Appendix 20 Port of Seattle Seattle-Tacoma International Airport Case Example

Appendix 20
Port of Seattle
Seattle-Tacoma International Airport (SEA)
Seattle, Washington

One of the Port of Seattle's Century Agenda objectives is to "be the greenest and most energy efficient Port in North America." The waste management program at Seattle-Tacoma International Airport (SEA) contributes to the progress toward this goal. SEA's centralized program includes waste reduction, reuse, recycling, and composting options for employees, tenants, and passengers. SEA is working toward 60% terminal waste diversion and 15% airfield waste diversion by 2020.

SEA's waste management program is overseen by staff from the Aviation Environmental and Facilities Department and Infrastructure Department. The City of Seatac Public Works Department has contracting authority while SEA coordinates waste hauling and recycling on airport property. The Airport Environmental Department manages the recycling service contracts; the Airport Facilities and Infrastructure Department manages the solid waste utility and funds waste management in its operating budget. The Airport Environmental Department tracks and reports waste diversion metrics tied to sustainability performance goals. The Facilities and Infrastructure Department monitors and tracks other aspects of the program, including those related to tenant billing and waste hauling company charges. The two departments collaborate to address program challenges and improvements.

Waste, recycling, and composting collection are conducted by private contractors. The waste and recycling contractors provide quantity data to the SEA; additional data for areas outside their services is estimated. When requested by SEA, the recycling contractor provides information about the market destination of single-stream recyclables processed at the material recovery facility, including materials collected from the Airport. King County owns and operates the local transfer station system and landfill. The landfill features a landfill gas collection system which produces natural gas. Cedar Grove operates the local composting facility. Janitorial services are provided by third-party vendors in agreement with SEA and directly with some tenants.

In 2015, a Solid Waste Management Plan was developed which documents the program's history, establishes waste diversion goals, and guides waste diversion efforts; this document is included at the end of this case example. SEA's internal goals and initiatives are the primary driver for action; while the facility is influenced by the policies of the local solid waste authority, the county, and the state, it lies outside of requirements from the City of Seattle. The Solid Waste Management Plan includes information about initiatives, responsibilities, and tasks associated with waste management. SEA also maintains communication protocols, service schedules, and documented maintenance requirements for the program.

Over the course of the program's history, SEA has conducted waste stream composition studies, passenger interviews and behavior studies, tenant surveys, and facility audits. SEA's program has been assessed and documented through the Solid Waste Management Plan as well as other waste management and sustainability reports. A copy of SEA's Solid Waste Growth Forecast and Capacity Analysis 2016-2034 is included at the end of this case example. SEA is in the process of developing an Airport Sustainable Master Plan which will include waste management elements.

In order to reduce the quantity of waste generated by airport activities, printers used by airport employees default to double sided printing and paper-free paychecks are standard. Airport procurement guidelines specify double-sided printed and digital submittals from vendors. SEA is also shifting from a paper-based capital project design review process to a digital process. Airport staff also reuse office supplies, pallets, and furniture. The procurement guidelines outlined in the SEA's Environmental Purchasing Policy apply to all Airport staff and prioritize supplies and other materials that are reusable, recyclable, compostable, sustainably sourced and packaged in bulk; or contain recycled content. These guidelines are preferred when they meet performance standards and are available in a reasonable amount of time at a reasonable cost. Airport employees recycle materials and compost food waste in their work areas and breakrooms. Management of construction waste salvages concrete, soil, and other materials; green waste generated from airport maintenance activities is composted.

The conversion of edible food from the waste stream into meals through donation represents reuse and targets all three elements of sustainability (social, environmental, and financial). Through SEA's food donation program, more than 20 concessionaire units diverted 56,000 pounds of food in 2016. The food donation program is a partnership between SEA, the food and beverage operators, and a local non-profit Food Bank focused on food insecurity. SEA provides access to coolers and freezers in a designated area for the safe storage of food items. The donated food is regularly collected by volunteers from the non-profit organization (Figure 1); from SEA, the food is transported to the local food bank where it is distributed to community members. SEA also donates furniture and other materials via a surplus program organized by partner municipalities. These donation programs divert waste from landfill, avoid disposal fees, and provide meals and materials to neighboring communities.

Food and beverage operators at SEA collect pre-consumer food waste for composting in their back of house areas (Figures 2 and 3). Airport administrative offices compost food scraps and compostables from pantries and conference rooms, and paper towels from employee restrooms. Previously, the composting program was voluntary; it is now required in tenant leases (a recent change) and represents the results of a long-standing collaboration between the tenants, SEA, and the composting facility. Tenants are required to offer compostable serviceware; they are also required to recycle materials generated by their activities. SEA provides waste, recycling, and compost bins in tenant back of house areas. The compost collection contractor estimates monthly quantities based on container sizes, collection frequency, volume estimates, and density factors. The composting facility allows a maximum contamination rate of ten percent; when the material exceeds this limit by visual inspection, the composting company leaves a notice, SEA or tenant takes corrective action, and the material is collected during the containers next service.

Fees for waste disposal are charged directly to tenants on a "pay as you throw" basis, creating a financial incentive for waste reduction, reuse, recycling, composting, and other strategies. SEA owns the compactors for waste and maintains an access control and usage monitoring system to track waste disposal. Tenant employees use a registered keycard to access the waste dumpster and the system tracks who disposed of waste and when (date and time). The tenant company is then charged about eight dollars for each waste disposal event. The recycling compactors are also owned by SEA; access to the recycling compactor is also controlled and tracked, however, recycling is free for tenants. Composting fees are included in the solid waste utility included in the tenants' lease; these fees are designed to be less expensive than the landfill disposal fees.

Recyclable materials collected from employees, tenants, and passengers are comingled in single stream (except glass and scrap metal). SEA receives rebates for recycled scrap metal. SEA does not receive rebates for comingled recycled materials; however, this service is free of cost to SEA thanks to the City's combined waste and recycling contract. Plastic film generated at SEA is collected and consolidated in a baler for recycling. Waste cooking oils are recycled into biodiesel, diverting approximately 70 tons from the landfill and sink drains. Waste materials are generated from construction activities at SEA; a portion of these materials are diverted (51 tons in 2016).

SEA operates a waste and recycling system for airfield materials. The airfield system consists of six sets of waste and recycling compactors arranged side by side (Figure 4). Some of the airlines recycle materials, including from deplaned waste, through SEA's program. Use of the airfield system is charged on a monthly basis based on the previous year's actual usage and other factors. The use of the previous year's activity to determine fees causes a lag between disposal activity and the financial incentive to recycle.

SEA provides waste, recycling, and compost containers in terminal public areas for passenger use (Figure 5). Post-consumer food waste and compostable service ware are collected for composting from passengers in the food court areas (Figure 6). Post-consumer composting is focused on the food court areas as the major source and capture potential. Passenger compost and tenant back of house composting divert more than 400 tons of food waste each year. SEA offers "equal opportunity" for recycling and disposal by pairing containers for each stream with a container for the other; containers have been installed in previously underserved areas. Waste, recycling, and composting containers are labeled and signed with instructions for their use; copies of the SEA's container labels are included at the end of this case example.

Liquid collection stations (Figure 7) and recycling bins are available at the security checkpoints. The annual quantity of liquid generated is estimated by the janitorial contractor based on periodic month-long measurement studies. Bottle filling stations are also available for passenger use (Figure 8); estimates of the number of plastic water bottles and resulting plastic diverted thanks to these fixtures is estimated based on their integrated tracking feature and bottle weight conversion factors. Information about recycling is also communicated to passengers through public address system announcements, window clings at gate hold rooms (Figure 9), and animation on terminal televisions.

Targeted education and outreach are provided to employees, tenants, and passengers. SEA produces guidance brochures specifically for employee and tenant users and posts signage on tenant recycling bins; an example brochure is included at the end of this case example and an example poster Is included as well. Employees are trained on recycling during on-boarding/new employee training and receive emails, newsletters, website updates, and social media messages about the program. Program progress updates and comparisons to business objectives and key performance indicators are included in internal annual progress reports

Tenants also receive training on the program; emails, brochures, and other information are sent to tenants. Airport staff regularly make presentations at tenant manager meetings where they summarize recycling requirements and provide progress updates for tenants. Inspections conducted by Airport staff also provide a mechanism for feedback on tenant performance. Annual facility and sustainability reports are available to employees, tenants, and the public via the Port of Seattle's website.

SEA is preparing to launch a program to disseminate sustainability information through mobile device messaging. SEA is also exploring ways to extract additional recyclable and compostable materials from the landfill bound stream and discussing a consolidated on-site waste management facility to increase the Airport's resiliency against changes in waste and recycling markets, technologies, etc. Airport staff are interested in providing support for other facility's efforts through sharing of best practices; this interest in based on the understanding that aviation is a connected industry and organizations' sustainability goals are linked together.

Figure 1: Food collection for donation; Courtesy of Port of Seattle

Figure 2: Back of house pre-consumer food waste collection for composting; courtesy of Port of Seattle

Figure 3: Back of house pre-consumer food waste collection for composting; courtesy of Port of Seattle

Figure 4: Side by side waste and recycling compactors; courtesy of Port of Seattle

Figure 5: Terminal waste, recycling, and compost containers; courtesy of Port of Seattle

Figure 6: Food court waste, recycling, and compost containers; courtesy of Port of Seattle

Figure 7: Liquid collection stations; courtesy of Port of Seattle

Figure 8: Terminal bottle filling station; courtesy of Port of Seattle

Figure 9: Window clings in gate hold room; courtesy of Port of Seattle

Seattle-Tacoma International Airport

Solid Waste Management Plan 2014

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A. Definitions

Table 1 below defines industry terms used throughout this document. Definitions were drawn from a number of industry sources, including the U.S. Composting Council, U.S. Environmental Protection Agency, and other Cascadia Consulting Group reports.

Table 1. List of Terms and Abbreviations Used in the This Document

Term or Abbreviation	Explanation
2014 SWMP	Seattle-Tacoma International Airport's 2014 Solid Waste Management Plan.
Aircraft and Ground Support	A generator group defined as: aircraft and ground crew services on the Airfield associated with passenger aircraft.
Airfield waste	Waste placed in Airfield collection sites (see Figure 3).The vast majority of this waste is created by the Aircraft and Ground Support generator group.
Airport	Seattle-Tacoma International Airport.
Airport Dining and Retail Concessions (ADR Concessions)	A generator group defined as: food and beverage, convenience and specialty retail, and duty-free concessions.
Capture rate	The percentage of a specific recoverable material or set of recoverable materials diverted for reuse, recycling, or composting, as opposed to disposal.
Central waste collection sites	Central sites at the Airport with garbage compactors, commingled recycling compactors, compostable waste dumpsters, and used cooking oil tanks.
Collection bin	A container for garbage, commingled recycling, or compostable waste where individual people discard waste, such as garbage bins in public areas of the terminals or in the back-of-house of tenant areas. Waste is later collected from bins to be transported to containers in central waste collection sites before being removed from the Airport by haulers.
Collection container	Containers, such as compactors, dumpsters, and drop boxes that collect waste from collection bins and from which haulers remove waste from the Airport.
Commingled recycling	Waste that is discarded with the intention of sending it to a facility that processes commingled materials for recycling.
Compostables	Waste that is fully biodegrade in an aerobic environment. Examples include food scraps, food-soiled paper, landscaping waste, wood waste, and certain bio-plastics.[1]
Construction and demolition (C&D) debris	Non-hazardous waste, including clean soil, generated by construction, renovation, or demolition activities.
Diversion	To redirect a material for reuse, recycling, or composting instead of disposing it as waste.
Efficiency rate	An estimate of the percentage of material that people participating in a given diversion program will divert. For example, an efficiency rate could be that among tenants that recycle, those participating tenants will recycle X percent of all the recyclable materials that they generate.

[1] Cedar Grove Composting, the Airport's compostable waste hauler, defines specific materials that fully biodegrade in their large scale commercial composting process.

Term or Abbreviation	Explanation
Environmentally preferable purchasing (EPP)	Reducing the adverse environmental impacts of purchasing decisions by buying goods and services that improve public health and safety, reduce pollution, and conserve natural resources.
Extended producer responsibility (EPR)	A mandatory type of product stewardship that includes, at a minimum, the requirement that the manufacturer's responsibility for its product extends to post-consumer management of that product and its packaging. There are two related features of EPR policy: (1) shifting financial and management responsibility, with government oversight, upstream to the manufacturer and away from the public sector; and (2) providing incentives to manufacturers to incorporate environmental considerations into the design of their products and packaging.
FAA	Federal Aviation Administration
Garbage	Waste that is discarded with the intention of sending it to a landfill.
Generator group	Groups of people, organizations, or areas of the Airport that generate similar types of waste. The generator groups defined for this project are: Public Areas, Airport Dining and Retail (ADR) Concessions, Aircraft and Ground Support, Port Maintenance Facilities, Tenant Terminal Areas, and Port Administrative Offices.
Hauler	Company that transports garbage, commingled recycling, compostables, or other waste from the Airport to a processing facility for recycling, composting, or final disposal. Haulers may also be processors. Recology CleanScapes is the Airport's current hauler/processors for garbage and commingled recycling. Cedar Grove Composting is the Airport's current hauler/processor for compostable waste.
Hazardous waste (HW)	Waste defined by the federal or state government as hazardous. Hazardous waste is commonly discussed with hazardous materials (representing hazardous waste before it becomes a waste) as hazardous waste and materials (HWM).
Landside waste	Waste from Airport areas other than the Terminal and Airfield, such as the car rental facility.
Material category	A specific type of waste material defined for this study, such as newspaper or aluminum.
Material class	A group incorporating similar waste material categories, such as paper, plastic, or glass.
Material efficiency rate	The percentage of a reusable, recyclable, or compostable material that could reasonably be captured for diversion.
Material recovery facility (MRF)	A facility that processes a mix of materials for recycling, using a combination of automated equipment and labor.
Mixed waste processing	Processing of mixed waste (a combination of recoverable and non-recoverable materials disposed as garbage) to recover recyclable and/or compostable materials.
Municipal solid waste (MSW)	Waste that is not hazardous and was not generated by construction, renovation, or demolition activities. While FAA guidelines for SWMPs include C&D debris in the definition of MSW, this SWMP limits the definition to have a unique, recognizable term that signifies non-hazardous waste generated by everyday activities.
Participation rate	An estimated percentage of people or organizations that participate in a given diversion program. Used with an efficiency rate.
Port	Port of Seattle—the organization that owns and operates Seattle-Tacoma International Airport as well as several seaport facilities. This SWMP addresses only Airport waste and operations.
Port Administrative Offices	A generator group defined as: Port of Seattle office areas.

Term or Abbreviation	Explanation
Port Maintenance Facilities	A generator group defined as: Port of Seattle maintenance operations, both on and off the Airfield.
Product stewardship	The act of minimizing the health, safety, environmental, and social impacts of a product and its packaging throughout all lifecycle stages, while also maximizing economic benefits. The manufacturer, or producer, of the product has the greatest ability to minimize adverse impacts, but other stakeholders, such as suppliers, retailers, and consumers, also play a role. Stewardship can be either voluntary or required by law.
Public Areas	A generator group defined as: areas accessible to the public in the terminals, ticketing (passenger-access areas), baggage claim, and parking garage, including both secure and non-secure areas.
Recoverable	Waste suitable for recycling, composting, or reuse.
Recycling	Processing used materials into new products. For example, recycling plastic bottles into carpet, or aluminum cans into aluminum cans.
Recycling rate	The percent of all waste generated recovered for recycling or composting.
Standardized collection station	A set of two or more collection bins. A standardized collection station contains three bins (one each for garbage, commingled recycling, and compostable waste) and uses a standard set of Airport-defined signal colors and labels.
Tenant Terminal Areas	A generator group defined as: airline administration, offices, ticketing (airline-employee-access areas), and baggage handling areas (secure area).
Terminal waste	Waste placed in central collection sites in the Terminal (see Figure 3). The vast majority of this waste is generated by ADR Concessions, Port Administrative Offices, Port Maintenance Facilities, Public Areas, and Tenant Terminal Areas.
To collect waste	To remove waste from collection bins and transport this waste to central waste collection sites so haulers can collect it.
TSA	Transportation Security Administration
Waste	Any materials that are discarded, whether as garbage, recycling, or composted.
Waste reduction	Preventing or decreasing the quantity of waste at the point of generation. For example, reusing ceramic plates instead of using one-time use disposable plastic plates.

B. Executive Summary

B.1.1. Overview

The Seattle-Tacoma International Airport (the Airport) is developing some of the nation's leading waste reduction and recycling programs in the aviation industry. The drivers for these programs include environmental, cost, and job-creating benefits of waste reduction and recycling as well as the Airport's commitment to environmental leadership. Through its efforts to date, the Airport has achieved a 31 percent diversion rate for Terminal waste, a 10 percent diversion rate for Airfield waste, a 98 percent diversion rate for C&D debris by Port contractors, and a 98 percent reduction in hazardous waste from its 10-year average. In addition, the Airport has won many aviation industry environmental awards, gained international media recognition for its innovative programs, and reduced its waste management costs.

B.1.2. Objectives

This document updates the Airport's Solid Waste Management Plan (SWMP), originally developed in 2010. The 2014 SWMP follows the Federal Aviation Administration's 2014 *Guidance on Airport Recycling, Reuse, and Waste Reduction Plans*.[2] Consistent with the FAA's guidance, this updated SWMP:

1. Documents existing Airport conditions.
2. Identifies and evaluates opportunities to further reduce Airport waste.
3. Recommends specific strategies to help the Airport achieve its established waste reduction and recycling objectives.

Key research findings informed the development and prioritization for the recommended strategies.

B.1.3. Plan Organization

This main body of this document is organized into the following seven sections, each with a number of sub-sections:

1. Introduction
2. Recommended Waste Reduction and Recycling Strategies
3. Current Waste Management System
4. Review of Contracts, Leases, Development Specifications, and Purchasing Policies
5. Current Education, Incentive, Engagement, and Pollution Prevention Strategies
6. Program Performance Measurement and Waste Characterization Results
7. Review of Recycling Feasibility

The Executive Summary synthesizes key information presented in these seven sections. Appendices follow the main body of the report, with additional detail on the FAA Guidance and the research conducted for the 2014 SWMP Update.

[2] Federal Aviation Administration, "Guidance on Airport Recycling, Reuse, and Waste Reduction Plans," retrieved September 2014 from https://www.faa.gov/airports/environmental/media/airport-recycling-reuse-waste-reduction-plans-guidance.pdf.

B.2. Recommended Waste Reduction and Recycling Strategies

To meet the Airport's waste reduction and recycling goals, this SWMP recommends a total of 43 strategies to implement over the next five years, including:

- Existing strategies that the Airport will continue to implement, some with new improvements.
- New strategies to initiate that were determined not to require more detailed analysis before implementing, including some pilot and research projects.
- New strategies that Cascadia and Airport Environmental staff recommended after performing a more detailed analysis.
- New strategies for collection, processing, incentives, and tenant requirements that could be reconsidered under more favorable conditions.

B.2.1. Organization of Recommended Strategies

Sections 2.3–2.7 present the complete list of the strategies, organized into five areas. The following areas are aligned with the FAA Guidance, the organization of recommendations in the 2010 SWMP, and the areas in which the Airport would take action:

- Ten recommended recycling and composting collection strategies
- Nine recommended procurement, contracting, and policy strategies
- Nine recommended education, incentive, engagement, and pollution prevention strategies
- Three recommended progress tracking and reporting strategies
- Twelve additional strategies recommended for future consideration

B.2.2. Methods Used to Identify and Analyze Strategies

Based on best management practices research with Airports and institutions—as well as input from Airport Environmental staff, Airport tenants, waste service providers, and government agencies—Cascadia staff identified and analyzed 45 potential strategies to meet the Airport's established objectives. Most strategies addressed Terminal diversion. Compared to the Airfield, the Terminal presents an opportunity to divert more tons, fewer challenges, and a higher degree of Airport control and influence. Strategies for C&D debris and hazardous waste focused on continuing the existing programs because they were both found to be very effective.

Cascadia and Airport Environmental staff conducted an initial screening of the strategies—incorporating local research findings and best practices from other Airports and institutions—to qualitatively assess the expected diversion potential, cost, and feasibility of 45 potential strategies. The screening stage divided strategies into three primary categories: 1) recommended without further analysis needed, 2) requiring further analysis to determine whether to recommend, or 3) not recommended at this time. The complete list of potential strategies addressed in the screening analysis, along with ratings and recommendations, is presented in Table 9 on page 30.

For the eight strategies identified as needing further analysis (as shown in Table 2), Cascadia staff conducted a more detailed analysis of the expected diversion, costs, and greenhouse gas impacts.[3] Cascadia and Airport Environmental staff used the results of this analysis to make recommendations regarding these strategies related to food packaging requirements, collection system and source separation requirements, and Airport collection containers.

B.2.3. Final Recommended Strategies and Projected Impacts

To achieve the Airport's Environmental Strategy Plan objective for Terminal diversion (50%) and respond to direction from the Port Commission to pursue use of durable and compostable service ware, **Cascadia and Airport Environmental staff recommend implementing six of the eight strategies that required additional analysis (See Strategies 2–5, 7, and 8, bolded in Table 2 below)**. **If implemented, these six strategies are expected to divert an additional 1,311 tons waste and increased the Terminal diversion rate to 54 percent, which would exceed the Airport's Environmental Strategy Plan objective for Terminal diversion of 50 percent, as shown in Table 3.**[4] Strategies that were recommended without detailed analysis either support these six strategies or are expected to increase Terminal and Airfield diversion even further.

Together, the six strategies recommended after detailed analysis are estimated to cost the Airport $33 per ton and tenants $852 per ton. The high cost-per-ton to tenants is primarily driven by Strategy 2 (requirements to use durable, compostable, or recyclable food service ware). Strategy 2 would not be implemented until the Airport rebids leases with Food and Beverage Concessionaires; Airport Environmental staff expect that these tenants will accommodate the cost increases by adjusting their financial proposals to the Airport.

Table 2. Results of Detailed Strategy Analysis, Including Diversion and Financial Projections

Strategy	Annual Diversion Potential (Tons)	Average Annual Net Cost (Savings) Per Ton ($/tons)		
		Overall	Airport	Tenants
Food Packaging Requirements				
1. Require Food and Beverage ADR Concessionaires to use durable or compostable food service ware (also affects public area waste).	367	$5,489	$54	$5,435
2. Require Food and Beverage ADR Concessionaires to use durable or compostable food service ware for items packaged by their company with the exception of cups, which must be recyclable or durable (also affects Public Areas).	**330**	**$3,772**	**$51**	**$3,721***

[3] A ninth strategy, composting paper towels from public restrooms, was selected for analysis but deemed unfeasible after further research.

[4] To mitigate double-counting, total diversion for Strategies 3, 4, and 5 (when all three strategies are selected) is assumed to equal that of Strategy 5. However, Strategy 5 would likely require tenants and ADR Concessions to install and standardize bins (incurring the costs of Strategies 3 and 4) in order to satisfy the requirements of Strategy 5. Diversion tons and costs do not include additional diversion and costs from strategies that were recommended without detailed analysis.

Strategy	Annual Diversion Potential (Tons)	Average Annual Net Cost (Savings) Per Ton ($/tons)		
		Overall	Airport	Tenants
Collection System and Source Separation Requirements				
3. Require all ADR Concessionaires to use standardized front-of-house collection stations and signage.	**107**	**$5**	**$45**	**($40)**
4. Require all ADR Concessionaires and Terminal Tenants to use standardized back-of-house collection stations and signage.	**256**	**($72)**	**$73**	**($145)**
5. Require all ADR Concessionaires and Terminal Tenants to recycle, compost, and prevent waste.	**494**	**($107)**	**$38**	**($145)**
6. Standardize the Airport's janitorial service to collect all garbage, recycling, and compostables from all ADR Concessionaires and Terminal Tenants.	69	NA**	NA**	NA**
Airport Collection Containers				
7. Standardize collection stations for all Airport-controlled bins and expand recycling media (affects Public Areas). Provide compostables bins in North and South satellites and Concourse A public food court areas.	**431**	**($25)**	**($25)**	**$0**
8. Relocate, improve signage, and add liquid collection stations for all security checkpoints.	**55**	**($91)**	**($91)**	**$0**

** Strategy 2 would not be implemented until the Airport rebids leases with Food and Beverage Concessionaires. Airport Environmental staff expect that these tenants will accommodate the cost increases by adjusting their financial proposals to the Airport.*

*** Supporting details to estimate the total cost of Strategy 6 are not available. The known cost components include one-time signage costs, one-time costs to develop and negotiate a new lease, and the annual amount paid to ABM for janitorial services. The Airport is waiting to obtain tenant estimates of their potential savings from no longer needing to transport their waste to central collection sites.*

Table 3. Projected Diversion Relative to Airport Goal of 50 Percent, Based on 2013 Waste Generation Estimates

	Annual Terminal Diversion (based on 2013 tons)	
	(Tons)	(Percent)
Current Terminal Diversion (2013)	1,793	31%
Terminal Strategies Recommended after Detailed Analysis*	1,311	23%
Terminal Strategies Recommended without Detailed Analysis	Not analyzed in detail	
Total	**3,104**	**54%**
Airport Environmental Strategy Plan Terminal Diversion Objective	2,876	50%

** To mitigate double-counting, total diversion for Strategies 3, 4, and 5 (when all three strategies are selected) is assumed to equal that of Strategy 5. However, Strategy 5 would likely require tenants and ADR Concessions to install and standardize bins (incurring the costs of Strategies 3 and 4) in order to satisfy the requirements of Strategy 5. Projected diversion tons and costs do not include additional diversion and costs from strategies that were recommended without detailed analysis.*

B.3. Current Waste Management System

B.3.1. Scope of Airport Control and Influence

This SWMP is focused on aspects of the waste management system where the Airport has direct control or influence over the five-year planning period. The Airport is expected to have the greatest impact in meeting its waste reduction and recycling goals by focusing on these areas. Level of control varies by generator and type of waste: municipal solid waste (MSW), construction and demolition (C&D) debris, and hazardous waste (HW). Table 4 identifies the Airport's level of control or influence over the generators and types of waste generated at the Airport.

Table 4. Summary of Airport's Waste Management Scope: Airport Control and Influence by Major Generator and Type of Waste

Generator	MSW	C&D	HW
Port of Seattle	Direct Control	Direct Control	Direct Control
Terminal and Landside tenants in Airport-operated facilities	Direct Control	Influence	No Control
Airfield tenants in Airport-operated facilities	Influence	Influence	No Control
Facilities controlled by tenants/sub-tenants	Minimal Influence	Minimal Influence	No Control
Port-hired construction contractors	Influence	Influence	Direct Control

Note: These wastes exclude regulated garbage from international flights which must be managed per U.S. Department of Agriculture requirements described in Appendix B.

B.3.2. Collection and Handling of MSW

Collection of MSW at the Airport originates through one of two primary pathways. "Front-of-house" (FOH) containers are used by the passengers and some tenants in publicly accessible areas. "Back of house" (BOH) containers are used by Airport employees, contractors (including janitorial), and tenants in areas not open to the general public. An estimated two-thirds of Airport-managed collection stations for passengers included recycling bins in 2014, an increase over recent years due to ongoing efforts to co-locate and re-sign bins. Container signage could be improved, however, to use best practices throughout the Airport. Many recommended strategies address opportunities to enhance and standardize bins, locations, and signage.

Janitorial staff and tenants transport most waste to compactors and other dumpsters at 12 central collection sites. All collection sites have commingled recycling compactors, and nine sites have compostables collection dumpsters. The Airport's current service contract for garbage collection also allows the Airport to recycle an unlimited amount of commingled recycling for no additional fees—a strong incentive to maximize recycling. Recommended strategies suggest continuing to effectively use and maintain the 12 central sites and continue to offer financial incentives for recycling service.

B.3.3. C&D Debris and Hazardous Waste Management

Construction and demolition (C&D) debris and hazardous wastes are also generated at the Airport. Airport construction contractors generate the majority of C&D debris and manage this material independently following the Port's Construction Waste Management specifications. The Port's Hazardous Waste Program ensures proper management of hazardous waste and industrial streams

generated by the Port and its construction contractors. In addition to proper hazardous waste management, the Port implements a Pollution Prevention Plan focused on overall reduction in hazardous waste generation by the Port and its contractors.

B.4. Program Performance Measurement and Waste Characterization Results

B.4.1. Program Performance Relative to Airport Goals

The Airport is committed to leading the U.S. airport industry in environmental innovation and minimizing the Airport's environmental impacts. Since adopting its 2010 SWMP, the Airport has made significant progress in adding new containers, enhancing participant training and signage, offering incentives, considering new policies, exploring mixed waste processing, and enhancing waste reduction programs. The Airport has also made other improvements beyond the 2010 SWMP recommendations in adding liquid drain stations at security check points, supporting the use of durable service ware at some Concessionaire locations, and expanding C&D debris collection services.

With these improvements, the Airport achieved a 31 percent Terminal diversion rate in 2013, and preliminary estimates suggest a 34 percent rate in the first quarter of 2015. This diversion rate is nearing the 36 percent projected in the 2010 SWMP as achievable through voluntary measures; reaching the Airport's objective of 50 percent Terminal diversion is expected to require implementing mandatory approaches or other ambitious recycling strategies.

The Airport has set objectives for materials and waste management in five key areas as presented in its Environmental Strategy Plan and listed in Table 5. To supplement and support achieving these objectives, the Airport has developed measurement systems for the performance indicators for these objectives and for other indicators that help the Airport determine whether it is on track to achieving them. Most of the 43 recommended waste reduction and recycling strategies focus on Terminal diversion of MSW because this is the area where the Airport has the most direct control and, therefore, the greatest opportunity for impact. As described in *Section 2 Recommended Waste Reduction and Recycling Strategies*, the project team also identified and analyzed additional strategies related to Airport objectives for Airfield diversion, C&D debris diversion, hazardous waste reduction, and environmentally preferable purchasing (EPP).

Table 5. Performance Measurement, Indicators, Objectives, and Current Results

Objective	Current Result
Terminal Diversion ▪ 2009 Objective: Diversion rate of 50% by 2014 ▪ 2015 Objective: Diversion rate of 50% by 2020 (maintain current objective)	31% in 2013
Airfield Diversion ▪ 2009 Objective: None[5] ▪ 2015 Objective: Diversion rate of 15% by 2020	10% in 2013

[5] Prior to 2010, airlines and ground service operators involved in Airfield operations managed deplaned and other Airfield waste independently outside the Port's direct control and influence.

Objective	Current Result
C&D Debris Diversion ▪ 2009 Objective: Implement Best Management Practices ▪ 2015 Objective: Diversion rate of 85% by 2020	98% in 2014
Hazardous Materials Reduction ▪ 2009 Objective: Continue to reduce use of hazardous materials and the generation of hazardous wastes. ▪ 2015 Objective: Reduce hazardous waste generated from Port operations to less than 220 pounds per month by 2020.	In 2014: ▪ 2,666 pounds annual total ▪ 2,020 pounds maximum monthly volume in storage ▪ 445 pounds maximum monthly volume generated
Environmentally Preferable Purchasing (EPP) ▪ 2009 Objective: Increase the amount of environmentally preferable products procured by the Airport by three products or categories each year. ▪ 2015 Objective: same	In 2014: ▪ 68% of purchased paper contained recyclable content ▪ 40% of purchased office products were environmentally preferable

B.4.2. Waste Characterization Results

In 2013, the year for which the most complete data were available for the 2014 SWMP, the Airport is estimated to have generated 7,888 tons of MSW. Table 6 presents annual tons of garbage, commingled recycling, composting, and other diversion for the Airfield, Terminal, and Airport overall, excluding C&D debris and hazardous waste. The three largest waste generators were Aircraft and Ground Support (31% of all garbage and commingled recycling), Public Areas (28%), and Airport Dining and Retail Concessions (27%). Recommended strategies focus on reducing waste and increasing recycling with these generator groups because they offer substantial opportunities for increasing diversion.

Table 6. Airport Waste Tonnages by Airfield and Terminal Areas, 2013[6]

Waste Stream	Airfield (tons)	Terminal (tons)	Overall (tons)
Garbage	1,918	3,959	**5,877**
Commingled Recycling	218	1,014	**1,232**
Composting	NA	423	**423**
Other Diversion	NA	356	**356**
Total Generation	**2,136**	**5,752**	**7,888**

Approximately 31 percent of Terminal waste (1,793 tons) was recovered in 2013 through commingled recycling, composting, and other diversion efforts, as shown in Table 6. While the Airport's Terminal diversion rate remains below the Airport's objective of 50 percent (Table 7), it reflects the highest annual diversion rate achieved since Airport recycling programs began in 1993. It also represents the latest point in a clear pattern of continuous program growth over the past decade, as shown in Figure 1. Approximately 10 percent, of Airfield waste (218 tons) was recovered as commingled recycling. This

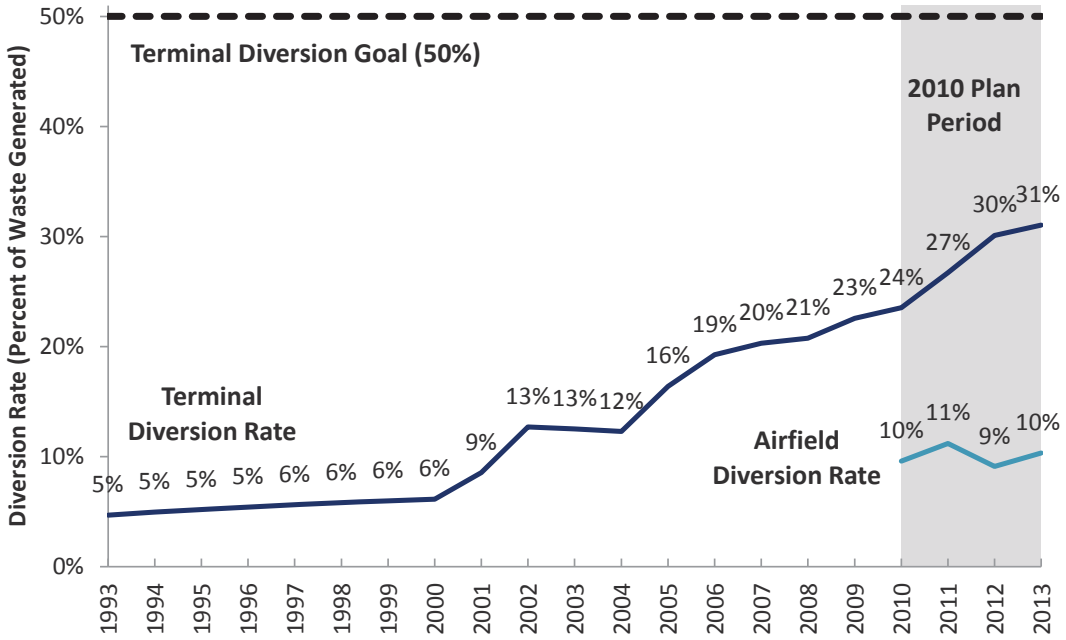
[6] Other diversion includes donated food, used cooking oil, source-separated glass, scrap metal, and wood.

diversion rate is consistent with average annual Airfield diversion since the Airport installed the Airfield Trash Handling and Recycling System in 2010.

Table 7. Airport Overall Diversion Rates by Airfield and Terminal, 2013[7]

Waste Stream	Airfield (tons)	Terminal tons)
2013 Diversion Rate	10%	31%
Diversion Rate Goal	15%	50%
Additional Tons to Reach Goal	**102**	**1,083**

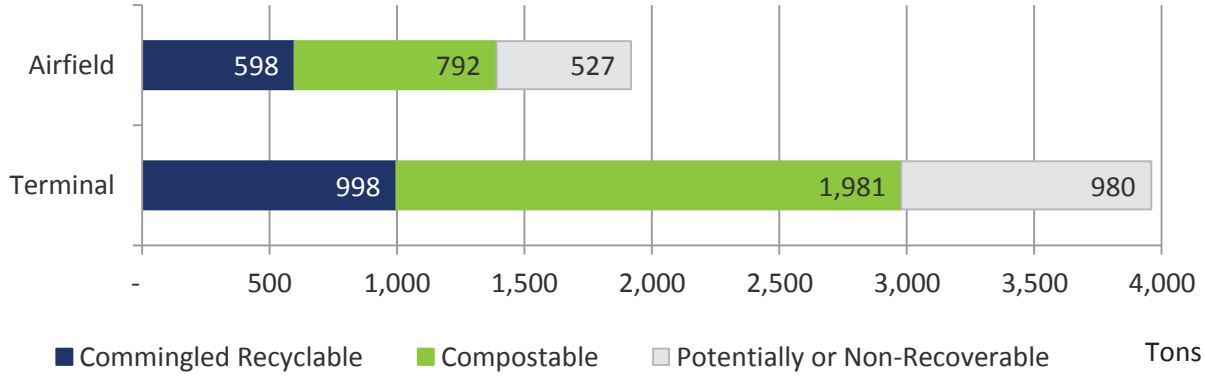
Figure 1. Airport Waste Diversion Rate History, 1993–2013



Approximately 4,370 tons, or 74 percent, of all Airport garbage is readily recoverable through existing commingled recycling and composting programs. As shown in Figure 2, the Terminal accounted for 2,979 tons of recoverable waste placed in garbage compactors. The Airfield accounted for 598 tons of recyclable waste placed in garbage compactors. Another 41 percent (792 tons) of Airfield garbage is compostable, but no Airfield composting system currently exists. Increasing Airfield recycling and initiating composting represent large opportunities to increase the Airfield diversion rate, but they also pose significant challenges.

[7] Other diversion includes donated food, used cooking oil, source-separated glass, scrap metal, and wood.

Figure 2. Recoverability Composition of Airfield and Terminal Garbage, by Weight



The following waste characterization findings underscore the importance of implementing waste reduction and recycling strategies focused on the ADR Concessions, Public Areas, and Terminal Tenants generator groups.

- ADR Concessions:
  - This generator group presents the largest opportunity to divert more Terminal compostable materials (887 tons disposed of as garbage).
  - Tenants reported moderate participation rates for composting (53 percent of those who generate compostable materials) and recycling (57 percent of those who generate recyclables materials).
  - Tenants recycle effectively when they participate: they achieved the highest capture rate for commingled recyclables (72%) among all generator groups and divert almost half of Airport commingled recyclables (46%).
- Public Areas:
  - This area represents a substantial opportunity to divert more Terminal compostable materials (793 tons disposed of as garbage).
  - Only nine percent of commingled recyclables are currently captured, leaving 595 tons disposed as garbage.
- Terminal Tenants:
  - This generator group represents a moderate opportunity to divert more recyclable and compostable waste, with 298 tons thrown away as garbage and a relatively low recycling capture rate of 31 percent.

Airport construction projects completed in 2014 reported recycling or reusing 98 percent of the 12,101 tons of C&D debris were generated from Airport construction projects and Port Construction Services small works projects.[8] This diversion rate indicates that current efforts to divert C&D debris are highly effective and should be continued.

[8] This figure does not include C&D debris from the Cargo 2, 5 and 6 upgrades project, which was substantially completed in 2014, but for which data were not available when this SWMP was written.

Hazardous waste generated at the Airport has fluctuated over the past decade, with an overall downward trend since the mid-1990s to 2,666 pounds in 2014. In 2005–2014, the Port achieved a 98 percent reduction in pounds of hazardous waste generated when compared to the previous decade. These numbers demonstrate the success of the Airport's pollution prevention efforts.

B.5. Key Challenges Impacting Recycling Feasibility

Recycling is highly feasible for the Airport as demonstrated by its record of waste diversion success. Since 1993, the Airport has recycled traditional recyclables from Terminal waste generators, including aluminum cans, plastic bottles, mixed office paper, and corrugated cardboard. In 2001, the Airport began collecting an expanded list of commingled materials, including plastic beverage cups. The Airport began collecting these same recyclables from Airfield waste generators starting in 2010.

Despite these successes, the Airport faces significant challenges to further reducing waste and increasing recycling. Cascadia and Airport Environmental staff developed and assigned relative importance to the list of challenges presented in Table 8. This assessment takes into account information obtained through discussions with Airport Environmental staff, surveys of Airport tenants, interviews with external stakeholders, and research on best management practices for airport recycling. These challenges directly influenced the feasibility ratings assigned to strategies in the screening analysis (described in more detail in *Section 7.5 Waste Management, Reduction, and Recycling Challenges*).

Cascadia and Airport Environmental staff considered and addressed challenges as follows during each phase of the SWMP development process.

- **Strategy identification and development:** Combined the proposed strategies with supporting actions to address applicable challenges to the greatest extent practical.
- **Strategy screening analysis:** Considered applicable challenges and assigned appropriate qualitative feasibility and cost ratings to each strategy.
- **Detailed analysis of selected strategies:** Incorporated key challenges (identified as having high importance) into the assumptions used to estimate costs and diversion potential.

To meet FAA Guidelines, Cascadia and Airport Environmental staff also reviewed other factors that could pose feasibility challenges to recycling at the Airport. These factors included recycling costs and savings, regional recycling markets, and waste-related regulations and policies that affect the Airport. The Airport has achieved financial savings from recycling and composting due to high tip fees at King County's Cedar Hills landfill and ready access to recycling markets and composting facilities charging lower per-ton fees for diverted materials. Overall, federal, state, and local regulations and policies were found to promote or support waste reduction and recycling by the Airport.

Table 8. Waste Management, Reduction, and Recycling Challenges

Challenge	Importance and Actions Taken to Address in SWMP
Passengers and tenants are generally inconsistent and ineffective at source-separating waste from recoverable materials.	**Importance: High** Incorporated recycling industry best practices for signage, labeling, and bin configuration to improve participant sorting effectiveness and minimize contamination in applicable strategies. Developed strategies to simplify passenger and tenant sorting. Included outreach and education, as well as enforcement and monitoring support to improve participant sorting effectiveness in applicable strategies. Included secondary waste sorting and mixed waste processing strategies to complement source-separation strategies.
Airport design specifications may still limit the ability to modify and upgrade signage on public garbage, recycling, and composting bins to include prominent color-coding and lists or images of materials accepted in bins.	**Importance: High** Public Areas represent the largest tonnages of recyclable/compostable materials currently disposed of as garbage in the Terminal, and Public Area diversion is limited primarily by lack of separation by passengers. Without secondary sorting, bin signage is the primary way to influence passenger sorting and is (therefore) the most important strategy for this area after co-location of bins. Considered and addressed primarily during strategy identification and development and reflected in initial screening ratings for each strategy. Recommended Airport conduct additional research on signage best practices to document justifications for changing Port-design specification.
A lack of consistent in-flight waste separation and recycling by airlines and ground service crews hampers Airfield recycling success.	**Importance: High** Acknowledged Airport's lack of control and limited influence by assigning low feasibility ratings to strategies during initial screening, directly attempting to increase commercial airline separation and recycling of in-flight waste. Also, assigned medium to high feasibility ratings to strategies that promote recycling in-flight waste from commercial aircraft or extend Airport recycling opportunities to Airfield and recycling at Air Cargo facilities, which do not rely on in-flight source separation.

Challenge	Importance and Actions Taken to Address in SWMP
Tenants are typically oppose new requirements, although the tenant surveys in 2010 and 2014 found strong support for mandatory recycling and moderate support for mandatory use of compostable or recyclable food service ware.	**Importance: High** Interpreted mixed information on tenant opposition as moderate and assigned medium level feasibility ratings to related strategies during initial screening analysis. Emphasized continuation and expansion of education, outreach, and technical assistance strategies to foster tenant support and promote compliance with recommended requirements. Incorporated appropriate levels of education, enforcement, and monitoring into assumptions used to estimate costs for applicable strategies during detailed analysis. Anticipate ongoing coordination with applicable Port departments (e.g., Airport Dining and Retail, Properties) to develop appropriate implementation strategies for recommended requirements. Anticipate timing changes with new tenant lease agreements to allow tenants to incorporate impacts into cost proposals.
Space constraints at existing Terminal loading docks and in BOH Concessionaire spaces limit the addition of recycling and composting bins and containers.	**Importance: Medium** Considered and addressed primarily during strategy identification and development process. Also reflected in initial screening feasibility ratings for each strategy.
Existing Airport geographical constraints and operational demands limit opportunities to scale waste handling infrastructure in order to meet growing demand.	**Importance: Medium** Considered and addressed primarily during strategy identification and development and reflected in initial screening ratings for each strategy. Developed recommended growth projection methodology to help Airport project expected growth of waste volumes and needed infrastructure in future Airport renovation and construction projects.
Lack of regional mixed waste processing capacity to conduct secondary sorting that could capture recyclable and compostable materials placed in garbage bins.	**Importance: Medium** Explored mixed waste processing potential with external stakeholders interviewed for the SWMP. Recommended mixed waste processing of garbage, contingent on a third party developing such processing capacity in the region.
Limited space within work area of Terminal construction projects to store and separate C&D debris.	**Importance: Medium** Considered and addressed primarily during strategy identification and development and reflected in initial screening ratings for each strategy.
Lack of control over waste generated at tenant-managed facilities, such as flight kitchens and air cargo.	**Importance: Low** Acknowledged Airport's lack of control and limited influence by assigning low or medium feasibility ratings during initial screening to voluntary strategies directly attempting to increase recycling and composting at tenant-managed facilities. Recommended expanding control over waste generated at tenant-managed areas.

Challenge	Importance and Actions Taken to Address in SWMP
Airport waste material composition is influenced by pre-packaged and other products beyond the control and influence of the Airport or its tenants.	**Importance: Low** Most other jurisdictions face this challenge, and several (such as Seattle) have overcome it. Moreover, 75% of Terminal garbage could be recycled or composted through existing Airport programs, indicating that sorting (rather than waste composition) is the limiting factor. Acknowledged Airport's lack of control and influence in this area by omitting these materials from food-service ware strategies. Maintained separate recycling, compost, and garbage streams in collection strategies to minimize potential contamination.
Flight kitchens and air cargo tenants reported that their challenges to recycling more include a lack of support for recycling from their airlines and clients as well as USDA international waste handling regulations.	**Importance: Low** Considered and addressed primarily during strategy identification and development and reflected in initial screening ratings for each strategy.

1. Introduction

1.1. Objectives

This updated SWMP documents current existing Airport conditions, identifies and evaluates opportunities to further reduce Airport waste (including hazardous materials and C&D debris), and meets defined objectives to help the Airport achieve established waste reduction and recycling goals. These defined objectives include satisfying new Federal Aviation Administration (FAA) requirements for Airport Recycling, Reuse, and Waste Reduction Plans.

1.2. Background

Airports present a substantial opportunity for waste reduction and recycling. Airport passengers, tenants, and operators generate large volumes of recoverable materials. Minimizing waste and maximizing recycling and composting creates environmental and economic benefits. Waste reduction and recycling reduce resource consumption, energy use, and emissions of greenhouse gases and other pollutants from extraction and manufacturing of products from virgin materials. For example, recycling aluminum from cans uses about 95 percent less energy than producing virgin aluminum from bauxite.[9]

In areas with strong recycling markets and high landfill fees, recycling and composting can reduce Airport costs related to waste management. Recycling and composting also create more jobs than landfill disposal. A 2011 study by the Tellus Institute estimated that every 1,000 tons of aluminum diverted to recycling creates 1.67 jobs in collection, 2 jobs in processing, and 17.63 jobs in manufacturing. By contrast, landfilling 1,000 tons of aluminum creates 0.56 jobs in collection and 0.10 jobs in landfilling.[10] Composting food scraps is estimated to generate 2.17 collection and processing jobs per 1,000 tons diverted while collection and landfill disposal of 1,000 tons of food scraps is estimated to generate only 0.66 jobs.

Airports also present unique challenges for waste reduction and recycling programs because of their unique blend of business operations, public services, and facility management activities that coexist in a busy air transportation hub.

The Seattle-Tacoma International Airport (the Airport) has taken advantage of these opportunities and addressed these challenges by developing some of the nation's leading waste reduction and recycling programs. The drivers for these programs include the environmental, cost, and job-creating benefits of waste reduction and recycling as well as the Airport's commitment to environmental leadership in the airport industry. As a result of its efforts, the Airport has achieved a 31 percent diversion rate for Terminal waste, a 10 percent diversion rate for Airfield waste, a 98 percent diversion rate for C&D debris by Port contractors, and a 98 percent reduction in hazardous waste quantities from its 10-year average.

[9] Pennsylvania Department of Environmental Protection, "Recycling Saves Energy," retrieved May 2015 from www.portal.state.pa.us/portal/server.pt/community/benefits_of_recycling/14061/save_energy/589519.
[10] Tellus Institute, "More Jobs, Less Pollution," 2011, retrieved May 2015 from http://www.nrdc.org/business/guides/recyclingreport.asp.

In addition, the Airport has won many aviation industry environmental awards, gained international media recognition for its innovative programs, and reduced its waste management costs.

In 2009, the Airport published its Environmental Strategy Plan to serve as a road map for sustainable initiatives through 2014 and beyond.[11] The plan established a 50 percent diversion rate objective for Terminal waste. To identify strategies for its waste diversion objectives and address the challenges of building upon well-established recycling programs, the Airport contracted with Cascadia Consulting Group, Inc. (Cascadia) in 2010 to develop its first comprehensive Solid Waste Management Plan (SWMP). In 2014, the Airport began updating its Environmental Strategy Plan and contracted with Cascadia again to update the SWMP.

On September 30, 2014, the Federal Aviation Administration (FAA) issued *Guidance on Airport Recycling, Reuse, and Waste Reduction Plans*.[12] This memorandum provides detailed guidance to help airports comply with the *FAA Modernization and Reform Act of 2012*, which requires that airports receiving Airport Improvement Plan funding address specific recycling issues when updating or preparing an airport master plan, sustainability master plan, or stand-alone recycling, reuse, and waste reduction plan. *Appendix A* presents a table that identifies where each of the required sections listed in the FAA guidance memorandum can be found in this updated SWMP. This SWMP is organized to facilitate the Airport's use of its contents and reduce repetition while including all items required by the FAA. Cascadia and Airport Environmental staff met with FAA staff members regarding the proposed SWMP structure to obtain their feedback.

General information about the Airport—including location, layout, aviation classification, governance and operational information, number of based aircraft, number and type of aircraft operations, enplaned passengers, and carriers that serve the Airport—can be found in the Airport's Sustainable Airport Master Plan.

