, and institutional (IC&I) food waste. Feedstock for consideration only includes commercial businesses in continuous operation, and does not consider food waste generated at discrete intervals, such as those from festivals and summer camps, or waste used as animal feed. Assumptions used in this analysis combine data provided from on-island businesses and calculations developed using a North American Industry Classification System (NAICS) code-based estimate of potential quantities generated. A total of 536 tons per year is assumed available from IC&I feedstock sources, as described in the section below.

3.2.4 ZWV Data Sources

ZWV contacted on-island businesses to determine approximate volume of food waste disposed in current operations. Since conversations were conducted directly with employees at these businesses, HDR assumed a high level of confidence in feedstock availability and did not provide a diversion factor. A total of approximately 376 tons per year was identified to be available during discussions with on-island businesses, as detailed below.

- Breweries are anticipated to produce 250 tons per year of feedstock material, assuming the two on-island breweries dispose an approximate 6 cubic yards per week of yeast, hot break, spent barley and hops, and compostable filter pads.
- Grocery stores are estimated at 90 tons per year of available feedstock material. This value assumes an approximate 3,470 pounds per week at the four on-island grocery stores.
- The Vashon Island Food Bank disposed 0.5 ton per week of spoiled pre-consumer food, or an approximate 26 annual tons per year of feedstock material.
- Coffee shops dispose 50–100 gallons of coffee grounds per week. With nine coffee shops on the island, an approximate 10 tons per year of feedstock material is anticipated.

Other data obtained by ZWV not described above were discussed in the exclusions discussion of Section 3.0 and have not been included in feedstock calculations for the proposed Facility.

3.2.5 NAICS Code-Based Quantity Estimation

Food production factors were applied to remaining food producers (after excluding those described previously) on Vashon Island using NAICS food generation factors obtained from SIC-NAICS LLC. NAICS factors were applied to full and partial service restaurants on Vashon Island, retirement homes, packaged frozen food merchant wholesalers, elementary and secondary schools, and drinking places. The generation factors provided by NAICS are given as tons of food waste per employee per year. These values were multiplied by the number of employees at each restaurant to approximate annual food waste disposed. HDR developed confidence levels for how much waste could be obtained from each source that are reflected in diversion factors. For example, 50 percent is assigned to moderate confidence generators. Diversion factors were applied to each source to approximate the percent of available feedstock would be disposed of at the proposed organics facility. Data is summarized in Table 1 below.

Table 1. Annual NAICS Food Generation Assumptions

Food Waste Generator	Total Employees[1]	NAICS Food Generation Factor (Tons Food Waste/Employee/Year)	Diversion Factor	Anticipated Available Feedstock (Tons per Year)
Restaurants	161	1.5	50%	121
Retirement Homes	41	0.65	50%	13
Packaged Frozen Food Merchant Wholesalers	19	0.5	25%	14
Elementary and Secondary Schools	330	0.1	25%	8
Drinking Places	29	0.5	25%	4
		TOTAL (Tons per Year)		**160**

3.2.6 Bulking Materials

With the anticipated maximum volume of food and highly putrescible feedstocks on the island, a bulking quantity that is greater than the yard waste known to be readily available on-island is needed. HDR offers that it is reasonable to assume a supply of other bulking materials could become available as the compost facility becomes a reality and attracts positive attention. Other possible bulking agents were discussed including the use of shipping pallets, backhauled shredded wood, King County road-clearing or even Asplundh trimmings. Cellulose-based bulking materials (e.g., cardboard or cellulose-based compostable materials) were considered for bulking but deemed inappropriate for the proposed Facility. Cellulose-based materials are too robust and resilient to microbial action for a facility of this size and have not been included for initial sizing and feedstock considerations.

Feedstock quantities were analyzed based on best management practices of ideal feedstock mix model. The analysis considered the characteristics of the various feedstocks anticipated for the compost process including tonnage, moisture percentage, carbon/nitrogen (C/N) ratio, and total nitrogen of each of the feedstock materials. The anticipated feedstock values described above were used to determine water weight, dry weight, nitrogen weight, and carbon weight for each feedstock These values were used to develop proposed composting technologies, as discussed in this Report

For facility sizing and site planning purposes, it was determined 1,000 tons per year of additional bulking materials could be generated to fulfill the mix design of the maximum quantity of food/highly putrescible feedstocks. As noted above, HDR expects this material could be

[1] Employee data acquired from the NAICS US Company Lookup Tool, accessed at US Business Directory • NAICS Company Lookup Tool on May 18, 2020.

secured by either lowering the tip fee (similar to the Port Townsend example) or secure woodchips from Asplundh.

4 COMPOSTING APPROACH

HDR collaborated with Zero Waste Vashon (ZWV) and KCSWD in evaluating preferred feedstocks (i.e., potential sources of yard waste and food waste available on Vashon Island) that could be utilized in an organics processing facility (*Draft Preferred Feedstocks for the Vashon Island Organics Processing Feasibility Study*, HDR 2020). Insomuch as the collection of food waste and other highly putrescible materials are typically slow to evolve, and since this study does not address the collection of these materials, for the purposes of sizing the facility two different operating conditions, technology, and sizing recommendations were developed for two different operating conditions. The two different technologies that are each capable of operating at different ranges of food waste were explored as follows:

- **Pipe on Grade (Ideally suited to a lower range of food waste):** This technology is suited to a lower range of food waste quantities for projected operations is based on projected quantities of green/yard waste material received at the VRTS, and assumes the proposed Facility will receive food waste consisting of up to 10 percent of the overall compost stream. The POG strategy uses covered aerated static piles (CASPs), where compost is stored in windrows and process control is provided via pipe-on-grade positive aeration.
- **Respirating Aerated Static Pile (Ideally suited to higher range of food waste):** This technology is based on the maximum envisioned feedstock volume of combined food and green waste quantities and assumes the proposed Facility will receive food waste consisting of up to approximately 34 percent of the overall compost stream. The ASP composting strategy assumes feedstock is stored in CASPS in bunkers and utilizes a biofilter for process control.

