King County
Department of Natural Resources and Parks
Wastewater Treatment Division
Regulatory Compliance and Land Acquisition Services
King Street Center, KSC-NR-0505
201 South Jackson Street
Seattle, WA 98104-3855

Submitted via email: NOC@pscleanair.gov

December 7, 2020

Mr. Alfredo Arroyo, Engineer
Puget Sound Clean Air Agency
Attn: NOC Application Submittal
1904 Third Avenue, Suite 105
Seattle, WA 98101

Subject: South Treatment Plant Loop® Compost Pilot Project
Notice of Construction Application for Order of Approval

Dear Mr. Arroyo:

The King County Wastewater Treatment Division (County) Biosolids Program is seeking a Notice of Construction (NOC) Order of Approval to build and operate a pilot-scale composting facility (Facility) at the County's South Treatment Plant in Renton, Washington.

The Facility will be temporary, with an expected operation period of approximately 5 years, or according to the term of its temporary use permit from the City of Renton. The Facility will be designed to demonstrate composting of Loop® biosolids mixed with bulking agents, such as wood chips and yard clippings, at various ratios. The Facility will be used to evaluate the business case for a potential full-scale Loop composting facility located off-site of South Plant and to evaluate various blends of feedstock to determine the optimal conditions for operations and marketable product quality.

The following information is attached to support our Notice of Construction application:

- PSCAA Notice of Construction Application for Order of Approval including:
  - Appendix A – PSCAA Form P
  - Appendix B – Emissions Workbook
  - Appendix C – Detailed Building Cost Estimate
  - Appendix D – ESC White Paper – Biofilter
  - Appendix E – AERMOD Source Inputs

The County, as State Environmental Policy Act (SEPA) Lead Agency, is developing the SEPA Environmental Checklist/Threshold Determination and anticipates it will be issued in early January 2021. A copy of the SEPA Checklist/Threshold Determination will be provided to PSCAA at that time.

If you have any questions or require additional information, please me at (206) 477-5458 or email at chris.dew@kingcounty.gov.

Sincerely,

Christopher Dew
Water Quality Planner/Project Manager IV

Attachments

cc: Ashley Mihle, King County
Jeff Hansen, HDR
Geoff Hill, HDR
Stacia Dugan, Jacobs
Bonnie Hutton, HDR

King County South Treatment Plant Loop® Compost Pilot Project

PSCAA Notice of Construction Application for Order of Approval

King County
December 7, 2020

Prepared for:
King County Wastewater Treatment Division

Prepared by:
Jacobs Engineering
HDR Engineering, Inc.

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Abbreviations

°F	degree(s) Fahrenheit
ASIL	acceptable source impact level
ASP	aerated static pile
ASTM	American Society of Testing and Materials
BACT	Best Available Control Technology
BMP	best management practice
CAS	Chemical Abstracts System
CASP	covered aerated static pile
CFR	Code of Federal Regulations
CH_4	methane
CO_2	carbon dioxide
County	King County
D/T	dilution(s) to threshold
DT	detection threshold
Ecology	Washington State Department of Ecology
EF	emission factor
eASP	extended Aerated Static Pile
EPA	U.S. Environmental Protection Agency
Facility	Pilot Biosolids Compost Facility
GHG	greenhouse gas
GWP	global warming potential
H_2S	hydrogen sulfide
HAP	hazardous air pollutant
hr	hour(s)
IPCC	Intergovernmental Panel on Climate Change
lb	pound(s)
m^3	cubic meter(s)
mg	milligram(s)
$mtCO_2e$	metric ton(s) of carbon dioxide equivalent
N_2O	nitrous oxide
NH_3	ammonia
NOC	Notice of Construction Application of Approval to Construct
NSR	new source review
OU	odor unit(s)
ppm	part(s) per million
PM_{10}	particulate matter with diameter less than 10 micrometers
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometers
PSCAA	Puget Sound Clean Air Agency
PTFE	polytetrafluoroethylene
RCW	Revised Code of Washington
RSC	reduced-sulfur compound
RT	recognition threshold
SCAQMD	South Coast Air Quality Management District
SJVAPCD	San Joaquin Valley Air Pollution Control District
STP	South Wastewater Treatment Plant
SQER	small quantity emission rate
TAP	toxic air pollutant
tBACT	Toxic Best Available Control Technology
tpy	ton(s) per year
VOCs	volatile organic compounds
WAC	Washington Administrative Code
WWTP	wastewater treatment plant
yd^3	cubic yard(s)
yr	year(s)

1 Introduction

The King County Wastewater Treatment Division (County) Biosolids Program is proposing a pilot-scale composting facility (Facility) at the County's South Treatment Plant (STP) in Renton, Washington. The Facility is temporary, with an expected operation period of approximately 5 years or according to the term of its temporary land use permit from the City of Renton. STP currently produces Class B Loop® biosolids. The Facility is designed to demonstrate composting of Class B Loop biosolids mixed with bulking agents, such as wood chips and yard clippings, at various ratios to produce Class A biosolids. The Facility will enable the County to demonstrate the business case for a full-scale Loop composting facility and evaluate various blends of feedstock to determine the optimal conditions for proceeding into a full-scale facility.

The Facility will employ a covered aerated static pile (CASP) technology using a bunker-style primary composting operation to fit within the limited available area of 0.8 acre. The information will also be used to inform the alternatives analysis for the full-scale facility, which will likely include both CASP technologies and in-vessel technologies.

The County is seeking a Notice of Construction (NOC) Order of Approval to build and operate the Facility. This NOC application contains the information required by the Notice of Construction Application for Order of Approval, General Information Form P and Form 50-170 Additional Notice of Construction Application Requirements for Composting. General Information Form P is included in Appendix A.

2 Project Background

Biosolids are a soil amendment (a natural soil conditioner and fertilizer replacement) that are made by cleaning the water that arrives at County wastewater treatment plants (WWTPs). The County's biosolids are Class B, which have some detectable pathogens and therefore restrictions for use (see further description of the biosolids regulatory framework in Section 4.2). At the WWTPs, the County's anaerobic digester tanks use naturally occurring bacteria and other microorganisms to break down the waste and kill disease-causing pathogens. These microorganisms transform the solids into a renewable, nutrient-rich, fully digested resource called biosolids. Most biosolids are used directly on farms and forests to improve crop yield and soil health. But Class B biosolids can also be mixed with bulking agents such as yard clippings and wood chips and processed further into a compost. Biosolids compost has a Class A regulatory designation from the Washington State Department of Ecology (Ecology), which allows for unrestricted use[1], just like any other retail garden product.

The County's WWTPs currently produce 120,000-130,000 wet tons per year (tpy) of biosolids, which are branded as Loop. Loop is used directly on farms and forests, with 25

[1] https://your.kingcounty.gov/dnrp/library/wastewater/wtd/about/SouthPlant/0811southplantBRO_process.pdf

percent applied to western Washington forests and 75 percent transported and applied to eastern Washington farms. Using biosolids on land to build the soil stores carbon and fights climate change. The County's biosolids carbon storage (approximately 40,000 metric tons of carbon dioxide equivalent [$mtCO_2e$]) is the equivalent of taking 8,000 cars off the road each year. However, transport of Loop can be suspended by road conditions on the Cascade mountain passes, which results in a rapid backlog of trucks filled with biosolids, especially in winter. The County has limited emergency storage options.

For the last 40 years, a small portion of the County's Loop product was sent to Groco, Inc., a private composter in Kent, Washington. Groco, Inc. mixed Loop with sawdust and composted the biosolids in windrows and static (unaerated) piles to produce GroCo, compost. In 2020, GroCo, Inc. closed its operation and the property has been listed or sold. This low-tech biosolids composting operation did not generate nuisance odor complaints despite being less than one mile from residential neighbors. The closing of this facility left the County without a local distribution option and terminated production of retail biosolids compost. The majority of the County's biosolids are distributed to the same markets and geographic locations, creating significant regulatory risk if the County were to unexpectedly lose a customer or distribution outlet. The County needs a local, secure, and long-term alternative to land application and a reliable long-term solution for the production of Loop compost. The county has many organic waste streams, and composters in the region are nearing capacity. A compost facility that processes biosolids needs a carbon-based feedstock to mix with it—the County has yard and wood waste available.

The County is looking into composting as a local alternative for recycling Loop because it would provide distribution options during inclement winter weather and can generate a useful local soil amendment with a low energy input requirement. Should composting not prove feasible or permittable, the County may have to consider more energy-intensive treatment, including incineration and thermal decomposition. Incineration is a common means for disposal of biosolids in the United States, with close to 200 incinerators in the country treating 1.5 million dry tons of biosolids, comprising 22 percent of facilities, second only to land application at 41 percent (EPA 1998). Landfilling or incinerating its biosolids is significantly more costly and not considered a beneficial use under Washington State biosolids rules. Additionally, incineration could result in emission increases of criteria pollutants, hazardous air pollutants (HAPs), and toxic air pollutants (TAPs) due to combustion. Surveys and public planning meetings indicate the County has strong public support for its current program and anticipates equity issues and significant community resistance to the incineration of biosolids.

The County plans to begin construction of the pilot-scale composting facility in the second half of 2021.

3 Process Description

The following sections discuss the site configuration, process operation, and throughput capacity for the Facility. Operating parameters that were part of the basis of design are included in the Excel emission workbook in Appendix B.

3.1 Site Configuration

The temporary pilot Facility will be located at the County's STP site in Renton, Washington. The STP site is a 94-acre property owned by the County and includes a public park on the northern end, called the Water Works Garden, which is open from dawn until dusk. The Facility will be within the fenceline of the STP property at the location of the former Fuel Cell Power Plant demonstration project. The Fuel Cell Power Plant demonstration project has not been operable for many years and is scheduled for demolition prior to construction of the Facility. The general project location is shown on Figure 3–1. The Facility layout is included in Figure 3-2.

Figure 3–1. Project Location Map

Approximate extent of Facility (Figure 3–2) is outlined in yellow and the South Treatment Plant fenceline is shown in blue.

The available area for constructing the Facility is limited to approximately 0.8 acre. The Facility is configured with a series of functional areas, each equipped to perform the function of a full-scale compost facility. The functional areas include areas for receipt, mixing, composting, curing, and screening. The Facility site configuration is illustrated on Figure 3–2. The functional areas are used in a counterclockwise direction, beginning with the bulking material receiving bunker in the southwest corner of the site and proceeding counterclockwise around the site to the finished product storage area located at the northwest corner of the site.

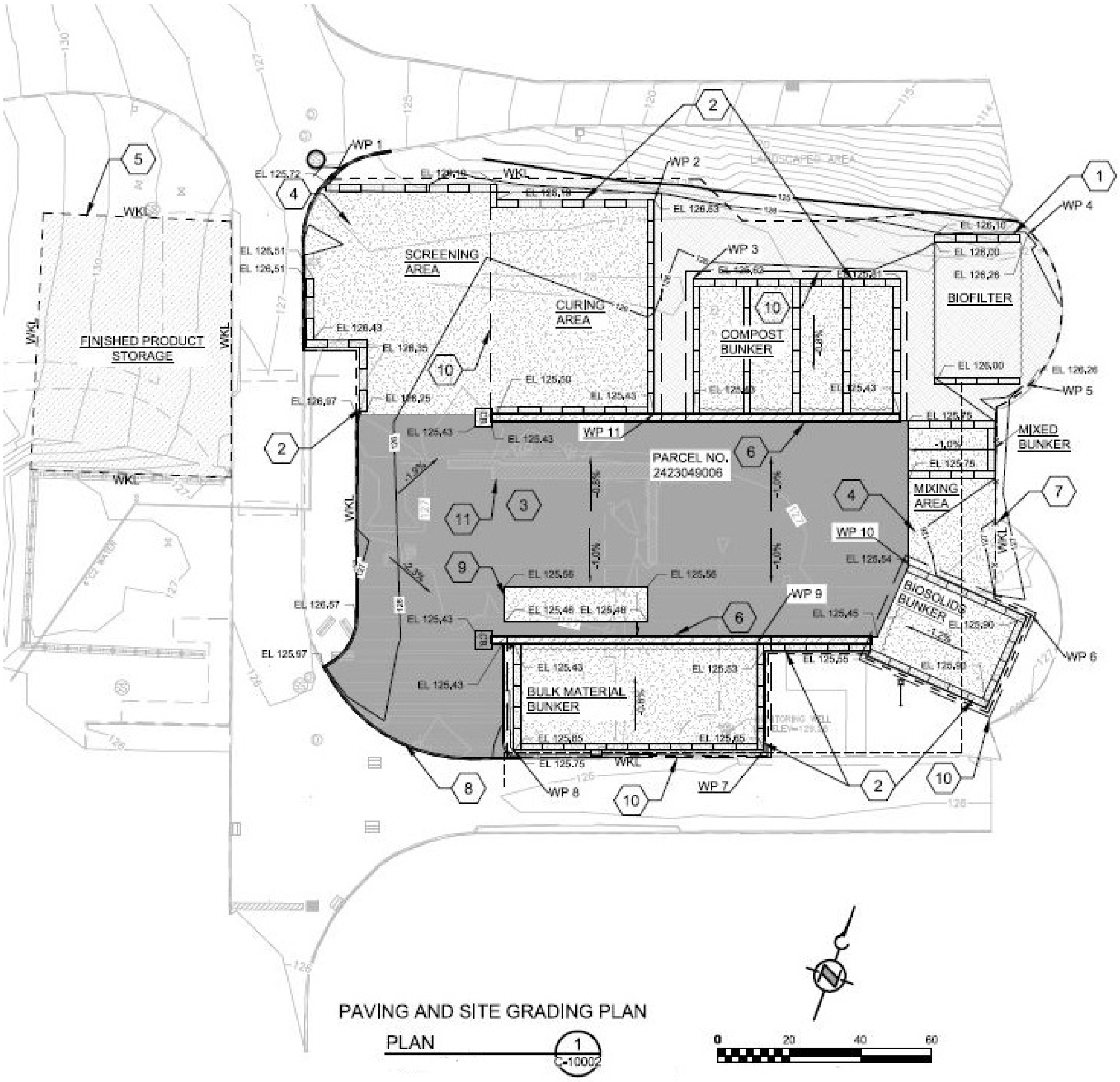

Figure 3–2. Pilot Biosolids Compost Facility Configuration

Source: 60% design drawings (February 2020). The extent of the area shown here is outlined in yellow on Figure 3–1

Because of the size limits of the site, the Facility is constrained in terms of how much space can be dedicated to any of the functions. The goal to include each of the major functions of a full-size facility further constrains the site capacity. One of these constraints is the amount of space that can be dedicated to the active compost functions. The Facility is sized such that the active compost phase occurs within four bunkers, each holding 70 cubic yards (yd^3). These bunkers are designed based on the estimated pilot batch size of a bulk-to-biosolids ratio of 3:1 by volume based on feedstock lab tests and Loop data. Batch sizes of greater bulk-to-biosolids ration (4:1 or 5:1), as described in this application, would require splitting the batch into two bunkers.

The bunkers are separated by block walls; this separation ensures each batch is isolated while pathogen destruction is achieved. Once achieved and moved to curing, the separation of batches becomes less critical and an extended bed configuration is used where successive batches moved to curing are placed next to each other, with sides of one pile stacked against the other. In the extended bed curing configuration, there is a break maintained between the youngest (recently placed) material and oldest material (nearly ready to be screened). This break is one pile width's wide and thus the curing area is five zones wide, but only ever holds four piles (four zones occupied) at any one time. The curing zone is never fully filled up, as this would place the youngest material adjacent, resulting in touching and mixing with the oldest material. This is not desirable from a final product stability and maturity perspective.

3.2 Process Operation

The Facility will function in a series of batches based on the amount of material received from the delivery of a single truck of Loop. The Facility is equipped to receive up to one truck per week but could receive material less frequently, if desired. Each Loop delivery will initiate the 2-months-long process described below.

Mixing of biosolids with bulking material occurs immediately upon receipt of a load of biosolids, directly followed by placement of the mixed material into an active composting bunker. This is intended to occur on the same day as receipt. Doing so will reduce the propensity of odorous emissions and remove the biosolids from exposure to vectors. The mixing activities can occur within a few hours, leaving time for the frontend loader to move the mixed material into an active bunker. The mixer will be powered by electricity.

Active composting is a 28-day process. Mixed material will be placed in one of the four bunkers and covered with a 6-inch- to 1-foot-thick biocover (also referred to as biolayer) of finished compost or overs (large wood chips) from the screening operation. This is also referred to as a covered ASP (CASP). The bunkers will be covered by a tent/fabric structure that is not fully enclosed but is intended to protect the bunkers from rainfall. During the retention time, the compost will remain static, yet will be managed by forced aeration and monitored for temperature. The surface of the piles can be irrigated with sprinklers if the material appears to be drier than desired. During negative aeration mode, the process will draw air from beneath the pile, into the air ducts placed on-grade beneath the pile, and out to the manifold directing the collected air to a biofilter located nearby. During this phase, the temperature of the compost is intended to rise to the range of 160 to 165 degrees Fahrenheit (°F) to meet federal Process to Further Reduce Pathogens requirements for composting biosolids.[2]

The aeration system is automatically reversing. Each pile has two temperature probes, with each probe having two temperature sensors: one sensor at 3-foot depth and one near the surface of the pile. When the temperature probes record a difference between the two sensors of more than 5°F to 10°F (a user-changeable set point), aeration will swing to the opposite direction to reduce the temperature differential.

