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GRIMM'S FUEL COMPANY Composting Assessment

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1 INTRODUCTION

This report summarizes activities and findings from the site assessment, community and records reviews, and analyses performed by the Green Mountain Technologies Team (GMT) (comprised of Green Mountain Technologies, Inc., Terre-Source LLC, and Air Sciences, Inc. (ASI)) in completion of Metro's scope of work and contract #935029. This report also presents findings and alternatives / options evaluated in accordance with that scope in service of mitigating nuisance conditions offsite, to help Metro balance business and local community needs with the preservation of yard debris composting in the region. Goals of this work include evaluating the current operation and proposed alternatives for public benefit and Metro's goal of increasing the region's waste reduction and recycling efforts.

The focus of this investigation was Grimm's Fuel Company's composting operation located at 18850 SW Cipole Rd, Tualatin, OR 97062. Grimm's Fuel Company is co-managed by brothers, President Daniel F. Grimm, Secretary Jeffery D. Grimm and Jake Grimm with on-going input by their father, Rod Grimm. Grimm's Fuel Company has been in business as a multiple product fuel supply company in Oregon since 1929 and has operated a resource recovery / composting facility at this location since 1975. Since 2013, and increasing with time, neighboring residents have complained that odors generated by Grimm's Fuel Company's organic material management has impacted their lives.

Grimm's Fuel Company (Grimm's) operates most of its composting activities on 15.3 acres (in 3 contiguous parcels) at the southeast corner of Pacific Highway and Cipole Road in the city of Tualatin, but also owns and utilizes an additional 31.6 acres (in 2 parcels) across one un-owned parcel (~230-feet) to the east. The company accepts yard wastes and land clearing debris, including sawdust, wood chips, Christmas trees, horse manure, spent mushroom substrate and scrap wood mostly for composting. The company produces two types of products, Garden Products, such as mulches, gravels and compost-based products, and fuels, including firewood and heating oil. With the exception of the small volume of heating oil dispensed from a 2,000-gallon tank on the facility, the rest of the products are produced from recycled materials.

For this project, the GMT team conducted multiple regulator and community interviews, performed site investigations, researched regulatory and land use status, took air measurements intended to evaluate odor potential and to inform the air quality impact (dispersion) modeling, and developed and evaluated alternative composting designs intended to mitigate Grimm's impacts on neighbors as well as improve processing capabilities on the existing facility. These activities are described in this report. Section 2 presents the Request for Proposal (RFP) approach to this study. Section 3 summarizes the history and operation of Grimm's composting operation, the relevant regulatory status of 5 parcels under Grimm's control, and describes the 5-year Tualatin Valley Fire and Rescue response history for this facility. Section 4 focuses on the community impact of odors generated by Grimm's composting activities and presents a composite description of those impacts on neighbors of the facility. The team's odor investigation, measurements and observations are presented in Section 5 along with description and discussion of the dispersion modeling performed, with a summary of what the information means and the evaluation found, as well as a discussion of the results with respect to Greenhouse Gas impacts. Section 6 presents a structured analysis of the problem with three alternative mitigations/solutions presented and discussed. All three alternative designs were developed to mitigate the impacts of composting odor on the community. The proposed alternatives are ranked according to Metro's criteria of public benefit, increasing waste reduction and recycling, and on-going ability to evaluate site management and odor assessment. Section 7 describes, in further depth, the recommended alternative. Section 8 concludes the report with a summary of the project findings, recommended alternatives, presents a list of recommended additional information that may help Metro in implementing mitigation steps for the facility. Relevant data are presented in attached Appendices or are available from GMT.

1.1 Definition of Composting

There is not yet a universally accepted definition of composting, although the industry is making strides to achieve such agreement. The United States Composting Council (USCC) recently reached agreement with the American Association of Plant Food Control Officials (AAPFCO) on a definition which solidifies the concept of "aerobic composting" as the process which produces "compost":

"Compost – is the product manufactured through the controlled ***aerobic, biological decomposition***[1] *of biodegradable materials. The product has undergone mesophilic and thermophilic temperatures, which significantly reduces the viability of pathogens and weed seeds, and stabilizes the carbon such that it is beneficial to plant growth. Compost is typically used as a soil amendment, but may also contribute plant nutrients."* [2]

The definition of "composting" per Oregon regulations OAR 340-093-0030, however, allows for anaerobic digestion in its definition:

"Composting" means the managed process of controlled biological decomposition of feedstocks. A managed process includes, but is not limited to, reducing feedstock particle size, adding moisture, mixing feedstocks, manipulating composting piles, and performing procedures to achieve

[1] Author's emphasis.

[2] USCC blog. Alexander, R. March 2, 2018. New Compost Definition – Results From USCC Work with AAPFCO. https://compostingcouncil.org/blog/news/new-compost-definition-results-from-uscc-work-with-aapfco/

human pathogen reduction. "Composting" includes both aerobic composting and anaerobic digestion. Other examples of composting include bokashi, fermentation, and vermiculture. [3]

What is generally agreed upon is that composting is a managed process that utilizes microbiota to elevate temperatures and to efficiently decompose organic materials to produce a useful agricultural soil amendment. It is a recycling activity rather than a disposal activity. It is not landfilling, nor piling without management.

GMT believes that oxygen content sufficient for aerobic metabolism by the myriad of bacteria and fungi responsible for the heat-generating decomposition of waste organics is critical to the process of composting. For the purpose of this document, the USCC definition of compost presented above is used.

COMPOST IS THE PRODUCT MANUFACTURED THROUGH THE CONTROLLED ***AEROBIC, BIOLOGICAL DECOMPOSITION*** *OF BIODEGRADABLE MATERIALS.*

[3] Oregon Secretary of State. Webpage for Department of Environmental Quality. Division 93. Solid Waste General Provisions. https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=1489

2 ASSESSMENT BACKGROUND

Metro, as the regional government for most areas of Washington, Multnomah, and Clackamas counties, is responsible for solid waste management, including composting. This management includes co-regulation with Oregon Department of Environmental Quality (DEQ) and providing planning and relevant recycling services.

As such, Metro attempts to "balance business and community needs with the preservation of yard debris composting capacity" as described in Metro's RFP in Appendix A-1.

Grimm's compost facility has over the years accumulated significant odor complaints from neighboring residential neighborhoods and which have increased over the past 5 years. Metro's oversight includes inspections for regulatory compliance and issuance of their operating license. In preparation for renewal of that license in 2017, Metro expanded their public notice procedures and held a public meeting to exchange information on the renewal process.

Through these public outreach mechanisms, Metro received numerous testimonials of impacts from Grimm's neighbors, primarily related to malodors. In order to assess the odor impacts and to assist in their response to the community, Metro issued this RFP. The resulting contract with Green Mountain Technologies, Inc. (GMT) sought third party, expert assessment of best practices with respect to composting operations and for odor mitigation recommendations to inform their license renewal process and future regulatory actions. More detail and description of this process is provided in Appendix A-1.

2.1 Odor Science Background

Odor science is a relatively recent field of study whose beginning is attributed to the perfume industry in the eighteenth century although evidence for use of perfumes has been found pre-2500 B.C.[4] Recent neuroscience has developed the beginning of an understanding of how humans detect and process odors and how those odors differ from nose to nose and from brain to brain[5].

Odors are technically defined as the experience of detecting a combination of odor molecules (odorants) via receptors inside the nose which relay messages to the brain[6]. When a person inhales, the odorant is carried past the olfactory sensors where they are dissolved in

[4] Oatman-Stanford, H. 2016. Our Pungent History: Sweat, Perfume, and the Scent of Death. March 8, 2016. https://www.collectorsweekly.com/articles/our-pungent-history/ downloaded 6-11-18.

[5] Howgego, J. 2013. Sense for scents traced down to genes. Nature/News. 01 August 2013. Download abstract from: https://www.nature.com/news/sense-for-scents-traced-down-to-genes-1.13493. Downloaded 6-11-18.

[6] Williams, S.C.P. 2014. Human Nose Can Detect a Trillion Smells. In ScienceMag.org. http://www.sciencemag.org/news/2014/03/human-nose-can-detect-trillion-smells downloaded 6-11-18.

mucus and transmitted to 2 areas of the brain: the limbic system, which processes emotion and memory response of the body; and the frontal cortex, where conscious sensations are processed against cumulative life experiences for the individual[7]. These hits on the brain occur in as little as 500 milliseconds reflecting the importance of this system to human survival. Odors are a human's primary sensory pathway to the microbial world. Microbes can't be seen, but the sense of smell has evolved to detect them. If food is "rotten", microbes are responsible for degrading the food which could then be dangerous. The speed of the response is also diverse and dependent upon the human "receptor". More is being discovered every day about the differing experiences of the combination of odor molecules which produce a given odor making them highly subjective.

Because each odor is comprised of a complicated combination types and numbers of molecules, mechanical measuring of single molecules is less efficient at measuring the combination of odorants which makes up an odor. However, humans are very good at identifying those combinations of odorants experienced as an identifiable odor[8]. If a single molecule could be found that would "indicate" presence and intensity of a compost facility's odor, it could be used as a surrogate for that odor and monitoring would be much easier. Unfortunately, that has not yet been identified.

On top of those complications, compost facility odors per se, are not considered a health risk[9]. Consequently, the regulator is protecting neighbor comfort and enjoyment as is referenced in many nuisance odor laws. These qualities are simply difficult to define except in the extremes of zero odors or pervasive inundation. At least part of the reason for the difficulty in definition is due to the previously indicated subjective nature of odors[9]. Section 7 of this report provides several strategies and tools to help the agencies monitor and lead the way to minimize nuisance compost odors for their communities.

A tool that is useful when dealing with odors is the ability to describe them objectively. Odors can be fairly completely described using two concepts, intensity and character. Intensity is the strength of the odor, which is related to the concentration of odorant molecules in the air. It can be quantified through concepts such as Dilution to Threshold. See Section 5 for a more thorough discussion. The character of an odor is a description of an odor based on what the smell resembles such as "sweet" or "chemical" or "earthy". Describing the odor relative to commonly encountered objects such as "banana" or "dirty socks" is a technique used to describe the "characteristic" of an odor. Appendix D-3 shows an Odor Characteristic Wheel often used to describe compost odors. With practice most people can provide recognizable descriptions of odors using this approach.

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[7] McGinley. 2000. "Odor Basics", Understanding and Using Odor Testing. St. Croix Sensory, Inc. http://www.fivesenses.com/Documents/Library/33%20%20Odor%20Basics.pdf

[8] Morrison, J. 2014. Human nose can detect 1 trillion odours. Nature. 20 March 2014. Download abstract from : https://www.nature.com/news/human-nose-can-detect-1-trillion-odours-1.14904

[9] CalRecycle. Odors. http://www.calrecycle.ca.gov/swfacilities/compostables/odor/default.htm downloaded 6-5-18.

3 FACILITY AND IMPACT RESEARCH

3.1 Facility Review

3.1.1 Site Description

Grimm's operates on 5 parcels on the southeast corner of Pacific Highway and Cipole (Sy-pole) Road in the city of Tualatin. See Figure 3.1.1 below and Appendix A-2 - Parcel Map.

- Parcel #1800 & #1900: Receiving, grinding, composting, and screening of composted and recycled waste organic materials are all performed on these two western parcels, on which "resource recovery" is allowed by Conditional Use
- Parcel #2190: This parcel, connected to the western parcels, is used for material storage, parking, equipment support activities, and Bio-ball product mixing. Although adjacent to the western parcels, resource recovery is not currently allowed on #2190, i.e. no tipping, and no active composting. However, product sales, and other outdoor storage activities may be allowed.
- Parcels #2100 & #2202: Compost product storage, firewood processing, concrete crushing, bark grinding, and screening are performed on the eastern-most parcels, which are separated from the other three by a lot owned by a non-related party.

The configuration of this facility is unusual due to the separation of Grimm's owned parcels by a parcel with unrelated ownership and with varying land use approvals on the individual parcels. Specific description of land use status is provided in section 3.4.3. Because of the discontinuity of ownership between the western 3 parcels and the eastern 2, material and equipment and personnel must travel on an easement between the two segments. This transport is not optimal, but Grimm's has developed a system which is pretty efficient and per Jeff Grimm "helps to keep guys employed in the off season as that is generally when we are moving the material".

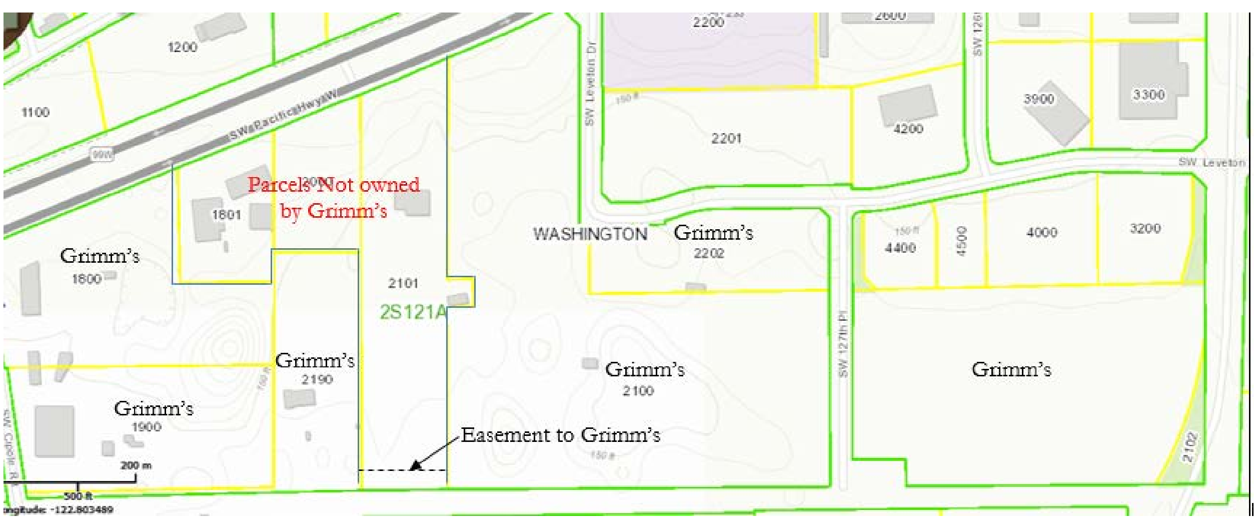

Figure 3.1-1 – Parcel Map *From ORMAP*

3.1.2 Facility Overview Observations

GMT interviewed Grimm's management, visited the site multiple times, and reviewed process documentation to understand the current composting operation and to evaluate its process and site characteristics. Feedstock type and volume were reviewed with respect to Metro's license and process steps were reviewed in light of the allowed land uses through their Conditional Use Permits. The first visit was January 31, 2018 prior to turning activities on the large static pile. The visit included a tour of the facility to obtain an understanding of the equipment and operational processes utilized by Grimm's. Their composting process is described in detail in section 3.1.3 below. Facility observations included:

- Odors from the facility were detected around a one-mile radius of the facility prior to the turning event. Wind conditions were calm and odor plumes appeared to waft off the pile surface.
- A very concise operation with all the processing equipment permanently installed and a close integration between feedstock grinding, compost pile construction and product screening;
- The equipment varied in age widely, however it appeared in excellent repair and functioned quietly and efficiently. It appeared to work well and was up to the processing capacity required of it.
- The receiving area for yard debris and wood was large for a facility of this size, helping customers to safely maneuver to the tipping line. Grimm's utilized a 'first in, first out' processing approach. The tipping area appeared well maintained, scraped up and uncluttered by neglected materials, and with little stockpile of unprocessed materials.
- The operation appeared to work efficiently, and the grinding operations were well laid out. Back up portable grinders were observed onsite and ready for use as needed to manage peak flows and allow time for planned maintenance and down time.
- The freshly ground materials were blended with the screened overs when grinding and screening were run concurrently. A very porous blend was observed coming off the processing equipment.
- The active composting pile was estimated at 35- to 50-feet in height. It appeared evenly compacted by a tracked large blade bulldozer, except on the edges of the sloped outer perimeter of the pile. This approach may help to prevent pile fires.
- A very tall (50' in height) discharge conveyor brought ground and blended materials out to the compost piles. The area under the discharge conveyor was able to store several days' worth of production below the belt, before it had to be moved into a pile. Odors were not significant at the belt discharge stockpile.
- Odors were significant on top of the pile when the older materials were being moved, but not bad down low around the base of the pile.

- There were some old concrete structures with equipment mounted on them that don't appear to have been used in decades near the south side of the processing area that were observed near a smoldering area of the pile.
- There were no significant odors observed from the rest of the site. Bark grinding had a strong odor, but with a pleasant character.

3.1.3 Review Existing Composting Operation

An overview of the composting activities and flow of materials are described in this section. Site and parcel maps are presented in Appendix A to facilitate visioning of the efficiencies and limitations of the current operation. Figure A-3 in Appendix A shows a recent (mid 2016) Google Earth aerial of the active composting piles and equipment.

3.1.3.1 FEEDSTOCK STATUS

Grimm's takes a wide variety of Type 1 and 2[10] feedstocks for composting and other processing in through its western receiving area. Most of the materials received are yard wastes from self-hauling homeowners, professional landscapers and residential yard waste collection companies, mostly for composting. The characteristics of the incoming yard wastes mimic the seasonal production from the local area. In general, it changes from woody pruning of shrubs, Christmas trees and storm cleanup in the winter, to mostly wet green grass and brushy yard cleanup in the spring, changing to drier grasses and shrub trimmings in the summer, and finally to a large volume of wet and dense leaves in the late fall depending upon the weather. These incoming material changes cause significant carbon to nitrogen ratio, moisture content and porosity changes in the mix throughout the year. Grimm's manages the variability in feedstock by grinding in woody overs as they are screened out of previous batches. This helps to even out the C:N ratio and add porosity in the spring, but is less helpful in the late fall and already woody winter mixes. The impact of these volume and character changes on odor generation is discussed in section 3.2, FEEDSTOCKS.

3.1.3.2 FACILITY MATERIAL FLOW

The current composting system is a '5 touch' handling system which includes:

1) the grinding and stacking of fresh feedstocks from a tall stacking conveyor;

2) Using a D-9 dozer to push ground material into the stockpile;

3) bulldozing the oldest stockpile into position 4;

4) screening the material using the loader and excavator and product screener in Line A and

[10] OAR Chapter 340-093-0030 defines 4 types of feedstocks. Type 1 is "source-separated yard and garden wastes, wood wastes, agricultural crop residues, wax-coated cardboard, vegetative food wastes including department approved industrially produced vegetative food waste…". Type 2 contains "manure and bedding…".

5) removing finished compost from under the screen and putting into the finished product piles for distribution.

These steps are performed over a 4- to 6-month time frame as delineated by 'pile turning' on that approximate frequency. This pile management method does not keep the sections and ages of material separate, but builds upon and alongside of each other making a single multi-lobed large pile of approximately 84,000 cubic yards[11]. During GMT's late January 2018 visit, the pile was estimated to be approximately 45 feet high at its highest points and ramped downward towards the screening area and the grinder discharge stacking conveyor. The perimeters of the pile were approximately 1,400 feet with a total footprint of just over 100,000 square feet or 2.3 acres. See Figure A-3 – process flow aerial in Appendix A.

3.1.3.3 RECEIVING

"Receiving" is the first operational step in a composting process and must allow for traffic flow, safe un-loading, an opportunity for inspection of materials dropped off, and a mechanism for measuring the loads.

Grimm's receiving area is in the northwestern quadrant of the property, located for easiest access from Cipole Road and good traffic flow. The approach for commercial and public customers is from the southernmost access to the site from Cipole Road via a single scale with a scale house sitting parallel to the road. Queueing capacity is roughly 14 vehicles from the road entrance to the scale house, although when incoming traffic is heavy Grimm's utilizes cones and personnel to create a holding loop through the southern portion of the site that can provide for approximately 7-times that holding capacity. See Appendix A-4 for a depiction of the Traffic Flow at the facility.

Most residential and small landscaper loads are measured and pay by cubic yard. These non-scaled customers line up on the right side and scaling customers on the other side of the scale house. Scaled customers, generally curbside collection yard waste trucks, weigh in and then weigh out. Trucks are then directed to the left outer road and then to turn right past the product piles into a 200-foot wide tipping floor with capacity for about 15 to 18 customers to actively unload at one time.

Wood is unloaded to the north and green waste to the south of the unloading area. Landscapers usually detach their equipment trailers before unloading their trucks. This is done in front of the wood sales sheds or up on the upper perimeter access road paralleling Highway 99W. After unloading, customers usually sweep out their trucks and then exit to the north of the scale house or if scaling out, head back to the scale, leaving from the middle Cipole Road access back off the property. In Fall of 2017, due to high incoming volumes managing the excess traffic flow

[11] Piles were measured via Google Earth Polygon analysis of active foot print and then height and area assumptions were confirmed during the site visit using the height scale on the stacking conveyor. An average height of 22.5 feet was used over the entire footprint, ignoring sloping sides.

was a challenge. Customers were staging or waiting for others to unload, and the perimeter access road became part of the exit queuing.

Grimm's maintains the receiving area by pushing recently tipped green material and wood to a stockpile area using a loader. Wood is stockpiled over a wall and held for batch grinding in a long10-foot deep pile, which also keeps the wall area safer. Green waste is stockpiled in an area about 80-feet by 75-feet and approximately 12-feet high holding up to 2,000 cubic yards. This stockpile area appears to be emptied on a regular basis with first in-first out flow.

The receiving area is well laid out and well maintained based on our site visits. Future work on traffic design, signage for better queuing and traffic control may be needed to accommodate future significant customer traffic events. If traffic backs up onto Cipole Road during these times, the measured scaling operations may need to be moved further north allowing for more holding capacity. Malodors and dust were not observed to be bad emanating from this location during GMT's site visits. No recommendations for improvement in odor control appear to be needed here. If dust is an issue during the summer, a water truck or sprinkler system should be used to keep the pad and unloaded material moist.

3.1.3.4 COMPOST MIX PREPARATION

Composting is optimized by preparing a mix of multiple types of green materials (feedstocks) that when ground and blended provide optimal environmental conditions for the bacterial populations that perform the decomposition of the feedstocks and create 'compost'. Several steps are important for this mix including: reducing the particle size (grinding); mixing different materials (optimizing carbon to nitrogen ratios); moisture conditioning (adding water); inoculating (adding materials that have already composted and contain populations of bacteria adapted to degrade the site-specific feedstocks) and ensuring adequate porosity (adding large woody particulate that keep pore spaces open for improved air flow).

Grimm's yard waste stockpile area has a drag chain feeder for their Jeffries Hammer Hog. This is the primary grinder used for processing all green wastes. A back up mobile grinder is used in the stockpile area or below in the wood storage area to keep production going if servicing is needed on the Jeffries Hammer Hog. There is a steep conveyor removing ground yard debris out from under the hammer hog and onto a stacker belt that goes directly to the compost pile. Parallel to and east of the grinder drag chain infeed is the finished product infeed drag chain for the screening operation. The screening operation uses a large diameter Trommel screen to separate the fine finished compost from the woody material or "overs". A second grinder can be used to grind these overs to a smaller size if desired. Normally the overs are directed by a belt to the same stacking conveyor that goes out to the compost pile and mixes them with the green feedstocks to both add porosity and to inoculate the incoming materials. The finished product screening and the fresh feedstock grinding are generally done concurrently to improve the feedstock mix and keep the mixture porous. Addition of inoculant and bulking is excellent practice and should be maintained as much as possible even if the composting methods are changed.