The purpose of developing of two different technologies to function on the different feedstock ranges is based on the perspective that it is more likely proposed Facility would begin its operation accepting primarily green/yard waste with minimal putrescible (food) material due primarily to the likelihood that a food waste collection system would not be in place at the beginning of the compost facility operation. Composting site requirements, composting methods, and overall site functionality described in this Report is predicated upon the decision to progress with ASPs to develop a generic schematic layout. Other technologies are thought to be similar in terms of key features, layout and sizing.

4.1 POG COMPOSTING (LOWER RANGE OF FOOD WASTE)

Small compost facilities that accept only green/yard waste can typically operate using less robust forms of technology, such as turned windrow or simple aerated static piles. This difference is very important in the development process when the cost of equipment is critical to the viability of a small volume composter. This is particularly true when considering the possibility of a lowered tip fee for these materials, which is often the case in the evolution of many compost facilities. It is possible a greater quantity of green/yard material is available on-island and if the cost to unload were sufficiently low, it’s possible an on-island facility could be mostly green/yard waste.

To develop a preliminary layout for the proposed Facility, the following feedstock is assumed available for composting in the Initial Phase:

- 3,700 tons of yard waste
- 370 tons of residential and/or ICI sources food waste (approximately 10 percent of the available yard waste)

As the quantity of suitable, available food waste increases over time, additional sources of yard waste than have historically been received at the VRTS would be needed to bulk the food waste into a compostable mix design. The need for additional bulking material generally assumes residential users will be attracted to use the Facility, increasing tonnages beyond KCSWD's forecast.

4.2 ASPCOMPOSTING (HIGHER RANGE OF FOOD WASTE)

As the food waste collection system evolves and the quantity of food waste increases, the Facility would need to evaluate the necessity for more robust composting process control, thus transitioning from the POG, Initial Phase to the ASP, Ultimate Phase. There are ample examples of compost facilities that transition their operating technology, particularly from non-aeriated to an aeriated program as food waste quantities increase. One option of transition could be to construct the initial compost facility using pipe-on-grade for a lower throughput leaving area for expansion as the aeriated bunker system.

As compost facilities grow and become more notable in the community, commercial landscapers, tree trimmers, and other green waste feedstock supplier volumes typically increase. Food from grocery stores (unsold produce) and some restaurants may eventually participate if their feedstock is sufficiently contaminant free to be accepted without the investment of significant pre-processing or labor to remove undesirable materials.

To develop a preliminary strategy and facility sizing for the Ultimate Phase, assumptions were developed for available feedstock for composting:

- 3,700 tons of yard waste (consistent with the Initial Phase)
- 1,134 tons of food waste diverted from MSW received at VRTS per projections from SWD
- 189 tons of yard waste diverted from MSW received at VRTS per projections from SWD
- 536 tons from IC&I feedstock from on-island business participation per dialogue between ZWV and on-island businesses, and the NAICS analysis described in this Report
- 1,000 tons from additional bulking material (e.g., wood chips) from additional on-island wood sources

5 INITIAL PHASE –COVERED PIPE ON GRADE AERATED STATIC PILE WINDROW

At the inception of the proposed Facility, the majority of feedstock anticipated to be received consists of green waste, with only a small portion (up to 10 percent of the green waste) of food waste per year. This section describes the proposed composting approach, and the associated sizing and infrastructure involved.

5.1 TECHNOLOGY APPROACH

As of the development of this Report, Vashon Island does not offer an on-island food waste collection service. It is anticipated that a food waste collection system would not be in place at the beginning of the compost facility operation, therefore initial food waste received at the Facility is anticipated to be consistent with current self-haul levels. For the purpose of sizing the proposed Facility, the Initial Phase features compost using a covered pipe-on-grade static pile windrow, otherwise referred to as CASPS.

A windrow is a long mound of yard waste that is commonly 10 to 20 feet wide, 5 to 10 feet tall, and built in rows that can extend hundreds of feet. Yard waste is commonly ground and conditioned with water (or other conditioning agents as appropriate) prior to placement into windrows. The size, shape, and insulating nature of the material results in exothermic reactions in which less heat is lost than generated. Compost stored in windrows is assumed to be covered with an organic cover (such as wood chips or finished compost) and aeriated using a pip-on-grade, positive aeration system to achieve and maintain a temperature sufficient to destroy pathogens. Once pathogens are destroyed, the cover may be removed, transitioning the CASP to an aerated static pile (ASP), if and when needed.

Figure 2. ASP system with pipe-on-grade aeration. Photo courtesy of O2 Compost Technologies.