As an example, during negative aeration, the surface will be cooler than at the 3-foot depth because of cool, fresh air being drawn onto the surface of the piles. As a result of exothermic reactions happening between the surface and 3-foot depth, heat is generated and moved with the air to the 3-foot depth as air is drawn toward the fan. The sensor at 3-foot depth heats up, and when it reads greater than 5°F to 10°F above the surface sensor temperature, the aeration direction switches. Positive aeration draws cool air into the fan and pushes it into the plenum on the floor and up in the pile. The sensor at the surface of the pile will eventually get hotter than the sensor at 3-foot depth because of the heat being transferred through the full pile and the extra heat generated in the 3-foot layer above the lower sensor. Over time the temperature differential will be eliminated and eventually swing it in the opposite direction. At this point the system will switch back to negative aeration. The principle objective of reversing aeration is to homogenize the temperature throughout the pile and improve the stability of the final product. For comparison, single direction air results in a regular and substantial temperature gradient through the pile that leads to differential composting rates and makes process and quality control more difficult.

Curing will occur in a secondary compost pile of extended bed configuration, comprised of four piles and five aeration zones, aerated with reversing aeration (having the option for positive or negative aeration in each zone). The material will be exhumed from the primary bunkers and placed in the curing area for 28 additional days. Each curing zone will be covered with a 6-inch- to 1-foot-thick biocover layer and equipped with air ducts beneath the pile to continue the removal of process air and odors while the mass cools and the biological process diminishes. Process air drawn from the curing bunker during negative aeration will be directed to the biofilter along with active composting process air. The system will also switch to positive aeration as controlled by the user-defined set points and temperature differential through pile depth in the same fashion as active composting.

Temperature probes (each having two sensors) will be placed into each control zone in the extended bed curing phase. The temperature sensors will inform the process control system of the conditions within the zone.

Three blowers are anticipated for this Facility: one negative aeration blower to draw process air from the active compost bunkers and curing zones, one positive blower to

[2] The requirement for biosolids under WAC 173-308 is 3 days at 131°F or higher. Vector attraction reduction is 14 days at 104°F, with an average temperature higher than 113°F. Washington State Legislature. Title 173. Sections 173-308-170 and 173-308-180. Available at https://apps.leg.wa.gov/WAC/default.aspx?cite=173-308-170 and https://apps.leg.wa.gov/WAC/default.aspx?cite=173-308-180. Accessed August 28, 2019.

push air into the active compost bunker areas, and a positive blower to push air into the curing zones. All of the blowers will be in nearly constant operation. Each bunker or zone will be controlled independently by the process control system. The process control system will inform and control dampers to deliver the correct aeration rate from a minimum of 10 percent up to 100 percent. Each blower will be equipped with variable-speed drives to allow ramping up or down depending on the demand for air, as directed by the user-set inputs. Each of the blowers will be connected to a manifold that either collects or distributes air to its respective plenums within the bunkers (active) or control zones (curing).

Composting is an aerobic process; when the process lacks sufficient oxygen it can be classified as hypoxic or anoxic. In these states odorous volatile compounds are produced including alcohols, acids, H2S, and NH3. The piles' aerobic conditions are determined by oxygen and temperature. From an aeration perspective, it takes 5-10 times higher aeration rate to cool an active pile than it takes to supply sufficient microbial oxygen. Literature on the topic suggests that the critical value in maintaining aerobic conditions are >2ppm of oxygen at the biofilm of the decomposing waste. This is achieved by keeping the pile temperature below 65C and providing ≥10% oxygen measured with an oxygen/temperature probe (e.g., from ReoTemp). From a facility design perspective, assurance is provided by supplying fans, ducting, and plenum than can supply sufficiently high and uniform aeration per cubic yard of material (units of CFM/CY). In this case, with biosolids and wood waste bulking agent, the facility has been designed with 5 CFM/CY of aeration capacity. This is likely greater than 5 times the aeration supply used in fabric covered compost systems which generally struggle to provide sufficient air for process cooling and also why fabric covered piles tend to run excessively hot (>65C). Curing composting is designed with 2.5 CFM/CY of aeration capacity as the majority of active carbon compounds have already been oxidized in active composting, diminishing the heat production rate in curing.

A **programmable logic controller (or equivalent process control system)** will receive information from the temperature sensors located in each of the active compost bunkers and curing zones. Temperature sensors will collect pile temperature, which is used by the control system to compare to user-input target set points. Based on actual temperature versus desired temperature, airflow is manipulated to each active bunker or control zone by damper position (open through closed) to affect the pile temperature. Pressure in each manifold is user set and pressure sensors in ducts limit fan speed and total potential airflow. The programmable logic controller will inform the actuators on each valve to open or close, thereby administering a vacuum or pressure to the pipes beneath the bunker.

The **biofilter** will scrub volatile organic compounds (VOCs) and odorous air contaminants from the process air extracted from the active compost and curing areas. The biofilter will be sized to receive organic-rich air from the projected loading of 15 wet tons of biosolids per week. The biofilter will be oversized compared to industry standards and provides an empty-bed retention time (the average time process air will spend getting through the volume occupied by the biofilter material) of 75 seconds, whereas the industry standard is 60 seconds.

The **screening and final product area** will receive material exhumed from the curing bunker using a frontend loader. The material should be stable, friable, and ready for screening to remove large wood items. The screening will be performed by a small-diameter, relatively short trommel screen (e.g., 4 to 5 feet in diameter, 12 to 14 feet long) that will fit within the constraints of the screening area available. The screen will have a 3/8-inch screened opening to allow small material to fall through the screen ("unders") and larger-diameter materials to pass through the end of the trommel barrel ("overs"). The unders will be moved to the final product storage and the overs will be added to the bulking material storage bunker.

The **finished product storage area** will store the material from the screening/final product area. It is sized to accommodate approximately 400 yd^3 of material, or approximately four to seven batches of processed material depending on the bulking ratio employed.

3.3 Throughput Capacity

As noted above, the Facility is sized to receive and process one truckload of Loop biosolids through a 2-month process, beginning with being blended at 3:1 (bulking material to biosolids by volume) to the appropriate feedstock mix design and then processed through each of the functional areas. The active compost phase occurs within four bunkers, each holding 70 yd^3. As different feedstock sources are explored, there is the possibility that different quantities of the blended material will need to be placed into the initial aerated compost phase. Mix-moisture content is one of the methods used to determine the best mix ratio. The moisture content of the bulking material will vary over the course of the year due to changes in the types of material available during a given season and changes in the weather. Evaluating a range of feedstock moisture contents is useful for sizing a full-scale facility.

The Facility will explore at least three different bulking ranges. The primary bulking ranges of interest are a bulk-to-biosolids ratio of 3:1, 4:1, and 5:1 by volume. The expectation for the Facility is that variable feedstock blends can be explored; each may be evaluated independently, as the process allows for the distinct material to proceed through the Facility as an individual batch of material. The exception to this is the finished product staging area, which is not designed to segregate batches. If the operator desires a specific batch of final product to be isolated from the remainder of the finished product, appropriate staging of the isolated pile within the finished product area will be necessary.

The Facility is designed to process up to 780 wet tpy of Loop biosolids (15 wet tons per truck, delivered once per week, 52 weeks per year). Depending on the density and moisture content of the bulking material, approximately 600 to 1,300 tpy of bulking material will be needed to perform the compost functions. The total Facility throughput in terms of weight is 1,400 to 2,100 tpy. In terms of volume, the Facility bunkers and infrastructure are sized to compost up to 70 yd^3 per week for 52 weeks, or approximately 3,600 yd^3 per year. However, the actual throughput is anticipated to be in the range of 2,500 to 3,500 yd^3 per year, depending on the quantity of bulking material used and the timing of developing sequential batch operations.

4 Regulatory Review

State and local air quality regulations in the project area are administered by the Puget Sound Clean Air Agency (PSCAA). Potential emissions from the Facility include odors, VOCs, HAPs, TAPs, greenhouse gases (GHG), and fugitive dust which includes particulate matter with diameter less than 10 micrometers (PM_{10}) and particulate matter with a diameter less than 2.5 micrometers ($PM_{2.5}$).

4.1 New Source Review

In the state of Washington, all new air emission sources must go through new source review (NSR) with the local permitting authority, in this case PSCAA, unless specifically exempted. The NSR process requires the source to submit a NOC application and receive an Order of Approval issued by PSCAA under PSCAA Regulation I, Article 6 prior to commencement of construction. To minimize emissions and comply with all state and local emission standards, all non-exempt new emission units must go through a technology review to determine Best Available Control Technology (BACT). The Facility must also estimate criteria and TAP emissions from the affected units and determine if there are any ambient impacts as a result of those emissions. GHG emissions are not subject to New Source Review per Washington Administrative Code (WAC) 173-400-110(5)(b).

In Section 8 Emission Estimates, emissions of VOC, PM_{10} and $PM_{2.5}$ are estimated to be below NSR exemption levels (2.0 tons per year, 0.75 ton per year, and 0.5 tons per year respectively) per WAC 173-400-110(5)(a)(i). Of the 33 TAPs identified as having potential emissions from the Facility, 11 exceeded their *de minimis* thresholds, but none of these TAPs exceeded their small quantity emission rates (SQER) identified in WAC 173-460-150.

4.2 Biosolids Regulatory Framework in Washington

Biosolids are regulated by the U.S. Environmental Protection Agency's (EPA's) Clean Water Act, Code of Federal Regulations (CFR) Title 40 Part 503, and Ecology's Biosolids Rule, WAC Chapter 173-308. **Biosolids** means municipal sewage sludge that is a primarily organic, semisolid product resulting from the wastewater treatment process that can be beneficially recycled and meets all applicable requirements under WAC 173-308.

Classification: Class A versus Class B. Biosolids quality is defined by the extent to which the biosolids are treated before their final use. There are two major classifications of biosolids: Class A and Class B. These classifications are used to define how the biosolids may be used.

Class A biosolids are treated to a greater extent such that they are nearly pathogen-free. Compost products made with biosolids are classified as Class A. Because they are nearly pathogen-free, Class A biosolids can be used by the general public and sold as a retail product, which provides the County with more opportunities to explore customers and markets in the Puget Sound region. Compost made from biosolids is Class A.

Ecology and EPA encourage the production of the highest quality biosolids where possible, specifically Class A biosolids.

Class B solids have been treated to the extent that most, but not all, of the pathogens have been removed. The County's Loop biosolids product is classified as Class B. Class B biosolids require special permitting before they can be used, so they are available only to large commercial customers.

Ecology has a beneficial-use mandate for biosolids, which encourages land application of biosolids for the purposes of improving soil characteristics including tilth, fertility, and stability to enhance the growth of vegetation consistent with protecting human health and the environment.

Composting of biosolids is regulated under the biosolids rule, WAC 173-308, not the solid waste rule, WAC 173-350. The state biosolids rule is a reciprocal rule with the solid waste rule and generally WWTPs composting biosolids are regulated only under WAC 173-308, subject to approval from Ecology and the local public health jurisdiction. If a composter processes additional materials to produce non-biosolids composts (such as manure or food waste composts), then it must comply with both rules.

The County composting pilot Facility will produce only biosolids compost, and is regulated under WAC 173-308 only, with approval granted from Ecology and Seattle-King County Public Health. The County's STP has a biosolids permit, which covers biosolids treatment processes such as composting. Ecology has issued a single general permit for the State of Washington to regulate biosolids production and use..

4.3 Toxic Air Pollutants

Under WAC 173-460 (as in PSCAA Regulation I, Section 6.01) facilities submitting a NOC application are required to complete a first-, second-, or third-tier review of the air quality impacts of TAPs to demonstrate that the proposed project does not have the potential to adversely affect the health of people in the surrounding community. WAC 173-460-010 establishes systematic control requirements for TAP sources. TAPs include both carcinogens and non-carcinogens. WAC 173-460-150 lists the regulated TAPs along with their respective averaging period, acceptable source impact level (ASIL), SQER, and *de minimis* emission values. Demonstrating compliance with the relevant standards by comparing project emissions to the TAP values listed in WAC 173-460-150 is considered to be a first-tier review.

The *de minimis* values are defined as the maximum level of emissions that do not pose a threat to human health or the environment. If emissions of a given TAP from a source do not exceed the associated *de minimis* emission values, then that TAP is exempt from further NSR evaluation. However, if emissions of a given TAP do exceed the associated *de minimis* emission values, then further NSR evaluation is required and Toxic Best Available Control Technology (tBACT) must be demonstrated.

SQER is defined as a level of emissions below which dispersion modeling is not required to demonstrate compliance with ASIL values. A TAP with emissions exceeding its SQER value requires an ASIL analysis using dispersion modeling to verify that emission levels will not result in an exceedance of the associated ASIL values for its respective averaging period. For a first-tier analysis, PSCAA will not issue a NOC until the facility demonstrates that tBACT has been applied to all TAPs with emissions above *de minimis* levels. In addition, each TAP must demonstrate compliance with its respective ASIL by either having an emission rate below the SQER or conducting air dispersion modeling.

PSCAA adopted changes to air toxics regulation (WAC 173-460) effective September 1, 2020. The emissions estimates, which are discussed in Section 8, were compared to the newly adopted air toxic regulation.

The analysis of this proposed Facility indicates that all TAP emissions are less than the SQER. Thus, modeling of TAP emissions is not required to demonstrate compliance with the ASIL. Odor emissions are not a TAP, even though compounds that are TAPs, like ammonia (NH_3), are a constituent of the odor.

4.4 Odor Regulations

The Facility will be subject to WAC 173-400-040(4) and 173-400-040(5) and PSCAA Regulation I, Section 9.11. Odor management is vital to the success of a compost facility. No compost facility is expected to be odor free. However, WAC 173-350-040 requires the Facility to not violate the regulating air authority's emission standards or ambient air quality standards at the property boundary.

PSCAA's Section 9.11, Emissions of Air Contaminant: Detriment to Person or Property, states:

> *(a) It shall be unlawful for any person to cause or allow the emission of any air contaminant in sufficient quantities and of such characteristics and duration as is, or is likely to be, injurious to human health, plant or animal life, or property, or which unreasonably interferes with enjoyment of life and property.*
>
> *(b) With respect to odor, the Agency may take enforcement action under this section if the Control Officer or a duly authorized representative has documented all of the following:*
>
> > *(1) The detection by the Control Officer or a duly authorized representative of an odor at a level 2 or greater, according to the following odor scale:*
> >
> > *level 0 – no odor detected;*
> >
> > *level 1 – odor barely detected;*
> >
> > *level 2 – odor is distinct and definite, any unpleasant characteristics recognizable;*
> >
> > *level 3 – odor is objectionable enough or strong enough to cause attempts at avoidance; and*
> >
> > *level 4 – odor is so strong that a person does not want to remain present;*
> >
> > *(2) An affidavit from a person making a complaint that demonstrates that they have experienced air contaminant emissions in sufficient quantities and of such characteristics and duration so as to unreasonably interfere with their enjoyment of life and property; and*

(3) The source of the odor. (c) Nothing in this Regulation shall be construed to impair any cause of action or legal remedy of any person, or the public for injury or damages arising from the emission of any air contaminant in such place, manner or concentration as to constitute air pollution or a common law nuisance.

Facilities must also comply with the Washington Clean Air Act (Revised Code of Washington [RCW] Chapter 70.94). The operating standards outlined in WAC 173-350-220(4)(a)(i) also require facilities to control dust, nuisance odors, and other contaminants to prevent migration of air contaminants beyond property boundaries.

4.5 Fugitive Dust

The Facility will be subject to PSCAA Regulation I, Section 9.15, Fugitive Dust Control Measures, which states that it shall be unlawful for any person to cause or allow visible emissions of fugitive dust unless reasonable precautions are employed to minimize the emissions.

Reasonable precautions include, but are not limited to, the following:

- The use of control equipment, enclosures, and wet (or chemical) suppression techniques, as practical, and curtailment during high winds
- Surfacing roadways and parking areas with asphalt, concrete, or gravel
- Treating temporary, low-traffic areas (e.g., construction sites) with water or chemical stabilizers, reducing vehicle speeds, constructing pavement or riprap exit aprons, and cleaning vehicle undercarriages before they exit to prevent the track-out of mud or dirt onto paved public roadways
- Covering or wetting truckloads or allowing adequate freeboard to prevent the escape of dust-bearing materials.

The feedstocks used in the composting process tend to contain enough moisture that fugitive dust is not an issue. However, if conditions create the potential for fugitive dust, such as long periods of hot weather, fugitive dust control measures will be employed.

4.6 State Environmental Policy Act

As State Environmental Policy Act (SEPA) Lead Agency, the County will prepare an environmental checklist and issue a threshold determination in early January 2021.

4.7 City of Renton

The City of Renton has determined that a Tier II Temporary Use Permit is the appropriate approval mechanism. The permit is valid for one year and can extend for one year increments. The County can apply for new Temporary Use Permit if the Facility operates beyond the 5-year period.

5 Odor Science

This section provides a brief review of odor science and odor sampling and analysis methods.

There are many key terms in the odor science world; these are defined below:

- **Area source**: This is a surface-emitting odor source, which can be solid (e.g., the spreading of wastes or material stockpiles) or liquid (e.g., manure storage lagoons, effluent treatment plant).
- **Character**: Odor character is a qualitative attribute of an odor and is expressed in words that describe what a substance smells like (e.g., fruity, rotten eggs).
- **Concentration**: This is measured as "dilution ratios" and reported as "detection threshold" (DT) or "recognition threshold" (RT) or as "dilution-to-threshold" (D/T) and sometimes assigned the pseudo-dimension of "odor units/cubic meter (OU/m^3)." (American Society of Testing and Materials [ASTM] methods E679 and EN13725)
- **Duration**: This is the period in which odorants are received by a receptor population and perceived as odors.
- **Odor strength**: This refers to either odor intensity or concentration.
- **Detection threshold**: This is the point at which an increasing concentration of an odor sample becomes strong enough to produce a first sensation in 50 percent of the people to whom the sample is presented.
- **Frequency**: This is how often an odorous emission will be experienced by a receptor population.
- **Hedonic tone**: This describes the degree of pleasantness or unpleasantness and is a subjective assessment of the offensiveness of an odor.
- **Intensity**: This refers to the perceived strength of the odor sensation and generally increases as a function of concentration. There are three different methods for odor intensity: descriptive word category scales, magnitude estimation, and referencing scales. (ASTM method E544-99)
- **Odor**: This is the perception experienced when one or more chemical substances in the air come in contact with the various human sensory systems (odor is a human response).
- **Odorant**: This is any chemical that is part of the perception of odor by a human (odorant is a chemical).
- **Point source**: This is an intentional point of release, such as a vent or a chimney.
- **Receptor**: This is a person (or group) who is or may be exposed to odor released from a given source.

