COMPOSTING IN CALIFORNIA

Addressing Air Quality Permitting and Regulatory Issues for Expanding Infrastructure

August 2018 Discussion Paper

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Authors/Contact Information:

Alan Abbs (alan@capcoa.org), Executive Director,
California Air Pollution Control Officers Association

California Air Resources Board

Dr. Crystal Reul-Chen (Crystal.Reul-Chen@calrecycle.ca.gov), CalRecycle

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List of Acronyms

AB	Assembly Bill
AD	Anaerobic digestion
ASP	Aerated static pile
AQMD	Air Quality Management District
APCD	Air Pollution Control District
ATC	Authority to construct
ATCM	Airborne toxic control measure
AVAQMD	Antelope Valley Air Quality Management District
BAAQMD	Bay Area Air Quality Management District
BACT	Best available control technology
BMP	Best management practice
°C	Degrees Celsius
CAA	Clean Air Act
CalRecycle	Department of Resources Recycling and Recovery
CalTrans	California Department of Transportation
CAPCOA	California Air Pollution Control Officers Association
CARB	California Air Resources Board
C-CORP	Comprehensive Compost Odor Response Project
CCR	California Code of Regulations
CDFA	California Department of Food and Agriculture
CEQA	California Environmental Quality Act
CH_4	Methane
CO_2	Carbon dioxide
CPS	Conservation practice standard
EF	Emission factor
ERC	Emission reduction credit
EPS	Essential public service
GACT	Generally available control technology
GHG	Greenhouse gas
HAP	Hazardous air pollutant
IC	Internal combustion
°F	Degrees Fahrenheit
LAER	Lowest achievable emission rate
MACT	Maximum achievable control technology
MBARD	Monterey Bay Air Resources District
MIR	Maximum incremental reactivity
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NH_3	Ammonia
N_2O	Nitrous oxide
NO_x	Oxides of nitrogen

List of Acronyms (continued)

NRCS	United States Department of Agriculture's Natural Resources Conservation Service
NSPS	New Source Performance Standards
NSR	New Source Review
OIMP	Odor Impact Minimization Plan
OMSM	Odor Mitigation Strategy Menu
PERP	Portable Equipment Registration Program
PM	Particulate matter
SB	Senate Bill
SCAQMD	South Coast Air Quality Management District
SIP	State Implementation Plan
SDCAPCD	San Diego County Air Pollution Control District
SJVAPCD	San Joaquin Valley Air Pollution Control District
SLCP	Short-lived Climate Pollutant Reduction Strategy
SOM	Soil organic matter
SWRCB	State Water Resources Control Board
TAC	Toxic air contaminant
tpy	Tons (short) per year
U.S. EPA	United States Environmental Pollution Agency
VCAPCD	Ventura County Air Pollution Control District
VOC	Volatile organic compound

Acknowledgments

This paper is the product of a collaborative effort between the California Air Resources Board (CARB), the California Air Pollution Control Officers Association (CAPCOA), and the Department of Resources Recycling and Recovery (CalRecycle) as well as the 35 air districts that CAPCOA represents. Within each of these agencies, an extensive list of people have contributed from numerous departments, including Jeremy Avise, Matthew Botill, Brian Clerico, Mary Jane Coombs, Rebecca Fancher, Mei Fong, Matthew Harrison, Ryan Huft, Jessica, Johnson, Trish Johnson, Stephanie Kato, Tung Le, Johanna Levine, David Mallory, Molly Munz, Melissa Niederreiter, Sam Pournazeri, Johnnie Raymond, Gabe Ruiz, David Salardino, and Floyd Vergara from CARB; Brian Larimore, Robert Horowitz, Howard Levenson, Victoria Ngo, Kyle Pogue, Brenda Smyth, Brian Stalker, Nevin Yates, and KIS Branch staff from CalRecycle; Carol Allen and Chad White from Bay Area Air Quality Management District; Greg Hinton from Colusa County Air Pollution Control District; Ian Ledbetter and Marcie Skelton from Glenn County Air Pollution Control District; Amy Clymo and Mary Giraudo from Monterey Bay Air Resources District; Jim Swaney from San Diego Air Pollution Control District; Arnaud Marjollet, Errol Villegas, Dave Warner from San Joaquin Valley Air Pollution Control District; Michael Goldman from Santa Barbara County Air Pollution Control District; Rob Bamford from Northern Sonoma County Air Pollution Control District; Dora Drexler from San Luis Obispo County Air Pollution Control District; Tracy Goss, Angela Shibata, Laki Tisopulos, and Charles Tupac from South Coast Air Quality Management District; Kerby Zozula from Ventura County Air Pollution Control District; and Paul Hensleigh and Mat Ehrhardt from Yolo-Solano Air Quality Management District. We extend our gratitude for their contributions to this paper, and to the body of knowledge on this topic.

Disclaimer

The purpose of this paper is to initiate a discussion amongst the numerous stakeholders as to how to permit compost facilities in light of the potential air quality challenges and barriers associated with moving organic waste materials from landfills to these facilities. This paper is intended to outline several of the issues and to supply sufficient background for further discussion. In addition to published results from studies, a greater body of information exists within the air district and composting communities, but this paper only presents that information in the few instances it was shared with us via direct communication. Therefore, the results presented in this paper should be taken as preliminary, and open both to discussion and future analysis. Further, this paper relies on assumptions of transportation of amounts of organic waste material, examples of potential facility sizes, and the resulting permitting challenges based on existing federal, state, and local air quality regulations. This document is not meant to substitute for discussion with a local air district about any individual project and its suitability to receive a permit. Finally, the focus of this paper is on permitting issues related to obtaining air quality permits and does not address the role of CEQA in the siting of these facilities.

Purpose

This discussion paper reflects a collaborative effort by the California Air Resources Board (CARB), the California Air Pollution Control Officers Association (CAPCOA), the 35 air districts in CAPCOA, and the Department of Resources Recycling and Recovery (CalRecycle) to define the current state of composting in California, discuss the associated air quality and regulatory issues for siting new and expanded large-scale composting facilities in California, and find ways to overcome the challenges of building the necessary composting infrastructure. It is the first step in a process of helping both air districts and potential owners or operators of large-scale compost facilities to site and permit these facilities.

The directed focus of the paper is on air permitting of composting facilities; especially with respect to volatile organic compound (VOC) emissions, and explores a range of permitting options. Some of these options are feasible while others are not. We document the options that are likely infeasible as a record to help focus future efforts on the feasible options listed in this document, and to solicit additional insight from stakeholders.

Introduction

Senate Bill (SB) 1383 (Lara, Chapter 395, Statutes of 2016) mandates that CalRecycle develop a regulation that reduces the disposal of organic materials in landfills by 50 percent by 2020 and 75 percent by 2025, compared to a 2014 baseline year. CalRecycle projects that the state will need between 75 and 100 new or expanded compost and anaerobic digestion facilities in California to process the amount of organic materials that will be required to be diverted. State agencies, air districts, the composting industry, and other stakeholders have long recognized that it will be challenging to site and permit these needed facilities within the existing air quality laws and requirements.

Overcoming these challenges is critical for the state to meet SB 1383 requirements. Air quality regulations and permitting requirements are in place to ensure that the health and safety of the state's inhabitants are maintained. The 35 local air quality management districts (AQMDs) and air pollution control districts (APCDs) are responsible for regulating stationary sources of air pollution within their districts. Due to differences in population, population density, geography, climate, business base, and the ambient levels of air pollution, each air district has developed different strategies to meet or maintain air quality standards specified under federal and state law. A "one size fits all" permitting approach is not appropriate for any facility—whether it be a composting facility or another type—because of the different public health needs in each air district and the resulting strategies required to reduce air emissions.

Achieving the SB 1383 organic diversion mandate will require innovative approaches to air quality permitting that meet the requirements of the Clean Air Act (CAA). In many cases, as part of permitting a new or expanding compost facility, the owner or operator will be required to purchase VOC offsets. It is unlikely that there are enough VOC offsets available at present to permit the required new and expanded organic composting facilities. This discussion paper identifies several other related air permit issues but ultimately focuses the discussion on the VOC offsets issue.

This paper covers the following topics:

- Chapter I: California's waste sector climate goals and the need for composting
- Chapter II: Composting 101
- Chapter III: Current and future infrastructure needs for processing organic waste materials
- Chapter IV: Air quality impacts from composting and management methods
- Chapter V: Overview of air quality permitting and regulatory requirements for new and existing California compost facilities
- Chapter VI: Key issues in permitting compost facilities
- Chapter VII: Options considered for addressing permitting and regulatory challenges
- Chapter VIII: Next steps

A number of options are explored in this document. Not all of them are feasible for all, or any, air districts to implement. Given that, the following options (in Chapter VIII) should be explored further by those air districts where the action would be feasible:

1) Explore utilizing regional air quality modeling to determine if new composting operations would reduce regional air quality impacts within an air basin compared to the landfilling of the organic materials. If composting reduces regional air quality impacts, determine if it is possible to develop a permitting pathway consistent with the CAA and the authority of individual air districts.
2) Determine if the creation of landfill emission reduction credits from the reductions associated with no longer landfilling the organic materials can provide the needed VOC offsets for new or expanded composting facilities.
3) Conduct an evaluation of the potential use of the essential public services designation to facilitate composting facility permitting for certain air districts.
4) Provide tools such as web-based guidance documents to project developers that assist in navigating the compost facility permitting process.
5) Identify research that would support the air permitting process for composting facilities.