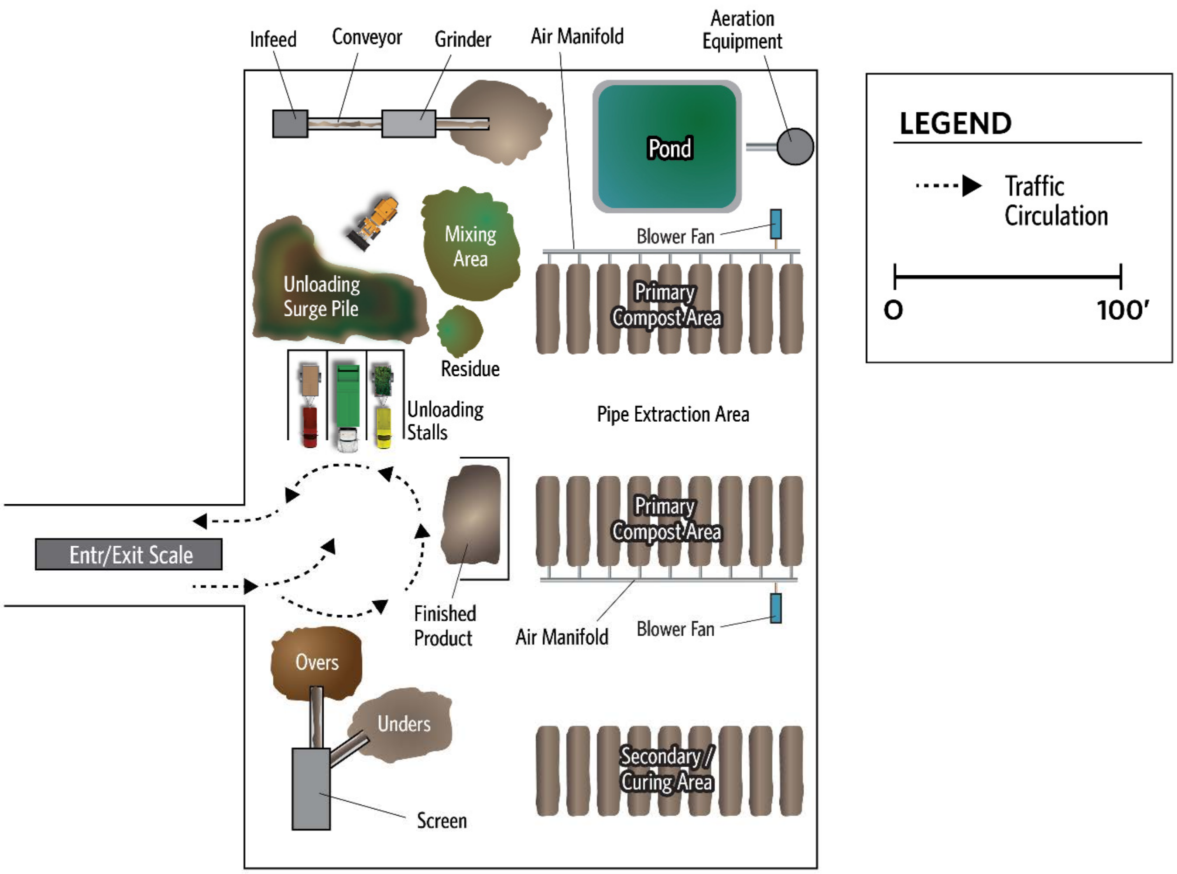

Figure 3. Phase 1 Composting Approach at the Proposed Facility

Pipe on grade infrastructure will be included below the windrows to force air into the bottom of piles (positive aeration) to initiate the biological/chemical reactions required for effective composting and for a basic level of process control.

Low oxygen concentration in the pore air of static windrows is common because the chimney effect by which windrows pull in fresh air is intermittent in space and time. Due to low oxygen and limited process control, the processing of food waste in windrows will tend to generate excessive odor, leading to the use of an organic cover. As feedstock increases in quantity and complexity, technology may need to feature greater process control beyond that provided by the organic cover and positive, thus transitioning to the Ultimate Phase, described later in this Report.

5.2 INITIAL PHASE PROCESSING AREAS

To develop the area requirements for Initial Phase composting strategy, assumptions were developed regarding the operational approach for the proposed Facility. The ensuing sections detail those assumptions

5.2.1 Receiving and Pre-Processing Area

Upon entering the site, a control point or toll booth is needed to determine the quality, quantity and associated fees for material to be unloaded. If the site is large enough, a weigh bridge or truck scale can be used. Following toll booth/weigh-in, customers will proceed to unloading stalls for material disposal and preprocessing. Two separate piles are included in the receiving area – one for green waste, and one for food waste – sized to accommodate anticipated peak volumes for each waste stream.

Maneuvering space is included for customers unloading stall to accommodate turning operations for a variety of anticipated customers, including self-haulers, collection vehicles, and transfer trailers, to accommodate a dynamic future compost stream.

Once unloaded, materials will be screened for contaminants. Contaminated materials will need to be removed from site in a timely manner to comply with cleanliness standards of the future compost permit. A refuse off-haul stockpile is included in the receiving area to collect contaminants for storage until collection is provided for proper disposal elsewhere (e.g., disposal at VRTS for MSW found in the compost piles).

Feedstock from the green waste pile may need to be further processed to obtain the proper size for composting. For sizing purposes, a small grinder is assumed for use at the Facility, and space is programmed for stockpiled material. Large stump grinders could be contracted for annual grinding of accumulated oversized feedstock. Although area is developed for initial sizing purposes, area available for grinding feedstock and material storage will be dictated by available space and site operations.