However, malodors and dust were generated in this processing area mostly from the screening of finished compost, rising with the hot vapor from the compost as it tumbles in the screen. During GMT's site inspections it was noticed that the elaborate grinding and screening operation was mostly enclosed with roofing and walls and structural equipment supports. GMT proposed that Grimm's consider collecting the air over the screeners and grinder and treating it through a biofilter to reduce the odors and capture dust. GMT strongly recommends collecting air from the areas where this highly odorous compost is being screened and ground and where odors can be intercepted. Treatment through biofilters can reduce odor compounds by 80 to 97% if well maintained.

GMT provided the design information necessary for Grimm's to begin construction of a biofilter to try to provide some immediate relief to the community. Grimm's was eager to begin construction and get some experience with biofiltration. Metro sent pictures of the distribution pipes they saw in place in early May during an inspection. It looked to be properly assembled, the media was not placed on the pipes at the time of the photo.

3.1.3.5 ACTIVE COMPOSTING

Active composting occurs when the feedstocks are blended such that the aerobic microbial populations within the feedstock mix will metabolize the available organics and generate predominately water, carbon dioxide and heat. During this phase, the microbes will consume large quantities of oxygen and give off carbon dioxide which can reduce the volume of an active pile on the order of 30% over a few weeks. The high temperatures generated kill weed seeds and the pathogenic bacteria that present human health risks in raw feedstocks. Specific pathogen reduction time and temperature relationships have been established by the US EPA to ensure the finished compost is safe for human handling[12]. This relationship is called the Process to Further Reduce Pathogens (PFRP) and is required by OAR 340-096-0070(4) and 340-096-0140(3)[13]. The active composting stage lasts as long as it takes for most of the readily available carbon molecules to be consumed to the point that many of the bacterial populations responsible for the decomposition die off and the temperatures in the pile naturally decline.

PFRP for an Aerated Static Pile (ASP) includes specific construction and handling procedures including insulating the pile and introducing air or removing air using fans or blowers and making sure by monitoring that all points within the pile reach 131°F or more at least 3 days. There is also a testing requirement for pathogens or pathogen indicators in the finished product before delivery to a customer. While Grimm's tests and passes the laboratory testing for pathogens, they can only document temperatures up to 6 feet below the surface with their existing testing equipment. The large non-aerated pile method has not been approved by EPA as an equivalent to either ASP or the Turned Windrow methods of achieving PFRP. While the risk may be minimal for green waste, and Grimm's tests the product for pathogens, the process does not meet EPA's and therefore, OAR's PFRP requirements.

[12] https://www.law.cornell.edu/cfr/text/40/appendix-B_to_part_503

[13] https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=71355

Grimm's uses a 200-foot long stacking conveyor set at 50-feet elevation, to place material in the compost pile with greatly minimized compaction. Then large D-9 bulldozers with large push blades ramp the material from the conveyor to pile position 1, 2 or 3, where they sit composting slowly for 4- to 7-months at a height of about 40- to 50-feet. After this time, the materials are pushed into pile 4, (See Appendix A-2 – Compost Material Flow showing the pile locations) which is the staging position for the product screening operations.

When the pile in position 4 is done being screened, the next oldest pile is pushed into position 4 from either positions 1,2 or 3 and newly ground material is placed in the empty position within 1,2 or 3. This single turning event occurred (over the past 5 years) on a 3- to 7-month frequency as reported by Jeffrey Grimm / Secretary of Grimm's. According to Mr. Grimm, in the past 5 years, as the volumes have increased, this procedure of moving and screening the material through position 4 has taken longer to finish.

Comparison of Active Composting Systems:

The large, static pile method is a relatively common, low-tech approach to composting primarily in rural areas. In a 2017 survey by Biocycle Magazine, "The State of Organics Recycling", of the 34 states that responded with technology types, Static Piles are the second most common method of composting at 22% of the responding states. Static Pile composting is intended to minimize handling, allowing the materials to sit and decompose slowly. Typically, the time for composting into a finished product is 6-months to 2-years using this method. The improvements Grimm's has employed in grinding and screening at the same time and reusing screened product overs in a consistent porous initial blend, and finally pile placement with bull dozers has allowed an increase in the composting rate to the current 4- to 7-months they take to achieve a stable finished product.

Most Static Pile (SP) systems are lower in height than the pile at Grimm's. Heights of 15 to 25 feet are more common, although some are higher. Lower height is generally due to equipment limitations and in the interest of reducing fire hazards and compaction of the material near the bottom of the piles. Still piles of these lower heights also tend to experience smoldering fires when the weather changes from dry to wet in the fall.

The SP method used at Grimm's is not the same as a "windrow" method of composting that requires five (5) turns over at least 14-days during which the composting material maintains a temperature of 131°F for a minimum of 15-days. While the windrow method is a legitimate and efficient method of creating high quality compost, it is usually utilized over a large surface area where land is inexpensive. Windrows are designed to passively aerate with a compost turner used to re-fluff the piles to maintain convective airflow and aerobic conditions within the pile. They are turned generally every 3 to 7 days. Windrows are typically of much smaller volumes in cross section. Typical windrows range from 10- to 24-feet wide by 6- to 10-feet tall depending upon the equipment used to turn them. Windrow composting generally takes 2- to 3-months to achieve a stable finished product.

A smaller windrow, with high porosity materials, is likely to supply more oxygen per mass of solids for a longer period of time. Turning frequency for that method is, also, typically expected within a range of days rather than months.[14] The goal of the process is to achieve heating consistently throughout the materials and meet sanitation requirements for pathogen reduction. The large stockpile method makes monitoring temperature deep within the pile almost impossible. Verification of time and temperature targets for pathogen control become conjecture rather than documentation. Turning only once before screening into finished product does not assure that the outer edges of a pile have been exposed to the higher interior temperatures either. Composting facilities required to achieve the Process to Further Reduce Pathogens (PFRP) should not use this large stockpile method without significant finished product testing and U.S. EPA approval of an equivalent process[15] assuming that was accepted by DEQ.

Aerated Static Pile (ASP) composting methods use pressure blowers and distribution pipes under the pile to push or pull air through the compost at a rate which typically is based on providing oxygen and controlling the pile temperature. It usually takes five to ten times more air to cool a compost pile than is necessary to provide adequate oxygen to reduce odors and speed up the composting process. ASP systems generally have oxygen levels over 16% within the pile compared to 0 to 5% in static piles and windrows at a 4-foot or greater depth. Air contains 21% oxygen. This higher oxygen level and the removal of excess heat allow ASP systems to be fully aerobic and keep the piles at optimum temperatures (<145° F) if well designed and operated. To meet PFRP they must be insulated with a biocover (usually older compost and overs) and achieve more than 131° F for 3 days throughout the pile. More effective degradation can be achieved through reversing air directions and keeping a relatively consistent temperature within the pile profile.

ASP systems also have the ability to treat the air being collected from below, or forced out of the top of the pile, using a combination of biofilters and biocovers. These methods help reduce the odor emissions further.

The most difficult challenge with the large static pile method, such as used at Grimm's, is that the depth of the pile consolidates the lower materials creating a dense core where oxygen is not able reach. This creates anaerobic conditions that produce reduced compounds from the organic wastes, such as methane, reduced sulfur compounds and amines, that smell bad to most people and add to Greenhouse Gas emissions. Within the composting industry, large static piles and large windrow systems are not typically used in populated areas due primarily to the odor impacts when the piles are moved.

[14] USEPA. 2003. Control of Pathogens and Vector Attraction in Sewage Sludge. https://www.epa.gov/sites/production/files/2015-04/documents/control_of_pathogens_and_vector_attraction_in_sewage_sludge_july_2003.pdf

[15] https://www.epa.gov/biosolids/examples-equivalent-processes-pfrp-and-psrp

GMT has observed over the last 7 years that SP composting systems are difficult to maintain as a viable composting system in densely populated areas and that many of those once small operators of SP systems are considering transitioning to ASP systems.

Biocycle Magazine focused their October 2017 issue on "The State of Organics Recycling in the US"[16], describing new data regarding 34 states reporting on the methods of composting used in their state. Part of the survey is shown in Table 3.1-1. The table shows that windrows are the most prevalent composting method at 1,135 facilities (63%), and static piles come in second at 409 facilities (22%) with ASP at only 170 (10%) and in-vessel at 81 facilities (<5%). However, the states with the most SP composters are also the lease densely populated. Population densities for the same states reporting the composting systems for 2015 are listed below[17] with the SP numbers.

Table 3.1-1
Composting Facilities by Method

State	Windrow	SP¹	ASP²	I-V³
Alaska	0	0	4	1
Arizona	5		1	
Arkansas	8	10		
California	151	0	12	13
Colorado	23	8	1	1
Delaware	1	1	3	0
Georgia	11	10	1	5
Idaho	3		2	
Iowa	25	6	48	1
Kansas	165	21		
Kentucky	33			
Louisiana	150	15	25	25
Maine	25	80	11	3
Maryland	16		2	
Minnesota	5	0	4	2
Mississippi	3	8		
Montana	13	27	1	1
Nebraska	8			
Nevada	5		1	
New Mexico	20	19	1	1
N. Carolina	14	2	4	2
N. Dakota	23	57	0	0
Ohio				10
Oklahoma	13		1	1
Oregon	32	13	8	0
Rhode Island	22	1		1
S. Carolina	7		1	
S. Dakota	16	126	0	1
Tennessee	7	0	1	
Texas	15	1	2	
Vermont	9	0	1	0
Virginia	18	0	4	5
Washington	24	4	30	8
Wisconsin	265	0	1	
Total	**1,135**	**409**	**170**	**81**

34 states reporting.
¹Static pile; ²Aeraed static pile; ³In-Vessel.

BIOCYCLE, THE ORGANICS RECYCLING AUTHORITY

South Dakota – 126 SP facilities. Pop. Dens. rank 52nd
Maine - 80 SP facilities Pop. Dens. Rank 44th
North Dakota – 57 SP facilities, Pop Dens. Rank 53rd
Montana – 27 SP facilities, Pop Dens. Rank 54th
Kansas – 21 SP facilities, Pop Density Rank 47th
New Mexico – 19 SP facilities, Pop Dens Rank 51st
Louisiana – 15 SP Facilities, Pop Density Rank 29th
Oregon – 13 SP facilities, Pop Density Rank 45th
Mississippi – 8 SP facilities, rank 38th,
Colorado – 8 SP facilities, rank 43rd,
Iowa – 6 SP facilities, rank 42nd,
Washington – 4 SP facilities, Rank 30th,

Based on these data, 398 out of 409 or 97% of the reported Static Pile facilities are in the bottom half of the US population density rankings. Notably, the states with the highest population density rankings in this report have only 14 SP facilities total:

Rhode Island 1 SP facility ranked 4th

[16] Biocycle Editors. 2017. The State of Organics Recycling in the U.S. https://www.biocycle.net/2017/10/06/subscriber-exclusive-state-organics-recycling-u-s-complete-report/

[17] Wikipedia 2015 Density population rank and land area.

Maryland 0 SP ranked 10th
Delaware – 1 SP facility Ranked 11th
Ohio 0 SP facility ranked 16th
California 0 SP facility ranked 17th
Virginia 0 SP facility ranked 20th
North Carolina 2 SP facilities Ranked 21st
Georgia 10 SP facilities ranked 23rd
Tennessee 0 SP facility rank 26th
Kentucky 0 SP facility Rank 28th

While this list is not complete it can be said that as communities densify, there is a clear trend away from static piles being used within the composting industry. Oregon in 2016 had the 6th largest growth rate in the US and as of 2017 there are a total of 53 compost facilities with 32 windrow, 13 SP systems, and 8 ASP systems. California with a total of 176 facilities has no static pile facilities reported. Washington now has 30 ASP facilities with only 24 windrow facilities and 4 SP facilities remaining. Washington is fifth in growth rate in the US. Clearly the prevalence of SP composting systems for the active composting stage will be changing within Oregon as well.

3.1.3.6 CURING / FINISHING

Curing and finishing are the final stages of composting. The Curing stage transitions from the Active phase as the temperature in the pile decreases due to thermophilic bacterial population reduction and fungal activities begin to dominate. Fungi metabolize the reticent carbon materials such as woody lignin that remain after the bacterial populations die off. This activity occurs at a much slower rate and at lower temperatures. This stage is important for compost quality and to ensure the food available for bacterial degradation is consumed which minimizes the potential for regrowth of pathogenic bacteria.

Prior to Grimm's 'turning' of a pile, materials are removed with an excavator from position 4 at the rate the screening equipment can separate the larger, woody pieces from the fine finished compost. The large pieces or "overs" are mixed back into the compost mix with the freshly ground yard debris to increase the mix porosity and finish composting. The screening process takes three to seven months, and a low but persistent level of odors are generated as materials are removed and screened from position 4. Capturing the air from the processing line during screening and biofiltering it will reduce the odor exposure of this process.

The finished product is stored in a separate product pile south of the main composting piles until transported to an overflow finished compost pile on parcel #2100, prior to being sold either as-is or following additional processing such as fine screening or blending with other materials to produce specialty blends. Based on our site visits during the slowest compost product sales months of January and February, there is not an unduly large volume of finished product, and no stockpiles of compost materials older than one growing season. Grimm's indicates that there are no problems selling the compost currently manufactured into the local market. The storage of finished compost did not appear to be the source of any significant malodors. Our DT readings with the Nasal Ranger®

were non-detects on the top of the finished product pile. Our observations indicate that the finished product piles were not a major contributor to the off-site odors.

3.2 Feedstocks

Grimm's receives green waste and wood waste in many forms along with some manures and sometimes spent mushroom substrate. These feedstocks are received, ground, and either screened or composted and screened. These feedstocks create many different finished products that are used in horticulture and home gardening. Most of Grimm's feedstocks are generated locally within an approximately eight-mile radius of this facility. This includes curbside collected yard waste arriving in packer trucks and tractor trailers from local hauling companies.

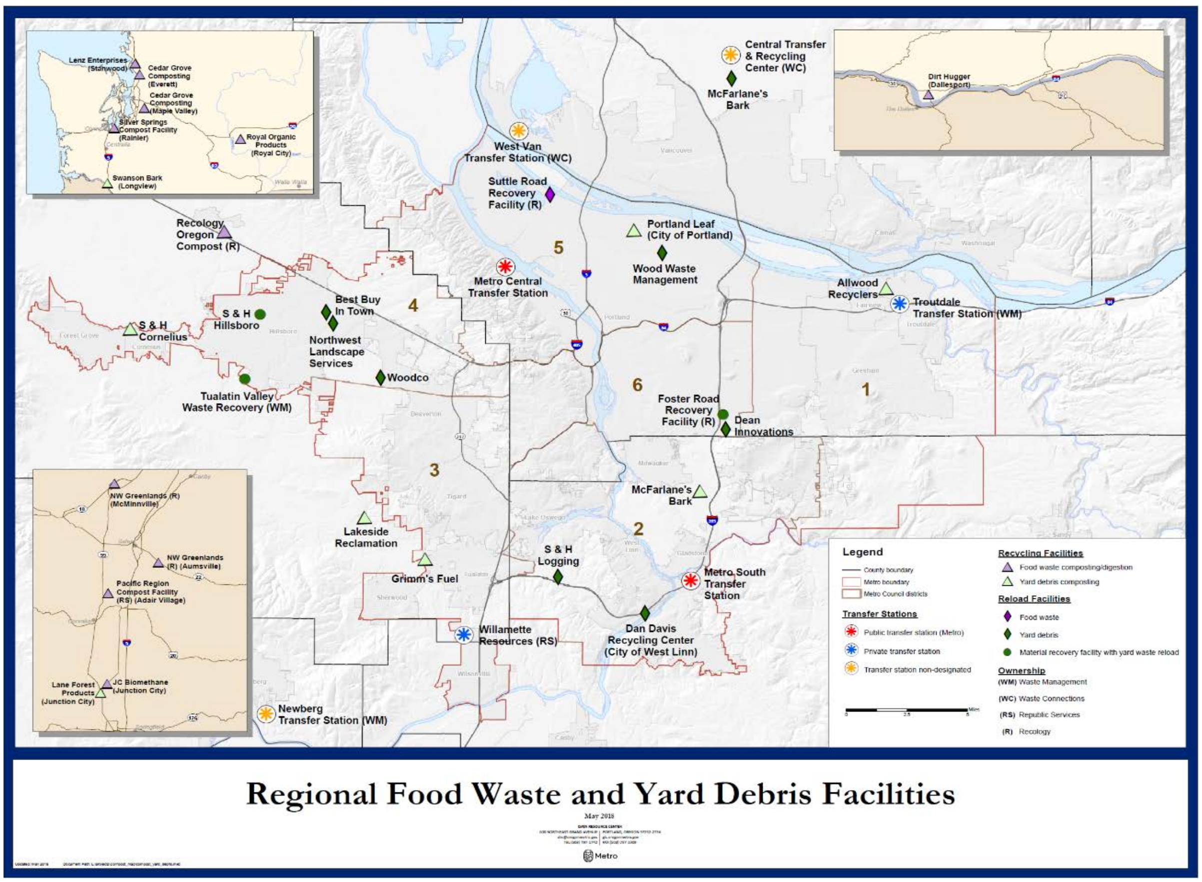

Figure 3.2-1 – Regional Food Waste and Yard Debris Facilities (by Metro)

The bulk of the materials are delivered by local homeowners and by numerous landscapers hauling their customers loads in trailers and trucks. Much of the material received is woody, bulky and loose. Some of it is chipped before it arrives by tree companies to reduce the number of haul trips they need to make.

There are two other composting facilities within 23 miles of Grimm's that are open to the public, McFarlane's Bark in Milwaukie and S&H Landscape Supply in Cornelius. Both are about 40-minutes away. There are three Yard Debris Transfer points somewhat closer: S&H Logging, 8 miles away on Stafford RD; Dan Davis Recycling Center, 12 miles away in West Linn; and Woodco, 12 miles away in Beaverton. These places can handle yard debris by transporting to another composting facility. Businesses and homeowners generally go to the closest facility to them. Prices for tipping loads of yard waste at the different facilities do not differ widely. Large volume customers with transfer trucks usually shop for the lowest price and can transport loads up to 50-miles economically. Many medium sized composting companies like Grimm's keep their small local haulers happy with competitive rates and by providing a shorter haul time.

Grimm's has been providing these services to the local community for over 35 years at this location. The population and volume of yard waste production has greatly increased in that time. Region-wide the area grew 36% in population from 1990 to 2010 and is expected to increase by another 30% by 2035. The infilling of the population brings acres out of agricultural production and intensifies the amount of managed landscapes. As newly planted deciduous trees in new developments mature, they produce more leaves. The trees provide shade and landscape benefits, but also create a large amount of flat, wet and energy poor leaves that need to be handled in a very short period of time in late Fall. There is pressure to keep the services needed for this changing population and its yard debris and increasingly its food wastes to be recycled locally.

Grimm's has seen an increase in incoming yard wastes over the past 5 years and their seasonal spikes in tonnage of leaves in the fall and grass in the spring have been increasing as well. In November of 2017 Grimm's saw almost double their previous November's volume as shown in Figure 3.2-2 below.

Using only average tonnage received over a year does not reveal the actual impact on day to day handling of the materials or the effect that peak seasonal flows have on that handling. Grimm's experienced only a 37% increase in tonnage from 2016 to 2017 but a 100% increase in their normal seasonal peak month in the fall from the previous year. Table 3.2-1 shows annual incoming tonnage over the previous 5 years.

Seasonal variability is a problem for a facility with no additional space where they are permitted to create active composting piles. Their only two options are to decrease the active composting time by making the composting process more efficient or stack it higher on the same foot print. Grimm's has been doing the latter and the results have been an increase in odor problems with no discernible acceleration of the process.

It is important to establish the volume a composting facility is expected to receive to assure that adequate aeration and processing capacity is designed into the system and the operator is prepared to take the changes in stride. The chart below indicates the expanding trend in material flows of Grimm's market. Often a facility is not designed to or not allowed to manage increasing materials until changes have been made to their facility. The choice may be made to close the doors entirely, which harms haulers under contract, homeowners and municipal governments who want to increase recycle volumes.

One of the short-term strategies to cope with these pressures may be to raise tip fee prices to divert a portion of customers to other facilities. This can be beneficial since it also allows the owner to maintain a better income with less cost and provide additional funds to invest in new equipment or systems.

The tons reported in Table 3.2-1 were derived from the monthly commodity reports provided by Grimm's. Grimm's receives some materials measured in yards and others in tons. The totals reported to the agencies utilize agency-preferred conversion rates between yards and tons. There is a wide diversity of bulk densities between material types and variations between wet and dry seasons. To achieve totals across all of the material types with common units, multiple conversions were needed. Conversions were based on commodity densities reported by USEPA in 2016.[18]

Table 3.2-1 Grimm's 5-year Annual Incoming Tonnage		
2013 total tons	*39,608*	*tons*
2014 total tons	*38,410*	*tons*
2015 total tons	*56,441*	*tons*
2016 total tons	*48,124*	*tons*
2017 total tons	*66,636*	*tons*
5-year average	***49,844***	***tons***

[18] U.S. EPA. 2016. Volume-to-Weight Conversion Factors U.S. Environmental Protection Agency Office of Resource Conservation and Recovery April 2016. https://www.epa.gov/sites/production/files/2016-04/documents/volume_to_weight_conversion_factors_memorandum_04192016_508fnl.pdf

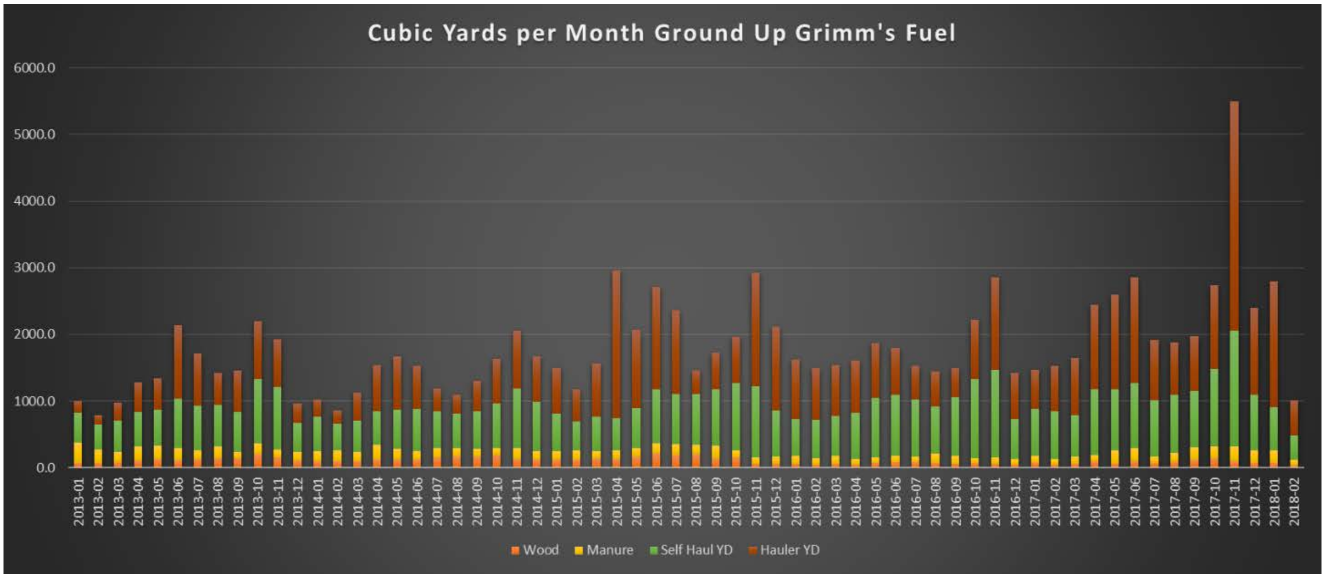

Figure 3.2-2 – Feedstock Volume (cubic yards) over 5 Years

Grimm's has seen a shift in the source of the volume they receive each month as well. Curbside yard waste collected by commercial haulers is increasing. To understand the categories, GMT has grouped them together as Wood, Manure, Self-Haul YD and Hauler YD in the table below.