Odors are produced during biological processes including the breakdown of organic waste. During the breakdown of complex organic compounds, there are multiple intermediate steps, and multiple intermediate compounds are produced. Some of these compounds are light enough to move into the vapor phase and can leave the process along with cooling air or a passing air current. These compounds can then travel through the air and become a source of odor. Common odorous compounds include VOCs, ammonia, and reduced-sulfur compounds (RSCs). Many specific chemicals have been examined for their potential to result in odors; numerous compounds have been assigned a characteristic smell [3].

Odors are experienced by humans as a result of chemical compounds interacting with receptors in the nasal cavity. Most odors are a combination of chemical compounds (McGinley 2000). Each chemical compound has its own DT. Background odor levels, due to grass, trees, motor vehicle etc., are typically in the range of 3 to 5 DT. Odors are not additive but chemicals can interact with each other in unpredictable ways to result in an odor detected in the nasal cavity.

There are a variety of different approaches to measuring, qualifying, and quantifying odors. This review focuses on those for which actual methods have been developed, as descriptive systems tend to have little utility in the operations and regulatory fronts because of their subjective nature[4].

Odor samples are commonly collected in bags made of Nalophan, Tedlar, polytetrafluoroethylene (PTFE) (Teflon), or stainless-steel chambers. PTFE bags are the only material acceptable by all standards, having the least propensity for holding or contributing odor, and can hold a sample for the longest time of all the plastic materials. Sample bags can be filled up with full-strength air or diluted during sample collection to prevent condensation from occurring in the bag. Sample bags can self-inflate with pressurized sources. Sample bags need to be filled with a lung chamber for negative pressure sources. A lung chamber sucks air into a bag without introducing any foreign air by vacating air from a chamber around the bag to a lower pressure than the sample source pressure. Sample bags are usually shipped overnight to the laboratory for analysis as odor tends to degrade with time. Each method has an explicit time frame between sampling and analysis.

Two of the more common and standardized methods for analyzing odor samples in the United States are ASTM E544-18 and ASTM E679. Internationally EN137125 is the most widely recognized standard and it is most similar to ASTM E679. ASTM E544-18 is an odor-intensity method, and its units are measured in parts per million (ppm). In this method an analyst compares the odor against a standard solution of a chemical, usually n-butanol. This method is conducted by at least eight analysts. This method is not as common as ASTM E679 or EN13725, which report odor concentration and OU, which are equivalent to DT. When performing calculations for dispersion modeling this value is placed over a cubic meter (OU/m^3). This method, known as dynamic olfactometry, is performed by presenting an increasing-strength odor sample to the nose of an analyst. When the analyst detects the odor, this is called the DT. Multiple analysists are required for these methods. For example, if the odor concentration starts at 100 dilutions (very dilute) but is detected at only 5 dilutions, then the analyst would assign a value of 5 DT

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[3] https://www.calrecycle.ca.gov/SWFacilities/Compostables/Odor/Characteris/

[4] https://www.biocycle.net/the-compost-odor-wheel/

(or 5 OUs, or 5 OU/m^3). If an odor is detected at very high dilutions (1,000 OUs), the odor is very strong, and it could be inferred that a little could travel a long way spatially to receptors' noses. The dynamic olfactometry method is an actual smell-based method and has become the norm in odor regulations.

The full ASTM and EN methods are conducted in the lab, but devices can be used to replicate the method in a field setting, field olfactometry, which would not comply with the standard method, but can be used to collect reasonable field measurements or collect pre-diluted samples for subsequent lab-based analysis. One such tool, sold by Scentroid (Stouffville, Ontario), is called the SM100.

Field olfactometry (D/T) and laboratory olfactometry (DT) yield statistically similar results.

DT = detection threshold

$$DT = \frac{Vd + Vo}{Vo}$$

D/T = dilutions to threshold

D/T = Vd/Vo

Where:

Vd = volumetric flow rate of odor free dilution air

Vo = volumetric flow rate of odor sample

Table 5-1 presents a relative comparison of human reactions to odors at varying D/T values. These levels should be considered order-of-magnitude approximations because reactions to odors are dependent upon individual sensitivity of the receptor, as well as the level of background odor that the receptor may be accustomed to prior to the introduction of a new odor. For example, an individual that works at a WWTP may develop an insensitivity to sulfur compounds due to olfactory fatigue. Conversely, an individual that is familiar with low concentrations of earthy/musty odorants may be overly sensitive to this odor grouping.

Note that, as mentioned previously, field olfactometry (D/T) and laboratory olfactometry (DT) yield statistically similar results. Therefore, the values presented in Table 5-1 are considered relevant for selecting an endorsed offsite odor limit herein. Although laboratory olfactometry is conducted in a controlled environment which provides sufficient QA/QC for yielding valid results, field olfactometry, if done correctly, also yields valid results in that a controlled environment is simulated in which the panelist "zeros" his/her nose prior to conducting a measurement.

Table 5-1. D/T Verses Human Response

D/T Level	Description	Reaction
Human Threshold	The lowest concentration at which the average nose can detect the odor.	The human nose can sense the odor and determine a difference from normal background odors. However, odor is not alarming at this level, just noticeable.
5	Odor is slightly detectable above background odors.	The human nose may determine the source if the nose has previously experienced higher strengths of this same odor compound. Odor may cause slight discomfort to some receptors, but typically is not alarming.
10	Odor is detectable above background levels to sensitive receptors.	Some sensitive individuals can determine the source (especially if the odor is familiar to them), and the odor may cause nuisance odor response.
20	Odor is detectable above background levels to general public.	The human nose can determine the source, even if it has not previously experienced it (may cause nuisance odor response with some individuals).
50	Odor is very detectable above background levels.	The human nose can easily determine the source, and the odor can result in a nuisance odor response with most individuals.
100 (plus)	Odor is extremely noticeable above background levels.	The human nose can detect the source, and the odor typically results in a nuisance odor response.

Compiled from various case studies by Jacobs Engineering Group Inc.

For evaluating odor impacts, 5 D/T was chosen as the odor threshold because it is generally considered to be the odor level at which people consciously detect and may become annoyed by an odor. It is also a common benchmark in jurisdictions that regulate off-site odor impacts quantitatively (Mahin 2003). Five DT is equivalent to 4 D/T, so these criteria provide a slightly conservative analysis for comparison to a 5 D/T benchmark. Odor complaints are most likely to occur at odor levels of greater than 5 D/T, and occasional detectable odors of limited duration (5 minutes or less) are also unlikely to cause complaints.

The County proposes to demonstrate that odor emissions from the Facility are unlikely to contribute significantly to ambient odors or to cause a violation of PSCAA Regulation I, Section 9.11 through dispersion modeling of worst-case odor emissions. Because no quantitative regulatory standards are in effect, the County proposes the following ambient impact criteria that the Facility will meet:

1. Annually, ambient impacts over 5 DT will not occur more frequently than 1 percent of hours, when odor impacts are considered on an hourly average basis.
2. Annually, ambient impacts over 5 DT will not occur more frequently than 2 percent of hours, when odor impacts are considered on a 5-minute average basis. For hours in which a 5-minute impact greater than 5 DT is modeled, this indicates that one or more 5-minute periods during the hour are expected to exceed 5 DT, but not necessarily the entire hour.

Additional details are provided in the modeling results section (Section 10.4) of this permit application.

6 Control Technology Review

New air pollution sources in Washington State must control criteria pollutant emissions to the BACT level and TAP emissions to the tBACT level. WAC 173-460 requires that new sources first demonstrate they will use BACT to control TAPs and then demonstrate that the TAP emissions will not exceed the ASILs provided in the regulation.

A BACT analysis typically includes five steps, called the “top-down” BACT approach. The five steps are as follows:

1. Identify all potential control technologies
2. Eliminate technically infeasible options
3. Rank effectiveness of control technologies
4. Evaluate control technologies on a case-by-case basis for economic, environmental, and energy impacts
5. Select the BACT.

The top-down approach ranks available control technologies in descending order of control effectiveness. To be “available,” a technology must be effectively demonstrated in a commercial application under comparable operating conditions. After available technologies are compiled and ranked, the technologies must be evaluated for technical feasibility, starting with the most effective technology. A control technology can be considered infeasible because of technical considerations, energy requirements, environmental impacts, or economic impacts. If the most effective technology is eliminated in this fashion, then the next most effective alternative is evaluated using these same criteria. The process is repeated until either a technology is selected or there are no remaining technologies to consider. BACT and tBACT analyses follow the same general approach and often result in the same outcome.

6.1 Odor, VOC, and TAP Control

Pollutants of concern from composting are primarily odor, VOCs, and ammonia. BACT determinations are available for the control of VOCs and ammonia emissions from composting from the California Air Resource Board (ARB), San Joaquin Valley Air Quality Management District (SJVAQMD), and South Coast Air Quality Management District (SCAQMD) BACT Clearinghouses. EPA and PSCAA have not published BACT determinations for composting. There is not a database for tBACT determinations, and the compounds that contribute to odor emissions can vary significantly from site to site. It is rare for a TAP like ammonia to have a specific control efficiency like it does for composting. Frequently, BACT for the control of VOCs is used as tBACT for the control of TAPs and odor.

VOC emissions occur primarily during the active and curing phases of composting. Ammonia is produced as a by-product of the microbial decomposition of the organic nitrogen compounds in biosolids. According to *Odors and Volatile Organic Compound Emissions from Composting Facilities*, 95 percent of the emissions from a composting facility are from the active and curing processes (Epstein 2000). According to the SCAQMD Rule 1133 final staff report, 80 percent of VOC emissions and 50 percent of NH_3 emissions occur during the first 22 days of composting or during the primary composting phase (SCAQMD Rule 1133 Final Staff Report 2011).

All other processes—material handling and storage, mixing, screening, and finished product storage—contribute to only 5 percent of the total VOC emissions. Therefore, the VOC and ammonia control technologies focus on the primary and secondary composting processes.

The Facility will process a maximum of 780 tpy of Loop biosolids. WAC 173-410-530(4) defines insignificant emission levels for various regulated pollutants. The insignificant emission level for VOCs is two tons or less per year. Assuming the worst-case scenario with all the bunkers and curing zones operating in positive aeration mode 8,760 hours per year, the estimated VOC emission rate would be 347 lb/year or 0.2 tpy, (Section 8, Emission Estimates). This may be why SCAQMD exempts co-composting facilities, which includes biosolids composting, with a design capacity less than 1,000 tpy from compliance with SCAQMD Rule 1133.2b and BACT requirements for VOC and ammonia.

RSCs, including hydrogen sulfide, and particulate matter emissions can also be generated by composting facilities but tend to be managed by using best management practices (BMPs). Particulate matter emissions tend to be in the form of fugitive dust, which can be controlled by following PSCAA guidelines in Regulation I, Section 9.15 and the County's operating procedures for controlling fugitive dust. RSCs tend to be generated during anaerobic conditions and can be kept to a minimum by operating the composting aeration system as designed. BMPs keep these emissions below the emission levels that would trigger a BACT analysis. However, the emission controls used for controlling TAPs from composting will also control RSCs.

6.1.1 Step 1: Identify All Possible Control Technologies

A BACT analysis for a composting facility needs to look at the entire process and not just add-on control technologies. First, the technology needs to reduce the generation of odors, VOCs and TAPs. Second, the technology needs to capture the emissions that are generated by the composting process. Finally, the technology needs to be able to reduce the captured emissions before they are emitted to the air.

There are three primary commercial composting methods for biosolids. Biosolids can also be disposed of using incineration.

1. **Windrows:** Waste is piled into long rows called "windrows" and aerated periodically by turning the piles. The ideal pile height is between 4 and 8 feet with a width of 14 to 16 feet. This method is considered to be the base emissions case (i.e., uncontrolled) for BACT evaluation purposes.
2. **Aerated static pile (ASP):** Waste is mixed in a large pile, loosely layered with bulking agents like wood chips to allow air to pass through the pile. A network of pipes underneath the pile either blows air into piles (positive) or sucks the air out of

the pile (negative) or a system that enables both positive and negative aeration interchangeably but not simultaneously (reversing aeration).

The ASP category also includes ASPs with a biocover and enclosed ASPs. ASPs with a biocover are ASPs that have a 6 inch to 1-foot layer of finished compost or overs covering the surface of the ASP. Enclosed ASPs include technologies like GORE where the material is placed under a cover, or ASPs located inside a building.

3. **In-vessel:** Waste is placed in a sealing drum, silo, or concrete-lined vessel where environmental conditions are mechanically controlled. In some vessels waste is physically turned or mixed.
4. **Incineration:** Incineration is combustion in the presence of air. Incineration of wastewater solids takes place in two steps. The first is drying the solids, so that their temperature is raised to the point that water in the solids evaporates. The second step is the actual combustion of the volatile fraction of the solids. Combustion can only take place after sufficient water is removed.

There are multiple technologies within the Windrow, ASP and in-vessel categories.

The California Air Resource Board (ARB) published *ARB Emission Inventory Methodology for Composting Facilities*, March 2, 2015. It is one of the few published and widely read documents on compost emissions and lists the composting technologies they had reviewed as of 2015. These technologies are provided in Table 6-1.

San Joaquin Valley Technology Advancement Program has been evaluating a prototype extended Aerated Static Pile (eASP) composting process, *Greenwaste Compost Site Emissions Reductions from Solar-powered Aeration and Biofilter Layer*, 5/14/2013. The eASP differ from ASP only in that consecutive zones are laid alongside each other along the long axis. The eASP utilized ambient air blown into the pile from the bottom; the blowers were powered by photovoltaic panels and associated batteries. The eASP had a biofiltration layer or biocover added to the surface as an air pollution control measure. The technology is providing emission reductions in the same range as the enclosed systems.

As discussed in Section 3, the proposed facility is an ASP with a biocover and a biofilter that can operate under positive and negative aeration. This technology can also be referred to as a covered ASP (CASP). The above documents provided information on a positive aeration ASP covered with a biofilter or biocover, but did not provide control efficiencies for an ASP with a biocover and biofilter under negative aeration. It was noted that additional emission reduction potential from ASP could not be quantified at this time. However, it was noted that the addition of a biocover greatly increases the capture efficiency for ASP systems.

Table 6-1. Control Techniques for Composting Operations

Control type	Aeration	Control Technology	Cover Material
Windrow Technologies			
Static pile: no biofilter	Passive	None	None
Managed windrow: no biofilter	Passive	None	None
Water management requirements[a]	Passive	Watering	None
Static pile/passively aerated windrow covered 15 days with a biofilter[b]	Passive	At least 6 inches of Compost Cover	Finished Compost or Compost Overs
Static pile/passively aerated windrow covered 22 days with a biofilter[a]	Passive	At least 6 inches of Compost Cover	Finished Compost or Compost Overs
Aerated static pile (ASP) Technologies			
Negative ASP with biofilter (classic)	Forced, negative air	At least 6 inches of Compost Cover (optional), Biofilter Bed	Finished Compost or Compost Overs
Positive ASP with biocover	Forced, positive air	At least 6 inches of Compost Cover	Finished Compost or Compost Overs
Positive windrow style ASP with biocover (eASP)	Forced, positive air	At least 6 inches of Compost Cover	Finished Compost or Compost Overs
Enclosed aerated static pile technologies			
Enclosed negative ASP with biofilter (e.g., ECS)	Forced, negative air	Biofilter Bed	Engineered Cover Tarp
Negative ASP with biofilter (Indoor)	Forced, negative air	Biofilter Bed	Building
Enclosed positive ASP (e.g., GORE cover)	Forced, positive air	None	Engineered Cover Membranes
Ag bag	Forced, positive air	None	Thick Mill Plastic Bag
General enclosed pile vented through a biofilter	Forced	Vented through biofilter	Finished Compost or Compost Overs
In-Vessel	Forced	Aerobic fermentation	None

Source: https://ww3.arb.ca.gov/ei/areasrc/composting_emissions_inventory_methodology_final_combined.pdf
[a] Requires compliance with pile management and/or watering requirements in SJVAPCD's rule 4566.
[b] Requires compliance with pile management and/or watering requirements in SCAQMD's rule 1133.3.

Biofilters or biocovers are the generally accepted odor reduction technologies for composting operations and are the only add-on technologies specified in the *ARB Emission Inventory Methodology for Composting Facilities*, March 2, 2015. Other odor control technologies have been used at wastewater treatment facilities and include:

- Carbon Adsorption
- Photo Ionization
- Bio-Trickling Filter

- Chemical Scrubber
- Thermal Oxidizer

Composting requires large volumes of air to maintain uniform temperatures and oxygen levels through the compost pile. The concentration of odors, VOCs and TAPs tend to be very low. The high-volume low concentration of the emissions makes carbon adsorption, photo ionization, bio-trickling filters and thermal oxidizers either too costly because of the very large size of the control devices or ineffective because the technology is not intended for treating low concentrations. Chemical scrubbers are generally designed for specific pollutants and are not well suited for complex odor compounds. None of these technologies, except biofiltration, have been demonstrated to be effective in practice at a composting facility, so they have not been evaluated beyond this point.

6.1.2 Step 2: Eliminate Technically Infeasible Options

All of the above technologies have been demonstrated effective in practice. However, as the County indicated above, it is not currently evaluating incineration for the pilot-scale project. The objective of the pilot project is to demonstrate the business case for a full-scale Loop composting facility and evaluate various blends of feedstock to determine the optimal conditions for proceeding into a full-scale facility. Incineration would not support this objective. Community surveys have indicated that the County should expect resistance from the community if incineration is proposed. The County is also subject to the Beneficial Use rule which incineration does not support. In addition, incineration has significant energy consumption and results in increased emissions from combustion. Therefore, incineration was removed from the evaluation because it was determined to be technically infeasible.