5.2.2 Primary Compost Pad and Secondary Curing Pad

Following pre-processing, feedstock will be placed in static windrows for primary composting. Parameters for windrow design - length, width, height and storage time - are dictated by available space and operational approach. During the primary composting phase, the pipe-on-grade infrastructure induces aeration through the windrows to promote decomposition. Windrows are separated by aisles with sufficient width to facilitate transport of materials. Since the pipe-on-grade aeration system is not protected or embedded into other infrastructure, sufficient space needs to be provided to remove the piping prior to transport of materials.

As the quantity of food waste increases and approaches 10 percent by weight in the compost, feedstock mix, the County will need to be prepared to transition from the primary compost pad to a secondary curing pad. Feedstock in the secondary curing area will be stored in piles and monitored while the mass cools.

Preliminary sizing assumes parameters for the windrows, with greater detail anticipated in the next phase of design.

5.2.3 Finished Compost Screening Area

Material from the curing area is transported to the finished composting screening area. Material is fed into a hopper and conveyed through a trommel screen to separate large diameter materials (“overs”) from finished compost (“unders”). The screen will be designed to allow unders to fall through the screen for transport to the final product storage area. Overs that pass through the end of the trommel barrel are sent back to the grinding area for additional processing or given away to island residents as mulch. The finished compost screening area will consist of space for traffic maneuvering, space for the hopper and trommel screen, and space for stockpiles of overs and unders.

5.2.4 Finished Product Storage Area

The finished product storage area will maintain material from the finished compost screening area. Access will be provided to this area to load vehicles for transport of finished compost from the facility. Compost in the storage pad will be stored in windrows.

6 ULTIMATE PHASE – REVERSING BIOFILTER

As public engagement increases for the proposed Facility, volume of wastes other than yard and green waste will also increase. When food waste becomes significant (e.g., in excess of 10 percent) additional techniques beyond CASPs may need to be implemented to facilitate process control. For the purpose of sizing the Ultimate Phase, the design has assumed a similar storage method of static piles with an addition of a biofilter for process control.

6.1 ULTIMATE PHASE ASP COMPOSTING STRATEGY

As the compost stream becomes more complex, the proposed composting strategy follows suit. In the Ultimate Phase, process control from the organic cover is supplemented by adding reversing blowers and a biofilter. Process control in the Ultimate Phase is provided by temperature control through aeration supplied by blowers. With sufficient blower capacity, the temperature of a pile of organic matter can be controlled by removing more heat than is generated by the process itself. Use of blowers minimizes handling, turning, and production of emissions and dust. The organic cover is necessary to provide insulation to the top of the pile and to maintain sufficient temperature to destroy pathogens. Once pathogens are sufficiently reduced, the cover is no longer needed, and the composting strategy becomes an ASP.

The Ultimate Phase provides greater process control than the Initial Phase, as windrows can have air forced into the bottom of piles (positive aeration, same as in the Initial Phase) or pulled through the top (negative aeration, not included in the Initial Phase). A schematic of a typical positive or negative aeration arrangements is shown in Figure 4. Some systems can alternate on a pile-by-pile basis or a set of piles basis between positive and negative aeration. This can minimize the temperature stratification that otherwise establishes from cool (fresh air) to hot (process exhaust air). Air delivered to or drawn from CASPs and ASPs in the Ultimate Phase will be delivered via in-floor aeration systems (pipes inside the ground). In-floor aeration is generally more efficient for leachate collection and reduces the operational costs and malfunctions that happen with pipes on the surface of a heavily travelled work site.

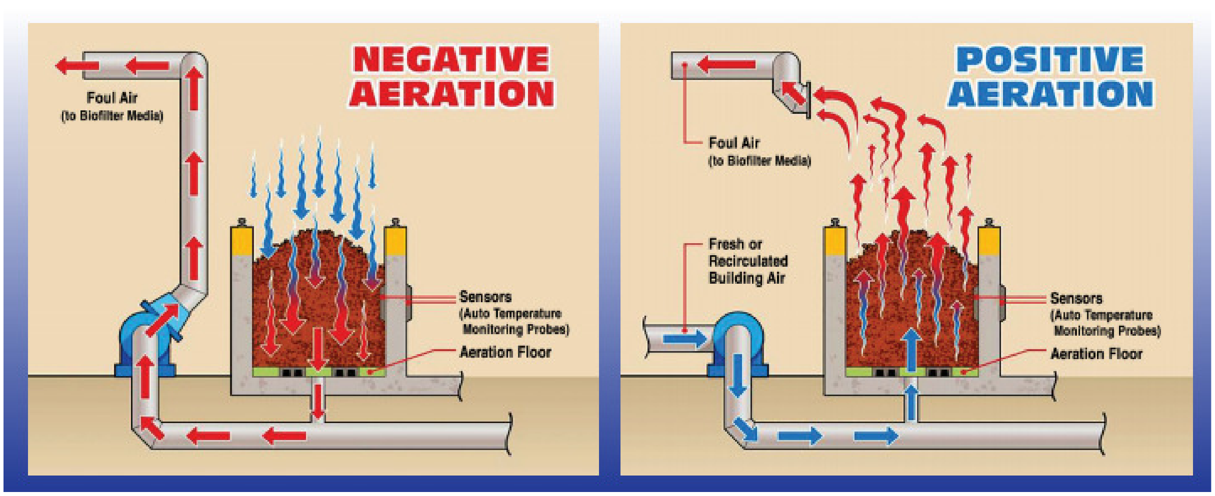

Figure 4. Typical negative or positive aeration arrangements. Photo courtesy of BacTee Systems, Inc.