Acronym	Description
CHS	Wood Chips
CTD	Wood Christmas Tree Donation
CTNC	Wood Christmas Tree (No Charge)
CTS	Wood Christmas Tree (Boy Scouts)
SC	Wood Scrap Wood
SD	Wood Sawdust
SH	Wood Shear (Land Clearing)
HM	Manure Horse Manure
YD	Self-Haul YD Yard Debris
YD 9.5	Hauler YD Yard Debris ($9.50/yd)
YDCS	Hauler YD (Compacted)
YDT	Hauler YD Yard Debris (Tons)

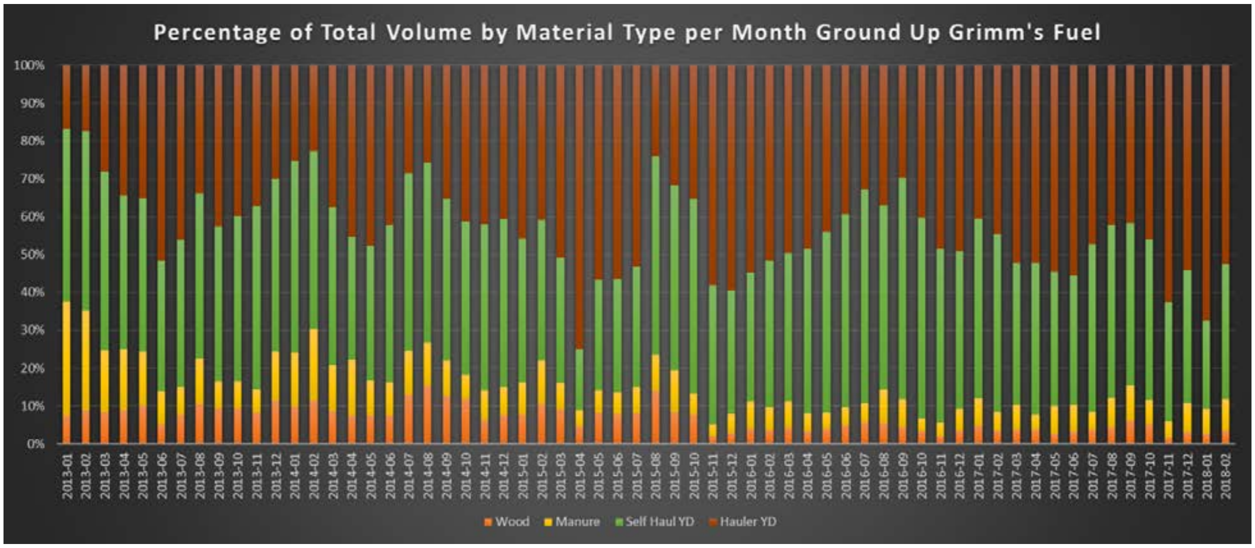

Figure 3.2-3 – Feedstock Type as weight percent of incoming mix over 5 years

Feedstocks change in character over the year from wet almost greasy nitrogen rich grass clippings in April and June to nice dry grasses and weeds in July and August, when Fall approaches fruit culls from trees abound and then the big leaf fall in November when everyone brings in these flat wet materials with low nitrogen and low energy. Finally, throughout the winter gardeners and landscapers bring in brush and branches trimmed from the dormant trees. Each of these changes in season brings its own challenges to manage the composting process. One of the advantages of screening materials that are 3 to 7 months older than the material entering the facility and blending in the screened over back into the fresh ground yard waste, is they generally have the best character to mitigate the challenges posed by the current season. Even so, odors and the odor potential changes with the season, and the composting system will emit a different characteristic of odor if not controlled and managed.

3.3 Historical Site and Compost Operations

Finding the most effective path into the future is often informed by understanding how a current situation arose. Grimm's is a third generation, family owned and operated business, begun in 1929 in Lake Oswego. It started with Fred and Wilda Grimm, cutting and delivering firewood, expanded into sawdust from local mills, then coal as it became more commonly used. In 1962, Rod Grimm (Fred's son) diversified into trucking and expanded the aged sawdust handling that was sometimes sold for garden use. The younger Grimm saw an opportunity in the piles of sawdust left to accumulate or be burned at sawmills and slash collected from the forest for the Forest Service. They began purposefully turning them into soil amendment products.

Grimm's compost technology evolved from that sawdust aging. Bark Dust was accepted soon after the wigwam burners were shut down throughout the region. At that time there was about 12 months of aging in large piles done before delivery to customers. In 1975 Grimm's moved from their Lake Oswego site to the current property on the corner of Highway 99 and Cipole Rd. lot #1800. They terraced the new site, installed in-ground tanks for their heating oil business and began composting bark dust and spent mushroom substrate for their landscaping customers in large piles like they had in Lake Oswego.

A few years later, Grimm's purchased the McCulley lot #1900 just south of #1800 where the office, shop and grinder now stand. Through the end of the 1970's and early 1980's Grimm's accepted yard waste and land clearing debris and composted it in a large extended pile without grinding it. By the early 1980s they were grinding the yard debris with a Jeffries hammer hog, pushing it into a pile, and the following season, screening on a flat shaker screen to sales. In the mid 1980's, they built the "B Side" grinding and screening system similar to the one seen today and began grinding feedstocks before composting in large extended piles, greatly improving the site capacity and shortening the processing time. With space becoming constrained, Grimm's also built a 150-foot by 40-foot concrete aerated slab and large bunker walls, hoping to accelerate the composting process and reduce handling costs. This air-floor design did not work well and was soon mothballed, and Grimm's went back to their large pile composting method.

In the late 1980's, Grimm's purchased the eastern parcels #2100 and #2202, and the properties were annexed to the City of Tualatin, who provided water and sewer and allowed residential zoning across Pacific Highway. Angel Haven mobile home development opened in 1991.

Grimm's material handling processes evolved in the late 1980s with increased investment in new and bigger equipment. By 1990/1991 the yard debris was coming in so fast the original grinder couldn't keep up. So, Grimm's purchased a much larger Jeffries Hammer hog, and put in their "A Line" grinder and screener system alongside the older one. This allowed them to grind fresh wastes and screen finished compost at the same time. They began to incorporate the large-sized overs from the screening process to improve the porosity of the ground yard waste in the large piles.

With this expanded capacity they started also taking in stumps. These were stockpiled in the NW corner of the site. Until November of 1991, when a large fire started in the stumps grinding pile. Tualatin Valley Fire and Rescue (TVFR) responded and the file was put out. From then on, the stumps were ground as they came in to avoid such accumulation.

Originally, the piles were managed using loaders to climb up the piles and place the materials in the large piles. This over-compacted the pile where the loader tires ran. It was unsafe for operators and caused differential compaction which increased the fire risks. In the mid 1990's, three improvements in Grimm's processing approach were implemented. A 200-foot conveyor was purchased which enabled placement of material in the compost pile higher and with greatly minimized compaction. Several D-9 dozer track rigs were purchased to replace the loaders for turning which also minimized compaction of pile. Thirdly, the 'C'-hog was added to grind overs prior to mixing them with the green feedstocks to both add porosity and to inoculate the incoming materials.

In 1994 the original conditional use permit (CUP) was granted by the City of Tualatin with multiple conditions (including submittal of an application for Architectural Review, minimizing dust impacts, develop procedures to minimize odor impacts, submit a landscaping plan to provide screening, and submit application for CUP review by 9-30-97) to expire in 5-years [CUP 94-11]. Grimm's addressed the conditions required by the first CU and applied for the second in 1997. In 1998, they received the next conditional use permit [CUP 97-03] with the single condition of constructing a permanent surface water quality facility for the paved surfaces of the site. In 1996 the first Pony Ridge homes were built. In 2011, the most current CUP was issued including approval to accept food waste (Type 3 feedstocks) with conditions including only allowing residential food waste, obtaining authorization from DEQ and Metro for food waste, completion of a Metro sponsored pilot project, remaining in compliance with earlier CUPs, and submittal of an odor mitigation program [CUP 11-03]. However, it appears that these conditions were never completed, and food waste has not been accepted at the facility. Appendix B-5 contains the Conditional Use documents.

Over the years more paving was added, primarily on the two original parcels. In 2010, Grimm's acquired parcel #2190, adjacent to those parcels to the east. See Parcel Map in Appendix A-1.

Grimm's applied for a building permit in 2000, to expand their shop building adding a 60'x100' shed. Multiple accommodations were required for that permit by the City of Tualatin, Washington County[19] and Oregon Department of Transportation (ODOT) including Grimm's relinquishing 30-feet along the west side of parcels #1800 and #1900 for future widening of Cipole Road, and improvements along Cipole road at Grimm's expense including sidewalks and landscaping and abandonment of one of Grimm's existing accesses. "Eventually", Jeff Grimm reported, "a judge determined the requirements were excessive for the size of the project"[20]. The building was constructed in 2002 and approved for use in 2003[21].

SP Newsprint, located in Newberg, had been taking ground pallets and urban wood from Grimm's as well as some municipal yard waste from local landscapers for their burners[22]. In October 2015, SP Newsprint was purchased and shut down unexpectedly. Grimm's lost that hogged fuel client and stopped accepting wood wastes in response. The shutdown caused a

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[19] Per telephone interview with Jeff Grimm / Grimm's Fuel Company Secretary on 2-16-18 by Tamara Thomas / Terre-Source LLC, Jeff Gage and Michael Bryan-Brown / Green Mountain Technologies, Inc. and

Oregonians in Action Education Center bimonthly newsletter. July/August 2002. Available at: http://www.oia.org/wp-content/uploads/2013/10/LookingForwardJuly-August2002.TL_.pdf

[20] ibid. telephone interview with Jeff Grimm / Grimm's Fuel Company Secretary.

[21] If such a drawn out and expensive permitting process is still in place, the alternatives described in section 6 may be limited to those that do not require permitting or land use changes for implementation.

[22] Ibid. Telephone interview with Jeff Grimm.

temporary back log of hogged fuel at Grimm's. Luckily, SP restarted the burner later that year, needing additional hogged fuel for cleanup of their site, which took care of Grimm's stockpile. The shutdown, however, also caused SP Newsprint's yard waste customers to seek alternative processors for their materials. Grimm's provided that alternative, which may have caused their feedstock intake to increase in late 2016 and 2017. Per Jeff Grimm, much of that increase came in as leaves in the fall and November 2017 volume was 60% higher than November 2016. The increase, at least partially a result of the SP Newsprint closure, also caused lines of trucks and trailers winding around the property to deliver yard waste in October and November 2017.

Per Jeff Grimm, it appeared some of the recent odor and complaint issues had to do with the extreme increase in volume – particularly the leaves that came in October and November 2017. The leaves went into cell 1 which had been cleaned out in September. Because the leaves came in all at once, there may not have been enough incoming woody bulking material to adequately blend with the leaves which compacted, further reducing air flow.

The highly expanded pile resulting from Fall 2017, needed to be turned in February to be in accordance with Grimm's normal processing. Grimm's typically turns the piles only when the wind is from the east to minimize the impact on their closest neighbors to the north and east. The pile had not been turned since September, although much of the volume (including a very large glut of leaves) had been in place only since November. Grimm's management watched the weather forecasts, and a high pressure system with east winds was predicted for the week of February 5th. Although the system had not fully materialized, the pressure was rising on the 5th, so Grimm's went ahead and turned the pile, expecting that the winds would come up as predicted. The winds never developed, and the inversion held the entire week, trapping late night and early morning air near the ground surface which greatly concentrated odors experienced by neighbors and others within a larger than typical radius.

The turning took longer than the customary 5 days due to the excess accumulation, primarily due to the exceedingly high volume that had come in November.

Odors appeared to predominately flow along the river and to the east and south east more so than usual as the air, not allowed to rise and dissipate, followed natural depressions as well as to the north with the slight prevailing winds. Metro's contractors' site visits for odor assessment of the facility, also attracted local media coverage. Local radio and newspaper articles published February 7 & 8 reported odors noticed from Sherwood to Portland[23]. Metro documented 91 odor complaints over the month of February 2018. On March 13, 2018, DEQ issued Grimm's a Pre-Enforcement Notice of Solid Waste Permit Violations, not pertaining to odors, that was based on their February 23 site inspection.

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[23] KGW8 News. 2018. Author Keely Chalmers. 7:57 PM PST February 7, 2018. Available at: https://www.kgw.com/article/news/local/mysterious-odor-is-from-tualatin-composting-facility/283-515907392

Current daily management of Grimm's is primarily the hands of brothers, Dan, Jeffrey and Mark and nephew, Jake Grimm. Multiple additional family members work for the company in various capacities and the company is noted for its low turnover and long-term retention of employees[24]. Altogether, Grimm's provides full time employment for 50 to 65 people in the Tualatin area depending upon the time of year and success at recruiting.

3.4 Relevant Regulations, Authorizations and Requirements Review

This section provides an overview of the most relevant regulations and regulatory authorizations that form the compliance environment for Grimm's composting. State, County, Regional, and City regulations are enforced through various types of authorizations such as DEQ's solid waste permit[25], Metro's solid waste facility license[26], DEQ's General Permit 1200-Z industrial storm water, which is administered by Clean Water Services as described in section 3.4.4 – DEQ Stormwater Permit, and the City of Tualatin's land use Conditional Use Permit[27], as well as the Tualatin Valley Fire and Rescue enforcement and interpretation of the Oregon Fire Code (OFC).

Compost facilities in the state of Oregon are subject to a layered approach to regulations. DEQ applies and enforces Oregon Administrative Rules (OARs) Chapter 340 Division 96, Solid Waste: Special Rules for Selected Solid Waste Disposal Sites, predominately. Sections 0060 through 0150 apply to compost facilities. Chapter 340, Division 208, sections 0300 through 0550 covers Nuisance Control Requirements and contain specific additional requirements for facilities within Clackamas, Columbia, Multnomah, and Washington counties. Additionally, DEQ regulates water quality impacts and as such issues NPDES permits that apply to Grimm's operation. These regulations and permits are discussed with specific application for Grimm's below and are reflected in their Solid Waste Disposal Site Permit: Composting.

At the County level, Washington County, does not have a role in regulation of the solid waste aspect of this facility. Washington County Health Department provides informational resources in relation to known health impacts. The County transportation department has oversight of Cipole Road, and its potential development or changes, as it is a County road. Cipole Road is of concern to the County due to the increase in traffic in the area and relatively uncontrolled intersection at Cipole and Highway 99 SW.

Metro manages solid waste issues in the urbanized 3-county area (see section 2 above). Title V of Metro's code covers solid waste and includes facility regulations, flow control rules,

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[24] As evidenced by presentation at Metro neighborhood meeting of ~30-year employee, and per experience of Jeff Gage/GMT.

[25] Permit No. 1433

[26] License No. L-043-12A

[27] CUP No. 11-03

community enhancement programs and the Regional Solid Waste Management Plan.[28] Metro issues a Solid Waste Facility License with specific conditions as discussed below.

Grimm's compost facility and nearby properties were incorporated into the City of Tualatin in the early1970s. At that time local regulatory control fell primarily to the City of Tualatin. Their requirements are structured primarily around Land Use issues. With respect to Grimm's site, Conditional Use permitting issued by the City of Tualatin Development Code chapter 32 contains conditions for compliance as described above and shown in CUPs in Appendix B-5.

Additionally, specific agency regulations are in effect including State of Oregon Fire Code as applied by the Tualatin Valley Fire and Rescue (TVFR).

3.4.1 DEQ Solid Waste Disposal Site Permit: Composting Facility [No. 1433] and Regulations

Grimm's DEQ solid waste permit contains a description of allowable activities, Operations and Design requirements, General Conditions and a Compliance Schedule. This permit is attached as Appendix B-3. The allowable activities addressed include the feedstock types that may be accepted for composting (Type 1 and 2, and Type 3-with conditions[29]). Grimm's may accept vegetative yard waste and wood wastes, manures and bedding. After performing a demonstration (pilot), submitting a revised Operations Plan, and obtaining specific approval from DEQ and Metro, Grimm's may accept curbside collected residential food waste mixed with yard debris. The permit also specifically prohibits open burning and acceptance of biosolids and other prohibited materials.

The Operations and Design requirements of the permit are presented partially as performance standards that generally require: not discharging leachate, or liquid digestate from the facility to surface water; not adversely impacting groundwater; controlling and minimizing odors that are likely to adversely impact outside the facility boundaries; achieving human pathogen reduction in the composted materials[30]; preventing vectors (such as rats, birds, flies); and complying with all other laws and regulations.

In addition to the performance standards, specific requirements are included requiring Grimm's to sample and analyze every 5,000 tons or at least monthly for fecal coliform or salmonella and to operate in accordance with an Operations Plan. The Operations Plan must include all elements required in OAR 340-096-0090(5). Required record keeping includes: incoming material tracking and reported on a monthly basis: documenting and reporting any non-compliance or leachate releases; pathogen testing; and complaints; and emergency reporting. The facility design and construction must also be documented, and reports submitted prior to any site modification.

[28] Metro Code webpage. Accessed 4-11-18. https://www.oregonmetro.gov/metro-code

[29] Feedstock Types are defined in OAR chapter 340-093-0030(43).

[30] PFRP as discussed in section 3.1.2.5 Active Composting.

General conditions of the permit include site operations requirements such as: cleaning containers on-site; requiring truck loads to be covered; diverting surface drainage from feedstock materials; minimizing leachate production and managing that which is produced; responding appropriately to any hazardous spills; ensuring that public access around the facility is not impaired by queues or load covering activities; providing adequate signage; controlling vectors and responding to complaints.

Finally, a table is included in the permit describing the dates required for various activities and reporting and when to notify DEQ.

To a great extent DEQ regulates and enforces the applicable OARs (Chapter 340 Divisions 093, 096, and 208 primarily) via a site-specific Operations Plan which describes how the solid waste handling facility is operated within compliance with the applicable regulations. Grimm's has prepared an Operations Plan in accordance with their understanding of the requirements of DEQ. The most current version, dated July 2017, is included as B-1 in Appendix B.

OAR 340-096-0090 requires an Odor Control Plan as part of a composting facility's required Operations Plan. The intent of the plan is to document and obtain concurrence with DEQ on the processes used to operate the facility in accordance with the Performance Standards for Odor which state that facilities shall "to the greatest extent practicable and consistent with proper facility design and operation, controls and minimizes odors that are likely to cause adverse impacts outside the boundaries of the facility."[31] Section 5 of Grimm's Operations Plan for DEQ dated July 2017 presents their approach to Odor Control and Minimization. Specific odor minimization activities in that Plan include:

- Inspecting incoming feedstocks
- Promoting aerobic conditions by grinding incoming materials coarsely
- Inoculating incoming materials with finished compost and minimizing initial mix disturbance
- Minimize compaction of the active compost pile
- Maximize aeration using the D-9 (to turn the pile)
- Monitoring the weather to inform scheduled activities on-site
- Conducting inspections
- Avoiding anaerobic conditions and
- Communicating with neighbors and Tracking complaints

3.4.2 Metro Solid waste License [No. L-043-18] and Operations Plan

Grimm's Solid Waste Facility License with Metro is provided as Appendix B-4. While similar in many respects to the DEQ's Solid Waste permit, this license is structured differently and most

[31] OAR 340-096-0070(4).

significantly, does not allow acceptance of residential yard waste mixed with food waste. Only incidental quantities of source-separated pre-consumer vegetative food waste are acceptable.

Additionally, Metro's license covers other solid waste aspects of Grimm's business such as the production of hogged fuel rather than specifically limiting coverage to composting. The license allows for acceptance of painted and treated wood (other than creosote-treated) for grinding and use for hogged fuel, but not for mulch, animal bedding, compost, or any other landscaping or agricultural products. The license also allows acceptance of inert materials such as clean concrete, asphalt, rock and dirt for processing and reuse.

Metro's license also requires qualified facility personnel to be on site during all hours of operation who are familiar with the requirements of this license and Grimm's Operations Plans with adequate training and authority to ensure prohibited wastes are rejected and properly managed.

Via this license, Grimm's must specifically perform most of the same elements from DEQ's permit that are abrogated to the Operations Plan, such as: provide fire prevention, protection and control measures, inspect loads and reject prohibited materials, manage piles within designated footprints[32], minimize dust generation from material transport, keep roadways clean, prevent off-site malodors, minimize and control vectors, prevent noise that causes off-site impacts, prevent solid waste contact with storm water, collect or treat leachate, maintain site control / fencing, respond to and document complaints.

Metro's license also requires an Operations Plan outlining the approach to the facility compliance. Grimm's has prepared a second, different Operations Plans for Metro's license as shown in B-2 of Appendix B. Operationally both Plans are similar, but Grimm's felt better able to address the requirements of the agencies in separate documents. Due to a recent order from DEQ, Grimm's is in the process of merging the two Operations Plan into one. The most current version of Grimm's Operations Plan obtained from Metro's webpage is dated March 1, 2013.

Of note is that neither DEQ, nor Metro specifically limit the amount of material accepted, processed or on site at any given time under their permits. Although the DEQ permit does require the Operations Plan to comply with all of the elements of OAR 340-096-0090(5) which includes item (a) "The Operations Plan must describe the types **and volumes** of feedstocks the facility will accept…". Metro's license makes no mention of a limit on the volume of feedstocks or materials handled on the site.

With regard to odor, Metro's regulation 5.01.090 License Contents includes the statement that the facility must be "designed and operated to avoid nuisance conditions including but not limited to litter, dust, odors, and noise."[33]

[32] Metro Solid Waste Facility License No. L-043-18, dated 12-18-17. Operating Conditions 5.6 Storage and exterior stockpiles (3).

[33] Metro. Title V. Section 5.01 Solid Waste Facility Regulation. Last published on-line March 18, 2018: https://www.oregonmetro.gov/metro-code

Metro's license does not regulate storm water or air quality. Grimm's Metro Operations Plan includes a similar but much shorter description of activities performed as their DEQ Odor Minimization Plan.

3.4.3 City of Tualatin Conditional Use Permit

Grimm's was composting in a similar manner to today before it was incorporated into the City of Tualatin in the1970s. With that in mind, the City utilizes a Conditional Use Permit (CUP) process to define allowed uses within the city limits. Chapter 32 of the Tualatin Development Code defines the process with the intent to allow "practical latitude for utilization of land and structures… and protection of the health, safety, convenience and general welfare of the community…"[34]. Grimm's original CUP-94-11 was issued for approval for yard debris composting on Tax Lots #1800 and #1900 with conditions.

In 1997, the next CUP was issued with the condition of construction of a storm water facility to comply with City code.