In-vessel enclosed ASPs, where waste is placed in a sealing drum, silo, or concrete-lined vessel and environmental conditions are mechanically controlled, are not feasible for a short pilot project because of the nature of the site, and temporary status of the project, all of which will not allow any permanent structures. Large concrete vessels cannot be poured on site for a 5-year project. In-vessel technology will be re-evaluated for the future full-scale facility.

6.1.3 Step 3: Rank Effectiveness of Control Technologies

HDR is engaged with CalRecycle in a research project to connect composting process conditions to emissions production, but results will not be available until late 2021. Fundamentally, the composting industry has not developed basic principles on what it means to maintain aerobic composting, nor can a definition of aerobic composting be readily found in North America. Drawing from United Kingdom and European research, aerobic composting can be defined as a process where oxygen is maintained above 2 ppm oxygen in the biofilm of decomposing waste. This is accomplished by forced aeration which delivers more than sufficient oxygen to supply aerobic reactions and also removes heat to maintain optimal temperatures for composting. A summary of the relationship between temperature and oxygen can be found in Biocycle[5].

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[5] https://www.biocycle.net/measuring-oxygen-in-compost/

The effectiveness of the technologies listed in Table 6-1 at controlling VOCs and ammonia (NH_3) are provided in Table 6-2. Since VOCs and NH3 contribute to odor, the data also indicates the technologies effectiveness at treating odor.

Composting processes using windrow technologies are the least efficient at reducing odors and VOCs, Emissions from passively aerated windrows with no biocover are considered to be uncontrolled. For this reason, windrows are not being considered for this project.

ASPs have more uniform aeration and oxygen levels throughout the compost pile which results in less emissions generated than from a windrow and therefore higher control efficiencies. The low VOC and NH_3 control efficiencies for negative ASP with biofilter (classic) when compared to an ASP with a biocover are mainly due to the low capture efficiency for the process. The addition of a biocover greatly improves the capture and removal efficiency as indicted in Table 6-2. Therefor ASPs without a biocover are not being considered for this project.

The remaining two technology categories, ASPs with a biocover and enclosed ASPs have similar VOC control efficiencies of 80 percent or greater. The eASPs has a range of control efficiency for ammonia, 53 to 84 percent, compared to a positive ASP with biofilter cover, 53 percent and an enclosed ASP, 70 percent. Both technologies will be considered for the future full-scale facility.

The document did not provide control efficiencies for an ASP with a biocover under negative aeration with a biofilter. It was noted that additional emission reduction potential from ASP could not be quantified at this time. However, it was mentioned the addition of a biocover greatly increases the capture efficiency for ASP systems. The addition of walls on either side of the piles also improves capture efficiency and distribution of airflow through the pile which reduce emissions. It is believed the control efficiency would be equal to or greater than an ASP with cover under positive aeration because you have the additional control efficiency provided by the biofilter. Most biofilters with appropriate media and sized for 45 to 60 seconds empty bed gas residence time are able to reduce odors by 85 to 90 percent (Fletcher *et al* 2014).

Table 6-2. Compost VOC and Ammonia Control Technology Effectiveness

Control type	Aeration	VOC Control Efficiency	NH_3 Control Efficiency
Windrow			
Static pile: no biofilter	Passive	0%	0%
Managed windrow: no biofilter	Passive	0%	0%
Water management requirements[a]	Passive	19%	19%
Static pile/passively aerated windrow covered 15 days with a biofilter[b]	Passive	40%	20%
Static pile/passively aerated windrow covered 22 days with a biofilter[a]	Passive	60%	20%
Aerated static pile (ASP)			
Negative ASP with biofilter (classic)	Forced, negative air	26%	23%
Aerated static pile (ASP) with biocover			
Positive ASP with biofilter cover	Forced, positive air	80%–98%	53%
Positive ASP with biofilter cover (eASP)	Forced, positive air	98.8%	53%-84%
Enclosed aerated static pile			
Enclosed negative ASP with biofilter (e.g., ECS)	Forced, negative air	80%–98%	70%–78%
Negative ASP with biofilter (Indoor)	Forced, negative air	80%–98%	80%–99%
Enclosed positive ASP (e.g., GORE cover)	Forced, positive air	80%	70%
Ag bag	Forced, positive air	80%	70%
General enclosed pile vented through a biofilter	Forced	80%	70%

Source: https://ww3.arb.ca.gov/ei/areasrc/composting_emissions_inventory_methodology_final_combined.pdf

[a] Requires compliance with pile management and/or watering requirements in SJVAPCD's rule 4566.

[b] Requires compliance with pile management and/or watering requirements in SCAQMD's rule 1133.3.

6.1.4 Step 4: Cost-Effectiveness Analysis

The County evaluated the cost of constructing an enclosed ASP by constructing a building over the active and curing composting processes and installing a ventilation system and biofilter to capture the emissions in the building. The cost for building and biofilter was estimated at 6.5 million dollars. Since the project has a 5-year limit, this would result in a cost of over 1 million dollars per year for an ammonia reduction of about 389 lbs per year. The detailed cost estimates are included in Appendix C. The current site footprint does not have space available for the biofilter large enough to control emissions from a building. Therefore, this type of enclosed ASP was eliminated based on both cost and feasibility.

6.1.5 Step 5: Select BACT

As discussed above, the remaining technologies, ASPs with a biocover and enclosed ASPs like GORE or Ag bag have similar VOC control efficiencies of 80 percent or greater. The eASPs, which is an ASP with a biocover with the configuration of a windrow instead of in a pile, has a range of control efficiency for ammonia, 53 to 84 percent, compared to a positive ASP with biofilter cover, 53 percent and an enclosed ASP, 70 percent.

The objective of this pilot Facility is to run the system in all aeration configurations, evaluate emissions, and make decisions for evaluating and planning a full-scale system. The only way to pilot all three aeration programs (positive, negative, and combination positive and negative) is to construct and operate a reversing aeration system. An ASP with a biocover is the technology best suited for this objective.

Enclosed ASP technologies, like GORE and Ag bag, are technically feasible for composting, but would not be able to operate under the desired operating conditions and would not provide the process data needed to design a full-scale facility. Therefore the GORE or Ag bag technologies are not being considered for the project.

The County is proposing an ASP with reversing aeration (both positive and negative) with the compost placed in concrete block bunkers for active composting and extended bed pile for curing. The compost is covered with a biolayer of overs or finished compost or wood chips for active composting and negative air is sent to a biofilter for treatment. This design is BACT because both ASPs with biocovers and enclosed ASPs have similar control efficiencies of greater than 80 percent control of VOCs and greater than 53 percent control of ammonia when under either positive or negative air. The proposed system is cost-effective and alternating the airflow allows the process to most closely mimic an in-vessel composting system, which will help with selecting the final design for a future permanent facility.

In addition, emission estimates based on a very conservative assumption of operating under the worst-case scenario, 8,760 hours per year, does not result in the emission of any TAP above the ASIL. Modeling of the odor emission will demonstrate that the emission will not exceed the limits established in the modeling protocol.

The pilot composting system will be designed to maintain oxygen concentrations greater than 2 ppm for greater than 90% of the composting process. This metric can be used to benchmark technology and is nondiscriminatory, being science and basic principles based. Ultimately this metric is likely to become the standard by which BACT is based.

Section 7 discusses other facilities that use similar composting processes.

7 Review of the Composting Process Used at Similar Facilities

Several small biosolids composting facilities are operating in western Washington. Three of them (Arlington, Lynden, and Westport) are presented and reviewed here, with Table

7-1 providing a summary. All three were designed and equipped by Engineered Compost Systems (ECS). The Arlington and Lynden facilities are very similar to what is proposed by the County, but both are substantially larger with greater throughput. Despite its smaller size, the aeration system for secondary composting at the proposed Facility has improved capture and control ability over these other two successful facilities as it is a reversing aeration system, capable of pulling process air into the fan for treatment by a fixed biofilter. The Westport biosolids composting facility uses containerized vessels for primary composting.

Table 7-1. Summary of Other Western Washington Biosolids Composting Facilities

	Arlington (2004)	Lynden	Westport 1997
Throughput (tpy)	8,500	8,000	2,500
Primary technology aeration system (days retention time)	CASP with reversing aeration and biofilter (22)	CASP with reversing aeration and biofilter (22)	Containerized in-vessel and biofilter
Secondary technology aeration system (days retention time)	ASP with positive aeration (22-60)	ASP with reversing aeration	ASP with reversing aeration
Odor complaints	One neighbor complains if biosolids are not processed within 36 hours	None on record that can be assigned to compost facility	None known
ECS page	https://www.compostsystems.com/product-page/city-of-arlington-arlington-wa	https://www.compostsystems.com/product-page/city-of-lynden-lynden-wa	https://www.compostsystems.com/product-page/city-of-westport-westport-wa
Operator	James X. Kelly, PE, Public Works Director, City of Arlington, (360) 403-3505	Mike Kim, City of Lynden, Plant Superintendent, Office: (360) 255-5470, Cell: (360) 603-6913	Unknown
Overview	https://nwbiosolids.org/whats-happening/member-spotlight/2015/january/city-arlington-waz	https://nwbiosolids.org/whats-happening/member-spotlight/2018/may/city-lynden#:~:text=At%20the%20Lynden%20wastewater%20treatment%20plant%2C%20we%20create,parks%2C%20and%20other%20wood%20sources.%20May%2021%2C%202018	http://www.ci.westport.wa.us/pbwrks.html

7.1 City of Arlington Water Reclamation Facility

The City of Arlington Water Reclamation Facility composting facility (Figure 7–1) was designed to convert the biosolids from the reclamation facility into compost. The plant ran successfully for 15 years. Operations have been suspended while capital and operating costs are being reviewed.

Figure 7–1. Arlington Water Reclamation Composting Facility

7.2 City of Lynden Sewer Treatment Plant

The City of Lynden Sewer Treatment Plan composting facility (Figure 7–2) is open and operating. It is near the center of the city and operates without odor complaints. The only complaints that have been made regarding the facility were attributed to the anaerobic digesters, not the composting operation.

Figure 7–2. Lynden Sewer Treatment Plant Composting Facility

7.3 City of Westport Wastewater Treatment Plant

The City of Westport WWTP composting facility (Figure 7–3) has been operating for close to two decades using containerized vessels. No odor complaints are on record.

Figure 7–3. Westport WWTP Composting Facility

8 Emission Estimates

The Facility has the potential to emit odors, VOCs, HAPs and TAPs, GHG, and fugitive dust (PM_{10} and $PM_{2.5}$). The detailed emission estimates are included in Appendix B.

8.1 Sources

Potential emission sources at the Facility consist of:

- Mixing areas: Loop biosolids bunker, bulk material bunker, and mixer
- Bunkers: four primary compost bunkers with biocover operated as CASPs, aerated with reversing aeration (having the option for positive and negative aeration in each bunker)
- Curing area: a secondary compost pile of extended bed configuration, comprised of four piles with biocover, aerated with reversing aeration (having the option for positive or negative aeration in each zone)
- Biofilter: a biofilter serving to scrub emissions from the bunkers and curing area when operating in negative aeration direction
- Screening: trommel screen powered by a 38 kW (51 horsepower) diesel engine
- Bulk Material Bunker: storage area for bulk material and overs
- Finished compost: a finished compost storage area.

Odors, VOC, and TAP emissions, including ammonia, occur primarily during the active and curing phases of the composting. According to *Odors and Volatile Organic Compound Emissions from Composting Facilities*, 95 percent of the emissions from a composting facility are from the active and curing processes (Epstein 2000). The active composting phase may also generate some HAPs.

The additional 5 percent is spread out among all the other areas in the composting process including mixing and screening. The screening unit will also generate criteria pollutants, TAPs, and HAPs from the combustion of diesel in the engine used to power the trommel screen.

VOC and ammonia emissions were estimated on a Facility-wide basis. Odors were evaluated for primary and secondary composting and for the finished storage pile. Odors were also evaluated for the mixing process to evaluate the short-term impact.

8.2 Emission Factors

Available emission factors (EFs) for biosolids composting is limited. However, source test results and published literature from multiple sources were reviewed to identify emission factors that had sufficient peer review and were representative of the proposed biosolids composting process.

8.2.1 Odor

The odor emission concentrations used in the emission estimates came from the Black & Veatch 1990 Peninsula Compost Facility Odor Control Study, page 566 of the *Practical Handbook of Compost Engineering* (Haug 1993). The odor emission concentrations were measured in the exhaust duct of a biosolids ASP operating under negative aeration. The study provided the average odor concentration for each week in weeks 1 to 6 for the biosolids composting operation. The study also provided the range of odor emission for weeks 1, 2 and 3. The highest value in the range was used as the odor emission rate for the entire week instead of the average. According to the SCAQMD Rule 1133 final staff report, 80 percent of VOC emissions and 50 percent of NH_3 emissions occur during the first 22 days of composting or during the primary composting phase (SCAQMD Rule 1133 Final Staff Report 2011). Therefore, using the highest value in the range for each of the first three weeks, will result in very conservative emission estimates.

In addition, the EFs were multiplied by 2 for the positive aeration mode. This assumption was based on a study which indicates that NH_3 emissions were reduced by approximately 55 percent during negative aeration compared to the positive pressure aeration treatment[6]. Therefore, it was assumed that if ammonia emission could double, then odor emission could also potentially double.

Odor emissions for the mixer were based on odor emissions from cake multiplied by 7.5. The ratio of 7.5 is based on ratio of odors from mixing/storage from Table 1 of Epstein (2000).

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[6] *Journal of Cleaner Production*, Volume 195, September 10, 2018, “Composting with negative pressure aeration for the mitigation of ammonia emissions and global warming potential”, Xuan Wang et al

8.2.2 VOC

The California Air Resource Board (ARB) has published facility-wide EFs for VOCs from biosolids facilities, *ARB Emissions Inventory Methodology for Composting Facilities (2015)*. The EFs are for uncontrolled facility-wide emissions in pounds per wet ton of biosolids processed. Composting using windrows, like in the ARB EF review, is considered to be uncontrolled compared to composting using aeration like the County proposes for this Facility.

8.2.3 HAP and TAP

As required by WAC 173-400-113(3), new or modified sources must demonstrate that they will not cause or contribute to a violation of an ambient air quality standard. New or modified sources of TAPs, as defined in WAC 173-460, must also comply with the requirements of that chapter. The requirements include an air quality impact analysis to demonstrate that the source(s) do not have the potential to adversely affect the health of people in the surrounding community.

Two sources, McGill (2005) and Epstein (2000), were used for estimating all HAP and TAP emissions, except for ammonia, naphthalene, and hydrogen sulfide which are discussed below. Many of the HAP and TAP compounds were included in both of these documents and had identical emission concentrations. If the concentrations were not identical in the two documents then the highest emission concentration was used. The EFs were provided as emission concentrations in milligrams per cubic meter (mg/m^3). The emission rate was calculated using the emission concentration and the airflow rate through the bunkers or zones.

Emissions were calculated in pounds per hour (lb/hr), pounds per 24 hours (lb/24-hr), and lb/yr for comparison to the *de minimus* and SQER levels in the air toxics regulation.

8.2.4 Ammonia

For ammonia, the ARB has published facility-wide EFs from biosolids facilities. The EFs are for uncontrolled facility-wide emissions in pounds per wet ton of biosolids processed. Composting using windrows is considered to be uncontrolled.

8.2.5 Naphthalene

Naphthalene emissions were provided by Table 10.11 in *The Science of Composting* (Epstein 1996). The naphthalene emission rate provided in McGill (2005) was the maximum naphthalene emissions rate observed at a municipal solid waste composting facility and did not reflect emissions from biosolids composting.

8.2.6 Reduced-Sulfur Compounds

Emission concentrations of RSCs were taken from Tables 3 and 4 in Odors and Volatile Organic Compound Emissions from Composting Facilities (Epstein 2000). The RSC, hydrogen sulfide, is a TAP.

8.2.7 Greenhouse Gas Emissions

Composting using CASP is an aerobic process and some fraction of the organic material is decomposed during composting to carbon dioxide (CO_2). The generation of nitrous oxide (N_2O) and methane (CH_4) can also occur. A standard set of EFs have been adopted by the Intergovernmental Panel on Climate Change (IPCC) from a review of the available literature and these values are used by the EPA. Emissions of these compounds depend on composting conditions. The 2006 IPCC Guideline reported CH_4 emissions ranging from less than 1 percent to a few percent of the initial carbon content of the compost and reported N_2O emissions have ranged from 0.5 to 5 percent of initial nitrogen in the material (IPCC 2006).

The emissions of CH_4 and N_2O are converted into an equivalent CO_2 emission rate using the global warming potentials (GWPs) of these gases. The GWPs are recommended by the IPCC in its periodic assessment reports. These values account for differences in atmospheric lifetime between CO_2 and the other GHGs and differences in their infrared absorption spectrum. These GWPs based on the 100-year time horizon are 25 for CH_4 and 298 for N_2O.

8.2.8 Material Handling

Emissions from material handling include fugitive emissions and emissions from the diesel engine powering the trommel screen. The screen is powered by a 38 kW (51 horsepower) diesel engine. Screening will be conducted a maximum of 4 hours per week. Emissions were calculated assuming a Tier 4 engine and AP-42, Section 3.3, Table 3.3-2.

The main source of potential fugitive dust emissions is from the movement of feedstock and compost around the Facility. Fugitive dust from vehicle traffic should be minimal because the Facility will follow current fugitive dust management procedures and maintain a clean site. However, the loading and unloading of materials in the different process areas may cause fugitive emissions. Therefore, fugitive emissions were calculated based on the number of drop points in the process. There are no generally accepted EFs for fugitive particulate emissions from composting. SJVAPCD recommends using the EF for crushed stone from AP-42 Table 11.19.2-2 (2006 Area Source Emissions Inventory Methodology [199 – Composting Waste Disposal]).