Unlike in the Initial Phase, CASPs and ASPs in the Ultimate Phase are configured in bunkers with concrete or block wall sides and backs in extended beds. The extended beds are configured such that one batch touches another along the full height of an adjacent batch making a large contiguous surface. Bunker ASPs are used at the Sky River Equestrian Center in Sultan, Washington, shown in Figure 5 below, and are assumed for the sizing requirements developed in this Report.

Figure 5. Aerated static pile system used in Sultan, Washington. Photo courtesy of O2Compost.

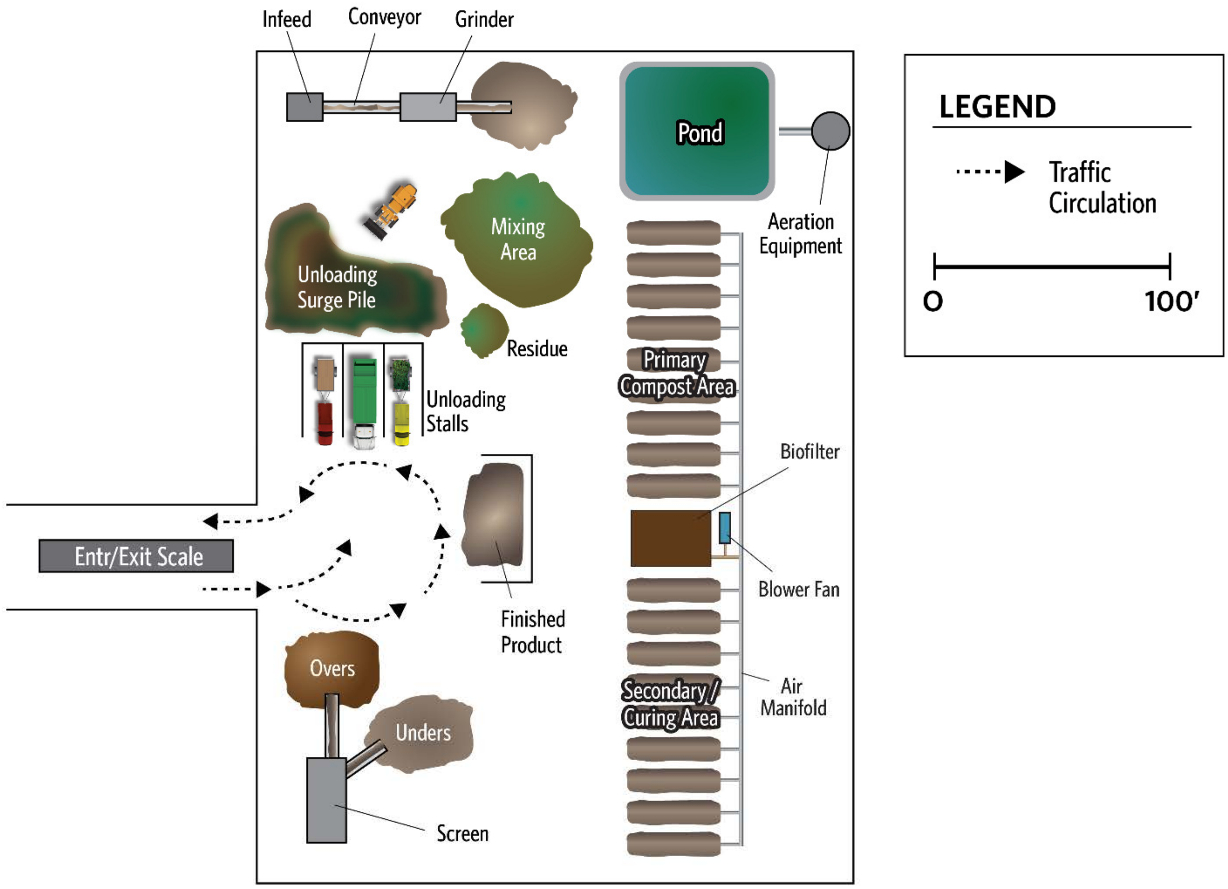

Figure 6. Phase 2 Composting Approach at the Proposed Facility.

6.2 ULTIMATE PHASE PROCESSING AREAS

To develop the area requirements for Ultimate Phase composting strategy, assumptions were developed regarding the operational approach for the proposed Facility. The ensuing sections detail those assumptions.

6.2.1 Receiving and Pre-Processing Area

Similar to the Initial Phase, a control point or toll booth is needed to determine the quality, quantity and associated fees for material to be unloaded. Customer access to the site, including area for stalls and maneuvering, is assumed to remain consistent between the Initial and Ultimate Phase.

Once unloaded, materials will be screened for contaminants, though it is anticipated more contamination will be included in the Ultimate Phase with the addition of food waste and increased overall community participation. Although the intent is that waste generators comply with guidance requests to supply only organic materials, experience has shown contamination will occur, typically in the form of packaging materials, film plastics, errant glass, and sometimes aspirational recycling.

Refuse and other non-compostable materials will need to be removed from site in a timely manner to comply with cleanliness standards of the future compost permit. Adequate space will be provided to accommodate stockpiling of compostable materials (the unloading surge pile for yard and food waste), and for residue (the contamination mentioned above will be stored in a refuse off-haul stockpile) to be hauled off-site for disposal elsewhere.