In October of 2011, the City adopted a resolution (No. 5072-11) allowing acceptance of food waste for composting on Tax Lots #1800 and #1900 with conditions. The conditions include: limiting acceptance to only authorized municipal food waste program sources; requiring authorization from Metro and DEQ; allowing participation in a Metro-sponsored Pilot Project for commercial food waste (which never materialized); requiring compliance with all conditions of the original CUP and Tualatin Development Code 63, Environmental regulations, including section 63.054 Odors which states "The emission of odors in such quantities as to create a nuisance condition at any point beyond the property line is prohibited"; and, finally, requiring the applicant prepare and submit an odor mitigation program documenting efforts and how to mitigate future odor complaints. This current CUP also required that if the City verified "unresolved odor complaints… the City Council may hold a hearing to determine whether the CUP should be allowed to remain as is, be modified with additional conditions, or revoked."

It appears that no further action towards accepting food waste was ever acted upon.

It is beyond the scope of this report to make the legal determination as to whether a nuisance condition has been created beyond the property line of this facility.

3.4.3.1 ZONING

The parcels comprising Grimm's are zoned General Manufacturing/MG or Light Manufacturing/ML. Per the Tualatin Development Code Chapter 07: Manufacturing Planning Districts, certain land uses are allowed within those zones. Composting, however, is considered by

[34] Tualatin Development Code Chapter 32: Conditional Uses. Section 32.010 Purpose and Intent. Downloaded 3-23-18 from: https://www.tualatinoregon.gov/developmentcode/tdc-chapter-32-conditional-uses

the City to be heavy manufacturing, which is not allowed within these zones except under Conditional Use allowance. The following table lists the applicable land uses within each of Grimm's parcels.

Table 3.4-1Allowed used on Grimm's Parcels		
Parcel #	**Zoning**	**CUP approved uses**
1800	MG/CUP	CUP 94-11 Yard Debris Composting, Resource Recovery CUP 97-03 Yard Debris Composting, Resource Recovery CUP 11-03 Composting food scraps with limitations
1900	MG/CUP	CUP 94-11 Yard Debris Composting, Resource Recovery CUP 97-03 Yard Debris Composting, Resource Recovery CUP 11-03 Composting food scraps with limitations
2190	MG	Per Tualatin TDC Ch7: light and heavier manufacturing and processing activities. Rail access, screened open storage, retail sales, professional services and commercial uses…
2100	MG/ML	MG as above. ML per TDC Ch7: warehousing, wholesaling and light manufacturing process that are not hazardous and do not create undue amounts of noise, dust, odor, vibration or smoke; retail sales
2202	MG	MG as above.

3.4.4 DEQ Stormwater Permit

Grimm's is covered under Oregon's General Permit for the National Pollutant Discharge Elimination System (NPDES) Stormwater Discharge Permit type 1200-Z for facilities that discharge industrial storm water to surface waters or to conveyance systems that discharge to surface waters of the state. This permit is administered by Clean Water Services.

Grimm's permit was most recently issued August 17, 2017 and expires July 31, 2022. Permit coverage is conditioned upon multiple requirements primarily related to minimizing storm water discharge volume, site operations to minimize contaminant content of any discharged storm water, sampling and reporting results from discharge points for benchmark parameters and maintaining and following conditions in a Storm water Pollution Prevention Plan.

Based on a Pre-Enforcement Notice letter from DEQ, dated March 13, 2018, leachate was reported to co-mingle with stormwater with the potential to discharge from the facility. Compliance with this requirement of the 1200-Z permit may require modification of the leachate collection system. GMT cannot verify the issue as described in the letter because it did not observe such leachate co-mingling during its site visits.

3.4.5 Tualatin Valley Fire and Rescue (TVFR) Code Requirements

Fires are an unfortunately common element of life for a compost facility[35]. Organic materials piled in sufficient quantity, height and biologic activity can spontaneously combust. Because of the nature of the unconsolidated materials and un-homogeneous pore spaces, these fires may smolder for periods of time prior to being noticed by the operator. They may be more obvious from off site, which is another reason that a composter's neighbors are so valuable. Grimm's has appreciated such notifications from neighbors on several occasions. When addressed early, these fires are relatively easy to remove from the fire and extinguish. The industry standard approach to an organic pile fire is to remove all the smoldering material and some of the surrounding materials, spread them out in a shallow layer, and compact and water them away from the pile.

Pile height has been linked to spontaneous combustion[36] and typically composting piles are recommended below 12-feet in height. The Oregon Fire Code regulates material pile heights with that dynamic in mind.

In a telephone interview on February 1, 2018, Fire Marshal Stephen Forster[37] / Tualatin Valley Fire and Rescue (TVFR) held that the Oregon Fire Code regulation Section 2807, "Storage of Wood Chips and Hogged Material Associated with Timber and Lumber Production Facilities" was the appropriate section for Grimm's piles. The Facility was grandfathered to this section because it had been established and operating with piles since before the regulation was promulgated. This regulation limited pile heights to 60-feet and size to 300-feet by 500-feet.

A subsequent letter, dated April 23, 2018, to Hila Ritter / Metro from Fire Marshal Stephen Forster[38] stated that TVFR was asked by DEQ and Metro to make a formal determination as to the application of the Fire Code to compost facilities. The determination was reached that TVFR will apply Oregon Fire Code regulation Section 2808 to storage of wood chips, hogged materials, fines, compost and raw products regardless of when the operation started. Section 2808 limits pile heights to 25-feet and pile sizes to 250-feet in length and width. The April TVFR determination is likely to require significant adaptation of Grimm's current composting practice and reduction of its existing processing volume if other design changes are not made. Alternatives presented in Section 6 were developed based on industry standards for ASP pile heights and do not exceed 14-feet. The letter is presented as Appendix B-6.

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[35] Rynk, R. 2008. Fires at Composting Facilities: Causes and Conditions (Part 1). BioCycle Magazine. J. G. Press. 2008. and

In the experience of the authors, and

Soil and Mulch Producers News. A Perfect Storm: Mulch Fir Dynamics and Prevention. http://www.uswebproducts.com/index.php/frontpage-articles-hidden/160-a-perfect-storm-mulch-fire-dynamics-and-prevention

[36] Ibid. Rynk, R. 2008.

[37] Per telephone interview with Stephen Forster / Tualatin Valley Fire and Rescue. February 1, 2018. By Tamara Thomas / Terre-Source LLC.

[38] TVFR. 4-23-18. Letter addressed to Hila Ritter / Metro. *RE: Applicability of 2014 OFC Section 2808 to Existing Compost Facilities*. Letter.

3.4.5.1 TVFR RESPONSE SUMMARY

Year	# responses	# Compost related	Comments
2013	4	1	3 smoldering fires-2 bark, 1-compost smoke, 1 cancelled
2014	2	1	Non-emergency smoke from compost pile, small smolder fire in bark pile
2015	2	0	2 false fire alarm incidents
2016	8	0	5 bark dust smoldering fires, 2 false alarms, 1 undetermined cause structure fire
2017	7	1	1 brush/grass mix fire, 3 bark/chip pile fires, 3 false alarm/cancellations
Per TVFR 3-1-18 reply to request. file: Grimm's Fuel – Incident Responses 1.1.13-1.31.18.pdf			

4 NEIGHBORHOOD EXPERIENCE INVESTIGATION

Odor is the experience in the nose and brain of a recipient (person or animal) of an odorant at a concentration above their ability to detect it (threshold). Within this document the term "malodor" is used to describe an odor that has an undue impact on a recipient in strength and character that they find offensive. This project reflects Metro's concern about the lack of apparent resolution of the community's experience of those malodors generated by Grimm's composting. Because odors and malodors are subjective to the recipient, it is difficult to corelate complaints to verified measurements of odor intensity. Multiple data sources have been utilized to get a clear picture of the community's experience of odors from this facility, including individual interviews of community members representative of areas within reach of odorants from Grimm's and compilation of the historic odor complaints to combined agencies and to Grimm's.

Grimm's has been operating at its current location for several decades, however, some of the residents in the impacted neighborhoods have lived 'next door' almost as long, or since the Pony Ridge development was constructed in the mid-1970s. Pony Ridge, located due north across 99W, is the most consistently impacted area. Angel Haven is a mobile home neighborhood located just east of Pony Ridge with similar impacts. The Hazelbrook neighborhood is located further away and to the east of Pony Ridge, however, residents in that neighborhood also feel impacted by the odors they experience from Grimm's on a regular basis. Several of the residents from these neighborhoods have formed a citizens' organization, CASE (Clean Air, Safe Environment), to advocate for resolution of the odors from Grimm's composting. The group has educated themselves on the concepts of composting and host a webpage where they have posted information such as public meeting dates, provided a link to Metro and DEQ to facilitate odor complaints, and have defined their position of calling for relief of "dust and odor" generated from Grimm's compost. The position page of their webpage is presented as Appendix C-3.

4.1 Odor Complaints

4.1.1 Compilation of Past 5-Years Odor Data

Metro requested GMT to retrieve, compile and summarize odor complaint logs and to develop use of the complaint data in analyses for this report, complaint records for the past 5 years (2013 through 2017) from Metro, DEQ, and Grimm's compost were consolidated into one spreadsheet based on the Metro list structure. To accomplish this task, Terre-Source LLC reviewed data from 2013 through 2017 from Metro's spreadsheets, added data obtained from a request for public records from DEQ, and data from Grimm's complaint database, then consolidated duplicate complaint records and formed a single spreadsheet that was compatible with the original Metro list structure. Because the turning and inversion event in February 2018 created such extreme odor conditions, the 2018 complaint data through February were included in the spreadsheet.

Limitations to these data include: difficulty reconciling different complaint forms between the agencies and the company; the varying formats of the files obtained from DEQ; the lack of information often given by anonymous complainants; and occasionally mis-leading information given by complainants. While currently, Metro and DEQ share most complaint information between themselves and with Grimm's, this collaboration has evolved and was less consistent in the past. Additionally, the advent of the CASE group and use of NextDoor has resulted in complaints often being lodged with more than one agency either with or without inclusion of contacting Grimm's directly. Even so, the number of complaints over time presents a useful picture of the seasonality and locational nature of at least, the worst events and of the nature of the impact on the community.

4.1.2 Analysis of Historic Odor Complaint Data

Odor complaints and consistent documentation of those complaints is not just an exercise in paperwork. Offsite experiences of odors are valuable to the operator and regulator in multiple ways. Odor complaints often describe abnormal odors that are not apparent on site. Jeff Grimm reported that neighbor complaints had alerted him to smoldering fires in certain piles, and alerted Clean Water Services and the City of Tualatin to a broken sewer line. Additionally, a pattern of complaints over time can alert an operator to operational issues such as seasonal spikes in microbial activity due to increased moisture from fall rains which indicate inadequate prior moisture and causing the pile to suddenly go anaerobic by sealing the pore spaces on the pile surface. Complaint volume changes can, however, be influenced by other stimuli such as neighbor communication or coordination that are not directly reflective of the odor source.

Analysis of the complaint data for Grimm's was undertaken to reveal patterns that could be useful in a recommended operational re-design. Observations and patterns found from 2013 through 2017 data included: increased complaints in September, October and November; and a slight to moderate correlation between pile turning and odor complaints. No correlation was found between complaints and incoming tonnage on a monthly or seasonal basis. Complaint volumes increased in 2016 and 2017, but over the period the increase has not been continual. Only 7 complaints were received in 2015. Jeff Grimm suggested in an interview that he remembered 2015 to be a dry year.

Within individual year data, particularly 2017, correlation between complaints and the 4 weeks following a turning event were evident. However, this correlation did not hold through the previous 4 years.

The following table summarizes information gleaned from those data and includes pile turning dates as reported by Jeff Grimm. The inconsistent correlation between the turnings and high levels of complaints was surprising. Over the 2013 through 2017 time period, of the 11 reported turnings[39] there were 7 spikes in complaints either during the month of a turning or the month after the turning. What is not explained is that the number of complaints had already been increasing over the month or two prior to 3 of these turnings. This contrasts with reports by numerous complainants, Grimm's manager, and Metro's inspector that the odors intensified "during" turnings. Additionally, GMT was onsite before and during the February 2018 turning and experienced the

[39] Per Jeff Grimm. Email 5-8-18 to Tamara Thomas / Terre-Source LLC

odor intensity during that event. Grimm's manager also reported sending notices to neighbors when they are about to turn the piles in order to prepare the community, although the dates of those notifications were not available. The complaint volumes don't appear to simply or directly reflect the turnings indicating that other factors were in play and that care must be taken in using the complaint data alone to reflect odors.

The following table 4.1-1 summarizes the number of complaints received by Grimm's, Metro and DEQ during particular months for 2013 through 2017. The third column shows the number of days for which the complaints were lodged. Often multiple complaints would be received about an odor experienced on the same day. This is useful, because it helps define the number of odor events rather than the number of complainants. Ultimately, an operator can only control odor events, not complainants. However, by reducing the odor events, both in frequency and in duration, complaint reductions should follow. Charts showing complaint data by month for these 5 years are presented in Appendix C-1. Since Metro took a major role in complaint tracking of Grimm's in 2017, the complaint data appeared more complete and consistently compiled.

Table 4.1-1

	Total # of Complaints	# Days referenced by Complaints	Highest # of Complaints in a month / month	# Months with >20 complaints	Turnings
2013	74	38	26/October	1 - October	~Apr, Sept
2014	33	20	9/May	0	May, Oct
2015	7	7	2/September	0	Apr, Oct
2016	109	67	27/September	2 – Sept, Oct	Jan, Jun, Oct
2017	162	92	32/October	4 – Apr, Sept, Oct, Nov	Apr, Sept
February 2018	92	22	91/February	-	Feb

4.2 Neighborhood Concerns

4.2.1 Structured Interview Development

An interview structure was developed by GMT and approved by Metro to obtain a descriptive range of information and opinions regarding lived experiences and concerns with odor impacts at each specific residence or business interviewed. Eighteen questions regarding odor impacts and other impacts and interactions with Grimm's Compost were prepared. These questions are listed in Appendix C-2.

Survey questions included confirmation of name, address, age decade, and description of any odors experienced and attributed to Grimm's compost facility. Figure 4.2-1 maps the location of each interviewee with respect to Grimm's facility.

Twelve participants were selected with input from Metro to represent as full a range of experience from Grimm's as was possible within the budget. Interviewees comprised an array of directions and distances from Grimm's compost pile, represented the CASE group, complainants, non-complainants, residences, and nearby businesses and institutions. A wide range of ages of interviewees were also documented. Participants represented such in the following manner:

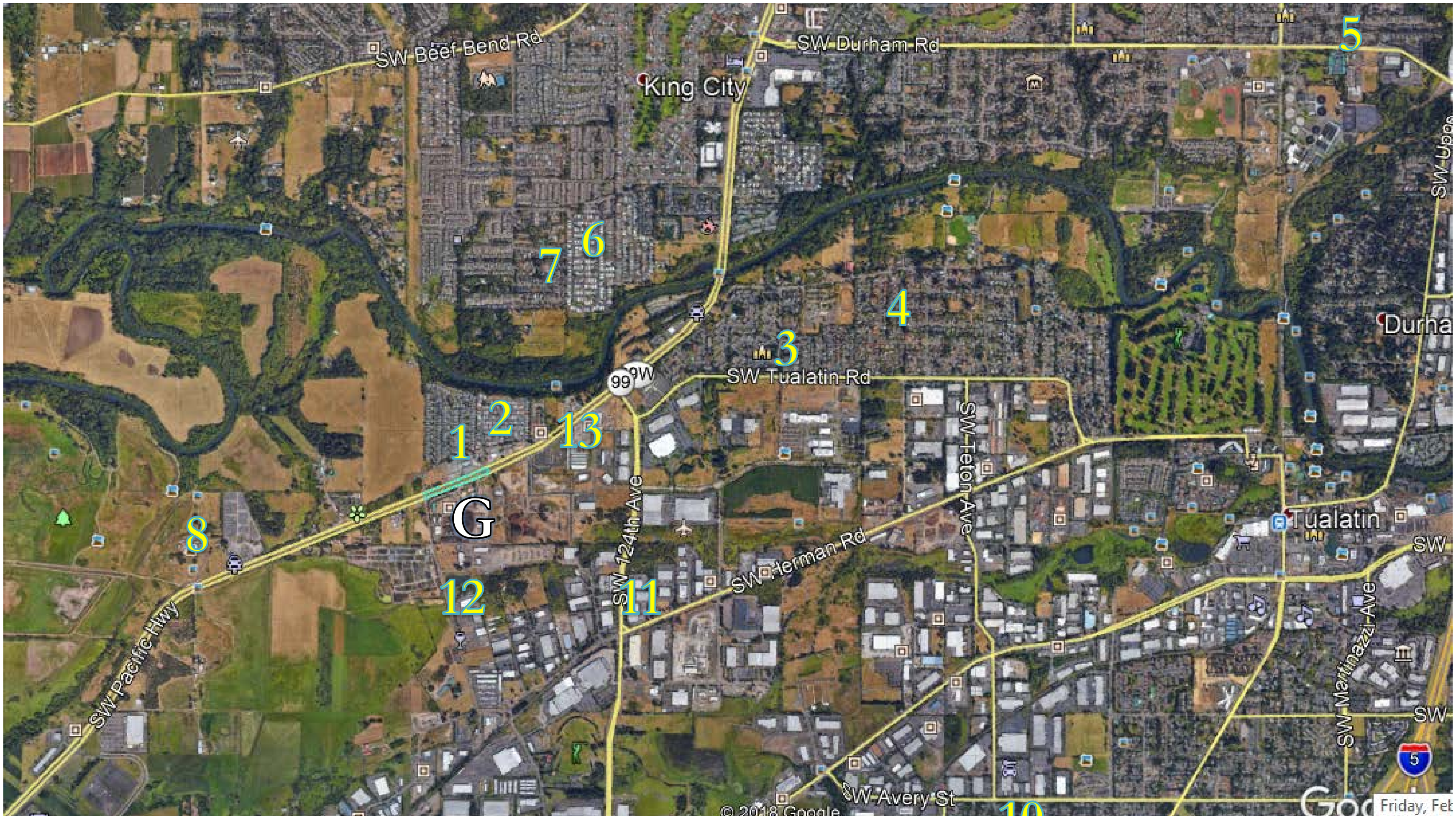
- 3 CASE representatives (Pony Ridge, Angel Haven, Hazelbrook)
- 1 non-complainant from Hazelbrook – via phone book
- 1 complainant in the King City Area
- 1 non-complainant in the King City Area (El Dorado Mobile Village)
- 1 complainant in Tigard (via Metro)
- Tualatin Valley Wildlife Refuge (representing W direction, institution)
- 1 non-complainant in Lafky Park area (representing SE direction, via Tualatin Elementary PTA)
- 3 additional businesses representing nearby S, SE, and NE directions
- 1 opportunistic location was added via the Office Manager of one of the businesses interviewed who lived less than 3 miles to the SW of Grimm's facility.

A breakdown of participant characteristics is shown in Table 4.2-1.

Each interview was initiated with the reading of the introductory statement:

"My name is Tamara Thomas. I am working with Green Mountain Technologies, who has been contracted with Metro to investigate and assess the community impacts from Grimm's Fuel Company's composting facility, which is located at the corner of 99 West and SW Cipole (sie-'poll) Road. We have reviewed complaint records and now are attempting to build an in-depth and accurate picture of individual experiences representing specific areas."

Interviews were conducted between March 2nd and March 29th. Terre-Source LLC performed all of the interviews for consistency. Interview responses were documented during the interviews and were compiled and analyzed resulting in a set of participant response impressions which was quantified by impact scoring in order to compare types and areas of higher versus lower impacts.



ODOR SURVEY PARTICIPANT LOCATIONS

1 CASE Pony Ridge	6 North – King City random	11 BUSINESS – SouthE – Suburban Door
2 CASE Angel Haven	7 North – King City complainant	12 BUSINESS – South – Sonic Audio
3 CASE Hazelbrook	8 BUSINESS – West – T.V. Wildlife Refuge	13 BUSINESS – NorthE – G.H.McCulloch
4 Hazelbrook - Random	9 2.85 mi SW – Sherwood – random	G GRIMM'S COMPOST FACILITY
5 NorthE – Tigard 1x complainant	10 ESE – Lafky Park – random	

2.8 miles

9

4.2.2 Structured Interview Results

Interviews were documented in real time and edited immediately afterward to prevent loss of content. Participants were extremely helpful and respectful. All of the people contacted (even those randomly selected from the telephone listing for address) agreed to answer the survey questions and added context voluntarily.

All of the participants had heard of Grimm's compost and were aware of some issues around odor. While performing the interview, the concept of whether the odor came from Grimm's or not came up only once. All of the other participants were sure of what they were smelling and attributed the odor they experienced to Grimm's. One participant reported never noticing the odor at his business (although he later qualified that statement as never noticing it "being bad"). He was still aware of what Grimm's smelled like from driving past the facility.

General survey response impressions:

- Wide variety of concern with odors – from fear of health impacts to extreme inconvenience to not at all concerned with any aspect.
- Wide variety of understanding of what Grimm's facility does and what if any impacts the business has on the community – Ranged from "landfill" to "I don't know" to experience with taking their and their neighbor's storm debris there and purchasing Grimm's compost over multiple years.
- Wide variety of appreciation of compost – from not knowing what it is, to loving the material and producing their own compost in their backyards.
- Impacts seemed to be as much direction related (predominately to the north and northeast) as distance related. Adverse impacts were also much more strongly felt at residences than businesses.
- Several people mentioned a difference in experience based on wind direction and temperature.
- Several people attributed the odor to the height of the pile. Reports gave the impression that the height itself was as much of a problem as the odor.
- Several people expressed anger that they felt Grimm's was flaunting the rules such as fire department pile height limit, or "getting away with" something such as avoiding upgrading to more high-tech system.
- Those who were concerned about the odor, predominately mentioned fear of health impacts and fear due to unknown nature of the content of the odors.
- One person mentioned concern for birds in the wetlands adjacent to the facility that might be experiencing contaminated run-off.

In order to quantify the documented experiences so that some relative conclusions might be gleaned from the very few interviews possible, a scoring system was used on the interview results. The system assigned 1 point for any of the following responses:

- Frequency greater than 12x per year (once per month[40])
- Intensity greater than "moderate" from description (highly subjective)
- Expressed "concern" over the odors beyond just smelling bad
- Attributed 'dust' or any other impact beyond odor, to the facility
- Interviewee made changes to their lives or activities to adapt to odors

By this technique a maximum impact score of 5 could be given to each interview and location. These impact scores were averaged over the particular grouped interviews as shown in Table 4.2-1. The actual scores are not statistically valid, but only indicators of relative high, medium or low as labeled.

Based on these scores, neighbors to the north and northeast appeared to be most impacted, although that appearance may be at least partially due to the fact that the highest density residential areas are closest to the north and northeast. Residences (versus businesses) also appeared to be most severely impacted, and most sensitive to impact, again potentially due to the fact that to the north and northeast, there are more residences and fewer businesses. The small sample size does not allow for any statistical analysis.

Table 4.2 - 1
Participant / Location Characteristics

Participant Description	# Participants or Locations	Average Dist to Grimm's Pile	Average Impact Scores
CASE Participants	3	0.5 mi	High 4.7
All Complainants	5	1.1 mi	High 3.6
Non-complainant residences	4	1.8 mi	Low 1.0
All Non-complainants	8	1.2 mi	Low 1.0
Businesses	4	0.5 mi	Low 1.0
Residences	9	Incl. Dupl. Participant: 1.4 mi	Medium 2.4
All	**Range: 0.2 mi - 2.9 mi**	**Average: 1.1 mi**	Medium **2.0**

[40] Although far from a consensus, at least one participant was quite clear that if the odor was only once (i.e. less than 1 day) per month, she would not be concerned.