I. California's Waste Sector Climate Goals and the Need for Composting

The California 2017 Climate Change Scoping Plan (2017 Scoping Plan) establishes the state's framework of action to meet the most aggressive climate target in North America—a 40 percent reduction in greenhouse gases (GHGs) by 2030 compared to 1990 levels, as required by SB 32 (Pavley, Statutes of 2016, Chapter 249)[1]. The 2017 Scoping Plan builds on the strong foundation of programs and policies already in place to achieve the 2020 target established under Assembly Bill (AB) 32 (Nuñez, Statutes of 2006, Chapter 488),[2] and the initial 2008 Climate Change Scoping Plan.[3] It integrates complementary state regulatory efforts across the energy, transportation, natural and working lands, waste management, and water sectors to help realize our climate and air quality goals. The 2017 Scoping Plan[4] analysis shows the potential for significant GHG emissions reductions from measures contained in the 2017 Short-Lived Climate Pollutant Reduction Strategy (SLCP Strategy)[5]. The SLCP Strategy's portfolio of policies and measures is therefore an integral part of the state's overall climate blueprint, and is expected to provide approximately 35 percent of cumulative needed GHG emissions reductions between 2021 to 2030 to meet the 2030 target.[6]

The First Update to the Climate Change Scoping Plan (2014 Scoping Plan Update) originally identified short-lived climate pollutants (SLCPs)—which include methane (CH_4), black carbon, and fluorinated gases—as an important aspect of a comprehensive approach to addressing climate change. Growing SLCP emissions (such as from fluorinated gases) threaten to erode the state's long-term progress; in other sectors (such as from oil, gas, and agriculture) continued emissions will put increased pressure on the remainder of the state's regulatory structure to maintain overall emissions below the GHG limit and to continue reductions (Figure 1). The Legislature directly recognized the critical role that SLCPs must play with the passage of two bills: SB 605 (Lara, Chapter 523, Statutes of 2014), which required CARB staff to develop a strategy to reduce SLCP emissions; and SB 1383 (Lara, Chapter 395, Statutes of

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[1] Senate Bill (SB) 32. California Global Warming Solutions Act of 2006 (Pavley, Chapter 249, Statutes of 2016). https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32.

[2] Assembly Bill (AB) 32. California Global Warming Solutions Act of 2006 (Nunez, Chapter 488, 2006). https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200520060AB32.

[3] California Air Resources Board (CARB). December 2008. Climate change scoping plan. https://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf.

[4] CARB. November 2017. California's 2017 Climate Change Scoping Plan: The strategy for achieving California's 2030 greenhouse gas targets. https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf.

[5] CARB. March 2017. Short-Lived Climate Pollutant Reduction Strategy. https://www.arb.ca.gov/cc/shortlived/meetings/03142017/final_slcp_report.pdf.

[6] CARB. November 2017. California's 2017 Climate Change Scoping Plan: The strategy for achieving California's 2030 greenhouse gas target. Chapter 2.: https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf.

2016)[7], which required CARB to approve and begin implementation of the SLCP Strategy by January 1, 2018, and set 2030 statewide reduction targets for SLCPs emissions of 40 percent below 2013 levels by 2030 for CH_4 and fluorinated gases, and 50 percent below 2013 levels by 2030 for anthropogenic black carbon emissions.

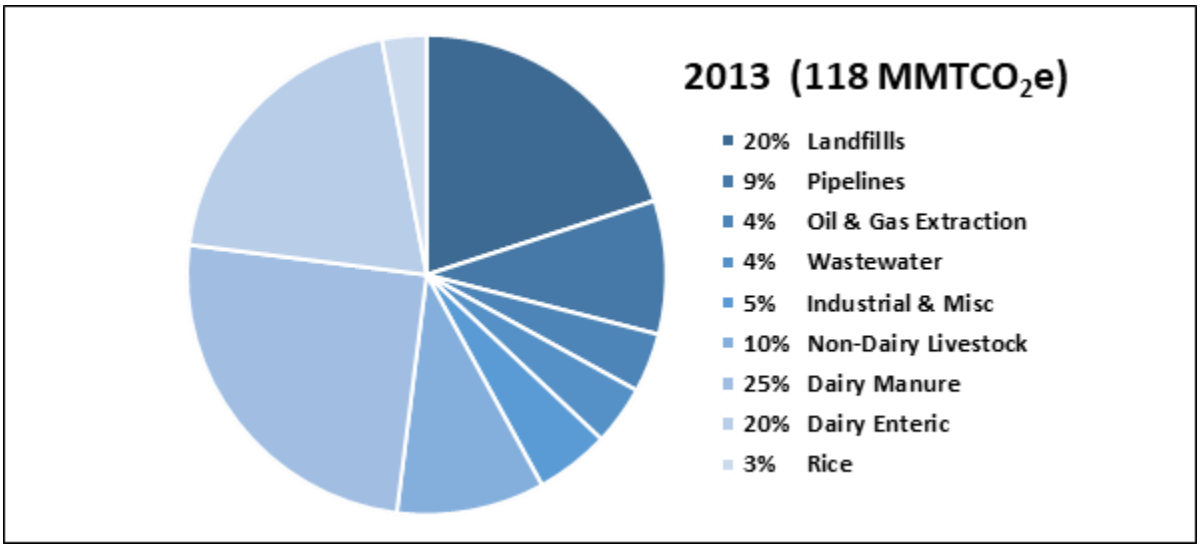

Figure 1. California 2013 Methane Emission Sources (Source: Appendix F SLCP)

Over the last 30 years, California has been establishing clear goals to reduce waste disposal and divert organic material from landfills for beneficial purposes. SB 1383 (2016[8]), Assembly Bill (AB) 1826 (2014[9]), AB 341 (2011[10]), AB 939 (1989[11]) all have provisions that require organics diversion. As California's organic waste streams are responsible for half of the state's CH_4 emissions,[12] they represent a valuable energy and soil-enhancing resource.

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[7] SB 1383. 2016. Short-lived climate pollutants (Lara, Chapter 395, 2016). http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB1383.

[8] Ibid.

[9] AB 1826. 2014. Solid Waste: organic waste (Chesbro, Ch. 727, 2014). http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB1826&search_keywords.

[10] AB 341. 2011. Solid Waste: diversion (Chesbro, Ch. 476, 2011). https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120AB341.

[11] CalRecycle. Laws Related to Waste Management, History of California Solid Waste Law (1985-1989). http://www.calrecycle.ca.gov/laws/legislation/calhist/1985to1989.htm.

[12] CARB. March 2017. Short-Lived Climate Pollutant Reduction Strategy. Figure 4: California 2013 Methane Emission Sources (using 20-year GWP). https://www.arb.ca.gov/cc/shortlived/meetings/03142017/final_slcp_report.pdf.

Technologies to recover CH_4 are already widely available and used in key sectors. For example, some CH_4 emissions from landfills, wastewater treatment facilities, or from manure at dairies are already captured, and used as a renewable source of natural gas to fuel vehicles or generate electricity. Some organic waste materials, such as food waste and yard trimmings, are being redirected from landfill disposal to anaerobic digestion and composting facilities to produce renewable energy, fuel, and soil amendments.

The SLCP Strategy subsumes the SB 1383 requirement that 50 percent of organics be diverted from landfill disposal by 2020,[13] 75 percent of organics be diverted from landfill disposal by 2025,[14] and that 20 percent of edible food being disposed of in landfills be recovered. In order to implement this provision, CalRecycle, in consultation with CARB, is required to adopt regulations to achieve these landfill organics disposal reduction goals. CalRecycle commenced regulatory development work in 2017, and plans to adopt regulations by 2019 to meet the mandated organics diversion targets. These regulations will take effect on, or after, January 1, 2022.

Currently, California recycles almost 20 million tons per year (tpy) of organic waste annually through a combination of existing composting, chip and grind, biomass energy, and anaerobic digestion facilities (Figure 2).[15] At full capacity, this existing organics recycling infrastructure could process about an additional six million tpy of organics annually, with almost two million tpy going to composting.

[13] Target is relative to a 2014 baseline.

[14] Ibid.

[15] CalRecycle. 2015. State of Recycling in California. Publication #DRRR 2015-1522. http://www.calrecycle.ca.gov/Publications/Documents/1522/20151522.pdf.

Facility Type	Statewide Active Facilities	Total Capacity (tpy)	Current Throughput (tpy)	Available Additional Capacity (tpy)
Anaerobic Digestion	13	467,000	187,000	280,000
Biomass Conversion	32	5,300,000	5,300,000	0
Composting	169	8,000,000	6,200,000	1,800,000
Composting – Research Operation	14	93,000	92,000	1,000
Chipping and Grinding	156	11,200,000	7,300,000	3,900,000
Other Organics Management	23	790,000	740,000	50,000
Total		**25,850,000**	**19,819,000**	**6,031,000**

Data accessed from CalRecycle's FacIT database on January 28, 2015. Facility counts reflect publicly listed facilities that are actively operating.

Figure 2. Active Organics Materials Management Facilities in California

The SB1383 requirement to divert organics from landfills means that over 12.5 million additional tpy of food, yard, wood, and other organic waste materials will need to be diverted from landfills and processed in a traditional organic waste material processing facility, such as a composting, chipping and grinding, or anaerobic digestion facility. When less compostable organic waste materials such as paper and other organic materials, like carpets and textiles are included, the total amount of materials that will need to be processed increases to over 20 million tpy.