1.3. Project Methodology

To update the Airport's SWMP, Cascadia and Airport Environmental staff reviewed existing information on Airport programs and policies, engaged internal and external stakeholders, and conducted focused research including a waste characterization study, literature review, and national best practices research to identify specific waste diversion areas of opportunities. Specifically, Cascadia conducted the following activities:

- Performed a waste characterization study
- Developed guidelines the Airport can use to project growth in MSW and analyze future capacity needs
- Conducted interviews and a literature review of waste reduction and recycling practices used by airports elsewhere

[11] Port of Seattle, "Environmental Strategy Plan 2009," retrieved April 2015 from https://www.portseattle.org/Environmental/Environmental-Documents/Documents/09_Env_Strategy_Plan.pdf.
[12] Federal Aviation Administration, "Guidance on Airport Recycling, Reuse, and Waste Reduction Plans," retrieved September 2014 from "https://www.faa.gov/airports/environmental/media/airport-recycling-reuse-waste-reduction-plans-guidance.pdf.

- Researched best practices for:
  - Cardboard management
  - Security checkpoint liquid container management
  - Loading dock design
- Conducted stakeholder research with:
  - Airport tenants located in the Terminal
  - Flight kitchen and air cargo tenants
  - Government and service provider representatives
- Developed and analyzed waste reduction and recycling strategies

Results from all research activities are presented in *Appendix C* through *Appendix K*. Cascadia and Airport Environmental staff used the results of this research to develop a list of strategies that could enhance waste reduction and recycling at the Airport. Cascadia and Airport Environmental staff conducted a screening analysis to identify and assess strategies to include in the SWMP. *Appendix L* and *Appendix M* document this analysis effort.

1.3.1. Stakeholder Engagement

Stakeholder engagement was an integral part of creating the original SWMP, providing insight into challenges and opportunities. In 2010, staff from concessions, airlines, janitorial companies, and the Port were invited to participate in a web-based survey, meetings, and a final review of waste reduction and recycling opportunities.

To update the SWMP in 2014, Cascadia and Airport Environmental staff again invited staff from Concessionaires, airlines, air cargo operations, and flight kitchens to participate in web-based surveys to update information about their recycling practices, challenges, and ideas and opinions on future opportunities. A total of 24 general tenants and 3 flight kitchen or air cargo tenants responded, out of the 87 individuals who were sent the survey.

To supplement the web-based surveys of internal Airport stakeholders, Cascadia staff interviewed six external stakeholders including representatives from waste services providers, local governments, and the FAA. These interviews addressed challenges, opportunities, key industry developments and trends, and future regulations or policies that could aid or hinder the Airport's waste reduction and recycling program.

Key findings from these surveys and interviews, summarized below and described in more detailed in *Appendix J* and *Appendix K*, informed the development and contents of the updated SWMP.

- Airport tenants reported general satisfaction with the Airport's waste collection program, though some commented on the need for improved cleanliness at collection sites and expanded availability of recycling and compost collection containers.
- Reported participation in compostables collection was lower than for mixed recyclables, with about half of respondents separating food scraps for composting.
- Reported barriers to increased recycling included the need for more employee training, logistical issues with sorting materials, and lack of employee time.
- The majority of respondents have used the Airport's back-of-house collection bins, recycling posters, and program brochures, but fewer were aware of available employee training and recycling stickers.

- All respondents supported a mandatory recycling program for common recyclables, and the large majority expressed support for a mandatory composting program for food scraps and food-soiled paper.
- Survey respondents reported that cost and corporate requirements posed barriers to using compostable and recyclable products.
- Service provider and government interviewees also identified opportunities and recognized challenges associated with increasing recycling, particularly compostables, at the Airport.

Opportunities identified by stakeholders were considered when developing the list of preliminary waste reduction and recycling strategies. Key challenges are presented in *Section 7.5 Waste Management, Reduction, and Recycling Challenges*.

1.3.2. Waste Reduction and Recycling Strategy Development and Analysis

Research and strategy identification. Based on research on best management practices as well as input from Airport Environmental staff, Airport tenants, waste service providers, and government agencies, Cascadia staff identified 45 potential strategies to enhance waste reduction and recycling to meet the Airport's goals. Proposed strategies addressed most areas of waste over which the Airport has direct control or influence. The majority of strategies focus on the largest opportunities identified during research: diverting more compostables and recyclable materials from ADR Concessions, Public Areas, and Terminal Tenants.

Screening analysis. Cascadia and Airport Environmental staff conducted an initial screening to qualitatively assess the expected diversion potential, cost, and feasibility of these 45 strategies. The screening stage divided strategies into three categories: recommended without further analysis needed, requiring further analysis to determine, or not recommended at this time.

Detailed analysis. Cascadia staff, working with Airport Environmental staff, conducted a more detailed analysis of the expected diversion potential, costs, and greenhouse gas impacts for the eight strategies identified as needing further analysis.

2. Recommended Waste Reduction and Recycling Strategies

2.1. Objectives

This section summarizes the process of identifying, prioritizing, and analyzing waste reduction and recycling strategies designed to support the Airport in meeting its objectives over the next five years.

Section Overview

- This section of the SWMP summarizes the 43 waste reduction and recycling strategies that Cascadia and Airport Environmental staff recommend implementing over the next five years including:
  - Existing strategies that the Airport will continue to implement, some with new improvements.
  - New strategies to initiate that did not require detailed analysis before implementing, including some pilot and research projects.
  - New strategies that Cascadia and Airport Environmental staff recommended after detailed analysis.
  - Strategies for collection, processing, incentives, and tenant requirements that could be reconsidered in the future under more favorable conditions
- Based on research on best management practices as well as input from Airport Environmental staff, Airport tenants, waste service providers, and government agencies, Cascadia staff identified 45 potential strategies to enhance waste reduction and recycling to meet the Airport's goals.
  - Cascadia and Airport Environmental staff conducted an initial screening—incorporating local research findings and best practices from elsewhere—to qualitatively assess the expected diversion potential, cost, and feasibility of these strategies.
  - The screening stage divided strategies into three categories: recommended without needing further analysis, requiring further analysis to determine, or not recommended at this time.
- For eight strategies identified as needing further analysis, Cascadia staff, working with Airport Environmental staff, conducted a more detailed analysis of the expected diversion potential, costs, and greenhouse gas impacts. Cascadia and Airport Environmental staff used the results of this analysis to recommend strategies related to food packaging requirements, collection system and source separation requirements, and Airport collection containers that would help the Airport meet Terminal diversion objectives.
- To meet the Environmental Strategy Plan objective for Terminal diversion (50%) and respond to Port Commission direction to pursue compostable food service ware, **Cascadia and Airport Environmental staff recommend implementing six of the eight strategies analyzed in detail (Strategies 2, 3, 4, 5, 7, and 9). Together these six strategies are expected to divert an additional 1,311 tons waste and increase the Terminal diversion rate to 54 percent while costing the Airport $33 per ton and tenants $852 per ton.**
  - Cost and tonnage figures should be considered planning-level estimates. A more detailed analysis or pilot testing is recommended before implementing the recommended strategies
- Strategies in this section are organized as follows:
  - Ten recommended recycling and composting collection strategies
  - Nine recommended procurement, contracting, and policy strategies

  - Nine recommended education, incentive, engagement, and pollution prevention strategies
  - Three recommended progress tracking and reporting strategies
  - Twelve additional strategies recommended for future consideration
- Additional detail on the strategies considered for analysis, the analysis methodology, and analysis results can be found in *Appendix L* and *Appendix M*.

2.2. Analysis of Waste Reduction and Recycling Strategies

Cascadia and Airport Environmental staff used the results of research collected during the 2014 SWMP update to develop a comprehensive list of 45 strategies that could enhance waste reduction and recycling at the Airport. These strategies were derived from a variety of research methods, including a literature search, stakeholder interviews, and input from Airport Environmental staff. Strategies were designed to be consolidated approaches that included related elements necessary for implementation. For example, standardized collection station strategies encompass elements related to bin and lid design, bin placement, signage design and placement, and co-location of recycling and garbage bins. However, strategies also represent distinct approaches that in some cases work better in combination: for example, expanding composting collection to additional food courts will improve the outcomes of requiring Food and Beverage Concessionaires to use recyclable or compostable food service ware.

Strategies addressed key opportunities and challenges identified during the research phase, including:

- **The Airport is approaching the upper limit of diversion possible to achieve from voluntary measures alone.**
  The Airport achieved a 31 percent Terminal diversion rate in 2013, and preliminary estimates suggest a 34 percent rate in the first quarter of 2015. This diversion rate is nearing the 36 percent previously identified as achievable through voluntary measures; reaching the Airport's objective of 50 percent Terminal diversion is expected to require mandatory approaches or other ambitious recycling strategies.
- **Most Terminal garbage is readily recoverable.**
  Overall, 75 percent of waste placed in Terminal garbage compactors is readily recoverable through existing recycling and composting programs. Half (50%) of Terminal garbage is compostable (primarily food and food-soiled or compostable paper) representing an opportunity to increase diversion through expanded composting.
- **ADR Concessions, Public Areas, and Terminal Tenants are the three Terminal generator groups representing the most substantial diversion potential.**
  ADR Concessions represents the largest opportunity to divert more Terminal compostable materials (887 tons), followed closely by Public Areas (793 tons). Twice during the development of this SWMP, the Port of Seattle Commission directed Airport Environmental staff to pursue use of durable and compostable service ware at Airport Food and Beverage Concessionaires as an approach to increasing diversion.
  - From Public Areas, only nine percent of commingled recyclables are currently captured, leaving 595 tons disposed of as garbage.
  - Terminal Tenants represent a moderate opportunity to divert more recyclable and compostable waste (298 tons) and have a relatively low recycling capture rate (31%).

  - In 2014, 43 percent of ADR Concessions tenants that generated recyclable materials were not recycling while 47 percent of these tenants with compostable waste were not composting.
- **The Airport achieved a 10 percent Airfield diversion rate in 2013, indicating more work is needed to reach the 2020 objective of 15 percent diversion.**
  - Overall, 31 percent of waste placed in Airfield garbage compactors is readily recoverable through the existing Airfield recycling programs (598 tons). Another 41 percent (792 tons) of Airfield garbage is compostable, but no Airfield composting system currently exists.
  - Increasing recycling and initiating composting represent large opportunities to increase the Airfield diversion rate but also face significant challenges, particularly the lack of consistent in-flight waste separation and recycling by airlines and ground service crews.
- **Existing central waste collection sites generally encourage effective participation in diversion programs: increased equipment maintenance and cleaning could further program success.**
  The Airport's 12 central waste collection sites support diversion: all collection sites have commingled recycling compactors and all Terminal collection sites have compostables collection dumpsters. However, Airport tenants commented on the need for improved cleanliness at collection sites. Airport Environmental staff confirmed cleanliness issues, including waste dumping when compactors break down due to lack of preventive maintenance.
- **The Airport's current programs for C&D debris, hazardous waste, and pollution prevention have been highly successful.**
  The Airport's efforts around C&D debris diversion, hazardous waste management, and pollution prevention are effective. Airport construction projects completed in 2014 reported recycling or reusing 98 percent of C&D debris, exceeding the Airport's objective of 85 percent. In 2005–2014, the Port generated less than 35,000 pounds of hazardous waste, approximately a 98 percent decreased compared to the previous decade. In 2014, the Port generated a maximum of 445 pounds in one month at the Airport, leaving some room for improvement to reach its objective of generating no more than 220 pounds in any month.
- **The Airport has opportunities to expand environmentally preferable purchasing efforts.**
  In 2014, 40 percent of purchased office products were environmentally preferable, indicating remaining opportunities to increase green purchasing. Green purchasing reduces waste toxicity and encourages the use of recycled materials in new products.

As a result, while proposed strategies address most areas of waste over which the Airport has direct control or influence, the majority of strategies focus on diverting compostables and recyclable materials from ADR Concessions, Public Areas, and Terminal Tenants. We analyzed this list in two stages: a screening analysis of all the strategies and a more detailed analysis of a smaller subset of strategies.

2.2.1. Screening Analysis

Cascadia and Airport Environmental staff assessed the following characteristics of each strategy:

- Material types and generator groups affected
- Estimated quantity of material currently in garbage that would be affected
- Status as a voluntary, mandatory, or system change approach
- Waste management hierarchy level (such as source reduction, reuse, recycling)
- Current implementation at the Airport

- Estimated cost (on a three-point scale of low, medium, and high)
- Estimated feasibility excluding cost (low, medium, high) with notes on feasibility issues

While the first three characteristics (affected quantity, cost, and feasibility) were given particular attention during this screening process, Cascadia and Airport Environmental staff used all of the characteristics to analyze and screen the strategies into the categories below.

- New strategies to analyze before including as a recommended action
- Current strategies to recommend expanding and new strategies to recommend adopting (without analysis)
- New strategies to recommend for pilot testing or more research (without analysis at this time)
- Current strategies to recommend continuing without expansion
- New strategies to recommend as long-term strategies, if conditions become right
- New strategies to recommend not doing or to combine with other strategies

Cascadia and Airport Environmental staff generally recommended without analysis strategies that were voluntary, were considered to affect large quantities of waste, be low cost, or be highly feasible; Cascadia and Airport Environmental staff also recommended without analysis strategies that improved waste collection or tracking. Examples of these strategies include increasing education and outreach to tenants and employees, improving compactor cleanliness and reliability, and improving waste tracking by generator group.

Some strategies affected large quantities of waste or were expansions of existing programs but also had major feasibility issues or uncertain costs. Cascadia and Airport Environmental staff recommended these strategies in the SWMP either for pilot projects, additional in-depth research (beyond the scope of this planning effort), or long-term options to be reconsidered under specified conditions. Examples of these strategies include using janitorial staff to sort recyclable materials out of garbage, requiring Food and Beverage Concessionaires to donate surplus edible food, requiring Airfield tenants to recycle and compost, and expanding the Airport's waste system to manage flight kitchen waste.

Table 9 presents the strategies included in the screening analysis along with the screening recommendation, tons available for diversion, cost rating (high, medium, low), feasibility rating (high, medium, low), and notes on the recommendation and feasibility issues.

Cascadia and Airport Environmental staff chose nine strategies to analyze in more detail because it was not clear whether the Airport should implement them. While these strategies generally affected large quantities of waste, they also either had medium feasibility, high feasibility but imposed mandatory requirements on tenants, or had potentially high costs (that could be estimated within the scope of this planning effort). Eight of these strategies are listed below with results of the detailed analysis. The ninth strategy—composting paper towels from public restrooms—was deemed unfeasible at this time after discussing options in detail with two local composting facilities and obtaining a preliminary cost estimate from the Airport's janitorial service provider for pre-sorting paper towels to remove contaminants.

Appendix L documents this screening analysis effort.

Table 9. Screening Analysis Results and Recommendations

Strategy	Analysis Recommendation	Reason/Discussion for Recommendation	2013 Tons in garbage[13]	Cost	Feasibility	Feasibility issues (other than cost)
Require ADR Concessions and Terminal Tenants to recycle, compost, and prevent waste.	Analyze before recommending.	High quantity (1,383 tons from ADR Concessions and Terminal Tenants), medium-low cost, and medium feasibility.	1,383	L-M	M	Tenant opposition, influence boundaries, compliance issues (even with training, monitoring, and enforcement).
Use the Airport's janitorial service to collect all waste directly from ADR Concessions and Terminal Tenants.	Analyze before recommending.	High quantity (1,383 tons from ADR Concessions and Terminal Tenants), medium cost, and medium feasibility.	1,383	M	M	Terminal Tenant opposition, collection logistics (for both ADR and tenants).
Continue co-locating public area collection bins; standardize color and signage using best practices.	Analyze before recommending.	High quantity (1,382 tons from Public Areas) and high feasibility.	1,382	M-H	H	Adherence to architectural standards (that don't allow multiple colors).
Require Food & Beverage Concessionaires to use only durable or compostable food service ware and packaging.	Analyze before recommending.	High quantity (1,267 tons), medium-low cost, and medium feasibility. Consider expanding to require paper bags to avoid contamination (as people dump without sorting) and confusion.	1,267	L-M	M	Tenant opposition; higher tenant costs for packaging (but offset by lower solid waste costs); enforcement; space for more organics dumpsters/compactors; collecting compostables beyond food courts.
Require Food & Beverage Concessionaires to use only durable, compostable, or recyclable (cups only) food service ware.	Analyze before recommending.	High quantity (1,025 tons), medium-low cost, and medium feasibility. Consider expanding to require paper bags to avoid contamination (as people dump without sorting) and confusion.	1,025	L-M	M	Tenant opposition; higher tenant costs for packaging (but offset by lower solid waste costs), enforcement; space for more organics dumpsters/compactors; collecting compostables beyond food courts.
Require ADR Concessionaires to use standard FOH 3-bin collection systems with Airport-approved signage.	Analyze before recommending.	Moderate quantity (543 tons), low cost, and high feasibility.	543	L	H	Tenant opposition (minor if implemented only during build-out or required renovations).

[13] Additional information on tonnage estimates, such as the proportion of generator tonnages assumed to be affected by each strategy, are presented in Appendix L.

Strategy	Analysis Recommendation	Reason/Discussion for Recommendation	2013 Tons in garbage[13]	Cost	Feasibility	Feasibility issues (other than cost)
Require ADR Concessionaires and terminal tenants to use standard BOH 3-bin collection systems with Airport-approved signage.	Analyze before recommending.	Moderate quantity (543 tons), low cost, and medium feasibility.	543	L	M	Tenant opposition (primarily space constraints, such as in small kitchens).
Improve location and signage for liquid collection stations at security lanes.	Analyze before recommending.	Moderate quantity (416 tons), low cost, and high feasibility. Tonnage data before/after implementation available from Portland. This strategy could be lower cost/ton than purchasing a puncture unit.	416	L	H	Passenger flow disruptions.
Compost paper towels from public restrooms.	Analyze before recommending.	Paper towel tons are likely underestimated in the waste composition and present a big opportunity for diversion for existing bathrooms that are not scheduled for renovation to hand dryers.	81	M	L-M	Current vendor does not accept paper towels from public restrooms; costs associated with additional compostable liners.
Use janitorial service to sort recyclable materials out of Airport Administration and Tenant Terminal garbage bins.	Recommend conducting pilot study for this generator group and using results to determine whether to implement.	This strategy has high potential for recovering materials. Janitorial contractor already collects all admin and much of tenant material. Additional pilot testing is needed to provide more accurate data on diversion tonnages and cost because the unpredictable nature of Airport and differences between Airport generators makes it difficult to model this on-the-ground activity.	139	M-H	H	Space constraints, requires continuous sorting schedule because STIA operates 24/7 (can't store unsorted waste).

Strategy	Analysis Recommendation	Reason/Discussion for Recommendation	2013 Tons in garbage[13]	Cost	Feasibility	Feasibility issues (other than cost)
Use janitorial service to sort recyclable materials out of public area garbage bins.	Recommend conducting pilot study for this generator group and using results to determine whether to implement.	This strategy has high potential for recovering materials. Janitorial contractor already collects this material. Additional pilot testing is needed to provide more accurate data on diversion tonnages and cost because the unpredictable nature of Airport and differences between Airport generators makes it difficult to model this on-the-ground activity.	595	M-H	H	Space constraints, requires continuous sorting schedule because STIA operates 24/7 (can't store unsorted waste).
Use janitorial service to sort recyclable materials out of ADR Concessions garbage bins.	Recommend conducting pilot study for this generator group and using results to determine whether to implement.	This strategy has high potential for recovering materials, although the janitorial contractor does not currently collect this material. Additional pilot testing is needed to provide more accurate data on diversion tonnages and cost because the unpredictable nature of Airport and differences between Airport generators makes it difficult to model this on-the-ground activity.	195	M-H	H	Space constraints, requires continuous sorting schedule because STIA operates 24/7 (can't store unsorted waste).
Assess the feasibility of tracking and billing systems for more accurate pay-as-you-throw fees.	Recommend without analysis to conduct future research to understand all technology options, if Airport does not recommend using janitorial service to collect all waste directly from ADR Concessions and Terminal Tenants.	Costs and capabilities will vary substantially depending on technology. Additional research is required to identify specific, suitable technology options.	2,792	H	L-M	Space constraints; technology/equipment limitations.
Collect cardboard separately for recycling.	Recommend conducting pilot project to assess on-the-ground feasibility and confirm results of analysis.	While feasibility is low, research and analysis indicated the strategy could pay for itself within a few years.	No Change	L	L	Space constraints; safety issues (baler); FOD issues (roll-off); Cost does not include additional labor for collecting cardboard and moving to collection point.

Strategy	Analysis Recommendation	Reason/Discussion for Recommendation	2013 Tons in garbage[13]	Cost	Feasibility	Feasibility issues (other than cost)
Purchase a bottle puncturing system to drain liquid-filled containers collected at security checkpoints.	Recommend provisionally, pending evaluation of pilot project conducted and analyzed by janitorial vendor.	This strategy addresses a moderate quantity (416 tons) and a planned pilot project will provide more information regarding feasibility and cost.	416	M	M-H	Space constraints; labor risk, training, etc.
Continue providing free BOH bins; encourage tenants to use standard FOH and BOH collection systems with Airport-approved signage.	Recommend without analysis.	Instead, analyze only the mandatory tenant bin strategy because this voluntary strategy has medium-low costs and high feasibility. In additional results of expanding an existing voluntary program would have less certainty because there is more variability in the results of voluntary programs and because analysis would require more assumptions (both adoption of signage and signal colors by tenants and employee/public use of the upgraded bins) than analysis of the mandatory version.	1,383	L-M	H	No major non-cost issues. (Cost to STIA = L, cost to tenant = M for the FOH bins).
Continue requiring reporting and CD&D diversion to "maximum extent feasible; require construction contractors to meet specific diversion targets.	Recommend without analysis.	While the tonnages are not known, this strategy has high feasibility and low costs due to the availability of local markets and related regulations in local jurisdictions.	Unknown	L	H	Contractor opposition; Project management & construction management opposition; increased complexity of project design and construction; Port accepts performance liability when directing contractor to build a specific way (around reuse and using recycled-content materials).
Increase green purchasing by identifying improvement opportunities and expanding resources and tools for procurement employees.	Recommend without analysis.	While the tonnages are not known, this strategy has high feasibility and low-medium costs. In addition, this strategy is important for STIA to "walk the talk."	Unknown	L-M	H	No major non-cost issues.

Strategy	Analysis Recommendation	Reason/Discussion for Recommendation	2013 Tons in garbage[13]	Cost	Feasibility	Feasibility issues (other than cost)
Collect materials from air cargo facilities.	Recommend without analysis.	While the tonnages are not known, this strategy has high feasibility and low costs.	Unknown	L	H	Tenant opposition, collection logistics; space constraints; Would increase staff requirements to manage systems, require Capital improvements, and require additional maintenance staff support.
Encourage food-service inventory reduction.	Recommend without analysis.	This strategy addresses a moderate quantity (323) through source reduction (the top of the waste management hierarchy), has medium costs, and medium-high feasibility.	323	M	M-H	
Increase passenger education on recycling and composting.	Recommend without analysis.	High quantity (1,382 tons), medium-low cost, and high feasibility.	1,382	L-M	H	Budget approval for advertising, but STIA has a budget for E&O.
Require any onsite employees, consultants, or vendors to recycle, compost, and prevent waste.	Recommend without analysis.	Difficult to estimate tonnages. The intent is to "walk the talk" with the organization's policies, particularly if similar requirements are imposed on tenants.	195	L	H	Employee opposition. Gather info regarding how CPO2 or other Port policies may serve proposed actions.
Continue current tracking and expand to include organics characterizations, annual weighing studies, and Airfield tenant reporting requirements.	Recommend continuing and expanding without analysis.	Strategy supports program but does not directly affect tons. Costs can be scaled as needed.	NA	M-H	H	Tenant opposition (for Airfield tenant tracking requirements) (H for overall but L for Airfield tenant requirements).
Expand current surplus process/exchange to tenants and to include electronics, furniture, and office supplies.	Recommend continuing and expanding (as feasible) without analysis.	While the tonnages are not known, and this strategy has medium costs and low-medium feasibility, the strategy should be continued and expansion can be scaled according to available space and budget.	Unknown	M	L-M	Space constraints, collection and distribution logistics.

Strategy	Analysis Recommendation	Reason/Discussion for Recommendation	2013 Tons in garbage[13]	Cost	Feasibility	Feasibility issues (other than cost)
Routinize and increase monitoring, cleaning, and preventive equipment maintenance of central waste collection sites.	Recommend continuing and expanding without analysis.	The current janitorial contract includes responsibility for compactor areas that could be more consistently enforced if a STIA employee were given "ownership" of the areas. While tonnages are not known, regular and preventative compactor maintenance could reduce costs and tenant disruption due to compactor breakdowns and emergency repairs.	Unknown	M-H	M	Facility upgrades to areas to make cleaning easier (e.g., bin washing stations); politically "selling" routine maintenance (as opposed to emergency repairs); no facility manager to provide oversight; enforcing existing janitorial contract to clean areas.
Increase outreach and technical assistance to Airfield tenants.	Recommend continuing and expanding without analysis.	Tonnages are moderate (625), costs are medium-low, and feasibility is high.	625	L-M	H	Tenant disinterest or constraints, POS influence boundaries.
Continue onsite stormwater treatment and increase reuse of non-potable water onsite.	Recommend continuing and expanding without analysis.	While tonnages are not known, costs are medium and feasibility is high.	Unknown	M	H	Water rights and NPDES permit constraints.
Routinize and increase visual waste audits to at least quarterly.	Recommend continuing and expanding without analysis.	Strategy supports program but does not directly affect tons. Costs can be scaled as needed.	NA	L	M-H	Requires coordinating for access to non Port-controlled containers for observation.
Expand internal stakeholder engagement to support waste reduction and recycling initiatives.	Recommend continuing and expanding without analysis.	Strategy supports program but does not directly affect tons. Costs are low and feasibility is high.	NA	L	H	No major non-cost issues.
Expand and better promote tenant and employee education and incentive programs/resources.	Recommend continuing and expanding without analysis.	This strategy addresses a high quantity (1,578 tons) and has medium cost and high feasibility.	1,578	M	H	No major non-cost issues.
Expand paper reduction efforts.	Recommend continuing and expanding without analysis.	While the strategy addresses a low quantity (41 tons), it focuses on source reduction (the top of the waste management hierarchy), has low costs, and medium feasibility.	41	L	M	Port of Seattle hardcopy requirements; Would require standardization of Port contracts and support from groups not within AV division (such as CPO).

Strategy	Analysis Recommendation	Reason/Discussion for Recommendation	2013 Tons in garbage[13]	Cost	Feasibility	Feasibility issues (other than cost)
Expand voluntary participation in food donation to Airfield tenants.	Recommend continuing and expanding without analysis.	Because most terminal tenants already participate, this strategy has a low quantity (65 tons) for this group and it is difficult to estimate tonnages from flight kitchens. Feasibility is low for flight kitchens to transport food to the Terminal collection area.	65	L-M	M-H	Difficult airline/FK access to existing FBD room requires either additional room, or direct haul/pickup by FB. (Low feasibility because FK unlikely to transport to Terminal room.)
Continue providing recycling and composting through central waste collection sites; expand organics collection to the Airfield.	Recommend continuing without expansion due to for lack of feasibility.	While expansion would address a moderate-large quantity (784 tons), expansion is not feasible due to lack of space for compactors and lack of in-flight separation. As a result, the only organic material available is coffee grounds from Horizon Air's on-ground brewing.	784	L-M	M	Space constraints for more compactors. Training ground service crews (mainly contractors) to use organics compactors properly.
Continue installing hand dryers to reduce paper towel use in public bathrooms.	Recommend continuing.	STIA plans/policies already call for new and remodeled STIA bathrooms to have hand dryers and only one paper towel dispenser.	81	M	M	For existing bathrooms, requires renovation.
Continue source-separating high-value materials and obtaining all or part of their market value.	Recommend continuing.	Strategy is already implemented.	No Change	L	H	Can't constantly rebid; difficult to change vendors (security, contracts).
Continue mulch mowing and composting green waste.	Recommend continuing.	Strategy is already implemented.	No Change	L	H	
Continue to incorporate recycling and composting into construction planning.	Recommend continuing.	Strategy is already implemented.	NA	L	M-H	Space constraints; Operational priorities (e.g. gates, gate hold rooms, baggage handling systems, conveyance, etc.); Architectural aesthetic preferences.
Continue external stakeholder engagement to support Airport, regional, and industry recycling efforts.	Recommend continuing.	Strategy is already implemented.	NA	L	H	No major non-cost issues.

Strategy	Analysis Recommendation	Reason/Discussion for Recommendation	2013 Tons in garbage[13]	Cost	Feasibility	Feasibility issues (other than cost)
Use janitorial service to sort recyclable materials out of garbage collected in flight.	Recommend without analysis as a long-term strategy: secondary sorting through an offsite facility or third-party vendor if such a facility or vendor offers services locally.	Deplaned garbage is highly sortable and presents a large tonnage opportunity but feasibility is very low. The Airfield is outside current janitorial contract, material cannot be sorted on the Airfield (FOD issues), and transporting the material elsewhere also presents logistical issues.	1,233	M-H	L	Space constraints, requires continuous sorting schedule because STIA operates 24/7 (can't store unsorted waste); FOD concerns; Would need to empty compactor somewhere for sorting offsite and run a mini-MRF.
Require Airfield tenants to recycle, compost, and reduce waste.	Recommend without analysis as a long-term strategy to be reconsidered once a critical mass of hub airports have recycling.	Airfield tenants are responsible for a large quantity (1,409 tons) of divertible material in garbage collected by STIA, but requiring recycling or composting is not feasible at this time because airlines cannot use unique procedures for only one airport.	1,409	M	L-M	Tenant opposition, influence boundaries, compliance issues (even with training, monitoring, and enforcement).
Require Food & Beverage tenants to use only durable or standardized compostable food service ware designated by the Airport.	Recommend without analysis as a long-term strategy to reconsider if alternative options (requiring use of compostable or compostable/recyclable food service ware without design requirements) are implemented but do not achieve sufficient diversion.	This strategy has low feasibility due to strong tenant opposition regarding product branding. Instead, analyze only the other mandatory strategies that do not affect product branding/labeling and incorporate into those strategies standardizing only cutlery and portion cups as those items are the least likely to be branded and present the most confusion for customers.	1,267	L-M	L	Strong tenant opposition; higher tenant costs for packaging (but offset by lower solid waste costs), enforcement; space for more organics dumpsters/compactors; collecting compostables beyond food courts.

Strategy	Analysis Recommendation	Reason/Discussion for Recommendation	2013 Tons in garbage[13]	Cost	Feasibility	Feasibility issues (other than cost)
Requiring Food & Beverage tenants to donate surplus edible food.	Recommend without analysis as a long-term strategy to research if voluntary participation in food donation decreases.	Because most terminal tenants already participate, this strategy has a low quantity (65 tons) and may cause substantial opposition. In addition, the quality of donations may decrease or may pose a liability issue if the requirement leads tenants to donate marginal food. Instead, focus on helping tenants with waste prevention to reduce excess food.	65	L-M	L-M	Tenant opposition and need for additional room; Difficult to enforce.
Collect materials from flight kitchens.	Recommend without analysis as a long-term strategy as flight kitchens redevelop through master planning process.	Tonnages are not known but are expected to be high. In addition, this strategy has medium feasibility and medium costs.	Unknown	M	M	Tenant opposition, collection logistics; space constraints; Would increase staff requirements to manage systems, Capital improvements, and additional maintenance staff support.
Extend CPO2 to require Airport employees and contractors to recycle and compost.	Combine with requiring any onsite employees, consultants, or vendors to recycle, compost, and prevent waste	Similar to related strategy (Require any onsite employees, consultants, or vendors to recycle, compost, and prevent waste).	195	L	H	Gather info regarding how CPO2 or other Port policies may serve proposed actions.
Ban petroleum-based plastic shopping/consumer bags.	Do not recommend but require food service vendors to use paper bags if strategy 12a or 12b is implemented.	This strategy has low feasibility and low tonnages. However, requiring food vendors to use paper bag (not compostable plastic) would simplify messaging and reduce public confusion by making all vendor-provided packaging clearly compostable or recyclable. Petroleum plastic bags from food-service vendors could contaminate composting while compostable plastic bags would be confused with petroleum-based bags.	11	L-M	L	Tenant opposition.

2.2.2. Detailed Analysis

For the eight strategies that were selected for detailed analysis before recommending, Cascadia staff worked with Airport Environmental staff to conduct a more detailed planning-level cost and diversion analysis using an updated version of the analysis model used for the 2010 SWMP. The analysis assessed total cost (to the Airport and to tenants), net cost (accounting for reduced garbage disposal fees), tons diverted, total and net cost per ton, and greenhouse gas emissions reductions.

Airport Environmental staff provided Airport-specific costs (such as janitorial and staffing costs) and facility details (such as number of garbage containers and tenants). Cascadia and Airport Environmental staff together agreed on assumptions to fill in data gaps to develop reasonable planning-level cost estimates. These costs (by individual cost component), data sources, and assumptions are presented in *Appendix M.* Because these are planning level costs, Cascadia staff recommend the Airport conduct additional research and analysis before implementing any recommended strategies that are expected to result in substantial net costs.

To estimate diversion potential, Cascadia staff combined data from the waste characterization study on tonnages of waste materials generated in total and disposed of as garbage with additional research on programs and plans elsewhere that included actual or projected diversion data. For some strategies (numbers 1, 2, 5, and 6), Cascadia staff calculated diversion potential by applying estimated participation and efficiency rates to the amount of material remaining in the garbage. Participation and efficiency rates were derived from a variety of sources, including published studies or plans, relevant Airport-provided data (i.e., from pilot studies), and expert review. Participation rates represent the percentage of the relevant generator group that is assumed to take any action in response to the strategy (such as the percentage of tenants that will install new collection containers). Efficiency rates represent the percentage of available material that participating generators will divert—that is, how efficiently those participating generators actually participate. When combined, they yield a capture rate. For example, a strategy with an 80 percent participation rate and a 50 percent efficiency rate would be projected to capture 40 percent of the available material (0.8 x 0.5 = 0.4).

For strategies where data on participation and efficiency rates were not available, Cascadia staff used other published information to estimate the percentage increase in recycling. For Strategies 3, 4, 7, and 8, Cascadia staff used existing data to estimate the percentage increase in the capture rate. For example, Cascadia staff estimated that improving color and signage on recycling containers would increase the capture rate by 65 percent, based on two research studies. Therefore, Cascadia staff estimated that this change to public collection bins would increase the public area recycling capture rate from 9 percent to 15 percent (a 65 percent increase).

Where possible, Cascadia staff used actual data from implemented programs or pilot projects, which is more accurate than using estimates alone without a measured, real-world reference point. When using actual data, Cascadia does not consider that the format (participation and efficiency rates or capture rates) substantially affects certainty because the combination of participation and efficiency rates equals the capture rate. When using expert estimates, Cascadia uses participation and efficiency rates because estimating the two numbers separately before combining them into a capture rate provides more accuracy than estimating a single capture rate that conflates two very different aspects of waste generators: the percentage that would participate and how well they would participate.

After estimating the diversion potential, Cascadia staff used the EPA's Waste Reduction Model (WARM) to estimate the greenhouse gas emissions reductions related to each strategy. However, according to research by Airport Environmental staff, WARM overestimates greenhouse gas (GHG) emissions reductions from recycling because it does not include emissions from overseas shipping of recyclables to end-markets (due to shipping emissions data reliability issues, as described in *Section 7.3 Regional Recycling Markets and Facilities*). As a result, both the WARM results and revised estimates (with recycling results reduced by one-third) are presented.

Appendix M presents details on the model including cost estimates; potential increases for participation, efficiency, and recycling capture rates; data sources and assumptions; and model results. As described above, Cascadia and Airport Environmental staff recommended adopting other strategies that are listed as "new" in the plan based on the initial screening analysis without a more detailed analysis.

Table 11 presents the analysis results for each of the eight strategies analyzed in detail. Cascadia and Airport Environmental staff used the results of this analysis to make recommendations regarding these strategies related to food packaging requirements, collection system and source separation requirements, and Airport collection containers.

To achieve the Airport's Environmental Strategy Plan objective for Terminal diversion (50%) and respond to direction from the Port Commission to pursue use of durable and compostable service ware, **Cascadia and Airport Environmental staff recommend implementing six of the eight strategies that required additional analysis (See Strategies 2–5, 7, and 8, noted in Table 11 below)**. **If implemented, these six strategies are expected to divert an additional 1,311 tons waste and increased the Terminal diversion rate to 54 percent, which would exceed the Airport's Environmental Strategy Plan objective for Terminal diversion of 50 percent, as shown in Table 10.**[14] Strategies that were recommended without detailed analysis either support these six strategies or are expected to increase Terminal and Airfield diversion even further.

Together, these six strategies are estimated to cost the Airport $33 per ton and tenants $852 per ton. The high cost-per-ton to tenants is primarily driven by Strategy 2 (requirements to use durable, compostable, or recyclable food service ware). Strategy 2 would not be implemented until the Airport rebids leases with Food and Beverage Concessionaires; Airport Environmental staff expect that these tenants will accommodate the cost increases by adjusting their financial proposals to the Airport. In addition to the diversion benefits, the Port of Seattle Commission is a key driver for Strategy 2: twice during the development of this SWMP the Commission directed Airport Environmental staff to pursue use of durable and compostable service ware by Airport Food and Beverage Concessionaires.

[14] To mitigate double-counting, total diversion for Strategies 3, 4, and 5 (when all three strategies are selected) is assumed to equal that of Strategy 5. However, Strategy 5 would likely require tenants and ADR Concessions to install and standardize bins (incurring the costs of Strategies 3 and 4) in order to satisfy the requirements of Strategy 5. Diversion tons and costs do not include additional diversion and costs from strategies that were recommended without detailed analysis.

Table 10. Projected Diversion, Based on 2013 Waste Generation Data

	Annual Terminal Diversion (based on 2013 tons)	
	(Tons)	(Percent)
Current Terminal Diversion (2013)	1,793	31%
Terminal Strategies Recommended after Detailed Analysis	1,311	23%
Terminal Strategies Recommended without Detailed Analysis	Not analyzed in detail	
Total	**3,104**	**54%**
Airport Environmental Strategy Plan Terminal Diversion Objective	2,876	50%

Table 11. Results of Detailed Strategy Analysis

Strategy	Annual Diversion Potential (Tons)	Average Annual Net Cost (Savings) Per Ton ($/tons)			GHG* Reduction ($MTCO_2E$)	Implementation Recommendation
		Overall	Airport	Tenants		
Food Packaging Requirements						
1. Require Food and Beverage ADR Concessionaires to use durable or compostable food service ware (also affects Public Area waste).	367	$5,489	$54	$5,435	174 [174]*	**No:** Do not implement (instead implement Strategy 2).
2. Require Food and Beverage ADR Concessionaires to use durable or compostable food service ware with the exception of cups, which must be recyclable or durable (also affects Public Area waste).	330	$3,772	$51	$3,721**	194 [193]	**Yes:** High diversion, moderate cost to Airport, costs to tenants are high per ton but moderate when considering service ware cost increases by 1.7% of total sales and can be accounted for during lease rebid, more feasible than Strategy 1, and consistent with City of Seattle plans.
Collection System and Source Separation Requirements						
3. Require all ADR Concessionaires to use standardized front-of-house collection stations and signage.	107	$5	$45	($40)	180 [149]	**Yes:** Moderate diversion, moderate cost to Airport, net savings to tenants from avoided garbage disposal costs, low overall cost, and highly feasible via design standard updates during rebid process.
4. Require all ADR Concessionaires and Terminal Tenants to use standardized back-of-house collection stations and signage.	256	($72)	$73	($145)	346 [300]	**Yes:** High diversion, moderate cost to Airport, net savings to tenants from avoided garbage disposal costs, highly feasible, and significant overall savings.
5. Require all ADR Concessionaires and Terminal Tenants to recycle, compost, and prevent waste.	494	($107)	$38	($145)	657 [575]	**Yes:** High diversion, low cost to Airport, net savings to tenants from avoided garbage disposal costs, highly feasible, and significant overall savings.
6. Standardize the Airport's janitorial service to collect all garbage, recycling, and compostables from all ADR Concessionaires and Terminal Tenants.	69	NA†	NA†	NA†	71 [64]	**No:** Continue to research with ABM and Concessions to determine financial feasibility and potential cost shifts of janitorial changes.

Strategy	Annual Diversion Potential (Tons)	Average Annual Net Cost (Savings) Per Ton ($/tons)			GHG* Reduction ($MTCO_2E$)	Implementation Recommendation
		Overall	Airport	Tenants		
Airport Collection Containers						
7. Standardize collection stations for all Airport-controlled bins and expand recycling advertising (affects Public Areas). Provide compostables bins in North and South satellites and Concourse A public food court areas.	431	($25)	($25)	$0	323 [303]	**Yes:** High diversion, net savings to Airport from avoided garbage disposal costs, no cost to tenants, highly feasible, and overall savings.
8. Relocate, improve signage, and add liquid collection stations for all security checkpoints.	55	($91)	($91)	$0	NA‡	**Yes:** High diversion, net savings to Airport from avoided garbage disposal costs, no cost to tenants, highly feasible, and significant overall savings.

** Calculated using the EPA's Waste Reduction Model (WARM). Figures in square brackets represent adjusted figures based on Airport Environmental staff research findings that WARM overestimates GHG emissions reductions for recycling exported overseas by approximately one-third. Currently, mixed paper and plastics #3–7 are sent to export markets.*

** Strategy 2 would not be implemented until the Airport rebids leases with Food and Beverage Concessionaires. Airport Environmental staff expect that these tenants will accommodate the cost increases by adjusting their financial proposals to the Airport.

† Supporting details to estimate the total cost of Strategy 6 are not available. The known cost components include one-time signage costs, one-time costs to develop and negotiate a new lease, and the annual amount paid to ABM for janitorial services. The Airport is waiting to obtain tenant estimates of their potential savings from no longer needing to transport their waste to central collection sites.

‡ Liquid waste from Strategy 8 is diverted to the sanitary sewer rather than to recycling or composting; however, tons are included in the diversion calculations as new diverted tons to represent the value (avoided disposal costs) of this strategy. These additional tons represent less than 1 percent of Terminal waste generation. Because liquid waste is diverted to the sanitary sewer, greenhouse gas (GHG) reductions cannot be estimated.

The following five subsections present the full set of 43 recommended strategies. These strategies are organized into the following areas, which are aligned with the FAA Guidance, organization of recommendations in the 2010 SWMP, and the areas in which the Airport would take action:

- Recommended recycling and composting collection strategies
- Recommended procurement, contracting, and policy strategies
- Recommended education, incentive, engagement, and pollution prevention strategies
- Recommended progress tracking and reporting strategies
- Additional strategies recommended for future consideration

2.3. Recommended Recycling and Composting Collection Strategies

The Airport will continue its current collection programs and adopt new or improved strategies to maximize the recycling of key materials currently accepted from airlines, other tenants, the public, and Airport employees and contractors. This collection program includes at a minimum paper, plastic bottles, aluminum cans, and plastic cups; more details and other materials collected for recycling are described in *Section 3.3 Municipal Solid Waste (MSW) Management*. Table 12 briefly lists the Airport's current collection programs and strategies for improvement. New elements are indicated by the orange-highlighted word NEW. Related objectives are listed in *Section 6.2 Performance Measurement System*. The estimated timeline represents a projection that will be evaluated with the Airport's other competing priorities including capital, operation, and maintenance needs during the budget development process.

The Airport did not identify that any recommendations required capital improvements. If any are identified, the Airport will include them in the Airport Capital Improvement Plan.

Table 12. Airport's Recycling and Composting Collection Strategies for 2015–2020

Recycling and Composting Collection Strategies	Estimated Timeline	Related Objective
Continue to relocate and re-sign Public Area collections bins to offer recycling at all garbage collection bins and label recycling bins with color-coded labels. NEW Standardize collection stations for all Airport-controlled bins and expand recycling media (affects Public Areas). Provide compostables bins in North and South satellites and Concourse A public food court areas.	Ongoing (current) 2016-2017 (new)	Terminal Diversion
Continue to use liquid collection stations at the three primary security checkpoints. NEW Relocate, improve signage, and add liquid collection stations for all security checkpoints.	Ongoing (current) 2016 (new)	Terminal Diversion
NEW Conduct a pilot study to reassess the potential for using janitorial services to perform secondary sorting to remove recyclable materials from garbage bins used by the following generator groups: Port Administration, Tenant Terminal, Public (inside food courts), Public (outside food courts), ADR Concessions.	2016-2017 (new)	Terminal and Airfield Diversion

Recycling and Composting Collection Strategies	Estimated Timeline	Related Objective
Continue maintenance of central waste collection sites. Monitor central waste disposal/compactor areas on a regular schedule for cleanliness, maintenance needs, and contamination. NEW ▪ Consolidate “ownership" of the compactor areas into one facility manager. Compactor area “ownership” will consist of overseeing janitorial contract (which covers cleaning of compactor areas). ▪ Routinize and increase maintenance of central waste collection sites to prevent breakdowns. Increase preventative and ongoing equipment maintenance to match manufacturer specifications. ▪ Monitor central waste disposal/compactor areas on a regular schedule for cleanliness, maintenance needs, and contamination. Increase cleaning frequency for compactor areas. Identify and address causes of contamination. ▪ Use additional education and monitoring to maintain diversion and prevent contamination when construction disrupts or closes waste disposal areas. ▪ If cleanliness or compactor misuse problems persist, consider video monitoring.	Ongoing (current) 2016-2017 (new)	Terminal and Airfield Diversion
NEW Expand Airport waste management collection systems to collect materials from air cargo facilities.	2017 (new)	Airfield Diversion
NEW Pending evaluation of a pilot project conducted by the Airport’s janitorial service provider, purchase a bottle puncture unit to drain liquid-filled containers collected at security checkpoints.	TBD (new)	Terminal Diversion
Continue to provide central recycling and composting collection sites including commingled recycling, compostables (at most/all collection sites), and (as needed) single-material recycling for high-value materials with local markets (such as scrap metal, pallets, cooking oil/grease, and glass).	Ongoing	Terminal and Airfield Diversion
Continue to incorporate recycling and composting collection infrastructure into design and construction projects (such as planning adequate space for compactors, shared collection containers, and standardized Airport-controlled collection bin stations).	Ongoing	Terminal and Airfield Diversion
Continue source separating materials into single-material streams for high-value materials (such as scrap metal, cooking oil, and glass). Continue reinvesting program cost savings into incentives, equipment, or other resources that further the Airport’s recycling success. Periodically rebid or negotiate hauler contracts for source-separated materials in single-material streams (such as scrap metal, cooking oil, and glass) to obtain all or part of the market value of those materials.	Ongoing	Terminal and Airfield Diversion

Recycling and Composting Collection Strategies	Estimated Timeline	Related Objective
Continue to treat wash water and contaminated stormwater though onsite treatment plant (IWTP) and discharge to Puget Sound under NPDES permit. (Note: this strategy reduces the Airport's liquid waste that must be managed but does not affect solid waste.)	Ongoing (current)	NA
NEW As feasible, reuse water onsite for construction dust control, cooling tower, and other applications that do not require potable water.	2018 (new)	

2.4. Recommended Procurement, Contracting, and Internal Policy Strategies

The Airport will continue its current strategies to minimize waste and maximize recycling and composting through intentionally designed waste handling procedures and janitorial contracts, tenant leases, development specifications, and purchasing policies. More details on the Airport's current efforts, including how the Airport's development specifications address recycling, are described in *Section 4 Review of Contracts, Leases, Development Specifications, and Purchasing Policies*. Table 13 briefly lists the Airport's current programs and strategies for improvement related to procurement, contracting, and policies—including any plans to update janitorial contracts, tenant leases, development specifications, and purchasing policies. New elements are indicated by the orange-highlighted word NEW. Related objectives are list in *Section 6.2 Performance Measurement System.* The estimated timeline represents a projection that will be evaluated with the Airport's other competing priorities including capital, operation, and maintenance needs during the budget development process.

The Airport did not identify that any recommendations required capital improvements. If any are identified, the Airport will include them in the Airport Capital Improvement Plan.