Direction from Grimm's:	# Participants or Locations	Distance Range from Grimm's pile (average dist)	Average Impact Scores
N	4	0.2 – 1 mile (0.6 avg)	High 3.5
NE	4	0.5 – 3.1 miles (1.5 avg)	Low 1.8
W	1	0.8 miles	Low 0
SE	2	0.5 – 1.9 miles (1.2 avg)	Low 0.5
S	1	**0.2 miles**	High 3
SW	1	Duplicate participant 2.9 miles	Low 1
Participant Age	Range: 20-70s	Average age: 48	
TOTAL	**12 participants**	**13 locations**	

4.2.3 Description of Experience of Odors

The experiences reported by the participants were highly varied and provide a good snapshot of the range of impacts from these odors on multiple types of exposures. Although (especially within the CASE group) similar phrasing was used, likely because of their communication over time regarding these odors, the impacts on each participant was quite individual. That said, the shared experience appears to have brought some communities together. Besides CASE, several participants mentioned "NextDoor" (https://nextdoor.com/), an internet based, private social network for specific neighborhoods from which they got information and reported many discussions about the Grimm's odor issue.

The varied responses from the survey participants reflected the transitory and variable impacts of the odors. The responses also indicated a situation in which, although the odors were noticed and identified broadly, the most intensely negative impacts appear to have been experienced in a relatively focused location with respect to direction and distance. In those focused areas, however, the impacts were severe, frequent, inescapable, unpredictable by the participants, and on-going over a very long period of time. The participants, both in and out of the most impacted areas, that reported having smelled the odors at their residences the longest, reported noticing it for 20 years or longer, and reported that the odors were increasing in intensity.

Multiple participants reported "heavy", "sickly sweet", "nauseous" odors, described as either "sileage", "garbage"-like or "sewage" as well as "bark dust" or generally "rotten" including "dead animal". A "rotten egg" odor was mentioned, as was "chemical" and "rancid shea butter" and "diaper pail". While some of these descriptors are useful, describing odor characteristics is a difficult and not widely shared ability. Several participants, knowing what the odor was from, described the odor as "decomposing organics" or "rotting vegetation". Because odors are so closely linked to emotional states, the description of an odor may say more about the recipient's emotional relationship to the odor than to its actual character. Those with the most negative experiences may also describe the odor as being similar to very negative, pejorative materials such as sewage, garbage, or dead animals.

The permeating nature of the odor was mentioned by several of the most impacted participants relative to the odor getting into their houses or into their clothes and hair. One participant reported that when the odor was bad they might leave the area to eat, but that the odor would follow him because it had attached to his mustache.

Impacts on those residential participants in the closest northern and northeasterly locations from Grimm's piles included:

- Going outside less;
- Irritation, anger at inability to stop the 'encroachment',
- Reduction of time given to outdoor hobbies such as walking, gardening,
- Reduced exercise associated with staying indoors,
- Less enjoyment of fresh air from open windows,
- Fear of health impacts of unknown odor content,
- Embarrassment with respect to social interaction leading to increased isolation – not wanting to invite friends and family to their homes,
- Reports of increased allergic reactions, and
- Fear of reduced property values.

Some of those same impacts were experienced by participants further from the most impacted area. One participant reported she rented out part of her house through Air BnB and feared getting a negative review that would impact her income from that activity. She also expressed concern that with the publicity associated with the odors that her property value might fall.

Only 1 business interviewed reported any impact beyond noticing an odor occasionally. They refrain from opening their bay door when the wind sends the odor their direction resulting in less air circulation / ventilation. Generally, businesses and the people interviewed at their business, as well as casually questioned during our site visits in early February, were less concerned with the odors. Workers that were encountered did not notice or mind the odor and attributed it to some other source such as "the pet store next door might be cleaning their cages".

The experiences described by the most impacted participants combined with the widespread nature of the odor impacts and corroboration of the experience by GMT contributed to our determination that mitigating the on-going nature of these odors is necessary. A number of source control options are presented and discussed in sections 6 – Alternatives and Options, 7 – Recommendations, and 8 – Conclusions.

5 AIR QUALITY DATA COLLECTION AND ANALYSIS BACKGROUND

Open pile burn bans for high population areas of Washington County were implemented in 2015. Wood smoke from open pile fires contributes particulate pollution, toxic harmful air pollutants including: benzene, formaldehyde, acrolein and polycyclic aromatic hydrocarbons (PAHs).[41]

In response to this limit on open burning, local private companies and municipalities have taken on the challenge of managing this expanded waste stream, which requires keeping it separated from mixed garbage, investing in machinery, property and structures that are close to the people they serve. When impacts like malodors are created from these changes, further work and development needs to be done to hold onto the gains being made in reducing air pollution.

By many accounts, odors from Grimm's have been increasingly impactful over the past five years. The local public, the government and the company are focused on solving these malodorous issues to maintain the important community value gained from the burn ban and to keep and expand the processing capacity and environmental and economic benefits that have been achieved so far.

5.1 Odor Audits

GMT performed three site visits to collect information on odors and emissions from Grimm's composting. Various measurements were taken around the facility, on several piles, near the Pony Ridge neighborhood, across the river in King City, near Hazelbrook, and within the City of Tualatin in the surrounding valley.

The first visit was January 31, 2018 prior to turning activities on the large static pile. This was intended to obtain an understanding of the normal levels of impact versus the reported increase in impacts during a turning event. The second visit took place during the turning event on February 7th and 8th, and the third on February 21st following the turning.

Typically, Grimm's monitors upcoming weather patterns and does large pile turning when an east wind is likely in order to minimize impacts on its nearest neighbors. Due to the extremely large fall leaf volume and a lack of ideal wind conditions over the prior month, Grimm's decided they must turn the pile when the conditions were not favorable but forecasted to improve. They informed Metro and the GMT team of the expected turn date.

Based on that information GMT visited the site on January 31st to make general odor observations around the facility and emission measurements on the undisturbed composting pile to represent "normal" conditions. The following Monday, February 5th, Grimm's began turning the pile although the forecasted weather conditions did not materialize. The GMT team arrived on-site on February 7th and 8th, 2018 to take odor observations, quantifications, and mid-turning emissions

[41] USEPA. https://www.epa.gov/burnwise/wood-smoke-and-your-health. Downloaded 5-14-18.

measurements on the disturbed pile surface and on the finished compost pile located on a separate parcel as well as to make DT measurements throughout the neighborhoods during the turning.

The last visit GMT made was on February 21, in order to replicate and re-measure pile surface emission measurements using equipment modified to better collect VOC data under condensing conditions.

5.1.1 Field Audits

5.1.1.1 NEIGHBORHOOD ODOR INTENSITY QUANTIFICATION (DILUTION TO THRESHOLD-DT)

The Nasal Ranger® Field Olfactometer was used to measure Dilution to Threshold (DT) levels. DT is the number of volumes of clean, odor-free air that would be necessary to dilute one volume of actual site air to the level at which the monitoring person could just detect the odor. The instrument does not measure specific compounds, but allows a human receptor (nose) to measure the intensity of a detected odor[42] in a relatively objective fashion. This measurement provides a basis for comparison of the relative strength of offsite odors.

This field method was not intended to determine a specific compound's existence or compliance level but rather to measure the total odor load presented to the inlet of the olfactometer at multiple locations in the vicinity of Grimm's. A benefit of this system is the observer's ability to distinguish between different odors during the monitoring. This minimizes the potential of different odors confusing the data and also allows the addition of odor characterization notes. The team was, therefore, able to focus on the recognizable odor characterization from Grimm's during the monitoring and decide if the odors likely were generated there. The downside of this system is the reliance on a human nose to detect the odor. Different people have different sensitivities to odors that must be taken into consideration for this testing.

Blind sensitivity testing of the Nasal Ranger operators was performed on both team members prior to arrival on the site using N-Butanol testing pens. This screening provided a relative level of odor detection sensitivity that is important to do if multiple people will be performing the measurements and to check periodically to ensure consistency. Both team members measured the same level of sensitivity prior to the second site visit. The Nasal Ranger Kit comes with N-butanol odor testing pens to do a blind nose sensitivity test. This was done for both Tamara Thomas and Jeffrey Gage the morning of February 7th, and both tested out to be in line with average sensitivity.

[42] An identifiable odor may be made up of tiny quantities of many different compounds. However, currently equipment that will measure an "odor" versus a single configuration of chemical molecules are not practicably available.

The Nasal Ranger® Field Olfactometer creates a calibrated series of discrete dilutions by mixing the odorous ambient air with odor-free (carbon) filtered air. Field olfactometry defines each discrete dilution level as a "Dilution-to-Threshold," DT, ratio. The "Dilution-to-Threshold" ratio is a measure of the number of dilutions needed to make the odorous ambient air "non-detectable". The Nasal Ranger has 6 discrete dilution levels (2, 4, 7, 15, 30 and 60). The larger DT means more dilutions are needed to make an odorous puff non-detectable. An odor DT of 2 is just noticeable, while is DT of 30 or more is considered objectionable. Field olfactometry calculates the "Dilution-to-Threshold" (DT) ratio as:

$$DT = \frac{\text{Volume of Carbon-Filtered Air}}{\text{Volume of Odorous Air}}$$

GMT's first visit odor monitoring tour was performed prior to a planned turning event by Grimm's. Michael Bryan-Brown and Jeff Gage arrived on January 31st, 2018 in the morning. The weather was cold and lightly overcast. Odors were observed at the Tualatin River bridge and at the river walk. The odors were noticeable but light, estimated at 7 DT, and variable and soon disappeared by the time all our equipment was out and ready for sampling.

GMT drove further down and turned into Fischbuck Road and SW Pacific Drive which had a very noticeable smell at the open lot on that corner, due north of the Grimm's compost pile. Three instruments for odor and gas sampling were used: a Nasal Ranger for Field Olfactometry; a confined space multiple gas meter called a MultiRAE Plus, which provides pumped air across a sensor array; and a second older gas meter called a QRAE Plus. All three instruments were used. There were no measurable gasses in the ambient air, several readings were taken with the Nasal Ranger at that location. Several neighbors stopped and introduced themselves while the Team was taking the first readings. The field olfactometry level at that time measured 15 Dilutions to Threshold ratio, or 15 DT.

On Monday February 5th, Grimm's began turning Pile 1 towards the screener. Strong odors were reportedly released, and complaints began rolling in. Tamara Thomas / Terre-Source and Jeffrey Gage / GMT drove down Wednesday morning as scheduled, and smelled Grimm's while southbound on I-5 approaching the Nyberg exit (approximately 3.1 miles from the site). The morning of February 7th was cold and foggy, The Team was joined by Kent Norville / Air Sciences, Inc. at the Starbucks next to Haggen at Tualatin-Sherwood Road and Boones Ferry (approximately 2.3 miles from the site). Grimm's distinctive odor was detected at that shopping center. A DT reading of 15 was made at 10:00am just as the fog lifted, the wind shifted, and the odor moved away.

The Team met with Duane Altig and Hila Ritter / Metro at Grimm's at 10:00am and proceeded to the effected neighborhoods to measure the odor impacts. The neighborhood readings included Pony Ridge and Hazelbrook. Odors were fleeting, making accurate measurement difficult. Even with Metro receiving real-time odor complaints, by the time the Team arrived at the complainant's location (within 15 minutes), the odor measured <2 DT or was not detectable. Odors were detected at Pony Ridge and later measured at Hazelbrook neighborhood where the DTs ranged from 4 to 30. The full analysis of the DT and the locations found and not found for the 7th and 8th in the neighborhoods are in Appendix D-1 and were used in the dispersion modeling.

GMT spent most of the day on February 8th doing a complete neighborhood odor survey, visiting all of the roads to the properties surrounding the site, and taking readings with the Nasal Ranger if any odor was noticed, and described the odor. While most of the readings documented Grimm's odors, several were from the lumber mill and one from the nearby swamp.

Odors moved throughout the day and several circumnavigations were made to keep up with where they were going. The odors were distinctive where they were found, and as the day wore on and winds picked up, they became more elusive and lighter the farther from the facility. In the early afternoon odors were found in the King City neighborhood across the river. A map of the pathways and waypoints along with some pictures of the neighborhood odor survey are shown below.

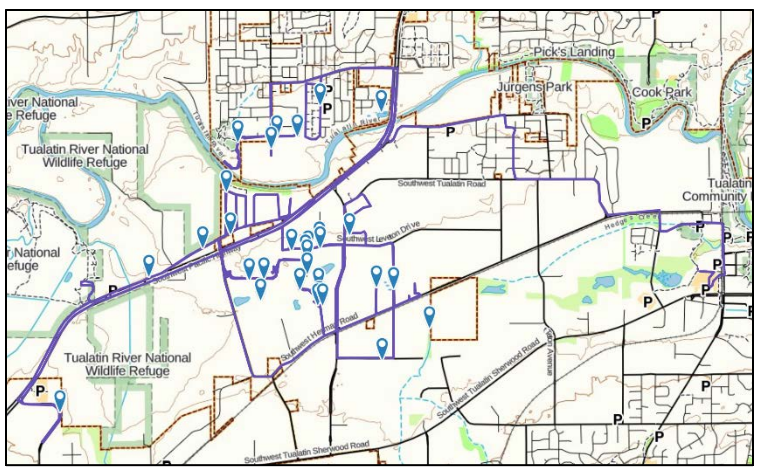


Figure 5.1-1 – Locations of DT Measurements on 2-8-18

When smelling for an odor over a long period of time, the nasal receptors tire or "blind" to the smell and you become less sensitive. This odor blinding occurred during the turning event on several occasions. The Team ran the neighborhood tests prior to the piles tests when possible and adjusted the neighborhood measurements to leave a strong odor plume after some time to maintain sensitivity as long as possible. Team clothing was double bagged, and a thorough cleaning of the inside of the car and sampling gear was done the night after pile sampling and prior to morning neighborhood inspections. The odors were easily found the morning of February 8th as they shifted across the neighborhood, maintaining sensitivity until pile sampling began later in the day. Day 2 of pile sampling blinded the teams noses fairly quickly, making it difficult to determine any kind of reasonable detection limit, after being on the pile for 30 minutes or more.

5.1.1.2 AIR SAMPLING EQUIPMENT AND METHODOLOGY

MultiRAE in situ, confined space gas sampling equipment was used to take multiple samples while avoiding significant laboratory and shipping costs. Confined space gas monitors are used throughout industrial activities and have achieved a high level of sensitivity and dependability even in challenging working environments. The instruments are intended to be carried by a worker into an enclosed space like a tank or a sewer manhole to monitor whether the air presents a hazard to the worker and to warn the worker as levels reach excessive or dangerous levels. Typically, they contain 4 to 5 sensors and a pump to pull air past the sensors.

Sensors can be chosen to fit the most likely compounds of interest, and typically include the percent oxygen (O2), the level of methane before it gets to the Lower Explosive Limit (LEL), which is reached at 20% by volume of the air, the amount of carbon monoxide, which can be elevated around internal combustion exhaust, and hydrogen sulfide, which is a poisonous gas that can be biologically generated. Some of these gases can be monitored using a Photo Ionization Detector which allows volatile organic compounds (VOC) to be measured. These five sensors (oxygen, methane, carbon monoxide, hydrogen sulfide, and VOCs) were chosen for this project. In addition, two more detectors were available to GMT and used. An ammonia sensor and a sulfur dioxide sensor were added to a rental detector to provide redundant measurements between the two instruments and to provide the desired sampling listed in the RFP.

Two methods of gas sampling were performed on the piles to observe differences between the gasses that lay beneath the surface of the pile, and those that were coming off the pile surface materials. The gas sample taken with hollow probe two feet below the surface is commonly used to sample and identify the below surface composting conditions. The subsurface sample can be used to help diagnose corrections to a composting system. The gas samples taken from the surface used a modified plastic bussing tub with a steel testing stack to measure velocity and volume of the gasses coming off the surface. This allowed identification of changes occurring as gasses moved through the top layer and reveal what the neighbors are exposed to on an ongoing basis. The tests were run side by side at each location at different locations on the pile.

During the pile sampling below the surface oxygen levels were expected to reach below breathable air requirements and methane to be above the Lower Explosive Limit (LEL), so the alarms and warning sounds were switched off in the program set up at the rental shop. These units record the levels of each compound sampled over the on-time for the unit with a date and time stamp enable looking back at trends or to replace written data.

The monitors only provide the concentration of the compounds pulled through their sampling tubes. To estimate the amount of these compounds released or calculate a flux rate, the airflow coming off of the pile must be measured. The flux rate can be measured using a hood placed on the surface and a stack to concentrate the flow with an air velocity meter to measure the speed of the air exiting the stack. This approach works for aerated composting systems or biofilters that have air flowing through them, but it was apparent after several attempts that there was inadequate air flow from the surface of the pile to be measured. Instead the edges of the tub were left exposed to allow the wind and convection currents to provide a reading. This was not accurate, however and the area under the hood cannot be used as a multiplier. The concentrations were probably valid as the replacement air coming under the exposed edge was directly from a surface similar to the one under the tub. While GMT believes the concentrations measured in the air to be accurate, the flux rate is not usable except in areas on the pile surface that were actively venting steam.

Figure 5.1-2 – Pile Emission Measuring Equipment

During the first two sampling events, it was noticed that the VOC readings were unexpectedly low. The instruments were recalibrated and the manufacturer contacted. It was discovered that the MultiRAE instrument experienced two issues which put the VOC readings in question.

First, desiccant gel filters were used to counteract the pile humidity and condensation impact on the VOC readings. Those filters, it was determined, absorb heavy, polar VOCs and amines (ammonia derived VOCs) predominately. The filters were removed prior to the 3rd site visit. However, the VOC readings taken on January 31 and February 7th and 8th are assumed to be reduced from actual totals present.

Second, methane was reported to reduce the PID response of these instruments. Thus in the readings with methane measured at 1% or more [equivalent of 20% LEL], the VOC reading was reduced. The impacted VOC readings are flagged in the reported data in Appendix D-2 and must be assumed to be impacted and therefore underreported.

5.1.1.3 PILE ODOR OBSERVATIONS / CHARACTERIZATION

On the first visit, observations made on-site while walking the site looking for all the potential odor sources noticeable at ground level included major sources of malodor: the large compost pile and the small pile of mushroom substrate located in the receiving pit area.

Very strong odors were observed on the pile with a wide variety of characteristics including: citrus, pinene, terpene, and "rotting logs". See Appendix D-3 – Odor Characteristic Wheel. The surface odors were found to be substantially more pleasant than the sub-surface odors in character. Once sampling from within the pile began, using the sampling pumps, the odors changed substantially in character to "oily rag", "chemical", "paint thinner", and "icky", which were determined to be coming from the anaerobic conditions encountered 2-feet below the surface.

Finally, as the Team was leaving the site that first day, a slight burning smell was identified in one spot indicating smoldering near a buried concrete column. These were all identified and described at various locations on the pile during sampling. The Nasal Ranger field olfactometer provided readings of 15, 60+, and 30 DT at various locations over the pile prior to the turning event.

Odor observations were made on top of the active pile during the turning event, but the odors were so strong that human noses were fairly quickly "blinded" to the odor. Even so, the quality of odor on the pile was noted to change dramatically. The normal musky, socks odor was replaced by a strong citrus/strawberry odor at one point on the pile during the sampling.

5.1.1.4 PILE EMISSIONS MONITORING

Pile measurements were taken on the afternoon of the pre-turning visit using the Nasal Ranger and the MultiRAE to characterize the odors and determine what differences there might be between the large compost pile surface and subsurface. The older QRAE meter did not respond to the fresh air calibration tests and was not used that first day. Pile monitoring data are presented in Appendix D-2.

Conditions just 2 feet below the surface indicated anaerobic conditions with methane reaching over 20% of the air by volume, or over 100% LEL for methane, which was the limit of the testing equipment. However, NO hydrogen sulfide was detected on the meters even though it was expected to be produced under anaerobic conditions. Oxygen levels below the surface never exceeded 10% and commonly were found to be 0.0%, and the surface oxygen levels were never below 16% as expected. There were modest amounts of carbon monoxide below the surface in the range of 2 to 103 ppm with the surface ranging from 3 to 32 ppm.

VOC readings were always higher above the surface than they were below the surface due most likely to the methane interference issue in the subsurface readings as discussed above.

Below the surface readings ranged from 1.2 to 2.1 ppm and 3.5 to 7.5 ppm from the surface collection tub.

Based on the low oxygen and high methane measurements, the composting system below 2 feet deep was mostly anaerobic, however the low VOC's and non-existent hydrogen sulfide were not as expected. GMT returned the confined space meters to the TTT Environmental gas monitor rental shop and had them checked for calibration. The old gas meter had sensors that were out of date. All four gas sensors were then replaced and calibrated. The newer gas meter tested out perfectly within the expected test gas parameters +/- 10%. New Ammonia and SO2 sensors for the MultiRAE Plus were installed and tested prior to the second sampling visit on February 7th and 8th.

Feb 7th: GMT returned to the piles and began doing sub-surface and at surface readings using the full sensor array in the areas being moved by D-9 Dozers. The DT levels all exceeded the 60 DT upper limit of the Nasal Ranger and this unit was quickly put aside to focus on the gas meter pile readings.

The gas readings from the February 7th pile sampling event showed much higher surface readings from where the pile was disturbed than on the January 31st undisturbed pile readings. VOC's went up from an average of 4.7 ppm to 11ppm on the surface. Carbon Monoxide (CO) went up on the surface from11.3 ppm to 90 ppm. Oxygen below the surface went up from 3.8% to 6%. Ammonia (NH_3) and Sulfur Dioxide (SO_2) were not sampled on the first day as the sensors were not available at that time. On the second sampling day, the difference in sulfur dioxide was surprisingly low between the surface average of 6 ppm and the below surface average at 2 ppm. Ammonia Emissions were a complete zero for all sampling points, and yet again the hydrogen sulfide (H_2S) readings were zero everywhere, which is very is unusual. The lack of ammonia does make sense if there is a neutral pH and little or no manures in the mixture being sampled.

The afternoon of February 8th, GMT performed measurements on top of the finished compost pile due East of the active compost piles. Finished pile odor conditions were much improved, with all DT at non-detect, confirming the first day site walk around. This is despite the more pronounced anaerobic conditions below the pile. Only 0.13 ppm SO_2 was measured below the surface.

The last day of sampling was on February 21st, 2018, two weeks after the pile turning event. There was a small amount of snow on the ground and Grimm's had started to place a wood chip biocover over the top 1/3rd of the pile using a chip blower truck. Samples were taken over the wood chip cover and over areas without wood chip. As shown in

Table 5.1-1 – Biofilter Surface Testing on Pile 2-21-18

Grimm's Fuel 2/21		VOC	
Pile 3	No Chip	60.9	ppm
Pile 3	With Chip	35.5	ppm
Pile 4	No Chip	43	ppm
Pile 4	With Chip	17	ppm

Table 5.1-1 there was a noticeable reduction of 42 to 60% in the amount of VOC's emitted through the chip layer versus the pile without a chip cover.

Pile sampling performed on February 21st (3rd visit) used no water absorption gel cartridges. The VOC levels were substantially higher without the absorption cartridges. Although the subsurface VOCs were still impaired by the methane in the subsurface readings. DT with the Nasal Ranger measured from 15 to 60 over the pile depending on the location. The strongest odors were at the steaming vents.