Feedstock from the unloading surge pile will need to be further processed to obtain the proper size for composting. The current design assumes use of a grinder to process feedstock. Area required for grinding feedstocks and material storage will be dictated by available space and site operations.

6.3 PRIMARY COMPOSTING AREA AND SECONDARY CURING AREA

For the Ultimate Phase, primary composting is managed by reversing aeration, with the option to monitor for temperature by a logic controller. The primary composting operation typically has two probes per zone: one sensor at a specified depth and one near the surface of the pile. When the temperature probes record a user-programmed difference between the two sensors, the aeration direction can be programmed to switch to reduce the differential and swing it in the opposite direction. Since bunkers are assumed for the Ultimate Phase, several space needs are decreased from the Initial Phase, as reflected in the sizing summary later in this Report. Pipes will not need to be pulled during material transport, and rows between windrows can be decreased to the width of the bunkers.

Similar to the Initial Phase, the primary composting system for the food/green waste operation will be covered via organic cover. However, the Ultimate Phase utilizes a biofilter for additional process control. The biofilter will be sized to scrub volatile organic compounds and odorous air contaminants from the process air extracted from the active compost area, the biofilter will require space to replace its media periodically, and for utilities associated with composting. The majority of pipes associated with the area will be stored underneath and within the composting zones, though additional space outside of the zone will be required to route air to and from the blower.

Additional levels of process automation are available for the primary composting phase. The surface of the piles can be irrigated with sprinklers if the material appears to be drier than desired. During the negative aeration mode, the process will draw air from beneath the pile into the air ducts placed on-grade beneath the pile and out to the manifold directing the collected air to a biofilter located nearby.

6.3.1 Secondary Curing Area

Similar to the Initial Phase, in the Ultimate Phase materials will be moved into a secondary curing after primary composting. During the curing period, a variety of possible aeration methods could be implemented. Air ducts will be provided at the bottom of curing bunkers to continue the active aeration and/or removal process of air and odors while the mass cools and biological processes diminish. Process air can be drawn or pushed into the material during curing. The process air can also be directed to the same biofilter that is utilized for the active composting phase, if odor management for sensitive receptors requires additional control. Similar to the composting area, bunkers are assumed for material storage in the curing area for the Ultimate Phase.

6.4 FINISHED PRODUCT STORAGE AREA

The finished product storage area is assumed to be similar design to the area described in the Initial Phase, though would likely need to increase in size to store a greater volume of compost produced at the proposed Facility.

7 ADDITIONAL SUPPORT AREAS

Support areas will be required for the proposed composting Facility and will be shared for both composting phases. Infrastructure will be necessary for operations and maintenance, site wayfinding, and for stormwater management.

7.1 MAINTENANCE SHOP

An on-site maintenance shop is typically needed for storage and repair and ongoing maintenance of Facility equipment. Space for the maintenance shop will include a storage area, an office, and a parking area. A generic maintenance shop is included in the preliminary site sizing analysis consistent with other projects observed by the design team.

7.2 SITE ACCESS ROADS

Paved or all-weather traffic lanes will be utilized throughout the site for transport to minimize dust suppression needs. Transport of the feedstock to the proper storage areas, appropriate ingress and egress for fire truck access, and adequate maneuvering for all user types will be provided. Space for a weigh-in/weigh-out scale is included in preliminary sizing the site access roads. The overall number of lanes needed is a function of the overall site operational area and driven by the ultimate functions programmed into the site, as well as the topography and environmental constraints of specific property. It is recommended that detailed routing and circulation plans are developed in the preliminary design phase to optimize site circulation.

7.3 STORMWATER MANAGEMENT

Stormwater for the Facility will be managed in accordance with the Department of Ecology's Stormwater Management Manual for Western Washington, and local regulations will be reviewed for their requirements. The design of run on and run off control systems is expected to require both water quality and quantity management and will be evaluated in the preliminary design phase. Stormwater in contact with putrescible materials (unloading, mixing and primary compost) will need to be collected and prevented from encountering materials at the remainder of the facility operation (e.g., post curing, and final product) to prevent passing pathogens to the final compost product. Depending on the quantity and quality of the stormwater, reuse of the water into the composting process or some form of treatment such as aeration of the water may be necessary.

7.4 SITE UTILITIES

Utilities will need to be provided to the Facility to accommodate composting and administrative activities. Pending selection of a preferred site, these utilities may need to be new installation, or may require upgrades to an existing system. As design is expanded and a preferred site is identified, utility requirements can be further developed to accommodate the proposed Facility.

Beyond the power required for composting operations, power will also be required for the weigh scales plaza and site communications. To accommodate year-round composting capabilities, site lighting will be necessary for safe and efficient operations.

Civil utilities beyond stormwater infrastructure will need to be included at the proposed Facility. Domestic and fire water services will be needed for the site for safety, operational efficiencies, and staff comfort. Pending strategic reuse of water on-site, sewer will be required for accommodating flow from washroom facilities.

8 PARTNERSHIP CONSIDERATIONS

In addition to developing partnerships to provide feedstocks to the proposed Facility, this Study reviewed potential opportunities to partner with on-island and local entities to share in project visioning and development. Possible partnerships could include engagement with private industry and/or other public agencies including King County divisions or departments, and engagement with public, educational, regulatory, and private entities. Partnerships considered in this Study are described below.