Table 13. Airport's Procurement, Contracting, and Policy Strategies for 2015–2020

Procurement, Contracting, and Policy Strategies	Estimated Timeline	Related Objective
Encourage ADR Concessions and Terminal Tenants to standardize back-of-house bins.	Ongoing (current)	Terminal Diversion
NEW Through requirements in tenant leases, require ADR Concessions (front- and back-of house) and Terminal Tenants (back-of house only) to create collection stations that use the same signage and signal colors as Airport-controlled stations. Offer smaller bins for space-constrained tenants.	In phases 2015-2017 (new)	
Require ADR Concessionaires and Terminal Tenants to recycle, compost, and prevent waste, through requirements in tenant leases. This strategy could be structured as a disposal ban and would require monitoring and enforcement.	In phases 2015-2017 (new)	Terminal Diversion

Procurement, Contracting, and Policy Strategies	Estimated Timeline	Related Objective
NEW Require Airport employees, onsite consultants, and vendors (acting onsite) to recycle, compost, and prevent waste. This strategy would require minor monitoring and enforcement. It would mainly be implemented as a policy in the employee handbook and consultant and vendor contracts. This strategy could involve extending CPO2 to include requirements to recycle and compost. C&D debris generated by construction contractors are addressed in a separate strategy.	Starting 2016 (new)	Terminal Diversion
Continue green purchasing through CPO2 policy, including reviewing purchasing records or researching product categories to identify opportunities to improve. Continue using 30 percent recycled-content paper, coreless toilet paper rolls, and green cleaning and hygiene products. NEW Increase green purchasing by enforcing CPO2 and introducing systematic review of purchasing records and service contracts (such as for janitorial services) to identify opportunities for the use of reusable, recyclable, compostable, recycled-content, less toxic, and minimal or reusable packaging options. This strategy may be phased for convenience and includes continuing to use the green procurement tool offered by the Airport's office supplier and educating procurement employees. Start using 100 percent recycled-content paper.	Ongoing (current) 2016-2017(new)	Green Purchasing
Continue programs/policies to reduce paper use by Airport employees, such as messaging to discourage printing, setting default duplex printing, promoting electronic billing and contracting, and using electronic construction design review. NEW Expand and encourage wide use of paper-reduction programs/policies by promoting electronic billing and contracting and using electronic construction design review.	Ongoing (current) 2016 (new)	Terminal Diversion
Continue to use Washington State's surplus process for selling surplus items. Continue existing internal surplus office exchange. NEW Explore opportunities to purchase surplus items (instead of new). Expand existing internal surplus office exchange to include tenants, if possible. Reusable items for internal exchange could include electronics, furniture, and office supplies.	Ongoing (current) 2017 (new)	No objective

Procurement, Contracting, and Policy Strategies	Estimated Timeline	Related Objective
Continue requiring Port-contracted construction contractors to divert C&D debris to the maximum extent practicable and to submit a pre-construction waste management plan and a final waste management report summarizing the fate and quantities of project-specific materials. NEW Evaluate whether tenants are also following the construction waste management specification and increase enforcement if needed.	Ongoing (current) 2016 (new)	C&D Debris Diversion
Continue implementing the Airport's Restroom Design Standards by installing hand dryers and only one paper towel dispenser per bathroom when building or renovating public area bathrooms.	Ongoing	Terminal Diversion
Continue to require landscape maintenance staff/service to mulch mow and to send green waste (noxious weeds) from wetland mitigation for commercial composting.	Ongoing	Terminal Diversion

2.5. Recommended Education, Incentive, Engagement, and Pollution Prevention Strategies

The Airport will continue its current waste reduction and recycling programs to minimize waste generation and maximize reuse, recycling, and composting. More details on the Airport's current efforts, including its education and outreach program, are described in *Section 5* Current Education, Incentive, Engagement, and Pollution Prevention Strategies. Table 14 briefly lists the Airport's current waste reduction and recycling education and incentive programs and strategies for improvement. New elements are indicated by the orange-highlighted word NEW. Related objectives are list in *Section 6.2 Performance Measurement System.* The estimated timeline represents a projection that will be evaluated with the Airport's other competing priorities including capital, operation, and maintenance needs during the budget development process.

The Airport did not identify that any recommendations required capital improvements. If any are identified, the Airport will include them in the Airport Capital Improvement Plan.

Table 14. Airport's Education, Incentive, Engagement, and Pollution Prevention Strategies for 2015–2020

Education, Incentive, Engagement, and Pollution Prevention Strategies	Estimated Timeline	Related Objective
Continue charging tenants based on garbage compactor use and tracking their garbage and recycling compactor usage.	Ongoing	Terminal and Airfield Diversion
Continue promotion of tenant and employee education and incentive programs/resources: [1] free standardized collection stations; [2] brochures, decals, and posters ; [3] employee training video; [4] monthly tenant meetings; [5] Environmental Excellence Awards ; [6] employee trainings; [7] technical assistance; and [8] periodic clean-up events. NEW Expand and increase promotion of tenant and employee education and incentive programs/resources: [1] expand distribution of free standardized collection stations and offer smaller bins if needed; [2] expand brochures, decals, and posters with Recology-provided materials; [5] research and promote regional environmental awards programs; [6] expand employee trainings to cover all key languages; [7] expand technical assistance to include Recology-provided assistance and to cover waste prevention, collection logistics and space, food packaging choices.	Ongoing (current) In phases 2015-2020 (new)	Terminal Diversion
Continue outreach and technical assistance to Airfield tenants (including airlines, ground support, air cargo, and flight kitchens) to increase diversion by helping or encouraging them to continue recycling currently accepted recyclables, including pallets and wood, commingled recyclables, scrap metal, and cooking oil. NEW Increase outreach and technical assistance to Airfield tenants by helping or encouraging them to: [1] recycle hard-to-recycle materials such as plastic film and textiles; [2] donate reusable items such as blankets, pillows, headphones, unused napkins/tissues/toilet rolls/toilet seat covers, and foreign-language periodicals; [3] donate surplus edible food; [4] include the Airport's recycling information on flight attendant departure sheets; and [5] develop waste management plans.	Ongoing (current) In phases 2015-2020 (new)	Airfield Diversion
Continue ADR Concessions participation in the food bank donation program for surplus food (instead of composting or disposing of it as garbage). NEW Expand participation in the food bank donation program for surplus food by promoting to airlines, flight kitchens, and remaining non-participating tenants.	Ongoing (current) Starting 2015 (new)	Terminal and Airfield Diversion

Education, Incentive, Engagement, and Pollution Prevention Strategies	Estimated Timeline	Related Objective
NEW Increase passenger education through external avenues. These avenues may include King County or SPU publications sent to residents (with the intent that they will be more educated next time they fly) or in-flight magazines (to educate incoming passengers). Messages for these publications may include how to recycle and compost as well as the availability of water refill stations.	As budget is available	Terminal Diversion
NEW Encourage food-service ADR Concessionaires to implement LeanPath or other inventory reduction systems.	2017 (new)	Terminal Diversion
Continue Airport's internal stakeholder engagement to support waste prevention and diversion, including the Materials Management Working Group (like a Green Team) and dedicated recycling and sustainability coordinators. NEW Expand the Materials Management Working Group to include more operations staff and tenant champions who are people of influence.	Ongoing (current) 2016 (new)	Terminal Diversion
Continue to encourage and support aviation industry waste reduction and recycling and local waste system development by coordinating with Airport service providers, local and regional government agencies (City of SeaTac, King County, Department of Ecology), industry trade groups (ACI, AAAE), and federal government agencies (EPA, FAA). Support for aviation industry and local waste system developments may include: ▪ Advocating for deplaned waste reduction and recycling efforts throughout the aviation industry. ▪ Advocating for future mixed waste processing or anaerobic digestion facilities in King County. ▪ Staying up-to-date on any developments at King County's Bow Lake Transfer Station, which accepts Airport garbage.	Ongoing	Terminal and Airfield Diversion
Continue pollution prevention efforts including trainings for Airport staff, construction contractors, and tenants, research on and use of less hazardous alternatives, and implementation of the Port's Pollution Prevention Plan.	Ongoing (current)	Hazardous Waste Generation

2.6. Recommended Progress Tracking and Reporting Strategies

To track and report progress on recommended strategies, Airport Environmental staff will compile and submit an annual status report to the Director of Aviation Planning and Environmental. The status report will describe progress on recommendations or challenges for strategies that are not progressing on schedule. In this status report, Airport Environmental staff will also review whether conditions have improved for strategies recommended for future consideration (described below in *Section 2.7*), list any new challenges that limit waste reduction and recycling, and identify any emerging opportunities to improve performance.

The Airport will also continue to use the performance measurement methods described in *Section 6.2 Performance Measurement System* and report results through internal memos and reports, the Airport's annual public report, and the Airport's 5-year SWMP update. Table 15 briefly summarizes the Airport's performance measurement programs and new strategies recommended for implementation. The estimated timeline represents a projection that will be evaluated with the Airport's other competing priorities including capital, operation, and maintenance needs during the budget development process.

The Airport did not identify that any recommendations required capital improvements. If any are identified, the Airport will include them in the Airport Capital Improvement Plan.

Table 15. Airport's Performance Measurement Strategies for 2015–2020

Performance Measurement Strategies	Estimated Timeline	Related Objective
Continue to review waste, recycling, and composting objectives, updating them as needed. Review, update as needed, and track performance metrics; and publicize results. Continue existing tracking methods: [1] characterizing garbage and commingled recycling every five years (by generator group), [2] compactor usage tracking (including tracking Airfield garbage and recyclables separately from Terminal-related garbage), and [3] annual tenant inspections. NEW Expand tracking to include a compostables characterization every five years, annual weighing studies (garbage, recycling, and compostables) to allocate tonnages to generator groups, and a requirement in Airfield tenant leases to track and report quantities of garbage, recycling, and composting generated.	Ongoing (current) TBD (new)	No objective
Continue visual audits of waste from individual compactors/dumpsters, Airfield tenants, or Terminal generator groups to identify issues or needed program refinements. NEW Increase visual audits of waste to at least quarterly. Routinize, document, and provide feedback from audits.	Ongoing (current) Starting 2015(new)	No objective

Performance Measurement Strategies	Estimated Timeline	Related Objective
Continue requiring construction contractors to submit construction debris recycling plans and final reports.	Ongoing (current)	C&D Debris Diversion
NEW Require construction contractors to meet established diversion objectives (by project and specific materials), including encouraging but not requiring reusing paving demolition debris onsite.	2016(new)	

2.7. Additional Strategies Recommended for Future Consideration

This section identifies strategies that were not adopted as recommendations but could be adopted in the future under more favorable conditions. Table 16 summarizes these strategies along with the conditions for reconsideration.

Table 16. Strategies for Future Consideration

Category	Strategy	Condition for Consideration
Collection	Expand compostables containers to Airfield and explore using compactors instead of dumpsters for compostables.	Airlines separate compostables on board for composting. Loading dock space becomes available for compactors.
Collection	Collect plastic film separately for baling and recycling.	Plastic film becomes more prevalent in Airport garbage.
Collection	Collect cardboard separately using either a baler or a roll-off container.	Loading dock space becomes available.
Collection	Add compost collection bins in public areas outside food courts.	Garbage and recycling collection bins in specific areas are observed to contain large amounts of compostable material after food service vendors are required to use compostable service ware.
Collection	As flight kitchens redevelop their facilities through the master planning process, explore expanding Airport waste management collection systems to collect materials from flight kitchens.	Lease agreements with flight kitchens change to expand the boundaries of the Airport's control.
Collection	Standardize the Airport's janitorial service to collect all garbage, recycling, and compostables from all ADR Concessions and Terminal Tenants.	Further research with the Airport's janitorial contractor and tenants determine this strategy is financially feasible based on potential cost shifts of janitorial plan changes.

Category	Strategy	Condition for Consideration
Collection	Send garbage with large percentages of recyclable materials remaining after generators source separate to an offsite mixed waste processing facility for secondary sorting.	A local mixed waste processing facility opens.
Collection	Collect paper towels from public restrooms separately for composting.	A compostables processing facility in the area changes their acceptance standards to include paper towels from public restrooms.
Education, Incentives, and Tenant Requirements	Conduct a dedicated research effort to better understand options for collection tracking and billing systems that would enable more accurate pay-as-you-throw fees for tenant garbage, recycling, and compostables services (expanding the current system, which is based on compactor use but not volume/weight, does not track compostables by tenant, and covers only tenants using Terminal compactors).	The strategy for the Airport's janitorial service provider to collect all waste from tenants (which would improve tracking without the need for a new Airport-run system) is not implemented.
Education, Incentive, and Tenant Requirements	Require Airfield tenants to recycle, compost, and prevent waste (include deplaned waste), through requirements in tenant leases. This strategy could be structured as a disposal ban and would require monitoring and enforcement.	A critical mass of hub airports has recycling available to airlines.
Education, Incentives, and Tenant Requirements	Require ADR Concessionaires to use only durable or a pre-defined, standardized set of compostable food service ware and food packaging (e.g., cups, plates, clamshells, utensils, sandwich/burrito wrappers). Standardization would likely include using an Airport-defined set of signal logos, words, and colors on all products (rather than requiring all tenants to use one identical set of products). Ideally these visual signals would be based on commonly used signals to increase product choice. This strategy excludes pre-packaged items such as canned soda, bottled juice, and bagged chips; it also excludes merchandise bags. This option substantially simplifies sorting for passengers. The requirement would be included in tenant leases.	Requirements to use compostable or recyclable food service ware without restricting design options is implemented but does not substantially increase diversion.
Education, Incentives, and Tenant Requirements	Require food service tenants in Terminal to donate surplus edible food through existing program instead of composting or disposing of it as garbage, through requirements in tenant leases and a commitment letter.	Voluntary participation in food donation decreases.

3. Current Waste Management System

3.1. Objectives

This section describes the current scope of the Airport's waste management system, including the management of municipal solid waste, C&D debris, and hazardous materials. Related operations and maintenance requirements and funding arrangements are also described in this section. Understanding the Airport's current waste management system was essential for developing recommended waste reduction and recycling strategies. Those strategies, presented in the previous section, build and improve upon the Airport's existing management systems, address or work within constraints, and focus on those areas where the Airport has the greatest opportunity for impact.

Key Findings

- **Recommended strategies focus on the areas where the Airport has direct control or influence.**
  - The Airport has direct control over all waste generated at the Airport by the Port of Seattle, municipal solid waste (MSW) generated by Terminal and Landside tenants in Airport-operated facilities, and hazardous waste generated by the Port and Port-hired construction contractors.
  - The Airport has influence over MSW generated by Airfield tenants in Airport-operated facilities and over C&D debris generated by all tenants in Airport-operated facilities.
- **Recommended MSW strategies addressed the Airport's two primary waste collection pathways.**
  - "Front-of-house" (FOH) containers are used by passengers and some tenants in publicly accessible areas.
  - "Back of house" (BOH) containers are used by Airport employees, contractors (including janitorial), and tenants in areas not open to the general public.
- **Public area bins represent opportunities to increase diversion through signage best practices.**
  - About two-thirds of Airport-managed collection stations for passengers included recycling bins in 2014, an increase over recent years due to ongoing efforts to relocate and re-purpose bins. To improve the effectiveness of passenger recycling efforts, bin signage could be improved to use best practices throughout the Airport.
- **Recommended strategies rely and build on the Airport's current collection infrastructure and recycling programs.**
  - Janitorial staff and tenants transport most of their waste to compactors and dumpsters at 12 central collection sites. All collection sites have commingled recycling compactors; nine have compostables collection dumpsters; and five have containers for source-separated glass and used cooking oil. The Airport also facilitates edible food donation by Food and Beverage Concessions tenants.
- **Given the substantial opportunity for increased diversion, many strategies focused on increasing ADR Concessions participation.**
  - In 2014, a reported 57 percent of Airport, Dining, and Retail (ADR) Concessions tenants that generated commingled recyclables were actively recycling, and 53 percent of ADR Concessions tenants with compostable waste were actively composting.

  - Selected strategies, such as requirements to have FOH and BOH recycling and composting bins and mandates to participate in recycling and composting programs focus on increasing ADR Concessions tenant participation in recycling and composting programs.
- **The Airport's C&D debris diversion programs are highly successful with Port-hired contractors. Recommended strategies suggest expanding these efforts in tenant construction.**
  - Construction contractors hired by the Airport account for the majority of C&D debris generated at the Airport. These contractors independently manage non-hazardous C&D debris from projects following the Airport's Construction Waste Management Specifications, which require contractors to implement best management practices to minimize and divert waste.
- **The Airport's hazardous waste programs have been very effective at reducing this waste type. Selected strategies recommend continuing these activities.**
  - The Port's Hazardous Waste Program ensures proper management of hazardous waste streams, and all other industrial waste streams generated by the Port, including hazardous waste generated from Port-contracted construction projects.
- **Recommended strategies propose continuing the Airport's current program funding and revenue recovery efforts as they incentivize tenants to recycle and compost.**
  - The program budget for 2015 includes annual expenses for operating the Airport's garbage disposal utility of nearly $1.3 million, while management expenses for waste reduction and recycling programs are budgeted at just over $200,000.
  - Because cost savings from reduced garbage disposal are passed back to tenants through lower garbage fees, waste generators at the Airport have a financial incentive to increase recycling and composting.
  - The screening analysis qualitatively assessed costs for all 45 strategies considered (as high, medium, or low) while quantitative costs were estimated for eight strategies selected for detailed analysis.

3.2. Scope of Airport's Waste Management System

This section describes the scope of the Airport's waste management system, including over which wastes and areas the Airport has control, influence, and neither control nor influence. Recommended SWMP waste reduction and recycling strategies focus on those areas where the Airport has direct control and influence in order to yield the greatest impact on increasing diversion. Table 17 summarizes the Airport's scope of control and influence over key generator areas and types of waste. Table 18 lists the facilities included in each of these generator areas. The following subsections describe the level of control and influence in more detail.

Table 17. Summary of Airport's Waste Management Scope

Generator	MSW	C&D	HW
Port of Seattle	Direct Control	Direct Control	Direct Control
Terminal and Landside tenants in Airport-operated facilities	Direct Control	Influence	No Control
Airfield tenants in Airport-operated facilities	Influence	Influence	No Control
Facilities controlled by tenants/sub-tenants	Minimal Influence	Minimal Influence	No Control
Port-hired construction contractors	Influence	Influence	Direct Control

Note: These wastes exclude regulated garbage from international flights which must be managed per USDA requirements described in Appendix B.

Table 18. Airport Facilities, Operators, and Solid Waste Recycling Service Boundaries

Facilities/Areas
Port of Seattle and Landside Tenants in Airport-Operated Facilities
Passenger Terminal, maintenance, and Airport support services ▪ Airport Main Terminal building including Concourses A, B, C, D, and North and South Satellites, Airport Office Building, Police Department, Security offices and Parking Garage ▪ Maintenance shops at Service Tunnel Load Dock and other Airport Terminal areas ▪ The Learning Center (Neighborhood Field Office) ▪ 160th Ground Transportation Lot (Taxi Holding Yard) ▪ Aviation Maintenance Distribution Facility ▪ Airport Transit Operations Center ▪ Bus Maintenance Facility ▪ Water tower field office ▪ Central Procurement Office logistics office ▪ Westside field office ▪ Aircraft Rescue and Firefighting Facility (ARFF) ▪ Runways Taxiways and other Airport grounds ▪ North Snow Dump Area ▪ Air Cargo 1 Recycling Area ▪ Maintenance Shop at Air Cargo 4 ▪ North Employee Parking Lot ▪ Industrial Waste Treatment Plant (IWTP)
Airfield Tenants in Airport-Operated Facilities
Aircraft and ground service operations ▪ Non-movement area within Air Operations Area (AOA), including ramp surrounding Concourses A, B, C, D, and North and South Satellites and Bagwell areas *(waste is disposed of in Airfield compactors)*
Facilities Controlled by Tenants and Sub-Tenants
▪ Remote Consolidated Rental Car Facility
▪ Flight kitchen and in-flight catering facilities
▪ Fuel Farm and fueling support service locations for aircraft fuel storage and distribution
▪ Aircraft Maintenance Hangars
▪ Transiplex and most Air Cargo and aviation support service facilities
▪ Air Traffic Control Tower (FAA)
▪ TRACON: Terminal Radar Approach Control (FAA)

3.2.1. Direct Control

The Port of Seattle has direct control over municipal solid waste in most major Airport facilities, including all Airport-operated facilities and areas identified in Table 18. In these areas, the Airport manages solid waste and recycling services for waste generated by Airport staff, Terminal and Landside tenants, and Airfield tenants. The Port also has direct control over management of hazardous and other industrial wastes from Port-specific operations and Port-contracted construction. The Port has Pollution Prevention construction specifications that require Port construction contractors to use designated facilities for management of these wastes.

3.2.2. Influence but No Control

Aircraft and Ground Support is the single largest generator of garbage by tonnage, accounting for 33 percent of all garbage managed by the Airport in 2013.[15] Overall, waste placed in garbage and commingled recycling compactors located on the Airfield (primarily used by Aircraft and Ground Support) accounted for 27 percent of all Airport-managed municipal solid waste (including compostables and other diversion). While this waste represents substantial opportunity for diversion, the Airport—as an individual airport—has limited ability to influence management of deplaned waste at this time. The other three main pathways for increasing recycling of Airfield waste depend on outside factors or are currently infeasible or costly to pursue. The three pathways are:

- An industry-wide agreement to separate recyclable materials on-board aircraft and to require ground support to place those materials in recycling collection containers.[16]
- A local mixed waste processing facility to sort recyclable materials out of deplaned waste.[17]
- Hand-sorting by the Airport's janitorial contractor, which would require 24-hour staffing to intercept and sort waste from aircraft. [18]

The Airport has influence but no direct control over C&D debris and MSW generated by construction and renovation contractors hired by the Port or by tenants in Airport-operated facilities (from tenant renovation activities). Port construction contracts include Port Construction Waste Management Specifications with specific waste reduction and recycling requirements that Port-hired contractors must meet using their own independently managed solid waste and recycling services. Airport tenants must

[15] Details on the quantity and composition of Airfield and Terminal municipal solid waste are presented in *Section 6.3 Municipal Solid Waste (MSW)*.

[16] Lack of consistency in recycling availability and implementation was cited as a main barrier to recycling from aircraft cabins in Airport Cooperative Research Program, "ACRP Report 100: Recycling Best Practices—A Guidebook for Advancing Recycling from Aircraft Cabins," 2013, retrieved May 2015 from http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_100.pdf.

[17] No mixed waste processing facility currently exists in the Puget Sound Region, although King County is exploring this strategy; see *Appendix K: External Stakeholder Interviews Report*.

[18] In August 2014, the Airport's janitorial contractor conducted a pilot project to sort garbage from food courts and back-of-house Concessionaires. The contractor found that decreased garbage hauler fees offset sorting costs by 15 percent during the pilot and estimated that they would offset garbage fees by 39 percent in a more efficient long-term scenario, resulting in an additional net cost to the Airport of between $15,000 and $30,000 per month.

follow the General Construction Requirements document that includes similar waste reduction and recycling requirements.

The Port of Seattle has no control and minimal influence over MSW generated at Airport support facilities operated by tenants, sub-tenants, or the Federal Aviation Administration (FAA). These tenants and sub-tenants independently manage their own waste and recycling services because existing lease and operating agreements specify that they operate their facilities separately and handle most aspects of property management at their facilities.

The Airport's influence over this waste consists of offering technical assistance, training, and educational support to encourage waste reduction and recycling at these facilities. In limited instances the Airport provides common-access recycling containers and manages associated solid waste and recycling services at or near facilities primarily operated by tenants (e.g., Air Cargo 1) or where Airport-operated facilities share common service area boundaries with tenant facilities (e.g., Maintenance Shop at Air Cargo 4).

3.2.3. No Control or Influence

The Port has no control or influence over hazardous and other industrial waste generated by tenants in Airport-operated facilities. Federal and state regulations explicitly assign responsibility and liability for management of the wastes to the specific generator. The Port does inspect tenant areas where these wastes are stored to protect the Port's interest as property owner.

Wastes that are deplaned from international flights as regulated garbage per United States Department of Agriculture (USDA) regulations are managed by airline-contracted flight kitchen services offsite, and therefore are not managed by the Airport. The Port does manage a small amount of regulated garbage generated from USDA inspection activities in the South Satellite. International regulated garbage is not included in the scope of this SWMP, in accordance with the FAA's guidance memo.

3.3. Municipal Solid Waste (MSW) Management

This section describes the waste management system for municipal solid waste that the Airport directly controls, as described in *Section 3.2 Scope of Airport's Waste Management System*.

3.3.1. Collection

Waste collection at the Airport occurs primarily through two pathways. In public areas of the Airport, Terminal passengers and some tenants use a "front-of-house" collection pathway. In non-public areas—including Airport administrative offices, support service or operation areas, and tenant-leased space—Airport tenants, employees, and contractors use a "back-of-house" collection pathway not accessible to the general public. See Table 19 below for a list of users and services applicable to each pathway. See Table 20 below for a list of materials currently recycled by the Airport and the date that recycling started for each material.

"Front-of-house" collection is accomplished through numerous bins distributed throughout public areas in the Terminal. The Airport maintains contracts for janitorial services in common use and public areas

within the Terminal. Tenants contract for janitorial services or handle their own waste in leased areas, both in front-of-house and back-of-house.

In 2015, the Airport had 448 public collection stations. Approximately 67 percent of these collection stations had multiple compartments or bins to collect garbage and recycling.[19] Another 13 percent of bins accepted only recycling, and 15 percent of bins accepted only garbage. In total, two-thirds of all "front-of-house" collection stations managed by the Airport included recycling options in 2014; this figure has increased significantly in recent years due to ongoing efforts to relocate and re-sign garbage bins to increase recycling locations for the public. Nonetheless, container signage could be improved to use best practices throughout the Airport. *Appendix B* contains the Airport's 2014 Airport Public Collection Bin Inventory, providing additional detail on the number, type, and condition of public collection bins.

In 2014, based on the annual inspection of tenants in the Airport Terminal, 57 percent of ADR Concessions tenants that generated commingled recyclables were actively recycling and 53 percent of ADR Concessions tenants with compostable waste were activity composting. In 2015, tenant inspections will be expanded to document the number of front-of-house and back-of-house collection bins. *Appendix B* contains the Airport's 2014 Tenant Inspection Memorandum.

The Airport emphasizes the use of different colored bags to visually show which materials are intended for recycling or composting versus waste disposal. Black bags indicate garbage, clear are for commingled recycling, and compostable green bags are used for compostable waste.

[19] Memorandum to Airport Environmental Department, "2015 Airport Waste Receptacle Inventory," March 2015.

Table 19. Summary of Airport Collection Systems

Collection and Consolidation System	Materials
"Front-of-house": *Used by passengers, some tenants, and general public*	
Passengers typically use two- or three-compartment bins to collect commingled mixed paper, plastic/aluminum containers, and garbage. Passengers also use a three-bin system in the Central Terminal food court area to recycle containers and paper, compostable waste for composting, and remaining garbage. Passengers passing through security checkpoints use liquid drain stations to discard TSA-banned liquids and commingled recycling bins to recycle beverage containers. Contracted janitorial crews take materials from bins to central collection sites.	▪ Commingled mixed paper, plastic containers, aluminum containers and glass ▪ Compostable waste (e.g., food scraps, food-soiled paper, and compostable products) ▪ Non-recyclable garbage ▪ TSA-banned liquids
"Back-of-house": *Used by Airport employees, contractors (including janitorial), and tenants (including dining, retail, airlines, and other organizations that lease Airport spaces)*	
Tenants use color-coded bins to collect commingled recyclables, compostable waste, and garbage from their leased areas. Tenants and contracted janitorial crews transport materials from tenant areas to designated central collection sites. Tenants and contracted janitorial crews transport loose scrap wood, scrap metal, and other recyclable material to central collection sites. Tenants transfer used cooking oil to onsite bulk collection tanks. Tenants donate surplus food to the Des Moines Area Food Bank via designated refrigerators.	▪ Commingled mixed paper, plastic containers, aluminum containers ▪ Glass containers (separate) ▪ Used cooking oil ▪ Compostable waste (e.g., food scraps, food-soiled paper, and compostable products) ▪ Scrap wood and pallets ▪ Scrap metal ▪ Surplus food (for donation) ▪ Non-recyclable garbage ▪ Special wastes (e.g., toner cartridges, batteries) ▪ Bulky items (e.g., appliances)

Table 20. Materials Currently Recycled and Date Started

Date Started	Material Diverted
1992	▪ Used oil, used oil filters, and antifreeze from Port Maintenance facilities
1993	▪ Lead acid batteries ▪ Basic recyclables from Terminal (aluminum cans, plastic bottles, mixed office paper, corrugated cardboard)
1994	▪ Toner cartridges ▪ Scrap metal
1995	▪ Alkaline batteries from shops and offices

Date Started	Material Diverted
1996	▪ Mercury containing light tubes and lamps ▪ Compressed gas cylinders
1997	▪ Empty paint aerosol cans (recycled as scrap metal) ▪ Refrigerant Freon from cooling systems
1999	▪ Gasoline and diesel fuel generated from vehicle maintenance (recycled as on-specification fuel) ▪ Non-PCB ballasts (recycled)
2001	▪ Expanded list of commingled recyclables (including plastic cups) plus office products (batteries, printer/copier cartridges, electronics, etc.) ▪ Began documenting some C&D recycling from construction projects, but not tracking data*
2002	▪ Glass
2004	▪ Wood ▪ Mercury switches (removed and recycled from all Port vehicles)
2005	▪ Used cooking oil ▪ Coffee grounds
2006	▪ Clean fill (reused onsite) ▪ Surplus food (donated to local food bank)
2007	▪ Non-paint aerosol cans (recycled as scrap metal) ▪ Incandescent and halogen light bulbs ▪ Bottles and cans from security checkpoints
2008	▪ Pre-consumer compostable waste composting (includes coffee grounds, food scraps, clean green waste, and wood/pallet composting)
2009	▪ C&D debris (began tracking C&D debris management from some Port-contracted projects) ▪ Post-consumer compostable waste composting (same materials as pre-consumer compostable waste)
2010	▪ Airfield garbage and commingled recycling (paper, plastic, cardboard, aluminum)
2011	▪ C&D debris (completion of first Port-contracted project with complete documentation of all construction waste)
2013	▪ Began using water to reduce waste generated from runway rubber removal
2014	▪ Liquid waste from security checkpoints (drained to sanitary sewer to reduce garbage weight) ▪ Bathroom towels (composting in most Port offices)

** Documentation of C&D recycled from construction projects dates back to 2001, but project results were not consistently verified, compiled, or tracked until 2009.*

3.3.2. Transportation to Central Collection Sites

Janitorial staff and tenants transport most waste from Airport tenants and public areas to the nearest central waste collection site using tilt trucks or service carts.

As shown in Figure 3, the Airport currently maintains 12 central waste collection sites in and adjacent to the Main Terminal—six in Terminal concourse areas and six on the Airfield. *Appendix B* includes a map with the location of all waste collection sites, including remote locations, and a table that documents the infrastructure at each of these locations by listing the materials collected, the container type and size, and the collection frequency.

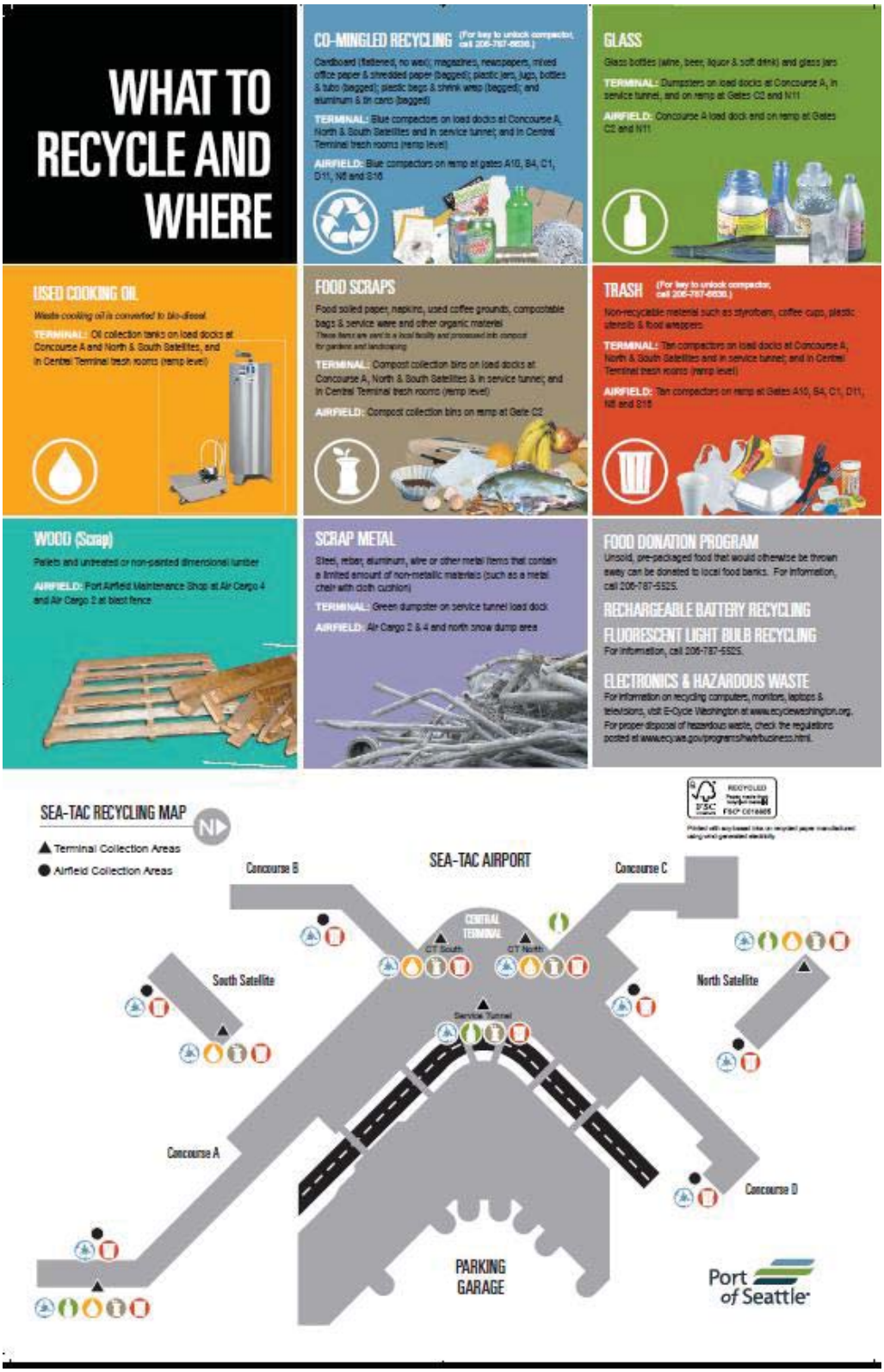
These collection sites handle waste generated in passenger terminals, office areas, and associated operation areas as well as deplaned waste.[20] All garbage and most commingled recycling compactors are equipped with a key card system that controls access to, and tracks usage for, specific tenants and areas. In 2013, 81 tenants, janitorial contractors, and Airport departments used compactors on the key card system at total of 120,273 times.

Each collection site has one compactor for commingled recyclables and one compactor for garbage. Most compactors are programmed to electronically notify haulers before reaching maximum capacity. Nine collection sites also have compostable waste collection dumpsters for food scraps and other compostable wastes. Five collection sites have containers for glass bottles and used oil collection. In addition to the 12 collection sites, numerous garbage and commingled recycling containers of varying sizes serve remote Airport facilities and operations, such as air cargo areas, maintenance, and Airport support service areas. As needed, the Airport also provides collection containers for high-value recyclable materials including scrap metal and clean wood.

The Airport's centralized waste collection system increases efficiencies, leverages economies of scale to reduce costs and enhance service, and improves the Airport's ability to create opportunities and shape programs, policies, and cost structures to maximize waste reduction and recycling program participation.

[20] Waste generated on international commercial passenger or cargo flights (excepting those of Canadian origin) must be disposed of in designated Airport-maintained trash containers according to USDA regulations. The Port does not track waste generated on-board aircraft and disposed of in flight kitchens.

Figure 3. Map of Recycling Facilities Adjacent to Airport's Main Terminal



3.3.3. Disposal and Processing

Multiple service providers haul garbage, recyclables, compostables, and other wastes from compactors, drop boxes, and dumpsters in the Airport's central waste collection sites for disposal and processing. Recology CleanScapes and Cedar Grove Composting handle the largest components of Airport wastes. Table 21 lists Airport waste service providers along with fate and processing facilities for the primary materials handled.

Table 21. Major Airport Waste and Recycling Service Providers

Waste Material	Fate	Service Provider	Processing Facility
Garbage	Landfilled	Recology CleanScapes	Bow Lake Transfer Station, then Cedar Hills Regional Landfill
Commingled Recycling	Recycled	Recology CleanScapes	RC's South Seattle MRF
Glass	Recycled	Recology CleanScapes	RC's South Seattle MRF
Compostables	Composted	Cedar Grove	CG's Maple Valley compost facility
Scrap Metal	Recycled	Young's Salvage	Various local scrap facilities
Used Cooking Oil	Recycled	General BioDiesel	GB's Seattle facility

Note: In addition to major service providers listed above, other service providers handle smaller components of recycled office and industrial waste material.

Recology CleanScapes, under contract with the City of SeaTac, provides franchised garbage and recycling services to residential and commercial customers within city boundaries, including the Airport. The City's contract requires Recology CleanScapes to collect all garbage and offer unlimited commercial recycling for designated materials at no extra charge, although the Airport has the option to contract with alternative recycling service providers. Recology CleanScapes hauls Airport garbage to the Bow Lake Transfer Station, owned and operated by King County. County transfer station operators then consolidate Airport garbage with garbage from other sources before transporting it to the Cedar Hills Regional Landfill (also owned and operated by King County) for disposal.

Recology CleanScapes hauls commingled recyclables from the Airport directly to its South Seattle material recovery facility (MRF) for processing. Recovered materials processed through this facility, which opened in 2014, are sold through various domestic and export end-markets to be recycled into new materials and products.

Cedar Grove Composting, under a direct contract with the Airport, provides hauling and composting services for compostable materials from the Airport. Cedar Grove Composting hauls compostables from the Airport to its Maple Valley composting facility, where it converts food scraps, green waste, and other organic material into nutrient-rich compost used for landscaping and gardening applications.

More information on waste handling contracts is provided in *Section 4.2 Waste Handling Contracts.*

3.4. Construction and Demolition (C&D) Debris Management

This section describes the waste management system for construction and demolition (C&D) debris generated by construction and renovation contractors hired by the Port, as described in *3.2 Scope of Airport's Waste Management System*.

Airport construction projects generate large amounts of waste. In 2014, 12,101 tons of C&D debris were generated from Airport projects and Port Construction Services works.[21] C&D debris that has hazardous characteristics is managed separately as hazardous waste (described in *3.5 Hazardous Waste Management*). Figure 20 on page 112 includes a map of regional facilities that process C&D debris for recycling. The majority of construction waste that is not recycled or reused is sent to Cedar Hills Landfill without passing through a transfer station.

Three main groups generate and manage C&D debris from Airport operations and construction:

- **Port construction contractors**, hired through individual major works contracts to complete specific projects, generate the majority of C&D debris. These contractors handle non-hazardous C&D debris from these projects for reuse onsite when possible or through their own independently managed solid waste and recycling services. Management methods depend on the types and volumes of waste generated. Hazardous waste generated from Port-contracted construction activities is handled by the Port through its hazardous waste management contracts.
- The **Port Maintenance Department** generates C&D debris from ongoing small maintenance and repair projects throughout the Airport. Maintenance staff transport this waste to dedicated C&D debris collection dumpsters permanently placed in strategic locations that are easily accessible. Recology CleanScapes hauls this waste to CDL Recycle for recycling.
- **Port Construction Services** (PCS), a division of the Port, generates C&D debris from small works construction projects. C&D debris from PCS is managed either through collection at its construction laydown yard or at the project site, depending on project logistics.

In 2009, the Airport developed an Environmental Strategy Plan objective to implement Best Management Practices (BMP) that reduce construction, demolition, and land clearing debris that the Airport and its contractors generate. To meet this objective, the Airport developed a Port Construction Waste Management Specification with specific waste reduction and recycling requirements that Port-hired contractors must meet. The final master specification was approved in 2013 for use in all future capital construction projects. This specification emphasizes recycling and requires construction contractors to submit a construction waste management plan at the beginning of each project and a final report at the end of each project documenting the amounts, types, onsite and offsite management, and fate of waste materials generated. This specification is described in more detail in *Section 4.5 Development Specifications*.

By consolidating information from final reports, the Airport will track the total amount and types of C&D debris generated by Port projects. The Airport began receiving construction project data in mid-2014 as projects begun under the new specification were completed. Data are stored in a Construction Waste Management Database and will be used to calculate a diversion rate for this waste stream and identify opportunities to increase waste reduction and recycling. This database and tracking for C&D debris is described in more detail in *Section 6.4 Construction and Demolition (C&D) Debris*.

[21] This figure does not include C&D debris from the Cargo 2, 5 and 6 upgrades project, which was substantially completed in 2014 but for which data were not available when this SWMP was written.

3.5. Hazardous Waste Management

This section describes the Port's program to properly handle and dispose of hazardous waste. The Port's Hazardous Waste Program ensures proper management of hazardous waste streams and all other industrial waste streams generated by the Port, including hazardous waste generated from Port-contracted construction projects. The Port is listed as the generator for all hazardous waste from Port construction projects and works directly with contractors to monitor compliance requirements. Port construction contractors must meet requirements associated with hazardous waste management as stated in Construction Specification 01631 Pollution Prevention Planning and Execution.

All wastes are managed under the federal Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (TSCA), and Washington State Dangerous Waste Regulations. The compliance program is managed by Port of Seattle Airport Environmental staff, with support from Aviation Maintenance staff. The program manages all industrial and hazardous waste from Port operations at the Airport including maintenance, construction activities, and abandoned waste. Waste managed under this program includes:

- Hazardous/dangerous waste including paints, solvents, part cleaners, degreasers, and aerosols.
- Universal waste including batteries, lights and other mercury containing materials, and CRT monitors.
- Vehicle and equipment maintenance wastes including off-specification fuels, used oil/filters, and spent antifreeze.
- Electronic scrap, including computers, and non-CFC containing appliances, and other electronics.
- Equipment containing refrigerant, appliances.
- PCB and Non-PCB waste.
- Off-specification and abandoned chemical products.
- Contaminated soil.
- Petroleum-contaminated sludge from industrial wastewater treatment plant (IWTP).
- Runway rubber and paint chips from Airfield maintenance.
- Prescription medicine not claimed from the Lost and Found office.

Hazardous wastes are accumulated at over 20 designated satellite accumulation areas at Port maintenance facilities around the Airport. All hazardous waste is stored in drums. No hazardous waste is stored in tanks. The Port also maintains a hazardous waste storage locker located on the west side of the Airfield. Used oil and spent antifreeze are stored in tanks at the Port Auto Shop and Bus Maintenance Facilities. This program also manages petroleum-contaminated sludges from the industrial wastewater treatment plant (IWTP), runway rubber, and non-hazardous paint chips at an onsite decant facility that is used to allow sludges to dry before landfill disposal. Contaminated soils generated from construction projects are stored temporarily onsite at the Environmental Stockpile Facility while testing and profiling is completed.

All wastes are designated, stored, transported, and disposed of in compliance with all applicable requirements. The program supports the waste management disposal hierarchy with landfill disposal as last option after minimization, reuse, and recycling. The Port uses the Washington Enterprise Services Hazardous Waste Disposal contract, currently held by Clean Harbors, Inc. The Port does not manage

hazardous or other industrial waste generated from operations of airline or other Airport tenants, such as TSA.

Hazardous waste and materials for which the Port is responsible are primarily handled by one of five vendors, depending on the material:

- Clean Harbors
- Emerald Services
- Ecolights
- Waste Management
- Total Reclaim

In the past, the Port participated in a Washington State persistent bio-accumulative toxics reduction initiative program which focused on removing mercury containing switches from Port vehicles. The Port is currently participating in the State Electronics Challenge (SEC), which encourages organizations to manage office equipment responsibly by purchasing greener office equipment, reducing the impacts of these products during use, and managing obsolete electronics in an environmentally safe way. As a part of the program, the Port receives an annual report which details energy, greenhouse gas, and waste reduction related to its use and management of electronic waste. In 2014 the Airport's participation saved 1.7 million kilowatts of energy; avoided the use of 98 pounds toxic materials (including lead and mercury); and prevented the generation of 267 metric tons of carbon-equivalent greenhouse gas emissions, 51,430 pounds of municipal solid waste, and 7.778 pound of hazardous waste.[22]

The specific materials and contract terms for each vendor are described in *Section 4 Review of Contracts, Leases, Development Specifications, and Purchasing Policies*.

3.6. Operations and Maintenance Requirements for Waste Handling

Multiple Port departments, contracted service providers, and business partners coordinate to address varying solid waste and recycling program operation and maintenance requirements according to established roles and responsibilities. In some cases, multiple parties share responsibilities per their operational, managerial, or administrative roles within a specific waste material segment.

The Airport's Facilities and Infrastructure Department (F&I Department) manages the MSW utility service. This includes delivering MSW utility services to Airport users (including recycling and composting), maintaining program infrastructure, and setting utility rates and billing customers.

The Airport's Environmental Department develops and manages Airport waste reduction and recycling programs and coordinates closely with all parties including the F&I Department, Maintenance Department, and Operations Department to ensure operations and maintenance support for evolving program infrastructure and initiatives.

[22] State Electronics Challenge, "Environmental Sustainability Report CY 2014 to Port of Seattle – Aviation Division," April 2015.

The Airport's Environmental Department also sets programmatic direction and establishes waste diversion objectives with support from various departments, in addition to implementing waste reduction and recycling initiatives, tracking and reporting progress towards objectives, and conducting stakeholder engagement and education and outreach initiatives.

Appendix B presents a detailed table showing the specific roles and responsibilities by waste stream (garbage, commingled recycling, compostables, C&D debris, and hazardous waste).

3.7. Waste Management System Funding Arrangements

This section is primarily designed to respond to FAA Guidance requirements related to Airport funding arrangements that support waste reduction and recycling. The SWMP recommends continuing to incentivize recycling and composting and to recover costs through the Airport's current system of charging tenants for waste-related services based on their actual usage of Airport-provided garbage compactors while offering composting and recycling for free. This system directly encourages tenants to reduce garbage and maximize recycling and composting.

The Airport's waste management system incurs both utility services costs to handle Airport-managed waste and other costs to fund the Airport's waste reduction and recycling programs. These costs are allocated in the Airport's annual operating budget, which includes the following items:

- Projected waste collection, disposal, and processing costs for Port-owned and -operated Airport facilities.
- Solid waste equipment operations and maintenance costs for these facilities.
- Funding for small-works improvement projects related to solid waste.
- Management of waste reduction and recycling programs by the Airport Environmental Department.

Funding for the waste management system is obtained primarily through cost recovery by the Airport solid waste utility.

The program budget for 2015 includes annual garbage disposal utility operating expenses of $1,291,632 and management expenses for waste reduction and recycling programs of $209,718 (including salaries and benefits).[23]

This section describes the development of the waste management system budget and funding through cost recovery in more detail.

Waste Management System Budget

The Airport's Facilities and Infrastructure Department (F&I Department) develops the Airport solid waste and recycling utility annual expense budget, including anticipated service costs for all Terminal, Landside, and Airfield facilities owned and operated by the Port. The Airport's F&I Department typically estimates annual solid waste utility costs by incorporating the prior year's annual solid waste expenses,

[23] Seattle-Tacoma International Airport, "Approved 2015 STIA Operating Budget," accessed May 2015.

known cost increases (e.g., increased tipping fees), and a projected growth factor (variable but typically 3%). The expense budget also includes costs for routine repair and related infrastructure maintenance.

Individual Port departments coordinate with the Airport's F&I department to set department level solid waste utility service costs within their own budgets. The actual costs are allocated to departments or contracted facility services (e.g., janitorial services) that use Airport disposal system equipment at Port-owned and -operated Terminal, Landside, or Airfield facilities. These department-level budgets typically include only utility service costs but may also include costs for equipment such as waste or recycling collection bins.

The Environmental Department's annual budget for waste reduction and recycling programs at the Airport includes expenses for program management and development support, collection equipment, and outreach/education. These expenses enable the Airport to refine and expand program initiatives and provide technical assistance and outreach to educate internal and external Airport waste system users.

A relatively small group of tenants operate on Airport properties but retain individual responsibility to manage their own solid waste and recycling services (such as in-flight caterers, air cargo operators, and the rental car facility). These entities budget and pay for their solid waste and recycling service needs independently from the Airport.

Funding Through Cost Recovery

The Airport's F&I Department administers the solid waste utility and recovers costs through established tariffs and fees. These fees may differ depending on the operational area (e.g., Terminal, Airfield, and Airport Support Facility).

For tenants using garbage and recycling compactors associated with the Terminal (such as Airport Dining and Retail Concessionaires), the F&I Department charges a pay-per-toss fee for their recorded usage of garbage compactors (but not recycling compactors or composting dumpsters).[24] The F&I Department periodically adjusts the pay-per-toss fee to account for fluctuating utility costs.

For tenants using garbage and recycling compactors associated with the Airfield (such as airlines, ground service crews, and other aircraft support), the F&I Department charges each user an individual flat monthly fee for solid waste utility service based on their past usage records. A pay-per-toss fee initially proposed during system introduction was not implemented because of resistance from airlines. The F&I Department periodically adjusts the flat monthly fees to account for fluctuating utility costs.

For service contractors and internal Port departments using the Port's Terminal or Airfield garbage and recycling compactors (such as janitorial service providers and Port Maintenance Department), the F&I Department charges the pay-per-toss fee to the appropriate Port department for recorded usage of garbage compactors but recovers costs via internal department billing.

For internal Airport departments using Airport-managed garbage and recycling containers at their Airport support facilities (such as the Police Station, Aviation Maintenance, and Distribution Facility), the

[24] Seattle-Tacoma International Airport Tariff No. 1, 2/252015: (Garbage Compactor Fee of $7.06 per use, and $20 per key).

F&I Department recovers costs by directly charging the actual monthly costs for containers dedicated to those facilities to the appropriate individual Airport departments.

4. Review of Contracts, Leases, Development Specifications, and Purchasing Policies

4.1. Objectives

This section addresses FAA Guidance requirements to review contracts, leases, specifications, and policies so the Airport can identify opportunities and barriers they pose to waste reduction and recycling success at the Airport.

Key Findings

- **The Airport has waste handling contracts that cover all types of waste generated at the Airport. Fees in waste contracts for MSW strongly incentivize recycling and composting.**
  - **Commingled recycling is free.**
    The City of SeaTac's contract with Recology CleanScapes requires the hauler to transport and process an unlimited quantity of recyclable material at no additional charge to customers, creating a strong incentive to divert waste from disposal to recycling.
  - **Composting costs approximately a quarter less than garbage, saving $37 per ton.**
    The Airport's contract with Cedar Grove Composting offers a financial incentive to divert compostables: composting costs the Airport approximately $108 per ton, while garbage costs approximately $145 per ton.
- **The Airport's janitorial services contract supports waste minimization in the provision of janitorial services as well as through waste reduction outreach to tenants by the janitorial service.**
  The Airport's janitorial services are consolidated in a single contract that includes waste minimization, green cleaning, and environmentally preferable purchasing provisions as well as outreach and technical assistance to tenants to promote waste reduction and recycling.
- **ADR Concessions leases give the Airport broad authority to mandate a "trash recycling" program, which could be strengthened when the majority of leases are rebid in 2015–2017.**
  The Airport and local jurisdictions do not currently require Airport tenants to divert waste, though the Airport's more than 100 Concession leases for Food and Beverage, Duty-Free, and Retail tenants give the Airport broad authority to mandate a "trash recycling" program.
  - The majority of Concessions leases are scheduled for rebidding in 2015–2017, which presents opportunities to improve recycling and green procurement in the new leases.
- **While Aircraft and Ground Support dispose of large tonnages of divertible materials as garbage, current leases limit the Airport's ability to influence their operations to increase recycling.**
  Aircraft and Ground Support contribute the largest component of MSW generated by the Airport (31%); these entities currently fall outside the Airport's control, though Airport Environmental staff will monitor these leases for future recycling opportunities as they are renegotiated beginning in 2017.
- **Development specifications effectively support recycling during Port-contracted construction.**
  Multiple development specifications currently govern Airport construction and tenant improvements. Initial data show that construction waste management specifications are leading to high diversion rates (98%). Current performance data on tenant improvements are not available, but

Airport Environmental staff will seek opportunities for improvement during an update planned in late 2015.