5.1.1.5 PILE MONITORING RESULTS

GMT found there was a persistent, high strength odor measured using a field olfactometer being released from the large pile surface prior to turning from 15 to 60 DT, and that there was a noticeably higher malodor at concentrations much higher than our field olfactometer could measure [greater than 60 DT] being released during the turning event.

Using a confined space gas monitor, GMT found that the conditions two feet below the surface were predominantly anaerobic along the ramps and top portion of the piles, with some slightly more aerobic conditions near the outer edge of the piles. Carbon monoxide levels were low overall but were elevated in spots that may indicate smoldering below the surface. The most interesting finding was that there was no hydrogen sulfide except in one probe sample, and that at a very low level. Ammonia was extremely low, well below the expected levels which may be due to the leaf mold feedstocks from fall being tested. The methane LEL sensors were at 100% for many of the below the surface samples, but were about half those levels as the gasses came out of the pile, likely due to some treatment occurring in the upper oxygenated layer of the piles.

Table 5.1-2 Average Pile Surface Emissions vs Subsurface Emissions

Grimm's Compost Pile	**O2%**	**CO ppm**	**H2S ppm**	**LEL% / %methane**	**O2%**	**NH3 ppm**	**LEL%**	**VOC * ppm**	**SO2 ppm**
Subsurface Average	3.9%	128	0.05	54% / 2.7%	4.4%	0.03	81% / 4.0%	3**	2
Tub (Surface) Average	11.9%	40	0	24% / 1.2%	17.6%	0.1	43% / 2.1%	15*	3

* potentially impacted by desiccant
**impacted by methane interference

Finally, GMT found evidence that the temporary wood chip cover had some effect on reducing VOC levels coming off the surface of the pile. Levels between 42% to 60% lower were measured from the sections of the pile that had wood chips placed over the top.

The pile sampling data are presented in Appendix D-2.

The data showed clearly that the pile was anaerobic two feet below the surface of the ramps and tops of the pile. It also showed that there was oxidation of the methane in the outer layers of the compost pile, illustrated by the fact that contrary to the subsurface readings, levels at the surface of the pile rarely reached the lower explosive limit. The oxidation performed by the aerobic rind, therefore, is partially mitigating the negative effects of the anaerobic pile. The data also showed that there was little or no hydrogen sulfide being produced within the piles, which was unexpected. Further inquiry into the literature indicated that hydrogen sulfide can be efficiently reduced to elemental sulfur by bacteria in a biologically active anaerobic layer of soil or compost if nitrate is available to support the bacteria that can reduce hydrogen sulfide into Sulfate[43].

VOCs were found to be higher on the surface than below the surface and are assumed to be the bulk of the odor compounds which are being emitted from the pile[44].

5.1.2 Dispersion Modeling

Dispersion modeling provides a means to estimate the amount of dilution that occurs as a plume of odor is transported downwind. To support this dispersion modeling, GMT and its sub-consultants conducted odor sampling in the neighborhood around the Grimm's facility (described above). This sampling occurred over three days, two of which were during the active pile turning the week of February 5, 2018. The odor sampling measured the "dilutions to threshold" (DT) value, which is the number of volumes of clean (odor-free) air that would be necessary to dilute one volume of site air to the level at point that an average person could not identify the odor.

Using the modeled derived dilution factors and the downwind observed DT values, a DT level at the downwind edge of the Grimm's compost pile was then estimated. This pile edge DT provides an indication of the strength of the odor generated at the pile. It can then be used to estimate spatial extent of the potential impact to the nearby community and provide estimates of the amount of reduction in pile odor would be needed to substantially reduce the input to the nearby community.

Results of the modeling and field measurements indicate that the Grimm's facility is inflicting odors on the surrounding community, as far as over 2 miles away, especially under light wind conditions. The modeling indicates that considerable reduction of the pile DT (from over 1000 to down to 30) is needed to reduce the impacts to the nearby community. The dispersion modeling was performed by Air Sciences, Inc. (ASI) whose report is presented in Appendix E-1.

5.1.2.1 FIELD MEASUREMENTS:

Odor sampling was conduction using The Nasal Ranger® Field Olfactometer. The Nasal Ranger is the "state-of-the-art" in field olfactometry for confidently measuring and quantifying

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[43] Daoroong Sungthong. 2010. Doctoral Thesis. Control Of Hydrogen Sulfide Emissions Using Autotrophic Denitrification Landfill Biocovers. University of Central Florida. Available for review upon request to UCF.

[44] Kumar et al. 2011. Volatile Organic Compound Emissions From Green Waste Composting: Characterization And Ozone Formation. Atmospheric Environment 45 (2011) pgs. 1841-1848.

odor strength in the ambient air. A Nasal Ranger creates a calibrated series of discrete dilutions by mixing the odorous ambient air with odor-free (carbon) filtered air. The Nasal Ranger has 6 discrete dilution levels (2, 4, 7, 15, 30 and 60). The larger DT means more dilutions are needed to make an odorous puff non-detectable. An odor DT of 2 is just noticeable, while is DT of 30 or more is considered objectionable. As an observer moves towards the odor source, the DT will increase.

The location and magnitude of the sampling is shown in Figure 5.1-3. This sampling occurred over three days: January 31, February 5, and February 8. The latter two days of sampling occurred during active pile turning. On all three of these days of sampling, winds were calm (less than 1 mph), as indicted by the weather station at the Grimm's site and at the Hillsboro Airport. These calm wind conditions occur about 20 percent of the time. During such events, plumes from the pile can slowly meander downwind and not diffuse effectively, causing a significant odor impact. These conditions can lead to odor complaints well downwind of the facility. The average wind speed, as measured at Grimm's, was 1.5 m/s (~ 3.4 mph).

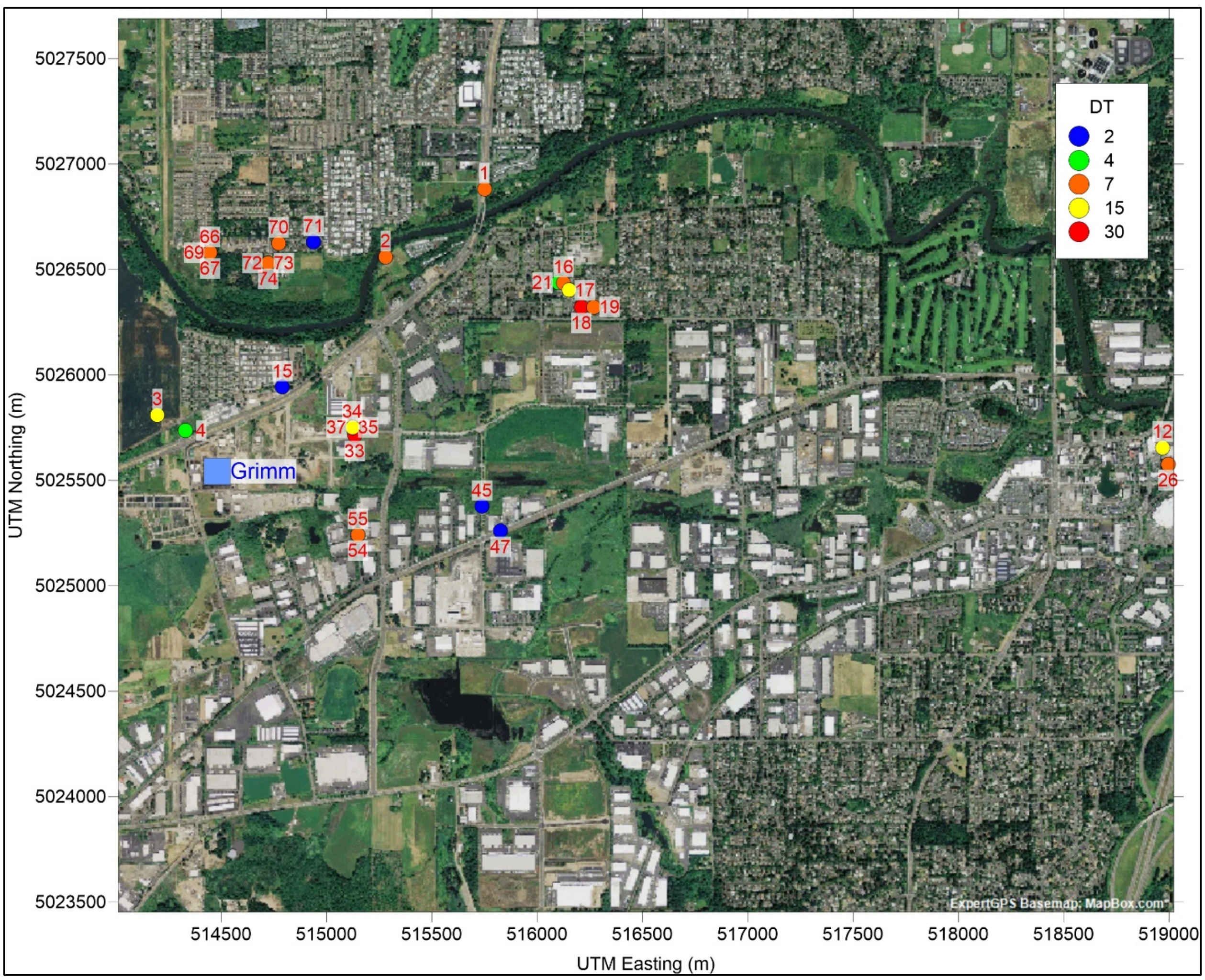

Figure 5.1-3 Location and Intensity of Odor Field Measurements

5.1.2.2 DISPERSION MODELING

Atmospheric dispersion modeling is a technique for estimating odor concentrations that are caused by emissions from a source. While it is not possible to fully model the complexities of the atmosphere and the exact transport and dispersion of an odor, a series of mathematical models have been developed from empirical and theoretical studies to reliably estimate downwind concentrations. For this analysis, U.S EPA's AERSCREEN model was used. AERSCREEN is a single source dispersion model designed to provide a conservative estimate of downwind concentrations from the source, without the need for hourly meteorological data. It includes several source types (point, volume, area, circular area, and flare), will generate receptor arrays, incorporate downwash (if applicable), and setup the meteorological data. It can calculate a conservative 1-hour average concentration at receptors downwind of the source.

For AERSCREEN, two wind speeds were considered: calm and average wind. To represent calm conditions, the lowest allowed wind speed was used (0.5 m/s). These calm conditions were prevalent (20 percent of the time). For average conditions, a wind speed of 1.5 m/s was used.

The pile was modeled as an elevated circular area source, with a diameter of 40 meters (130 ft) and an average pile height was 43 feet (13.1 m). Receptors (an evaluation point) were placed down wind of the pile to determine the concentration, from which the DT is calculated. One receptor was placed on downwind edge at the very top edge of the pile (X = 41 m, Y = 13.1 m) to determine the impact on the top of the pile. Ground level receptors were then placed downwind of the area at nose level (6 ft) at regular intervals out to several miles. The model was run using a unit emission rate of 1 g/s to get the receptor concentrations. The dilution factors (DF) were found as a function of downwind distance by dividing the elevated pile edge concentration by the ground based downwind distance concentrations. Then, for each field DT observations over 2, the pile edge DT was back-calculated by multiplying the field DT by the appropriate diffusion factor (DF).

5.1.2.3 RESULTS

For each field observation with an DT over 2, a pile DT was calculated. Figure 5.1-4 shows the pile DT for each field sample. Only calm conditions were used to derive the pile DT values. Since DT readings span a range of possible values (e.g., a DT of 7 could anywhere between 7 to 15), the range was shown to bracket the estimate. For January 31, pile DT values range from 19 to 400. Turning was not occurring on this day so it represents a "typical" winter day. Note that DT measurement taken on the pile during the late afternoon ranged from 30 to 60.

On February 7 and 8, active turning was occurring. Pile DT values were considerably higher, ranging from 62 to 1916 DT. Note that any single DT back-calculation is subject to considerable uncertainty as the exact plume location is highly variable under the calm wind conditions. The values on Feb 8 are likely too low as plume tracking was more difficult on that day. At best, the measurement will likely underestimate the pile DT.

For a "typical" day, the pile DT was assumed to be the mid-range of sample #1 (pile DT = 278). For a "turning" day, the pile DT was assumed to be the mid-range of sample #12 (pile DT = 1437).

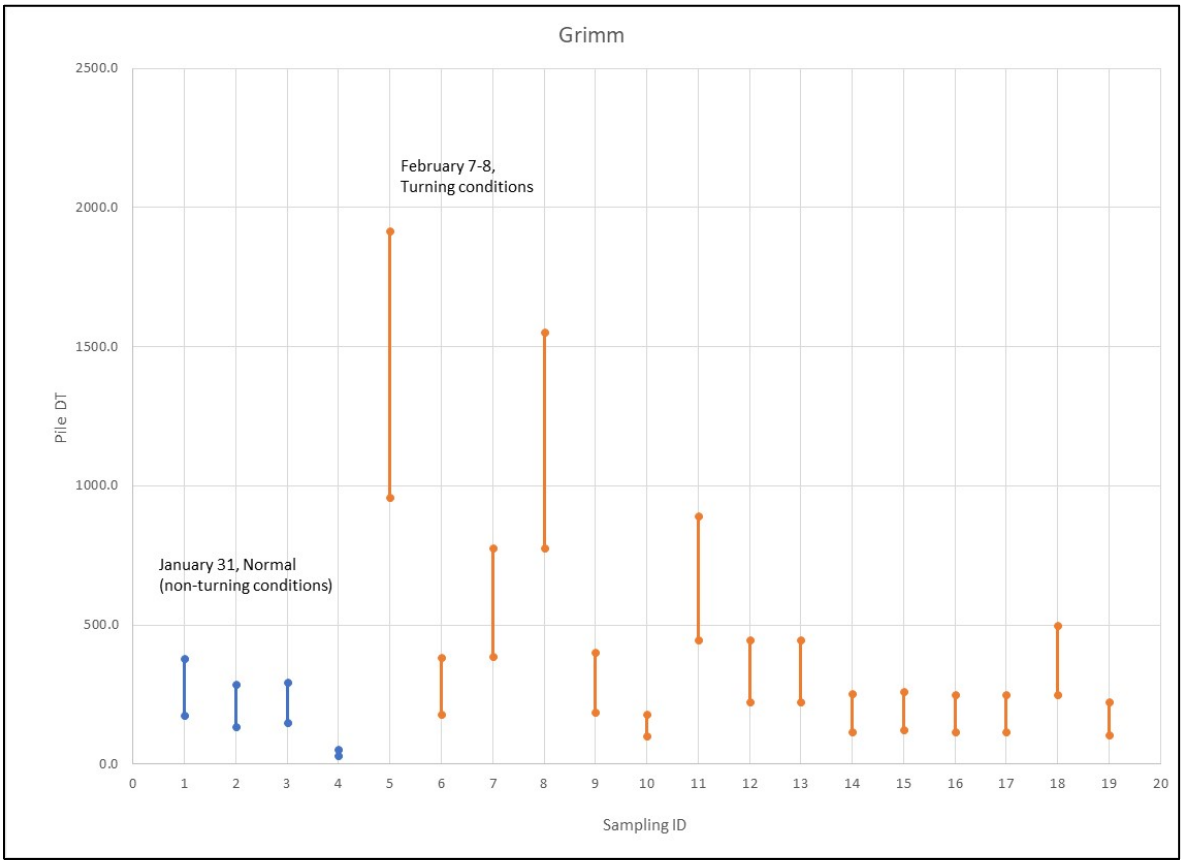

Figure 5.1-4 Pile DT for each field sample greater than 2 DT

Using these pile DT, an estimate of the area impacted by the facility is shown in Figure 5.1-5 for both calm and average wind conditions. Turning activities result in substantial impacts (DT ≥ 30), extending out to almost 3.5 kilometers (2.2 miles) from the facility under calm conditions and out to 1.1 kilometers (0.7 miles) under average winds conditions.

For the "typical" (non-turning) conditions, substantial impacts (DT ≥ 30), extending out to almost 375 meters (0.25 miles) from the facility under calm conditions For average wind conditions, dispersion is sufficient to keep DT under 30. These results indicate that the Grimm operations, as currently configured, are having a significant impact in the nearby community.

The nearest residential location is approximately 300 meters from the center of the pile. At this distance, the diffusion factors are about 8. Thus, to keep the offsite DT under 10, the pile DT would need to be reduced by roughly a factor of 18, to a DT of 80 or less.

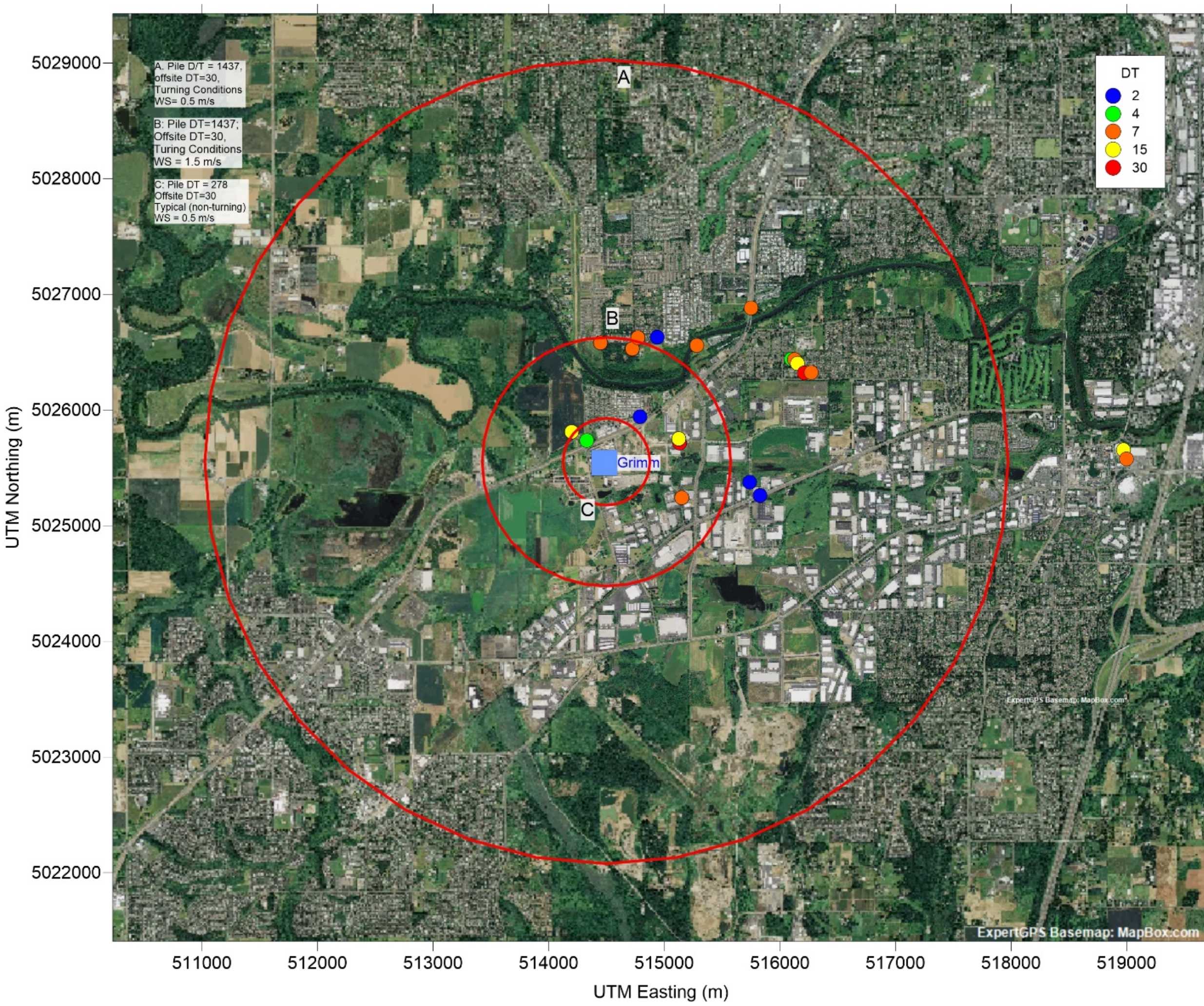

Figure 5.1-5 Circles of Significant Impact (DT ≥ 30) under Turning and Typical conditions

5.2 Greenhouse Gas & Emissions Analysis

Greenhouse Gas emissions are considered to be approximately balanced in a well-managed compost system. Carbon within the organic materials is aerobically degraded which emits mostly carbon dioxide and water. The environmental benefits of composting arise from the avoidance of methane and nitrous oxide production in a landfill or other non-aerated disposal, as well as the environmental benefits of compost use in soils. This GHG avoidance, however, is minimized in a facility in which the materials are allowed to become anaerobic and the bacteria continue to break down the organics utilizing anaerobic metabolism that emits methane, water, reduced sulfur compounds, and reduced nitrogen compounds including nitrous oxides. Methane is estimated to exert approximately 21-times the Global Warming Potential of carbon dioxide on the atmosphere. Nitrous oxide is estimated to provide approximately 310-times that of carbon dioxide.

It is apparent that composting only helps with greenhouse gas emissions IF it is managed aerobically. An aerobic compost process generates almost 94%[45] less methane than an anaerobic process. GMT's pile emissions screening targets for Grimm's compost piles included methane (as approximately by %LEL) to indicate the impacts of that pile on greenhouse gas emissions. A good general discussion of the impact of composting on greenhouse gases is provided by the US Composting Council and is presented as Appendix D-3.

Methane levels above the surface of the piles at Grimm's were varied and averaged 43% LEL, which translates into 2.2% methane by volume of air. Methane samples pulled from approximately 2-feet below the surface often reached the LEL saturation of the sensor of 20% methane by air volume (100% LEL). The average reading at 2-feet below the surface was 81% LEL, or ~4% methane of the total air volume. There was a 53% reduction in methane from the 2-foot depth to the surface. However, this average underestimates the actual methane in that zone due to the 20% upper limit of the instrument. Literature reports of methane in similar situations upwards of 90% have been measured by researchers[46]. Anaerobic digestion biogases usually generate on the order of 60% by volume of air. A German compost greenhouse gas emission study[47] measured air surrounding windrows using a wind tunnel. They showed that as concentrations of methane increased to 16% of the air volume in the pore space of the windrow, the emissions were nearly 80g methane (Mg waste)-1 per day.

At Grimm's, the more aerobic 'rind' may also be reducing the amount of methane emitted from the mass. This is due to the surface conditions that develop with microbes that eat methane in the top layer of compost. If the methane concentration is low below the surface they can remove almost all of the methane leaving the surface, however if the concentrations are high, the piles still release methane to the atmosphere. Grimm's is still releasing methane to the atmosphere.

Nitrous oxide is usually only generated from composting piles as they get older, and is generally associated with manure-based composts that are high in nitrogen. Green waste composts usually show no significant nitrous oxide emissions. However, if food waste is added to green waste composting then the nitrous oxide levels can double, making a fully aerobic system much more important.

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[45] Nguyen Thanh Phong, 01. August 2012
http://hss.ulb.uni-bonn.de/2012/3002/3002.pdf

[46] Sanchez, A. et al. 2015. Chapter 2. Greenhouse Gas from Organic Waste Composting: Emissions and Measurement. In CO2 Sequestration, Biofuels, and Depollution. Lichtfouse, Schwartzbauer, Robert (Eds). Springer. XIII. 388 p.

[47] Nguyen Thanh Phong, 01. August 2012
http://hss.ulb.uni-bonn.de/2012/3002/3002.pdf

The greenhouse gasses measured on Grimm's piles are expected to decrease by over 90% from current conditions in a forced aeration composting system.