California envisions the "loading order" for management of organic waste as first reducing the waste at the source, beginning with distributing edible food to food-insecure populations, and finally transporting leftover organic waste materials to material recovery through recycling organic waste into beneficial products. The landfilling of organic material should be a last resort. Composting will likely be the primary process for diverting much of this organic material. Anaerobic digestion is the most expensive management option but it can handle wet materials with high nitrogen content, such as food waste, and produces renewable fuels. Also, depending on the composition of the digestate (residual material left over at the end of the anaerobic digestion process), this material may be land-applied or composted rather than landfilled. Biomass-to-energy facilities have utilized urban woody waste, but the number of facilities is declining, and there is more pressure to use the remaining facilities to address the tree mortality crisis and for agricultural residue as an alternative to open pile burning. The least expensive option is to land apply uncomposted organic waste material (i.e., minimally processed through a chipping and grinding process, but not composted or anaerobically digested first) throughout the state where it will decompose in an uncontrolled environment. However, this activity may result in CH_4 emissions, and also has a higher potential to spread both physical and pathogenic contaminants and affect water throughout the state. It is likely all of these options and others will probably be needed to process all of the diverted organic waste materials. Consistent with state, federal, and local laws, the operation of these facilities

must not interfere with meeting and maintaining ambient air quality standards, meeting other environmental protection requirements, and protecting public health.

II. Composting 101

What is Composting?

Composting is the natural or controlled aerobic decomposition of organic solid waste materials into a humus-like material commonly called compost. The exothermic microbial action at the heart of the composting process initially produces enough heat that feedstock pathogens are reduced. A succession of microbes and fungi, which thrive on different compounds in the feedstock and at different temperature ranges, are fundamental to the composting process, as is oxygen, which the microbes require to consume the organic materials for energy. The efficiency of the composting process can be optimized by providing the correct balance of carbon, nitrogen-containing feedstocks, water, and oxygen. It is an important best management practice (BMP) to ensure food waste, manures, biosolids, and yard waste are mixed in a proper ratio to preserve the nutrients within the final compost product.

Composting Methods

There are two basic types of commercial-scale composting methods: windrows and aerated static piles (ASP). All facilities start the composting process by grinding, shredding, or otherwise reducing the size of the incoming feedstock. Most facilities remove physical contaminants such as plastic, metal, and glass from incoming feedstock. After feedstock preparation, the materials are moved to the active composting phase.

Windrows are elongated piles of material that can range from eight to 20 feet wide, up to 10 feet tall, and hundreds of feet long. A machine that straddles the pile turns the windrow by moving along its length, churning the material, breaking up clumps, fluffing the pile, and moving materials to and from the pile core. This action ensures all feedstock is subject to the high internal temperatures of the pile, which reduces pathogens. Fluffing up the pile ensures air can reach into the pile core, facilitating high temperatures and rapid decomposition. Turning can also be accomplished with front-end loaders.

Aerated Static Pile composting, increasingly common in California, uses electric blowers to push or pull air through the piles during the active composting phase. Positive aeration occurs when ambient air is blown into the pile; negative aeration occurs when air is drawn from the pile. ASPs are engineered to reduce pollutants such as VOCs and ammonia (NH_3). Positive aeration systems may use fabric covers or a thick top layer of finished, unscreened compost that acts a biofilter. Negative aeration systems discharge air from the piles through a dedicated biofilter that further reduces pollutants.

To-date, for the purposes of assessing compost pile emissions at air districts, there are two basic stages of composting, which happen in the following order:

- **Active phase**: Composting begins when temperatures exceed 122 °F (50 °C) and continues as temperatures rise to more than 131 °F (55 °C), beginning the process for further reduction of pathogens (CCR Title 14, Section 17868.3). This stage may last up to a month for windrow composting, and be completed more rapidly for ASP composting. Repeated turning of windrows or forced aeration is necessary to prevent

rapid depletion of oxygen within the pile. The active phase continues while compost matures. Temperatures decline but are still above ambient levels. Mesophilic actinomycetes and fungi begin to break down more stable materials. Maturation may last another month or more.

- **Curing phase**: Temperatures are nearly ambient. Actinomycetes and fungi continue to work on woody materials, forming humic compounds. Biological carbon respiration drops to near ambient conditions. This stage may last many months.

After the composting process is completed, the finished compost is screened for size and for contaminants, before being sold. Sometimes compost is bagged for sale to homeowners. Other times it is used as a soil amendment or an input to the production of commercial soil for sale.

What Is Compost?

Compost is the finished product from the composting process. The term compost should not be used interchangeably with feedstock, which are the raw materials such as yard trimmings or food waste, or with mulch, a more coarse soil covering that only goes through mechanical size reduction. Compost is a soil amendment that improves soil health. Characteristics of finished compost are:

- **Low temperature**: The compost should not be warmer than ambient conditions.
- **Pleasant aroma**: Finished compost smells earthy and pleasant. There should be no strong smells of NH_3 or other unpleasant odors.
- **No visible feedstock**: No recognizable grass, leaves, bits of food, or other source materials are visible. Wood breaks down slowly, so visible wood pieces are normal.

Who Uses Compost?

Agricultural operations use most of the compost produced[16] in California, by both conventional and organic growers. The primary use of compost being in organic farming. Certified organic farmers operate under an approved organic system plan that ensures that compost meets labeled standards,[17] and these plans include documentation of compost use. There are now more than one million acres in organic production in California, with crops worth nearly $3 billion in 2016, according to the US Department of Agriculture. The California Department of Food & Agriculture (CDFA) regulates the sale of compost as an input for any soil amendment used for crop nutrition, in both organic and conventional farming.

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[16] CalRecycle. 2010. Third Assessment of California's Compost and Mulch-Producing Infrastructure – Management Practices and Market Conditions. Publication #DRRR-2010-007. http://www.calrecycle.ca.gov/Publications/Documents/Organics/2010007.pdf.

[17] California Department of Food and Agriculture (CDFA). Fertilizing Materials Inspection Program – Organic Input Material Program. https://www.cdfa.ca.gov/is/ffldrs/fertilizer_OIM.html.

Nurseries, landscapers and low-impact development[18] (water quality protection practices that improve stormwater infiltration) are also important compost purchasers. In nurseries, compost can help replace peat, a commonly imported product with higher GHG emissions than compost.[19] In landscaping, California's Model Water Efficient Landscape Ordinance[20] requires compost application at a rate of four cubic yards per 1,000 square feet for all planted areas for new or remodeled landscapes. Low impact development is a growing field and compost can be an important part of engineered soil mixtures to reduce runoff and promote water percolation. The California Department of Transportation (CalTrans) uses hundreds of thousands of tons of compost per year along state highways to reduce erosion and support vegetation. [21]

Benefits of the Composting Process

Reduces Landfill VOC Emissions

Organic materials decompose and emit VOCs regardless of whether that process occurs within a managed compost pile, a stockpile, or an active face of a landfill. Research conducted for CalRecycle by the University of California indicates that a well-managed composting process produces fewer VOC emissions than when organic material degrades on its own.[22] In contrast, VOC emissions from initial landfilling operations (i.e., from receipt until gas collection is installed) are poorly characterized.

Studies of landfill emissions tend to focus on CH_4, hydrogen sulfide, and other gases captured in the active landfill gas collection system or CH_4 emissions through intermediate or final covers. For example, one study conducted in France[23] indicated that landfill operations, particularly the continuous compacting of dumped materials, emitted a wide variety of VOCs, including benzene, toluene, ethylene, and xylene (BTEX) compounds and other toxic air contaminants (TACs) that are typically associated with fossil fuels and synthetically-derived

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[18] Caltrans. Low Impact Development (LID). http://www.dot.ca.gov/design/lap/landscape-design/erosion-control/lid/overview.html.

[19] Ceglie, FG, Bustamante, MA, Amara, MB, and Tittarelli, F. 2015. The Challenge of Peat Substitution in Organic Seedling Production: Optimization of Growing Media Formulation through Mixture Design and Response Surface Analysis. PLoS ONE 10 (6): e0128600. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4466503/.

[20] California Code of Regulations, Sections 490-495, Chapter 2.7, Division 2, Title 23. https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=I55B69DB0D45A11DEA95CA4428EC25FA0&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default).

[21] California Department of Transportation (Caltrans). Compost home page. http://www.dot.ca.gov/design/lap/landscape-design/erosion-control/organics/compost.html.

[22] Buyuksonmez, F, Evans, J. 2007. Biogenic Emissions from Green Waste and Comparison to the Emissions Resulting from Composting Part II: Volatile Organic Compounds (VOCs). Compost Science & Utilization, Vol. 15, No. 3 191-199. http://www.calrecycle.ca.gov/organics/Air/BiogenicEmis.pdf.

compounds, but not those typically associated with VOCs from the degradation of organic waste materials as defined by CalRecycle's proposed SB1383 regulation.

In operational areas where active landfilling occurs, landfill gas collection systems typically are not installed until months after waste is in place. During this time, there may be only daily or, at best, intermediate cover in place. Therefore, the most readily biodegradable organic substances, such as food waste, may have already emitted most of their VOCs prior to installation of a gas collection system. Further study is required to obtain a better understanding of what VOC emissions from waste in landfills occur prior to the installation of a gas collection system.

Reduces Landfill GHG Emissions

Under anaerobic landfill conditions, organic material degradation produces CH_4, a climate warming gas 72 times more potent than carbon dioxide (CO2) over a 20-year time horizon.[24] Moreover, because food waste degradation is particularly rapid, CH_4 can be released before the landfill gas system is in place. Because of its large global warming potential over the short term, CH_4 is the target of California climate laws and regulations designed to reduce CH_4 emissions in general and from landfills specifically.