8.2.9 Summary of Emissions Factors

Table 8-1 provides a summary of the EF references discussed above. The table indicates if the EF came from a Passively Aerated Windrow System (PAWS) or ASP.

Table 8-1. Summary of Emission Factor References

Source	EF Source		Factor Reference	Adjustment	Reference
	PAWS	ASP			
Odors					
Mixer			Haug (1993)	Cake Flux Rate x 7.5	Epstein (2000)
Primary Bunkers		X	Haug (1993)	OU/M^3 x 2 for positive aeration only	Xuan Wang et al (2018)
Curing Zones		X			
Biofilter		X			
Finished Product		X			
HAPs and TAPs					
Primary Bunkers		X	McGill (2005), Epstein (1996, 2000)		
Curing Zones		X			
Biofilter		X			
Facility-wide Emission Factors					
VOC	X		ARB (2015)		
Ammonia	X		ARB (2015)		
Fugitive Dust			AP-42 Table 11.19.2-2		

8.3 Control Efficiencies

The control efficiencies provided by the BACT analysis were not always used in the emission estimates. Frequently an even more conservative control efficiency was used. The control efficiencies in the BACT analysis for VOC and NH3 are in comparison to emission data from windrows. Some of the emission data did not come from windrows. The HAP and TAP emission data was collected from an ASP under negative aeration upstream of a biofilter not from a windrow. There was no HAP and TAP data available from windrows composting biosolids. Therefore, a more conservative (lower) control efficiency was assumed when estimating HAP and TAP emissions. The assumptions used for the control efficiencies are described in greater detail below.

The primary bunkers and curing zones are covered with a 6-inch to 12-inch biolayer. It was assumed that this biolayer would provide a 35 percent reduction in odor emissions. *ARB Emission Inventory Methodology for Composting Facilities*, March 2, 2015 Table III-3: Control Techniques for Composting Operations provides a VOC control efficiency of 60 percent and an ammonia control efficiency of 20 percent for a static pile or passively aerated windrow covered for 22 days with a biolayer. Using the ARB EFs for VOC and ammonia emissions from windrow composting of biosolids, and the control efficiencies provided in Table 8-2, an overall control efficiency of 35 percent was calculated. Therefore, it was assumed the biolayer would provide a removal efficiency of 35 percent for odor.

Table III-3 also provides a VOC and ammonia control efficiency for a positive ASP with a biocover of 80 to 98 percent for VOCs and 53 percent for ammonia when compared to windrow composting. This is significantly higher than the control efficiency for just the biolayer, because aerating the compost also helps reduce emissions.

When operating in negative aeration mode, the emissions are sent to the biofilter for treatment. It was conservatively assumed that the biofilter would reduce odors by 75 percent (low in the range of performance published rates of 75 to 90 percent). Most biofilters with appropriate media and sized for 45 to 60 seconds empty bed gas residence time are able to reduce odors by 85 to 90 percent (Fletcher *et al* 2014). However, some biosolids odorants can be complex and more difficult to remove. For this reason, a more conservative removal rate of 75 percent has been assumed herein.

Therefore, if the EF for a pollutant was from an ASP under negative aeration;

- A control efficiency of 75 percent was applied. when the emissions are sent to the biofilter
- In positive aeration mode, the EF was doubled and a 35 percent control efficiency was assumed for the biolayer.

Since the ammonia and VOC EFs are from a PAWS the control efficiency for positive aeration with a biolayer was assumed to be 75 percent for VOCs and 53 percent for ammonia.

Table 8-2 provides a summary of the control efficiencies.

Table 8-2. Summary of Control Efficiencies.

Source	EF Source		Control	Efficiency (percent)			Reference
	PAWS	ASP		Odors	VOCs	NH_3	
Mixer			Uncontrolled	0	0	0	
Primary Bunkers		X	Biolayer	35[a]	NA (60)	NA (20)	ARB (2015), Passively aerated windrow covered for 22 days with a biolayer.
Curing Zones		X					
Biofilter		X	Biofilter	75 (80-98)	75 (80-98)	70	Fletcher *et al* 2014, ARB (2015), Enclosed (CASP) negative ASP with biofilter.
Finished Product		X	Uncontrolled	0	0	0	
Facility-wide Emission Factors							
VOC	X		Biolayer		75 (80-98)		ARB (2015),Positive ASP with biolayer cover
VOC	X		Biofilter		75[a] (80-98)		Enclosed (CASP) negative ASP with biofilter.
Ammonia	X		Biolayer			53[a]	ARB (2015),Positive ASP with biolayer cover
Ammonia	X		Biofilter			70[a]	Enclosed (CASP) negative ASP with biofilter.

[a] Control Efficiency used for HAP and TAP emissions

8.4 Process Scenarios

Odors, VOCs, and HAP and TAP emissions, including ammonia, occur primarily during the active and curing phases of the composting. Typically, 95 percent of the emissions from a composting facility are from the active and curing processes (Epstein 2000). The remaining five percent of emissions from a composting facility, after active composting and curing, are spread out among all the other areas in the composting process, including mixing and screening.

To allow for operational flexibility, emissions were calculated for three operating scenarios. Scenario 1 (Positive Aeration) has the highest estimated emissions and Scenario 3 (Negative Aeration) has the lowest. Actual operation will involve a mix of Scenarios 1, 2 and 3, and emissions will fall somewhere near or below the middle of the emission estimates for Scenarios 1 and 3.

The following is a description of each scenario:

Scenario 1 (Positive Aeration): All four bunkers and four curing zones are in operation with the mixing area inactive. Emissions from the finished compost area are also included. The fifth curing zone will not be in operation because, as in all cases, a gap is left between the loading face and soon to be unloaded face of the extended bed. The mixing area would not be in operation when all four bunkers are already loaded with mixed material. Under this scenario, all active and curing composting bunkers and zones are aerated in the positive aeration direction. The biofilter is not modeled in this scenario because there is no negative aeration airflow through any bunkers or zones and thus no air flow pushed out the biofilter during this scenario.

This scenario has the highest potential for emissions but is very unlikely to occur in practice because the control system switches regularly between positive and negative. In addition, the system tends to be biased toward negative aeration for the beginning of active composting where most emissions are generated. Since each of the bunkers and zones have a 50 percent chance of being in positive aeration direction, the probabilities are multiplied to obtain the likelihood of all being in positive aeration mode at the same time (50%^9) which is less than 0.2 percent of the time. The potential exception is when the Facility intentionally operates under this condition for the purpose of emission testing which would be a planned event resulting in actual emission data.

Scenario 2 (Positive Aeration with Mixer): This scenario models emissions from three of the four bunkers in active composting, four of the five zones in the curing area, and the mixing area. Emissions from the finished compost area are also included. One active bunker would remain empty in order to receive the soon-to-be produced fresh mix of material. Under this scenario, positive aeration is considered as the only aeration direction used to control the compost process in the active bunkers and in the curing zones. The biofilter is not included because there is no airflow through the biofilter during this scenario (no negative aeration). This scenario represents worst-case for odors when a new batch of biosolids and bulking material are being prepared and are soon to be placed in one of the active bunkers. The odors from Scenario 2 are less than Scenario 1, but more than scenario 3.

Scenario 3 (Negative Aeration): This last scenario models all four bunkers and four curing piles in operation, with control by negative aeration. In this scenario the mixing area is inactive and not producing emissions as all four active bunkers are full and there is no space to place any fresh mixed material (thus not utilized). Under this scenario negative aeration is solely used to control the primary bunkers and curing zones, and all the process air is routed to the biofilter.

A summary of the process scenarios is provided in Table 8-3.

Table 8-3. Process Scenarios

	Scenario 1	Scenario 2	Scenario 3
Mixing Areas (1-4)	Inactive	Active	Inactive
Compost Bunker (5)	↑ 4 Positive Aeration	↑ 3 Positive Aeration	↓ 4 Negative Aeration
Curing Area (6)	↑ 4 Positive Aeration	↑ 4 Positive Aeration	↓ 4 Negative Aeration
Screening Area (7)	-	-	-
Finished Product (8)	Active	Active	Active
Biofilter (▲)	Inactive	Inactive	Active
Emissions	Highest (0.2% of the time)		Lowest

8.5 Summary of Emissions

A summary of emissions is provided in Table 8-4. Odor emissions are expressed in units of OU/min (odor units per minute). As mentioned in Section 5, OUs measure odor concentration with respect to the perception threshold for an odorous sample. An odor concentration in OUs is equal to the number of volumes of dilution air which are required to dilute a single volume of odorous air to the point at which half of a group of odor panelists perceive an odor and half do not. At an odor concentration of 1 OU per cubic meter, 50 percent of panelists would perceive an odor. Alternative terminology in use includes: D/T and Effective Dose at 50% of the population (ED50) (ASTM 2004 Bluebook).

The emissions for each scenario were calculated assuming 8,760 hours per year (24 hours per day, 365 days per year).

A breakdown of the odor emissions by process area are provided in Table 8-5.

Table 8-4. Facility Emissions for Scenarios 1-3

Emission Source	Odor (OU/min)	VOC (lb/yr)	HAPs & TAPs (lb/yr)	Fugitive Particulate [PM_{10}/$PM_{2.5}$] (lb/yr)
Scenario 1: Positive Aeration (4 bunkers and 4 curing zones in operation)				
Facility Total	52,808	347	1,421	3.1/0.47
Scenario 2: Positive Aeration with Mixer (3 bunkers, mixer, and 4 curing zones in operation)				
Facility Total	30,269	347	1,348	3.1/0.47
Scenario 3: Negative Aeration (4 bunkers, biofilter, and 4 curing zones in operation)				
Facility Total	12,107	347	820	3.1/0.47

lb/yr = pound(s) per year
OU/min = odor unit(s) per minute.

Table 8-5. Odor Emissions by Process Area for Scenarios 1-3

Emission Source	Emission Factor	Units	Odor Emissions (OU/min)
Scenario 1: Positive Aeration (4 bunkers and 4 curing zones in operation)			
Primary Compost Bunkers (Week 1)	3,540	OU/M^3	22,791
Primary Compost Bunkers (Week 2)	1,740	OU/M^3	11,203
Primary Compost Bunkers (Week 3)	1,240	OU/M^3	7,983
Primary Compost Bunkers (Week 4)	600	OU/M^3	3,863
Secondary Compost Pile (Curing)	464	OU/M^3	6,828
Finish Product Storage	0.4	OU/M^2/min	139
Facility Total			**52,807**
Scenario 2: Positive Aeration with Mixer (3 bunkers, mixer, and 4 curing zones in operation)			
Primary Compost Bunkers (Week 2)	1,740	OU/M^3	11,203
Primary Compost Bunkers (Week 3)	1,240	OU/M^3	7,983
Primary Compost Bunkers (Week 4)	600	OU/M^3	3,863
Secondary Compost Pile (Curing)	464	OU/M^3	6,828
Mixing System and Areas (Combined Factors)[1]	18.1	OU/M^2/min	253
Finish Product Storage	0.4	OU/M^2/min	139
Facility Total			**30,269**
Scenario 3: Negative Aeration (4 bunkers, biofilter, and 4 curing zones in operation)			
Primary Compost Bunkers	6	OU/M^2/min	1,044
Secondary Compost Pile (Curing)	4	OU/M^2/min	750
Primary and Secondary Biofilter	150	OU/M3	10,174
Finish Product Storage	0.4	OU/M^2/min	139
Facility Total			**12,107**

Total of flux rate for cake (1.9), mixing (14.3) and feedstock (1.9) in OU/M^2/min.
OU/min = odor unit(s) per minute
OU/M^3 = odor unit(s) per cubic meter
OU/M^2/min = odor units(s) per square meter per minute.

The emission sources will be conservatively modeled as area sources, and the scenario with the highest emissions will have the highest ambient impacts. Therefore, Scenario 1 was selected to use in the dispersion model.

9 Operation and Monitoring Procedures

9.1 Proposed Biofilter Odor Monitoring Procedures

The biofilter will be operated and maintained according to recommendations provided by Engineered Compost Systems (ECS) White Paper 2020-4: "Biofilter Theory, Design, and Operation," by Tim O'Neill & Aimee Manderlink, Updated 11/2/2020. This document is included in Appendix D.

9.2 Emission Sampling Objectives

The objective of emission sampling at the Facility at STP will be to evaluate the emission rates used in the modeling exercise so that more accurate odor modeling can be performed for a possible full-scale facility. There are limited studies on odor emissions from biosolids composting facilities in Washington's climate, and there is a large variability in emission rate and compound depending on the feedstock mix, operation, and climate. The objective of testing will be to ascertain which factors have the most influence on odor emission rates and document these with sufficient sampling to build a strong database that can be used as input for full-scale facility modeling.

The emission sampling protocol has not been developed at this time. After the County has operated the Facility for a period long enough to establish potential operating scenarios for a full-scale facility and identify information gaps, the County will develop a source test plan. The source test plan will be provided to PSCAA for review and approval.

10 Air Quality Impact Analysis

As mentioned in Section 4, Regulatory Review, state and local air quality regulations in the project area are administered by the PSCAA. Potential Facility emissions of VOCs, GHG, PM_{10} and $PM_{2.5}$ do not trigger any air impact analysis or dispersion modeling requirements. VOCs, PM_{10} and $PM_{2.5}$ emissions are below NSR exemption levels of 2.0 tons per year, 0.75 ton per year, and 0.5 tons per year respectively per WAC 173-400-110(5)(a)(i).

10.1 Hazardous Air Pollutants/Toxic Air Pollutants

Typically, PM_{10}, $PM_{2.5}$ and VOC modeling are triggered when emissions of a criteria pollutant exceed their significant impact levels for major source permitting. As discussed above, this project is not a major source. The emissions are well below the significant impact levels and below NSR exemption levels. Therefore, the ambient air impacts were assumed to be negligible, and the emissions were not modeled. However, PSCAA may request modeling if it believes the emission increase could cause or contribute to a violation of the National Ambient Air Quality Standards (NAAQS). There is not a NAAQS for VOCs. However, VOCs contribute to ozone, and there is a NAAQS for ozone.

As discussed in Section 4.2, the TAPs with projected emissions need to be evaluated against the *de minimis* thresholds, SQER, and ASIL. Of the 33 TAPs identified as having potential emissions from the Facility, 11 exceeded their *de minimis* thresholds. These 11 TAPs, their estimated annual potential to emit, and their SQER are listed in Table 10-1. None of the 11 TAPs exceed the SQER; therefore, according to PSCAA Regulation III Section 2.07 (c) (1) (A), the Facility has demonstrated compliance with ASIL for TAPs. The first-tier analysis may be considered complete without requiring dispersion modeling.

Table 10-1. TAPs with Emission Rates Exceeding *De Minimis* Levels, Compared to SQER

TAP	CAS Number	Emission Rate (lb/averaging period)	Averaging Period	SQER (lb/averaging period)	Exceeds SQER?
1,1,2-Trichloroethane	79-00-5	0.85	lb/year	10	No
Allyl chloride	107-05-1	2.1	lb/year	27	No
Ammonia	7664-41-7	2.9	lb/24-hr	37	No
Benzene	71-43-2	3.4	lb/year	21	No
Carbon tetrachloride	56-23-5	9.2	lb/year	27	No
Chloroform	67-66-3	1.7	lb/year	7.1	No
Ethylbenzene	100-41-4	5.4	lb/year	65	No
Hydrogen sulfide	7783-06-4	0.10	lb/24-hr	0.15	No
Napthalene	91-20-3	1.4	lb/year	4.8	No
Triethylamine	121-44-8	0.78	lb/24-hr	15	No
Diesel PM	—	0.51	lb/year	0.54	No

CAS = Chemical Abstracts System
lb = pound(s)

10.2 Odor Modeling Emissions

Odor emissions are regulated through PSCAA Regulation I, Section 9.11, which states: "*It shall be unlawful to cause or permit the emission of an air contaminant in sufficient quantities and of such characteristics and duration as is, or is likely to be, injurious to human health, plant or animal life, or property, or which unreasonably interferes with enjoyment of life and property*." Enforcement actions are allowed under 9.11(b) if an odor complaint is verified and a representative of the PSCAA is able to document that a facility is the source of a distinct, definite odor with recognizable unpleasant characteristics. No quantitative regulatory standards apply to odor emissions or ambient odor impacts in the project area. As discussed in Section 5, the odor dispersion modeling analysis will be compared to the following two odor standards:

- Annually, ambient impacts over five DT will not occur more frequently than one percent of hours, when odor impacts are considered on an hourly average basis.
- Annually, ambient impacts over five DT will not occur more frequently than two percent of hours, when odor impacts are considered on a five-minute average basis. For hours in which a five-minute impact greater than five DT is modeled, this

indicates that one or more five-minute periods during the hour are expected to exceed five DT, but not necessarily the entire hour.

Operating Scenario 1 (positive aeration with four bunkers and four curing piles in operation) has the highest emission rates and consists of emission sources that are closest to the Facility fenceline. Therefore, Scenario 1 is considered the worst-case operating scenario, which has a probability of occurring 0.2 percent of the time. It is theoretically possible in a reversing aeration system to randomly have all zones in positive aeration direction but probability calculations show that with the total number of zones in this design, the random chance of all being in positive is very low. There may be instances when the Facility desires to test all zones in positive for a short period of time, and this is another reason to run the modeling in this worst-case scenario.

To establish worst-case conditions, dispersion modeling was performed that is representative of this worst-case operating scenario being in effect during all hours of the year. Area-specific odor emission rates and modeled emission rates for each source are presented in Table 10-2.