- **Development specifications support recycling after construction through requiring garbage bins to be paired with recycling bins; however, design specifications limit the use of best practices for bin signage.**
- **The Port of Seattle generally has adequate purchasing policies in place to encourage procurement of environmentally preferable products, though additional review of purchasing records may identify opportunities for future improvement.**

4.2. Waste Handling Contracts

Multiple service providers collect garbage, recyclables, compostables, and hazardous waste from the Airport. Overall, these contracts involve high costs for landfilling waste ($145 per ton), free commingled recycling, reduced fees for composting ($108 per ton), and variable rates for other materials.

Except for non-hazardous garbage, the Airport may choose any qualified service provider for waste collection services. Existing waste handling contracts include adequate types and levels of service to accommodate current and future waste handling and recycling needs at the Airport. The absence of mixed waste processing capabilities within these contracts reflects a regional lack of services, which may constrain the Airport's ability to achieve industry-leading airport waste diversion rates as source-separation strategies approach maximum participation and efficiency rates.

For transport and disposal of non-hazardous garbage generated at the Airport, the Airport is required to use the City of SeaTac's contracted solid waste hauler, Recology CleanScapes.[25] The City of SeaTac's *Comprehensive Garbage, Recyclables, and Compostables Collection Contract* grants exclusive rights to Recology CleanScapes to collect municipal solid waste disposed of as garbage from all residential and commercial customers within the city's service area.

Commercial customers that separate materials for recycling or composting are allowed to choose any qualified recycling or composting service provider. The same is true for all hazardous waste. The Airport chooses to use Recology CleanScapes for common commingled recyclables because the City's contract requires Recology CleanScapes to transport and process an unlimited quantity of these materials at no additional charge to customers. This contract provision, combined with some of the nation's highest landfill tipping fees, creates strong financial incentive to divert Airport waste from landfill. The Airport incorporates this incentive into garbage utility rates charged to tenants to encourage recycling.

Rate schedules within the City's contract are fixed through the initial contract term regardless of value of recyclables, ensuring a continued incentive to divert waste from landfill. Service rate adjustments are

[25] City of SeaTac and CleanScapes, "Comprehensive Garbage, Recyclables, and Compostables Collection Contract, retrieved May 2015 from http://www.ci.seatac.wa.us/Modules/ShowDocument.aspx?documentid=10014.

allowed per the contract's specified schedule and are tied to the Consumer Price Index. The King County Solid Waste Division maintains jurisdiction over future adjustments to landfill tipping fees.

Special contract dispensation allows for 24-hour waste collection on Port of Seattle properties (including the Airport) not adjacent to residential properties. All garbage collected under the contract is disposed of in King County's disposal system, of which the nearest facility is the Bow Lake Recycling and Transfer Station. The contract requires Recology CleanScapes to recycle and compost all materials collected for these purposes and to develop a plan to identify and remedy contamination issues. Under the contract, Recology CleanScapes must also provide outreach to customers to promote recycling as well as general waste reduction, minimization, and reuse concepts. Recology CleanScapes has provided this outreach to Airport tenants in partnership with the Airport Environmental Department.

Appendix B includes a detailed list of all contractors that handle municipal solid and hazardous waste managed by the Airport. The table identifies the contract number (where applicable), the contract expiration date, and the rates for transport, disposal, or processing (where available).

4.3. Janitorial Contracts

The Airport obtains janitorial services through Port of Seattle contract C-00317927 with American Building Maintenance (ABM). The current contract term extends to January 31, 2017 and includes two optional one-year extensions for a final maximum contract end date of January 31, 2019. The current contract scope of work includes providing janitorial services at Airport facilities including waste collection, transport, and disposal at all major areas under the Airport's direct control and at additional Airport support facilities owned and operated by the Port of Seattle (such as the Transit Operations Center, Maintenance Distribution Facility, and the Airport Rescue and Fire Fighting facility).

During the latest janitorial contract procurement process, the Airport introduced specific environmental stewardship requirements to minimize negative environmental impacts of janitorial services, reduce waste, and directly support waste reduction and recycling programs at the Airport. Specifically, the contract requires the vendor to:

- Obtain "green cleaning" certification.
- Use environmentally preferable products.
- Reduce packaging of supplies and materials.
- Staff a professional sustainability manager to coordinate with Airport staff on waste reduction and recycling program initiatives.
- Support Airport waste minimization objectives.

These environmental stewardship requirements have proven extremely effective at distributing responsibility for waste reduction and recycling program performance from Airport staff to the janitorial contractor management and janitorial teams directly involved in daily waste collection, consolidation, and transportation roles. As a result, the Airport tested various sustainability pilot projects with janitorial team support, implemented paper towel composting programs in Airport administration bathrooms, and expanded the security checkpoint liquid drain diversion program. The Airport expects these environmental stewardship requirements to provide ongoing support to implement future waste reduction and recycling strategies and to evaluate emerging opportunities.

4.4. Tenant Leases

Airport Environmental staff reviewed tenant leases and arrangements to identify existing provisions related to waste reduction and recycling and to summarize renewal schedules. This section describes the high-level findings of this lease review, the methodology used to select leases to review, and the lease renewal schedules.

Lease Review Findings

The Airport has not officially invoked lease language that requires tenants to divert and prevent waste, nor does the City of SeaTac or other applicable municipal or regional authority with jurisdiction in the SeaTac area require these actions. Rather, the Airport conducts voluntary waste reduction and recycling initiatives that rely on financial and publicity incentives to motivate tenant support and achieve Airport waste diversion objectives, described in *Section 5 Current Education, Incentive, Engagement, and Pollution Prevention Strategies*.

During the review of tenant leases, Airport Environmental staff determined that only the Concession class of agreements including Food and Beverage, Duty Free, and Retail tenant lease sub types include any reference to waste reduction or recycling. Specifically, a "mandatory program" section within these leases includes broad Airport authority to implement a "trash recycling" program among other program or initiatives. The Airport has not yet explicitly invoked this authority but may consider its effectiveness for future mandatory actions. The Airport has 21 Food and Beverage leases, which make up 21 percent of the 101 leases/agreements in the Concession Agreement class and 7 percent of all 311 leases/agreements identified during this review.

Concession leases, especially Food and Beverage leases, represent the greatest and most immediate opportunity within the Airport's influence and control to introduce waste reduction and recycling requirements into leases. Food and Beverage operators generate significant amounts of Terminal waste including compostables and recyclables. In addition, they directly influence waste quantity and composition within the Airport Terminal through their operations and purchasing practices. Similarly, Concessionaires have the ability to collect and divert pre- and post-consumer waste material through front-of-house (FOH) in-store waste separation and back-of-house (BOH) collection practices. The Airport's Business Development Department plans to rebid the majority of Concession Food and Beverage leases between 2015 and 2017, and Environmental Department staff will evaluate opportunities to enhance Concessionaire waste collection, separation, and product procurement during the rebid process.

Inflight Catering leases and Airline Signatory Lease and Operating Agreements have expiration dates beginning in 2017, but the Airport has no control and limited influence over these tenants due to their operational independence. Waste from the Aircraft and Ground Support generator group constituted the single largest component of MSW managed by the Airport (31 %), but the Airport has no control over inflight waste separation. Airport Environmental staff will continue to monitor these leases for developments in operational changes that may signal an opportunity to influence waste reduction and recycling activities.

Review Approach

Airport Environmental staff reviewed 15 representative sample leases from a total of 311 identified leases/agreements to determine the extent to which leases encourage or impede the purchase and use of environmentally preferred products and to identify upcoming opportunities to integrate waste reduction, reuse, and recycling objectives into leases. Airport Environmental staff selected leases to review by focusing on lease agreement types that either a) pertain to operational aspects of defined waste generator groups that generate significant amounts of waste, or b) had lease expiration dates occurring within two years (excluding month-to-month terms). Lease agreements with no obvious links to waste reduction or recycling opportunities (e.g., storage leases, easement agreements, land-leases, operating permits, hold-harmless agreements, license agreements) were excluded from review. Within those agreement types, Airport Environmental staff reviewed a combination of specific and randomly selected lease agreements to evaluate a broad cross-section of content. Airport Environmental staff obtained lease review support from Airport Business Development – Properties Department staff including access to lease information, digital inventories, and direction regarding lease structure and content consistencies within similar lease/agreement types.

Lease Renewal Schedules

Lease renewal schedules vary by lease class and type and include rolling renewal schedules and clustered renewal schedules around specific dates. Lease class, agreement type, and associated expiration or renewal dates are summarized in *Appendix B*.

4.5. Development Specifications

The Airport has adopted several development specifications that affect waste and recycling. These specifications govern both how waste is handled during construction activities and how facilities are designed and constructed to facilitate waste reduction and recycling. Most of these specifications support waste reduction and recycling, particularly in Airport-contracted construction. At this time, the extent to which the specifications lead to waste reduction and recycling during tenant-contracted construction is not clear. In addition, while a 2010 update to the Architectural Standards prioritizes recycling collection bins or co-located garbage and recycling collection bins over standalone recycling collection bins, the Architectural Standards may still prevent Airport Environmental staff from applying best practices for bin color and signage.

Appendix B briefly summarizes the following development specifications:

- Construction Design Review Process
- Construction Specifications Related to Hazardous and Industrial Waste Management
- Construction Waste Management
- Tenant Improvement Construction General Requirements (2014 Edition)
- Architecture Standards (2008)
- Restroom Design Standards (Draft – Revised June 2009)
- Tenant and Construction Design Guidelines (2001)
- Concession Design Guidelines (November 2009)

4.6. Purchasing Policies or Requirements

The Airport has adopted several purchasing policies and requirements that facilitate waste reduction and recycling. Generally, the Airport has adequate purchasing policies in place to direct Airport staff to consider and procure environmentally preferable products and services (EPP) that meet the end user's balanced needs.

One notable policy is CPO-2, the green purchasing policy, which requires all Port divisions and departments to purchase and use environmentally preferable products and services (EPPs) whenever cost effective and to the extent practicable as determined by the end user of the product or service. To implement this policy, the Airport makes ongoing efforts to review purchasing records and research product categories to identify opportunities to improve. As a result of this purchasing policy, the Airport uses 30 percent recycled-content paper, coreless toilet paper rolls, and green cleaning and hygiene products. Additional monitoring of EPP purchasing records by the Environmental Purchasing Working Group, identified in the Port of Seattle's Environmental Purchasing Policy (CPO-2), may provide additional insight into levels of EPP purchases or additional EPP opportunities to drive future decisions on policy direction and enforcement.

Appendix B summarizes the following purchasing policies and requirements:

- Port of Seattle Environmental Purchasing Policy (CPO-2)
- Port of Seattle Policy and Procedure for Procurement and Receipt of Goods and/or Services (CPO-5)
- Port of Seattle Sustainable Asset Management Policy (EX-15)
- Port of Seattle Disposition of Property Policy (AC-13)
- Office Supply Contract: Keeney's Contract with City of Seattle (ILA)

5. Current Education, Incentive, Engagement, and Pollution Prevention Strategies

5.1. Objectives

This section describes the strategies that the Airport uses to encourage employees, tenants, and passengers to effectively use the recycling and composting infrastructure provided by the Airport's waste management system (described in *Section 3 Current Waste Management System*). These strategies include:

- Recycling and composting education and outreach
- Incentives and awards
- Ongoing stakeholder engagement
- Pollution prevention

Understanding the Airport's current education, incentive, engagement, and pollution prevention strategies was essential for developing recommended waste reduction and recycling strategies. Those strategies, presented in *Section 2 Recommended Waste Reduction and Recycling Strategies*, build and improve upon the Airport's existing strategies, address or work within constraints, and focus on those areas where the Airport has the greatest opportunity for impact.

Key Findings

- **The Airport has made significant progress on recommendations and goals in the 2010 SWMP.** Since adopting its 2010 SWMP, the Airport has made significant progress in adding new containers, enhancing training and signage, offering incentives, considering new policies, exploring mixed waste processing, and increasing its waste reduction efforts.
  - The Airport has also made other improvements beyond the SWMP recommendations in adding liquid drain stations, supporting durable service ware at some Concessionaires, and expanding C&D debris collection services.
- **The Airport is approaching the upper limit of diversion possible from voluntary measures alone.** With these improvements, the Airport achieved a 31 percent Terminal diversion rate in 2013, and preliminary estimates suggest a 34 percent rate in the first quarter of 2015. This diversion rate is nearing the 36 percent previously identified as achievable through voluntary measures; reaching the Airport's objective of 50 percent Terminal diversion is expected to involve mandatory approaches or other ambitious recycling strategies.
- **The existing strategies in this section are comprehensive, but many tenants are not currently aware of all of the assistance available to them through the Airport.** The Airport has a comprehensive set of education, outreach, incentive, and pollution prevention programs for employees and tenants as well as internal policies, requirements, and support systems to promote waste reduction and recycling. However, many tenants are not yet aware of all of the assistance the Airport offers. Education and outreach could also be improved to better promote waste prevention.

5.2. Progress on Recommendations in 2010 SWMP

The Airport's 2010 Solid Waste Management Plan made recommendations in six categories of waste reduction and recycling opportunities. In the last four years, the Airport has made significant progress in many of these areas, as listed in Table 22. The Airport has also made improvements beyond these recommendations, in the following areas:

- Added liquid drain stations to three of the Airport's six security checkpoints to keep this heavy material out of the garbage and to promote reuse and recycling of beverage bottles.
- Supported Concessionaire efforts to replace disposable service ware with durable alternatives.
- Expanding C&D collection services for Aviation Maintenance activities.

Through these improvements, the Airport achieved a 31 percent Terminal diversion rate in 2013, and anecdotally reached 34 percent in the first quarter of 2015. This diversion level is approaching the 36 percent rate that Cascadia estimated was achievable through the voluntary scenario in the 2010 SWMP. To reach its 50 percent diversion objective, the Airport will need to use mandatory strategies or other similarly ambitious approaches.

Table 22. Progress in 2010 SWMP Recommendations

2010 Recommendation	Status
Add New Containers	
North and South Satellites (glass)	Added glass recycling containers at North and South Satellite central waste collection sites.
Public Areas (recycling)	Added commingled recycling collection bins in the parking garage, arrival/departure drives, underserved Terminal areas, and baggage claim. Repurposed and relocated bins in Terminal areas to reduce stand-alone garbage bins.
Tenant Terminal areas (recycling)	Added recycling bins in the Aviation Maintenance shops at Air Cargo 4 and Service Tunnel load dock, Aviation and Maintenance offices, the new Bus Maintenance Facility, Airport Transit Operations Center, Toll Plaza, and Bagwell.
Concessions (compostables)	Added compostable collection at Taxi Lot and Port Fire Station and bathroom towel composting in the Aviation Office Building (AOB).
Common use employee areas (recycling)	Added recycling collection containers for wood and plastic sheeting and metal recycling in Air Cargo areas.
Food courts (compostables)	Added composting bins in the main food court. Proposed installation of additional compostables collection bins at other food courts was postponed until 2015 due to concerns about post-consumer contamination impacts on viability of Airport composting services.

2010 Recommendation	Status
Enhance Education and Training	
Training	Provided an expanded variety of education and training resources for tenants, including annual recycling training with janitorial service providers and Concessionaire tenants. Many tenants now include recycling procedures in their new employee training.
Signage	Applied new standardized recycling decals to some Terminal waste collection bins and implemented a Terminal education outreach campaign that highlights Terminal recycling collection bins and Airfield recycling compactors to passengers.
Goal setting	In 2013, updated its waste-related objectives, listed in *Section 6.2 Performance Measurement System*.
Offer Additional Incentives	
Financial incentives	Continued pay-per-use fees for garbage compactors.
Publicity incentives	In 2010, implemented Environmental Excellence Awards for Airport tenants and business partners to recognize outstanding environmental accomplishments and encourage ongoing program support.
Consider New Policies and Regulations	
Mandatory recycling	In 2013, implemented new construction specifications that require Airport and its construction contractors to reduce and recycle construction, demolition, and land clearing (CDL) debris to the maximum extent practicable.
Voluntary recyclable packaging	Continuing to investigate implementation frameworks for voluntary recyclable packaging policies.
Mandatory recyclable packaging	Continuing to investigate implementation frameworks for mandatory recyclable packaging policies and a mandatory recycling policy.
Further Waste Reduction	
Food donation	Expanded food donation program from tenants in secure areas to 35,000 pounds in 2013.
Hand dryers	Currently conducting a pilot to use hand dryers in restrooms instead of paper towels.
Explore Processing Options	
Mixed waste processing	In 2014, conducted a month-long pilot project to assess the effectiveness of sorting mixed waste in-house with janitorial staff support. Resulting diversion and costs savings were lower than expected, but lessons learned will be incorporated into future pilot projects.

5.3. Recycling and Composting Education and Outreach

The Airport provides education and outreach to employees, Terminal and Airfield tenants, and passengers on recycling, composting, and (to a lesser extent) waste prevention.

Employees and Terminal Tenants

The Airport provides a variety of education and training resources for employees and Terminal-based tenants, including annual recycling trainings with janitorial service providers and Concessionaires, a

training video, and onsite trainings for Concessionaire staff. Airport Environmental staff attend regularly scheduled tenant manager meetings to provide program updates and announce new recycling services or discuss challenges and opportunities with existing programs (such as contamination issues). Airport Environmental staff provide tenants with a comprehensive recycling brochure that outlines the Airport's waste minimization objectives, identifies collected materials and specific recycling services available at disposal locations throughout the Airport, and identifies contacts for further information. Many tenants include recycling procedures in their new employee training. Airport Environmental staff also provide technical information and resources to tenants for proper disposal of hazardous and industrial wastes.

The Airport also conducts annual inspections of all Concessionaire facilities, including a survey of their current waste management practices. During the spring 2014 inspection, 57 percent of tenants reported participating in recycling programs and 53 percent reported participating in composting programs. Currently 45 percent of eligible tenants participate in the food donation program and another 33 percent said they were willing to begin participating. Of the 11 tenants that generate used cooking oil, 10 tenants reported recycling this material.

The Airport has also adopted strategies to reduce paper use by Port employees, such as messaging to discourage printing, setting default duplex printing, promoting electronic billing and contracting, and using specialized software to support electronic construction design review.

Airfield Tenants

The Airport provides outreach and technical assistance to Airfield tenants (including airlines, ground support, air cargo, and flight kitchens) to help them to recycle currently accepted materials including pallets and clean wood, commingled recyclables, scrap metal, food waste, and cooking oil. Airport Environmental staff engage tenants about participation in recycling programs during regular meetings and periodically conduct visual audits of waste in Airfield tenant containers to identify additional outreach needs.

Traveling Public

Education and outreach to the traveling public is conducted primarily through signage on collection bins as well as through audio, billboard, and video messaging within the Airport. The Airport established a new messaging campaign, "pitch it in the right bin," with recycling signage and wraps on bins in the ticketing area, esplanade, and Main Terminal concourse areas. A new Terminal education outreach campaign highlights Airfield recycling compactors to passengers using see-through signage on windows and high-visibility signage on compactors. Liquid collection stations at security checkpoints promote reuse by advertising bottle refill stations located after security.

5.4. Incentives and Awards

The Airport uses financial incentives, collection support, and awards to motivate tenants to reduce waste and increase recycling. These incentives and awards include the following:

- Pay-per-toss fees for tenants in the Terminal based on garbage compactor use combined with unlimited recycling and composting at no extra charge as a financial incentive to reduce garbage and divert recoverable material.

- Periodic clean-up events that allow tenants to recycle otherwise hard-to-recycle items—such as used appliances, shelving, and furniture or other bulky items—and that promote recycling, composting, reuse, and proper disposal of hazardous materials.
- Free signage and back-of-house recycling and compostables collection bins to provide tenants with the necessary infrastructure to participate in Airport waste diversion programs.
- Environmental Excellence Awards Program, initiated in 2010, which recognizes tenants and business partners for outstanding accomplishments in three areas: environmental performance, environmental education and outreach, and environmental innovation. Award winners receive a commemorative plaque as well as recognition in a Port press release, on the Port's website, and other publicity.

5.5. Ongoing Stakeholder Engagement

To support waste reduction and recycling, the Airport has established internal and external stakeholder engagement and coordination. Internal coordination includes the Materials Management Working Group (similar to a Green Team) and dedicated recycling and sustainability coordinators. To encourage strong coordination and communication among external stakeholders, the Airport works with service providers, local governments (City of SeaTac, King County, City of Seattle), industry trade groups (ACI, AAAE), and federal government agencies (EPA, FAA). Coordination includes advocating for Airport waste reduction and recycling efforts and participating in local waste system developments (such as future mixed waste processing or anaerobic digestion facilities). Continuing these internal and external support systems will be essential for supporting the success of the SWMP and implementing recommended waste reduction and recycling strategies presented in this SWMP.

5.6. Pollution Prevention

The Port began developing progressive pollution prevention strategies in 1995. Since that time it has implemented many strategies to reduce the amount of waste generated, reduce the amount of chemicals used, use safer chemicals, and regularly evaluate materials to meet changing environmental standards.

The Port reduces its hazardous waste by recycling off-specification fuels and fuel filters, puncturing empty aerosol cans to be recycled as scrap metal, using lead-free and water-based paint for Airfield and road markings, and minimizing use of solvents to clean painting equipment. The Port also uses high-flashpoint solvents and water-based part washers instead of flammable or toxic solvents. To prevent products that are rarely used or have a short shelf-life from becoming unusable hazardous waste, the Airport purchases them in small quantities.

Airport Environmental staff also trains other Airport staff, construction contractors, and tenants through regular trainings and discussions on pollution prevention, proper waste management, waste reduction strategies, and the benefits of using and generating less hazardous materials and waste. This education emphasizes being aware of and minimizing off-specification, unused products, cross-contamination of wastes, and abandoned chemicals, which can inadvertently increase the annual amount of waste generated.

Airport staff use only chemicals on the Port's Approved Chemical Products List. Airport Environmental staff work directly with Port Maintenance staff to research less hazardous alternatives that can replace hazardous products or prevent the use of new products containing chemicals such as isocyanates, chlorinated solvents, other toxic solvents, and flammable materials. Airport Environmental staff evaluate and approve all procedures and new chemical products before they are added to the approved list.

In addition to proper hazardous waste management, the Port implements a Pollution Prevention Plan focused on overall reduction in hazardous waste generation, reducing the processes that generate hazardous waste, and minimizing the amount of hazardous waste generated from required processes. The Pollution Prevention Program also includes ongoing evaluation of all current hazardous waste streams and processed generating waste to identify waste minimization opportunities.

6. Program Performance Measurement and Waste Characterization Results

6.1. Objectives

The Airport's Environmental Strategy Plan sets objectives for diversion and waste management. This section first summarizes those objectives and the performance measurement system the Airport uses to assess progress toward achieving them (*Section 6.2*). Subsequent subsections (*Sections 6.3–6.5*) provide details on Airport waste and fulfill FAA Guideline requirements to help identify successes and opportunities for improvement. These details include sources, quantities, and composition of municipal solid waste (MSW), construction and demolition (C&D) debris, and hazardous waste and materials (HWM). To obtain more detailed information on MSW, the 2014 SWMP Update included a waste characterization study of garbage and recycling collected in Airport-controlled containers.

The remainder of section is organized into the following sub-sections:

- Performance measurement system
- Municipal solid waste
- Construction and demolition (C&D) debris
- Hazardous waste and materials

Key Findings

- **The Terminal diversion rate increased to 31 percent, below the Airport's 50 percent objective.** The Airport achieved a 31 percent Terminal diversion rate in 2013, its highest rate achieved to date. Although the program has grown continuously over the past decade, the diversion rate is substantially less than the Airport's 50 percent objective for 2014.
- **The Airport could reach its Terminal diversion goal by diverting less than half of the recyclable and compostable materials currently disposed of as garbage in the Terminal.**
  - Overall, 75 percent of waste placed in Terminal garbage compactors could be recycled or composted through existing Airport programs (2,979 tons).
  - **Compostables represent the largest opportunity in tons to increase Terminal diversion**. Half (50%) of Terminal garbage is compostable, representing an opportunity to increase diversion through expanded composting programs.
- **Public Areas represent both the biggest opportunity to recycle and compost Terminal waste and the largest challenge in motivating a generator group to separate materials for diversion.**
  - Only 9 percent of Public Area commingled recyclables were captured, leaving 595 tons in the garbage. Public Areas also disposed of 793 tons of compostables as garbage.
- **ADR Concessions represents the second largest opportunity to divert more Terminal waste and has proven success at successfully diverting recyclables.**
  - This generator group disposed of 887 tons of compostable materials as garbage in 2013. In 2014, nearly half (47%) of ADR Concessions tenants with compostable waste were not composting.

  - ADR Concessions has the highest capture rate for commingled recyclables (72%) among all generator groups. Almost half of Airport commingled recyclables (46%) were diverted by ADR Concessions. Airport recycling education, outreach, and incentive efforts have contributed to this success. This generator group still leaves an estimated 205 tons of recyclables in the garbage, however. Approximately 43 percent of ADR Concessions tenants who generate recyclable materials did not participate in recycling in 2014.
- **Terminal Tenants have moderate potential to divert more recyclable and compostable waste.**
  - This group disposed of 298 tons of recyclables and compostables as garbage and achieved a relatively low recycling capture rate of 31 percent.
- **Increasing recycling and initiating composting on the Airfield represent large opportunities to increase the Airfield diversion rate, but also pose significant challenges.**
  - The Airfield's diversion rate was 10 percent in 2013, consistent with average annual Airfield diversion rate since Airfield garbage and recycling data tracking began in 2010.
  - Overall, 31 percent of waste placed in Airfield garbage compactors is readily recoverable through the existing Airfield recycling programs (598 tons).
  - Another 41 percent (792 tons) of Airfield garbage is compostable, but no Airfield composting system currently exists.
  - The Airport has no control and limited influence related to Airfield waste management.
- **Airport construction projects completed in 2014 reported recycling or reusing 98 percent of C&D debris, indicating that current strategies to divert C&D debris are highly effective.**
- **Hazardous waste has measurably declined since the mid-1990s, indicating current strategies are effective.**
  - Hazardous waste generated at the Airport has fluctuated over the past decade, with an overall downward trend since the mid-1990s. In 2005–2014, the Port generated less than 35,000 pounds of hazardous waste, approximately a 98 percent decrease compared to the previous decade.
- **Opportunities remain to increase environmentally preferable purchasing.**
  - In 2014, about 40 percent of purchased office products were environmentally preferable, indicating remaining opportunities to increase green purchasing activity.

6.2. Performance Measurement System

The Airport is committed to leading the U.S. airport industry in environmental innovation and minimizing the Airport's environmental impacts. To demonstrate this leadership, the Airport has used its Environmental Strategy Plan to set objectives for materials and waste management in five key areas:

- Terminal diversion rate
- Airfield diversion rate
- C&D debris diversion rate
- Hazardous waste generation
- Environmentally preferable products

To supplement and support achieving these objectives, the Airport has developed measurement systems for objectives in these key areas and for other indicators that help the Airport determine whether it is on track to achieving Environmental Strategy Plan objectives. Table 23 lists these measurement systems along with their associated performance indicators and current results, where available.

The Airport reports the results of these measurement efforts in three main ways:

- Annual Environmental Strategy Plan progress reports
- Periodic internal memos and reports
- Annual report to the public

Table 23. Performance Measurement, Indicators, Objective, and Current Results

Measurement System	Performance Indicator	Objective	Current Result
Annual summary of monthly hauler and processor records for MSW	Pounds generated per passenger	NA	0.45 pounds per passenger in 2013[26]
	Tons of Terminal waste diverted from landfill	NA	2,011 Tons in 2013[27]
	Percentage of Terminal waste diverted from landfill	▪ 2009 Objective: Diversion rate of 50% by 2014 ▪ 2015 Objective: Diversion rate of 50% by 2020 (maintain current objective)	31% in 2013[28]
	Tons of Airfield waste diverted from landfill	NA	218 tons in 2013[29]
	Percentage of Airfield waste diverted from landfill	▪ 2009 Objective: None[30] ▪ 2015 Objective: Diversion rate of 15% by 2020	10% in 2013[31]
Waste and recycling characterization studies for MSW, every 5 years or as needed	Capture rates for commingled recyclable and compostable material	NA	Airport wide in 2013:[32] ▪ 44% of recyclable paper ▪ 24% of other commingled recyclables ▪ 13% of compostables

[26] Calculated based on 7,888 tons generated and 34,826,741 air passengers (Port of Seattle, "Airport Statistics: Total Air Passengers," retrieved April 2015 from https://www.portseattle.org/About/Publications/Statistics/Airport-Statistics/Pages/default.aspx).
[27] See *Appendix C – Airport Waste Characterization Report*.
[28] See *Appendix C – Airport Waste Characterization Report*.
[29] See *Appendix C – Airport Waste Characterization Report*.
[30] Prior to 2010, airlines and ground service operators involved in Airfield operations managed deplaned and other Airfield waste outside the Port's direct control and influence. In 2010 the Port constructed the central Airfield Trash Handling and Recycling System, which is now used by most Airfield operators.
[31] See *Appendix C – Airport Waste Characterization Report.*
[32] See *Appendix C – Airport Waste Characterization Report.*

Measurement System	Performance Indicator	Objective	Current Result
Annual tenant inspections	Percentage of ADR Concessions applicable tenants participating in recycling and composting	NA	In 2014:[33] ▪ 57% recycle ▪ 53% compost
Annual public bin inventory	Percentage of public bins characterized as good or excellent by meeting criteria for co-location, standardized signage, and condition.	NA	In 2014: ▪ 70% Good; ▪ 19% Excellent[34]
Periodic air cargo and flight kitchen visual audits (not necessarily annual)	NA (anecdotal report on recycling participation)	NA	NA
Project-end reports by Port construction contractors	▪ Tons of C&D debris generated ▪ Tons of C&D debris diverted ▪ Percentage of C&D debris diverted	▪ 2009 Objective: Implement Best Management Practices ▪ 2015 Objective: Diversion rate of 85% by 2020	98% in 2014[35]
Hazardous waste manifest records	Pounds of hazardous waste generated	▪ 2009 Objective: Continue to reduce use of hazardous materials and the generation of hazardous wastes ▪ 2015 Objective: Reduce hazardous waste generated from Port operations to less than 220 pounds per month by 2020.	In 2014:[36] ▪ 2,666 pounds annual total ▪ 2,020 pounds maximum monthly volume in storage ▪ 445 pounds maximum monthly volume generated
Purchasing guidelines	Proportion of products or categories procured by the Airport that are environmentally preferable products (EPP).	▪ 2009 Objective: Increase the amount of environmentally preferable products procured by the Airport by three products or categories each year ▪ 2015 Objective: Same	In 2014:[37] ▪ 68% of purchased paper contained recyclable content ▪ 40% of purchased office products were environmentally preferable

[33] See *2014 Tenant Inspection Memorandum in Appendix B.*
[34] See *2014 Public Collection Bin Inventory Memorandum in Appendix B.*
[35] Data provided by Airport Environmental staff, email communication May 2015. This figure does not include C&D debris from the Cargo 2, 5 and 6 upgrades project, which was substantially completed in 2014 but for which data were not available when this SWMP was written.
[36] Data provided by Airport Environmental staff, email communication May 2015.
[37] Data provided by Airport Environmental staff, email communication May 2015.

6.3. Municipal Solid Waste (MSW)

6.3.1. Sources of MSW

Passengers, tenants of Airport-operated facilities, and Airport staff generate the MSW over which the Airport has direct control. These materials were the focus of the 2014 MSW characterization study. For this study, garbage and commingled recycling materials were assigned to one of the following six generator groups:

- **Aircraft and Ground Support**: aircraft and ground crew services on the Airfield associated with passenger aircraft.
- **Airport Dining and Retail Concessions (ADR Concessions):** food and beverage, convenience and specialty retail, and duty-free concessions.
- **Port Administrative Offices**: Port of Seattle office areas.
- **Port Maintenance Facilities**: Port of Seattle maintenance operations, both on and off the Airfield.
- **Public Areas**: areas accessible to the public in the terminals and parking garage, including both secure and non-secure areas.
- **Tenant Terminal Areas**: airline administration, offices, and ticketing, rental car, and baggage handling areas.

Waste which is not placed in Airport-controlled containers, as described in *Section 3.2 Scope of Airport's Waste Management System*, was not included in the waste characterization study. The waste characterization study also did not address compostable waste diverted for composting, although total quantities of compostables diverted were obtained from service provider invoices.

6.3.2. Overview of Study Methodology

For the characterization study, Airport Environmental staff captured a total of 177 garbage samples and 167 commingled recycling samples across all generator groups, which were later sorted by Cascadia staff. Samples were randomly selected from loads delivered to the Airport's central collection sites, with samples averaging 25 pounds for garbage and 13 pounds for commingled recycling.

All samples were used to generate weight estimates; 94 garbage samples and 78 commingled recycling samples were also hand-sorted into 38 material categories to develop composition estimates. Each material category falls into one of five recoverability classes: recyclable paper, other recyclables, compostables, potentially recoverable, and non-recoverable.

Appendix C includes a full set of definitions for all material categories and recoverability classes, as well as sample details and a comparison of results to the waste characterization study conducted for the 2010 SWMP.

6.3.3. Waste Quantities

The Airport generated approximately 7,888 tons of municipal solid waste materials in 2013. Table 24 presents annual tons of garbage, commingled recycling, composting, and other diversion for the Airfield, Terminal, and Airport overall. Shown in Table 24, about 1,793 tons, or 31 percent, of Terminal waste was

recovered in 2013 through commingled recycling, composting, and other diversion efforts (described in *Section 3.3 Municipal Solid Waste (MSW) Management*). Other diversion includes donated food, used cooking oil, source-separated glass, scrap metal, and wood. In 2013, tenants donated 35,000 pounds of food, which is equivalent to 544 meals per week; this represents an increase of 40 percent over the previous year.

While the Terminal's diversion rate was below the Airport's waste diversion objective of 50 percent by 2014, it reflects the highest annual diversion rate achieved since Airport recycling programs began in 1993. It also represents the latest point in a clear pattern of continuous program growth over the past decade. Figure 4 summarizes the Airport's waste diversion rate history from 1993 to 2013.

Another 218 tons, or 10 percent, of Airfield waste was recovered as commingled recycling. This diversion rate is consistent with average annual Airfield diversion since the Airport installed the Airfield trash handling and recycling system in 2010. Diversion rates for the Airfield had not been calculated prior to 2010 due to the lack of airline waste data.

Table 24. Airport Waste Tonnages and Overall Diversion Rates by Airfield and Terminal, 2013[38]

	Airfield	Terminal	Overall
Garbage	1,918	3,959	**5,877**
Commingled Recycling	218	1,014	**1,232**
Composting	N/A	423	**423**
Other Diversion	N/A	356	**356**
Total Generation	**2,136**	**5,752**	**7,888**
Diversion Rate	10%	31%	25%

[38] Other diversion includes donated food, used cooking oil, source-separated glass, scrap metal, and wood.

Figure 4. Airport Waste Diversion Rate History 1993–2013[39]

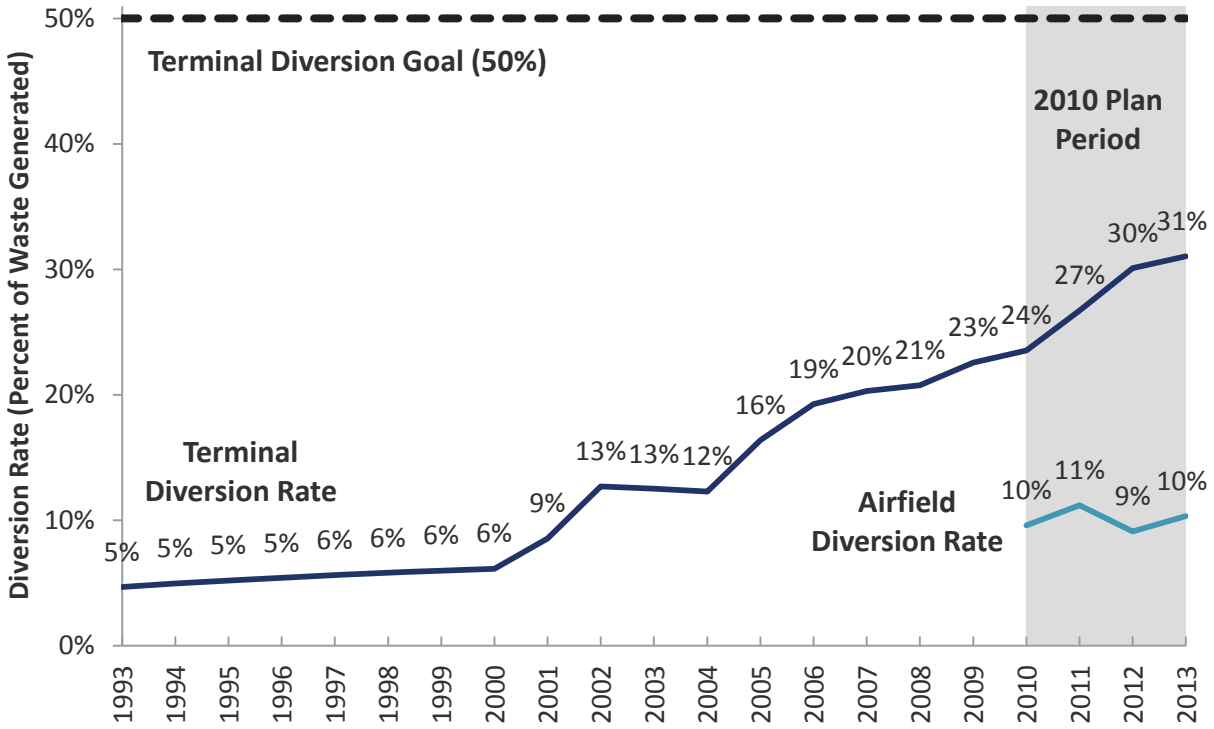


Figure 5 and Table 25 show total tons of garbage and commingled recycling discarded by generator group. Annual tons were estimated from 2014 sampling events and 2013 generated tons. See *Appendix C* for the detailed calculations methodology. The three largest waste generators together discard 85 percent of all garbage and commingled recyclables: Aircraft and Ground Support (31%), Public Areas (28%), and Airport Dining and Retail Concessions (27%).[40] Almost half of Airport commingled recyclables, 46 percent, were diverted by ADR Concessions.

[39] Historic data provided by the Airport's Environmental Department.
[40] The rounded sum of the unrounded individual percentages is 85 percent.

Figure 5. Estimated Annual Tons and Percent Distribution of Garbage and Commingled Recycling by Generator Group, 2013

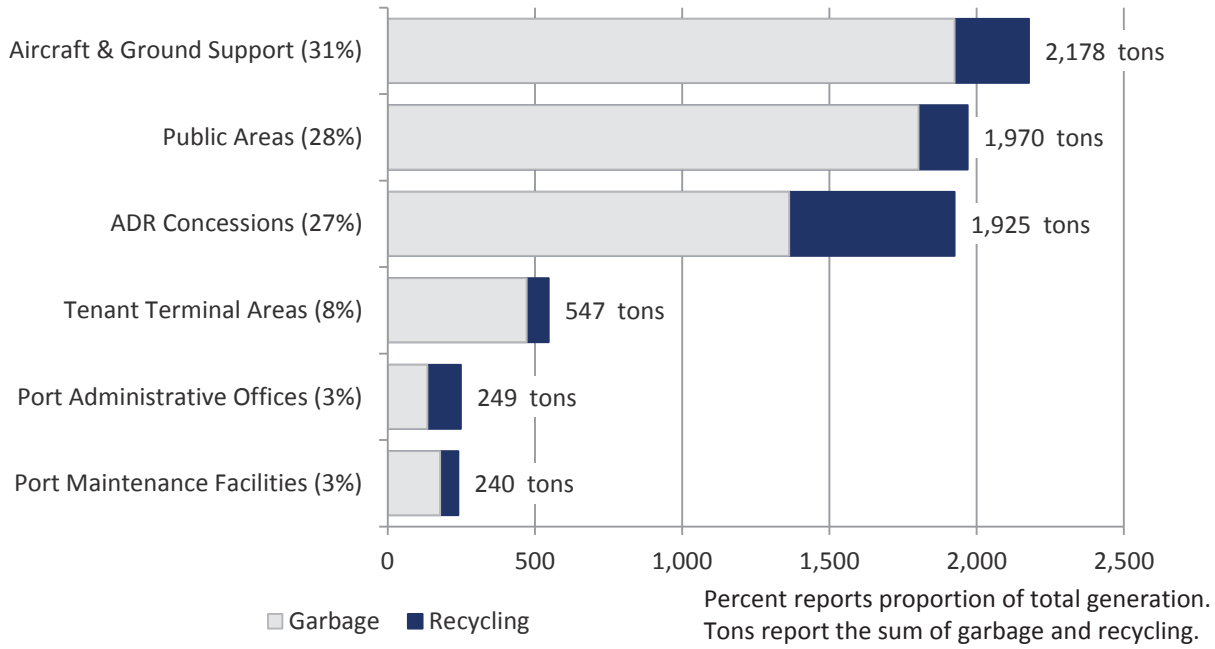


Table 25. Estimated Annual Tons of Garbage and Commingled Recycling, by Generator Group

	Garbage		Commingled Recycling		Total	
Generator Group	**Tons**	**Percent**	**Tons**	**Percent**	**Tons**	**Percent**
Aircraft & Ground Support	1,926	33%	252	20%	**2,178**	**31%**
ADR Concessions	1,364	23%	562	46%	**1,925**	**27%**
Port Administrative Offices	134	2%	114	9%	**249**	**3%**
Port Maintenance Facilities	178	3%	62	5%	**240**	**3%**
Public Areas	1,803	31%	167	14%	**1,970**	**28%**
Tenant Terminal Areas	472	8%	75	6%	**547**	**8%**
Total	**5,877**	**100%**	**1,232**	**100%**	**7,109**	**100%**

6.3.4. Waste Composition

Table 26 summarizes the tons of commingled recyclables and compostables that each generator group currently disposes of as garbage. Based on tons, Aircraft & Ground Support, Public Areas, and ADR Concessions represent the largest quantities of readily recoverable materials in the garbage. Overall, compostables represent a larger diversion opportunity by tons than commingled recyclables, particularly among ADR Concessions and Public Areas.

Table 26. Summary of Readily Recoverable Materials in Garbage, by Generator Group

	Commingled Recyclables		Compostables		Total	
	Tons	Percent	Tons	Percent	Tons	Percent
Aircraft & Ground Support	616	39%	790	28%	1,406	32%
ADR Concessions	205	13%	887	32%	1,092	25%
Port Administrative Offices	52	3%	46	2%	98	2%
Port Maintenance Facilities	41	3%	55	2%	96	2%
Public Areas	595	37%	793	29%	1,388	32%
Tenant Terminal Areas	85	5%	213	8%	298	7%
Total	1,594	100%	2,783	100%	4,377	100%

Overall, about 75 percent of waste placed in Terminal garbage compactors is readily recoverable through existing recycling and composting programs. Roughly half (50%) of Terminal garbage is compostable (primarily food and food-soiled or compostable paper) representing an opportunity to increase diversion through expanded composting. Another 17 percent of Terminal garbage is estimated to be recyclable paper, although the Airport is capturing nearly half (49%) of all recyclable paper generated in the Terminal (632 tons).

ADR Concessions has the highest capture rate for commingled recyclables (excluding compostables): 72 percent. The high recycling capture rate by ADR Concessions is a result of the success of Airport recycling education, outreach, and incentive efforts. At the same time, this study estimated that this generator group leaves 205 tons of recyclables in the garbage. ADR Concessions represents the largest opportunity to divert more Terminal compostable materials (887 tons), followed closely by Public Areas (793 tons). Public Areas also represent a large opportunity to divert more recyclable materials. Only 9 percent of commingled recycling generated in Public Areas is captured, leaving 595 tons in the garbage.

Overall, 31 percent of waste placed in Airfield garbage compactors is readily recoverable through the existing Airfield recycling programs (598 tons).[41] Of this recoverable waste, 396 tons consisted of recyclable paper. Another 41 percent (792 tons) of Airfield garbage is compostable, but no Airfield composting system currently exists. Anecdotally, a noticeable share of these compostables consisted of full or partially full disposable water bottles.[42] Overall, the Aircraft and Ground Support generator group

[41] Discrepancies between figures for Airfield waste (placed in Airfield compactors) and Aircraft and Ground Support waste (discarded by this generator group) occur because occasionally Terminal generators use Airfield Compactors and Aircraft and Ground Support generators use Terminal Compactors. These discrepancies do not appear to affect the results substantially.

[42] During the waste characterization study, Cascadia staff categorized full or partially full water bottles as food because the water composed the majority of these items by weight.

is capturing 28 percent of the commingled recyclables it generates. Increasing recycling and initiating composting represent large opportunities to increase the Airfield diversion rate but also pose significant challenges. Lack of consistent in-flight waste separation and recycling by airlines and ground service crews hampers Airfield recycling efforts. In-flight composting would pose even more challenges by introducing a third waste stream.

Appendix C provides more detailed results, including the recoverability composition of commingled recycling.

Airport Overall

As shown in Figure 6, approximately 4,370 tons, or 74 percent, of all Airport garbage is readily recoverable through existing recycling and composting programs. An additional 200 tons, or 3 percent, is potentially recoverable. The remaining 1,308 tons, 22 percent, is considered non-recoverable. Potentially recoverable describes materials that are not accepted in commingled recycling but for which a recycling market exists. These materials include expanded polystyrene food service, expanded polystyrene packaging, durable plastic items, pallets and clean wood, electronic goods, and textiles.

Compostables, primarily food and food-soiled paper, made up 47 percent of all Airport garbage (2,774 tons), representing a major diversion opportunity. The next largest recoverability category was recyclable paper, accounting for 18 percent of garbage (1,049 tons). Food service-related materials accounted for an estimated 4,099 tons, nearly 70 percent of Airport garbage.

Figure 6. Recoverability Composition by Weight, Garbage—Airport Overall

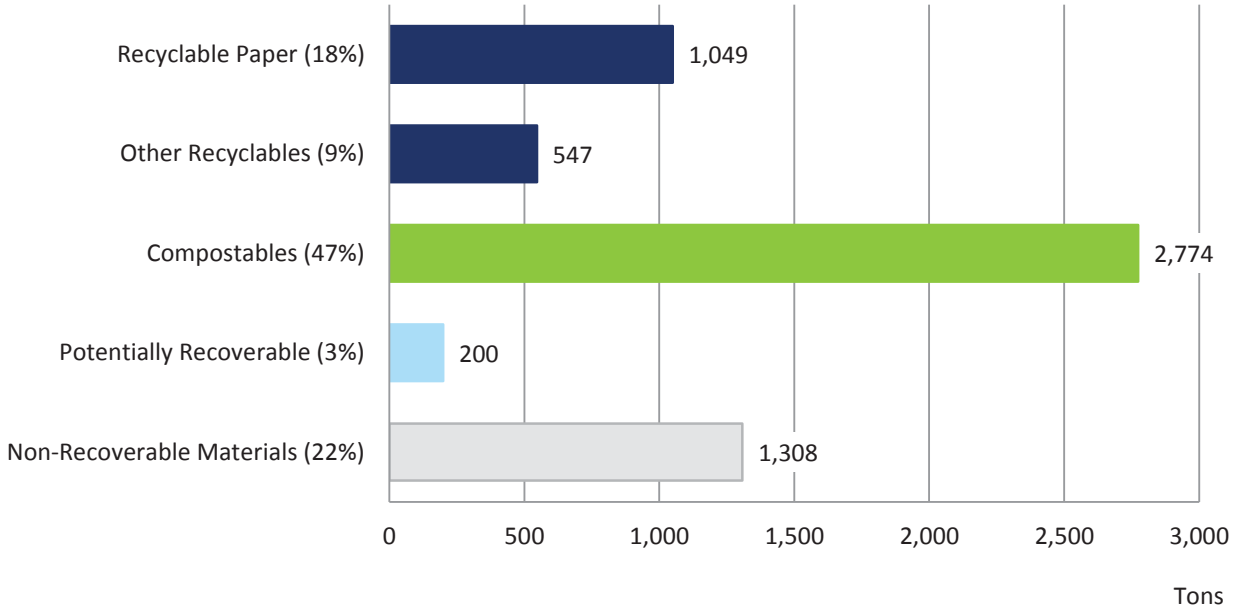
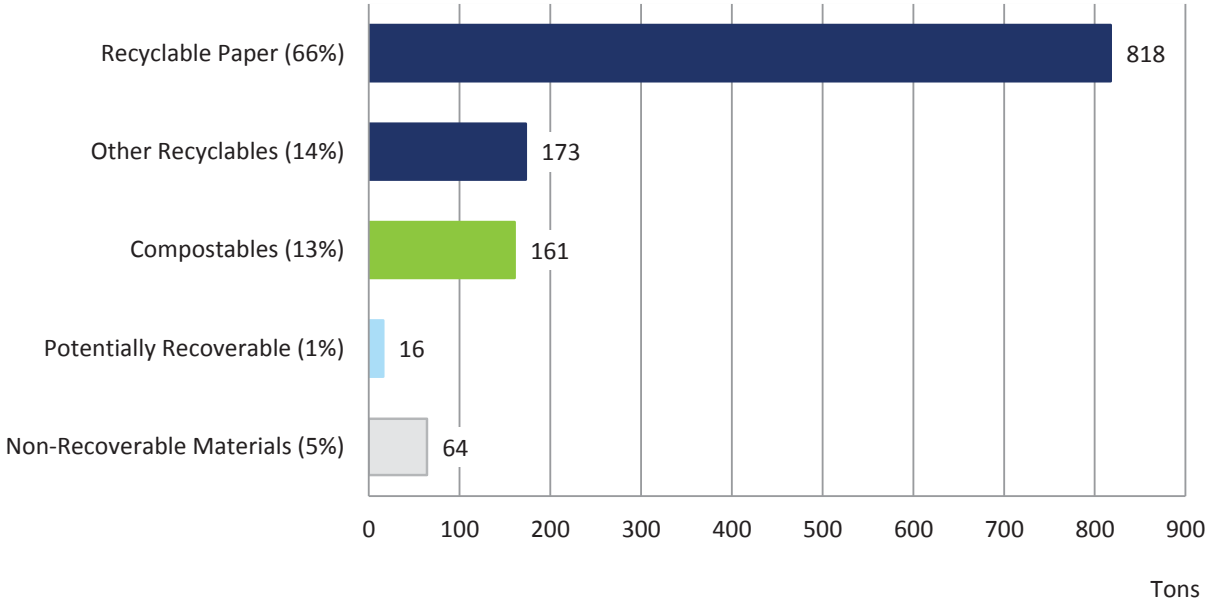


Figure 7 shows composition percentages and estimated tons of materials currently placed in Airport-managed commingled recycling containers in the Airport overall by recoverability category. The most common material class in this stream was recyclable paper, which made up 818 tons (66%) of discarded

commingled recycling. In this case, compostables, potentially recoverable, and non-recoverable materials are contaminants in the commingled recycling stream. Overall, Cascadia staff estimated the Airport commingled recycling had a contamination rate of 19 percent at the time of the study. However, several months after the characterizations study, Recology CleanScapes anecdotally observed that the Airport's commingled recycling had relatively little contamination. Airport Environmental staff hypothesize that the reopening of the Central Terminal Freight service elevator allowed access to an adjacent central waste collection site, which made it easier for tenants to transport their waste and recycling, which in turn improved their recycling performance.