Table 5.2-1 – Greenhouse Gas Pile Emission Results

GMT Emissions Evaluation		Grimm's Fuel		OLD PGM 2000-E		NEW PGM 6228	
ID#	Date	Location	Surface Flow fpm	O2%	LEL%	O2%	LEL%
Probe Average	**1/31/2018**	**Compost pile**				**3.82**	**78.80**
Tub Average	**1/31/2018**	**Compost pile**				**16.30**	**63.25**
Probe Average	**2/7/2018**	**Compost pile**		**6.98**	**71.17**	**5.96**	**72.86**
Tub Average	**2/7/2018**	**Compost pile**	**0.43**	**17.42**	**40.50**	**17.61**	**32.79**
Probe Average	**2/21/2018**	**Compost pile**		**4.80**	**91.27**	**3.38**	**90.27**
Tub Average	**2/21/2018**	**Compost pile**	**0.82**	**18.38**	**32**	**18.82**	**33.3**

Average of all Pile Samples		
80.64	**Probe % LEL**	
43.11	**Tub % LEL**	
53%	reduction at surface	

6 ALTERNATIVES AND OPTIONS

6.1.1 Alternative Development

Analysis of the limitations of Grimm's Compost technology with respect to odor generation and processing efficiency guided the development and selection process of four alternative compost technology designs. Primary observations included the anaerobic environment below about 2-feet on the active composting piles. Strong odors were experienced that were explained by the anaerobic nature of so much organic material. Consequently, the first goal of any compost technology applied to this facility is that it must provide adequate aeration to maintain aerobic conditions throughout at least the active compost phase.

The next most important observation with respect to community odor impacts was the height of the active compost pile which exceeded the surrounding buffer and was visible to many in the Pony Ridge and Angel Haven neighborhoods. The height of the pile reflected the increasing volume of organic material being handled at the facility, raised the source of the odors to a position that was directly in line with neighbor receptors, and provided conditions --- to spontaneous combustion. To optimize aeration, minimize dispersion of odors, and minimize fire potential, all of the alternatives developed will not exceed 12- to 14-feet in material height.

Neighborhood odor complaints indicated and reflected higher odor impacts during turning events. This observation was recognized by Grimm's operator and at least partially confirmed by examination of the formal odor complaints over the past 5 years. This observation corresponds with traditional approaches to compost odor management, that recommend minimizing disturbance of the organic materials during the initial active phase. The alternatives developed will not include windrow technology that would require 5 turns within the period of time that the composting material remains above 131°F. Alternatives developed for evaluation only include fully mechanically aerated systems that will not disturb composting materials during the first 20-days of aerated composting.

Additionally, biofilter technology is a well-established standard of the compost industry for odor control for composting. All systems proposed will include some type of biofilter or biocover for odor control.

To optimize efficiency of any aeration system, material preparation that increases porosity within the composting mass will be recommended. Depending upon the system and technology the optimum porosity will be determined, and this processing will be part of the operational requirements of the technology.

Finally, Metro's objective is to find a technology that will manage at least the existing volume of incoming feedstock, as one of their goals is to increase the Region's waste reduction and recycling capacity. All of the alternatives developed meet or increase the volume processing capacity of the existing facility.

With those criteria in mind, the GMT team developed 4 compost design alternatives for evaluation as presented here:

6.1.2 Alternative Descriptions

The alternatives developed for consideration are all developed as improvements over the existing turned pile technology with respect to odor generation primarily, but also with respect to process efficiency and expected final product quality, although that is determined to a great extent by secondary processing steps. Other designs may be developed, but these four offer a range of options from fairly simple and standard of the industry, to very site specific and to a system offering the highest level of control, efficiency and expansion.

6.1.2.1 ALTERNATIVE 1: AERATED STATIC PILE BAY CONFIGURATION, POSITIVE AND NEGATIVE AERATION OPTIONS WITH BIOFILTER

The Aerated Static Pile in a Bay Configuration is the most common style of Aerated Static Pile used to reduce the operating footprint, provide controls for controlled aerobic conditions, and optimize the composting capacity. These systems can be constructed relatively inexpensively with pipes on-grade using negative aeration, such as at Nature's Needs in North Plains, OR or using positive aeration, such as at Cowlitz County Compost in Longview, WA. This16-aeration zone system with 25,000 cubic yards total in-place capacity over a minimum of 40 days, turning once to re-water and consolidate, provides a maximum throughput of 274 tons per day, or 100,000 tpy.

- This design uses negative aeration during the first 20-days of composting and treats the collected air through an engineered biofilter (North side). The pile is then turned and re-watered and placed on a second, 30% smaller, aeration system that uses positive aeration only (South side) with a biocover added. Biocovers are irrigated to keep the surface moist and to maintain odor scrubbing capacity. A biocover must be applied during negative aeration to insulate the surface to achieve PFRP. If food waste is added, the biocover will control bird or rodent attraction. Dust is managed by watering materials as they leave the grinder and using a mobile oscillating dust suppression system during turning events. Asphalt pavement is recommended to keep the center alley clean.
- A schematic of the alternative design is presented in Appendix F-1.
- The proposed implementation timeline is 6-months to complete the transition from the current system to the proposed system. A recommended transition procedure is to relocate pile 3 and the north bit of pile 4 into the sunken area immediately to the North and then add the biofilter, blowers and a back push wall for the nine new northern aeration zones. Then, as materials are removed from the east side of pile 2 into pile 4 to be screened, new materials can be added with pipes placed underneath in the area under pile 2, and the new aeration system can begin to be filled as new materials are ground, continuing westward until all 9 northern zones are filled with active compost. Finally, the south aeration system can be installed behind a push wall, and the materials removed from pile one, and the older compost from the north piles turned, re-watered into the new southern ASP system. Then materials from pile 3 can be screened.

Asphalt can be laid after the piles are removed to pile 4. Six months total time is possible to complete the transition with minimal disturbance to current operations.

- This system is estimated to cost ~$800,000 for the blowers and pipes for the north with biofilter and south with no biofilter. 510 concrete blocks to cost $47,600, pavement for asphalt 6-inches thick is estimated to cost ~$400,000 over 100,000 square feet. The area mister is estimated at ~$45,000. Relocating the discharge of the stacking conveyor 40-feet to the north is also required. Total Cost ~$1.3 million.
- Capital cost per ton = $4.27/ton. Calculation uses 50,000 tons per year as this matches the past 5-year average flow rate to divide the expected depreciation life for each type of construction or equipment even though actual capacity is almost double this.
  - 5 years for pipes and blowers and controls; $800,000/5 years = $160,000/year
  - 7.5 years for portable/mobile equipment mister; $45,000/7.5 years = $6,000/year
  - 10 years for site improvements/utilities/paving/blocks; $476,000/10 years = $47,600/year
- These systems have been proven to manage food waste using negative aeration to a biofilter for odor control and biocovers to limit vector attraction.

6.1.2.2 ALTERNATIVE 2: RADIAL AERATED STATIC PILE (rASP) DOUGHNUT CONFIGURATION, POSITIVE AERATION ONLY

The rASP Doughnut Configuration is an innovative GMT patent pending rearrangement of the ASP Bay configuration that uses a Telescoping Radial Conveyor that eliminates double handling by a loader and greatly improves the porosity of the built piles and the depth and consistency of the biocover. Because of these features, this system can be operated in a positive aeration direction even with food waste. This reduces blower electricity costs, assures the correct placement of biocovers, and eliminates loader costs for one step of the process. Loaders are still used to remove the 20-day old pile for re-watering and consolidation. This is also a pipe on-grade system and has a similar capacity of 26,000 cubic yards in place and processing capacity up to 280 tons per day over 40 days.

- This system provides a superior biocover odor control system up to 18-inches deep over the whole surface, which also provides insulation required to meet PFRP. Dust control is easier as re-watering is done on the feed hoppers and conveyors. A Mobile oscillating area mister is still needed to reduce dust during loader movements Asphalt is not necessary but is still recommended to improve site cleanup and water quality.
- A schematic of the proposed alternative is presented in Appendix F-2.
- This system will take about the same time to develop as the first alternative, however the construction time for the conveyor is at about 6 months according to the manufacturer. Assuming it takes one month to place and start up the commission the telescoping conveyor, this will take seven to 8-months to transition and install this alternative.

- The cost for this system is estimated to be ~$400,000 for asphalt pavement 6-inches thick over 100,000 square feet, $700,000 for the blower system and pipes, $500,000 for the telescoping conveyor, $240,000 for the mulch hopper feeder with watering system and $45,000 for the area water mister. Total cost ~$1.9 million.
- Capital cost per ton = $5.80/ton. Calculation uses 50,000 tons per year as the past 5-year average flow rate to divide the expected depreciation life for each type of construction or equipment. This is less than ½ of the actual system capacity and is conservative.
  - 5 years for pipes and blowers and controls; $700,000/5 years = $140,000/year
  - 7.5 years for portable/mobile equipment mister; $785,000/7.5 years = $104,600/year
  - 10 years for site improvements/utilities/paving/blocks; $453,700/10 years = $45,370/year
- This system is designed to manage food waste as normally operated.

6.1.2.3 ALTERNATIVE 3: STRUCTURE COVERED AERATED STATIC PILE SYSTEM WITH EXPANDED SITE PERMITTING

This is the Cadillac of composting systems. It is designed to be operated indoors for the first 20 days of composting and after that is operated on an aerated curing floor with a roof only. A biocover must also be utilized during this phase to insulate the surface to achieve PFRP. All aeration pipes are located below a concrete surface, so no pipe handling is required improving the efficiency of pile construction. The aeration system is both positive and negative giving superior temperature control and the oversized biofilters (about one acre) treat all of the indoor air. The piles are turned every 6- to 8-days and re-watered using a mobile compost turner. Finished cured product can be made in 47-days all under a roof so there is no leachate generated from rainfall. It is the best system for encroaching neighborhoods and expanding site capacity. 31,000 cubic yards capacity with a processing capacity of up to 337 tons per day over 40 days. A similar system has been in operation at the Compost Factory in Puyallup Washington since 1999 alongside residential communities and businesses. Due to the constructed enclosure, this system cannot be easily expanded.

- Being fully enclosed, for the first 20 days, there is no dust impact from turning and odors are minimized to what the biofilter efficiency can achieve, usually over 95% reduction in odor.
- Schematic of the proposed alternative is presented in Appendix F-3.
- The time line for a building construction project like this can be over 18-months to 2-years (assuming the land use approvals were in place) including engineering, permitting and construction. However, since the location of this facility would be on a separate parcel from the existing system, the transition would be much easier and impact to the business during construction would be minimal.
- Costs are Estimated at $14,000,000 for the building, blowers and biofilters and an additional 1 million dollars for 2 compost turners with hose reels. Total cost ~$15 million.

- Capital cost per ton = $17.87/ton. Calculation uses 67,160 tons per year as the average flow rate the building can hold to divide the expected depreciation life for each type of construction or equipment. Actual capacity is almost double that at 123,000 tons per year, so this is conservative price per ton.
    - 5 years for blowers and controls; $1,300,000/5 years = $260,000/year
    - 7.5 years for portable turning equipment, hose; $600,000/7.5 years = $80,000/year
    - 10 years for site improvements/utilities/paving; $400,000/10 years = $40,000/year
    - 15 years for buildings, pipe concrete floor $12,300,000/15 years = $820,000/year
- This system is designed to handle food waste as is.

6.1.2.4 ALTERNATIVE 4: AERATED STATIC PILE SYSTEM WITH EXPANDED SITE PERMITTING AND IN-GROUND AERATION

This alternative provides the advantages of easier operation due to the in-floor aeration system (which removes the requirement of pulling aeration pipes prior to moving material), and provides the reversing aeration from Alternative 3, and the outdoor operation and biofiltration with biocovers of Alternative 1. This alternative has no building but can operate with similar controls to a recent installation at the 27th Ave Compost Facility in Phoenix, Arizona. The design is located on the eastern Parcel #2100, which necessitates expansion of the Conditional Use Permit similar to Alternative 3, but is more reasonably priced due to avoidance of the high cost of a structure. This alternative also enables expansion of the facility to accommodate future demand.

- This design offers high level of flexibility in aeration, turning, and processing volume. Aeration can be performed in positive or negative modes and provides external biofilters to the south of the 3 extended aeration piles. Turning can be minimized to 1 or 2 turns using a loader following the first 20-days of composting, or turns can be increased more efficiently with face-turning equipment and a hose reel that (following the first 20-days) turn the rows in a progressive manner which although increases handling, also minimizes the time required to achieve a finished product. The facility can be constructed in phases of 60,000 tons per year up to 120,000 tons per year assuming 47 days on the composting aeration pad. The external biofiltration is used for the first 20 days and reversing aeration allows for more effective moisture and temperature control, increasing the capacity. Biocovers are irrigated to keep the surface moist and to maintain odor scrubbing capacity through the initial 20-days. A biocover must be applied during the initial 20-day phase to insulate the surface to achieve PFRP. Dust is managed by using a mobile oscillating dust suppression system during turning events. Water is added during turning. Asphalt pavement to keep the alleys clean.
- A drawback of not having a building is that water will come in contact with compost and under heavy rainfall generate leachate and wet piles. Leachate treatment and storage is not

estimated in this cost estimate. An expanded leachate collection pond may be desired for this alternative.

- A schematic of the alternative design is presented in Appendix F-4.
- The time line for this Alternative's construction can be performed within 6-months to 1-year (assuming the land use approvals were in place). Because the location of this facility is completely separate from the existing system, the transition would be much easier and impact to the business during construction would be minimal.
- This system is estimated to cost $550,000 for 1 compost turner and a hose reel and $45,000 for a mister system; road pavement for $373,200; The concrete aeration system is estimated to cost ~$2.9 million per 60,000 tpy (164 tpd) capacity with 2 sections built, the estimated cost is $5.8 million for the 120,000 tpy capacity (328 tpd). Leachate treatment and storage is not provided in this cost estimate. However exposed pavement is minimal. Note that the system may be expanded in 60,000 tpy increments, and a system built initially to 180,000 tpy is expected to cost approximately $11 million.
- Capital cost per ton = $8.30/ton. Calculation uses 89,618 tons per year as the half peak capacity flow rate. This is used to divide by the expected depreciation life for each type of construction or equipment that totals $744,320 per year made up of the following:
  - 5 years for pipes and blowers and controls; $1,200,000/5 years = $240,000/year
  - 7.5 years for compost turners, hoses, mister; $595,000/7.5 years = $80,000/year
  - 10 years for site improvements/utilities/paving; $373,200/10 years = $37,320/year
  - 15 years for pipes and concrete floor $5,805,000/15 years = $387,000
- This system is designed to manage food waste using negative aeration to a biofilter for odor control and biocovers to limit vector attraction.

6.1.3 Alternatives Evaluation

The primary goal of this project was to determine approaches to help relieve the burden of odors experienced by Grimm's nearest neighborhoods. Because these alternatives were developed to achieve Metro's goals, ALL OF THE ALTERNATIVES ARE DESIGNED TO MITIGATE THE ODOR IMPACTS ON GRIMM'S NEIGHBORS.

The performance factors by which to rank each alternative.

The evaluation of these 4 Alternatives serves to inform Metro and the reader of this analysis of the benefits and limitations of the alternatives with respect to the performance factors and goals listed in Metro's RFP (as shown in Appendix A-1). Primary to each alternative development was the goal of dramatically reducing odor impacts beyond the facility boundary.

The site assessment performed as described in section 3 above, showed that the greatest contributor to the off-site odor impacts appear to originate from the anaerobic active piles located on parcel #1900. These high piles not only generate odors due to the anaerobic core, they are physically tall, which places the surface closer and in line of sight (and smell) of the Pony Ridge neighborhood to the north. While other processes, such as grinding and screening may contribute to the odors, the pile turning that occurs several times per year is reported to be the most odor inflicting activity based on most complainants. The increased volume of materials handled necessarily on the same footprint (See section 7.4 - Consistency of Land Use Options) not only increased the pile heights, it increased the length of time needed to complete a 'turn' of the piles.

All of the 4 alternatives recommended lowering the active composting piles to a maximum of 14-feet (from 45- to 50-feet observed in February 2018). All of the alternatives developed utilize state of the art, engineered, forced-aeration technologies with varying types of biofilters for treatment of off-gasses. All of the alternatives can and should be operated to maintain oxygen levels within the piles above 10% oxygen (unlike the existing system that cannot, at anywhere near current volumes, be operated to maintain that level of oxygen). All of the alternatives recommended are designed to operate more efficiently in terms of tons per day handled, which allows for lesser volumes on site at any given day than the volumes currently processed at Grimm's. This reduced volume and increased efficiency not only reduces the potential for odor impacts, but also allows for a more cost-effective operation for the operators.

There are downsides to each alternative, that are presented in the Evaluation below relative to each other. A downside to all of these options versus Grimm's existing system is the increase in power use required by the aeration systems. It is possible, however, that the power cost may be partially offset by reduced handling resulting in lower fuel costs for equipment time. That possibility remains to be completely assessed and will depend to a great extent on which Alternative is selected and how it is implemented.

Analyses of the Alternatives is performed by ranking each criterion relative to the other three alternatives by way of judging HIGH, MEDIUM, and LOW. The rankings were given 1 point for LOW (if it is the least positive ranking), 2 points for MEDIUM, and 3 points for a HIGH ranking (ifd it is the most positive ranking). Cost, for instance, given a HIGH ranking, would be given 1 point (least positive ranking), while Good Value for the money, given a HIGH ranking would be given 3 points (most positive ranking).

The Metro requested performance criteria are:

- ***Public Benefits of:***
  1. *Protecting human health*
  2. *Protecting the environment*
  3. *Getting good value for the people's money*
  4. *Commitment to the highest and best use of materials*
  5. *Adaptive and responsive to changing needs and circumstances*

6. *Ensure adequate and reliable services are available to all types of customers*

- ***Goal of increasing the Region's waste reduction and recycling efforts***
- ***Ongoing ability to evaluate the site operations and odor assessment.***

In addition to these criteria, the following parameters recommended by GMT are ranked for each Alternative:

1. Processing efficiency
2. Aeration efficiency
3. Yearly throughput capacity
4. Foot print / Efficient use of site
5. On-site volume reduction
6. Impact on Storm water use and generation
7. Operational Power requirement
8. Water needs
9. Cost
10. Regulatory / permitting requirements

6.1.3.1 EVALUATION RESULTS

The evaluation performed and displayed in Table 6.1-1 below resulted in showed that the final ranking of all 4 Alternatives were not widely spread. Alternative 4 was ranked most highly due to a combination of high performance on a number of criteria including flexibility, ability to provide for expansion, protectiveness against odor generation, and relative cost. However, all of the alternatives offer great improvement to odor control, material handling, and ability to achieve PFRP.

Table 6.1-1 ALTERNATIVES EVALUATION					
	Alternative One	**Alternative Two**	**Alternative Three**	**Alternative Four**	
Criteria	**ASP BAYS: + & - Aeration**	**ASP Doughnut: + Aeration Only**	**Structure: Covered ASP: - Aeration Exp. CUP**	**In-Ground ASP w/ +&- Aeration Exp. CUP**	**Notes**
Protecting Human Health	H 3	H 3	H 3	H 3	All options protect human health both on- and off-site
Protecting the environment / Reduction of emissions & odors	M-H 2.5	M 2	H 3	H 3	All options protect the environment. A-3 provides most control over odors and process parameters. A-3 and A-4 have the added advantage that they move the active processing slightly further away from the most impacted community. A-4 allows the most flexibility of processing, which can provide optimum impact reduction if used skillfully.
Getting good value for the people's money	H 3	M 2	M 2	M-H 2.5	A-1 is less adaptable to changing volumes as designed, but additional bays could be constructed if CUP allowed on adjacent parcels. A-3 provides most control, but at highest cost and highest regulatory impact due to requirement of expanded CUP. A-4 optimizes flexibility and expansion potential for less than double A-1.
Commitment to the highest and best use of materials	H 3	H 3	M-H 2.5	H 3	All options invest in proper management / recycling of organic materials. A-3 uses more materials due to structure installation.

Table 6.1-1 ALTERNATIVES EVALUATION					
	Alternative One	**Alternative Two**	**Alternative Three**	**Alternative Four**	
Criteria	**ASP BAYS: + & - Aeration**	**ASP Doughnut: + Aeration Only**	**Structure: Covered ASP: - Aeration Exp. CUP**	**In-Ground ASP w/ +&- Aeration Exp. CUP**	**Notes**
Adaptive and responsive to changing needs and circumstances	H 3	M 2	H 3	H 3	A-1 allows for expansion via addition of bays; A-2 would be more difficult to expand, requiring changing foot print and / or additional doughnut off parcel; A-3 if allowed could be expanded by adding buildings, but expensive. A-3 would be easiest to adapt to acceptance of food waste; A-4 allows most options for operation and expansion.
Ensure adequate and reliable services are available to all types of customers	H 3	H 3	H 3	H 3	All options provide recycling service to the region
Increases Region's Waste Reduction and Recycling efforts	M 2	M 2	H 3	H 3	All options allow for some expansion of composting volume and are equipped to handle food waste with addition of a tipping structure. A-3 allows for easiest addition of food waste composting. A-4 allows for easiest expansion for volume.

Table 6.1-1 ALTERNATIVES EVALUATION					
	Alternative One	**Alternative Two**	**Alternative Three**	**Alternative Four**	
Criteria	**ASP BAYS: + & - Aeration**	**ASP Doughnut: + Aeration Only**	**Structure: Covered ASP: - Aeration Exp. CUP**	**In-Ground ASP w/ +&- Aeration Exp. CUP**	**Notes**
Processing efficiency	M 2	H 3	H 3	M-H 2.5	A-2 provides minimal handling of materials, while A-3 and A-4 allow faster composting within a smaller footprint per ton of material and highest aeration and temperature control. A-4 could utilize different turning options, but as scoped will rely on loader turning which is less efficient.
Aeration efficiency	M 2	H 3	H 3	H 3	Positive aeration is the most efficient application of oxygen in a pile because it utilizes thermal diffusion & heat rise. But the ability to control the aeration positive and negative can provide the optimum composting efficiency.
Yearly throughput capacity	100,000 tpy M - 2	102,000 tpy M - 2	123,000 tpy M - 2	120,000 tpy (2 phases) H-3	A-4 is expandable to 180,000 tpy throughput
Footprint / Site Use efficiency (sf / ton)	H 3	M 2	H 3	H 3	A-1 requires less footprint due to lack of separate biofilter. A-3 requires highest footprint due to largest biofilter processing capability performed inside, which makes the efficiency very high. A-4 allows for highest processing capability per footprint.

Table 6.1-1 ALTERNATIVES EVALUATION					
	Alternative One	**Alternative Two**	**Alternative Three**	**Alternative Four**	
Criteria	**ASP BAYS: + & - Aeration**	**ASP Doughnut: + Aeration Only**	**Structure: Covered ASP: - Aeration Exp. CUP**	**In-Ground ASP w/ +&- Aeration Exp. CUP**	**Notes**
On-site volume reduction	H 3	H 3	M-H 2.5	H 3	All options provide increased process efficiency which allows incoming material to be processed more quickly and then sold. Reducing the time the material spends on site reduces the overall volume of material on site at any given time. Also the more quickly the first stages of degradation are reached, the less odor generating time is experienced.
Impact on Storm water use and generation	M 2	M-H 2.5	H 3	L 1	Rainwater falling on the A-3 structure may be treated as storm water rather than leachate. Water falling on the biofilter will be mostly absorbed, but any run off will be leachate. A-1 and A-2 will absorb rainfall, but any run off will be leachate. A-1and A-4 include larger areas for leachate generation.
Operational Power efficiency	M 2	H 3	L 1	M 2	Per ton, positive aeration utilizes less power to provide than negative aeration. A-3 would consume additional power to operate doors, lights, ventilation, as well as negative aeration.
Water needs efficiency	M 2	M 2	L 1	M 2	A-3 handling material in a building will require more added water per ton as rainfall will not reach the piles. A-4 offers most flexibility to utilize leachate generated on the pad, a pond may be needed, but would provide for water needs.