8.1 SITE

Selection of the site is perhaps the most challenging aspect of the development of an on-island compost facility. Partnering with entities that have the most to benefit from this type of facility could be ideal in identifying and securing a site. This section, although possibly aspirational, is intended to provide examples and ideas of what could occur if the circumstances become available.

Typically, companies providing excavation and landscaping services may have substantial equipment yards to host the proposed Facility. ZWV contacted all of the on-island landscaping companies and report none of the companies are interested in hosting a compost facility with the exception of one company who reportedly has a three acre site they would be willing to entertain a lease to the County for composting.

The former Vashon NIKE missile site (also known as the Sunrise Ridge) has been repurposed to the Clinic, the Foodbank and several other organizations. ZWV report the suitability of this site for composting is dubious.

Local nurseries were considered for potential hosts for the proposed Facility. Through discussion with ZWV and on-island nurseries, nurseries were determined to be too small or not interested in hosting a compost facility.

8.2 EDUCATION, OUTREACH, AND PUBLIC ENGAGEMENT

The Washington State University (WSU) may consider participation in the proposed Facility as a part of WSU's agricultural education program. WSU is the sponsor of the 4H program which is one of the largest youth educational programs in the United States.[2] WSU also supports the home composting program under the direction of Dr. Craig Cogger.[3] Additionally, WSU's Embrey Bronstad has been researching integrated organic recycling systems.[4] Given the local/community interest on Vashon Island, the possibility of inviting and engaging WSU, University of Washington, Evergreen State College, Puget Sound University, and other relevant academic institutions to partner with the KCSWD or ZWV in a variety of ways could be explored. Similar programs in other states have robust agricultural science education programs such as the University of California system and their hosting of the 4H and Future Farmers of America (FFA) programs at high schools,[5] although these programs do not currently exist at Vashon Island. At the University of California Davis, the agricultural program is the sponsor of a wide variety of education programs including the certified composter program.[6]

[2] https://extension.wsu.edu/4h/
[3] http://gardening.wsu.edu/compost-and-mulch/
[4] CSANR | Washington State University (wsu.edu)
[5] http://4h.ucanr.edu/contactus/StateOffice/
[6] http://pcmg.ucanr.org/Composting_Information/

Exploration of interest from the local elementary school and high school could be considered. The benefit of engagement of these programs could offer both feedstock and educational opportunities for students as they explore biological sciences, agricultural sciences, and other related programs.

8.3 PUBLIC PARTICIPATION

One of the keys of a successful, local compost project is community support. Community support can come from a wide range of possible sources beyond those mentioned in the education community above.

Business community involvement could include local growers, farm and agricultural entities, the local chamber of commerce, etc. The environmental/sustainability community could be further engaged beyond ZWV to include the Vashon Island Growers Association, Vashon Fruit Club, Vashon Garden Club, Vashon Maury Land Trust, The Whole Vashon Project, Backbone Campaign, and other Equity and Diversity groups. Although historically focused on transportation infrastructure to reduce greenhouse gases intergovernmental agencies such as the Pacific Coast Collaborative teamed with ReFED, the World Wildlife Fund and others by announcing a food waste reduction plan and reduce greenhouse gases.[7]

8.4 REGULATORY

Despite the reality that a compost facility on Vashon Island will be under the scrutiny of several regulatory agencies, the benefit of early engagement and support cannot be overestimated. Early engagement of the Puget Sound Clean Air Agency (PSCAA), County Panning, County Health, State Health and related agencies could endear these agencies in support of the program due to the greater environmental benefit an on-island compost facility offers.

8.5 PRODUCT OFFTAKE AND SUPPORT

According to ZWV, there is a strong demand for compost on Vashon, all of which is currently brought from the mainland. Vashon is home to a large number of home gardeners, community gardens, parks, landscape companies and small farms, and they are well-versed in the benefits of healthy soil and will create a strong market for the compost by an on-island facility.

Although compost retailers, nurseries and landscapers typically have an interest in compost and related nutrient-rich soil enhancements, and are likely to have an interest in purchasing the finished compost, none of the companies on-island have expressed interest in hosting a compost facility.

9 TECHNOLOGY VENDORS

To accommodate phased composting approach described in this Report, various technologies will need to be considered as the composting techniques are advanced. The following technology vendors have produced equipment for composting facilities within Washington State:

- O2Compost
- Engineered Compost Systems (ECS)
- Green Mountain Technologies (GMT)

[7] http://pacificcoastcollaborative.org/pcc-to-lead-partneship-reduce-food-waste/

- Sustainable Generation/GORE
- Renewable Carbon/NaturTech

9.1 O2COMPOST

Peter Moon owns and operates O2Compost[8] and has designed and provided thousands of small compost systems throughout the world. O2Compost systems are simple to operate, have low capital cost, and can be rapidly deployed and constructed using standard plan sets. Temperatures are recorded manually and temperature control by aeration blower is set with a timer based on manual temperature measurements through time and operator experience. O2Compost is based in Edmonds, Washington.

9.2 ENGINEERED COMPOST SYSTEMS

Engineered Compost Systems[9] (ECS) is a Seattle-based company that provides a range of composting systems around the world. It has equipment at close to 100 different sites. ECS has multiple design engineers and produces many of its own electrical and mechanical parts in the UL panel shop in Seattle, Washington. They have a range of technologies and provide equipment from 1,000 tons per year up to 500,000 tons per year. The ECS control system uses automated temperature measurements to feedback and control damper position and fan speed to adjust air flow to individual zones. ECS is owned and operated by Tim O’Neill.