Cardboard and Kraft paper was the most prevalent material type in commingled recycling, making up nearly 48 percent of commingled recyclables, or an estimated 586 tons per year. The next most prevalent material was mixed paper. Mixed paper accounted for approximately 199 tons, or 16 percent of commingled recycling. An estimated 363 tons, or 30 percent, of Airport commingled recycling was related to food service.

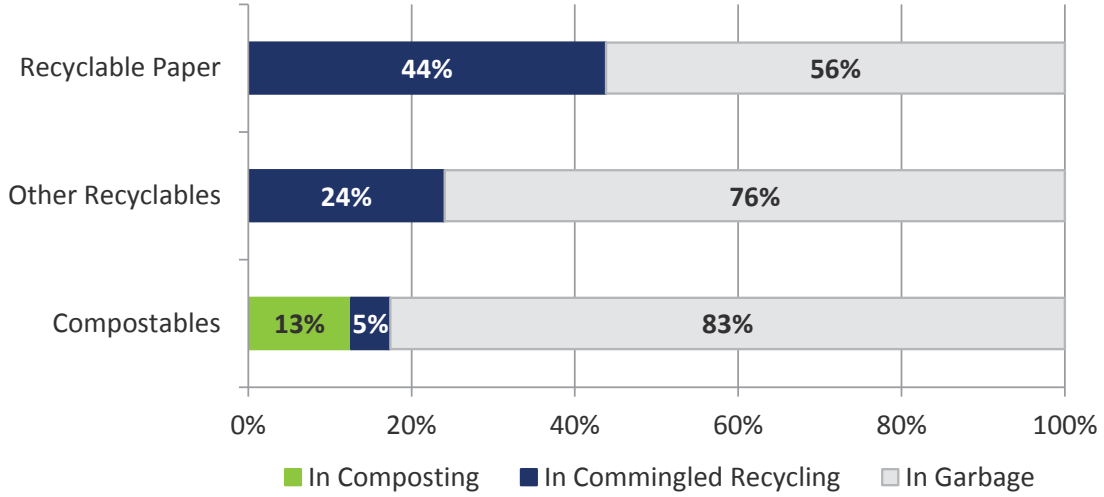
Figure 7. Recoverability Composition by Weight, Commingled Recycling—Airport Overall



Note: As described above, several months after the characterizations study, Recology CleanScapes anecdotally observed that the Airport's commingled recycling had relatively little contamination.

Figure 8 presents Airport overall capture rates for recyclable paper, other commingled recyclables, and compostable materials. The capture rate describes the proportion of a material that was diverted compared to the total tons generated of that material. For example, the capture rate for compostables is 13 percent, meaning 13 percent of all compostable materials generated at the Airport were placed in Airport-managed compost collection containers, while 87 percent was placed in either garbage or commingled recycling containers. The 5 percent of compostable material that was placed in commingled recycling containers is considered commingled recycling contamination and does not contribute to the capture rate.[43]

Figure 8. Airport Overall Capture Rates



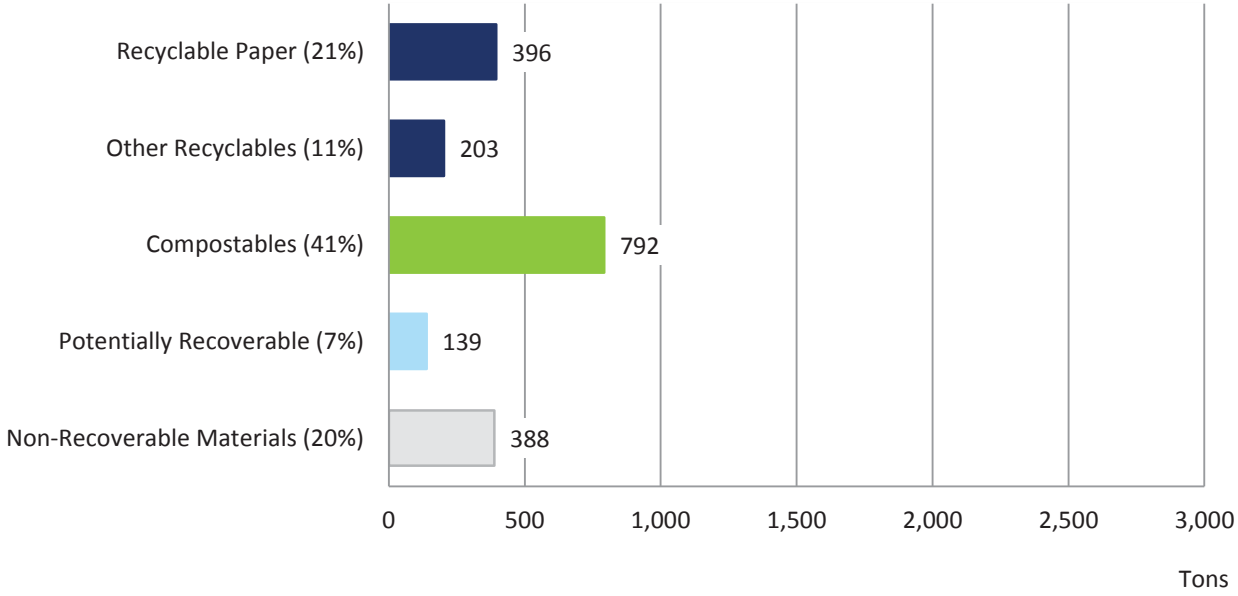
Airfield

This section presents waste composition results for Airfield waste collection sites. Airfield waste collection sites primarily serve the Aircraft and Ground Support generator group. As Figure 9 shows, 1,391 tons, or almost 73 percent, of Airfield garbage is recoverable. Compostables is the largest recoverability group at an estimated 792 tons, or 41 percent, of Airfield garbage. An additional 139 tons, or 7 percent, of Airfield garbage is potentially recoverable. The remaining 388 tons, or 20 percent, is considered non-recoverable. Lack of consistent in-flight waste separation and recycling by airlines and ground service crews hampers Airfield recycling efforts. In-flight composting would pose even more challenges by introducing a third waste stream.

[43] Capture rates for compostable materials is only presented for the Airport overall, the Airfield, and the Terminal because compost quantities by waste collection site was not available and compost samples were not sorted as a part of this study. Annual tons presented in this report were provided by Airport Environmental staff and reflect annual tons of compostable material excluding contamination. Therefore it was not possible to estimate annual tons diverted by generator group.

Food was the most prevalent material in Airfield garbage, making up an estimated 622 tons, or more than 32 percent, of Airfield garbage.[44] The next most prevalent material was mixed paper, accounting for an estimated 347 tons, or 18 percent, of Airfield garbage.

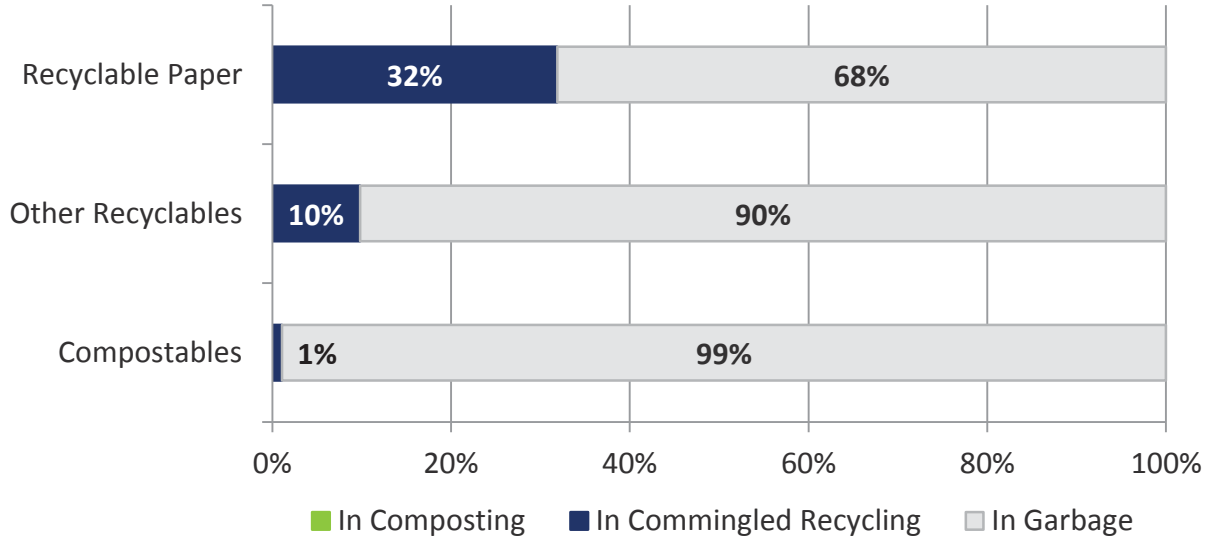
Figure 9. Recoverability Composition by Weight, Garbage—Airfield



The estimated capture rates for commingled recycling and compostable material are shown in Figure 10. Currently, food and compostable paper compost collection is not available at these sites.

[44] During sampling events, Cascadia sorting staff observed that full water bottles accounted for a substantial portion of the food material category.

Figure 10. Capture Rates for Commingled Recyclables, Airfield

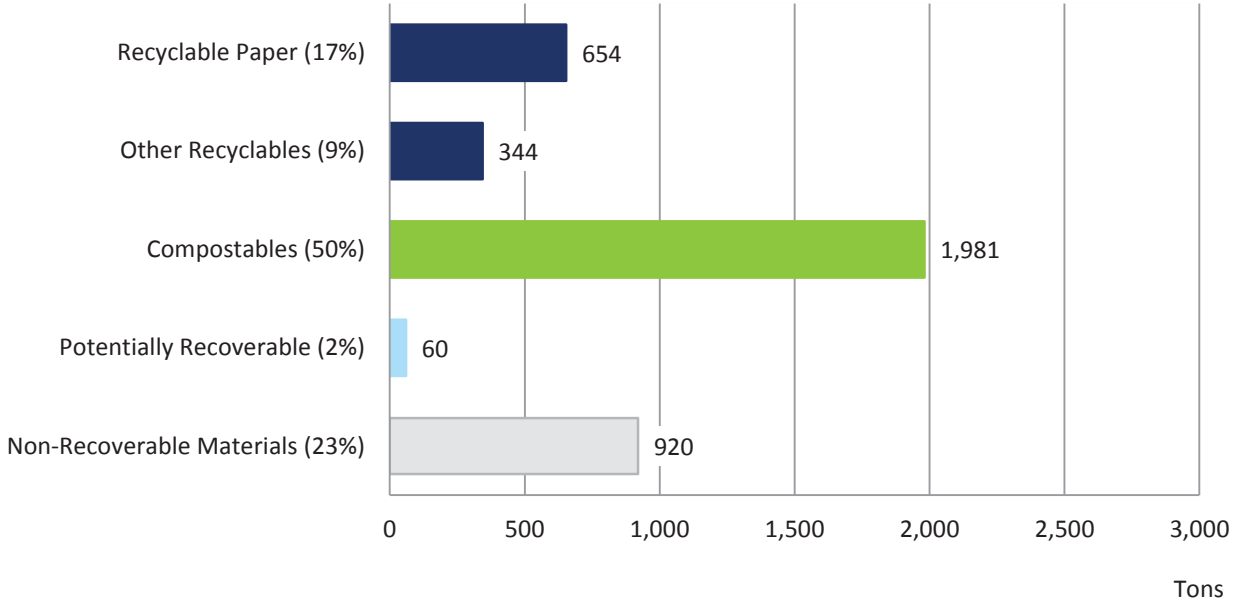


Terminal

This section presents waste composition results for Terminal waste collection sites. The Terminal waste collection sites include containers located on interior and exterior loading docks. These collection sites primarily receive waste from the five generator groups besides Aircraft and Ground Support. Figure 11 presents recoverability of Terminal garbage. An estimated 2,979 tons (76%) of Terminal garbage is readily recoverable. Compostables is the largest recoverable material group in the Terminal garbage stream, accounting for 1,981 tons. Terminal waste collection sites received an estimated 1,316 tons of food—about 33 percent of Terminal garbage.[45] The next most common material type was food-soiled and compostable paper, which accounted for 659 tons (17%), of Terminal garbage.

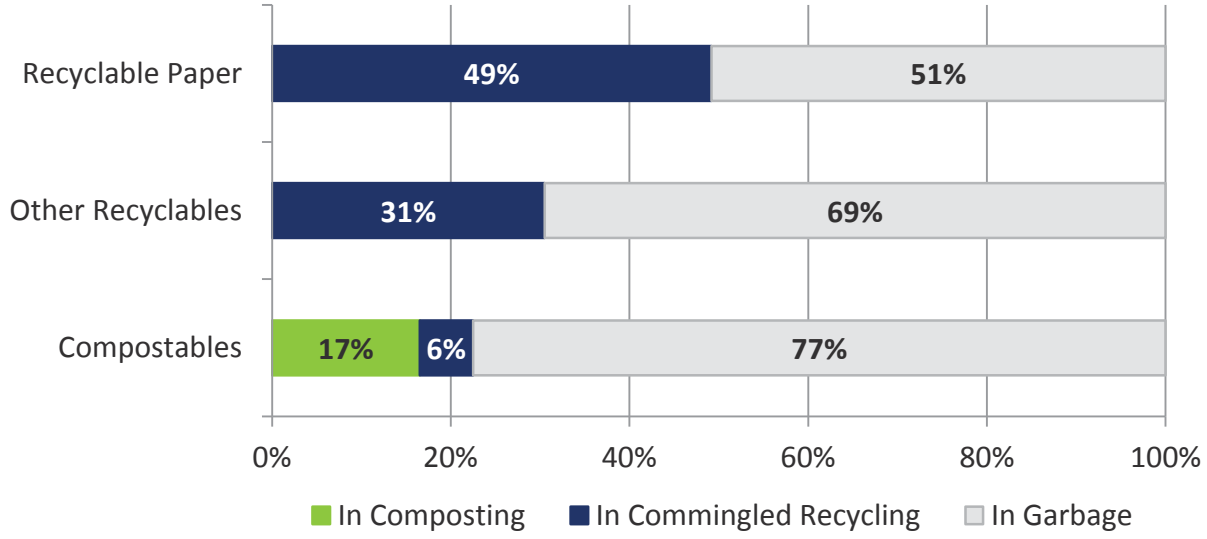
[45] This accounts for over 65 percent of all food disposed at the Airport overall.

Figure 11. Recoverability Composition by Weight, Garbage—Terminal



Capture rates for commingled recycling and compostable materials generated in the Terminal are shown in Figure 12. Again, recyclable paper had the highest capture rate of approximately 49 percent.

Figure 12. Capture Rates for Commingled Recyclables, Terminal



Generator Groups

The figures below show the diversion potential by generator group through the tons of recyclable and compostable materials remaining in the garbage for each of six generator groups (Figure 13) and commingled recyclables capture rates these groups achieved (Figure 14).

Aircraft and Ground Support, Public Areas, and ADR Concessions represent the highest raw tonnages of diversion potential with 2,469 tons of compostable and 1,416 tons of recyclable materials remaining in their garbage. While ADR Concessions achieved the highest capture rate for commingled recyclables (72%), it also accounts for the highest tonnage of compostable material remaining in the garbage (887 tons).

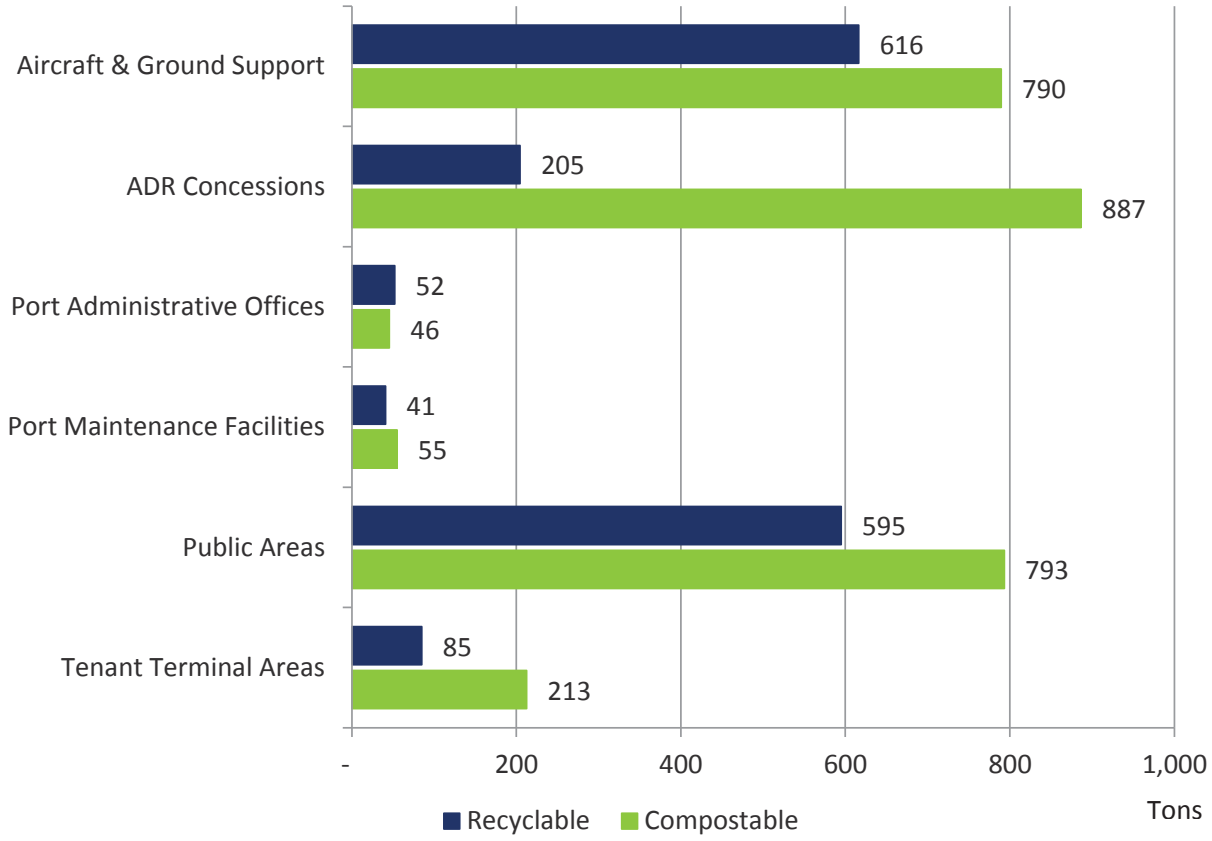
For all generator groups, compostable materials made up the most prevalent recoverability group in disposed garbage, ranging from 30 percent to 65 percent. Food was either the first or second largest material type disposed by all generators. Food-soiled and compostable paper was among the top three materials in the garbage for five of the six generator groups. Other prominent material types found in the garbage included mixed paper; paper bags; restroom paper towels; and non-compostable paper plates, bowls, tubs, and trays.

In commingled recycling, recyclable paper was the largest recoverability group for all generator groups (details presented in *Appendix C*). Commingled recycling contamination rates by generator group ranged from an estimated 6 percent to 65 percent.[46] Contamination estimates were highest for Public Areas (65%), Terminal Tenant Areas (45%), and Port Maintenance Facilities (24%). The remainder of the generator groups had contamination rates of less than 11 percent. Compostable material was the most common commingled recycling contaminant for all generator groups, with food as the largest contributor for five of the six groups.

Detailed charts and tables presenting the composition of garbage and commingled recycling by material type for each generator can be found in *Appendix C*.

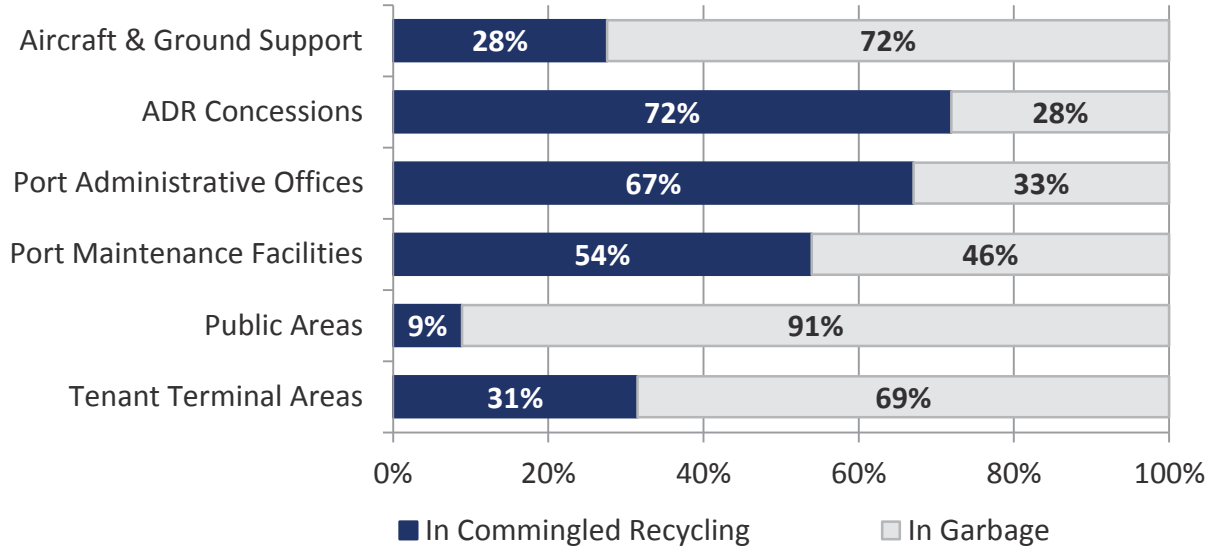
[46] As noted previously, several months after the characterization study, Recology CleanScapes anecdotally observed that the Airport's commingled recycling had relatively little contamination.

Figure 13. Tons of Recyclable and Compostable Materials in Garbage, by Generator Group



ADR Concessions, the Port Administrative Offices, and the Port Maintenance Facilities achieved commingled recycling capture rates greater than 50 percent, as shown in Figure 14. Public Areas had the lowest capture rate (9%). Cascadia staff hypothesize that this capture rate may be so low because passengers have little time to learn the Airport's recycling system, are often in a hurry to reach their flights, and may not read the English-only signs that are currently posted in the Terminal. In addition, while collection containers are generally consistent within each concourse, not all containers follow best practices for standardized colors and signage that identifies the materials that can be recycled. These generator-specific capture rates do not include compostable materials because the composition study did not address material placed in composting containers.

Figure 14. Capture Rates for All Commingled Recyclables by Generator Group



6.4. Construction and Demolition (C&D) Debris

The Airport has very effective C&D debris recycling programs in place. As a result, very few recommended waste reduction and recycling strategies focus on this waste stream beyond continuing existing efforts.

6.4.1. Sources of C&D Debris

C&D debris at the Airport is generated by construction, demolition, and renovation activities conducted primarily by construction contractors hired by the Port or by the Airport's tenants. A small amount of C&D debris is generated by PCS and Port maintenance staff. An unknown amount is generated by tenant-hired contractors. C&D activities range widely from the construction of new buildings and runway improvements to Terminal remodeling and tenant renovations to minor repairs.

6.4.2. C&D Debris Quantities and Composition

The Airport began receiving project data in in mid-2014 as Port-contracted projects were completed. The Airport does not collect data on tenant-contracted projects. The Airport has developed a Construction Waste Management Database to store data from final project reports submitted by Port contractors. The database generates project-specific diversion reports as well as annual summary reports and specific materials diversion reports.

Due to potential variability in diversion rates for different types of projects, all construction projects are categorized into one of three classifications; Airfield, Terminal, or Landside. This allows the Airport to track differences in diversion rates for projects that generate very different types of waste and have different onsite recycling strategies and challenges. For example, Airfield projects mainly involve earth

and pavement work, such as runway reconstruction, that generate large amounts of asphalt, concrete, metal, and soil—which can commonly be reused onsite. Airfield project sites also typically have adequate space for source separation. In contrast, Terminal projects usually consist of building demolition and renovation with minimal space for source separation of C&D debris. Landside projects are typically a mixture of roadwork and construction or demolition of buildings and other structures, with variable challenges to recycling. Evaluating these three types of projects separately allows the Airport to better understand C&D debris management and identify opportunities to improve for each type of project.

In 2014, 12,101 tons of C&D debris were generated from Airport construction projects and Port Construction Services small works projects.[47] Table 27 presents the tonnages and diversion rates by type of project. Overall, projects at the Airport generated 12,101 tons of C&D debris, of which 98 percent was recycled or reused offsite. The largest material generated and diverted was clean soil: 10,465 tons were reused offsite. Concrete was the second largest diverted material: 1,275 tons were recycled off-site. Approximately 117 tons, or 1 percent of C&D debris generated, consisted of mixed C&D debris that was landfilled but could have been recycled or reused.

Table 27. Disposition of C&D Debris Generated (in tons), 2014

Project Type	Recycled/Reused	Landfilled	Total	Diversion Rate
Airfield	1,483	92	**1,575**	94%
Terminal	94	15	**109**	86%
Landside	10,248	101	**10,349**	99%
Port Construction Services	68	0	**68**	100%
Total	**11,893**	**208**	**12,101**	**98%**

Notes: Figures have been rounded to the nearest pound. Port Construction Services (PCS) quantities include only C&D debris placed in the collection container in the PCS construction laydown yard. Additional data for waste generated from PCS projects were not available.

The Airport's 2014 Construction Waste Management Annual Summary Report includes the following data:[48]

- Annual tonnages of C&D debris generated, sent to landfill, and diverted from landfill—by material and project type.
- Percentage of C&D debris generated that was diverted from landfill, by material and project type.
- Composition of C&D debris generated.
- Diversion rates for C&D debris, by reporting project.

[47] This figure does not include C&D debris from the Cargo 2, 5 and 6 upgrades project, which was substantially completed in 2014 but for which data were not available when this SWMP was written.
[48] Port of Seattle, "2014 Construction Waste Management Annual Summary Report," June 2015.

6.5. Hazardous Waste (HW)

The Airport has created and maintained high-performing programs for reducing and managing its hazardous wastes. These programs have been developed in various working group processes and are described in more detail in the Airport's Environmental Strategy Plan.

6.5.1. Sources of Hazardous and Other Industrial Wastes

The primary sources generating hazardous waste from Airport operations include:

- Vehicle and equipment maintenance and cleaning including buses, fleet vehicles, snow removal equipment, satellite transit trains
- Airport Terminal facilities, mechanical systems, and electrical systems (including lighting and conveyor systems and passenger loading bridges)
- Painting including interior structures and Airfield and roadway stripping
- General maintenance of Airfield and off-Airport grounds
- Industrial wastewater treatment plant (IWTP)
- Spill cleanup debris
- Hazardous materials abatement and soil excavation during construction
- Disposal of items confiscated by the Port or abandoned by unknown parties

The general categories of hazardous waste streams generated by the Port are:

- Broken lamps
- Construction waste (lead paint, PCB waste, and universal waste)
- Contaminated used oil
- Flammable liquid from aerosol puncture unit
- Off-specification chemical products (such as non-lead paint, adhesives, and sealants)
- Spent paint solvents
- Spent parts washer—aqueous
- Spent parts washer—solvent
- Security/lost and found abandoned waste
- Spill cleanup debris (antifreeze/gasoline)
- Treatment plant (IWTP) lab waste
- Un-punctured aerosols
- PCB electrical ballasts and bulk product waste

The types of universal and industrial waste generated by the Port and sent for recycling are:

- Non-PCB ballasts and universal waste lamps
- Used oil and oil filters
- Spent antifreeze
- Batteries
- Electronics, appliances, computer monitors, and televisions
- Tires

The types of universal and industrial waste generated by the Port and send for landfill disposal are:

- Non-hazardous paint chips
- Runway rubber
- Industrial sludges from stormwater treatment facilities
- Petroleum contaminated soils
- Grease interceptor waste

6.5.2. Hazardous and Industrial Quantities and Composition

The Port tracks annual hazardous waste volumes at the Airport using the Washington State Turbowaste software. Waste types and quantities generated from individual waste-generating processes are reported in the annual Pollution Prevention Plan. Each month, Port staff weigh all containers holding hazardous waste stored onsite at the Airport to determine monthly waste generation and storage volumes. The Port tracks these monthly waste volumes to verify the Airport's hazardous waste generator status. The Port has been categorized as a medium quantity generator since 2012.[49]

Hazardous waste generation at the Airport has fluctuated over the past ten years, with an overall downward trend over the past twenty years. From 2005 to 2014, the Airport generated a total of 34,891 pounds of hazardous waste, approximately 2 percent of the 1,624,782 pounds generated between 1995 and 2004.[50] In 2009, the Airport generated its smallest amount of hazardous waste ever: 1,599 pounds. In 2014, the Airport generated 2,666 pounds of hazardous waste, as shown in Figure 15. Currently, the two waste streams that compose the majority of hazardous waste generated are parts cleaning waste and unused or off-specification chemical products. As shown in Table 28, the majority of the Airport's hazardous waste is incinerated in an incinerator approved for hazardous waste. The remainder of this waste is either recycled or sent to a hazardous waste landfill.

[49] Businesses that create hazardous waste are called dangerous waste generators and are regulated according to how much and what type of wastes they generate each month and accumulate (temporarily store) onsite at any given time. Detailed definitions of large, medium, and conditionally exempt small quantity generators can be found in Department of Ecology, Dangerous Waste Annual Report: Dangerous Waste Generator Status at www.ecy.wa.gov/programs/hwtr/waste-report/gen_status_table.htm.

[50] Hazardous waste tonnage data provided by Airport Environmental staff.

Figure 15. Annual Pounds of Hazardous Waste Generated, 2005–2014

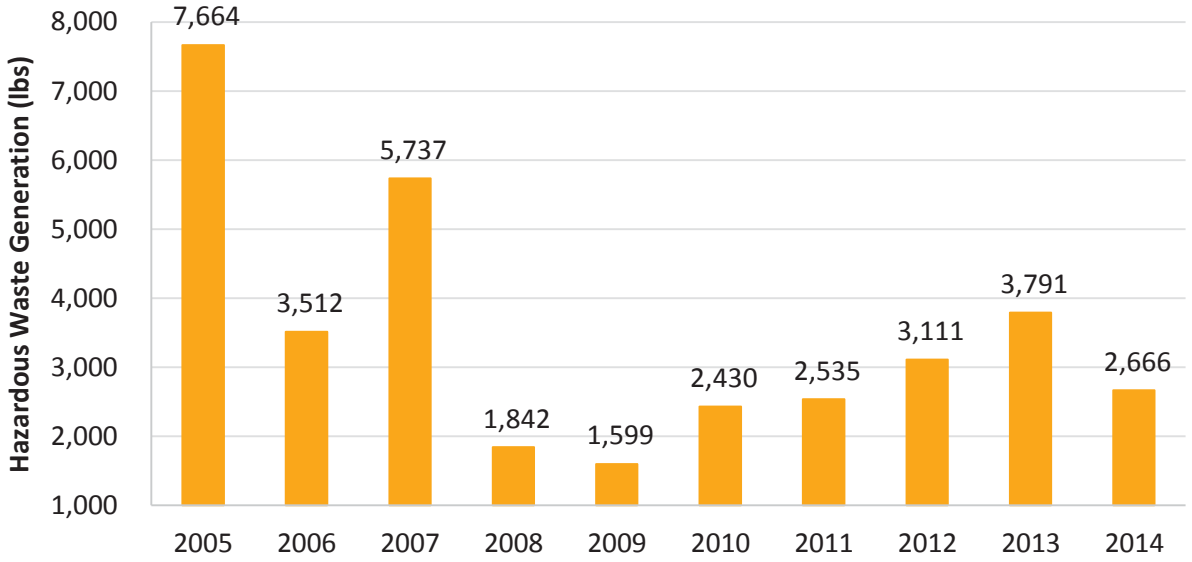


Table 28. Disposition of Hazardous Waste Generated (in pounds), 2010–2014

Year	Incinerated	Recycled	Landfilled	Total
2010	2,430	0	0	**2,430**
2011	2,019	517	0	**2,535**
2012	2,963	148	0	**3,111**
2013	2,787	19	985	**3,791**
2014	2,650	16	0	**2,666**

Note: Figures have been rounded to the nearest pound.

7. Review of Recycling Feasibility

7.1. Objectives

FAA Guidelines require the Airport to assess recycling feasibility in the following areas:

- Materials currently recycled and the costs and savings from recycling
- Regional recycling markets and facilities
- Regulatory and policy context including federal, state, and local policies
- Waste management, reduction, and recycling challenges
- Conflicts between the SWMP and existing Airport plans and programs

The primary goal of this section is to identify any issues that affect the viability or potential expansion of recycling programs at the Airport. Issues identified in this section were incorporated into the qualitative feasibility assessment of each waste reduction and recycling strategy reviewed during the screening analysis and prioritization process that ultimately led to the final recommended strategies in *Section 2 Recommended Waste Reduction and Recycling Strategies*.

Key Findings

- **The Airport continues to experience recycling- and composting-related cost savings, even as programs expand and accept a wider range of basic recyclable and compostable materials**. Recycling at the Airport dates back to 1993, and the quantities and types of materials collected have expanded significantly over the years.
  - In 2013, the Airport recycled 1,232 tons of commingled recyclables, resulting in savings of nearly $180,000 from avoided disposal costs.
  - The Airport diverted 423 tons of compostables, saving more than $15,000 on disposal.
  - Additional diversion included more than 356 tons of scrap metal, scrap wood, cooking oil, and source-separated glass recycling as well as food donations—reducing disposal costs and yielding rebates for high-value materials.
- **Strong recycling markets combined with high landfill tip fees in the region provide strong financial incentives for recycling.**
  - The Puget Sound region enjoys access to more than 40 material recovery facilities and to Asian export markets; these facilities and markets provide options for handling recyclables, though prices vary with economic conditions.
- **The vast majority of federal, state, and local regulations and policies support the Airport's waste reduction and recycling efforts.**
  - The Airport's solid waste management practices must comply with a complex web of policies and regulations at the federal, state, county, and city levels; additional local policies affect the Airport indirectly, such the City of Seattle's requirement that single-use food containers be recyclable or compostable, which increases local availability of such containers for Airport tenants.
- **The SWMP identifies several challenges to improving waste reduction and recycling efforts.**
  - Challenges considered to have the highest importance are as follows: inconsistent sorting by

passengers and tenants, Airport design specifications that limit the use of best practices for waste collection bin signage, lack of consistent in-flight waste separation, and potential for tenant opposition to new requirements.

- These challenges were incorporated into feasibility ratings during the screening analysis and into assumptions regarding participation, efficiency, capture rates, and costs as part of the detailed strategy analysis.

- **Tenant surveys in 2010 and 2014 found strong support for mandatory recycling and moderate support for requiring the use of compostable or recyclable food service ware at the Airport.**

7.2. Airport Recycling Overview, Costs, and Savings

Since 1993, the Airport has recycled most of the basic materials identified by the FAA (aluminum cans, plastic bottles, mixed office paper, and corrugated cardboard) from Terminal waste generators. In 2001, the Airport began collecting an expanded list of commingled recyclables, including plastic cups (the final basic material identified by the FAA). The Airport extended collection of these materials to Airfield waste generators in 2010 by constructing an Airfield trash handling and recycling system.

In 2013, the Airport recycled 1,232 tons of commingled recyclables. This recycling resulted in savings of $178,640 on avoided garbage disposal, based on the average per-ton garbage cost of $145. Composting of 423 tons at $108 per ton generated cost savings of $15,651. The Airport also diverted 356 tons of other materials through recycling of scrap metal, scrap wood, cooking oil, and source-separated glass as well as food donations. This other diversion avoided a garbage disposal cost of $51,620. In addition, scrap metal diversion yielded commodity revenues of $119 per ton on average between 2010 and 2014.

Table 29 presents the per-ton collection and processing costs for disposal, recycling, and composting as well as the savings achieved by recycling and composting. The rate structures for collection and processing for each material stream are described in more detail in *Appendix B*.

Table 29. Per-Ton Collection, Processing, and Disposal Costs

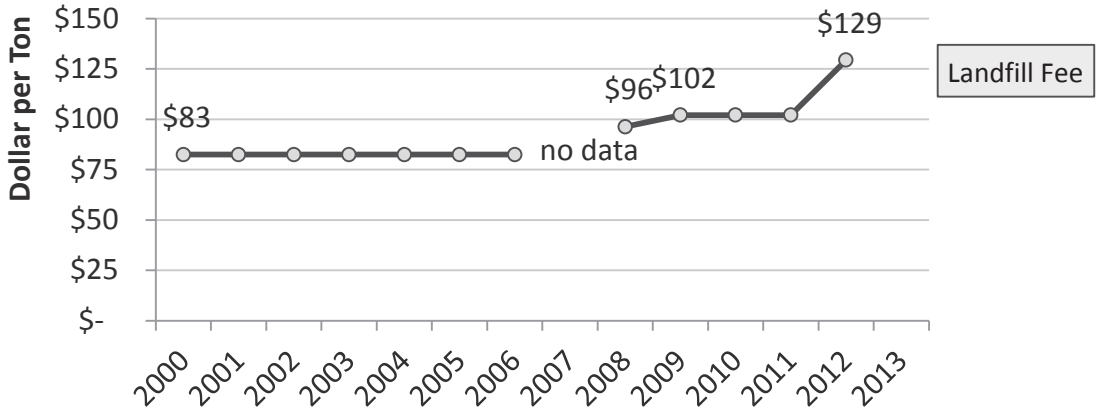
Material Stream	Estimated Average Cost Per Ton	Savings Per Ton Compared to Disposal as Garbage
Garbage	$145	NA
Commingled recycling	$0	$145
Compostables composting	$108	$37
Scrap metal	($119)	$264
Scrap wood	$0	$145
Cooking oil	$0	$145
Source-separated glass	$0	$145
Food donations	$0	$145
C&D debris recycling	$108	$37

Notes: Per-ton costs include all fees for tipping or processing, hauling, and surcharges and taxes. Scrap metal costs represent the average rebate for scrap metal between 2010 and 2014, according to Airport Environmental staff.

7.3. Regional Recycling Markets and Facilities

The Puget Sound region has easy access to recycling markets, relatively high landfill costs, and robust city and county recycling programs. These factors provide strong incentives for reducing waste and increasing recycling and composting at the Airport and throughout the region. In 2012, the landfill tip fee at Cedar Hills Landfill was more than $129 per ton, compared to a national average of $45 per ton.[51] Figure 16 presents tip fees for garbage at Cedar Hills Landfill from 1996 to 2012.[52]

Figure 16. Garbage Tip Fees at Cedar Hills Landfill, 1996 to 2012[53]



Source: Washington Department of Ecology (no date)

Commingled Recycling Markets

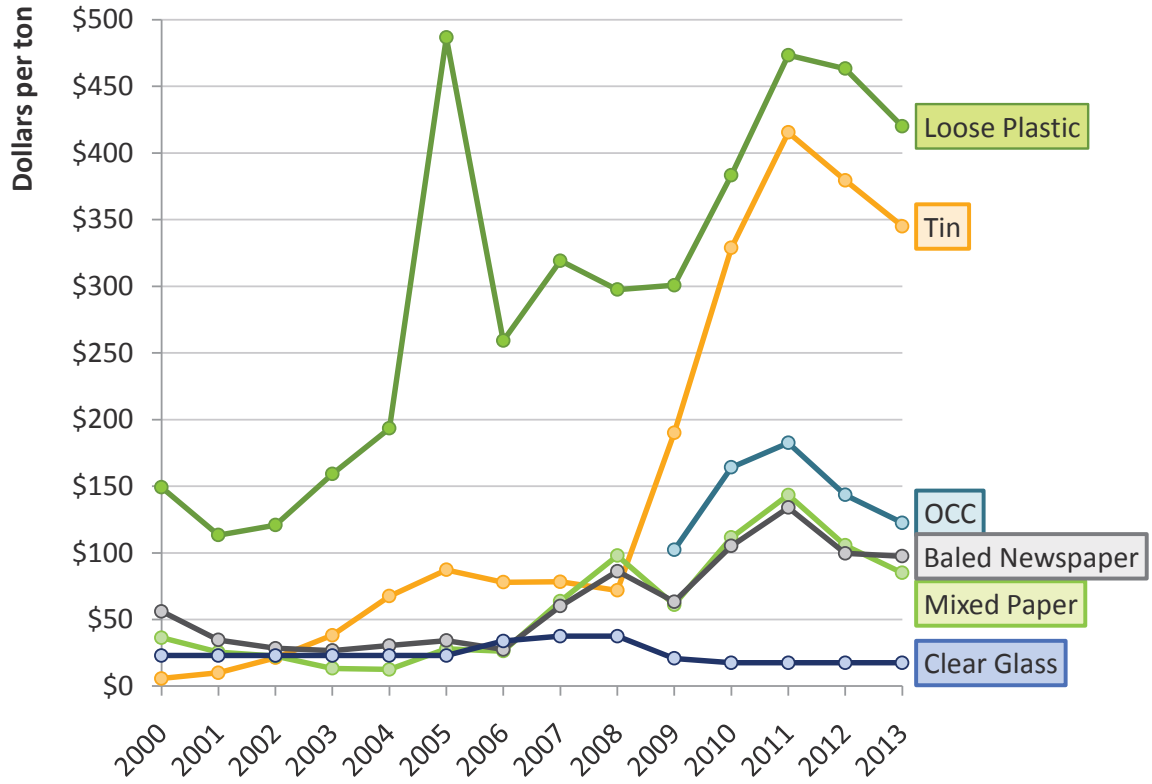
The Puget Sound region has 43 material recovery facilities (nearly 60% of the 72 material recovery facilities in Washington State)[54] and ready access to Asian export markets for recyclables. Recycling commodity markets are available for ferrous and non-ferrous metals, paper, cardboard, many plastics, compostables (including food waste), clean wood, and other C&D debris materials.

Though the price of commodity recycling varies greatly depending on economic conditions, the West Coast generally enjoys strong market demand for paper and plastic containers because of access to

[51] Washington State Department of Ecology, "Tipping Fees for MSW Landfills in Washington State," retrieved March 2015 from http://www.ecy.wa.gov/programs/swfa/solidwastedata/disposal/TippingFees.pdf.
United States Environmental Protection Agency, "Municipal Solid Waste Landfills: Economic Impact Analysis for the Proposed New Subpart to the New Source Performance Standards," Published June 2014, (Table 2-5 Average Regional and National Per-Ton Tip Fees (Rounded): 1995-2012. Page 2-19), retrieved from http://www.epa.gov/airtoxics/landfill/landfills_nsps_proposal_eia.pdf.
[52] Washington State Department of Ecology, "Tipping Fees for MSW Landfills in Washington State," retrieved March 2015 from http://www.ecy.wa.gov/programs/swfa/solidwastedata/disposal/TippingFees.pdf.
[53] Washington State Department of Ecology, "Tipping Fees for MSW Landfills in Washington State," retrieved March 2015 from http://www.ecy.wa.gov/programs/swfa/solidwastedata/disposal/TippingFees.pdf.
[54] Washington State Department of Ecology, Excel Matrix of Solid Waste Facilities by Type, retrieved March 2015 from http://www.ecy.wa.gov/programs/swfa/facilities/

Asian export markets for recyclable materials. Figure 17 and Figure 18 present price trends for common curbside recyclable materials from 2000 to 2013, as tracked by Seattle Public Utilities.[55]

Figure 17. Average Price for Recycled Materials (except aluminum) for Seattle, 2000-2013

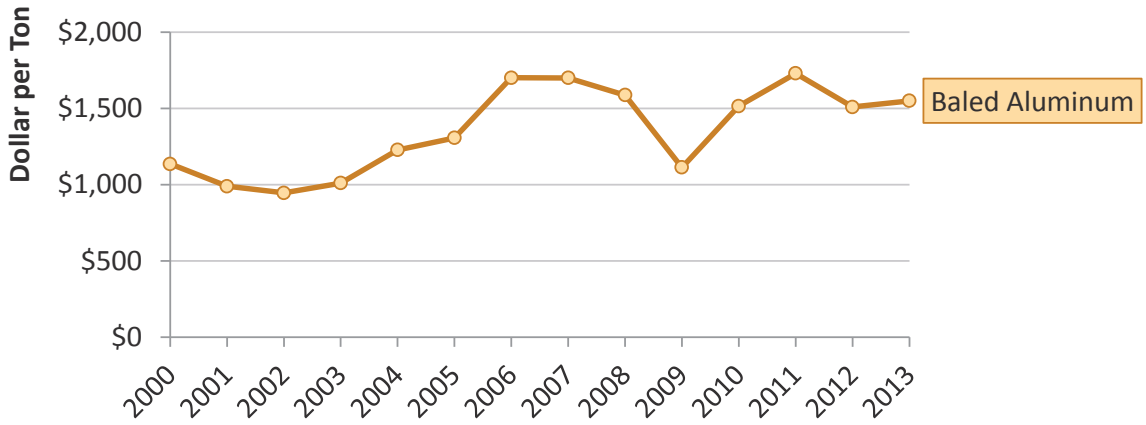


OCC prices not available before 2009.

Source: Seattle Public Utilities, Economic Services (April 2013)

[55] Seattle Public Utilities Economic Services, "SPU Residential Survey Market Prices ($/Ton)," April 2013, retrieved April 2015 from http://www.seattle.gov/Util/Documents/Reports/SolidWasteReports/index.htm.

Figure 18. Average Price for Baled Aluminum for Seattle, 2000-2013



Source: Seattle Public Utilities, Economic Services (April 2013)

Commingled recycling makes up more than three-quarters of the material recycled by the Airport, as shown in *Section 6.3 Municipal Solid Waste (MSW)*. Once sorted at a material recovery facility (MRF), mixed paper and mixed plastics are sent to China for further processing while most other material streams are further processed domestically in the Pacific Northwest, as shown in Table 30. However, market conditions change frequently, which can cause material destinations to shift as MRFs seek the highest commodity prices available. A recent study of recycling markets that Cascadia staff conducted for King County found that paper and glass markets are stable, plastics markets are growing, and metals markets are weak.[56]

Other non-commingled materials recycled by the Airport include compostables, used cooking oil, glass, and scrap metal. These materials are sent to domestic end-markets for recycling or composting within the Pacific Northwest region. Regionally much of the demand for recyclables, particularly for paper and plastics, also comes from export markets in Asia, although detailed regional data are not available.

[56] King County Waste Monitoring Program, "Market Assessment for Recyclable Materials," prepared by Cascadia Consulting Group, February 2015, retrieved May 2015 from http://your.kingcounty.gov/solidwaste/about/waste_documents.asp.

Table 30. End-Market Destinations of Airport Commingled Recyclables

Recycled Material	Domestic Processing	Domestic Destination	Foreign Processing	Foreign Destination
OCC (old corrugated cardboard)	75%	Toledo, Oregon	25%	Mainland China
Mixed Paper	0%	-	100%	Mainland China
ONP (old newspaper)	100%	Newberg, Oregon	0%	-
PET Bottles	100%*	Portland, Oregon	0%	-
HDPE Bottles	100%	Northern California	0%	-
Plastics (#3–#7)	0%	-	100%**	Mainland China
UBC (used aluminum beverage containers)	100%	California	0%	-
Tin	100%	Oregon and/or California	0%	-
Scrap metal	100%	Seattle, Washington	0%	-

Notes: Figures fluctuate with market conditions and are snapshot estimates that may change; all domestic shipments by truck/trailer combination; export shipments drayed to POS and shipped via container; occasional intermodal ship via rail (courtesy of Recology CleanScapes, December 2014).
** Based on recycled product quality; ** Likely final destination per Recology-CleanScapes*

Until recently, export markets tolerated some level of contamination (such as plastics with food residue) and commingling of materials within a material class (such as mixed #3-#7 plastics). In 2013, China conducted Operation Green Fence, which strictly enforced rules on the amount of contamination and commingling allowed in imported bales of recyclable materials and, as a result, reduced importation of recyclable materials. Material recovery facilities faced weaker markets with lower commodities prices and, in some cases, were forced to stockpile materials until they could find a buyer. While the trend toward recycling more materials commingled has increased convenience for many residential and commercial generators, including Airport tenants and passengers, Operation Green Fence's significant negative effects on recycling markets indicates the need for the waste industry to balance user convenience with cleaner end-market materials.