When the landfill gas collection system is in place and becomes operational, it capture much of the CH_4 generated in the landfill. However, some CH_4 continues to be emitted from the landfill through cracks in the landfilled material or leaks in the system. Diverting organic waste material to composting operations prevents CH_4 emissions generated from anaerobic processes in landfills. Composting (rather than landfilling) one ton of yard trimmings can prevent the production of 0.2 metric tons of CO_2 equivalent ($MTCO_2e$), and composting one ton of food waste can prevent the production of approximately 0.3 $MTCO_2e$.[25]

Pests & Pesticides

The high heat of composting kills nearly all types of pests, including insects and plant diseases. Composting is recognized as an appropriate treatment for green materials from quarantine zones. Chipping and grinding alone does not provide this level of protection. The very hot active composting phase also degrades a variety of pesticides. Some toxins decay into simpler molecules, some form bonds with other compounds (adsorption), others become part of complex humus molecules, and still others are mineralized. With a few exceptions (discussed later in Persistent Pesticides section), pesticides do not persist in compost at levels that can harm human health or the environment.[26]

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[24] Intergovernmental Panel on Climate Change. IPCC Fourth Assessment Report: Climate Change 2007. 2.10.2 Direct Global Warming Potentials. Table 2.14. https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html.

[25]CARB. May 2017. Final Draft Method for Estimating Greenhouse Gas Emission Reductions From Diversion of Organic Waste From Landfills to Compost Facilities. https://www.arb.ca.gov/cc/waste/cerffinal.pdf.

[26] Michel, FC, and Doohan, D. Clopyralid and Other Pesticides in Composts. Ohio State University. AEX-714-03. https://www.global2000.at/sites/global/files/Clopyralid_Factsheet.pdf.

Potential Adverse Impacts of the Composting Process

Odors, VOC, and GHG emissions

The composting process can generate odors and result in VOC, NH_3, and GHG emissions. While air districts receive odor complaints associated with compost facilities, they do not have enforcement authority over odors from composting facilities per Section 41705 of the Health and Safety Code. The local enforcement agency (EA in code, generally known as LEA) has enforcement authority over nuisance odors from composting facilities, and can issue violations for nuisance odors.[27] Minimizing odors from compost operations is discussed in further detail in Chapter VI.

Water Quality

In August 2015, the California State Water Resources Control Board (SWRCB) adopted a General Order for composting facilities, establishing standard requirements for water quality protection at eligible facilities. For facilities accepting food waste or processing over 25,000 cubic yards at any given time],[28] these requirements include lined detention basins, surfaces with low permeability in the areas where composting occurs, and berms and ditches designed to prevent water from running on or off the site. Regional Water Boards may require other criteria, if warranted. According to the most recent information from the SWRCB, approximately 40 composting facilities have enrolled in the General Order. Other facilities are regulated through individual waste discharge requirements or waivers of waste discharge requirements.

Benefits of Compost Application

Soil Health and Carbon Storage

The application of compost provides organic matter, small amounts of macronutrients and micronutrients, and a biological boost to soil. The average compost sold in California is about 22 percent carbon by weight.[29] Compost provides food for biological organisms living in soil, boosting their numbers. The microbes living in compost augment the biological diversity of the soil. Plants grown in a biologically active and diverse soil tend to be healthier than plants grown in soil low in of organic matter and biology, and may need fewer pesticides and fertilizers. In addition to providing soil carbon, compost also increases plant vigor and biomass

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[27] Title 14, Chapter 3.1. Section 17867(a)(2) – All compostable materials handling operations and facilities shall meet the following requirements: (a)(2): “All handling activities shall be conducted in a manner that minimizes odor impacts as to not cause a nuisance.” A nuisance is defined in Title 14, Chapter 3.1 Section 17852 (27.5).

[28] State Water Resources Control Board. August 4, 2015. Order WQ 2015-0121-DWQ, General Waste Discharge Requirements for Composting Operations. https://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2015/wqo2015_0121_dwq.pdf.

[29] State Water Resources Control Board. Regulation of Composting Operations Webpage. https://www.waterboards.ca.gov/water_issues/programs/compost/.

that removes carbon from the atmosphere and stores it in the soil. The bigger, healthier plants grown in compost-amended soil contribute to a growing biological carbon pool, not only through the biological mass in their roots, but also by exuding basic sugars and amino acids, thus attracting and stimulating a diverse soil ecosystem.[30]

Soil microbes help plants extract nutrients trapped in the soil, potentially reducing fertilizer needs. Compost contains, on average, 1.6 percent nitrogen, 1.4 percent phosphorus, 1.3 percent potassium, 3.3 percent calcium, and 0.6 percent magnesium.[31] It also contains a wide variety of micronutrients that are not present in most common synthetic fertilizers, but are important for healthy plants.

Increasing carbon storage in the soil is a key climate change strategy. California farmland typically contains less than one percent organic matter. One of Governor Brown's six pillars of the state's climate strategy is to increase carbon storage in the land base.[32] CDFA's Healthy Soils Initiative is shining light on the importance of building soil carbon by promoting the application of compost amendments as an alternative to landfilling organic materials.[33] Another initiative, "4 per 1000," launched by the French government at the COP 21 climate conference in 2015, calls for an increase in global soil carbon stocks of 0.4 percent per year.[34]

Water Savings, Runoff and Erosion

California compost is approximately 42 percent organic matter. Adding organic matter to soil increases the capacity of soil to hold water. Blending compost into soil holds water within the plant-available zone, reducing irrigation needs.[35] By helping to form soil aggregates, compost enhances the ability of soils—particularly fine-grained soils—to capture stormwater as it falls, reducing runoff and erosion, protecting surface water quality and reducing irrigation needs.

Potential Adverse Impacts of Compost Application

Inerts

The main adverse impact of compost application, particularly with compost made from the municipal waste stream, is inert contaminants such as plastic and glass. Technology for

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[30] Lal, R. September 2016. Soil health and carbon management. Food & Energy Security 5(4): 212-222. https://onlinelibrary.wiley.com/doi/full/10.1002/fes3.96.

[31] CalRecycle. 2014. Internal data set, 1336 samples from the Southwestern United States, Soil Control Laboratories, Watsonville, CA.

[32]CARB. Last updated Sept. 20, 2016. The Governor's Climate Change Pillars: 2030 Greenhouse Gas Reduction Goals. https://www.arb.ca.gov/cc/pillars/pillars.htm.

[33] CDFA. Healthy Soils Initiative. https://www.cdfa.ca.gov/healthysoils/.

[34] "4 Per 1000" Initiative webpage. https://www.4p1000.org/.

[35] Sullivan, P. November 2002. Drought Resistant Soil. Appropriate Technology Transfer for Rural Areas. National Center for Appropriate Technology. http://www.growingsolutions.com/wp-content/uploads/2016/02/ATTRA-Drought-Resistant-Soil-doc.pdf.

removing inert contaminants is improving, but it remains difficult for operators to remove all contaminants from composting feedstocks. While glass remains largely an aesthetic problem for farmers, it is a bigger issue for landscapers and home gardeners. There is also increasing concern about micro-plastics in the environment. CalRecycle has an inert contaminant standard in place for finished compost. CalRecycle's draft SB 1383 regulations include provisions designed to minimize contamination of organic waste materials collected from residences and businesses.

Persistent Pesticides

A small number of herbicides survive breakdown in the compost process at concentrations that are toxic to plants. These are called persistent pesticides.[36] In order to mitigate negative impacts, the California Department of Pesticide Regulation limits their use to commercial applicators and the product's label clearly indicates that plant material treated is not for use in mulch or compost. These active ingredients are: aminocyclopyrachlor, aminopyralid, and clopyralid, and are banned from the residential market.

[36] United States Composting Council. 2015. Persistent Herbicides – Fact Sheet #1: https://compostingcouncil.org/wp-content/uploads/2015/06/USCC-PH-Fact-Sheet-1-for-web.pdf.

III. California's Composting Infrastructure and Operations

California does not currently have the needed infrastructure to recycle the organic waste materials that are required to be diverted from landfills by 2025. SB 1383's organic waste material diversion mandate will require that about 20 million tpy of additional organic waste material be diverted from landfills by 2025, with some of this material going to anaerobic digestion, food recovery, and other organic waste recycling efforts and facilities. Accounting for maximizing existing throughput of material at composting facilities, additional expanded composting infrastructure is needed to accommodate roughly 5.3 million more tpy by 2025.

The need for composting infrastructure is not evenly distributed throughout the state because organic waste generation is related to population density. Therefore, more new infrastructure will be needed to handle the waste from more heavily populated urban air districts than for less heavily populated rural air districts. For example, the population in the South Coast Air Quality Management District (SCAQMD) generates the greatest amount of organic waste materials, but currently has the least amount of available composting capacity. In addition, siting new facilities within the SCAQMD is difficult due to its densely populated urban environment.

Current Industry Profile

The majority of large composting facilities are currently located in the San Joaquin Valley, outside of major urban areas where materials are generated but closer to large agricultural areas where compost is used. The rural areas between Los Angeles and the southern end of the San Joaquin Valley, and between the Bay Area and the northern end of San Joaquin Valley have some of the largest composting facilities in California. Likewise, most of the available excess composting capacity exists in these same areas of the San Joaquin Valley. The areas with the greatest deficit of composting capacity compared to the generation of compostable materials in California is the southern-most part of the State, which includes the Inland Empire and the counties of Orange, San Diego, and Ventura.