9.3 GREEN MOUNTAIN TECHNOLOGIES

Green Mountain Technologies[10] (GMT) was founded in 1992 by Tim O’Neill and Michael Bryan Brown. Tim and Michael split up prior to 2000 and Tim established ECS and Michael kept GMT. GMT started with a focus on containerized systems and in the last decade has branched out to compete with ECS on larger scale CASP and aerated turned-pile systems. GMT is run from Bainbridge Island, Washington.

9.4 SUSTAINABLE GENERATION/GORE

Sustainable Generation[11] is the North American distributor of the GORE compost technology. GORE systems are used at Cedar Grove’s two Washington compost facilities. GORE systems are used on a wide range of scales from 100 tons per year pilot scale systems to 200,000 tons per year systems such as those found at Cedar Grove. The Sustainable Generation address is not listed on its website.

9.5 RENEWABLE CARBON/NATURTECH

Renewable Carbon Management, a firm from Saint Cloud, Minnesota, has produced a container vessel system and sold it to Whidbey Island Naval Air Station. The design is robust. In 2015 the controls stopped working and were replaced with an ECS controls system. ECS replaced the aeration system as well.

[8] O2Compost website: https://www.o2compost.com/
[9] Engineered Compost Systems website: https://www.compostsystems.com/
[10] Green Mountain Technologies website: https://compostingtechnology.com/
[11] Sustainable Generation, the American distributor of Gore, website: https://sustainable-generation.com/

9.6 EXAMPLES OF COMPOST SYSTEMS IN WASHINGTON

The phased composting approach described in this Report features two varieties of CASP composting systems – positive aeration in the Initial Phase, and reversing aeration in the Ultimate Phase.

CASPs are a common form of composting technology and there are numerous CASP systems in Washington State. Below is a list of those most similar to what is envisioned for Vashon Island.

Table 2. CASP System Reference Facilities

Facility Name	Technology Provider	Aeration Method	Annual Throughput (tons per year)	Link to website/pictures
Sky River Equestrian Center, Sultan, WA	O2Compost	Positive	9600	https://www.o2compost.com/past-projects.aspx?item=248&c=1542
Woodland Park Zoo, Seattle, WA	ECS	Positive	1,000	https://www.compostsystems.com/product-page/woodland-park-zoo-seattle-wa
City of Lynden, WA	ECS	Reversing with process air capture and scrubbing while in negative aeration direction	8,000	https://www.compostsystems.com/product-page/city-of-lynden-lynden-wa
Port Angeles, WA	ECS	Reversing with process air capture and scrubbing while in negative aeration direction	2,000	https://www.compostsystems.com/product-page/city-of-port-angeles-port-angeles-wa
Olympic Organics	GMT	Positive aeration	22,000	Olympic Organics Case Study
Sun Peaks	GMT containerized compost system	Positive	2,100	Sun Peaks Case Study
Heyday Farms	GMT's Site Built Earth Flow In-Vessel	Positive	438	Heyday Farms Case Study

10 SUMMARY OF PHASED COMPOSTING AREAS

Preliminary sizing for the phased composting areas is included in the table below. Although assumptions were used for preliminary sizing, the ultimate layout of the proposed Facility will require a balance of composting strategy, site configuration, operational approach, and availability of existing versus need for upgraded utilities.

Table 3. Summary of Approximate Composting Site Areas for Type of Operation

Feedstock Type/Source	Initial Phase (SF)	Ultimate Phase (SF)
Receiving and Pre-Processing Areas	6,000 to 8,000	12,000 to 14,000
Composting, Curing, and Biofiltration Areas	33,000 to 35,000	15,000 to 17,000
Finished Product Screening and Loadout Areas	14,000 to 16,000	16,000 to 18,000
Other Support Areas	36,000 to 38,000	34,000 to 36,000
TOTAL AREA	**89,000 to 97,000**	**77,000 to 85,000**
	2 to 2.2 Acres	**1.8 to 2 Acres**

Substantial sizing differences are figured between the two phases for the receiving and pre-processing areas, and composting, curing, and biofiltration areas. As participation increases in the proposed Facility from the Initial to Ultimate Phase, additional area is required for disposal and pre-processing of materials. Increased feedstock volume also leads to increased feedstock complexity, requiring greater process control from the Initial to Ultimate Phase. Although additional space is required for the biofiltration process, bunkers assumed for the Ultimate Phase decreases area requirements for the slab-on-grade layout for the Initial Phase.

11 RECOMMENDATIONS AND NEXT STEPS

Design parameters utilized to develop preliminary sizing are based on assumptions from existing facility operations and were utilized to develop initial schematic site layouts. These parameters will need to be further expanded during the second phase of this analysis, based on proposed sites, access to utilities, existing infrastructure, and other conditions established by KCSWD.

The next steps of this effort will be to determine the financial viability of implementing an on-island composting facility. After review and consideration of this study and at the direction of KCSWD, HDR will prepare a capital and operating cost estimate of the initial or ultimate compost facilities described above as a part of Phase 2 of this study. This expanded analysis will also address how the on-island compost facility would influence the existing SWD operations in terms of avoided cost, freeing up capacity in transfer operations, etc. The second phase of the report will also address the environmental changes such as greenhouse gas impacts from transportation activities of the current off-island management of these materials