In 2013, Airport Environmental staff researched the environmental benefits of recycling and the environmental impacts of transporting recyclable materials to export markets. They used the EPA's Waste Reduction Model (WARM) to estimate that the Airport's recycling efforts in 2013 avoided emissions amounting to more than 3,000 metric tons of carbon dioxide equivalent (MTCO2e). According to the Airport Environmental staff's email exchanges with EPA staff, these greenhouse gas benefits are likely overestimated because WARM does not include emissions from overseas shipping of recyclables to end-markets due to data reliability issues. Airport Environmental staff found no readily available literature that specifically addressed the environmental impacts of transporting recyclable materials from Seattle to export markets. Similarly, life cycle assessment (LCA) documents reviewed did not explicitly describe how they addressed impacts of long-distance foreign transport. Airport Environmental staff conservatively estimated that one-third of carbon emission reductions resulting from recycling would be offset by carbon emissions generated during the long-distance transport of

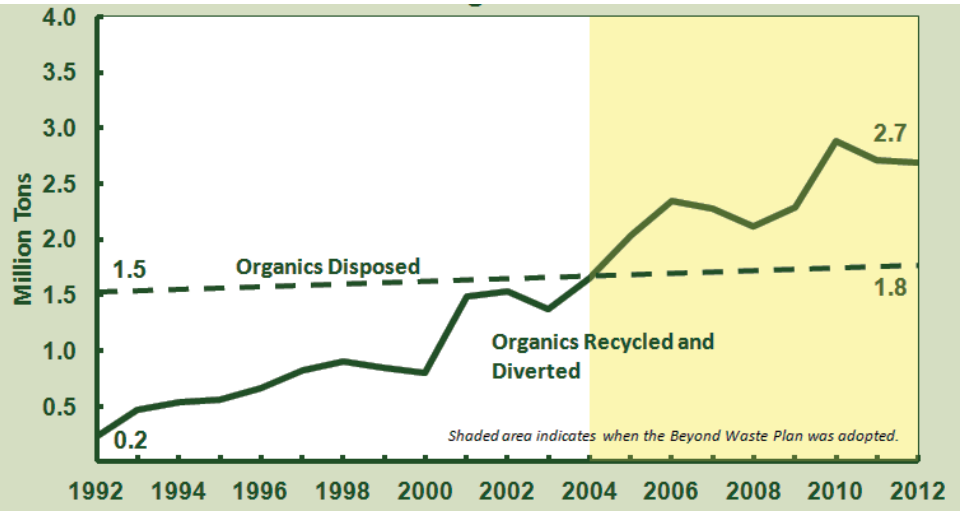
Airport recyclables to export markets, based on a European study on transporting recyclables from the United Kingdom to China.[57]

Despite data limitations, the Airport Environmental staff's research indicated that the impacts of transporting recyclables to export markets are relatively small compared to upstream savings achieved when virgin feedstock is replaced with recycled material in the product manufacturing stage.[58] This relationship between recycled content feedstock and environmental savings illustrates the importance of environmental preferable purchasing. Additional research into this subject would provide the Airport's managers with actionable information to assist in near- and long-term material management and planning decisions.

Composting and Other Recycling Markets

In recent years, the Puget Sound region has also seen growth in markets for composting, construction and demolition material recovery, and used cooking oil recovery for biofuels. Figure 19 shows a sharp increase in the amount of organic materials recycled and diverted (solid line) versus disposed (dotted line) in Washington State over the past 20 years. Currently more organic material is being recycled and diverted than is being disposed of in landfills. The Airport has taken advantage organics markets, most notably compostable waste composting and used cooking oil recycling.

Figure 19. Organic Materials Recycled, Diverted, and Disposed in Washington, 1992-2012[59]



Source: Washington State Department of Ecology

[57] Waste & Resources Action Programme (WRAP), "CO2 Impacts of Transporting the UK's Recovered Paper and Plastic Bottles to China," August 2008.

[58] Morris, J. (2004). Comparative LCS's for Curbside Recycling Versus Either Landfilling or Incineration with Energy Recovery. *InLCA*, 12.
Morris J. (1996). Recycling versus incineration: an energy conservation analysis. Journal of Hazardous Materials, 47.

[59] Department of Ecology, "Increasing Recycling for Organic Materials," retrieved September 2014 from http://www.ecy.wa.gov/beyondwaste/bwprogOrganics.html.

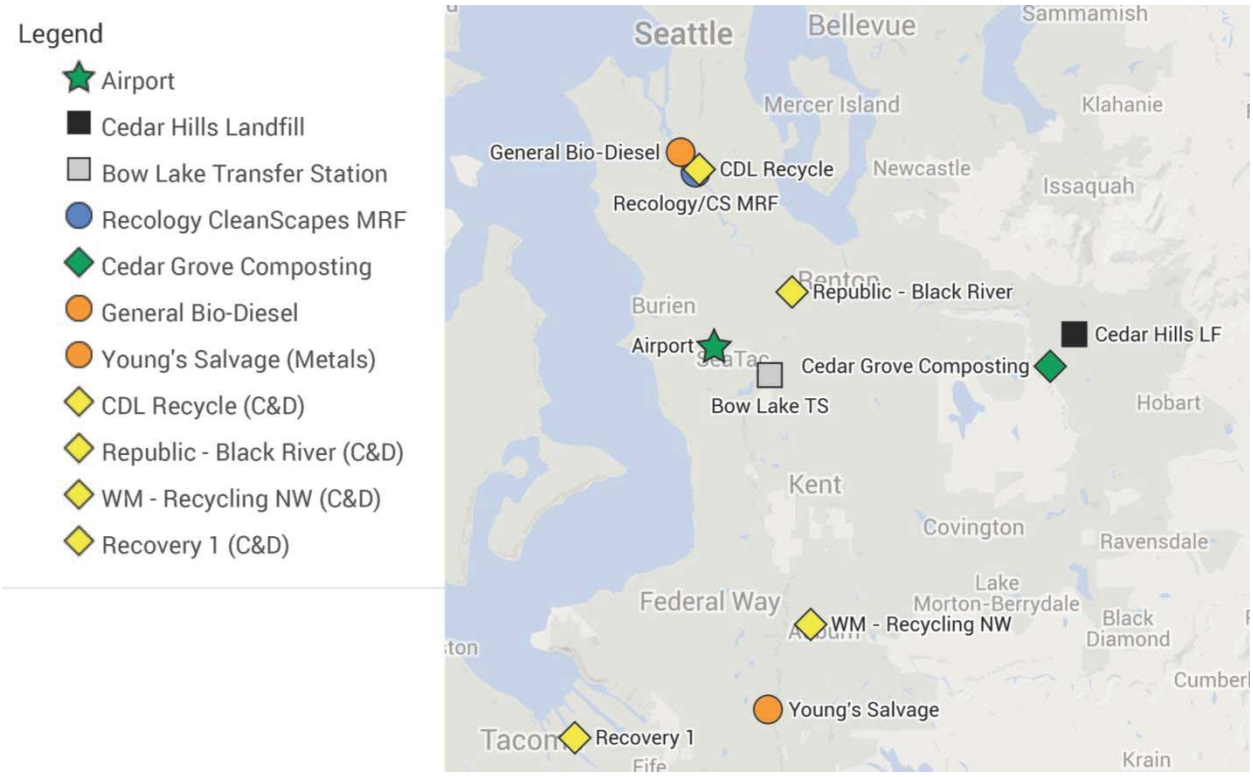
Regional Waste Management Facilities

Garbage from the Airport is sent through the Bow Lake transfer station to the local Cedar Hills Landfill. The 920-acre landfill is located in Maple Valley and currently receives over 800,000 tons of waste a year, but landfill space is becoming less available. In 2010, King County approved a redevelopment plan for the Cedar Hills Landfill that will provide additional landfill capacity through 2024. Cedar Hills is the only landfill still open in King County.

Fortunately, the Puget Sound region contains many recycling, composting, and other processing facilities. Figure 20 shows the location of regional MSW and C&D Debris facilities that currently receive Airport waste. Vendors accepting hazardous, universal, industrial, other unusual waste from the Airport are listed in *Appendix B* but are not included on the map.

Other material recovery facilities (MRFs) for commingled recyclables and material-specific recyclers (for example, recyclers for scrap metal and expanded polystyrene foam used for non-food packaging) are available in the Puget Sound region. King County maintains an online, searchable database of companies and facilities that collect and process a wide variety of diverted materials at http://your.kingcounty.gov/solidwaste/wdidw.

Figure 20. MSW and C&D Debris Facilities Receiving Airport Waste



Note: The Airport sends Port-managed C&D debris to CDL Recycle. Other C&D recycling facilities on the map represent additional facilities that Port construction contractors may use.

7.4. Regulatory and Policy Context

The Airport operates within federal, state, and local regulations and policies on solid waste management. Except for United States Department of Agriculture (USDA) International Waste Handling Requirements, these regulations and policies generally support (or do not hinder) waste reduction and recycling by the Airport. The Plant and Health Inspection Service requires special handling of garbage from international flights that contains or has been associated with fruits, vegetables, meats, or other plants or animals (including poultry).[60] To prevent the spread of agricultural diseases, this international waste must be sterilized, incinerated, or disposed in an approved sewage system. This regulation limits the Airport's ability to increase recycling of regulated international waste.

Appendix B briefly lists relevant laws, rules, and policies that affect the Airport.

7.5. Waste Management, Reduction, and Recycling Challenges

The Airport has a successful record of waste diversion. Since 1993, the Airport has recycled most of the basic materials identified by the FAA (aluminum cans, plastic bottles, mixed office paper, and corrugated cardboard) from Terminal waste generators. In 2001, the Airport began collecting an expanded list of commingled materials, including plastic cups (the final basic material identified by the FAA). The Airport extended collection of these materials to Airfield waste generators in 2010.

Despite these successes, the Airport faces significant challenges to further reducing waste and increasing recycling at the Airport. Cascadia and Airport Environmental staff developed and assigned importance to the list of challenges presented in Table 31 based on consultant and Airport Environmental staff expertise, surveys of Airport tenants, interviews with external stakeholders, and research on best management practices for airport recycling.

Cascadia and Airport Environmental staff considered and addressed challenges during each phase of the SWMP development process according to their importance and relevance to each strategy. During strategy identification and development, proposed strategies were combined with supporting actions to address applicable challenges to the greatest extent practicable. During the strategy screening analysis, Cascadia and Airport Environmental staff considered applicable challenges and assigned appropriate qualitative feasibility and cost ratings to each strategy. During detailed analysis of selected strategies, key challenges (identified as having high importance) were incorporated into the assumptions used to estimate costs and select appropriate participation and efficiency rates or capture rates for estimating diversion potential.

[60] U.S. Government Printing Office, "Federal Code of Regulations, Title 7, Chapter 3, Part 330.400," retrieved 2014 from http://edocket.access.gpo.gov/cfr_2006/janqtr/pdf/7cfr330.400.pdf.

Table 31. Waste Management, Reduction, and Recycling Challenges

Challenge	Importance and Actions Taken to Address in SWMP
Passengers and tenants are generally inconsistent and ineffective at source-separating waste from recoverable materials.	**Importance: High** Incorporated recycling industry best practices for signage, labeling, and bin configuration to improve participant sorting effectiveness and minimize contamination in applicable strategies. Developed strategies to simplify passenger and tenant sorting. Included outreach and education, as well as enforcement and monitoring support to improve participant sorting effectiveness in applicable strategies. Included secondary waste sorting and mixed waste processing strategies to complement source-separation strategies.
Airport design specifications may still limit the ability to modify and upgrade signage on public garbage, recycling, and composting bins to include prominent color-coding and lists or images of materials accepted in bins.	**Importance: High** Public Areas represent the largest tonnages of recyclable/compostable materials currently disposed of as garbage in the Terminal, and Public Area diversion is limited primarily by lack of separation by passengers. Without secondary sorting, bin signage is the primary way to influence passenger sorting and is (therefore) the most important strategy for this area after co-location of bins. Considered and addressed primarily during strategy identification and development and reflected in initial screening ratings for each strategy. Recommended Airport conduct additional research on signage best practices to document justifications for changing Port-design specification.
A lack of consistent in-flight waste separation and recycling by airlines and ground service crews hampers Airfield recycling success.	**Importance: High** Acknowledged Airport's lack of control and limited influence by assigning low feasibility ratings to strategies during initial screening, directly attempting to increase commercial airline separation and recycling of in-flight waste. Also, assigned medium to high feasibility ratings to strategies that promote recycling in-flight waste from commercial aircraft or extend Airport recycling opportunities to Airfield and recycling at Air Cargo facilities, which do not rely on in-flight source separation.

Challenge	Importance and Actions Taken to Address in SWMP
Tenants are typically oppose new requirements, although the tenant surveys in 2010 and 2014 found strong support for mandatory recycling and moderate support for mandatory use of compostable or recyclable food service ware.	**Importance: High** Interpreted mixed information on tenant opposition as moderate and assigned medium level feasibility ratings to related strategies during initial screening analysis. Emphasized continuation and expansion of education, outreach, and technical assistance strategies to foster tenant support and promote compliance with recommended requirements. Incorporated appropriate levels of education, enforcement, and monitoring into assumptions used to estimate costs for applicable strategies during detailed analysis. Anticipate ongoing coordination with applicable Port departments (e.g., Airport Dining and Retail, Properties) to develop appropriate implementation strategies for recommended requirements. Anticipate timing changes with new tenant lease agreements to allow tenants to incorporate impacts into cost proposals.
Space constraints at existing Terminal loading docks and in BOH Concessionaire spaces limit the addition of recycling and composting bins and containers.	**Importance: Medium** Considered and addressed primarily during strategy identification and development process. Also reflected in initial screening feasibility ratings for each strategy.
Existing Airport geographical constraints and operational demands limit opportunities to scale waste handling infrastructure in order to meet growing demand.	**Importance: Medium** Considered and addressed primarily during strategy identification and development and reflected in initial screening ratings for each strategy. Developed recommended growth projection methodology to help Airport project expected growth of waste volumes and needed infrastructure in future Airport renovation and construction projects.
Lack of regional mixed waste processing capacity to conduct secondary sorting that could capture recyclable and compostable materials placed in garbage bins.	**Importance: Medium** Explored mixed waste processing potential with external stakeholders interviewed for the SWMP. Recommended mixed waste processing of garbage, contingent on a third party developing such processing capacity in the region.
Limited space within work area of Terminal construction projects to store and separate C&D debris.	**Importance: Medium** Considered and addressed primarily during strategy identification and development and reflected in initial screening ratings for each strategy.
Lack of control over waste generated at tenant-managed facilities, such as flight kitchens and air cargo.	**Importance: Low** Acknowledged Airport's lack of control and limited influence by assigning low or medium feasibility ratings during initial screening to voluntary strategies directly attempting to increase recycling and composting at tenant-managed facilities. Recommended expanding control over waste generated at tenant-managed areas.

Challenge	Importance and Actions Taken to Address in SWMP
Airport waste material composition is influenced by pre-packaged and other products beyond the control and influence of the Airport or its tenants.	**Importance: Low** Most other jurisdictions face this challenge, and several (such as Seattle) have overcome it. Moreover, 75% of Terminal garbage could be recycled or composted through existing Airport programs, indicating that sorting (rather than waste composition) is the limiting factor. Acknowledged Airport's lack of control and influence in this area by omitting these materials from food-service ware strategies. Maintained separate recycling, compost, and garbage streams in collection strategies to minimize potential contamination.
Flight kitchens and air cargo tenants reported that their challenges to recycling more include a lack of support for recycling from their airlines and clients as well as USDA international waste handling regulations.	**Importance: Low** Considered and addressed primarily during strategy identification and development and reflected in initial screening ratings for each strategy.

7.6. SWMP Conflicts with Existing Plans and Programs

Key Airport stakeholders responsible for other related plans and programs reviewed the SWMP and did not identify any conflicts with existing Airport plans or programs.

Appendices

Appendix A: Cross-Reference to Federal Aviation Administration Guidelines

Appendix B: Supporting Documentation

Appendix C: Airport Waste Characterization Report

Appendix D: Growth Modeling Methodology Guidelines

Appendix E: Airport Best Practices Literature Review

Appendix F: Airport Best Practices Interviews Report

Appendix G:Cardboard Management Research Report

Appendix H:Checkpoint Liquid Container Management Research Report

Appendix I: Loading Dock Research Report

Appendix J: Tenant, Flight Kitchen, and Air Cargo Surveys Report

Appendix K: External Stakeholder Interviews Report

Appendix L: Screening-Level Strategies Analysis

Appendix M: Detailed Strategies Analysis

Seattle-Tacoma International Airport Solid Waste Growth Forecast and Capacity Analysis 2016–2034

FINAL REPORT: November 11, 2016

Prepared by
Cascadia Consulting Group, Inc.

CASCADIA
CONSULTING GROUP

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1. Introduction

To prepare for future waste handling infrastructure needs and investments, Seattle-Tacoma International Airport (Airport) commissioned Cascadia Consulting Group (Cascadia) to conduct a study to forecast growth in municipal solid waste volumes through 2034, forecast collection costs, analyze waste system capacity, and assess strategies to overcome capacity constraints. Based on the results of this study, Cascadia developed recommendations and a schedule for implementing strategies to grow infrastructure capacity over time. Note that proposed changes to grow Airport infrastructure capacity are planning-level recommendations only; the Airport should conduct feasibility studies before implementation. Definitions of key terms are presented in Appendix A. Appendix B describes the study methodology.

2. Top Recommendations

Key findings and recommendations regarding future quantities, capacity issues, and costs represent forecasts based on modeling using best estimates regarding key assumptions and are subject to uncertainty limitations described throughout this report, particularly in Section 5.1.1. Key Assumptions and Uncertainties. All recommendations require additional feasibility analysis by the Airport before implementing.

In 2018, forecasted composting quantities will exceed collection system maximum capacity and require a system change to expand capacity at Central Terminal – South (CT-South) and Central Terminal – North (CT-North). This surge is due to new composting and food service ware requirements in tenant leases combined with substantial passenger growth and Airport Dining and Retail (ADR) tenant expansion.

To respond to this surge in composting volumes, Cascadia recommends two key actions:

- **As a temporary, immediate strategy to expand composting collection capacity, (a) convert the recycling compactor at CT-South to collect composting from CT-South and CT-North and (b) collect all CT-South recycling at the CT-North compactor.**
  - Tenants and the janitorial contractor would need to shift waste between the two collection points.
- **As soon as possible and to create a long-term solution, make infrastructure changes to construct space for an additional compactor each at CT-South and CT-North** so that each collection point has three compactors: one each for garbage, commingled recycling, and composting.
- **In addition, conduct a detailed feasibility study process regarding using dehydrators and liquefiers to reduce the volume of composting collected as an alternative long-term solution.**

All other forecasted capacity limitations can be addressed with increasing collection frequency or container size.

3. Key Findings

3.1.1. Growth Forecast

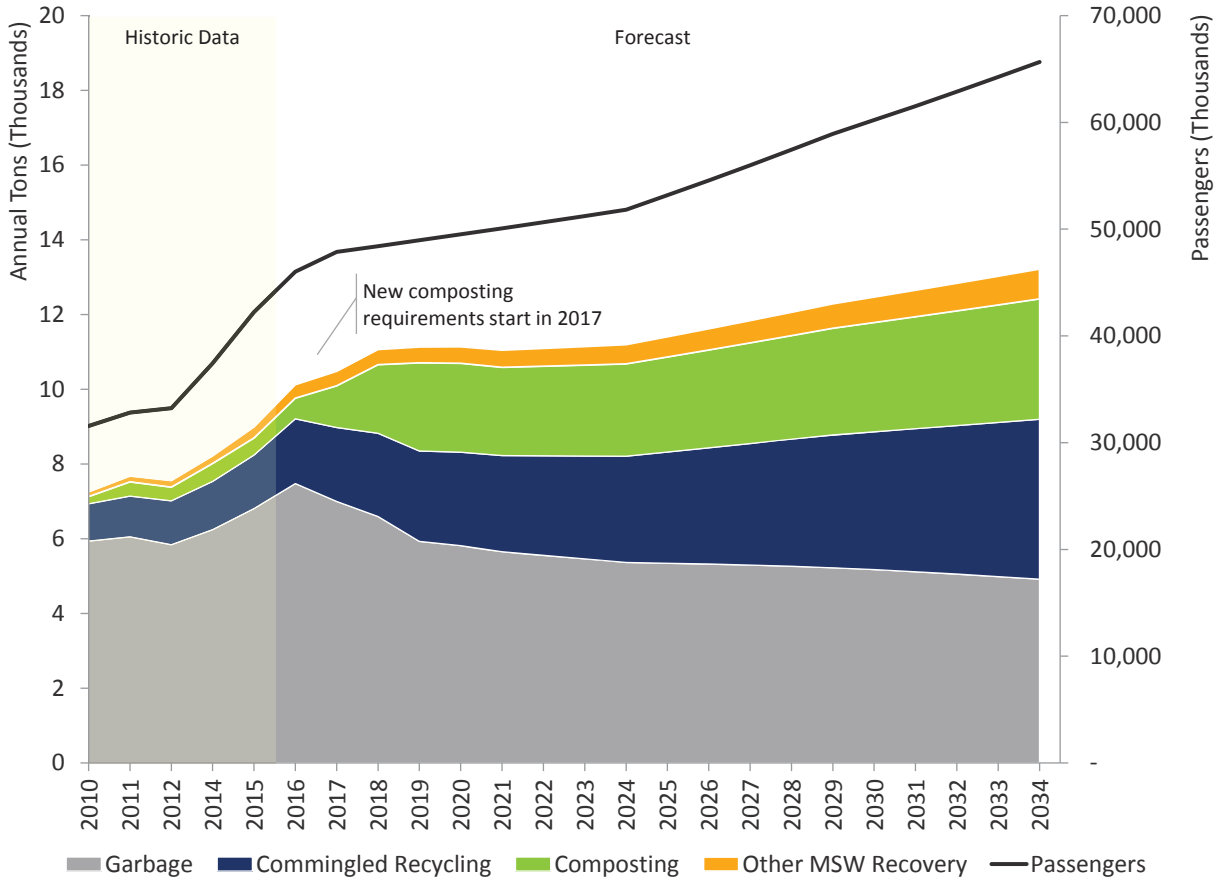
- **Forecasted waste quantities increase nearly as fast as passengers increase.**
  - By 2034, total waste volumes are projected to increase by nearly 50% compared to 2015 (see Table 1 and Figure 1).
- **Composting tonnages are expected to surge starting in 2017—eventually quintupling by 2019—due primarily to new composting and compostable food service ware requirements in tenant leases.**
  - By 2034, forecasted composting amounts will increase by more than 600% compared to 2015.
- **Airport waste diversion efforts are projected to lower both the percentage and tons of disposed garbage.**
  - By 2034, forecasted garbage will decrease by nearly 30% compared to 2015.

Table 1. Change in projected waste 2015–2034

Waste Stream	Tons in 2015	Tons in 2034	Change 2015–2034
Composting	457	3,221	+604%
Commingled recycling	1,433	4,279	+199%
Garbage	6,806	4,918	-28%
Other diverted MSW*	361	799	+168%
Total waste	8,994	13,217	+47%

* Other diverted MSW (municipal solid waste) includes material such as scrap metal, used cooking oil, and wood.

Figure 1. Aggregate Airport Passenger and Waste Forecast



Key Growth Assumptions and Uncertainty

In recent years, actual passenger counts—the biggest factor affecting waste quantities—have significantly exceeded forecasted passenger counts. This analysis uses the most recent passenger forecasts developed by the Airport; however, if future actual passenger counts exceed current forecasts, the study results may underestimate future waste quantities.

Based on historic Airport trends, Cascadia assumes that annual waste tonnage per passenger will decrease by about 10% between 2015 and 2034. If waste per passenger does not continue to decrease, study results may underestimate future quantities.

Similarly, composting may not increase as much as forecasted if ADR concessionaires use more recyclable and less compostable food service ware than modeled in the 2014 Solid Waste Management Plan (SWMP). Composting and recycling may not increase as rapidly if tenants implement lease requirements to compost and recycle more slowly than the Airport expects.

Utility Costs

By 2034, forecasted Airport waste collection costs will increase by approximately 50% to more than $2 million, mainly due to the Airport's assumption based on historic trends that per-ton fees will increase by 3% each year. If fees were held constant, forecasted Airport collection costs would instead *decrease* by more than 10% because of the relative shift away from higher-cost garbage and toward lower-cost composting and free recycling services. Costs vary by a few percentage points depending on whether composting is collected loose in dumpsters or in compactors in the future.

3.1.2. Capacity Analysis

- **Two collection points (CT-South and CT-North) are forecasted to require system changes, such as transferring waste between collection points and making capital improvements to the collection systems.**
  - Composting at these two collection points represents the biggest capacity challenge, requiring system changes by 2018.
  - The CT-South and CT-North collection points currently account for 73% of the Airport's total composting collection.

Waste projections and capacity thresholds in cubic yards per week for garbage, commingled recycling, and composting are presented in Figure 2 and Figure 3, below on pages 8 and 9. Capacity is typically measured in weekly rather than monthly quantities because collection schedules are typically weekly and months vary in length.

- **Between 2017 and 2034, 17 out of 24 collection points are forecasted to exceed their existing capacity in composting, recycling, or both waste streams**:
  - **8 collection points in composting**
    - **2 points require system changes** (CT-South and CT North), described above.
    - **5 points require larger containers** (Concourse A Load Dock, N-9/N-10, Service Tunnel, S-6 in the Terminal as well as the remote site at C-10).
    - **1 point requires only increased collection frequency** (Fire Station).
  - **16 collection points in recycling**
    - All recycling capacity limitations can be addressed by increasing collection frequency.
  - **No collection points in garbage**.

Forecasted rapid growth in composting volumes combined with limited space for additional composting collection infrastructure requires facility enhancements or expansion within the next two years to accommodate anticipated growth and existing waste diversion objectives. Composting poses capacity challenges for two main reasons. First, composting quantities are projected to quintuple by 2019 as the Airport implements diversion strategies from the 2014 Solid Waste Management Plan and

expands space for food and beverage concessionaires, both of which are forecasted to shift tonnages away from garbage disposal and toward composting as well as toward commingled recycling. Second, composting collection infrastructure is currently limited to smaller, low-volume dumpsters, whereas garbage and commingled recycling are frequently collected in larger, high-volume compactors.

Table 2 on page 10 summarizes the tonnages for each waste stream that each collection point is forecasted to generate in 2034 along with the years in which enlarged containers or system changes are required to accommodate forecasted growth. The Detailed Findings section presents a full list of collection points for composting (Table 6), commingled recycling (Table 7), and garbage (Table 8) along with projected dates to increase collection frequency, enlarge containers, and make system changes.

Figure 2. Waste Forecast and Capacity Analysis for CT-South (cubic yards per week)

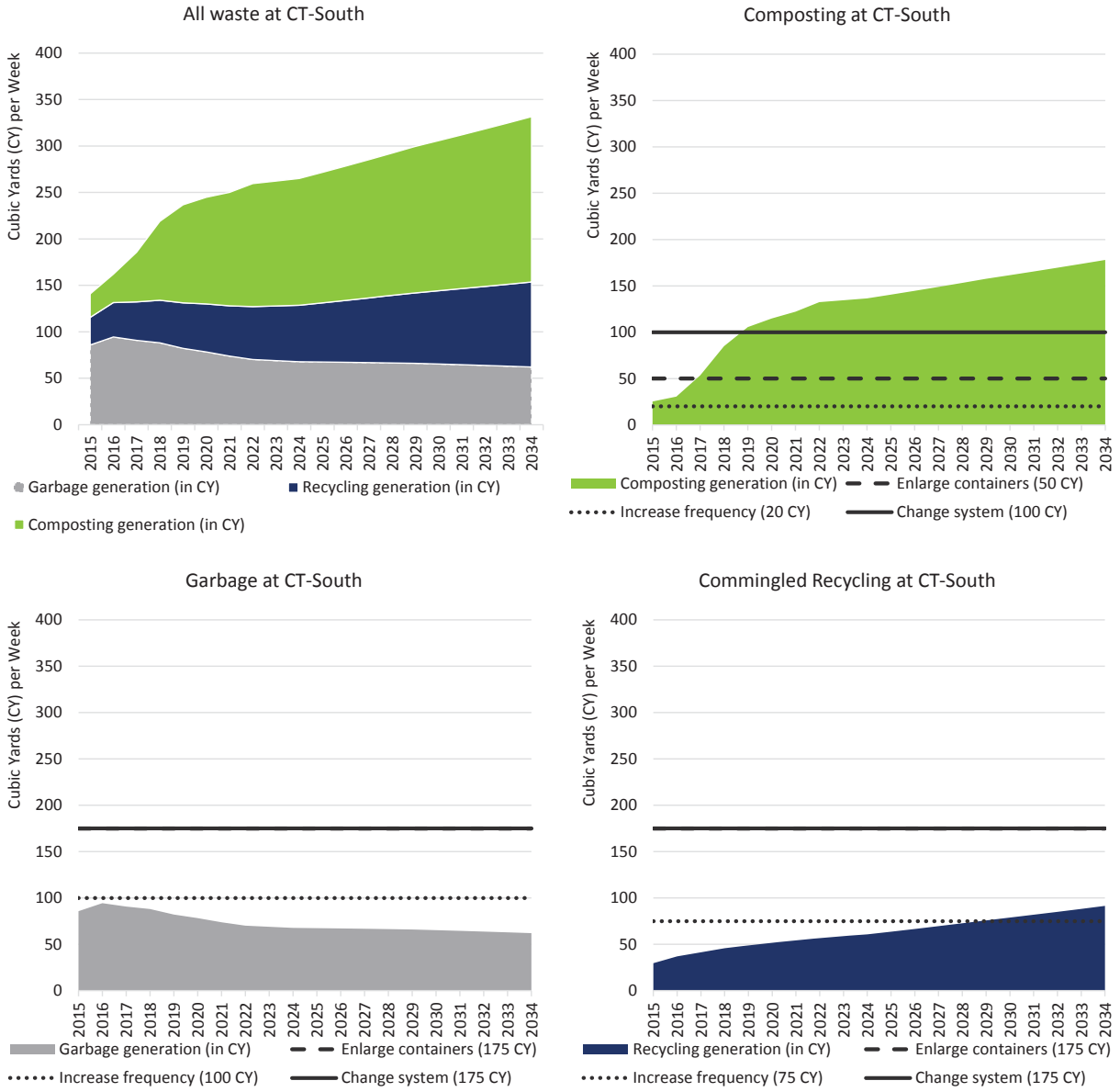


Figure 3. Waste Forecast and Capacity Analysis for CT-North (cubic yards per week)

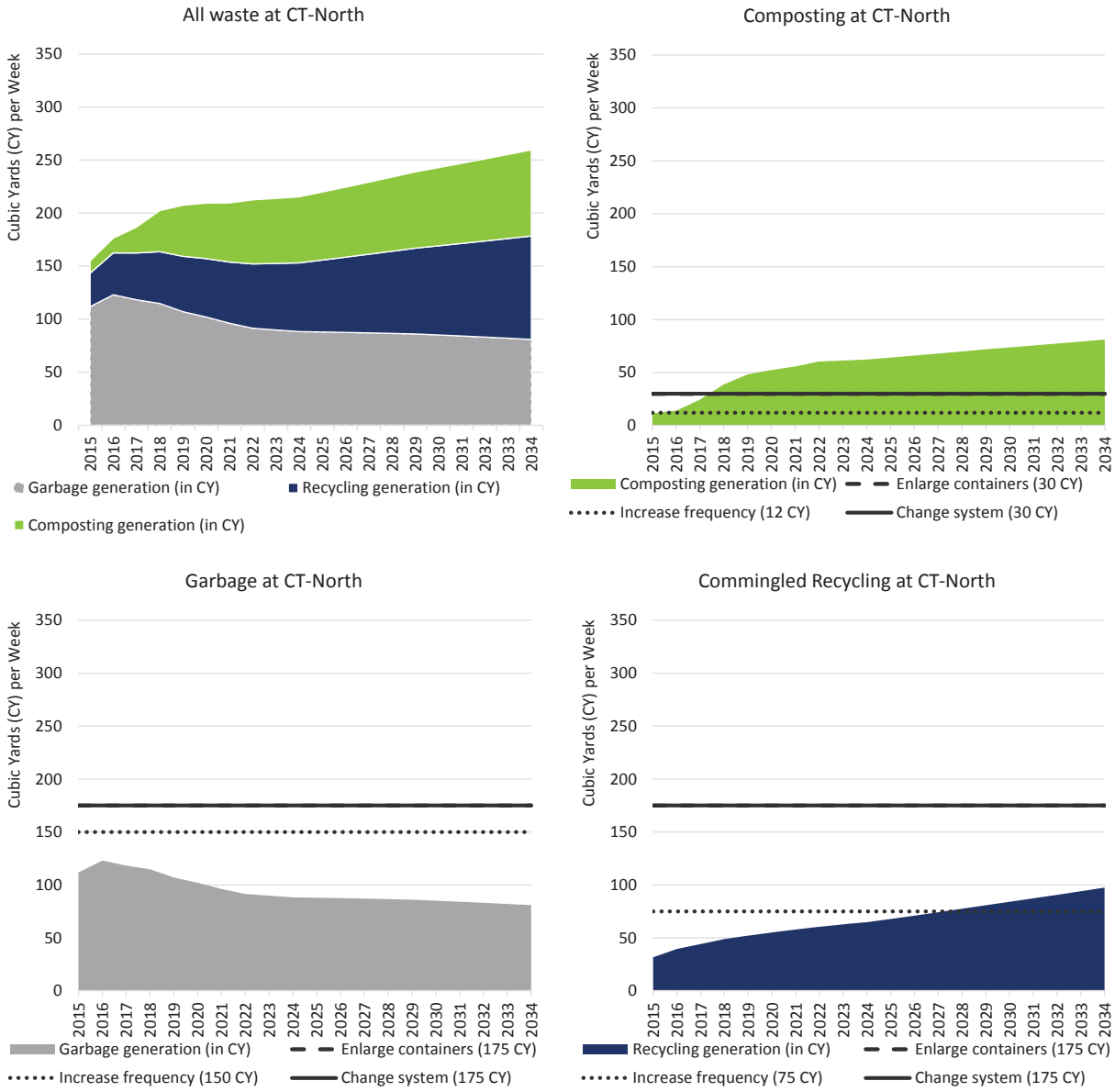


Table 2. Forecasted Tonnages in 2034 by Sector, Collection Point, and Waste Stream

Sector	Collection Point	Garbage	Recycling	Composting
Terminal	Concourse A Load Dock	261	320	73 ***
	CT-North	864	931	739 ** ‡
	CT-South	664	874	1,620 * §
	N-9/N-10	358	176	211 †
	Service Tunnel	631	745	350 *
	S-6	311	417	152 ***
Terminal Subtotal		**3,089**	**3,463**	**3,145**
Airfield	A-10	136	50	--
	B-6	461	141	--
	C-3	131	46	--
	D-11	448	381	--
	N-6	21	--	--
	S-16	490	62	--
Airfield Subtotal		**1,686**	**679**	
Remote Sites	Air Cargo 4 - East Building	5	4	--
	Autoshop at Air Cargo 4	31	14	--
	AV/M DC	4	5	--
	Bus Maintenance Facility	17	31	--
	C-10	--	--	52 †
	Fire Station	5	21	24
	Learning Center	4	7	--
	Snow Shed	55	--	--
	Taxi Stand	14	11	--
Remote Sites Subtotal		**134**	**93**	
CIP Construction	CPO Logistics	4	15	--
	Water Tower	2	10	--
	Westside Office Building	3	20	--
CIP Construction Subtotal		**9**	**44**	

Cells are color-coded by whether they will require the following changes before 2034:

-- Increased collection frequency

-- Enlarged containers

-- System changes

*by 2017 **by 2018 ***by 2020 †by 2029 ‡by 2018 §by 2019

Note: Due to rounding, subtotals may differ slightly from the sum of individual collection points.

3.1.3. Strategies and Recommendations to Expand Capacity

Cascadia analyzed several strategies to expand waste collection system capacity at the Airport. In addition to increasing collection frequency and enlarging collection containers, Cascadia considered several system changes, including shifting waste between collection points, making capital improvements to create space for replacing dumpsters with compactors, and using new collection and storage technology.

Cascadia makes the following recommendations to address capacity issues:

- **The Airport should consider a short-term solution to expand composting capacity in 2017:**
  - **Convert the recycling compactor at CT-South to collect composting from CT-South and CT-North.** The Airport may need to continue using dumpsters to hold excess composting starting in 2019
  - **Collect all CT-South recycling at the CT-North compactor.** This compactor may need to be collected more frequently.
- **As soon as possible, the Airport should make infrastructure changes to construct space for an additional compactor each at CT-South and CT-North** so each collection point has three compactors: one each for garbage, commingled recycling, and composting.
- **Simultaneously, the Airport should conduct a detailed feasibility study and stakeholder engagement process regarding the potential to use dehydrators and liquefiers to reduce the volume of composting collected.**

Before implementing these recommendations, the Airport should conduct additional feasibility analysis to assess operational and infrastructure implications in more detail.

4. Background and Approach

Airport passengers have substantially increased since 2014 and are expected to continue increasing substantially in the near future. To accommodate this significant growth, the Airport conducted this study to evaluate current waste handling infrastructure capacity and determine future expansion needs and associated timing through 2034 (the planning period). Concurrent with passenger growth, the Airport is implementing strategies identified in its 2014 Solid Waste Management Plan (SWMP) and expanding space allocated to Airport Dining and Retail (ADR) Concessions that provide food services, both of which are expected to substantially and relatively quickly increase the amount of compostable materials diverted to composting. Strategies in the SWMP are also forecasted to increase commingled recycling quantities to a lesser degree.

The forecast included municipal solid waste collected in regularly used compactors, dumpsters, and other solid waste collection containers (see Table 3). Cascadia forecasted quantities for the Airport as a whole based on passenger projections, historic data on waste generated per passenger, modeling results from the 2014 SWMP, and new modeling related to increases in square footage of food service concessionaires.

The capacity analysis focused on the waste streams of garbage, commingled recycling, and composting—excluding source-separated materials such as donated food and cooking oil. Using Airport data on current collection quantities, Cascadia allocated forecasted quantities by waste stream to each sector (Airfield, Terminal, Remote Sites, and CIP Construction) and collection point (e.g., Main Service Tunnel, Central Terminal North). Cascadia determined the capacity constraints for each collection point using guidance from Airport waste service providers on the maximum feasible collection frequency and guidance from Airport janitorial contractors on the maximum feasible container size allowable without capital improvements. Quantities by collection point and waste stream were compared to these known capacity constraints to identify when the Airport would need to increase collection frequency, enlarge collection containers, and make system changes (such as transferring waste between collection points or making capital improvements). Cascadia also forecasted waste-handling costs based on current actual and estimated future per-ton costs.

Details on the forecasting and capacity analysis methodology, including adjustments to the originally planned methodology, are presented in Appendix B. The primary adjustment was to exclude data from 2013 because construction projects made waste quantities and flow abnormal in that year.

During the capacity analysis, Cascadia identified and evaluated potential strategies to expand the solid waste system capacity, determined key constraints and feasibility considerations for those strategies, and developed recommendations and an associated schedule to maintain adequate system service during the planning period.

Table 3. Sectors and Waste Collection Points included in Forecast and Capacity Analysis

Sector	Collection Point	Garbage	Recycling	Composting
Terminal	Concourse A Load Dock	Yes	Yes	Yes
	CT-North	Yes	Yes	Yes
	CT-South	Yes	Yes	Yes
	N-9/N-10	Yes	Yes	Yes
	Service Tunnel	Yes	Yes	Yes
	S-6	Yes	Yes	Yes
Airfield	A-10	Yes	Yes	--
	B-6	Yes	Yes	--
	C-3	Yes	Yes	--
	D-11	Yes	Yes	--
	N-6	Yes	Yes	--
	S-16	Yes	Yes	--
Remote Sites	Air Cargo 4 - East Building	Yes	Yes	--
	Autoshop at Air Cargo 4	Yes	Yes	--
	AV/M DC	Yes	Yes	--
	Bus Maintenance Facility	Yes	Yes	--
	C-10	--	--	Yes
	Fire Station	Yes	Yes	Yes
	Learning Center	Yes	Yes	--
	Snow Shed	Yes	--	--
	Taxi Stand	Yes	Yes	Yes
CIP Construction	CPO Logistics	Yes	Yes	--
	Water Tower	Yes	Yes	--
	Westside Office Building	Yes	Yes	--

Note: double dashes (--) indicate the collection point did not generate that waste stream in 2015.

5. Detailed Findings

5.1. Waste Forecast

The waste forecast included municipal solid waste collected in regularly used compactors, dumpsters, and other solid waste collection containers. Figure 4 (below) maps the locations included in the study; Table 3 (in the Study Overview section) lists the collection points and waste streams included. Cascadia forecasted waste quantities for the Airport as a whole using:

- Passenger forecasts developed by the Airport in 2016.
- Historic data on waste generated per passenger, showing a trend that total waste per passenger is decreasing by an average of 0.74% annually.
- Modeling results from 2014 SWMP strategies that shift materials from garbage to commingled recycling and composting.
- New modeling to estimate changes in waste per passenger due to expanding space allocated to food-service concessionaires, in conjunction with modeling the effects of 2014 SWMP strategies on these concessionaires.

Details on the forecasting methodology are presented in Appendix B.

5.1.1. Key Assumptions and Uncertainties

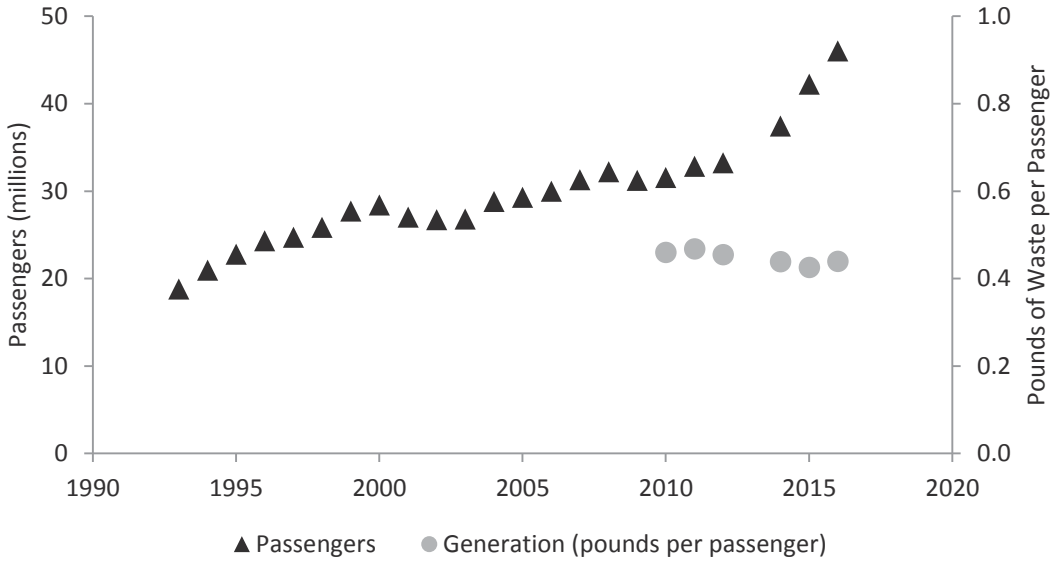
Figure 5, below presents historic data on passenger counts and pounds generated per passenger. Based on historic trends, the model assumes that annual waste per passenger will decrease from 0.426 pounds per passenger in 2015 to 0.385 in 2034, about a 10% reduction. If waste per passenger does not continue to decrease, model results may underestimate future quantities.

In recent years, actual passenger counts have significantly exceeded forecasted passenger counts. Historically, passenger counts have been the biggest factor affecting waste quantities. If future passenger counts exceed current forecasts, the model may underestimate future waste quantities. Cascadia analyzed waste quantities generated in seven scenarios, varying passenger forecasts and pounds of waste per passenger; results are presented in Appendix C. This analysis uses the most recent passenger forecasts provide by the Airport.

The Airport is including new composting, recycling, and food service ware requirements into tenant leases for ADR concessionaires over the next few years. The current waste forecast model uses an estimate of the effects on the Airport's composting and recycling rate originally modeled in the 2014 Solid Waste Management Plan (SWMP). If ADR concessionaires use more recyclable and less compostable food service ware than modeled in the 2014 SWMP, then composting may increase less than forecasted in the current model. Similarly, these increases could occur more slowly than forecasted this this capacity study if ADR concessionaires implement the lease requirements more slowly than expected.

Figure 4. Waste Collection Points included in Forecasting and Analysis

Figure 5. Historic Airport Passenger and Waste per Passenger Data



5.1.2. Overall Waste Forecast

By 2034, the Airport is projected to serve 65,647,200 passengers per year and to generate 4,918 tons of garbage, 4,279 tons of commingled recycling, 3,221 tons of composting, and 799 tons of other recovered municipal solid waste. Overall, this represents a 55% increase in passengers and a 47% increase in total municipal solid waste over 2015.

Figure 6 presents the forecast of passengers and tons graphically. Table 4 presents the tonnage forecast for each waste stream, rounded to the nearest ton. Forecasted waste generation grows largely in proportion to forecasted passenger counts. New tenant requirements related to composting, recycling, and using compostable and recyclable food service ware are projected to shift materials substantially from garbage to composting and recycling. To a lesser extent, expansion of ADR concessionaires is also forecasted to increase composting and recycling.

Figure 6. Aggregate Airport Passenger and Waste Forecast

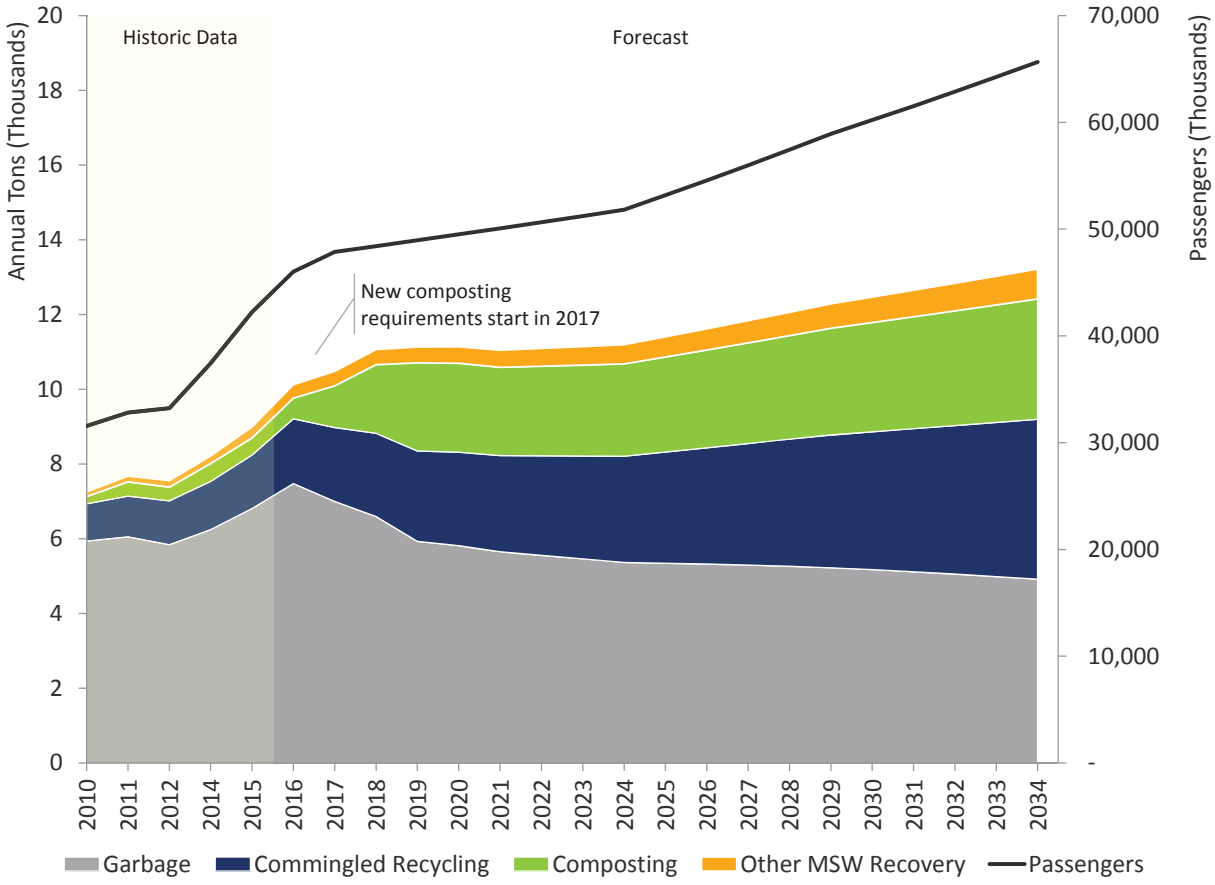


Table 4. Overall Airport Waste Tonnage Forecast

Year	Garbage	Commingled Recycling	Composting	Other MSW Recovery	Total Tons	Recovery rate*
2015	6,806	1,433	457	299	8,994	24%
2016	7,477	1,732	553	361	10,123	26%
2017	7,188	1,937	967	389	10,481	31%
2018	6,977	2,143	1,537	406	11,064	37%
2019	6,506	2,292	1,910	424	11,132	42%
2020	6,201	2,416	2,078	442	11,137	44%
2021	5,846	2,531	2,210	460	11,047	47%
2022	5,557	2,662	2,397	478	11,094	50%
2023	5,461	2,752	2,433	496	11,142	51%
2024	5,366	2,843	2,470	515	11,194	52%
2025	5,344	2,976	2,543	541	11,404	53%
2026	5,319	3,114	2,618	568	11,619	54%
2027	5,292	3,255	2,694	596	11,837	55%
2028	5,262	3,400	2,772	625	12,060	56%
2029	5,229	3,550	2,853	654	12,286	57%
2030	5,173	3,689	2,924	682	12,467	59%
2031	5,113	3,831	2,996	710	12,650	60%
2032	5,051	3,977	3,069	739	12,836	61%
2033	4,986	4,126	3,144	769	13,025	62%
2034	4,918	4,279	3,221	799	13,217	63%

Note: Other MSW recovery includes source-separated glass and donated food.