Table 6.1-1 ALTERNATIVES EVALUATION					
	Alternative One	**Alternative Two**	**Alternative Three**	**Alternative Four**	
Criteria	**ASP BAYS: + & - Aeration**	**ASP Doughnut: + Aeration Only**	**Structure: Covered ASP: - Aeration Exp. CUP**	**In-Ground ASP w/ +&- Aeration Exp. CUP**	**Notes**
Cost (OM estimates)	$1.3 M M-L – 2.5	$1.9 M M-L – 2.5	$15 M H - 1	$5.8 M (2 phases) M - 2	Note expanding the paved surface in A-4 will require additional leachate and stormwater handling which is not included in this cost. However, the room is available, versus if needed for A-1 or A-2. A-4 is expandable to 3 phases-180k tpy- ~$11M for all 3 phases
Regulatory / permitting requirements	M 2	M 2	H 1	H 1	A-3 and A-4 require CUP allowance of composting and resource recovery activities on parcels #2100 and #2202
SUMMARY TOTAL RANKING	**42**	**42**	**40**	**43.5**	

7 RECOMMENDATIONS

Based on the above investigation, GMT believes the best approach for Metro, Grimm's compost and the neighbors of this facility, is to implement one of the proposed Alternative composting technology upgrades as soon as possible. All of the factors leading to the untenable odor events in February of this year are still in place including: increasing demands on the facility to accept higher volumes of organic materials from the surrounding area, heightened sensitivity of the surrounding community and residents even further afield due to increased media awareness, and anaerobic conditions in the interior of the piles that increase in mass relative to the surface area as the pile size increases. In addition, the neighbors increasingly fear that another summer will be impacted by malodors from Grimm's facility as the weather warms and that time period approaches.

All of the alternatives will take time to construct and implement. Because of the permitting and extent of construction required for Alternative 3, the implementation would be on the order of 1-plus years rather than multiple months. All of the alternatives will require paving, and the complexities of constructing a facility within the foot print of the current pile system without shutting it down will be difficult. On the other hand, Alternatives 3 and 4 can be constructed without impacting the current operation and provide the highest level of environmental controls as well as the highest throughput capacity within the designs.

7.1 Recommended Alternative Design / Composting Technology

Based on the analysis of the Alternatives presented in section 6 above, GMT recommends installing an aerated static pile bay system similar to Alternative 4. This system provides the best processing capability and environmental controls and flexibility for operation and includes ability to expand. This system provides the ability to run positive aeration and negative aeration. It is designed to run in negative aeration mode with a biocover, directing off-gasses to a standalone biofilter, during the first twenty days, which covers the highest odorant generating phase of degradation. This Alternative provides the most odor control during that phase, after which the material is moved to a positively aerated bay covered with a biofilter. The move allows the materials to be mixed and re-wetted, which will likely generate a new increase in temperature prior to transitioning into a curing phase.

The system allows for in-row turning for the second phase that can decrease the processing time or it can be allowed to aerate in place which minimizes handling. The bays will be designed to aerate materials up to 14-feet in height. Just lowering the material surface (from existing) is expected to reduce dispersion of the malodors into the neighborhoods immediately adjacent and will reduce generation of dust as well as complying with the recent interpretation of the Oregon Fire Code. The aeration system will be designed to provide adequate aeration to all of the material in the bays such that optimum degradation can occur, and compost produced much faster than the current system, which reduces the volume of material on site at any given time without reducing throughput. This configuration includes the final equivalent of 4-primary bays and 4 secondary bays with a capability of processing on the order of approximately 180,000 tons of ground material per year.

The system is intended to be operated with more moisture than is currently being utilized in Grimm's static piles. However, as noted above, the expanded pavement will require additional leachate and / or stormwater management capacity which will need to be addressed during engineering design of the facility. This location does allow for the area to expand such a system unlike the existing footprint utilized for Alternatives 1 and 2.

7.2 Site Improvements

7.2.1 Capture and Treatment of Air Over Processing Equipment

During both grinding and screening there is an increased exposure of materials to the air. Currently the finished compost smells bad, and the fresh yard debris smells better. Once aerated composting systems are in place, the finished compost will smell good and the fresh yard debris will smell worse. No matter what, it is prudent to capture the odors from this processing equipment and send them through a biofilter or other odor treatment system. Hoods are easily installed over each processing point and each conveyor, except the drag chain feed conveyors. Pulling air from each of these enclosed spaces using a high-volume fan and directing it to a properly sized biofilter with an irrigation system will provide great reduction in the current odor emissions.

7.2.2 Removal of Relic Objects On-Site

GMT identified old concrete supports, barriers and steel equipment that will be in the way of complete use of the south side of the existing composting area. These are relics from the early 1990's and have not been useful in the current operations. Near this location, smoldering was detected on the first day of inspection in the pile set against the relics. This is common to have concrete blocks and pillars function as a conduit for air to dry and fan hot conditions in a static pile to the point of chemical oxidation, and fires, if it has not been turned for several months. GMT recommends that these materials be removed before paving or construction begins.

7.3 Objective Regulatory Tools

7.3.1 Odor Monitoring Tools for Metro's Regulators

Metro's RFP requested a recommendation for an approach to monitoring and determining unacceptable levels of malodors from the Grimm's facility, or any composting or other odor generating industry. There are several instruments that could be used. The simplest is a field olfactometer similar to the Nasal Ranger field olfactometer used by GMT for this assessment, although other brands are available. Metro would determine appropriate DT limits for certain locations in or near the facility and within the neighborhoods, along with training and practice of use by Metro's inspectors, real time compliance could be measured.

A more expensive option that has the advantage of being more automatic and consistent is the "electronic nose" such as OdoTech's eNose. Such artificial olfactometry has improved in recent years, but is still quite expensive[48]. The device is mounted in a set location from which it 'samples' ambient air at regular intervals and uses sensors to detect particular chemicals (versus an actual odor). The traditional difficulty with this technology has been that of detection limit. The human nose can detect multiple odors at much lower concentrations than the equipment could. This is changing, and automatic sensors are being increasingly used. OdoTech representatives contacted emphasized that while efficient, the device was not intended for use in a court of law and would not stand up to legal scrutiny as proof of non-compliance.

While odors are subjective as mentioned before, the intensity of an odorant can be measured utilizing the Dilution to Threshold concept applied to data collection informing the Dispersion Modeling described in section 5. An advantage to use of a human operated olfactometer to monitor odor is that the human can recognize a particular odor that is reflective of a particular source perhaps more accurately than a sensor, especially, which is likely, when that odorant is made up of a combination of volatile compounds. Chemical emissions can be detected, and numeric concentrations measured for that individual compound. Composting odors, like many others, are the result of the combination in a person's nose of very minute quantities of multiple different volatile compounds that merge to form the impression of the combined odor in their brain[49][50]. The combination of history, memory, experience, sensitivity and other qualities will influence the experience of the person detecting the odor. So, while a machine can be set up to measure a methyl-mercaptan, the actual odor coming from a compost pile may be a combination of methyl-mercaptan, pinene, and ammonia (just for example). The combination will not smell like any of the individual parts. And a human nose may be able to detect the combination at much lower concentration than a mechanical sensor, although technology is improving and bringing detection limits down.

Dilutions to Threshold (DT) can be measured using a field olfactometer that filters air from the environment in varying levels to the receptor which is the nose of the person monitoring. The Nasal Ranger manufactured by Saint Croix Sensory is the olfactometer used in this study. While it takes a bit of training and practice to obtain consistent and accurate readings, it can at least produce objective quantified odor intensity measurements, much more cost effectively. The instrument could be used by Metro inspectors either at the pile, or in the neighborhood and at the

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[48] Communication with OdoTech resulted in an off the cuff estimate of a typical system on the order of $30,000 for the instrument and a $2,000 per month monitoring fee. If only one "indicator" compound could be determined the instrument cost could be reduced to under $10,000, but the monthly fee would be the same.

[49] Kosmider, J Krajewska, B. 2007. Determining Temporary Odour Concentrations under Field Conditions – Comparison of Methods. Polish J. of Environ. Stud. Vol 16. No. 2. 215-225.

[50] SanDiego State University. 2007. Comprehensive Compost Odor Response Project Report. Integrated Waste Management Board. Sacramento, CA. Pub # 442-07-001. 171 pgs.

property line, to measure odor intensity. Nasal Ranger has two sets of cartridges that focus on high or low DT readings. The typical, low DT, measurements are desired for off-site monitoring. If it were determined to be preferable to monitor on top of the unimproved compost pile, the higher DT cartridge would be needed. The higher DTs would not be sufficiently sensitive to provide readings off-site.

Another instrument, the Scentroid SM100 Infield Olfactometer[51] provides a breathable compressed air canister and mask with a small measured air inlet valve that shows the DT setting. A regulator could carry this in a small backpack which would allow walking right up to the piles without getting 'nose blinded'. To avoid chasing odors throughout the neighborhood, using a high DT capable system would allow the regulator to stand on or near the odor source where odor is most concentrated and get a reliable reading.

What remains to be determined are the levels that are or are not acceptable in any given situation. Using the Dispersion Modeling results performed during this project on the current pile configuration and an assumed acceptable odor level of 10 DT in the neighborhoods, a DT of "80 or less" at the pile would be required[52]. A discussion of these levels and re-modeling based on the different size and height and location of a future compost configuration should be performed to determine a target DT at the future pile(s) to achieve the desired result. A recommended process would be to: 1) implement an improved composting technology, 2) use the newly designed configuration and odor generating surfaces back in the Dispersion Model and confirm with additional DT measurements and 3) re-calculate the maximum DT that could be generated from those surfaces that would result in a DT of 10 or less in the neighborhoods of concern. Additional detail of a plan of action could be laid out by GMT's team if contracted to do so.

7.3.2 Other Regulatory Tool Options for License / Permit Requirements

A series of regulatory recommendations related to aerobic composting and monitoring were devised based on GMT's experience with facility monitoring and regulatory requirements that have worked well. Such recommendations include:

- Oxygen monitoring should be above 10% at all locations in the pile to ensure aerobic conditions for composting microbes. Oxygen probes used should be a minimum of 4-feet long or monitoring ports could be devised to allow measurement at locations further into the pile.
- Maximum pile height – active composting materials should not exceed 14-feet (including the biocover thickness) to minimize the opportunity for spontaneous combustion and to allow efficient aeration of the materials. Other fire suppression management tools that are useful include maintaining moisture content above 40% and regularly turning the pile.

[51] http://scentroid.com/sm100-infield-olfactometer/

[52] Norville, K. 2018. Odor Dispersion Modeling Analysis for the Grimm's Facility. 5-14-18. Prepared for Green Mountain Technologies, Inc. Presented in Appendix E-1.

- Minimum biocover depth of 12-inches of an engineered mix of porous overs and composted materials, maintained at a minimum of 50% moisture, should be used over all composting material surfaces for at least the first 20-days of composting.
- No disturbance of materials should be allowed within a minimum of 14-days of placement in an aerobic active composting pile.
- Continuous aeration – while the highest oxygen demand for active composting occurs early in that composting phase, oxygen is still consumed throughout the process and through curing – only at lesser required volumes. Aeration should be provided to all but the most stable piles to prevent anaerobic conditions.
- Sampling should occur on at least a quarterly basis (frequency may be on a volume or time frequency basis). Samples should be composites of the pile represented and should be analyzed for fecal coliform and salmonella, stability, pH, C:N ratio, electrical conductivity, and metals (if required). Field stability testing using Solvita™ test kits can be very useful to check the progress of stability and to inform timing of moving a pile.
- PFRP per OAR 340-096-0140 should be achieved on each compost pile.
- Temperature monitoring should be documented on a daily basis at some minimum number of locations depending upon the size and configuration of the piles through PFRP and for at least 20-total days. Then all piles should be monitored at least weekly in a similar number of locations.
- Require compost operator training certification from an approved composting training program. This training provides a basis for agreement on the parameters required for composting and serves to ensure that all operators understand the minimum requirements of composting according to industry standards which assists in communication as well as raising the bar for composting processes.
- Mitigation Strategy Menu[53] – California's Integrated Waste Management Board sponsored a very useful document that includes a step-by-composting-step list of potential odor generating locations on a composting site. Recommendations are provided for each potential odor source which can be very useful in mitigating specific site odors.

7.3.3 Other Regulatory Tool Options – regulation changes

As described in section 1.1 Definition of Composting, the concept of "aerobic" composting is not required in the OAR definition. GMT believes that maintaining aerobic conditions for composting is critical to minimizing odor generation and maximizing the efficiency of producing compost. The definition developed by USCC should be used in the regulatory framework for composting.

It is in the interest of the community and Metro that composting facilities utilize the most effective methods to process the growing volumes of organic materials into compost valuable for soil amendment, stormwater quality uses, and greenhouse gas mitigations. However, required

[53] California Integrated Waste Management Board / Cal Recycle. 2007. Comprehensive Compost Odor Response Project (C-CORP) Report. Sacramento, CA. 171 pages. Available at: http://www.calrecycle.ca.gov/swfacilities/compostables/BMP/CCORP/default.htm

upgrades can be very expensive. Metro should implement a program to support financial investment in effective technology.

Implementing such upgrades to a compost facility may also require land use flexibility in order to optimize aerobic conditions in the materials processed. Metro should work with the other regulatory levels of government to streamline the permitting process such that more effective technologies could be used at existing facilities. See section 7.4 Land Use Options.

7.4 Consistency of Land Use Options

The Grimm's compost facility is restricted by the difference in land use allowances on the various parcels under its control. Composting on a smaller footprint may not be more efficient or more environmentally favorable than on a larger footprint. Consideration should be given to allowing the adjacent parcels currently owned and operated by Grimm's to be given the same Conditional Use Permit allowances as parcels #1800 and #1900. This additional flexibility would allow further benefits to the alternatives such as providing room to allow for a separate biofilter for Alternative 2, allowing expansion of material bays in Alternative 1, and enabling the highest level of control as shown in Alternatives 3 and 4. Such land use consistency could also allow Alternative 2 to utilize rotating positive / negative aeration or adaptation to negative aeration if the situation called for it. Those enhancements could offer even more improved odor control in the Alternatives described which would benefit the community.

Grimm's experience with permitting improvements on their Cipole Road site has been marked by delays and attachment of multiple unrelated conditions that required lawsuits to mitigate. The ordeal over construction of the shop building is described in Section 3.3 Historical Site and Composting Operations. Such a regulatory environment has resulted in a disinclination by Grimm's to implement any facility changes that might require permitting or regulatory changes. Given that processes should change with surrounding changes, the difficulty with permitting appears to GMT to be detrimental to the community as well as to the facility. While Metro does not have jurisdiction over the City of Tualatin land use or building permitting, perhaps the Agency could lead a joint regulatory agreement whereby solutions to permitting could be streamlined when required for improved processing capability and control.

This report was performed with the goal of providing solutions to the odor impacts from Grimm's composting facility. If permits needed for solutions are not allowed or are tied to punitive conditions such that Grimm's cannot implement recommendations, the goal of this report is unlikely be met.

7.5 Financial Stability Implications

Operating a business requires financial stability reflected in part by the ability to obtain business loans for both operating expenses and for capital improvements. Businesses develop strong relationships with financial institutions that provide those funds on varying levels of frequency depending upon the business structure. Financial institutions evaluate businesses as good risk when they have longevity and stability as demonstrated by long term contracts with customers and stable regulatory status.

Because all of the alternatives presented here will necessitate capital investments into site restructuring and equipment, long term contracts and stable regulatory framework are very important. A recommendation of this evaluation includes development of a stable regulatory framework such as an intergovernmental agreement as to the lead agency and roles of other agencies. This may or may not be possible under Oregon laws, but establishing some type of communication train such that, perhaps, Metro provides the first level of regulatory interaction and transmits and interprets requests from other agencies to the facility management could help.

Similarly, any required permits should be issued on a minimum 5-year basis such that they could be revoked sooner for non-compliance, but that the facility could "bank" on not needing to reapply for coverage under a particular permit on a yearly or more frequent basis.

Relative to long term contracts, Metro, as the solid waste managing entity, could investigate the potential of establishing such contracts with Grimm's for municipal green waste processing. Such an approach might be useful in exchange for the investment required for implementation of one or a combination of the recommended alternatives.

7.6 Composter / Neighbor Interactions

The Odor Experience Survey revealed much about the variations and commonalities of the neighborhood experiences and interpretations of Grimm's odors. It was also apparent that although a few of those surveyed were highly knowledgeable about composting, most did not understand the most rudimentary concepts of the process or even what compost was or how a compost facility differed from a landfill. As an educated community is more likely to be able to help solve issues as they arise and as an approach to improving community communication, Grimm's operator may consider offering a series of open house gatherings at the facility during the construction and transition to the new system whichever is selected. The neighbors could participate in watching each element of the compost technology and learn how it works and what it takes to operate the system. This learning and sharing experience could create an improvement in communication between Grimm's and the neighbors that could benefit them both.

8 CONCLUSIONS

GMT performed three site assessments before, during and after the February pile turning event which gave the team direct experience with both the quality and extent of the transport of odors generated at the facility. Odors characteristic of Grimm's were observed from the I-5 freeway north of the Tualatin-Sherwood Road exit on February 7th as well as measurable by instrumentation at the Starbucks at Tualatin-Sherwood shopping center. Dispersion modeling of odor observations, coupled with meteorological data, was used to estimate the radius of impacted areas and back calculate a level of odor emissions at the pile surface. The modelling correlated with the locations of the complaint records indicating that Grimm's was the likely source of the odor impacts. Design improvements should provide a dramatic reduction in odor emissions and show predicted impacts below 10 DT (dilution to threshold) in the closest neighborhoods.

Gas sampling data from the static pile showed that the conditions were primarily anaerobic with production of methane, VOC's and little to no oxygen at a depth of 2 feet into the pile. Surface sampling showed a reduction in methane indicating an "aerobic shell" approximately 2-feet deep over the surface of the pile. Thus, 95% of the compost in the pile is anaerobic which produces a wide array of malodorous compounds typically associated with composting off-site odor impacts. Oxygen monitoring should be part of the operating plan moving forward as well as setting minimum allowable levels in the pile.

A review of the complaint records from 2013 through 2017 showed a large number of complaints mostly associated with a small group of complainants. This indicates that the negative impacts from Grimm's has been, predominately, experienced in a relatively narrow area. This conflicts with the complaints received in February 2018 during the pile turning event that was performed under disadvantageous weather conditions and received a great deal of publicity. The records did show increases in complaints associated with the time period near the pile turnings, although the correlation was not as direct as expected based on observations and individual reports. Odor complaint volumes tended to be higher in the late fall which may correlate with larger volumes of fresh material in the static pile and the increase in moisture on the pile causing reactivation of decomposition.

The Odor Experience Survey revealed how differently individuals experienced the odor impacts even within the same neighborhood. Descriptions provided by some of the impacted individuals clearly illustrated how the situation is negatively impacting their lifestyle at home.

GMT's review of feedstock quantities revealed a very large inflow of wet leaves in November 2017. The volume of feedstocks received greatly exceeded previous years which resulted in the large volume and height of the static pile being turned in February. Clearly, the volume and moisture content of the composting materials at Grimm's contributed to the intensity of malodors this spring. This lends credence to the recommendation that the facility should be regulated based on its design capacity.

8.1 Recommended Alternative

Reasonable cost alternatives exist to assure adequate aeration and control over the process without continuing to negatively impact neighbors. Financial assurances and assistance, along with regulatory consistency will help to support the necessary financing of an alternative sufficient to meet Metro's goals of increasing recycling infrastructure in the region.

Alternative 4, In-Ground Aerated Static Pile Configuration, with Positive and Negative Aeration Options and External Biofilter is recommended as the most flexible and cost-effective design with the highest flexibility and volume throughput for the investment IF the permitting and CUP expansion is allowed. A large portion of the cost is for the in-ground aeration system and concrete paving. The conceptual design provided should be taken to a further level of detail to provide better cost estimating and for additional planning for construction regardless of the Alternative actually selected. This system has the advantage of being relatively 'traditional', i.e. tried and true extended pile system similar to several other facilities in the region. The option of utilizing both positive and negative aeration can help the operator dial in the least impact operation throughout the year. The system would utilize more water per ton of incoming material but with the additional hard surface will also generate more leachate and stormwater. Additional analysis of that requirement needs to be made. This system also provides the highest ultimate processing capacity with the least additional cost.

That said, all of the Alternatives are viable, legitimate solutions that, properly operated, will greatly improve the odor impacts off site.

8.2 Additional Recommendations

Metro also asked for regulatory tools that could be used for compost facilities in general to attempt to avoid generation of high levels of malodors that impact communities. In section 7, GMT recommended several options that were developed to encourage aerobic conditions within a composting pile and to enable Metro, as regulator, to enforce such operations.

Beyond the specifics described in section 7.3.2, regulatory requirements could be established that would include aerobic conditions in Oregon's definition of compost.

Additionally, Washington State has included a requirement that all compost facilities must be "supervised and controlled by a properly trained individual(s) during all hours of operation" as evidenced by a certificate from an approved compost training program. This training requirement does help all operators in the state share the terminology and understanding of the processes required and regulations in place for compost facilities. The Washington Organic Recycling Council's Compost Facility Operator Training is just one option that receives very high levels of satisfaction from the attendees. Other approved training programs include the U.S. Composting

Council, and "other training as approved by …"[54] regulators. The same training is similarly recommended for regulators of compost facilities.

8.3 Additional research suggested

To utilize the Nasal Ranger as an enforcement tool for the existing configuration at Grimm's compost facility, additional dispersion analysis may be desired to investigate the different impacts on the community given different levels of DT measured at the pile following implementation of a new composting technology. Additionally, a DT at the property line might be investigated that would be protective of the odor condition in the neighborhoods.

A different set of modeling should be performed to inform the DT that should be expected at the pile or property line once a new composting system and configuration is in place. Because one of the inputs to such dispersion modeling is the surface area and height and location of the source surface, when the new system is implemented, the new configuration will need to be used in additional modeling to determine the appropriate DTs and locations for those measurements. Additional testing may be required for other composting facilities in the region.

Additional research will be needed if Metro intends to address neighborhood concerns of health impacts. Part of the questions raised by some of the community involve whether their health is being impacted by the compost odors. A literature study of compost emissions was reported to have been done by Oregon Health Authority and may be a cost-effective way to approach those fears. Actual monitoring is expensive and not always conclusive. If a site-specific investigation is desired, one of the first steps would be to identify specific compounds to measure, such as specific VOCs, and then for the appropriate health authority, which in this case is Washington County Health Department and Oregon Health Authority, to do the literature investigation to determine what if any health risks are posed by those compounds and at what concentrations and over what periods of time.

[54] WAC 173-350-220(4)(a)(vi)

9 ADDITIONAL REFERENCES

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History and Background Miscellaneous Notes and References

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