There are currently 60 large composting facilities permitted by CalRecycle processing about 4.5 million tpy or more of compostable materials from the solid waste stream. There are an additional 20 very small permitted composting facilities that process just over 600,000 tons per year. The remaining 100 composting facilities are primarily only authorized to handle agricultural materials, and generally do not accept materials from the solid waste sector.[37]

Of the 80 composting facilities mentioned above, only 35 are permitted to process food waste. Facilities processing food waste are typically designed with emissions control technologies such as fabric-covered, ASPs or biofilters. In addition, the facilities have comprehensive solid waste permits that allow for a wide variety of feedstock materials and increased regulatory oversight. The 20 largest composting facilities in California currently handle a little more than of green and food waste currently being composted annually.

[37] CalRecycle. Solid Waste Information System (SWIS) search webpage. http://www.calrecycle.ca.gov/swfacilities/directory/search.aspx.

Expected Infrastructure Needs

Organic waste streams are composed of various types of naturally degradable materials, and composting is just one of the main processes available to manage them. CalRecycle (see Table 1 below; see Appendix E for background on analysis) predicts that composting will be the primary pathway to manage the newly diverted 3.7 million tpy of the compostable paper, leaves and grasses, prunings and trimmings, and alternative daily cover. In addition, Table 1 shows that roughly four million tpy of food waste will be managed by anaerobic digestion or composting. Assuming that composting will need to manage a fraction of that four million tpy in the form of digestate, then composting may need to process around an additional 5.3 million tpy of organic waste materials.

Table 1. Potential Organic Material Pathways to Meet the 75% Diversion Target.[38]

Organic Waste Material Type	2014 Waste (Wet Tons)	Estimated Distribution of Organic Waste (Wet Tons)					
		Landfill	Reduction or Recycle	Food Recovery	Compost	Anaerobic Digestion or Compost	Chip & Grind
Compostable Paper	2,093,462	628,039	209,346		1,256,077		
Food	5,591,179	385,791		1,118,236		4,087,152	
Leaves and Grasses	1,172,925				586,463	586,463	
Prunings and Trimmings	962,262				962,262		
Branches and Stumps	528,493	396,370					132,123
Lumber	3,676,710	1,103,013	367,671				2,206,026
Remainder/ Composite Organic	1,323,465	1,323,465					
Alternative Daily Cover	1,294,515	388,355			906,161		
2014 TOTAL	**16,643,011**	**4,225,032**	**577,017**	**1,118,236**	**3,710,962**	**4,673,614**	**2,338,149**
Percent of 2014 Waste	**25%**	**75%**					

In an analysis conducted by CalRecycle in 2017 (see Appendix E for details), staff attempted to predict where the significant infrastructure expansion might need to occur to process the approximately 5.3 million tpy of additional compostable materials. Table 2 is based on the location of waste generation within each air district boundary and represents another perspective of the total amount of additional waste that will need to be diverted from landfills to compost facilities. This analysis shows additional diversion of the roughly 5.3 million tpy that

[38] CARB. March 2017. Short-Lived Climate Pollutant Reduction Strategy, Appendix F, Table 26. https://www.arb.ca.gov/cc/shortlived/meetings/03142017/appendixf.pdf.

will be needed, and is in good agreement with the waste diversion analysis found in the SLCP Strategy regarding the types and quantities of material that will need to be diverted to meet SLCP reduction goals.

Table 2 shows two scenarios based on current organic waste generation rates, and illustrates potential infrastructure needs, and where this material may need to be composted instead of being landfilled. The first scenario is based on the assumption that all the waste will be composted in the air district where it is generated. This assumption provides for distributed organic waste materials management where each local county manages their own materials. The first scenario might reduce trucking miles traveled, and reduce emissions from transportation. The second scenario uses a business as usual (what is already occurring) assumption that a portion of the generated waste is currently transported out of the district, whether for composting or landfilling. Scenario two assumes that Los Angeles County and Orange County will retain and process about 25 to 30 percent of the material they generate, that Alameda County and Santa Clara County will retain and process approximately 50 percent of the material they generate, and that the remainder of the material generated by these counties will be exported to other air districts for composting. The assumptions of material transport in the second scenario are conservative and is only one of the possible scenarios that could occur. The actual number of facilities within each district will be determined by a number of factors, including ability to site a facility (land use and CEQA issues) and permit a facility. The issue of material transport will be discussed in further detail later in this document.

This approach might not change the overall trucking miles traveled, keeping trucking emissions roughly the same by locating new facilities closer to organic waste material generators, and or using zero/low emissions vehicles to transport the material. This is briefly discussed later in this document, but warrants further analysis.

Regardless of where these materials are processed, a total of roughly 75 to 100 new compost facilities, each processing an average annual throughput of 60,000 tons of material, will be needed statewide regardless of where the material is composted.

Table 2. Two Scenarios that Estimate New Compost Facilities Needed in Air Districts by the year 2025.

Air Districts	Scenario 1: Organic Materials are Composted Within the Air District That They Were Generated		Scenario 2: Some Organic Materials are Exported to Adjacent Air Districts for Composting	
	Additional Organic Material Diverted from Landfills (TPY)	Number of New Compost Facilities[1] Needed to Process Diverted Materials	Additional Organic Material Diverted from Landfills (TPY)	Number of New Compost Facilities[1] Needed to Process Diverted Materials
Bay Area	900,000	15	700,000	12
Imperial	40,000	1	200,000	3
Mojave Desert	35,000	1	125,000	2
Sacramento Metro	230,000	4	230,000	4
San Diego	600,000	10	400,000	7
San Joaquin Valley	300,000	5	700,000	12
South Coast	2,600,000	43	2,300,000	38
Ventura	145,000	2	145,000	2
All other air districts[2]	450,000	8	500,000	8
Grand Total	**5,300,000**	**88**	**5,300,000**	**88**

[1] Assumes new compost facilities process 60,000 tons per year.
[2] All other air districts will need less than one new facility per air district based the diversion of organic waste materials predicted in these scenarios.

Most of the new composting infrastructure will likely be located in the Bay Area, San Diego, San Joaquin Valley, and South Coast Air Districts. Figure 3's two maps show the approximate number of new compost facilities in each air district for both of the scenarios presented above. The locations on the map with the red highlight will need the most new facilities (~15-45), followed by orange (~5-15), yellow (~1-5), and green (0-<1).

Scenario 1 **Scenario 2**

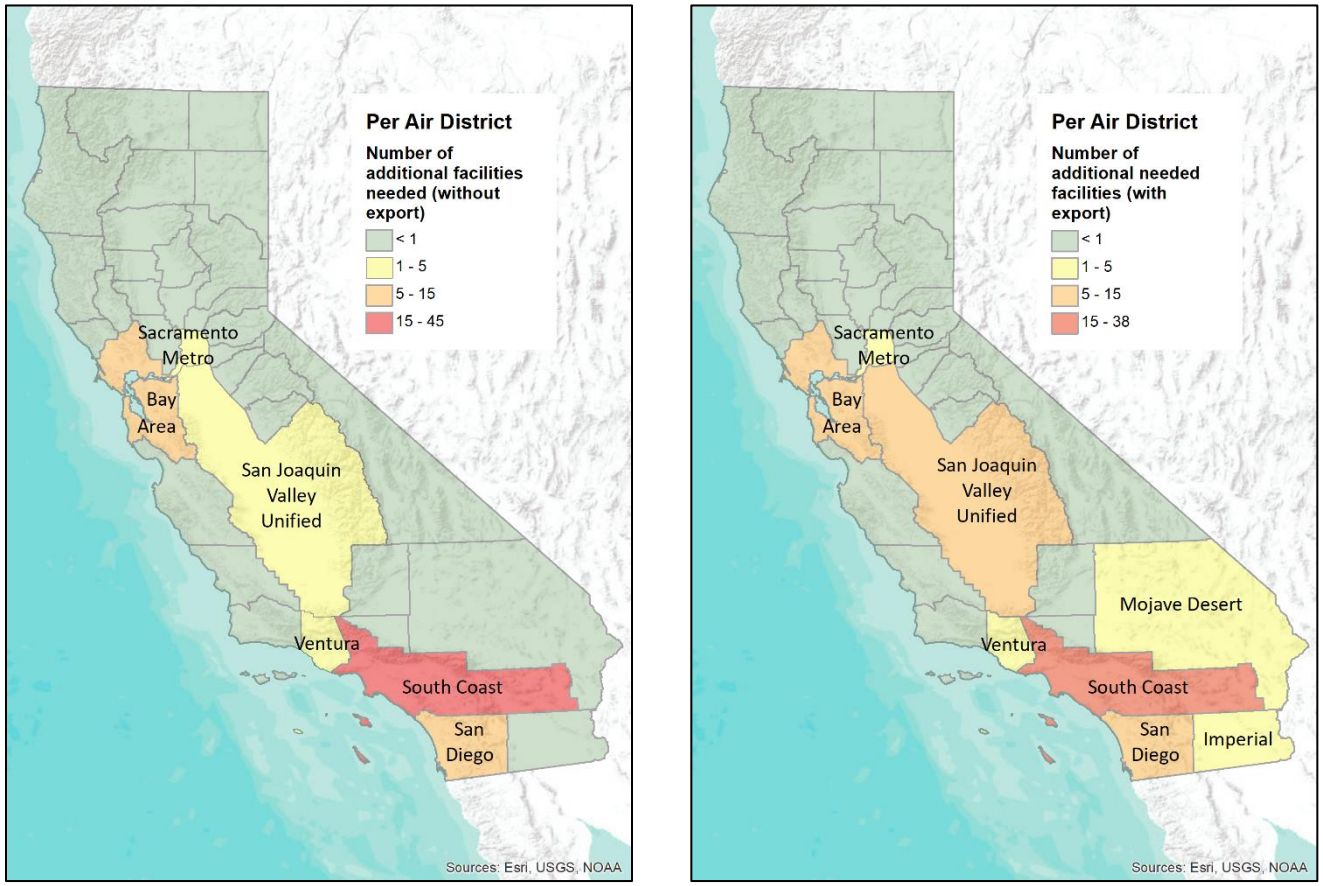

Figure 3. (Left side) Location and Number of New Compost Facilities by Air District with Compostable Materials Processed Within Jurisdiction of Origination. (Right side) Location and Number of New Compost Facilities by Air District with a Portion of Compostable Materials Moving Between Air Districts.