* The 2014 SWMP forecasted that if all recommended strategies had been fully implemented, the Airport recycling rate would have been 40% in 2013 with a Terminal-only recycling rate of 54%. Unlike the 2014 SMWP model, the current waste forecast also takes into account the Airport's historic trend of increasing diversion over time and plans to increase food service tenants, yielding a higher recycling rate in 2022 when all recommended strategies are assumed to be fully implemented.

The following subsections present projections for each waste stream in more detail.

5.1.3. Composting Forecasts

Composting tonnages are forecasted to surge between 2017 and 2019 as composting and compostable food service ware requirements are incorporated into tenant lease renewals. In addition, the square footage allocated to food service tenants is expected to expand during this same period, further increasing composting quantities. In 2019, the Airport plans to allocate more than 13,000 additional square feet to food service tenants, a 15% increase over 2015. Some food service tenant square footage will be removed in 2020 and 2021, for a final increase of nearly 9,600 additional square feet (11%) compared to 2015. The vast majority of composting is generated in the Terminal, primarily at CT-South and CT-North. The Service Tunnel and Terminal collection points at the North and South Terminals also generate substantial quantities of composting.

Figure 7. Composting Projections by Collection Point 2016–2034 (in tons per year)

Sector	Collection Point	Current 2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Terminal	Concourse A Load Dock	10	13	22	35	44	47	50	55	55	56	58	60	61	63	65	67	68	70	72	73
	CT-North	105	127	222	353	438	477	507	550	558	567	583	600	618	636	654	671	687	704	721	739
	CT-South	230	278	486	773	961	1045	1111	1205	1224	1242	1279	1316	1355	1394	1435	1470	1506	1543	1581	1620
	N-9/N-10	30	36	63	101	125	136	145	157	160	162	167	172	177	182	187	192	196	201	206	211
	S-6	22	26	46	72	90	98	104	113	114	116	120	123	127	130	134	138	141	144	148	152
	Service Tunnel	50	60	105	167	208	226	240	261	265	269	277	285	293	302	310	318	326	334	342	350
Terminal Subtotal		**446**	**540**	**944**	**1501**	**1865**	**2029**	**2158**	**2341**	**2376**	**2412**	**2483**	**2556**	**2631**	**2707**	**2786**	**2855**	**2925**	**2997**	**3070**	**3145**
Remote Sites	C-10	7	9	16	25	31	34	36	39	39	40	41	42	44	45	46	47	48	50	51	52
	Fire Station	3	4	7	11	14	15	16	18	18	18	19	19	20	20	21	21	22	23	23	24
	Taxi Stand	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Remote Sites Subtotal		**11**	**13**	**23**	**36**	**45**	**49**	**52**	**56**	**57**	**58**	**60**	**62**	**63**	**65**	**67**	**69**	**70**	**72**	**74**	**76**

Notes: Taxi Stand generated no composting in 2015. Due to rounding, subtotals may differ slightly from the sum of individual collection points.

5.1.4. Commingled Recycling Forecasts

Commingled recycling tonnages are forecasted to increase between 2017 and 2019 as recycling and recyclable food service ware requirements are incorporated into tenant lease renewals, although the increase is relatively minor compared to the growth in composting. The vast majority of recycling is generated in the Terminal, primarily at CT-South, CT-North, and the Service Tunnel. Terminal collections point S-6 and Concourse A Load Dock as well as Airfield collection point D-11 also generate substantial quantities of commingled recycling.

Figure 8. Commingled Recycling Projections by Collection Point 2016–2034 (in tons per year)

Sector	Collection Point	Current 2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Terminal	Concourse A Load Dock	104	129	145	160	171	181	189	199	206	213	222	233	243	254	265	276	286	297	308	320
	CT-North	302	377	421	466	499	526	551	579	599	619	648	677	708	740	772	803	834	865	898	931
	CT-South	284	354	396	438	468	494	517	544	562	581	608	636	665	694	725	753	783	812	843	874
	N-9/N-10	57	71	80	88	94	100	104	110	113	117	123	128	134	140	146	152	158	164	170	176
	S-6	135	169	189	209	223	235	246	259	268	277	290	303	317	331	346	359	373	387	402	417
	Service Tunnel	242	302	337	373	399	421	441	464	479	495	518	542	567	592	618	642	667	693	718	745
Terminal Subtotal		**1123**	**1402**	**1567**	**1735**	**1855**	**1955**	**2048**	**2155**	**2227**	**2301**	**2409**	**2520**	**2634**	**2752**	**2873**	**2985**	**3101**	**3219**	**3339**	**3463**
Airfield	A-10	16	20	22	25	27	28	29	31	32	33	35	36	38	39	41	43	44	46	48	50
	B-6	46	57	64	71	76	80	83	88	91	94	98	103	107	112	117	122	126	131	136	141
	C-3	15	19	21	23	25	26	27	29	30	31	32	34	35	37	38	40	41	43	44	46
	D-11	124	154	172	191	204	215	225	237	245	253	265	277	290	303	316	328	341	354	367	381
	N-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S-16	20	25	28	31	33	35	36	38	40	41	43	45	47	49	51	53	55	57	59	62
Airfield Subtotal		**220**	**275**	**307**	**340**	**364**	**384**	**402**	**423**	**437**	**451**	**472**	**494**	**517**	**540**	**563**	**586**	**608**	**631**	**655**	**679**
Remote Sites	AV/M DC	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5
	Air Cargo 4 - East Building	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4
	Autoshop at Air Cargo 4	5	6	6	7	8	8	8	9	9	9	10	10	11	11	12	12	13	13	14	14
	Bus Maintenance Facility	10	13	14	15	17	17	18	19	20	21	21	22	24	25	26	27	28	29	30	31
	Fire Station	7	9	10	11	11	12	12	13	14	14	15	15	16	17	17	18	19	20	20	21
	Learning Center	2	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6	6	7	7	7
	Taxi Stand	4	5	5	6	6	6	7	7	7	7	8	8	9	9	9	10	10	10	11	11
Remote Sites Subtotal		**30**	**38**	**42**	**46**	**50**	**52**	**55**	**58**	**60**	**62**	**64**	**67**	**71**	**74**	**77**	**80**	**83**	**86**	**89**	**93**
CIP Construction	CPO Logistics	5	6	7	7	8	8	9	9	9	10	10	11	11	12	12	13	13	14	14	15
	Water Tower	3	4	4	5	5	6	6	6	6	7	7	7	7	8	8	8	9	9	9	10
	Westside Office Building	6	8	9	10	11	11	12	12	13	13	14	14	15	16	16	17	18	18	19	20
CIP Construction Subtotal		**14**	**18**	**20**	**22**	**24**	**25**	**26**	**28**	**28**	**29**	**31**	**32**	**34**	**35**	**37**	**38**	**40**	**41**	**43**	**44**

Note: Due to rounding, subtotals may differ slightly from the sum of individual collection points.

5.1.5. Garbage Forecasts

Garbage tonnages are forecasted to increase in 2016 and then begin to decrease starting in 2017 as waste shifts from garbage to composting and commingled recycling. Increasing diversion rates are forecasted to decrease garbage tonnages, more than offsetting the effects of increased passenger counts. As with commingled recycling, the majority of garbage is generated in the Terminal, primarily at CT-North, CT-South, and the Service Tunnel. Airfield collection points S-16, B-6, and D-11 also generate substantial quantities of garbage.

Figure 9. Garbage Projections by Collection Point 2016–2034 (in tons per year)

Sector	Collection Point	Current 2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Terminal	Concourse A Load Dock	360	397	381	370	345	329	310	295	290	285	283	282	281	279	277	274	271	268	264	261
	CT-North	1194	1314	1263	1226	1143	1090	1027	977	960	943	939	935	930	925	919	909	899	888	876	864
	CT-South	917	1009	970	941	878	837	789	750	737	724	721	718	714	710	706	698	690	681	673	664
	N-9/N-10	495	545	524	509	474	452	426	405	398	391	390	388	386	384	381	377	373	368	363	358
	S-6	429	472	454	441	411	392	369	351	345	339	337	336	334	332	330	327	323	319	315	311
	Service Tunnel	872	959	922	895	835	796	750	713	701	688	686	683	679	675	671	664	656	648	640	631
Terminal Subtotal		**4266**	**4696**	**4515**	**4382**	**4086**	**3894**	**3671**	**3490**	**3430**	**3370**	**3356**	**3341**	**3324**	**3305**	**3284**	**3249**	**3211**	**3172**	**3131**	**3089**
Airfield	A-10	187	206	198	192	179	171	161	153	151	148	147	147	146	145	144	143	141	139	138	136
	B-6	637	701	674	654	610	581	548	521	512	503	501	499	496	493	490	485	479	474	468	461
	C-3	181	199	191	186	173	165	155	148	145	143	142	141	141	140	139	138	136	134	133	131
	D-11	619	681	655	636	593	565	533	506	498	489	487	485	482	480	477	471	466	460	454	448
	N-6	28	31	30	29	27	26	24	23	23	22	22	22	22	22	22	22	21	21	21	21
	S-16	676	745	716	695	648	617	582	553	544	534	532	530	527	524	521	515	509	503	497	490
Airfield Subtotal		**2329**	**2563**	**2464**	**2392**	**2230**	**2126**	**2004**	**1905**	**1872**	**1840**	**1832**	**1824**	**1814**	**1804**	**1793**	**1773**	**1753**	**1732**	**1709**	**1686**
Remote Sites	Air Cargo 4 - East Building	6	7	7	7	6	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5
	Autoshop at Air Cargo 4	43	48	46	45	42	40	37	35	35	34	34	34	34	34	33	33	33	32	32	31
	AV/M DC	5	6	6	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4
	Bus Maintenance Facility	23	26	25	24	22	21	20	19	19	19	18	18	18	18	18	18	18	17	17	17
	Fire Station	6	7	7	7	6	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5
	Learning Center	5	6	6	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4
	Snow Shed	76	84	80	78	73	69	65	62	61	60	60	60	59	59	59	58	57	57	56	55
	Taxi Stand	19	21	20	20	19	18	17	16	16	15	15	15	15	15	15	15	15	14	14	14
Remote Sites Subtotal		**186**	**204**	**196**	**191**	**178**	**169**	**160**	**152**	**149**	**147**	**146**	**145**	**145**	**144**	**143**	**141**	**140**	**138**	**136**	**134**
CIP Construction	CPO Logistics	5	6	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	Water Tower	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Westside Office Building	4	5	5	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3
CIP Construction Subtotal		**12**	**13**	**13**	**12**	**12**	**11**	**10**	**10**	**10**	**10**	**10**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**

Note: Due to rounding, subtotals may differ slightly from the sum of individual collection points.

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5.2. Capacity and Cost Analysis

To conduct the capacity analysis, Cascadia allocated the forecasted quantities by waste stream to each sector (Airfield, Terminal, Remote Sites, and CIP Construction) and collection point (e.g., Main Service Tunnel, Central Terminal North) and converted tonnages to volumes in cubic yards using material-specific density factors (see Table 5).

Table 5. Density Factors and Sources

Commercial Waste Stream	Pounds per cubic yard	Source
Composting (not compacted)	350	Cedar Grove Estimate, per communication August 2016
Composting (compacted)	700	Cedar Grove Estimate, per communication October 2016
Garbage (not compacted)	124	Cascadia garbage study for State of California (2008)
Garbage (compacted)	411	Average density of Airport compactors when serviced (2009 to 2016)
Recycle (not compacted)	88	Cascadia recycling study for private hauler (2013)
Recycle (compacted)	367	Average density of Airport compactors when serviced (2009 to 2016)

Airport Environmental staff and janitorial contractors provided data on observed weekly capacity constraints and extension potential by collection point, including:

- Current weekly capacity, after which the Airport must **increase collection frequency**.
- Maximum weekly capacity with increased frequency, after which the Airport must **enlarge containers**.
- Maximum weekly capacity with enlarged containers, after which the Airport must **make system changes**.

The following three tables present those weekly capacity thresholds for composting (Table 6), commingled recycling (Table 7), and garbage (Table 8) along with existing generation in 2015 and the projected dates at which collection points reach and exceed weekly capacity thresholds. Cascadia compared projected future volumes by collection point and waste stream to these capacity constraints to identify when the Airport would need to increase collection frequency, enlarge collection containers, and make system changes (such as transferring waste between collection points or making capital improvements).

Only composting containers are forecasted to require system changes; all other forecasted capacity issues can be managed by increasing collection frequency or enlarging containers. Some of the containers are forecasted to require frequency increases in 2016. Details on the capacity and cost analysis methodology are presented in Appendix B.

Table 6. Existing Composting Generation and Capacity Thresholds by Sector and Collection Point (cubic yards per week)

Sector	Collection Point	Existing Generation (CY)	Existing Capacity (CY)	Increase Frequency by (Year)	New Capacity (CY)	Enlarge Containers by (Year)	Max Capacity (CY)	Change System by (Year)
Terminal	Concourse A Load Dock	1.1	1	2016	5	2019	25	
	CT-North	11.5	12	2016	30	2018	30	2018
	CT-South	25.3	20	2016	50	2017	100	2018
	N-9/N-10	3.3	4	2017	20	2029	50	
	Service Tunnel	5.5	4	2016	10	2017	40	
	S-6	2.4	2	2016	10	2019	25	
Remote Sites	C-10	0.8	1	2017	5	2029	13	
	Fire Station	0.4	1	2018	5		15	
	Taxi Stand	0.0	0.5		2		6	

Table 7. Existing Commingled Recycling Generation and Capacity Thresholds by Sector and Collection Point (cubic yards per week)

Sector	Collection Point	Existing Generation (CY)	Existing Capacity (CY)	Increase Frequency by (Year)	New Capacity (CY)	Enlarge Containers by (Year)	Max Capacity (CY)	Change System by (Year)
Terminal	Concourse A Load Dock	10.9	30	2032	210		210	
	CT-North	31.6	75	2028	175		175	
	CT-South	29.7	75	2029	175		175	
	N-9/N-10	6.0	15	2029	210		210	
	Service Tunnel	25.3	60	2028	210		210	
	S-6	14.1	15	2016	210		210	
Airfield	A-10	1.7	15		210		210	
	B-6	4.8	15		210		210	
	C-3	1.6	30		210		210	
	D-11	12.9	30	2027	210		210	
	N-6	0.0	30		210		210	
	S-16	2.1	30		210		210	
Remote Sites	Air Cargo 4 - East Building	0.5	1	2024	5		5	
	Autoshop at Air Cargo 4	2.0	4	2024	20		150	
	AV/M DC	0.2	10		70		210	
	Bus Maintenance Facility	4.4	8	2021	40		100	
	Fire Station	3.0	6	2024	30		30	
	Learning Center	1.0	3	2034	15		75	
	Taxi Stand	1.6	4	2029	20		50	
CIP Construction	CPO Logistics	2.1	4	2022	20		100	
	Water Tower	1.4	2	2018	10		10	
	Westside Office Building	2.8	4	2018	20		100	

Table 8. Existing Garbage Generation and Capacity Thresholds by Sector and Collection Point (cubic yards per week)

Sector	Collection Point	Existing Generation (CY)	Existing Capacity (CY)	Increase Frequency by (Year)	New Capacity (CY)	Enlarge Containers by (Year)	Max Capacity (CY)	Change System by (Year)
Terminal	Concourse A Load Dock	33.7	30	2016	210		210	
	CT-North	111.7	150		175		175	
	CT-South	85.8	100		175		175	
	N-9/N-10	46.4	90		210		210	
	Service Tunnel	81.6	120		210		210	
	S-6	40.2	60		210		210	
Airfield	A-10	17.5	30		210		210	
	B-6	59.6	120		210		210	
	C-3	16.9	30		210		210	
	D-11	57.9	90		210		210	
	N-6	2.7	30		210		210	
	S-16	63.3	90		210		210	
Remote Sites	Air Cargo 4 - East Building	0.6	24		160		160	
	Autoshop at Air Cargo 4	4.1	30		210		210	
	AV/M DC	0.5	20		140		280	
	Bus Maintenance Facility	7.3	8	2016	40		100	
	Fire Station	2.0	4		20		30	
	Learning Center	1.7	3		15		75	
	Snow Shed	7.1	60		210		210	
	Taxi Stand	6.0	12		30		75	
CIP Construction	CPO Logistics	1.6	2		10		50	
	Water Tower	0.8	2		10		10	
	Westside Office Building	1.4	2		10		50	

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5.2.1. Composting Capacity

All collection points with composting (except Taxi Stand) are forecasted to experience capacity issues by 2018. The most severe forecasted issues occur at CT-South and CT-North, which both require a system change in 2018. Other capacity issues can be addressed by first increasing collection frequency and then enlarging containers—without system changes. Cascadia forecasts that the Airport must enlarge containers in 2017 (CT-South and Service Tunnel), 2019 (S-6 and Concourse A Load Dock), and 2029 (N-9/N-10 and C-10). Table 9 presents volumes for composting collected in dumpsters, the current method; volumes would be less for composting collected in compactors. Cedar Grove Composting confirmed that it could collect composting from the Airport in 20-yard compactors.

Table 9. Composting Volume Forecast by Collection Point and Waste Stream (in cubic yards per week) with Capacity Thresholds 2016–2034

Sector	Collection Point	Current 2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Terminal	Concourse A Load Dock	1.1	1.4	2.8	4.6	5.9	6.0	5.9	6.0	6.1	6.2	6.4	6.6	6.7	6.9	7.1	7.3	7.5	7.7	7.9	8.1
	CT-North	11.5	13.9	28.1	46.3	59.5	60.0	59.5	60.4	61.3	62.3	64.1	66.0	67.9	69.9	71.9	73.7	75.5	77.4	79.3	81.2
	CT-South	25.3	30.6	61.7	101.4	130.4	131.5	130.5	132.5	134.5	136.5	140.5	144.6	148.9	153.2	157.7	161.6	165.5	169.6	173.8	178.0
	N-9/N-10	3.3	4.0	8.0	13.2	17.0	17.1	17.0	17.3	17.5	17.8	18.3	18.9	19.4	20.0	20.6	21.1	21.6	22.1	22.7	23.2
	S-6	2.4	2.9	5.8	9.5	12.2	12.3	12.2	12.4	12.6	12.8	13.1	13.5	13.9	14.3	14.8	15.1	15.5	15.9	16.3	16.7
	Service Tunnel	5.5	6.6	13.3	22.0	28.2	28.4	28.2	28.7	29.1	29.5	30.4	31.3	32.2	33.2	34.1	35.0	35.8	36.7	37.6	38.5
Remote Sites	C-10	0.8	1.0	2.0	3.3	4.2	4.2	4.2	4.3	4.3	4.4	4.5	4.7	4.8	4.9	5.1	5.2	5.3	5.5	5.6	5.7
	Fire Station	0.4	0.4	0.9	1.5	1.9	1.9	1.9	1.9	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.4	2.4	2.5	2.5	2.6
	Taxi Stand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: Taxi Stand generated no composting in 2015.

Cells are color-coded by the changes required:

* Increased collection frequency
* Enlarged containers
* System changes

5.2.2. Commingled Recycling Capacity

Most collection points with commingled recycling outside the Airfield are forecasted to experience capacity issues during the planning period. All forecasted capacity issues can be addressed solely by increasing collection frequency. Enlarged containers and system changes are not needed. The earliest forecasted capacity issues occur at collection points S-6, Water Tower, and Westside Office Building. All Terminal collection points are forecasted to require increased collection frequency. On the Airfield, only collection point D-11 is forecasted to require increased collection frequency, and the capacity issue is not forecasted to occur until 2027.

Table 10. Commingled Recycling Volume Forecast by Collection Point and Waste Stream (in cubic yards per week) with Capacity Thresholds 2016–2034

Sector	Collection Point	Current 2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Terminal	Concourse A Load Dock	10.9	13.6	15.5	17.4	18.9	19.6	20.1	20.8	21.5	22.2	23.3	24.4	25.5	26.6	27.8	28.9	30.0	31.1	32.3	33.5
	CT-North	31.6	39.5	45.1	50.7	55.1	57.0	58.6	60.7	62.7	64.8	67.8	70.9	74.1	77.5	80.9	84.0	87.3	90.6	94.0	97.5
	CT-South	29.7	37.0	42.3	47.6	51.7	53.5	55.0	56.9	58.9	60.8	63.7	66.6	69.6	72.7	75.9	78.9	81.9	85.1	88.2	91.5
	N-9/N-10	6.0	7.5	8.5	9.6	10.4	10.8	11.1	11.5	11.9	12.3	12.9	13.4	14.1	14.7	15.3	15.9	16.5	17.2	17.8	18.5
	S-6	14.1	17.7	20.2	22.7	24.7	25.5	26.2	27.1	28.1	29.0	30.3	31.7	33.2	34.7	36.2	37.6	39.1	40.5	42.1	43.6
	Service Tunnel	25.3	31.6	36.1	40.6	44.1	45.6	46.9	48.5	50.2	51.8	54.3	56.8	59.3	62.0	64.7	67.3	69.9	72.5	75.2	78.0
Airfield	A-10	1.7	2.1	2.4	2.7	2.9	3.0	3.1	3.2	3.3	3.5	3.6	3.8	4.0	4.1	4.3	4.5	4.6	4.8	5.0	5.2
	B-6	4.8	6.0	6.8	7.7	8.3	8.6	8.9	9.2	9.5	9.8	10.3	10.7	11.2	11.7	12.2	12.7	13.2	13.7	14.2	14.8
	C-3	1.6	2.0	2.2	2.5	2.7	2.8	2.9	3.0	3.1	3.2	3.4	3.5	3.7	3.8	4.0	4.2	4.3	4.5	4.7	4.8
	D-11	12.9	16.1	18.4	20.8	22.5	23.3	24.0	24.8	25.6	26.5	27.7	29.0	30.3	31.7	33.1	34.4	35.7	37.1	38.4	39.9
	N-6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S-16	2.1	2.6	3.0	3.4	3.6	3.8	3.9	4.0	4.2	4.3	4.5	4.7	4.9	5.1	5.4	5.6	5.8	6.0	6.2	6.5
Remote Sites	AV/M DC	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5
	Air Cargo 4 - East Building	0.5	0.6	0.7	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5
	Autoshop at Air Cargo 4	2.0	2.5	2.9	3.2	3.5	3.6	3.7	3.8	4.0	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.5	5.7	5.9	6.2
	Bus Maintenance Facility	4.4	5.5	6.3	7.1	7.7	7.9	8.2	8.4	8.7	9.0	9.4	9.9	10.3	10.8	11.3	11.7	12.1	12.6	13.1	13.6
	Fire Station	3.0	3.7	4.3	4.8	5.2	5.4	5.6	5.8	5.9	6.1	6.4	6.7	7.0	7.3	7.7	8.0	8.3	8.6	8.9	9.2
	Learning Center	1.0	1.3	1.4	1.6	1.8	1.8	1.9	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1
	Taxi Stand	1.6	2.0	2.3	2.6	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.6	3.8	3.9	4.1	4.3	4.4	4.6	4.8	4.9
CIP Construction	CPO Logistics	2.1	2.6	3.0	3.4	3.7	3.8	3.9	4.0	4.2	4.3	4.5	4.7	4.9	5.1	5.4	5.6	5.8	6.0	6.2	6.5
	Water Tower	1.4	1.7	2.0	2.2	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.3	3.4	3.6	3.7	3.9	4.0	4.2	4.3
	Westside Office Building	2.8	3.5	4.0	4.5	4.9	5.0	5.2	5.4	5.6	5.7	6.0	6.3	6.6	6.9	7.2	7.4	7.7	8.0	8.3	8.6

Cells are color-coded by the changes required:

* Increased collection frequency
* Enlarged containers
* System changes

5.2.3. Garbage Capacity

Only two collection points with garbage are forecasted to experience capacity issues during the planning period. Both capacity issues emerge early in the planning period and can be addressed solely by increasing collection frequency. Concourse A Load Dock is already forecasted to require increased collection frequency. The collection point at Bus Maintenance Facility is projected to need increased frequency only in 2016, after which it can decrease frequency to the current level. While this analysis did not assess the opportunity to decrease frequency, it is likely that the Airport can decrease garbage collection frequency in the future.

Table 11. Garbage Volume Forecast by Collection Point and Waste Stream (in cubic yards per week) with Capacity Thresholds 2016–2034

Sector	Collection Point	Current 2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Terminal	Concourse A Load Dock	33.7	37.1	34.7	32.7	29.4	28.9	28.1	27.6	27.1	26.6	26.5	26.4	26.3	26.1	26.0	25.7	25.4	25.1	24.8	24.4
	CT-North	111.7	123.0	115.1	108.5	97.5	95.6	93.0	91.4	89.8	88.3	87.9	87.5	87.0	86.6	86.0	85.1	84.1	83.1	82.0	80.9
	CT-South	85.8	94.4	88.4	83.3	74.9	73.4	71.4	70.2	69.0	67.8	67.5	67.2	66.8	66.5	66.0	65.3	64.6	63.8	63.0	62.1
	N-9/N-10	46.4	51.0	47.7	45.0	40.5	39.7	38.6	37.9	37.3	36.6	36.5	36.3	36.1	35.9	35.7	35.3	34.9	34.5	34.0	33.6
	S-6	40.2	44.2	41.4	39.0	35.0	34.4	33.4	32.8	32.3	31.7	31.6	31.4	31.3	31.1	30.9	30.6	30.2	29.9	29.5	29.1
	Service Tunnel	81.6	89.8	84.0	79.2	71.2	69.8	67.9	66.7	65.6	64.4	64.2	63.9	63.6	63.2	62.8	62.1	61.4	60.7	59.9	59.1
Airfield	A-10	17.5	19.3	18.1	17.0	15.3	15.0	14.6	14.3	14.1	13.9	13.8	13.7	13.7	13.6	13.5	13.4	13.2	13.0	12.9	12.7
	B-6	59.6	65.6	61.4	57.9	52.0	51.0	49.6	48.8	47.9	47.1	46.9	46.7	46.5	46.2	45.9	45.4	44.9	44.3	43.8	43.2
	C-3	16.9	18.6	17.4	16.4	14.8	14.5	14.1	13.8	13.6	13.4	13.3	13.2	13.2	13.1	13.0	12.9	12.7	12.6	12.4	12.2
	D-11	57.9	63.8	59.7	56.3	50.6	49.6	48.2	47.4	46.6	45.8	45.6	45.4	45.1	44.9	44.6	44.1	43.6	43.1	42.5	42.0
	N-6	2.7	2.9	2.7	2.6	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.0	1.9	1.9
	S-16	63.3	69.7	65.2	61.5	55.3	54.2	52.7	51.8	50.9	50.0	49.8	49.6	49.3	49.0	48.7	48.2	47.7	47.1	46.5	45.8
Remote Sites	Air Cargo 4 - East Building	0.6	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4
	Autoshop at Air Cargo 4	4.1	4.5	4.2	3.9	3.5	3.5	3.4	3.3	3.3	3.2	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.0	3.0	2.9
	AV/M DC	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	Bus Maintenance Facility	7.3	8.0	7.5	7.1	6.4	6.2	6.1	6.0	5.8	5.7	5.7	5.7	5.7	5.6	5.6	5.5	5.5	5.4	5.3	5.3
	Fire Station	2.0	2.2	2.1	1.9	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.5	1.4
	Learning Center	1.7	1.8	1.7	1.6	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2
	Snow Shed	7.1	7.8	7.3	6.9	6.2	6.1	5.9	5.8	5.7	5.6	5.6	5.6	5.5	5.5	5.5	5.4	5.4	5.3	5.2	5.2
	Taxi Stand	6.0	6.6	6.2	5.8	5.2	5.1	5.0	4.9	4.8	4.7	4.7	4.7	4.7	4.6	4.6	4.6	4.5	4.5	4.4	4.3
CIP Construction	CPO Logistics	1.6	1.8	1.6	1.6	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
	Water Tower	0.8	0.9	0.8	0.8	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Westside Office Building	1.4	1.5	1.4	1.3	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Cells are color-coded by the changes required:

* Increased collection frequency
* Enlarged containers
* System changes

5.2.4. Cost Analysis

Cascadia also forecasted waste-handling costs based on the Airport's current per-ton costs and standard escalation factor of 3% per year based on historic trends in Airport costs. Due to this escalation, forecasted waste costs increase in all years except 2019, when the cost-saving effects of increased diversion overcome the effects of increased total generation and the escalation factor. Overall, forecasted costs in 2034 are $700,000 more than in 2016 if all composting continues to be collected in dumpsters (see Table 12). Collecting composting at CT-South and CT-North in compactors instead is forecasted to save approximately $40,000 in 2034 (see Table 13). Without the escalation factor, total forecasted costs in 2034 would decrease by approximately $150,000 (all dumpsters for composting) to $170,000 (composting at CT-South and CT-North in compactors).

Costs would increase much more substantially without the forecasted increase in composting and recycling rates. The current composting vendor, Cedar Grove Composting, charges the Airport approximately $108 per tons for dumpster-based composting collection. Compactor-based composting collection is estimated to cost $97 per ton when using a 20-yard compactor, according to estimates provided by Cedar Grove Composting. Garbage is considerably more expensive at nearly $172 per ton.

The Airport currently receives unlimited collection of commingled recycling at no extra cost due to the City of SeaTac's contract with the garbage hauler (Recology). The City and Recology's contract is scheduled to expire in 2021 (with the option to extend for up to four more years); if a new contract does not include free recycling, the Airport's costs could be substantially different from forecasted amounts. Similarly, if fees negotiated between the hauler and the City increase more than the estimated 3% escalation rate, then the Airport's costs could also be substantially higher.

Figure 10. Aggregate Airport Waste Cost Forecast (with escalation factor)

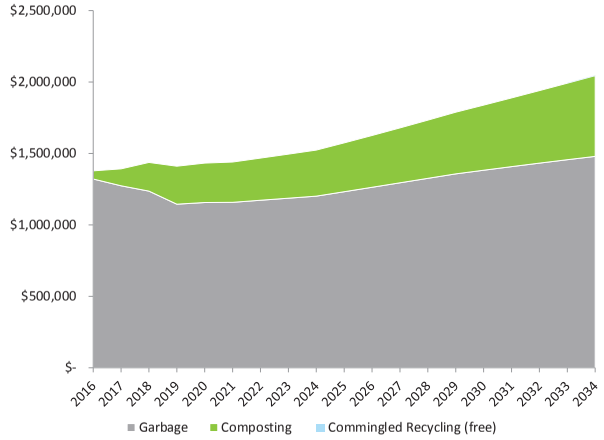


Table 12. Analysis of Annual Waste Costs 2016–2034 (all composting collected in dumpsters)

Waste Stream	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Garbage	$ 1,321,241	$ 1,273,700	$ 1,236,373	$ 1,144,985	$ 1,156,567	$ 1,157,908	$ 1,172,537	$ 1,186,822	$ 1,201,127	$ 1,232,124	$ 1,263,280	$ 1,294,534	$ 1,325,823	$ 1,357,074	$ 1,382,612	$ 1,407,721	$ 1,432,313	$ 1,456,291	$ 1,479,550
Composting	$ 61,507	$ 127,845	$ 216,652	$ 286,849	$ 297,843	$ 304,501	$ 318,390	$ 332,873	$ 348,092	$ 369,093	$ 391,317	$ 414,835	$ 439,720	$ 466,050	$ 491,914	$ 519,163	$ 547,868	$ 578,106	$ 609,955
Commingled Recycling	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	**$ 1,382,748**	**$ 1,401,545**	**$ 1,453,024**	**$ 1,431,834**	**$ 1,454,410**	**$ 1,462,409**	**$ 1,490,927**	**$ 1,519,695**	**$ 1,549,219**	**$ 1,601,217**	**$ 1,654,597**	**$ 1,709,369**	**$ 1,765,543**	**$ 1,823,124**	**$ 1,874,527**	**$ 1,926,885**	**$ 1,980,182**	**$ 2,034,396**	**$ 2,089,505**

Note: the current garbage hauler provides unlimited commingled recycling at no extra cost to the Airport.

Table 13. Analysis of Annual Waste Costs 2016–2034 (composting at CT-South and CT-North collected in compactors)

Waste Stream	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Garbage	$ 1,321,241	$ 1,273,700	$ 1,236,373	$ 1,144,985	$ 1,156,567	$ 1,157,908	$ 1,172,537	$ 1,186,822	$ 1,201,127	$ 1,232,124	$ 1,263,280	$ 1,294,534	$ 1,325,823	$ 1,357,074	$ 1,382,612	$ 1,407,721	$ 1,432,313	$ 1,456,291	$ 1,479,550
Composting	$ 56,979	$ 118,434	$ 200,704	$ 265,734	$ 275,918	$ 282,086	$ 294,952	$ 308,369	$ 322,469	$ 341,923	$ 362,511	$ 384,298	$ 407,351	$ 431,743	$ 455,704	$ 480,947	$ 507,539	$ 535,550	$ 565,055
Commingled Recycling	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	**$ 1,378,220**	**$ 1,392,134**	**$ 1,437,076**	**$ 1,410,719**	**$ 1,432,485**	**$ 1,439,994**	**$ 1,467,490**	**$ 1,495,192**	**$ 1,523,595**	**$ 1,574,047**	**$ 1,625,791**	**$ 1,678,833**	**$ 1,733,174**	**$ 1,788,817**	**$ 1,838,316**	**$ 1,888,668**	**$ 1,939,852**	**$ 1,991,841**	**$ 2,044,605**

Note: the current garbage hauler provides unlimited commingled recycling at no extra cost to the Airport.

5.3. Strategies to Address Capacity Issues

C-3. Strategies to Address Capacity Issues

At the beginning of the forecasting and analysis project, Cascadia identified four primary strategies to address capacity issues:

- **Increase collection frequency** using existing containers.
- **Enlarge collection containers** within existing loading dock and designated collection spaces.
- **Shift waste between nearby collection points**, a system change affecting operations.
- **Create additional space** for larger or additional containers at collection points. *(Requires capital investment.)*.

These strategies will need to be employed when forecasted volumes exceed existing system capacity. In addition to the above strategies and specifically for composting, Cascadia conducted exploratory research on various types of technologies aimed at reducing the volume of food waste and compostable food service ware to further optimize the Airport's existing collection system capacity. Cascadia identified the following technologies through online research and discussions with industry experts.[1]

5.3.1. Mechanical Pretreatment Systems

These systems are designed to reduce the volume of organic waste through grinding, dewatering, dehydration, or pressing. For example, dewatering machines typically pulp organic waste and mechanically remove excess liquid, typically draining to the sanitary sewer. Dehydration systems typically grind and heat organic material in batches to a temperature sufficiently high to evaporate water from within the material.

- **Pros**: Reduces volume for greater utilization of existing collection containers. Some units can handle small amounts of compostable service ware (typically less than 20% by volume).
- **Cons**: Clean organic waste consisting of 80% or more organic (wet) material typically produces the best output for composting. These systems are typically not designed to separate plastics from organic materials. Some systems can have intensive water or energy demands. Staff training is required for operating these units. Requires nearby access to sanitary sewer drains.

Table 14 presents a selection of examples of mechanical pre-treatment dehydration systems along with information provided by the manufacturers. Cascadia did not independently verify the information and does not endorse specific products.

[1] Experts included Seattle-area haulers, institutional recycling managers, and vendors that sell these alternative technologies.

Table 14. Examples of Mechanical Pre-Treatment Dehydration Systems

Product	Typical Customers	Capacity	Notes
Eco-system Ecovim	Hotels, colleges, convention centers, supermarkets, corporate campus cafes	▪ 125 to 6,600 lbs. processed per day, depending on model ▪ 80% to 90% volume reduction	▪ Optimal feedstock is 85% to 90% wet waste and 10% to 15% dry organic waste. ▪ 1 gallon of water output per 10 pounds of food waste (depending on input). ▪ No water required. ▪ Output is sterilized soil amendment. ▪ Eco650 unit (650 lbs. / day) dimensions: 63” x 49.6” x 60.2”
Somat DH-100	Schools, hospitals, casinos, colleges, cafeterias, cruise ships, government facilities	▪ 110 to220 lbs. processed per day ▪ 80% to 90% volume reduction	▪ Optimal feedstock is 85% to 90% wet waste and 10% to 15% dry organic waste input. ▪ 1 gallon of water output per 10 pounds of food waste (depending on input). ▪ No water required. ▪ Output is sterilized soil amendment.
BioGreen360	Hotels, colleges, convention centers, supermarkets, corporate campus cafes	▪ 1,500 lbs. processed per day ▪ 80% to 90% volume reduction	▪ Requires microorganism additive. ▪ No water output. ▪ No water required. ▪ Output is soil amendment. ▪ Dimensions: 90”W x 65”L x 68”H
EnviroPure Dry	Hotels, colleges, convention centers, supermarkets, corporate campus cafes	▪ 220 to 2,200 lbs. per day ▪ 99% volume reduction	▪ Requires proprietary BioMix bacteria substance and natural cedar chips. ▪ EPD-2200 unit (2,200 lbs./day) dimensions: 17’L x 8’W x 8’H

5.3.2. Liquifiers

Liquefiers grind organic materials into a slurry for disposal to the sanitary sewer—an industrial version of an in-sink garbage disposal. At the wastewaster treatment facility, the organic material could be strained out into biosolids for organics processing, such as anaerobic digestion, composting, or forest application as a soil amendment.

- **Pros**: Reduces collection capacity needed for food waste by diverting the material directly into the sanitary sewer.
- **Cons**: Typically designed to process clean, wet organic material without compostable food service ware. Can place burden on plumbing, sewer, and wastewater systems, such as increased clogging and pipe degradation. Many wastewater treatment facilities are not equipped to process this material.

Table 15 presents a selected example of liquefier along with information provided by the manufacturer. Cascadia did not independently verify the information and does not endorse specific products.

Table 15. Example of a Liquefier

Product	Typical Customers	Capacity	Notes
BIO-EZ Waste to Water	Hotels, colleges, convention centers, supermarkets, corporate campus cafes	▪ 350 to 2,000 lbs. processed per day, depending on model ▪ 100% volume reduction	▪ Not designed for use with compostable dry goods, only food waste. ▪ Output is water to sewer drain. ▪ Bio-EZ XL unit (1,500 lbs. per day) dimensions: 93.15”L x 35.13”L x 53.19”H x

The project team does not currently recommend the Airport invest in either of these two technologies, without first conducting a feasibility study to better understand specific technologies and their associated costs and benefits, technical feasibility, operational and regulatory requirements (e.g., dedicated and trained staff to feed materials into and operate equipment), risks, successes and challenges with similar customers, and other issues. The feasibility study should include consulting key stakeholders, such as technology vendor representatives, the composting waste collection service provider, the wastewater utility provider and regulators, architects and designers, utilities finance team members, and tenants and custodial teams that are responsible for handling and managing organics wastes and could potentially be tasked with operating new equipment.

6. Conclusions and Recommendations

Rapid forecasted growth in composting combined with limited space for additional composting collection infrastructure will require facility enhancements or expansion within the next two years to accommodate forecasted growth and existing waste diversion objectives. Composting poses capacity challenges for two main reasons. First, projected composting quantities quintuple by 2019 as the Airport implements waste diversion strategies from the 2014 Solid Waste Management Plan and expands space for food and beverage concessionaires, both of which are forecasted to shift tonnages from garbage disposal to composting and commingled recycling collection. Second, composting collection infrastructure is currently limited to smaller, low-volume dumpsters, whereas garbage and commingled recycling are frequently collected in larger, high-capacity compactors.

The CT-South and CT-North collection points currently account for 73% of the Airport's total composting generation. Composting at these two collection points represents the biggest forecasted capacity challenge, requiring system changes by 2018.

As a temporary, immediate strategy to expand composting capacity, Cascadia recommends the following two adjustments, which were developed in consultation with Airport staff and service providers.

- **Converting the CT-South recycling compactor to collect composting from CT-South and CT-North.**
- **Collecting all CT-South recycling at the CT-North compactor.**

In this strategy, tenants and the janitorial contractor would need to shift waste between the two collection points. Before implementing this strategy, the Airport will need to assess and address potential issues with safety, security, operations, and customer encounters with concessionaires and janitorial contractors transporting waste further and more frequently through bagwell and public areas in the Central Terminal. In addition, the decreased convenience for tenants currently composting at CT-North and recycling at CT-South may also decrease waste diversion. The CT-North recycling compactor would need to be collected more frequently. Cedar Grove Composting, the Airport's composting service provider, has confirmed that the company can collect composting in 20-yard compactors. However, the Airport may need to continue using dumpsters to hold excess composting starting in 2019, until the Airport can implement a longer-term solution.

As soon as possible to create a long-term solution, Cascadia recommends:

- **Making facility changes to accommodate an additional compactor each at CT-South and CT-North.**

The goal of this strategy is for each collection point to contain three compactors: one each for garbage, commingled recycling, and composting. The Airport will need to conduct a more detailed feasibility assessment and coordinate infrastructure changes with existing plans and options for facility upgrades to best meet current and future needs.

In addition, Cascadia recommends:

- **Conducting a detailed feasibility study process regarding using dehydrators and liquefiers to reduce the volume of composting collected.**

Dehydrators and liquefiers could alleviate composting capacity issues by reducing the volume of food waste and compostable food service ware, but they require a detailed feasibility study and stakeholder engagement process for successful implementation.

All other forecasted capacity limitations in composting, commingled recycling, and garbage collection can be addressed with no capital investment. These limitations require only increasing collection frequency or collection container size without the need for new construction. As waste diversion increases, the Airport should monitor garbage quantities to assess whether collection frequencies can be decreased.

Appendix A. Definitions for Key Terms

Table 16 below defines industry terms used throughout this document. Definitions were drawn from a number of industry sources, including the U.S. Composting Council, U.S. Environmental Protection Agency, and other Cascadia Consulting Group reports.

Table 16. List of Terms and Abbreviations Used in the This Document

Term or Abbreviation	Explanation
2014 SWMP	Seattle-Tacoma International Airport's 2014 Solid Waste Management Plan.
Airport	Seattle-Tacoma International Airport.
Airport Dining and Retail Concessions (ADR Concessions)	A generator group defined as: food and beverage, convenience and specialty retail, and duty-free concessions.
Waste collection point	Central sites at the Airport with garbage compactors, commingled recycling compactors, and compostable waste dumpsters.
Commingled recycling	Waste that is discarded with the intention of sending it to a facility that processes commingled materials for recycling.
Compostables	Waste that is fully biodegradable in an aerobic environment. Examples include food scraps, food-soiled paper, landscaping waste, wood waste, and certain bio-plastics.[2]
Composting	Waste that is discarded with the intention of sending it to a facility that processes compostables into a usable compost product.
Construction and demolition (C&D) debris	Non-hazardous waste, including clean soil and waste generated by construction, renovation, or demolition activities.
Diversion	To redirect a material for reuse, recycling, or composting instead of disposing it as waste.
Garbage	Waste that is discarded with the intention of sending it to a landfill.
Hazardous waste (HW)	Waste defined by the federal or state government as hazardous. Hazardous waste is commonly discussed with hazardous materials (representing hazardous waste before it becomes a waste) as hazardous waste and materials (HWM).
Municipal solid waste (MSW)	Waste that is not hazardous and was not generated by construction, renovation, or demolition activities. While FAA guidelines for SWMPs include C&D debris in the definition of MSW, the Airport's SWMP limits the definition to have a unique, recognizable term that signifies non-hazardous waste generated by everyday activities.
Planning period	The planning period for this analysis is 2016 through 2034.
Recycling	Processing used materials into new products. For example, recycling plastic bottles into carpet, or aluminum cans into aluminum cans.

[2] Cedar Grove Composting, the Airport's compostable waste hauler, defines specific materials that fully biodegrade in their large-scale commercial composting process.

Term or Abbreviation	Explanation
Recycling rate	The percent of all waste generated that is recovered for recycling or composting.
Sectors	Areas of the Airport with similar uses and waste generation characteristics. The Airport is divided into four sectors: ▪ Airfield—primarily aircraft and ground support operations ▪ Terminal—operations in the terminal including public areas, airport dining and retail tenants, airline tenants' indoor operations, and Airport administration ▪ Remote sites—air cargo operations, taxi stand, and others ▪ CIP construction— Capital Improvement Program (CIP) offices including engineering, logistics, and west-side field offices
System change	System changes include shifting waste between collection points (operational change), making capital improvements to create additional space for larger or additional containers at collection points, or installing new waste handling technology. System changes do not include increasing collection frequency or increasing container size without capital improvements.
Waste	Any materials that are discarded, whether as garbage, recycling, or composted.
Wasteshed	Adjacent waste collection points between which waste could be shifted if one collection point requires additional capacity. A wasteshed is similar to a watershed, in that all waste in the wasteshed is transported to those collection points.

Appendix B. Growth Forecast and Capacity Analysis Methodology

This document presents the methodology Cascadia Consulting Group (Cascadia) used to develop growth forecasts and conduct capacity analyses to inform planning for future waste management infrastructure needs at the Seattle-Tacoma International Airport (the Airport).

B.1. Background and Objectives

Because Airport passengers are expected to increase substantially in the near future, the Airport must prepare for future waste handling infrastructure needs and investments. To help the Airport anticipate those needs, Cascadia:

- Forecasted Airport solid waste tonnages and utility metrics through 2034 (the project-planning period).
- Determined current Airport solid waste utility system (system) capacity including subtotals for each sector (e.g., terminal, airfield), collection point (e.g., Main Service Tunnel, Central Terminal North), and aggregate total.
- Forecasted when future solid waste volumes might approach and exceed current system capacity (for entire system, each sector, and each specific collection point) and system implications.
- Identified key constraints and feasibility considerations for strategies to enhance solid waste system capacity.
- Identified strategies to expand or enhance solid waste system capacity and analyze their potential to extend current capacity.
- Developed recommendations and associated schedule to maintain adequate system service levels throughout the project-planning period.

This methodology addresses modeling terminal and airfield municipal solid waste metrics based on historical trends. Hazardous waste and construction and demolition (C&D) debris were not included because the generation of these waste streams depends on many factors besides Airport passengers.

B.2. Growth Forecasting Methodology

This section describes the steps Cascadia used to forecast total quantities of garbage, commingled recycling, and compost for the Airport as a whole. Cascadia applied the same principles to other regularly generated municipal solid waste streams (such as source-separated recycling and food donation) but not to hazardous waste or C&D debris. This forecast was conducted using Microsoft Excel.

To conduct forecasts for subgroups (such as individual collection points), Cascadia analyzed the most recent year (2015) of complete data provided by the Airport and allocated percentages to the different

subgroups. These percent allocations were applied to the overall future forecasts to estimates splits between the different subgroups identified.

Step 1. Define Study Universe of Waste Streams and Locations

Waste Streams

The universe of waste streams for this forecast include garbage, commingled recycling, and composting. Airport staff also provided data regarding regularly generated source-separated materials, such as donated food and cooking oil, which has been be incorporated into the growth forecast but not the capacity analysis.

Hazardous waste and C&D debris were not included because they are expected to vary more strongly with other trends, such as Airport construction, than with trends in passenger counts. These materials would not be disposed of in the Airport's regular garbage compactors or dumpsters.

Note: During a program transition period in 2013, the Airport changed recycling service providers multiple times and initiated major construction projects that affected waste handling procedures in the Central terminal area. These events caused significant disruptions to airport waste handling practices in the Central Terminal North and South areas, which led to confusion among tenants and contamination of recycling and compost waste streams. Airport staff consider data from this period to be unrepresentative of typical conditions. In addition, Airport staff considered the level of effort to compile container-specific data from disposal records received from multiple hauler's during this period to be excessive relative to value of including data in the study. Cascadia staff confirmed the absence of this data would not significantly affect forecasting and capacity analysis activities or results. For these reasons, Port and Cascadia staff agreed to exclude 2013 solid waste data from the growth forecasting.

Airport Areas or Waste Collection Sites

All regular compactors, dumpsters, and other solid waste containers managed by the Airport were included in this growth forecast. Cascadia forecasted waste generation for the whole Airport, in addition to providing separate results for individual collection areas sorted by predetermined sectors (Airfield, Terminal, Remote Sites, and CIP Construction).

Step 2. Collect Data

Cascadia obtained Excel spreadsheets, maps, and qualitative data from the Airport that informed the growth forecast. Table 17 outlines key data sets, relevant timeframes, and brief summaries of documents provided by the Airport.

Table 17. Key Growth Modeling Data Inputs

Type	Dataset	Filename	Timeframe	Description	Use(s)
Airport Dining and Retail (ADR)	Concession Master Planning Spreadsheet	LG2 LG3 Host Hudson Roster as of Mar 29 2016.xls	Current as of May 2016	List of existing vendors including location, lease expiration date, type, annual revenue, and square footage	Lease expiration dates and new vendor information were compared with usage analysis to refine forecasted waste generation.
Infrastructure	Solid Waste Container Inventory and Collection Schedule	SEA_Airport_GarbageRecyclingServiceSchedule_20150923.xls	Current as of May 2016	Master list of compactors, containers, and current collection schedule	Collection schedule was used to determine current and maximum container capacity profiles.
	Sketch of Current Wastesheds	Wasteshed Sketch.pdf	Current as of May 2016	Hand-drawn map provided by Airport staff outlining current wastesheds	Sketch informed existing universe boundaries and defined wastesheds for analysis.
	Janitorial Staff Narrative of Waste Pathways	Email	Current as of May 2016	Email provided by janitorial staff (ABM) identifying current procedures for breakdowns and capacity overflow issues	Narrative was used to identify waste overflow locations and alternative collection points.

Type	Dataset	Filename	Timeframe	Description	Use(s)
Passengers	Historical Passenger Counts	Historic Passenger Counts.pdf	2002 to 2015	Table outlining total domestic and international passengers for 2002 to 2015	Passenger counts were used to identify historical correlation with waste generation.
	Forecasted Passenger Counts	SEA SAMP FORECASTS DRAFT 09 17 2015 (2)_Forecasted Passenger Counts.pdf	Current as of May 2016 (forecasted through 2034)	Table 6-1 contains detailed passenger forecast numbers through 2034	Passenger counts were used to forecast future waste generation based on historical collection.
	Updated Passenger Forecasts	Email	2016 to 2034	Updated passenger forecasts provided by the Airport's Planning Department.	Updated passenger counts were used to refine forecasted waste generation.