Table 10-2. Modeled Sources and Odor Emission Rates for Scenario 1

Source	Area-Specific Odor Emission Rate[a] ($OU/m^2/min$)	Modeled Odor Emission Rate (OU/s)[b]
Primary Compost Bunkers - Week 1 (per bunker)	524	380
Primary Compost Bunkers - Week 2 (per bunker)	258	187
Primary Compost Bunkers - Week 3 (per bunker)	184	133
Primary Compost Bunkers - Week 4 (per bunker)	89	64
Secondary Compost Pile (Curing)	36	114
Finished Product Storage	0.4	2.3

[a] Area-specific odor emission rates are calculated using the maximum aeration rate and account for a 35% reduction in odors due to the biocover layer, except for Finished Product Storage. The Finished Product Storage EF was provided as an area-specific odor emission rate.

[b] Modeled odor emission rates are calculated for the entire source using the source surface area and are converted to OU/s for modeling ambient odor impacts in units of DT.

$OU/m^2/min$ = odor unit(s) per square meter per minute

OU/s = odor unit(s) per second

Odor emission rates from the bunkers depend on the residency time of the compost, beginning at a higher emission rate for the first week and gradually decreasing through four weeks of residence time as the compost material stabilizes. To capture the worst-case spatial configuration for the bunkers, combinations of all four bunkers at all four weeks of emissions rates were evaluated and the worst-case configuration results are displayed (refer to Section 10.3.7 Worst-Case Bunker Configuration Determination for additional details).

10.3 Dispersion Model Selection

The EPA-recommended AERMOD dispersion modeling system was used to estimate air quality impacts. AERMOD (version 19191) was used with regulatory default options, as per 40 CFR Part 51 Appendix W (2017).

The following supporting preprocessing programs for AERMOD were also used:

- AERMET (Version 19191)
- AERMINUTE (Version 15272)
- AERSURFACE (Version 20060)
- AERMAP (Version 18081)

10.3.1 Meteorological Data

The most representative available surface and upper air meteorological data have been used in AERMET to process an AERMOD-ready dataset for this analysis.

10.3.2 Meteorological Stations and Time Period

Surface observation data from the National Weather Service Renton Municipal Airport (call sign: KRNT; WBAN: 94248; USAF: 727934) Automated Surface Observing System (ASOS) station for the most recent available years (2015 through 2019) were selected. The Renton Municipal Airport meteorological tower is approximately 1.7 miles northeast of the STP. This National Weather Service site is considered representative of the project site due to proximity, similar geophysical situation (east of Puget Sound and west of the Cascade Mountains) and lack of intervening complex terrain. The 1-minute wind data from this ASOS station were processed using AERMINUTE to supplement the surface data. Concurrent twice daily upper air soundings collected at Quillayute Airport (call sign: KUIL; WBAN: 94240; WMO: 72797) station were also input into AERMET. Located approximately 112 miles northwest of the STP, Quillayute Airport is the closest upper air station to the project site.

10.3.3 Surface Characteristics

Surface characteristics used in AERMET Stage 3 processing for the area surrounding the Renton Municipal Airport meteorological tower were determined using the AERSURFACE preprocessor. United States Geological Survey (USGS) National Land Cover Data from 2016, including land cover, impervious surface, and tree canopy layers, were input into AERSURFACE. As recommended by the AERSURFACE user guide (EPA 2020), the VARYAP option was used in order to more accurately define surface roughness around the meteorological tower by classifying sectors consisting primarily of runways or parking lots as “airport” land use and other sectors as “non-airport” land use (Figure 10–1).

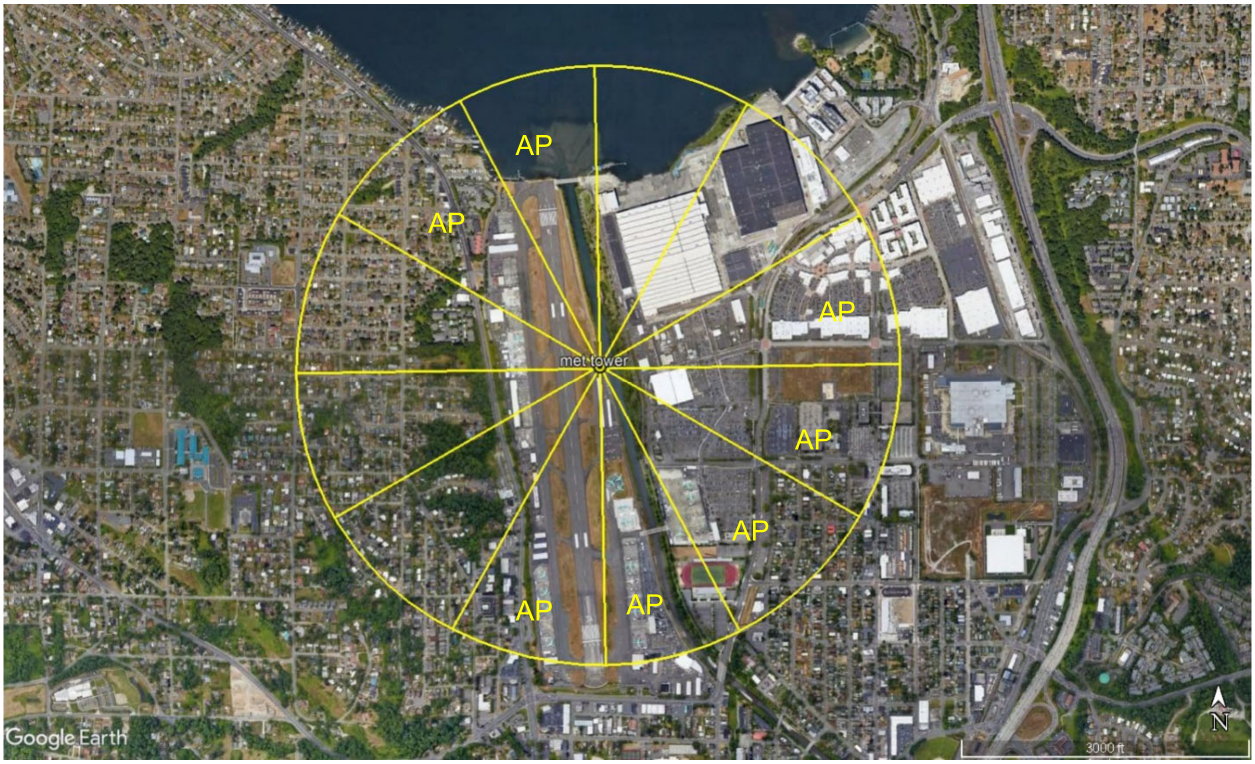

Figure 10–1. Airport/Non-Airport Sector Classification for AERSURFACE
AP = Airport Sector. Non-Airport Sectors are unlabeled.

Years modeled were given moisture classification of dry, wet, or average based on the 30th and 70th percentiles of annual precipitation data from Seattle-Tacoma Airport over a 30-year period (1990 through 2019)[7]. Table 10-3 presents the classifications used:

Table 10-3. Moisture Classifications Used in AERSURFACE

Year	Moisture Classification
2015	Wet
2016	Wet
2017	Wet
2018	Average
2019	Dry

10.3.4 AERMET Model Options

AERMET Stage 3 processing includes the EPA-approved adjusted u-star trigger in order to more accurately capture surface velocity during periods of low-wind (wind speeds less than 0.5 meter per second [m/s]).

[7] SEATTLE TACOMA INTL AP, WA (457473) from http://www.wrcc.dri.edu/

10.3.5 Data Completeness and Wind Statistics

The 2015 through 2019 AERMOD-ready dataset processed as described previously meets EPA criteria for completeness, with less than 10 percent of hours missing or calm for each year (Table 10-4).

Table 10-4. Completeness Statistics for 2015-2019 Meteorological Data Modeled

	2015	2016	2017	2018	2019
Number of hours processed	8,760	8,784	8,760	8,760	8,760
Number of calm hours	92	178	213	351	546
Number of missing hours	180	109	83	137	185
% calm hours	1.1%	2.0%	2.4%	4.0%	6.2%
% missing hours	2.1%	1.2%	0.9%	1.6%	2.1%
% hours modeled in AERMOD	97%	97%	97%	94%	92%

Figure 10–2 is a wind rose diagram that illustrates the annual distribution of surface wind speeds and directions at Renton Municipal Airport between 2015 and 2019. The mean wind speed is 2.67 m/s. A wind rose is a graphical representation of wind speed and direction over a discrete period of time. It is a 360-degree compass that looks like a flower with petals that represent the direction from which the wind is blowing. The wind rose petals represent the 16 compass points. The length of each segment of a petal represents the frequency of wind within a speed category, as noted by the labeled rings. The wind speed categories are identified by different colors in the legend at the bottom of the wind rose figure.

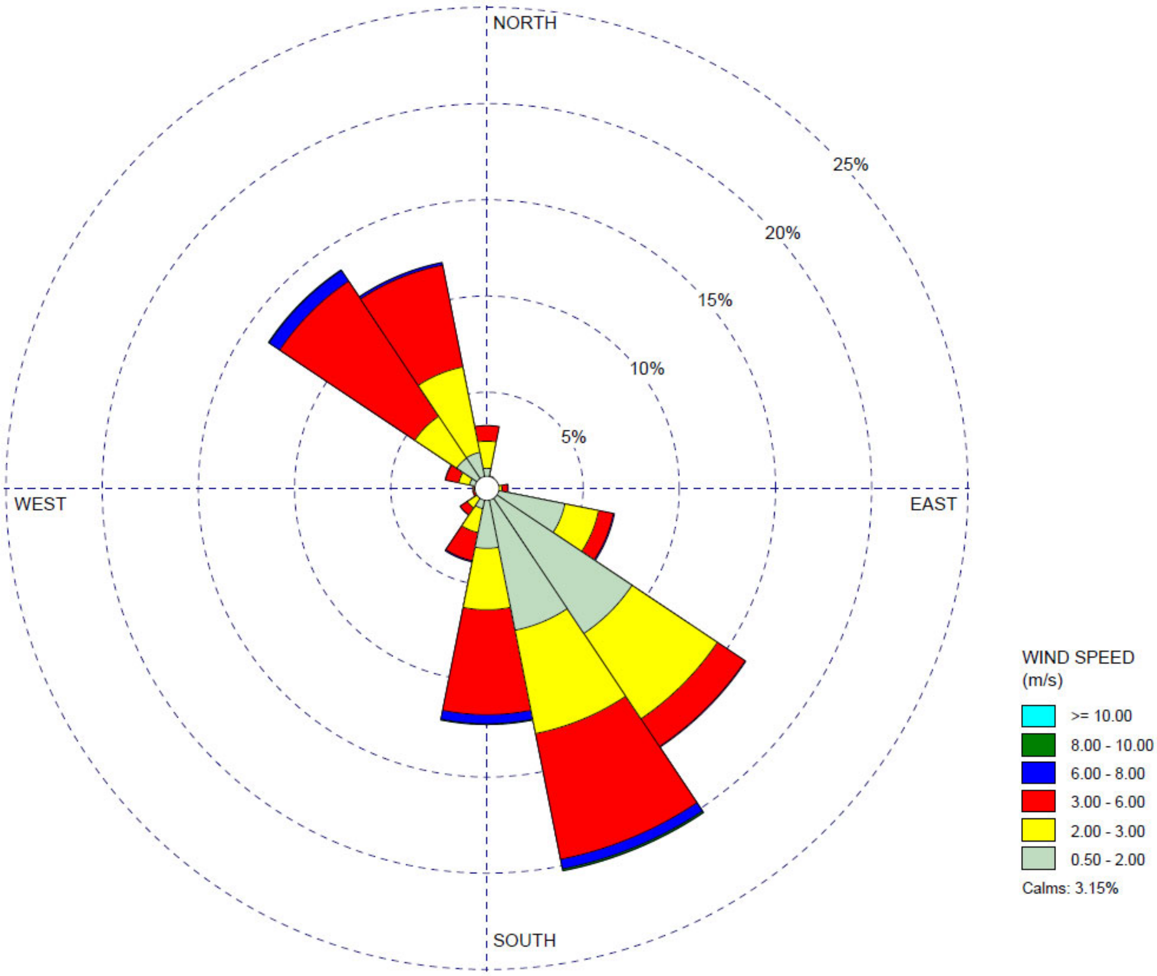

Figure 10–2. Wind Rose for KRNT (Renton International Airport) Surface Data Site
Wind direction is the direction the wind blows from.

10.3.6 Source Parameters

All modeled emission sources are compost pile surfaces with two-dimensional release profiles and are modeled as non-buoyant area sources. The modeled release heights and area dimensions were obtained from Facility basis-of-design documentation. Locations and base elevations are taken from 60 percent design drawings. Modeled source parameters are provided in Table 10-5.

Table 10-5. AERMOD Input Parameters for Modeled Sources

Source Description	Easting X (meters)[a]	Northing Y (meters)[a]	Base Elevation (feet)[b]	Easterly Length (feet)	Northerly Length (feet)	Release Height (feet)
Primary Compost Bunker 1	557246.95	5257825.53	29.2	13	36	4.5
Primary Compost Bunker 2	557242.90	5257824.21	29.2	13	36	4.5
Primary Compost Bunker 3	557238.84	5257822.89	29.1	13	36	4.5
Primary Compost Bunker 4	557234.78	5257821.57	29.1	13	36	4.5
Secondary Compost Pile (Curing)[c]	557216.86	5257819.00	29.5	42	48	4
Finished Product Storage	557181.55	5257799.34	32.6	52	72	9

[a] Universal Transverse Mercator North American Datum 83 Zone 10
[b] Above mean sea level.
[c] Only four of the five available curing area zones operate at a time, on a rotating basis. To capture worst-case conditions, the four northernmost zones (closest to the fenceline) are assumed to be in use for all hours modeled.

Modeled source locations and the STP fenceline are shown on Figure 10–3.

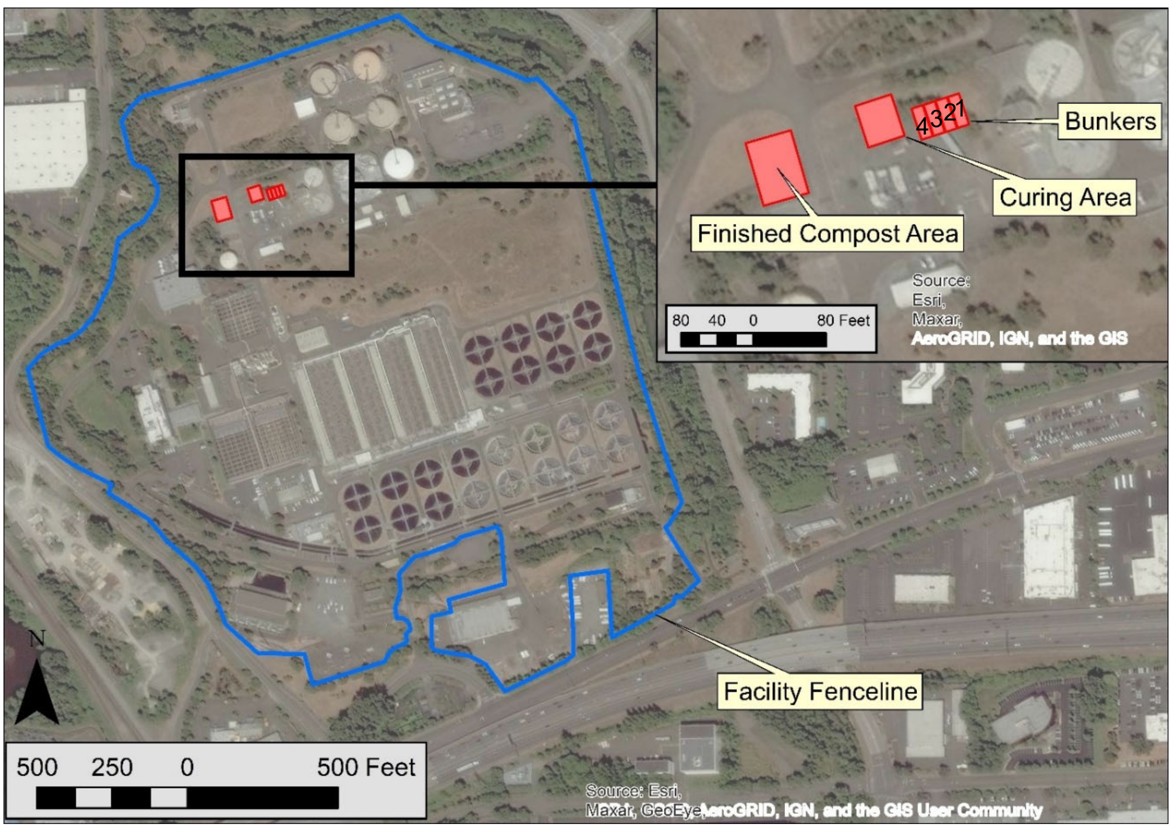

Figure 10–3. Locations of Modeled Sources and STP Fenceline

10.3.7 Worst-Case Bunker Configuration Determination

Each bunker emits a different week's emissions (refer to Table 10-2 for emission rates). However, different spatial configurations of the bunkers at various emission rates may result in different ambient odor impacts. To ensure modeling of the worst-case scenario, source groups in the model were used to determine the worst-case spatial configuration of bunkers at these rates, and bunkers will be assumed to be in this configuration during all hours of the year throughout the year. Table 10-6 describes the bunker emissions configuration for each of the 24 source groups (Source groups A through X). Each of the source groups includes the four bunkers, the secondary compost pile (curing), and the finished product storage area (as described in Table 10-2). The worst-case source group results are shown in this application. Detailed source inputs are included in Appendix E.