IV. Air Quality Impacts from Composting and Management Methods

The composting process results in the emission of various pollutants, including GHGs, criteria air pollutants or their precursors, and TACs. The amounts and types of emissions depend on a number of variables such as the feedstock composition, age of the pile, temperature, sunlight, oxygen content, humidity, and pH.

GHG Emissions from Composting Process

Composting piles emit small amounts of CO_2, CH_4, and even smaller amounts of nitrous oxide (N_2O).[39] A number of studies have been conducted, or are being conducted, that measure the GHG emissions from compost piles as well as BMPs to mitigate emissions. In one study performed for the San Joaquin Valley Air Pollution Control District (SJVAPCD), a 12-inch-thick compost cap biofilter reduced N_2O emissions by nearly 88 percent, CH_4 emissions by 13 percent, and overall CO_2e by 65 percent.[40] Other research studies are still underway, including one conducted by University of California Berkeley researchers for the 4th California Climate Change Assessment due to be published at the end of August 2018.

Methane emissions from composting are indicative of anaerobic conditions, which are caused by a lack of oxygen typically due to poor pile construction, excessive moisture, or poor pile management. N_2O emissions are somewhat correlated with excessively hot and dry compost, but are thought to be relatively insignificant when compared to the prevented CH_4 emissions from not landfilling organic waste. CARB staff determined that the average emissions rates during composting for both N_2O and CH_4 are 0.07 $MTCO_2e$ per short ton of feedstock, which are significantly less than the prevented CH_4 emissions of 0.30 $MTCO_2e$ from not landfilling the mixed organic waste.[41]

Soil Carbon Storage from Compost Application

One of the benefits of composting organic materials compared to landfilling is the creation of a useful soil amendment. The GHG benefit of using compost as a soil amendment includes storing carbon. USDA's Natural Resources Conservation Services (NRCS) determined carbon storage potential of a number of soil conservation practices that include storing 1.00 - 1.75 Mg

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[39] Horwath, WR; Barker, XZ; Bailey, S; Burger, M; Kent, ER; Paw U, KT. October 2015. Research to Evaluate Nitrous Oxide (N_2O) Emissions from Compost in Support of AB 32 Scoping Plan Composting Measure. Calrecycle Publication No. DRRR-2015-1544. http://www.calrecycle.ca.gov/Publications/Documents/1544/201501544.pdf.

[40] San Joaquin Valley Technology Advancement Program (SJVTAP). May 2013. Greenwaste Compost Site Emissions Reductions from Solar-powered Aeration and Biofilter Layer. http://www.valleyair.org/Grant_Programs/TAP/documents/C-15636-ACP/C-15636_ACP_FinalReport.pdf.

[41] CARB. May 2017. Final Draft Method for Estimating Greenhouse Gas Emission Reductions from Diversion of Organic Waste from Landfills to Compost Facilities. https://www.arb.ca.gov/cc/waste/cerffinal.pdf....

C/ha-yr.[42] Two conservation practice standards (CPS) estimating GHG benefits for compost and mulch already exist within COMET-Planner,[43] a tool developed for estimating GHG benefits for cropland management: CPS 484 – Mulching and CPS 590 – Replacing Synthetic Nitrogen Fertilizer with Soil Amendments. Additionally, Marin Carbon Project[44] and UC Berkeley have developed a free online tool called Compost-Planner[45] that estimates the carbon benefits of applying compost to croplands and rangelands. This tool is used by applicants who are applying for CDFA's Healthy Soils Initiative grant funding.[46,47]

VOC Emissions from Composting Process

VOCs are emitted as a result of decomposition of organic material within active compost piles and also directly from feedstock when it is stockpiled. The majority of VOC emissions occur during the first few weeks of the active composting phase that typically lasts between eight and twelve weeks. The type of feedstock determines the composition of VOCs emitted. VOCs are regulated under the federal CAA as a precursor to ground-level ozone, a component of smog. The two largest air districts (SJVAPCD and SCAQMD) have adopted emissions factors for composting operations that average around five pounds of VOC per ton of feedstock.[48,49].

Researchers have determined that VOCs have a range of potential to contribute to the formation of ground-level ozone[50] with some having a much greater potential than others, and, as such, created a maximum incremental reactivity scale (MIR). According to one study, over

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[42] Swan, A; Williams, SA; Brown, K; Chambers, A; Creque, J; Wick, J; Paustian, K. 2015. COMET-Planner Carbon and Greenhouse Gas Evaluation for NRCS Conservation Practice Planning. http://comet-planner.nrel.colostate.edu/COMET-Planner_Report_Final.pdf.

[43] NRCS, COMET-Planner, Carbon and greenhouse gas evaluation for NRCS conservation practice planning – A companion report to www.comet-planner.com.http://scc.ca.gov/webmaster/ftp/pdf/sccbb/2017/1704/20170427Board03B_Carbon_Farming_Ex2.pdf

[44] Marin Carbon Project webpage. Soil Carbon Measurement & Modeling. https://www.marincarbonproject.org/science/measurement--models.

[45] Compost Planner webpage. Tool to estimate net greenhouse gas benefits from applying compost to cropland and grassland: http://www.compost-planner.com/.

[46] Marin Carbon Project webpage. Soil Carbon Measurement & Modeling. https://www.marincarbonproject.org/science/measurement--models.

[47] CARB. Greenhouse Gas Quantification Methodology for the California Department of Food and Agriculture Healthy Soils Program, Greenhouse Gas Reduction Fund (2016-17). https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/cdfahsfinalqm16-17.pdf?_ga=2.18508793.1509302341.1526407907-1714282302.1476286804.

[48] South Coast Air Quality Management District. July 8, 2011. Emission Reductions from Greenwaste Composting Operations, Rule 1133.3. https://www.arb.ca.gov/DRDB/SC/CURHTML/R1133-3.PDF.

[49] San Joaquin Valley Unified Air Pollution Control District. August 18, 2011. Organic Material Composting Operations, Rule 4566. https://www.arb.ca.gov/drdb/sju/curhtml/R4566.PDF.

[50] Carter, W. June 22, 2009. Updated Maximum Incremental Reactivity Scale and Hydrocarbon Bin Reactivities for Regulatory Application. CARB Contract 07-339. https://www.arb.ca.gov/research/reactivity/mir09.pdf.

70 percent of emissions from composting are low-ozone forming alcohols with MIR of 1.53 or less (see Appendix H for list). This reactivity profile appears to be unique to the controlled decomposition of the composting process. For example, research on similar feedstock (greenwaste materials) in an uncontrolled degradation process of direct land application showed that VOC emissions are higher MIR monoterpenes representing about 50 percent of emissions with a MIR in the range of 3–5.[51]

In addition, research conducted at San Diego State University suggests that a managed composting process produces fewer VOC emissions than when organic materials are land applied or decay in situ.[52] UC Davis researchers found low reactive VOCs (primarily alcohols) dominated the emissions profile (over 70 percent of emissions) over other VOC compounds.[53]. Additional research at UC Davis corroborated San Diego State University's research findings that composting VOC emission profiles have a lower general reactivity than when similar feedstocks are land applied as mulch.[54]

For landfills, joint research by CARB and CalRecycle is underway to speciate VOCs from landfills in order to determine the quantity, type, and reactivity of VOCs from that anaerobic degradation process which takes place in an uncontrolled environment compared to composting.

Previous studies of composting emissions by CalRecycle found that 70-80 percent of all composting VOCs were emitted during the first two weeks of the process)[55]. This same study found that 70-85 percent of all composting emissions occurred on the top of the windrow, as opposed to the sides or toe. It also found that a compost cap composed of finish compost placed over the ridgeline of a well-managed windrow reduced VOC emissions by about 75 percent over the first two weeks of composting.

Several subsequent studies validated the efficacy of the compost cap to reduce VOCs. In one study, funded by the SJVAPCD a 12" thick compost cap on top of a large, positively-aerated pile (air forced into the pile) reduced VOC emissions by more than 98 percent when compared

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[51] US EPA. Tables of Maximum Incremental Reactivity (MIR) Values, Subchapter 8.6, Article 1., 94700, MIR Values for Compounds. https://www3.epa.gov/region9/CA-Air-SIP/California%20Code%20of%20Regulations/Title%2017,%20Division%203,%20Chapter%201,%20Subchapter%208.6,%20Article%201,%20Sections%2094700%20-%2094701.pdf.

[52] Buyuksonmez, F, and Evans, J. 2007.