Type	Dataset	Filename	Timeframe	Description	Use(s)
Waste Data	Container Fullness Estimates	SEA_Airport_GarbageRecyclingServiceSchedule 6.1.16.xls	Current as of May 2016	Estimates of container fullness levels from Airport janitorial service provider (ABM). Most recent iteration (6/1/16) contains qualitative estimates of maximum capacity by collection area.	Compost fullness estimates were used to determine percentage generation split between different collection areas. Container fullness estimates were used to forecast current generation for Remote Sites and CIP Construction containers.
	Waste Tonnage Reports	CR_SeaTac Airport Tonnage Report.xls	2014 to 2016	Monthly tonnage reports by container	Input for historical recycling generation estimations.
	Compost Tonnage Reports	SEA Compost Tonnage2011-2016.xls	2009 to 2016	Monthly tonnages provided by Cedar Grove	Input for historical compost generation estimations.
	Recycling Tonnage Reports	Seadrunar Recycling Data.xls	June 2008 to December 2011	Commingled recycling pounds per month by compactor location	Input for historical recycling generation estimations.
	Historical Diversion and Generation Analysis	Terminal v Airfield Waste and Recycling Tracking.xls	2010 to 2015	Quantities of waste by disposal stream (terminal vs. airfield), with monthly and annual summaries and supporting tables and charts	Input for historical waste generation estimations.
	Unconstrained Waste Forecast	SEA Waste Forecast.xls	Current as of May 2016 (forecasted through 2034)	Unconstrained forecast based on tons per passenger conducted during Sustainable Airport Master Plan (SAMP) development in 2016	Point of comparison for Cascadia's constrained forecast.

Step 3. Calculate Historical Generation Rates in Pounds per Passenger (PPP)

Cascadia calculated the total pounds of waste generated per passenger using historical passenger counts and waste generation data. For every year of waste generation and passenger data, Cascadia added the tons per year from all waste streams and areas within the study universe defined in Step 1. Cascadia divided the totals by the number of passengers in that year to obtain the pounds per passenger (PPP) generated per year.

Step 4. Calculate Historical Diversion Rates, by Waste Stream

Cascadia calculated the percentage of the total waste stream diverted by key diversion methods (such as commingled recycling, composting, and other diversion). Diversion rates were calculated on a stream-by-stream basis to be used in further analysis.

For each year of data, the tons of each diverted stream were divided by the total tons of waste generated. For example, to calculate the commingled recycling diversion rate, tons of commingled recycling were divided by the sum of tons of garbage, commingled recycling, composting, and other diverted materials.

These diversion rates were representative of typical operations.

Step 5. Forecast Future Quantities of Waste Generated

Cascadia used the data provided in Table 17 to forecast future waste generation. This section outlines the overall approach to forecasting the future tons of waste generation and identifies how individual datasets were incorporated into this analysis.

Estimating the Decreasing Trend in Waste Generation

Using Microsoft Excel, Cascadia calculated the average decrease in waste generation rates (in PPP) for the years 2010 to 2016 (excluding 2013). This was calculated as the Compound Annual Growth Rate (CAGR), rather than the mathematical average. CAGR is preferable to the arithmetic mean because it limits the volatility of future shifts from forecasted passenger counts.

Future Total Tons of Waste Generated

Cascadia forecasted the total tons of waste generated in future years by multiplying the forecasted total generation rates (in pounds per passenger) by the numbers of passengers forecasted for that year.

Modifying the Forecast

In order to account for historic trends increasing diversion, implementation of the 2014 Solid Waste Management Plan (SWMP) recommendations, and planned expansion of Airport Dining and Retail (ADR) space and Cascadia conducted additional analyses to further refine the forecasts.

Estimating the Increasing Trend in Diversion

Using Microsoft Excel's TREND function, Cascadia calculated the average increase in the percentage of waste diverted for the years 2010 to 2015 (excluding 2013). This diversion rate was applied to total generation to estimate an initial split between garbage versus commingled recycling or composting.

Estimating the Impact of Recommended 2014 SWMP Strategy Implementation

Airport staff provided estimated years for the implementation of select waste reduction and diversion strategies from the 2014 SWMP. Cascadia calculated the impact of these strategies and the quantities of waste that would be diverted to recycling, composting, and source reduction. These changes and the years they took place are used to further refine the overall waste forecasts by increasing diversion rates accordingly.

Estimating the Impact of Planned ADR Expansions

Cascadia calculated the historical quantities and composition of waste associated with Food & Beverage space as determined by the 2013 STIA waste characterization study. While 2013 data are not ideal for reasons described in Step 1, 2013 is the only year for which composition data are available. The result of this calculation was a generation rate in pounds per square foot for divertible materials identified in the characterization study. These generation rates were applied to the anticipated changes in square footage associated with Food & Beverage vendors to estimate that increase in waste generation by year that the expansion would cause.

Future Estimated Disposal Costs

Cascadia used historical data on the cost per ton to dispose, recycle, and compost waste provided by Airport staff to forecast estimated disposal or processing costs for garbage, recycling, and compost tonnage. The Airport finance staff plans for a 3% annual increase in garbage and compost disposal fees, which Cascadia used to escalate projected future cost.

Future Cubic Yards of Waste Generated

Final results are presented in tons and cubic yards. In order to convert waste tonnages to cubic yards, Cascadia used a combination of the density factors presented in Table 18. All conversion factors are for commercial waste.

Table 18. Density Conversion Factors, by Stream

Stream	Pounds per Cubic yard	Source
Composting (not compacted)	350	Cedar Grove Estimate, per communication August 2016
Composting (compacted)	700	Cedar Grove Estimate, per communication October 2016
Garbage (not compacted)	124	Cascadia garbage study for State of California (2008)
Garbage (compacted)	411	Average density of Airport compactors when serviced (2009 to 2016)
Recycle (not compacted)	88	Cascadia recycling study for private hauler (2013)
Recycle (compacted)	367	Average density of Airport compactors when serviced (2009 to 2016)

Step 6. Graphical Analysis and Expert Review of Results

Cascadia created a series of charts and graphs that append forecasts onto historical data for total tons generated, tons disposed of as garbage and diverted to each diversion stream, total pounds generated per passenger, pounds generated per passenger by waste stream, and percentage of waste disposed of as garbage and diverted to each diversion stream.

These graphs were reviewed with Airport Environmental staff familiar with the Airport's waste system and waste history to identify outliers, changes in the relationship between waste and passengers, unrealistically low quantities of waste disposed of as garbage, and other results that seem improbable. Cascadia reviewed and incorporated this feedback, and has included it in the final model.

B.3. Capacity Analysis Methodology

This section describes the steps Cascadia took to determine when and where the Airport is forecasted to need to increase waste collection capacity. This analysis assesses existing container capacity (a combination of container size and collection frequency) of to forecast shortfalls at each waste container that cannot be handled by increasing collection frequency alone. This methodology applies only to waste generated within the same universe defined for growth forecasts.

Step 1. Data Collection

The Airport provided additional data to supplement the growth modeling data that informed the capacity analysis. Table 19 outlines these additional datasets along with their relevant timeframes and brief descriptions and summaries of uses.

Table 19. Key Capacity Analysis Data Inputs

Type	Dataset	Filename	Timeframe	Description	Use(s)
Infrastructure	Solid Waste Container Inventory and Collection Schedule	SEA_Airport_GarbageRecyclingServiceSchedule_20150923.xls	Current as of May 2016	Master list of compactors, containers, and current collection schedule	Collection schedule will be used to determine current and maximum container capacity profiles.
	Sketch of current wastesheds	Wasteshed Sketch.pdf	Current as of May 2016	Hand-drawn map provided by SEA staff outlining current wastesheds	Sketch will inform existing universe boundaries and define wastesheds for analysis split.
	Janitorial Staff Narrative of Waste Pathways	Email	Current as of May 2016	Email provided by janitorial staff (ABM) identifying current procedures for breakdowns and capacity overflow issues	Narrative will be used to identify waste overflow locations and alternative collection points.
	Maximum Collection Schedule	Email	Current as of May 2016	Emails provided by Recology and Cedar Grove outlining maximum collection schedules	Input data for maximum collection frequency.
	Maximum Container Size	SEA_Airport_GarbageRecyclingServiceSchedule 6.1.16.xls	Current as of May 2016	Estimates provided by janitorial staff (ABM) identifying the maximum container size for each collection point and waste stream	Input data for maximum container size.
Waste Data	Container Fullness Estimates	SEA_Airport_GarbageRecyclingServiceSchedule 6.1.16.xls	Current as of May 2016	Estimates of container fullness levels provided by janitorial staff (ABM)	Input data for maximum capacity calculations.

Step 2. Create Capacity Profiles by Collection Location

Cascadia estimated the existing capacity for each collection location by reviewing and confirming container and compactor sizes and locations with Airport Environmental staff and the Airport's janitorial contractor. Maximum capacities were estimated at three different thresholds:

- *Current capacity*: Cascadia estimated the current volumetric capacity based on current container size and current collection frequency. Upon reaching this threshold, the Airport would increase collection frequency.
- *Maximum capacity with increased collection frequency:* Cascadia estimated the maximum number of pickups for each container based on interviews with the Airport's haulers. These maximum frequencies were reviewed and modified by Airport Environmental staff to account for any operational constraints. Upon reaching this threshold, the Airport would enlarge containers.
- *Maximum capacity with increased container size:* Cascadia estimated the maximum capacity with increased container size by analyzing data provided by the Airport's janitorial contractor regarding the size of collection locations and potential for additional bins or an increase in container size. Maximum container size was combined with the maximum collection frequency to create a final threshold. Upon reaching this threshold, the Airport would need to make system changes.

Step 3. Forecast the Years in Which Thresholds are Reached

Cascadia combined the capacity profiles for each collection point with the forecasted annual volumes by collection location to forecast in which year (if at all) each collection point would reach the thresholds described in Step 2 for each waste stream.

Step 4. Research Additional Strategies to Address Capacity

In addition to increasing collection frequency, increasing the amount or size of collection containers, shifting waste to alternate collection locations, and making capital investment to increase the size of collection areas, Cascadia conducted web-based research interviewed industry experts to identify and evaluate alternative solutions for collecting and processing excess waste. Experts included Seattle-area haulers, institutional recycling managers, and vendors that sell these alternative technologies

B.4. Modeling Examples and Resources

Cascadia reviewed solid waste growth models in the following plans when developing the growth forecasting methodology for this project.

- Spokane County (WA), "2015 Spokane County Solid Waste and Moderate Risk Waste Management Plan," (2014) available at http://www.spokanecounty.org/data/utilitiessolidwaste/Draft%20Final-Spokane%20County%202015%20Solid%20Waste%20Management%20Plan.pdf.

- County of Fairfax (VA), "2015 Solid Waste Management Plan Update for Fairfax County, Virginia," (2015) available at http://www.fairfaxcounty.gov/dpwes/trashplan2015/draft-county-2015-update-submittal.pdf.

- Pierce County (WA), "Pierce County Waste Trends & Disposal Projections." (2013) available at https://www.co.pierce.wa.us/DocumentCenter/View/22596.

- Los Angeles World Airport, "LAX Master Plan EIS/EIR: 10. Solid Waste Technical Report," (2001) available at http://www.lawa.org/uploadedFiles/OurLAX/Past_Projects_and_Studies/Past_Publications/Draft%20EIS-EIR_T10_LR.pdf.

Appendix C. Alternative Scenarios for Projecting Total Waste Tonnages

This document presents alternative scenarios for projecting total tons of MSW generated at Seattle-Tacoma International Airport (STIA). In the results, quantities for 2010–2015 reflect historic actuals, quantities for 2016 reflect a projection based on the unprecedented growth between January and July 2016, and quantities for 2017–2034 reflect projections based on the assumptions described below.

All scenarios contain the same assumptions regarding the effects of an increase in ADR Concessions square footage and the adoption of waste diversion strategies from STIA's Solid Waste Management Plan (SWMP). The scenarios vary in assumptions (described in each scenario summary) regarding per-passenger waste generation rates and projections of total passengers for 2017–2034.

Selected Forecast Scenario:

Airport Planning Department staff selected Scenario 6, which uses:

- **New passenger counts and projections** provided by STIA's Planning Department in August 2016.
  - These passenger counts avoid an unrealistic decrease in passengers in 2017
- **Trended waste generation rate.**
  - This rate incorporates the trend at STIA (corresponding to a statewide and national trend) that waste generated per passenger has decreased on average from 2010–2016.[3]
  - Using a rate that incorporates the decreasing per-capita generation trend may offset potential overestimates due to overestimates of passenger projections; however, it may also create unexpected capacity issues if the trend does not continue.

Numerical Results

Year or Scenario	Passengers (pass.)	Generation lbs per pass.	Disposal (tons)	Recycling (tons)	Organics (tons)	Other MSW Recovery (tons)
2010	31,553,166	0.460	5,935	998	194	129
2016	46,723,921	0.433	7,476	1,733	553	361
2034 (1)	65,647,200	0.362	4,839	4,005	2,876	753
2034 (2)	65,647,200	0.425	5,581	4,686	3,356	882
2034 (3)	69,411,918	0.425	5,901	4,955	3,549	933
2034 (4)	65,647,200	0.425	5,581	4,686	3,356	882
2034 (5)	69,411,918	0.362	5,116	4,235	3,041	796
2034 (6)	65,647,200	0.385	5,111	4,254	3,052	800
2034 (7)	65,647,200	0.426	5,597	4,700	3,366	885

[3] For examples of the statewide and national trend, see Table 4.1 of Washington Department of Ecology, "Solid Waste in Washington State – 23rd Annual Status Report," published December 2014 (https://fortress.wa.gov/ecy/publications/documents/1407035.pdf). Also see Figure 1 of United States Environmental Protection Agency, "Advancing Sustainable Materials Management: 2013 Fact Sheet," published June 2015. (www.epa.gov/sites/production/files/2015-09/documents/2013_advncng_smm_fs.pdf).

The following sections present the assumptions, benefits, limitations, and a graphical representation of passenger and waste projections for each of the seven scenarios.

C.1. Official Passenger Projections with Trended Per-Passenger Generation Rate

Key Assumptions 2017–2034

Passenger counts: official projections

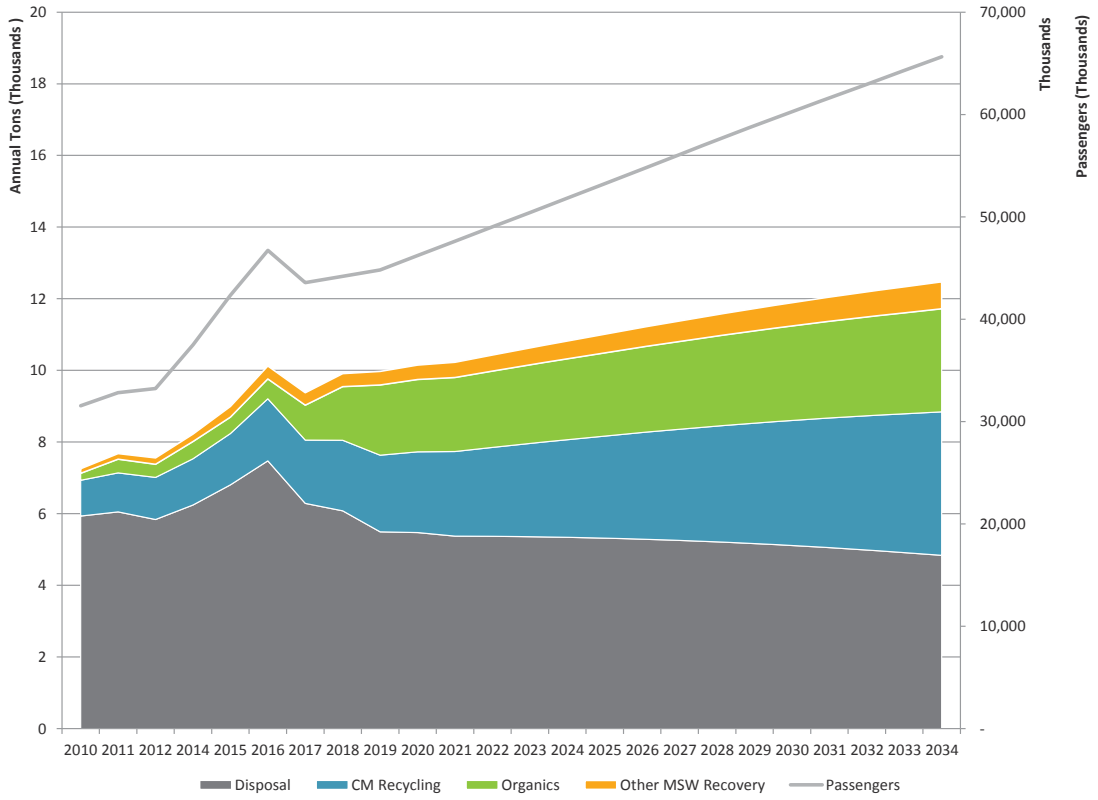
Per-passenger waste generation: Trended to decrease 0.99% per year, in line with the 2010–2016 average trend. (Note, the previous version used a more aggressive linear trend.)

Benefits

Incorporates the trend at STIA that waste generated per passenger has decreased on average from 2010–2016. STIA's decrease corresponds to a broader statewide and national trend of decreasing waste per capita.

Limitations

It appears unrealistic to project that passenger counts will drop so substantially in 2017.



C.2. Official Passenger Projections with Static Per-Passenger Generation Rate

Key Assumptions 2017–2034

Passenger counts: official projections

Per-passenger waste generation: Held static at the 2015 rate of 0.425 lbs/passenger.

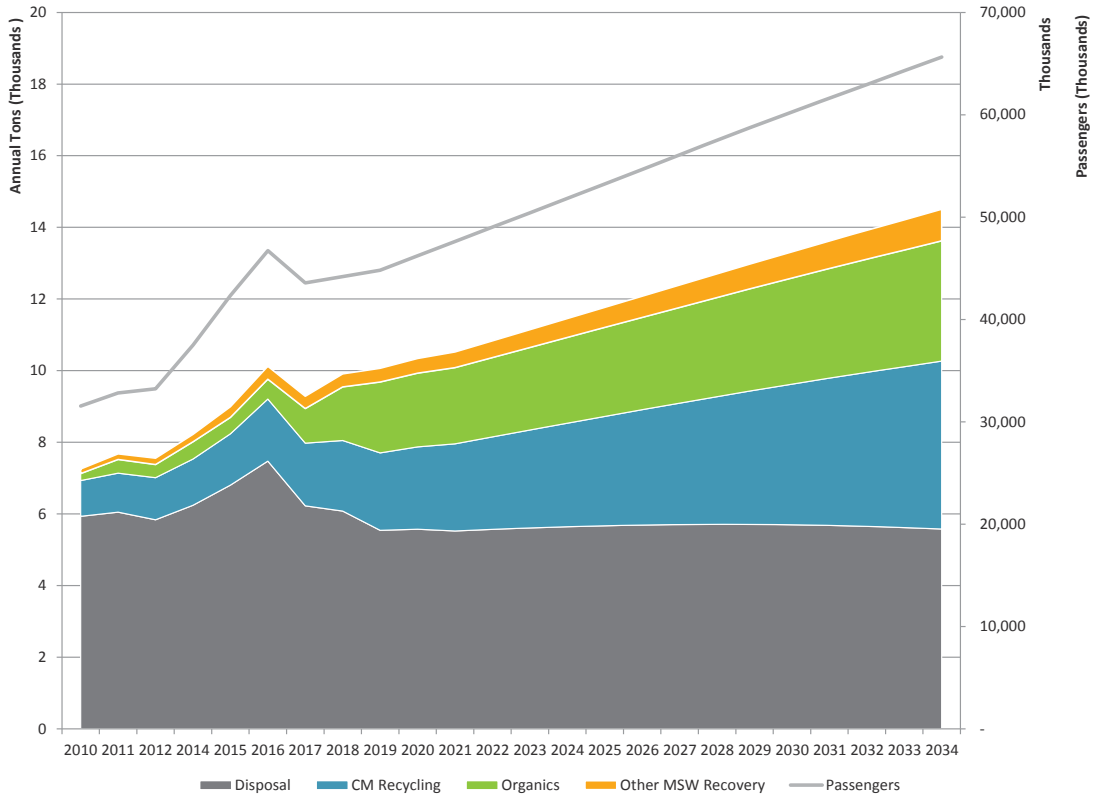
Benefits

Simpler method to project per-passenger waste generation.

Limitations

Does not incorporate trends in per-person waste generation rates trend seen at STIA and elsewhere.

It appears unrealistic to project that passenger counts will drop so substantially in 2017.



C.3. Alternative 1 Passenger Projections with Static Per-Passenger Generation Rate

Key Assumptions 2017–2034

Passenger counts: Modified to increase passenger counts by 3,764,718, the number of additional, unexpected passengers in 2016; the annual growth rate (slope) matches the official projections.

Per-passenger waste generation: Held static at the 2015 rate of 0.425 lbs/passenger.

Benefits

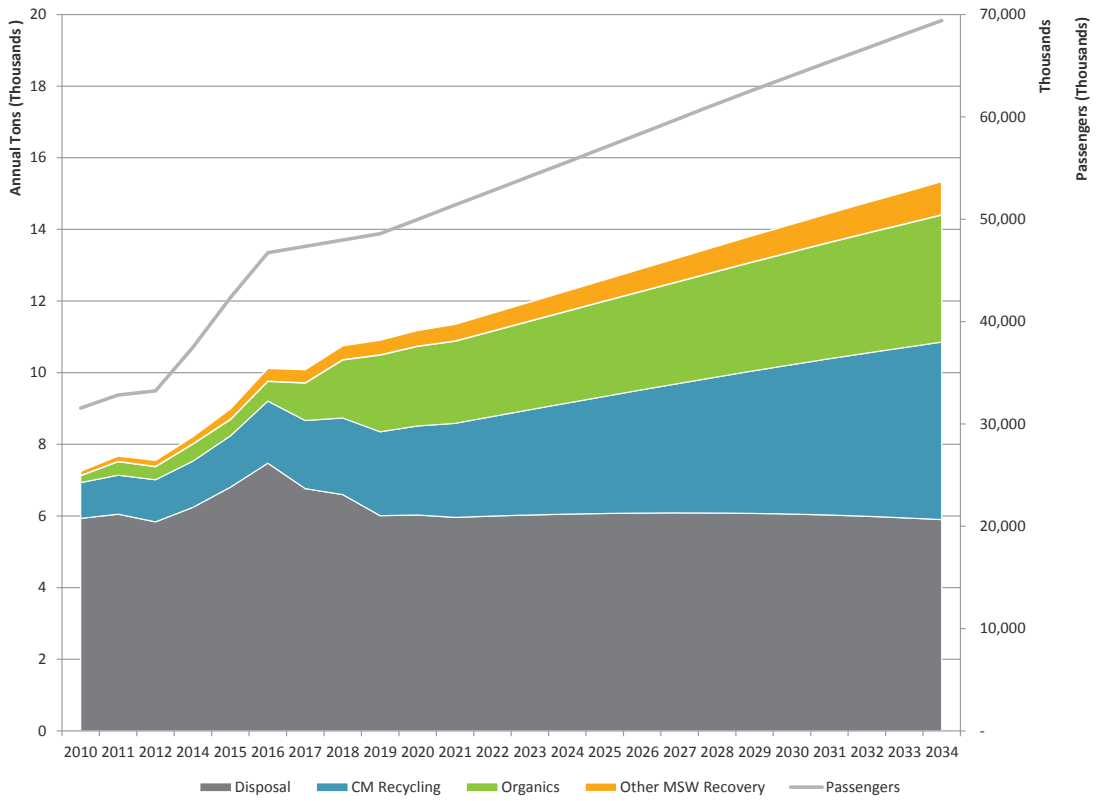
Avoids an unrealistic decrease in passengers in 2017 while maintaining the same year-over-year growth trend (slope) as the official passenger projections after adjusting for a one-time increase in 2016.

Simpler method to project per-passenger waste generation.

Limitations

Does not incorporate trends in per-person waste generation rates trend seen at STIA and elsewhere.

May overestimate passengers and waste in 2034 if the long-term projection for 2034 is accurate but did not sufficiently front-load growth into the near term.



C.4. Alternative 2 Passenger Projections with Static Per-Passenger Generation Rate

Key Assumptions 2017–2034

Passenger counts: Modified to incorporate the unexpected increase in passengers in 2016 while maintaining the long-term projection of 65,647,200 passenger in 2034.

Per-passenger waste generation: Held static at the 2015 rate of 0.425 lbs/passenger.

Benefits

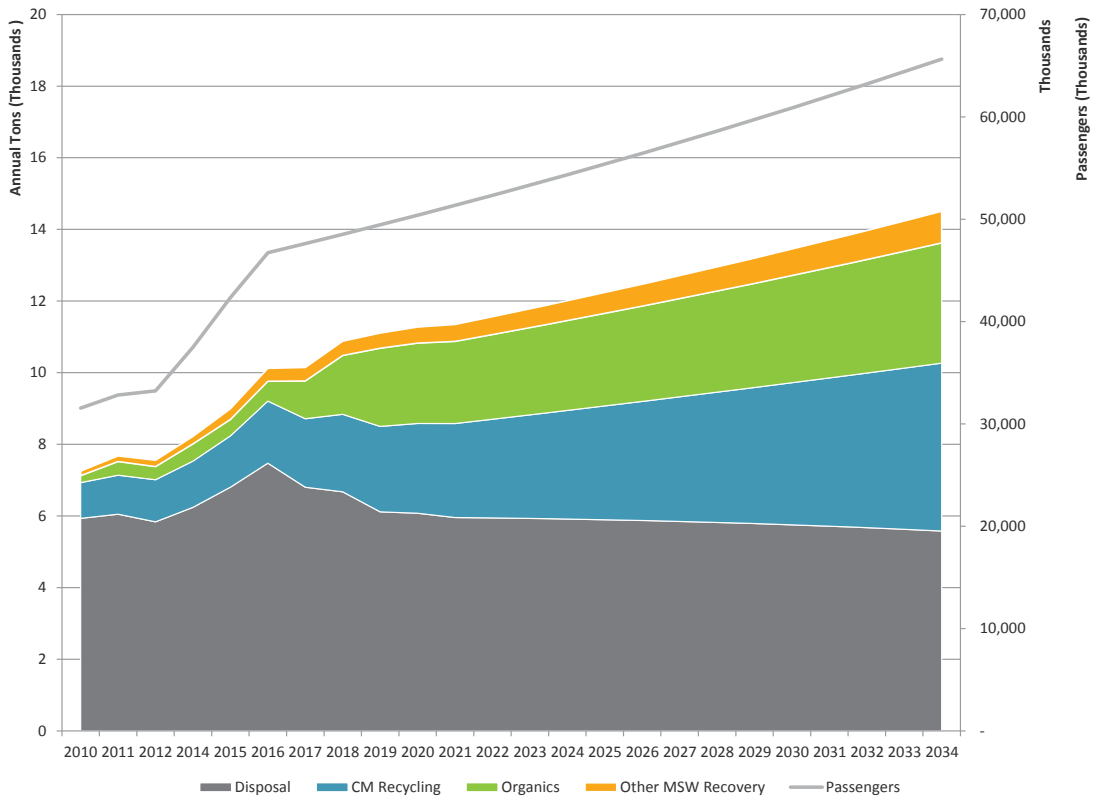
Avoids an unrealistic decrease in passengers in 2017 while maintaining the same long-term passenger projections for 2034.

Simpler method to project per-passenger waste generation.

Limitations

Does not incorporate trends in per-person waste generation rates trend seen at STIA and elsewhere.

May underestimate passengers and waste, particularly in the short term, if passenger growth continues to substantially exceed projections.



C.5. Alternative 1 Passenger Projections with Trended Per-Passenger Generation Rate

Key Assumptions 2017–2034

Passenger counts: Modified to increase passenger counts by 3,764,718, the number of additional, passengers in 2016; the annual growth rate (slope) matches the official projections, as in Scenario B.

Per-passenger waste generation: Trended to decrease 0.99% per year, in line with the 2010–2016 average trend, as in Scenario A. (Note, the previous version used a more aggressive linear trend.)

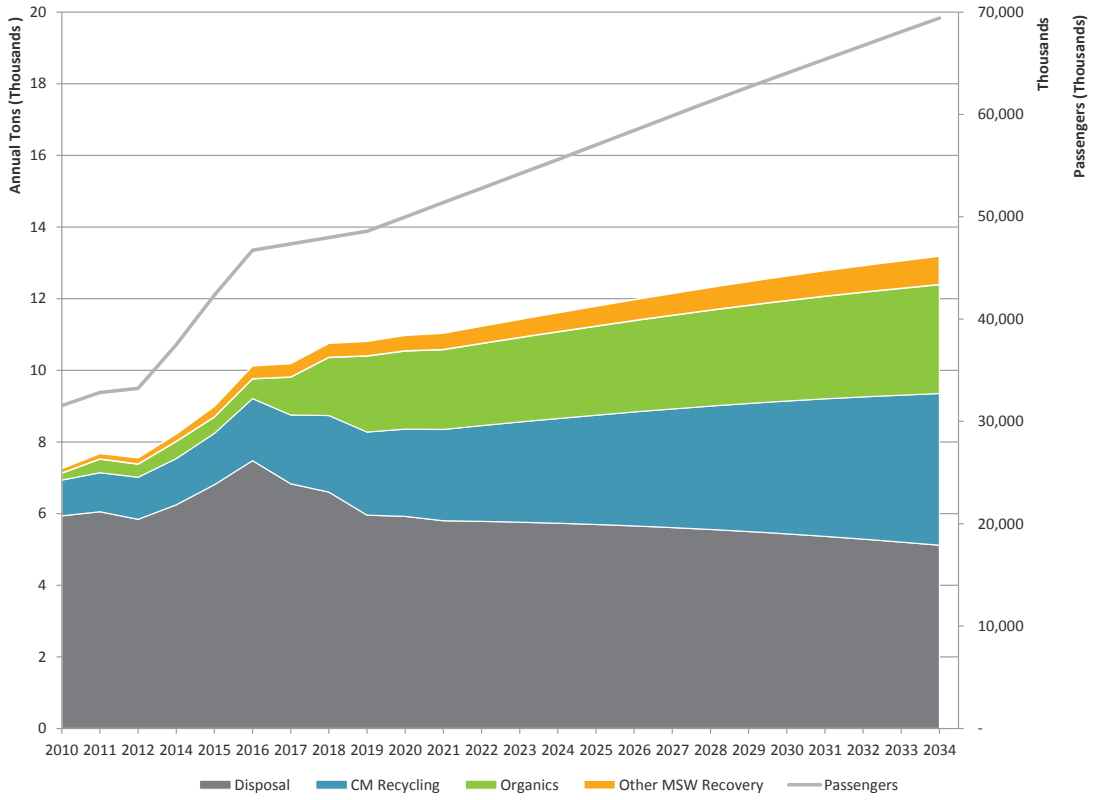
Benefits

Incorporates the trend at STIA (corresponding to a statewide and national trend) that waste generated per passenger has decreased on average from 2010–2016; combining a decreasing per-capita generation trend may also offset potential overestimates due to overestimates of passenger projections.

Avoids an unrealistic decrease in passengers in 2017 while maintaining the same year-over-year growth trend (slope) as the official passenger projections after adjusting for a one-time increase in 2016.

Limitations

May overestimate passengers if the long-term projection for 2034 is accurate but did not sufficiently front-load growth into the near term.



C.6. Revised Official Passenger Projections with Trended Per-Passenger Generation Rate

Key Assumptions 2017–2034

Passenger counts: Uses new passenger counts and projections provided by STIA's Planning Department.

Per-passenger waste generation: Trended to decrease 0.74% per year, in line with the 2010–2016 average trend. (Note: changes in the passenger projections for 2016 since the original scenario analysis—from 46,723,921 passengers to 46,018,088 passengers—affected the generation trend.)

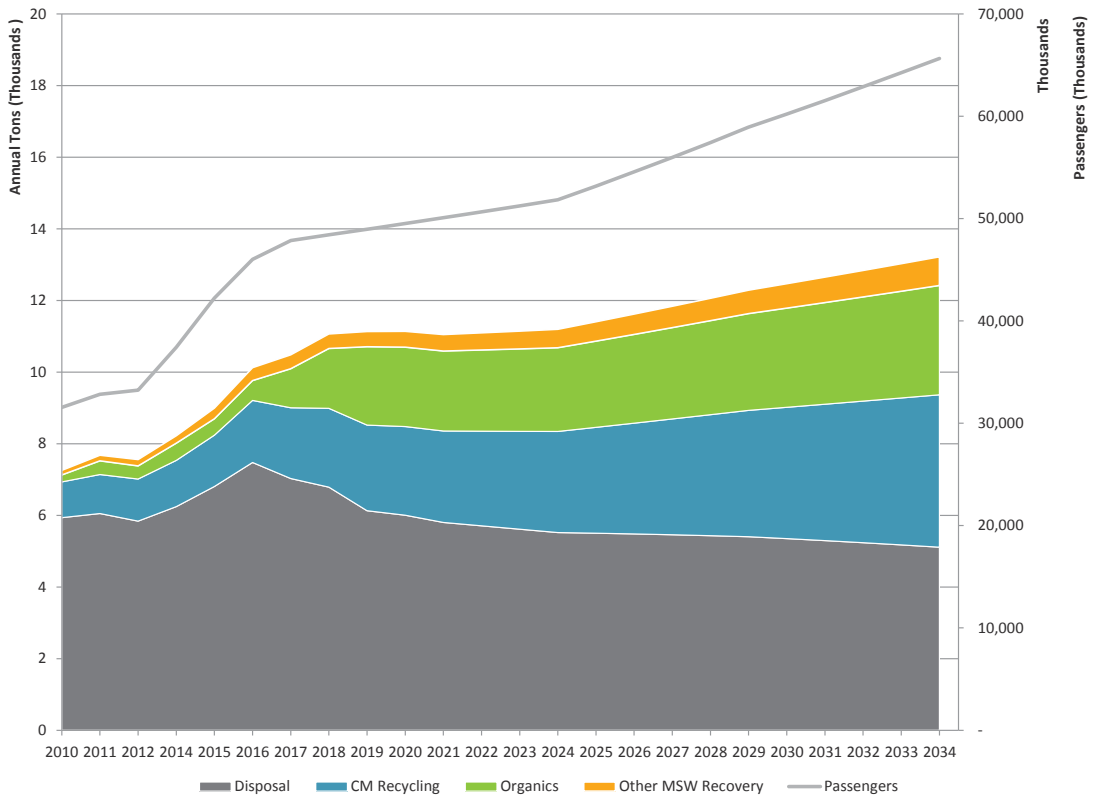
Benefits

Incorporates the trend at STIA (corresponding to a statewide and national trend) that waste generated per passenger has decreased on average from 2010–2016; combining a decreasing per-capita generation trend may also offset potential overestimates due to overestimates of passenger projections.

Uses revised official passenger projections that avoid an unrealistic decrease in passengers in 2017.

Limitations

May underestimate waste quantities if the trend of decreasing waste per passenger does not continue.



C.7. Revised Official Passenger Projections with Static Per-Passenger Generation Rate

Key Assumptions 2017–2034

Passenger counts: Uses new passenger counts and projections provided by STIA's Planning Department.

Per-passenger waste generation: Held static at the 2015 rate of 0.426 lbs/passenger. (Note: changes in the passenger counts for 2015 since the original scenario analysis—from 42,340,537 passengers to 42,217,512 passengers—affected the generation rate slightly.)

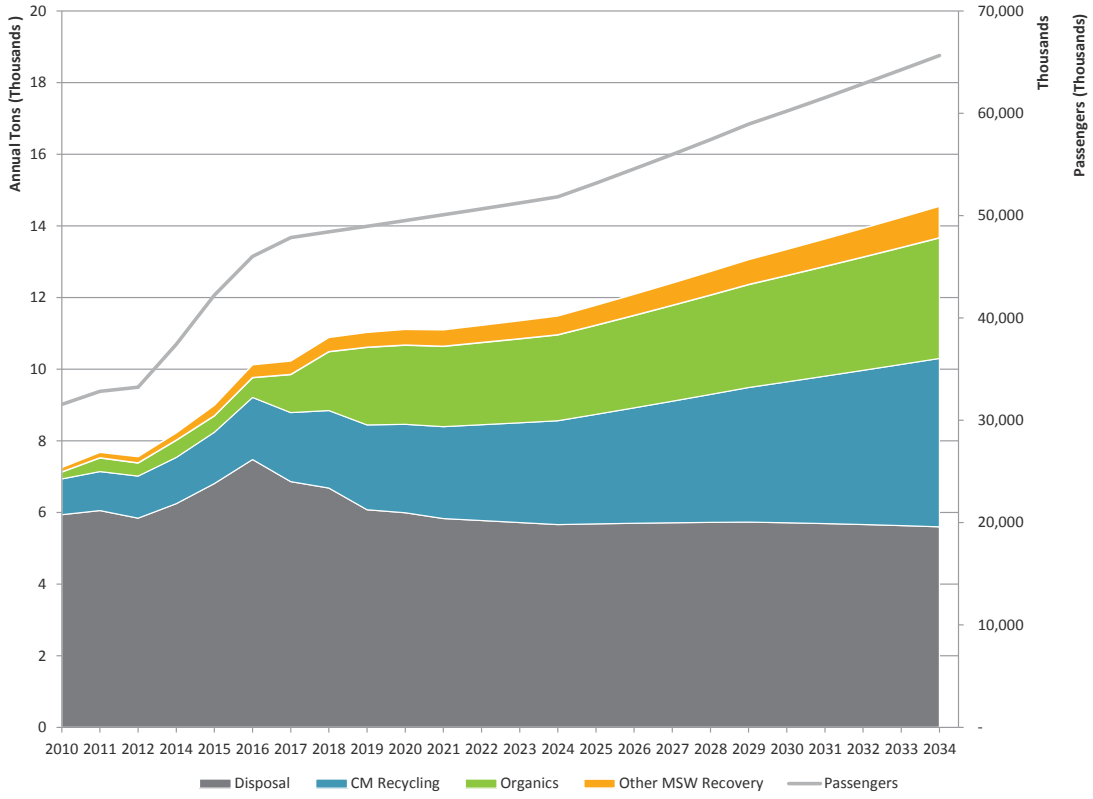
Benefits

Simpler method to project per-passenger waste generation. Provides a conservative estimate of waste quantities.

Uses revised official passenger projections that avoid an unrealistic decrease in passengers in 2017.

Limitations

May overestimate waste quantities if the trend of decreasing waste per passenger continues.



4” Round Sticker

9” W x 3” H Rectangle Sticker

18” W x 4” H Rectangle Sticker

Client: Port of Seattle, SeaTac Airport Envonmental

Project: Airport Food+ Communications Stickers

TCi Design+Branding

4” Round Sticker

9” W x 3” H Rectangle Sticker

18” W x 4” H Rectangle Sticker

Client: Port of Seattle, SeaTac Airport Envonmental

Project: Airport Recycling Communications Stickers

TCi Design+Branding

4” Round Sticker

9” W x 3” H Rectangle Sticker

18” W x 4” H Rectangle Sticker

Client: Port of Seattle, SeaTac Airport Envonmental

Project: Airport Garbage Communications Stickers

TCi Design+Branding

Why Recycle?

Waste reduction and recycling is a key element of the Airport's Environmental Strategy Plan that generates financial, environmental, and social returns.

Tenant Recycling & Food Service Ware Requirements

Recycling and using durable or approved compostable and recyclable food service ware is also a requirement for tenants operating at Sea-Tac.

Visit our website: *www.portseattle.org/Environmental/Materials-Management/Recycling/* for more information about Airport recycling programs, free resources for tenants, and requirements.

Our Recycling Goal

Sea-Tac Airport's goals align with those of communities we serve and further support broader regional and national waste diversion efforts.

Terminal Waste Diversion Rate
60% by 2020

Airfield Waste Diversion Rate
15% by 2020

How to, and where

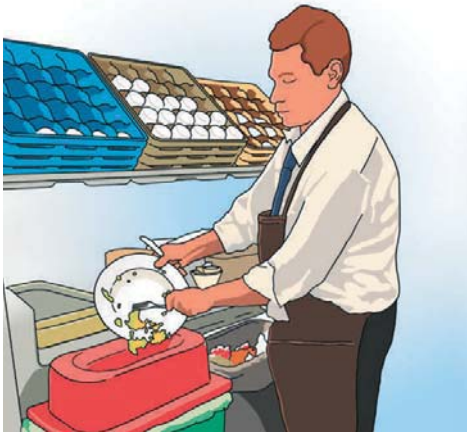
There are many places around the airport where recyclable materials are generated. Tenants can help by placing convenient and clearly marked recycling bins in their leased areas, training staff in airport recycling procedures, and setting goals and celebrating progress with employees.

The airport maintains conveniently located recycling collection areas throughout the main terminal, satellites and airfield. To find out where and what you can recycle, see the fold-out map inside for details.

Benefits of Recycling:

- Reduce waste to landfills. In 2013, 8 million tons of material was collected for recycling in Washington.
- Conserves energy and prevents pollution caused by manufacturing. For every ton of scrap metal recycled, we avoid mining and processing two tons of limestone, iron ore and coal.
- Decreases greenhouse gas (GHG) emissions that contribute to global climate change. According to statewide figures, recycling about 8 million tons of material prevented nearly 3 million tons of GHG emissions.
- Conserves natural resources by reducing the demand for raw materials such as timber, petroleum, water and minerals. By recycling more than 540,000 tons of paper, Washingtonians prevented the use of 9.3 million trees and 3.8 billion gallons of water.
- Saves on disposal fees and may generate revenue from recyclable material.
- Helps sustain the environment for future generations.

(Data courtesy of Washington State Department of Ecology)



FREE RESOURCES

Sea-Tac Airport provides free resources to assist tenants and their employees in achieving our recycling goals.

POSTERS FOR RESTAURANT DINING AREA

(Set of Three/Multiple languages available)

COLLECTION BIN LABELS

PACKAGING, BINS AND SERVICE INFORMATION:

Food Service Ware & Packaging
Contacts for suppliers and manufacturers of compostable and recyclable packaging

Collection Bins
Available in various size and color options

Bag Guidelines
- Black bags for garbage.
- Clear bags for recyclables.
- Approved compostable bags for food & compostables.

Request free posters, bins, and labels by contacting:
recycle@portseattle.org or 206-787-5525

www.portseattle.org/Environmental/Materials-Management

Port of Seattle®

Port of Seattle
Seattle-Tacoma International Airport
17801 International Blvd. S.
Airport Office Building
Seattle, WA 98158
www.portseattle.org/community/environment/

Questions?
Call 206-787-5525
Waste Reduction and Recycling
Aviation Environmental Programs

02/17 2M

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Seattle-Tacoma International Airport

Recycling Guide

www.portseattle.org

WHAT TO RECYCLE AND WHERE?

For key to unlock compactor, call 206-787-6638

Recycling

Cardboard (flattened); magazines, newspapers, mixed paper & shredded paper (bagged); cartons, plastic jars, jugs, bottles & tubs (bagged); plastic bags & shrink wrap (bagged); and aluminum & tin cans (bagged), glass (separate dumpsters available). These items are sent to a local facility for processing and recycling into new products.

TERMINAL: Blue compactors on load docks
AIRFIELD: Blue compactors on ramp.

Food + Compostables

Food, soiled paper, napkins, used coffee grounds, approved compostable bags & service ware and other organic material. These items are sent to a local facility and processed into compost for gardens and landscaping. These items are sent to a local facility for processing and recycling into new products.

TERMINAL: Compost collection bins on load docks.
AIRFIELD: Compost collection bins on ramp.

Garbage

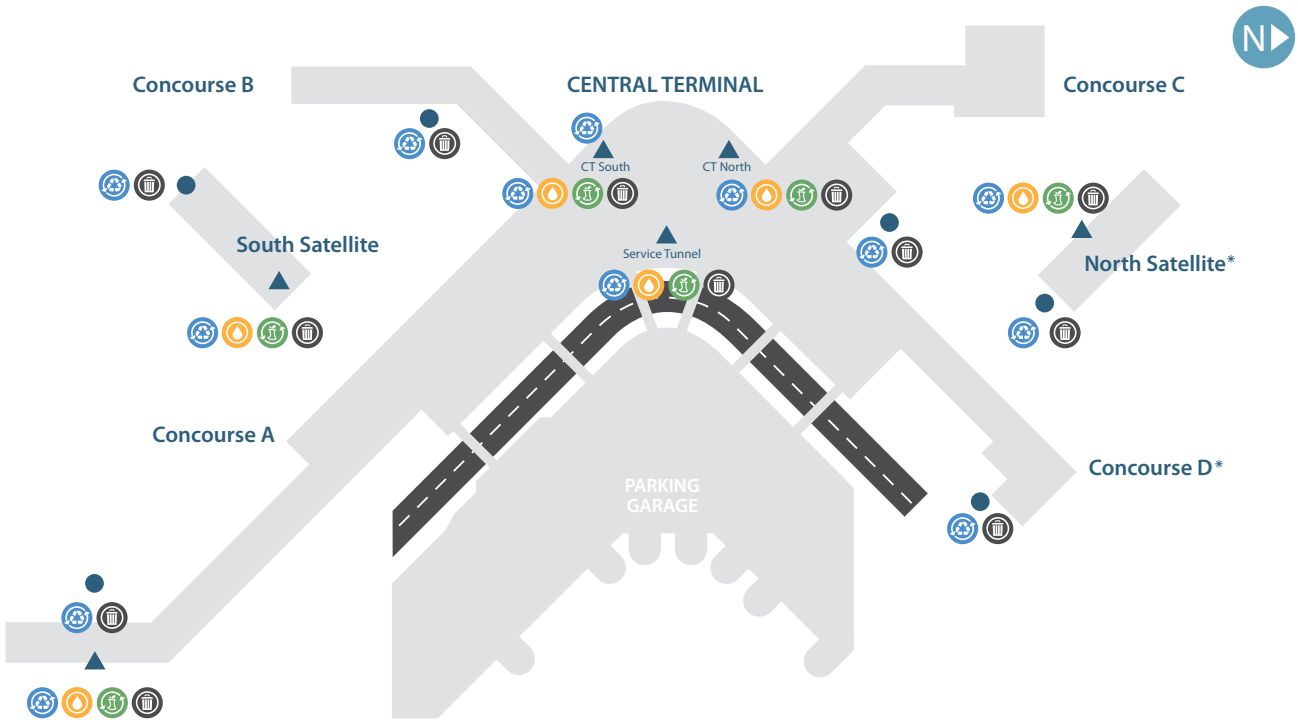
Non-recyclable material such as styrofoam, coffee cups, plastic utensils & food wrappers. These materials are sent King County's Cedar Hills Regional Landfill.

TERMINAL: Tan compactors on load docks.
AIRFIELD: Tan compactors on ramp.

OTHER RECYCLING:

USED COOKING OIL:	Waste cooking oil is converted to bio-diesel. **TERMINAL:** Oil collection tanks on load docks at Concourse A and North & South Satellites, and in Central Terminal trash rooms (ramp level)
METAL (Scrap):	Steel, rebar, aluminum, wire or other metal items that contain a limited amount of non-metallic materials (such as a metal chair with cloth cushion) **TERMINAL:** Green dumpster on service tunnel load dock **AIRFIELD:** Air Cargo 1 & 4.
WOOD (Scrap):	Pallets and untreated or non-painted dimensional lumber **AIRFIELD:** Air Cargo 1 & 4.
FOOD DONATION :	Donate unsold food through the Airport Food Donation Program to help local communities through collaboration with Des Moines Area Food Bank. Place donations in refrigerators in room MT6009BM located above checkpoint 3 on the mezzanine near elevator 3F. For information, call 206-787-5525
OTHER WASTES :	For information on recycling electronics like computers, monitors, laptops & televisions, visit E-Cycle Washington at **ecyclewashington.org.** For information on recycling of fluorescent light tubes and bulbs, visit **ecy.wa.gov/programs/swfa/mercurylights/** For information on disposal of paint, cleaners or other chemicals, visit **hazwastehelp.org/BHW/sqg.aspx or call 206-787-5525.**
LARGE BULKY ITEMS:	For management of large or bulky items contact 206-787-5525.

SEA-TAC RECYCLING MAP



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* Future construction will temporarily close these locations. Tenants should use nearest alternate waste collection areas during closures.

LEGEND:

- Food + Compostables
- Recycling
- Garbage
- Used Cooking Oil
- Terminal Collection Areas
- Airfield Collection Areas

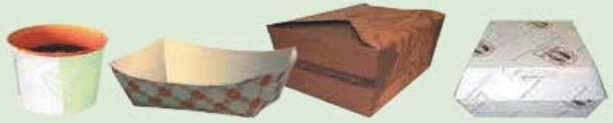
Food+ Compostables

Food

Food Soiled Paper

Uncoated Paper Plates

Approved Compostable Packaging



NO Plastic. NO Metal. NO Glass.

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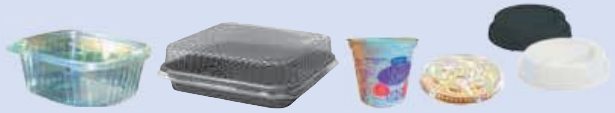
Recycling

Cans & Bottles*

Empty Cups

Clean Plastic Containers & Lids



Paper & Empty Cartons

ITEMS MUST BE EMPTY AND CLEAN *Now accepting plastic bottle caps in commingle recycle. Lids are to be placed back on the bottle and the bottle should be empty.

Port of Seattle www.portseattle.org/Environmental/Materials-Management recycle@portseattle.org 206-787-5525

Garbage

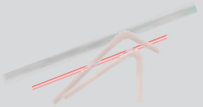
Snack Bags

Wrappers

Condiment Packages

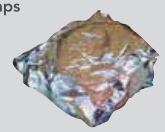
Plastic Disposable Utensils

Caps

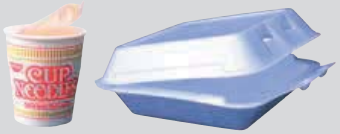


Straws

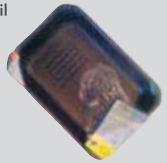
Plastic Wrap



Soiled Foil



Foam Containers



Foam Trays

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