Table 10-6. List of Proposed Source Groups and Emission Rates

Source Group	Bunker 1	Bunker 2	Bunker 3	Bunker 4
Group A	Week 1	Week 2	Week 3	Week 4
Group B	Week 1	Week 2	Week 4	Week 3
Group C	Week 1	Week 3	Week 2	Week 4
Group D	Week 1	Week 3	Week 4	Week 2
Group E	Week 1	Week 4	Week 2	Week 3
Group F	Week 1	Week 4	Week 3	Week 2
Group G	Week 2	Week 1	Week 3	Week 4
Group H	Week 2	Week 1	Week 4	Week 3
Group I	Week 2	Week 3	Week 1	Week 4
Group J	Week 2	Week 3	Week 4	Week 1
Group K	Week 2	Week 4	Week 1	Week 3
Group L	Week 2	Week 4	Week 3	Week 1
Group M	Week 3	Week 1	Week 2	Week 4
Group N	Week 3	Week 1	Week 4	Week 2
Group O	Week 3	Week 2	Week 1	Week 4
Group P	Week 3	Week 2	Week 4	Week 1
Group Q	Week 3	Week 4	Week 1	Week 2
Group R	Week 3	Week 4	Week 2	Week 1
Group S	Week 4	Week 1	Week 2	Week 3
Group T	Week 4	Week 1	Week 3	Week 2
Group U	Week 4	Week 2	Week 1	Week 3
Group V	Week 4	Week 2	Week 3	Week 1
Group W	Week 4	Week 3	Week 1	Week 2
Group X	Week 4	Week 3	Week 2	Week 1

Modeled emission rates in OU/s are provided in Table 10-2.

10.3.8 Model Units

For odor modeling, non-default units were set in AERMOD. Using the CONCUNIT keyword, the factor for conversion of emission rate input units of OU/s to output units of DT were set to one to reflect the relationship between OU and DT:

$$OU = DT \times m^3$$

10.3.9 Estimation of 5-minute Average Concentrations

Because AERMOD does not estimate concentrations for averaging periods of less than one hour, hourly averages were converted to five minute averages as needed, using the following peak-to-mean ratio equation (Porter et al. 1994):

$$C_1 = C_0 * (t_0 / t_1)^p$$

Where: C_0 = initial (1-hour) concentration with an averaging time, t_0 (60 minutes)

C_1 = desired concentration with an averaging time, t_1 (3 to 5 minutes)

p = power law factor of 1/5

Therefore, a factor of 1.64 was applied to the predicted 1-hour impact concentrations to determine the 5-minute concentrations. The 5-minute 5 DT threshold was divided by 1.64 to determine the 1-hour equivalent DT of 3.04 to determine 5-minute 5 DT threshold frequency.

10.3.10 Receptors and Ambient Air Boundary

For the dispersion analysis the ambient air is defined as the area at and beyond the STP fenceline (refer to Figure 10–3).

Receptor locations in AERMOD are as follows (WA Ecology 2015):

- 12.5-meter (m) spacing from 0 to 150 m from the ambient air boundary
- 25-m spacing from 150 to 400 m from the ambient air boundary
- 50-m spacing from 400 to 900 m from the ambient air boundary
- 100-m spacing from 900 to 2000 m from the ambient air boundary
- 300-m spacing from 2000 to 4500 m from the ambient air boundary

USGS National Elevation Dataset terrain data was used in conjunction with the AERMAP preprocessor to determine receptor elevations and critical hill heights. All receptor locations are displayed in Universal Transverse Mercator North American Datum 83 Zone 10.

10.3.11 Urban versus Rural Land Use Classification

The land use surrounding the Facility has been evaluated for classification as either urban or rural, consistent with Section 7.2.1.1 of 40 CFR Part 51 Appendix W (2017). A land use analysis was performed following the Auer land use methodology (Auer 1978) as closely as possible while using the most recent available data. Land cover and impervious surface data within a three-kilometer (km) radius from the ambient air boundary were obtained from the USGS 2016 National Land Cover Database (NLCD). The land cover dataset classifies each 30-m by 30-m cell into one of 20 land use categories and the impervious surface dataset provides the percent impervious surface for each of the 30-m by 30-m cells.

Per Auer's methodology, populated land classifications with less than 35 percent vegetated surface are considered "urban". Of the 20 land use categories in the 2016 NLCD dataset, only the Developed, High Intensity category (NLCD Code 24) is populated and has less than 35 percent vegetated area (this classification includes highly developed areas for which impervious surfaces account for 80 to 100 percent of the total cover). A second category, Developed, Medium Intensity (NLCD Code 23), includes areas with a mixture of constructed materials and vegetation for which impervious surfaces account for 50 to 79 percent of the total cover. For this category, impervious surface data were used to determine the amount of "urban" area as a percentage of the total NCLD Code 23 area. NLCD Code 23 cells with greater than or equal to 65 percent impervious surface were considered "urban."

If more than 50 percent of the area within three km can be classified as urban land use, urban dispersion coefficients may be used in AERMOD modeling of the Facility. Land use analysis showed that approximately 38 percent of the land within a three-km radius of the Facility may be classified as urban based on Auer's methodology; therefore, rural dispersion coefficients were used.

Urban area analysis results are presented Table 10-7.

Table 10-7. Urban Land Use within Three Kilometers of Facility

Land Use Category	Percent of Land in this Land use Category within 3-km Radius of Ambient Air Boundary	Percent of Land in this Land Use Category Considered Urban (< 35 Percent Vegetated)	Total Urban Area in this Land Use Category within 3-km Radius of Ambient Air Boundary (Column 1 x Column 2)
Developed, High Intensity (NLCD Code 24)	24	100	24
Developed, Medium Intensity (NLCD Code 23)	29	48	14
Total Urban Area			**38**

10.3.12 Building Downwash

AERMOD considers building downwash only for point sources. No point sources were included in this analysis; therefore, building downwash parameters was not calculated for the sources in this model.

10.4 Modeling Results

The predicted odor impacts are shown in Figure 10–4. The maximum concentration is predicted to be 6.32 DT for 1-hour average and 10.39 DT for the 5-minute average. The maximum predicted impacts occur in model year 2018 under Source Group X in Table 10-6 (where bunker 1 is emitting week 4 emissions, bunker 2 is emitting week 3 emissions, bunker 3 is emitting week 2 emissions and bunker 4 is emitting week 1 emissions). As shown in Figure 10–4 the extent of the 5-minute 5 DT concentration isopleth is mostly on the County-owned parcel with some impacts on Oaksdale Avenue SW. No nearby businesses or residences show 5-minute impacts greater than 5 DT. 1-hour 5 DT impacts are located along the northern ambient air boundary.

Figure 10–5 displays the 5-minute 5 DT frequency isopleth. The most frequently hit 5-minute receptor occurred in model year 2015 under Source Group X and exceeded 5 DT 173 times annually. The 1-hour 5 DT isopleth is not displayed since the maximum frequency was one 5 DT exceedance annually. The modeling analysis predicted ambient odor impacts of 5 DT less than one percent of hours annually on an hourly basis and meets the threshold the ambient odor impacts of 5 DT two percent annually or less on a 5-minute averaging basis. The maximum frequency 5-minute 5 DT receptor is located on the north side of the ambient air boundary.

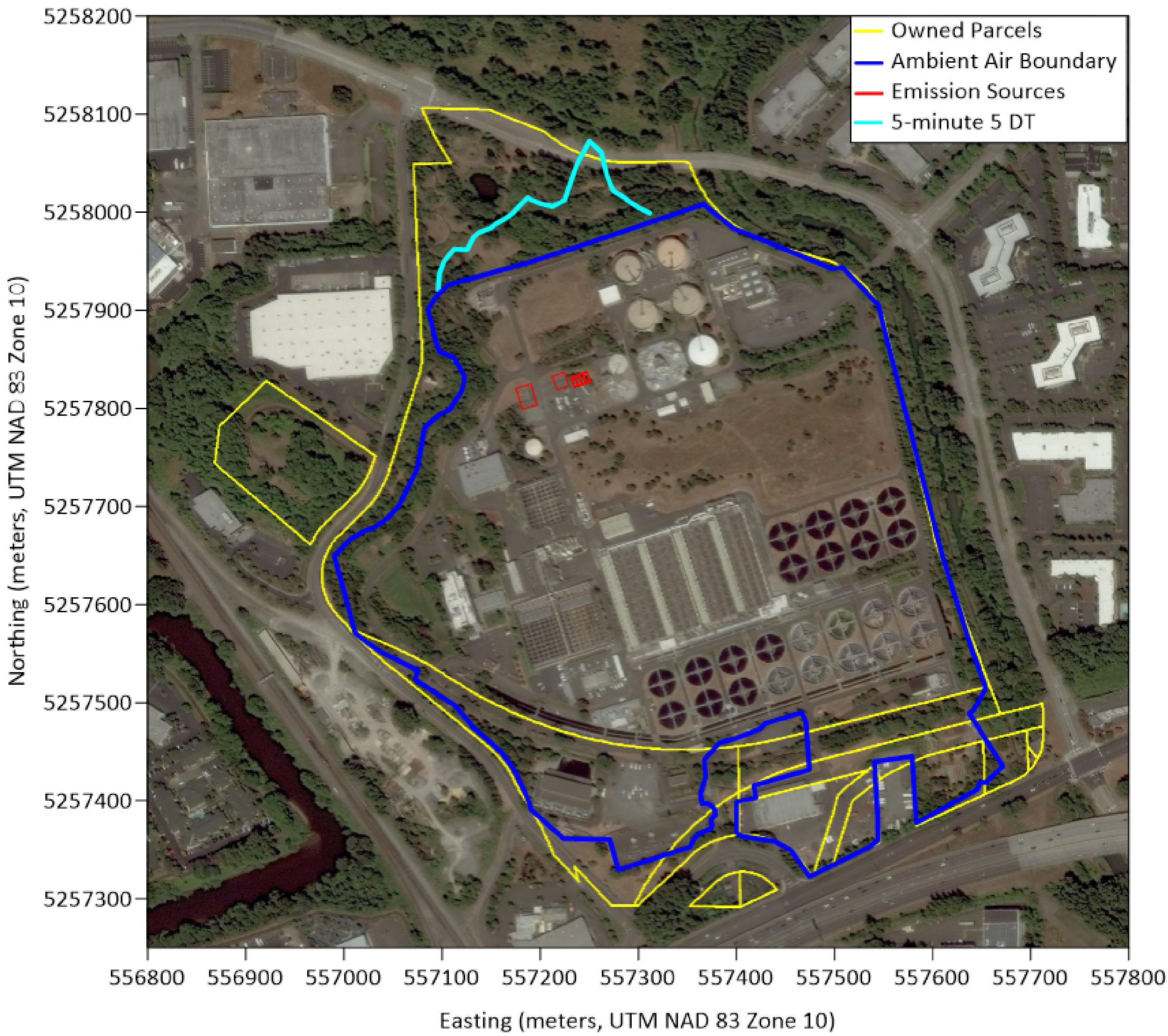

Figure 10–4. Maximum Ambient Odor Concentration Impacts for Source Group X in 2018.

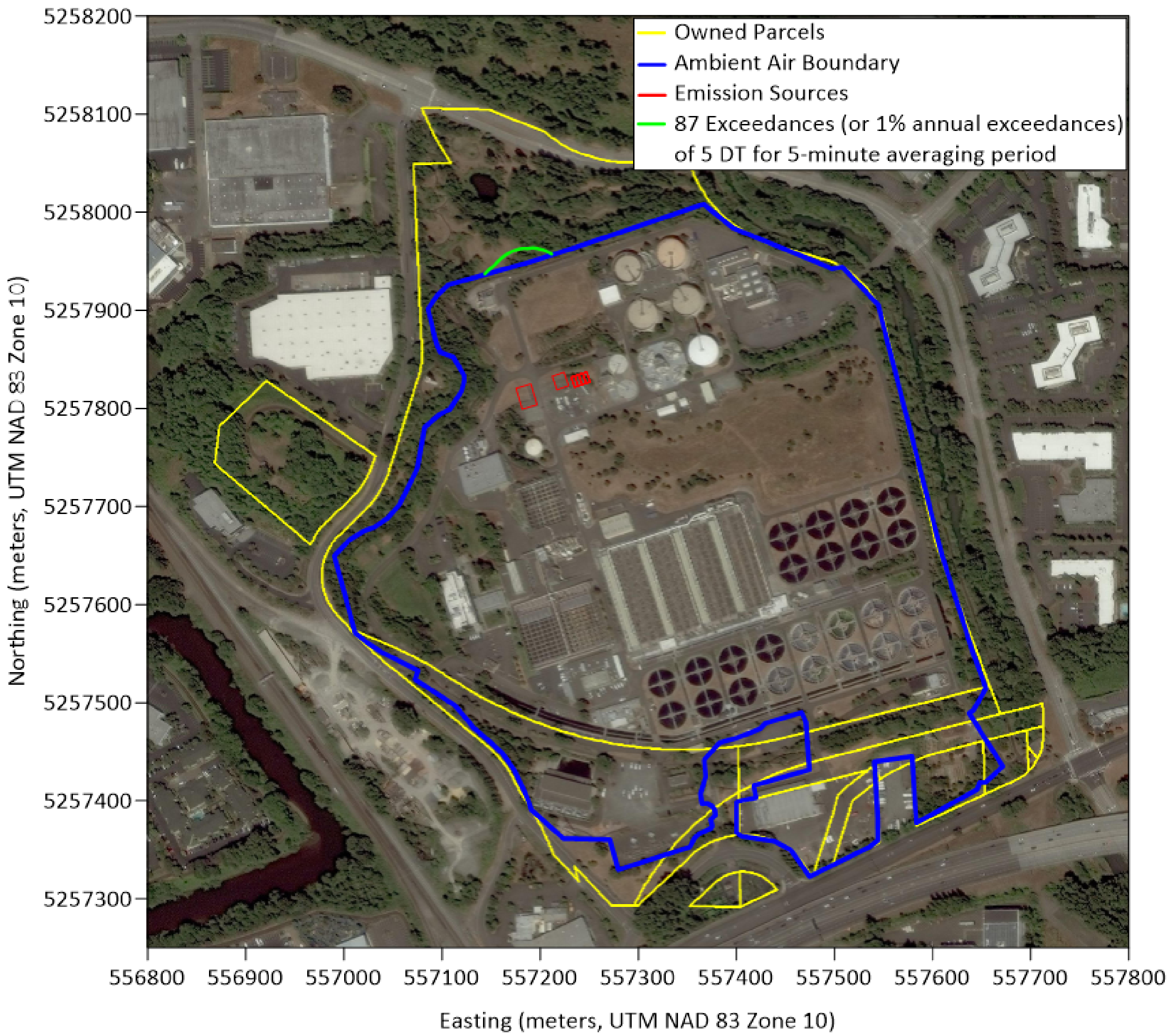

Figure 10–5. Maximum Ambient Odor Concentration Frequency for Source Group X in 2015.

11 References

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Appendix A
Notice of Construction Form P

AGENCY USE ONLY	NOC#: 12082	REG#: 28503	Date Fee Pd: 12/15/20	Eng. Assigned:

PUGET SOUND Clean Air Agency

1904 3rd Ave #105, Seattle, WA 98101
206-343-8800
pscleanair.gov

NOTICE OF CONSTRUCTION APPLICATION FOR ORDER OF APPROVAL

The following information must be submitted as part of this application packet before an Agency engineer is assigned to review your project.

SECTION 1. FACILITY INFORMATION

Business Name
King County South Treatment Plant

Equipment Installation Address	City	State	Zip
1200 Monster Road SW	Renton	WA	98057

Is the business registered with the Agency at this equipment installation address?

☒ Yes. Current Registration or AOP No. 28503 ☐ No, not registered ☐ Unknown

Business Owner Name
King County DNRP/WTD

Business Mailing Address	City	State	Zip
201 South Jackson Street	Seattle	WA	98104

Type of Business
Public Utility

Is the installation address located within the city limits?

☒ Yes ☐ No

NAICS Code	NAICS Description
325314 (2017)	Compost Manufacturing

Contact Name (for this application)	Phone	Email
Christopher Dew	206-477-5458	chris.dew@kingcounty.gov

Description for Agency Website

Provide a 1-2 sentence simple description of this project. See examples www.pscleanair.gov/176

Pilot project to process Class B Loop® biosolids into a Class A Loop compost. Demonstrate proof of concept and develop a business case for a future off-site permanent facility.

SECTION 2: REQUIRED APPLICATION PACKET ATTACHMENTS

1) **Process flow diagram** See Section 3 Process Description of the NOC Permit Application
☒ YES, attached. ☐ NO, not attached. This application is incomplete

2) **Emission estimate**. Emission rate increases for all pollutants. See Section 8 Emission Estimates of the NOC Permit Application
☒ YES, attached. ☐ NO, not attached. This application is incomplete.

3) **Environmental Checklist** (or a determination made by another Agency under the State Environmental Policy Act) www.pscleanair.gov/DocumentCenter/View/170 The County, as SEPA Lead Agency, will provide the threshold determination in early January 2021.
☐ YES, attached. ☒ NO, not attached. This application is incomplete.

SECTION 2: REQUIRED APPLICATION PACKET ATTACHMENTS (CONT)

4) Attach **equipment form**(s) applicable to your operation. Forms are available online at www.pscleanair.gov/179

☒ YES, attached. ☐ NO, not attached. This application is incomplete. Information provided in NOC application.

5) **Detailed Project Description** See Sections 2 and 3 of the NOC Permit Application

The project description must include a detailed description of the project, a list of process and control equipment to be installed or modified, a description of how the proposed project will impact your existing operations (if applicable), and measures that will be taken to minimize air emissions.

Detailed description of the proposed project included in packet?

☒ YES, attached. ☐ NO, not attached. This application is incomplete.

6) **$1,150 filing fee** (nonrefundable)

☐ PAY BY CHECK – Attached and made payable to **Puget Sound Clean Air Agency**

☒ PAY BY CREDIT – Accounting technician will contact person identified below for payment information

Contact Name:	Contact Number:
Christopher Dew	206-477-5458

SECTION 3: PROCESS AND CONTROL EQUIPMENT (attach additional pages if necessary)

Process Equipment		Does this equipment have air pollution control equipment?	**Air Pollution Control Equipment**	
# of Units	Equipment Type & Design Capacity		# of Units	Equipment Type
	Please see NOC Application	☒ Yes ☐ No		Please see NOC Application
		☐ Yes ☐ No		
		☐ Yes ☐ No		
		☐ Yes ☐ No		

SECTION 4: CERTIFICATION STATEMENT

I, the undersigned, certify that the information contained in this application and the accompanying forms, plans, specifications, and supplemental data described herein is, to the best of my knowledge, accurate and complete.