[53] Kumar, A.; Alaimo, CP; Horowitz, R; Mitloeher, FM; Kleeman, MJ; Green PG. 2011. Volatile organic compound emissions from green waste composting: Characterization and ozone formation, Atmos.. Env. 45: 1841-1848. https://pdfs.semanticscholar.org/1473/f7f0780c407a510a56d70bed59afcc9da402.pdf.

[54] Burger, M; Zhu-Barker, X; and Green, PG. July 2015. Research to Evaluate Environmental Impacts or Direct Land Application of Uncomposted Green and Woody Wastes on Air and Water Quality, CalRecycle Publication DRRR-2015-1531. https://www2.calrecycle.ca.gov/Publications/Details/1531.

[55] California Integrated Waste Management Board. 2007/2008. Emissions Testing of Volatile Organic Compounds from Greenwaste Compost at the Modesto Compost Facility in the San Joaquin Valley. Publication No. 442-2007-0009. https://www2.calrecycle.ca.gov/Publications/Details/1263.

to the control windrow.[56] This was under very hot summer conditions and the compost cap was watered several times a day using an irrigation system placed on top. This project is discussed in more detail below in the section on Air Emissions Control Technologies. This study both validated the use of a compost cap as a biofilter, and an earlier study performed for Valley Air, which indicated that keeping the top of the windrow wet was an effective VOC control measure. Additional information on relevant research can be found at CalRecycle's website.[57]

Ammonia

Ammonia is a regulated air pollutant under the CAA, and is a source of odor. It contributes to fine particulate formation, or $PM_{2.5}$, which is also an air pollutant regulated under the CAA. NH_3 emissions are a concern when composting significant amounts of manure, biosolids, or other high-nitrogen feedstock. If compost operations receiving high-nitrogen feedstocks do not use a sufficient amount of bulking agents containing readily available carbon, such as finely ground wood or sawdust, the composting piles will release NH_3 to the atmosphere. This is a particular concern with agricultural composting operations located on dairies and feedlots. Agricultural composting operations are excluded from solid waste regulations because they only compost materials generated on their own site and return all of those materials to their own site (or a site owned by the parent company).

The same technique proven effective against VOCs—biofiltration—also reduces NH_3 emissions. Biofiltration uses a bioreactor containing living material to capture and biologically degrade pollutants. Various biofilter materials possess different filtering abilities. For example, in the Tulare study performed for SJVAPCD, the biofilter of 12-inches of finished compost that rested as a cap on top of the compost windrow, reduced NH_3 emissions by 53-83 percent, depending on the test method used. [58]

Odors

Compost facilities can create odors that are closely associated with the type of feedstocks used and anaerobic conditions caused by poor pile management. Odors are subjective; some people tolerate the orange smell created from the VOC d-limonene or the pine smell from alpha-pinene VOC emissions. However, sometimes other composting odors can be perceived as objectionable, especially the so-called "rotten egg" compounds that form in an anaerobic environment when sulfurous compounds decay. Materials higher in nitrogen and/or sulfur, such as food waste, liquid wastes (especially ones that contain grease or oils), manures, and biosolids, have the greatest potential for creating offensive odors.

Although feedstock composition can determine odor to a large extent, management practices can also have a large impact, and in some cases mitigate odor production. Well-constructed, properly aerated piles produce fewer odors. Balancing the carbon and nitrogen of the initial

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[56] SJVTAP, 2013.

[57] CalRecycle. Air Emissions Reduction from Composting and Related Facilities webpage. http://www.calrecycle.ca.gov/organics/Air/default.htm.

[58] SJVTAP, 2013.

feedstock, and ensuring particle size is large enough to allow airflow, helps mitigate odors. Offensive odors from food and liquid wastes can be minimized by incorporating the wastes into a composting pile on the same day they are received. Water retention basins, if not aerated, can also produce strong odors.

California regulation requires compost facilities to have an Odor Impact Management Plan.[59] These plans, and complaints arising from composting site odors, are managed by the CalRecycle-delegated LEA, which is usually the county environmental health office.

Impacts from Transportation

One of the main sources of emissions from the composting process occurs during the collection of the initial feedstock and delivery of the finished compost. These emissions occur when fossil fuels are combusted in heavy-duty vehicles that collect and transport yard trimmings and food waste to a composting facility, and when the finished compost from the composting facility is delivered to its final destination. The two main air pollutants of concern stemming from transportation emissions are oxides of nitrogen (NO_x, a ground-level ozone pre-cursor and criteria air pollutant, and for diesel-fueled vehicles, diesel particulate matter (PM), a TAC.

The impact of shifting management of organic materials from landfills to compost facilities is unknown at this time, in part, because we do not know where the new compost facilities will be sited. It is possible that transportation emissions will not increase, because the organic waste materials are already being collected and transported to landfills, often at great distances from the point of waste generation. If compost facilities were sited closer to the areas where the organic waste material is being generated, transportation emissions could decrease. Likewise, if new compost facilities need to be sited significantly further away than the landfills the waste currently goes to, the transportation emissions could similarly increase. These potential increased emissions could be mitigated by the use of lower emissions trucks.

A thorough discussion of GHG emissions associated with collection of feedstock and delivery of compost is provided in CARB's report on methods for estimating GHG emissions reductions from diversion of organic waste materials from landfills to compost facilities[60]. In this study, CARB found that the average statewide transportation emissions for the feedstock collection (inbound) and compost delivery (outbound) are functionally equivalent to landfilling the same organic waste. While one might extrapolate that this would be similar for NO_x and diesel PM emission, further modeling to better understand the impact siting might have on these transportation-related emissions may be valuable in assessing total potential shift in emissions.

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[59] California Code of Regulations, 17863.4 Odor Impact Minimization Plan (14 CCR, Section 17863.4). https://govt.westlaw.com/calregs/Document/I31D188B73FF04F7599512C43DAE2E0B1?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default).

[60] CARB. May 2017. Final Draft Method for Estimating Greenhouse Gas Emission Reductions from Diversion of Organic Waste from Landfills to Compost Facilities. https://www.arb.ca.gov/cc/waste/cerffinal.pdf.

Air Emissions Control Technologies

Equipment Control Technologies

Emissions from compost operations can be reduced in one of two ways—either through reducing emissions from equipment used at the facility (e.g., by converting from diesel-power to electric-powered equipment, or using solar-powered blowers for ASPs), or by reducing emissions from compost piles themselves. Operators, regulators, and researchers alike have found the most effective method for reducing emissions from compost piles is by aerating them, covering them, maintaining proper moisture content, and using biofilters. Forcing air through the piles, using either a positive (pushing air up through the pile) or negative (puling air down through the pile) aeration system with a pump, maintains aerobic conditions within the piles. Covering piles using breathable fabrics or a finished compost cap, reduces odors as well as VOCs and NH_3 emissions from the piles. The finished compost cap on compost piles for a positively aerated pile, or a biofilter of mulch (or other binding material) for negatively aerated piles, further reduces emissions.[61]

Mitigation measures for reducing VOCs from composting are also reasonably effective at reducing GHGs from composting.

Effectiveness of Control Technologies

In 2012, CalRecycle partnered with the Association of Compost Producers, the City of Bakersfield, and O2 Compost, and emissions' consultants Chuck Schmidt and Tom Card to test the potential emissions reductions from using a small-horsepower positive aeration system connected to a photovoltaic power system, in conjunction with a biofilter compost cap for emissions control.[62] The project was funded by the SJVAPCD through its Technology Advancement Program. The project was hosted by Harvest Power at its Tulare location. Kevin Barnes, compost site manager for the City of Bakersfield, designed and built an electric conveyor system to move feedstocks directly from the grinder to the pile without the use of diesel power.

The project showed VOC emissions reductions of nearly 99 percent for the aerated system, along with significant reductions in NH_3 and GHG emissions, when compared to conventional windrow composting the same feedstock materials on the same day. Diesel use for pile construction and active-phase management was reduced by 87 percent when compared to conventional windrows. Water savings from the ASP system averaged around 20 percent, and the footprint was 55 percent smaller than that required by conventional windrows. Compost produced through the advanced technology ASP system was similar in quality and maturity to the product from conventionally managed windrows after 30 days.

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[61] CalRecycle. Organics - Covered and Aerated Compost Systems, webpage. http://www.calrecycle.ca.gov/organics/Processors/Systems/default.htm.

[62] SJVTAP. 2013.

Best Management Practices

Significant emission reductions can be achieved at compost facilities by employing BMPs such as aerating, covering, proper pile geometry, sustaining sufficient residence time, and maintaining optimal temperature and moisture of the piles. CalRecycle, air districts, and compost facility operators have studied these BMPs. The emissions reductions range from 40 to 99 percent for VOCs, and 20 to 95 percent for NH_3, depending on the BMP used. The more comprehensive the BMP system and the better managed a system is, the greater the reductions that can be achieved.

Large-scale composting comes with some challenges that exist at all facilities that handle organic waste materials, since the degradation of organic materials occurs regardless of whether the material is stockpiled or actively managed for compost. One of the ways to reduce emissions of criteria air pollutants and GHGs are to use an ASP system, that either draws air through the pile (negative ASP) and out a piping system to a biofilter composed of absorbent materials, or pushes air through the pile capped with a pseudobiofilter (positive ASP). ASP is used as a BMP at a number of compost facilities, and is likely to become the industry standard instead of conventional open windrows.[63] Some ASP piles are covered with breathable fabrics (e.g., Gore® cover) while others are capped with a biofilter comprised of wood chips, finished compost, or soil. A biofiltration system relies on microorganisms that live on the surfaces of cover materials and degrade ammonia and VOCs, reducing emissions. A negative pressure aeration system will also install a biofilter at the end of a pipe. The air pollutants pass through the biofilter and are reduced by microorganisms in the media, thus minimizing the VOC and ammonia emissions from the pile. Additionally, forced aeration helps avoid anaerobic conditions created by the restricted convective airflow due to the cover or pile size.