[signature]	12/7/2020
Signature	Date
Christopher Dew	WQ Planner/Project Manager IV
Printed Name	Title

SECTION 5: APPLICATION SUBMITTAL

☒ **EMAIL application and attachments to:**

NOC@pscleanair.gov

-OR-

☐ **MAIL application, payment, and attachments to:**

Puget Sound Clean Air Agency
ATTN: NOC Application Submittal
1904 3rd Ave, Suite 105 - Seattle, WA 98101

Appendix B
Emissions Workbook

(Note: See separate Excel file.)

Appendix C
Detailed Building Cost Estimate

Estimate - AACEI Class 3					
Project Name:	Loop Biosolids Compost Pilot - Prefab Enclosed Building			**Date:**	10/29/2020
Location:	South Treatment Plant - Renton, WA			**Estimator:**	Peter Sutton
Description:	Additional costs for enclosed prefab building			**Version:**	3
DIRECT: SUBTOTAL CONSTRUCTION COSTS					
Item No.	**Item Description**	**Quantity**	**Units**	**Unit Cost**	**Item Cost**
1	**Substructure**	1	LS	$ 394,000	$ 394,000
2	**Superstructure**	1	LS	$ 953,000	$ 953,000
3	**Exterior Closure**	1	LS	$ 271,000	$ 271,000
4	**Roofing - Snow Guard & Skylights**	1	LS	$ 43,000	$ 43,000
5	**Interior Finishes**	1	LS	$ 60,000	$ 60,000
6	**HVAC System**	1	LS	$ 397,000	$ 397,000
7	**Fire Protection Sprinkler System**	1	LS	$ 61,000	$ 61,000
8	**Electrical Systems**	1	LS	$ 367,000	$ 367,000
9	**Allowance for Larger Biofilter**	1	LS	$ 339,000	$ 339,000
11					$ -
12					$ -
				Subtotal Construction Costs	***$ 2,885,000***
				Allowance for Indeterminates (Design Allowance)	$ 432,750
				Street Use Permit	$ -
				ESTIMATED PROBABLE COST OF CONSTRUCTION BID	***$ 3,317,750***
DIRECT: SUBTOTAL ADDITIONAL CONSTRUCTION COSTS					
				Mitigation Construction Contracts	$ -
				Construction Change Order Allowance	$ 331,775
				Material Pricing Uncertainty Allowance	$ -
				Subtotal Primary Construction Amount	***$ 3,649,525***
				Construction Sales Tax	$ 364,953
				Owner Furnished Equipment	$ -
				Outside Agency Construction	$ -
				Subtotal KC Contribution to Construction	***$ 4,014,478***
DIRECT: SUBTOTAL OTHER CAPITAL CHARGES					
				KC/WTD Direct Implementation	$ -
				Misc. Capital Costs	$ 7,299
				TOTAL DIRECT CONSTRUCTION COSTS	***$ 4,022,000***
INDIRECT: NON-CONSTRUCTION COSTS					
				Design and Construction Consulting	$ 248,301
				Other Consulting Services	$ -
				Permitting & Other Agency Support	$ 162,498
				Right-of-Way	$ -
				Misc. Service & Materials	$ 65,691
				Non-WTD Support	$ 23,722
				WTD Staff Labor	$ 1,072,240
				Subtotal Non-Construction Costs	***$ 1,572,452***
				Project Contingency	$ 848,406
				Initiatives	$ 122,141
				TOTAL INDIRECT NON-CONSTRUCTION COSTS	***$ 2,543,000***
				TOTAL PROJECT COST	***$ 6,565,000***

Appendix D
ECS White Paper 2020-4: Biofilter Theory, Design, and Operation

ECS White Paper 2020-4: Biofilter Theory, Design, and Operation

ECS White Paper 2020-4: Biofilter Theory, Design, and Operation

By Tim O'Neill & Aimee Manderlink Updated: 11/2/2020

Biofilters are a common method of scrubbing process emissions and odors from composting and other biological and chemical processes such as from waste water treatment plants. This paper provides a brief background on how biofilters work and outlines key elements in their design and operation that determine their efficiency.

1. Overview: Biofilters

Biofiltration is a proven, cost-effective method of scrubbing odorous and volatile organic compound (VOC) rich air exhausted during industrial processes such as composting. Odor complaints and VOC levels above those permitted by local air quality standards can shut down a composting operation. A well maintained biofilter can reduce the odor and VOC concentration by well over 90%. The following sections include ECS' recommendations for constructing, operating, and maintaining a biofilter.

2. Design Theory

Figure 1: Compost particle biofilm Figure 1, below, depicts the watery biofilm on the surface of a compost particle. Biofilter media (usually coarse wood chips) can also be wetted and therefore have a biofilm. As is the case in the composting process, the biochemical conditions in the biofilm on the media are critically important to the biofilter's performance, or scrubbing efficiency.

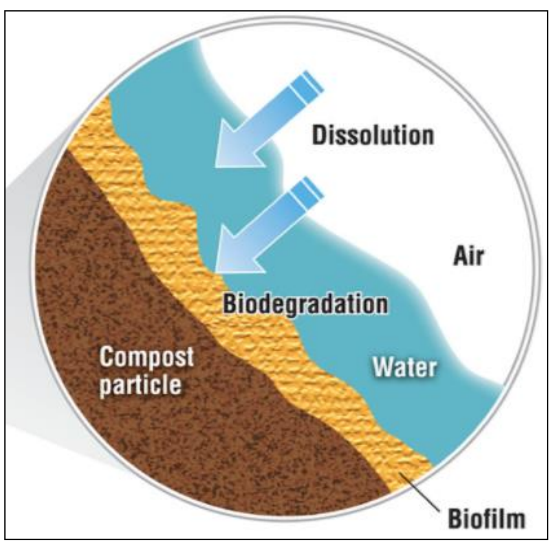

Figure 1: Compost particle biofilm

A biofilter absorbs volatile compounds from the exhaust air stream into the biofilm layer. The biofilm, rich with aerobic bacteria and other microorganisms (aerobes), bio-oxidizes (consumes) the absorbed compounds, releasing energy and/or essential nutrients, such as nitrogen in ammonia (NH_3), which are necessary for cellular maintenance and division. The following conditions in the media determine the efficiency of the aerobes:

- Amount of surface area
- Relatively uniform airflow distribution
- Contact time of the air in the media
- Levels and consistency of moisture, temperatures, and pH

When these conditions are maintained within a reasonable range, biofilters efficiently oxidize a broad spectrum of volatile chemicals present in low part-per-million concentrations. The rule-of-thumb for scrubbing efficiency stipulates that the average biofilter will provide at least one log (factor of 10) reduction of most bio-oxidizable compounds (or alternatively, enact a 90% reduction in odor and VOCs).

Biofilters have shown good resilience to varying environmental and process conditions. Even with one or more of the media conditions out of the target range, they still s generally provide 70 – 85% reduction in VOCs and odors, depending on the degree and duration of the non-target conditions.

3. Design Specifications

The specifications for biofilter design depend on the types and concentrations of the compounds to be scrubbed in the exhaust air, the climate, and the site's sensitivity to either odor generation or regulated VOC and NH_3 emissions. Table 1 lists a typical range of biofilter design specifications.

Specification	Typical Range of Values
Empty-Bed Residence Time	15 - 60 seconds
Media Temperature	40° - 120°F
Media pH	5 - 9
Active Media Depth	36" – 72"
Media Moisture Content	> 50%
Initial Pressure Drop Thru Fresh Media	< 0.2" wc/foot of depth
Max Pressure Drop Thru Aged Media	< 0.8" wc/foot of depth
Dry Media Density (assuming wood)	< 600 lb/yd^3
Main Media Screen Size	2"+
Base Layer Screen Size	4"+
Base Layer Depth	12" – 24"

Table 1: Biofilter design specifications

ECS recommends replacing biofilter media when the maximum pressure drop through the biofilter media exceeds 0.8 in W.C. of static pressure per foot of depth at full design airflow.

4. Biofilter Media Preparation & Placement

When building the biofilter, the media choice and preparation is key to all performance metrics including: scrubbing efficiency, fan power consumption, and media longevity. A bed of relatively coarse, stable media with a base layer of coarser media will provide more uniform flow, higher surface area, lower friction loss, and a longer lifetime than a bed of finer degradable media. Good quality media should last from two to four years and this lifetime can often be extended by adding an additional one to two feet of media over the top of the bed.

When preparing the media, add only a very small amount (1-2% by volume) of more degradable fines, such as compost, to otherwise coarse, clean, freshly shredded wood. The primary reason for adding compost to the media is to shorten the biological conditioning period by allowing the biofilm of the media to be thoroughly colonized by microbes. Colonization typically takes four to eight weeks to reach peak performance.

ECS recommends the following media preparation procedure:

1. Obtain root/stump wood (best) or trunk wood. Hardwood is best for longevity, fir is acceptable, avoid cedar or soft deciduous woods like cottonwood or hybrid poplar (fast growing pulp trees).
2. If possibly, process wood in a shear shredder with semi-coarse grates (6 – 8”).
3. Screen enough of the shredded wood to make a base layer using a 4”+ screen. Do not wet this material or add any compost to it. Keep the base layer material sperate from the rest of the prepared media.
4. Add the fines back to the shredded wood pile, along with 1 – 2% (by volume) stable compost fines. Mix with a wheel loader bucket.
5. Run the material over a 2” screen, setting the fines aside.
6. Heavily wet the overs as they exit the screen and allow them to sit 4+ hours so that the water can soak in.

The media should be placed in sections that are small enough to allow the base layer to be laid down, then the wetted media layer to be added over the top without driving on the base layer. If placing material with a conveyor, or an extended reach machine, large sections can be constructed at one time. If placing material with an smaller excavator or wheel loader, the reach of the machine will limit the width of the section that can be built at one time. Once the base layer is placed, carefully place wetted media on top up to the initial design depth. Compression limits the useful life of the media; Never drive on top of the media with a machine. If a uniform top surface is desired, hand raking is almost always required.

5. Operations

Maintaining the correct moisture content in the filter media is an important operational factor for a biofilter. The compost site operator should maintain the media between 40 and 60 percent moisture (see the following section for maintenance recommendations). Media that becomes too dry will suppress microbiological activity, reduce absorption, and will not fully bio-oxidize odorous gases. Assuming the media is porous, it is quite difficult to err on the higher end of moisture content (>65%) as the media will drain well and not hold the water. However, if the media has significantly degraded, it may absorb more than 65% moisture. The potential for the media to channel or crack also increases with age. This allows air to move faster through drier passages causing further localized drying and shrinkage of the media, reducing overall performance. Once this occurs, the operator should add additional media. The operator should change the media when it begins to visibly degrade, densify, and crack.

The exhaust air from a composting process is generally saturated (100% relative humidity, or RH). This is not true for building exhaust air. An airstream with 100% RH will constantly deliver moisture to the majority of the media as it cools when passing through the bed. If a significant volume of building exhaust air is to be included, then an in-line humification system should be considered. Even when fed with moist exhaust air, the upper layer of the media will often appear dry due to evaporation to ambient air. This generally does not strongly impact the overall performance. Adding irrigation to the surface or within the media can improve performance, especially in dry hot environments. This can be done by either placing tight-spaced soaker hoses at the top of the pile or using surface sprinklers. Irrigation can have the added benefit of washing out soluble nitrates that can build-up in the media (especially while composting biosolids).

Temperature of the biofilter media is another important operational factor. The ideal media temperature ranges between >10° F and 110°F. Biofilter efficiency slowly declines up to 120 - 130°F and thereafter falls off more quickly. The media itself will also degrade more quickly at temperatures above 130°F (a settled bed may lose a foot of depth in a matter of months if temperatures above 135°F are maintained). Short term excursions up to 130°F are generally acceptable so long as monthly average media temperatures are ≤ 115°F. The compost aeration and control system should monitor, log, and control the temperatures of exhaust air and biofilter media. Ideally, the system will automatically control the exhaust air temperature to an operator chosen setpoint by adjusting the volume of added ambient air. If performance is critical, psychrometric (the thermodynamics of mixing air) and heat transfer calculations should be carried out to ascertain if additional humidification is required to prevent dilution air from over-drying the biofilter media.

The pH of the media can also impact both the scrubbing effectiveness and the nature of the odor emitted. Measuring the pH of media can be tricky since the pH is, by definition, an aqueous phase phenomenon. The loading rate, chemical spectrum, and the pH of the air stream and the irrigation water over time are typically the primary drivers of pH. As the pH changes, the biofilter scrubs different compounds with different efficiencies (acidic media better scrubs NH3 and mildly alkaline media best treats organic acids). ECS has measured the pH effect of VOC scrubbing efficiency of two identical biofilters at the same site. One biofilter had an apparent pH of 5.5 and an efficiency of 90% (factor of 10), and the second biofilter had a pH of 5.0 and a scrubbing efficiency of 80%. A few weeks later the second biofilter's pH had risen to 5.7 and the scrubbing efficiency increased back above 90%. While pH is important, little can be done to change the pH of a biofilter in operation. Sustained low pH most likely indicates an inadequately managed composting process that is producing the low pH droplets that are depositing in the biofilter.

Figure 2: Biofilter with Above Grade Pipe and Coarse Media

Figure 3: Biofilter with a Suspended Perforated Floor

6. MAINTENANCE

Even though biofilters are quite resilient to varying inlet and environmental conditions, there are several parameters a compost site operator should periodically monitor.

Moisture

The operator should take grab samples from at least 12" deep in the media once every two weeks to test for moisture content. If the media appears to be over-drying, increase humidification (if present) or irrigation.

Temperature

The operator should monitor the biofilter media temperature weekly (this temperature will be displayed on the operator's graphical user interface (GUI) screen in the automated control and monitoring software). The operator can vary make-up and exhaust damper control setpoints, as well as the relative settings of the supply and exhaust blowers, to control the temperature of this exhaust air. These settings are typically adjusted seasonally.

pH

The operator should monitor the biofilter media pH monthly. Monitor the pH more frequently if it is out of the target range. Assuming the pH of the water will bring the media within the target range, increase irrigation rates.

Pressure Drop/Media Densification

The operator should record the static pressure drop through the biofilter at a standardized operating condition (compost aeration process supplier should specify system setting during start-up that identify such a condition). Pressure drops should be measured with the biofilter floor bare, then with new media, then once every six months to track densification in the media.

General Inspection

The useful life of the biofilter media depends on the material used and the operating conditions. Different types of coarse ground wood have varying resistance to breaking down. Also, higher temperatures tend to degrade biofilters more quickly. Generally, one should expect the media to last one to three years. Spent biofilter media is characterized by:

- Cracking and channeling
- Breakthrough of contaminants (odors)
- Increased head loss (compaction and increased density)
- Shifts in media pH

Once the media has degraded, it should be changed. The operator can screen old media can be screened and reuse the coarse overs (2"+). Otherwise, it can be added into the compost mix as an amendment or used as well-matured compost.

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Appendix E
AERMOD Source Inputs

AERMOD Source Inputs

Source ID	Source Description	Easting (x) (meters)	Northing (y) (meters)	Base Elevation (feet)	Release Height (feet)	Easterly Length (feet)	Northerly Length (feet)	Angle from North	Odor (OU/s)
B1_W1	Primary Compost Bunker 1 - Week 1	557246.95	5257825.53	29.2	4.5	13	36	342	380
B2_W1	Primary Compost Bunker 2 - Week 1	557242.90	5257824.21	29.2	4.5	13	36	342	380
B3_W1	Primary Compost Bunker 3 - Week 1	557238.84	5257822.89	29.1	4.5	13	36	342	380
B4_W1	Primary Compost Bunker 4 - Week 1	557234.78	5257821.57	29.1	4.5	13	36	342	380
B1_W2	Primary Compost Bunker 1 - Week 2	557246.95	5257825.53	29.2	4.5	13	36	342	187
B2_W2	Primary Compost Bunker 2 - Week 2	557242.90	5257824.21	29.2	4.5	13	36	342	187
B3_W2	Primary Compost Bunker 3 - Week 2	557238.84	5257822.89	29.1	4.5	13	36	342	187
B4_W2	Primary Compost Bunker 4 - Week 2	557234.78	5257821.57	29.1	4.5	13	36	342	187
B1_W3	Primary Compost Bunker 1 - Week 3	557246.95	5257825.53	29.2	4.5	13	36	342	133
B2_W3	Primary Compost Bunker 2 - Week 3	557242.90	5257824.21	29.2	4.5	13	36	342	133
B3_W3	Primary Compost Bunker 3 - Week 3	557238.84	5257822.89	29.1	4.5	13	36	342	133
B4_W3	Primary Compost Bunker 4 - Week 3	557234.78	5257821.57	29.1	4.5	13	36	342	133
B1_W4	Primary Compost Bunker 1 - Week 4	557246.95	5257825.53	29.2	4.5	13	36	342	64
B2_W4	Primary Compost Bunker 2 - Week 4	557242.90	5257824.21	29.2	4.5	13	36	342	64
B3_W4	Primary Compost Bunker 3 - Week 4	557238.84	5257822.89	29.1	4.5	13	36	342	64
B4_W4	Primary Compost Bunker 4 - Week 4	557234.78	5257821.57	29.1	4.5	13	36	342	64
CURE	Secondary Compost Pile (Curing)	557216.86	5257819.00	29.5	4	42	48	342	114
FINISH	Finished Product Storage	557181.55	5257799.34	32.6	9	52	72	344	2.3