Three California air districts have regulations in place to reduce emissions from compost facilities by employing BMPs: SCAQMD, Antelope Valley Air Quality Management District (AVAQMD), and SJVAPCD. SCAQMD's Rule 1133.3[64] requires compost facilities to cover active piles with a pseudobiofilter cap of at least six inches of finished compost and ensure sufficient water content of the pile for optimal composting. Rule 1133[65] in AVAQMD establishes a BMP similar to SCAQMD's that includes establishing the optimal carbon-to nitrogen ratio of not less than 20:1, and maintaining moisture content between 40 and 70 percent, or covering the active and curing piles with a waterproof cover (e.g., Gore cover), at least six inches of finished compost, or at least six inches of soil. SJVAPCD's Rule 4566[66] has

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[63] CalRecycle. Organics - Covered and Aerated Compost Systems, webpage. http://www.calrecycle.ca.gov/Organics/Processors/Systems/default.htm.

[64] South Coast Air Quality Management District. July 8, 2011. Emission Reductions from Greenwaste Composting Operations, Rule 1133.3. https://www.arb.ca.gov/DRDB/SC/CURHTML/R1133-3.PDF.

[65] South Coast Air Quality Management District. July 8, 2011. Emission Reductions from Greenwaste Composting Operations, Rule 1133.3. https://www.arb.ca.gov/DRDB/SC/CURHTML/R1133-3.PDF.

[66] San Joaquin Valley Unified Air Pollution Control District. August 18, 2011. Organic Material Composting Operations, Rule 4566. http://www.valleyair.org/rules/currntrules/Rule4566CleanRule.pdf.

similar BMPs meant to reduce VOC emissions from composting. Rule 4566 addresses emissions reductions based on operation sizes. Smaller operations (processing less than 100,000 tpy) of material are required to reduce VOC emissions by 19 percent, and larger operations (processing greater than 750,000 tpy of material) are required to reduce VOC emissions by 80 percent. Further, Rule 4566 includes the following three BMPs: covering the organic material with a securely anchored waterproof cover with at least a six-foot overlap of adjacent sheets or finished compost cover, turning the pile a minimum of three times during the active composting phase, and using a water system to maintain optimal water content for composting. Using these BMPs optimizes the composting process, thus reducing conditions that could lead to anaerobic conditions and CH_4 emissions.

V. Overview of Air Quality Permitting and Regulatory Requirements for New and Existing California Compost Facilities

This chapter contains information about air quality laws, permitting processes, and regulatory requirements that apply to new and existing composting facilities in California. Laws at the federal, state, and local government levels define how sources of air pollution—such as composting operations–are controlled to meet national and state ambient air quality standards.

Local air districts are the primary air quality regulatory authority for composting operations.[67] Federal and state air emissions requirements that apply to composting operations are generally administered through the local air districts. Therefore, project developers should make the local air district their primary point of contact for ensuring their project complies with all applicable air quality permitting requirements.

Federal

The federal CAA requires the United States Environmental Protection Agency (U.S. EPA) to protect public health and the environment by implementing and enforcing its provisions. The CAA gives states the primary responsibility to clean the air, but the U.S. EPA has oversight authority to ensure that states implement the provisions of the CAA.

To demonstrate attainment of federal ambient air quality standards, each state must submit a state implementation plan (SIP) to the U.S. EPA that describes the blueprint for how the state will achieve or maintain air quality that satisfies federal ambient air quality standards. The SIP includes technical information about emission inventories and air quality monitoring, control measures and strategies, and enforcement mechanisms. The SIP is also composed of local air quality management plans in addition to state and local air quality regulations.

The U.S. EPA also requires local air districts to implement the federal Title V operating permit process. This process requires local air districts to include all federally required permit terms and conditions in the Title V permit for all stationary sources that meet the federal definition of major source of air pollution. A major difference between state and federal law for stationary sources of air pollution is that Title V permits must go through a public notice and comment process before the permit can be granted, and smaller sources are not subject to the public notice requirements.

The U.S. EPA uses a lowest achievable emissions rate (LAER) that has been achieved in practice to determine if criteria air pollutant emissions emitted by a new or modified major stationary source or category of equipment types are acceptable for the SIP. The local air district must consider LAER requirements when a new stationary source, such as a composting facility, is located in a non-attainment air basin.

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[67] U.S. EPA retains air permitting authority, however, on tribal lands. U.S. EPA also retains authority to issue Prevention of Significant Deterioration permits for certain local air districts in California.

The federal CAA has provisions for regulating emissions of hazardous air pollutants (HAPs) and includes a list of approximately 189 substances. The U.S. EPA publishes a list of categories for which standards are be issued. A schedule and list of deadlines for U.S. EPA issuance of standards for each of the categories is listed in the Federal Register. Title V major new sources are expected to meet maximum achievable control technology (MACT). For the MACT standard of a particular source category, U.S. EPA looks at the levels of emissions control currently being achieved in industry practice. These emissions levels set a baseline for the MACT standard. In addition, any sources that emit HAPs that are not defined as a Title V major source are considered an "area source." If categorized as an area source of emissions, then the source must meet generally available control technology (GACT) requirements established by U.S. EPA, which are not defined explicitly in federal law.

Table 3. Federal Air Regulations Pertinent to Composting Operations.

Requirement(s)	Reference	Applies to composting operations?
New Source Performance Standards (NSPS)[68]	Section 111 CAA and 40 CFR 60	As of the date of this document, no NSPS, NESHAP, or MACT standards apply to the composting piles or non-road internal combustion (IC) engines typically used in composting operations (e.g., IC engines powering portable screens, and chippers). However, because the composting operation may include equipment other than compost piles and non-road IC engines, and new standards may be added over time, the permitting authority will always need to conduct a review of all stationary sources of air contaminants and potentially applicable requirements.
National Emissions Standards for Hazardous Air Pollutants (NESHAP)	Section 112 CAA and 40 CFR 61	
Maximum Achievable Control Technology (MACT)	Section 112 CAA and 40 CFR 63	
Federal operating permit[69]	Title V CAA	Yes, <u>if</u> the potential to emit (of non-fugitive emissions) is above the major source threshold of any regulated New Source Review pollutant (which depends on the non-attainment classification of the air basin), or 10 tpy or more of any one HAP, or 25 tpy or more of any combination of HAPs.

State

CARB is the state-level air pollution control agency. CARB implements the laws enacted by the California Legislature in the California Health and Safety Code and regulations

[68] Local air district may be delegated enforcement of all or some NSPS, NESHAP, and MACT standards: https://www.epa.gov/caa-permitting/air-standards-delegations-region-9,

[69] All California air districts are delegated Title V permitting authority with UEPA oversight. U.SEPA is both the New Source Review and Title V permitting authority on tribal lands.

promulgated by the U.S. EPA to do what is necessary to meet the requirements of the state and federal CAAs. CARB must adopt rules and regulations to implement the laws. Both state and federal law address pollutants such as ozone, criteria air pollutants, and toxic pollutants such as benzene, TACs, and HAPs.

CARB oversees compliance with state and federal clean air laws by working as a clean air partner with California's 35 local air districts. The U.S. EPA, CARB, and the local air districts work very closely together to complement each other's efforts to achieve clean air. CARB and the local air districts frequently work together on many air quality programs throughout California, including the development of SIPs for achieving the National Ambient Air Quality Standards.

Table 4. State Air Regulations Pertinent to Composting Operations.

Requirement(s)	Reference	Applies to composting operations?
Portable Diesel Engine Airborne Toxic Control Measure (ATCM)	17 California Code of Regulations (CCR) § 93116	Yes, to IC engines (50 brake horsepower and greater) typically used to power compost screens and wood chippers.
Portable Equipment Registration Program (PERP)	13 CCR § 2450	Check with local air district. PERP registration may not be acceptable in lieu of district permitting requirements for equipment that is permanently or periodically operated at the composting site.
AB 2588 Air Toxics Hot Spots	HSC 44300-44384	Yes. Annual air toxics emissions reporting requirement administered by local air districts. Facilities causing significant adverse local health impacts may have further requirements to conduct a health risk assessment, notify the affected public, and develop a risk reduction plan.

Local

At the local level, the air districts issue permits to operate for most businesses that emit air pollutants. These permits have conditions that the business must follow that may include limits on the amount of pollution that can be emitted, the type of pollution control equipment that must be installed and maintained, emissions tests that may be required to quantify emissions from and verify performance of such pollution control equipment, and various record keeping requirements with which the facility must comply. As part of this permitting process, local air districts' rules to meet federal and state requirements for New Source Review (NSR) programs may be applicable to sources of air pollution. These rules are intended to improve or maintain a region's air quality by assuring that new emissions from new and modified facilities do not slow progress toward cleaner air or worsen air quality in regions that attain air quality standards. The best available control technology (BACT) provisions of NSR provide assurance that emissions from any large new or modified industrial source will be stringently controlled.

Additionally, if new construction or modification results in the facility exceeding an air district's NSR offset thresholds, then the facility must either reduce emissions elsewhere at the facility or obtain emission reduction credits in amounts greater than the direct emissions increase. These credits must be obtained from within the region or from areas close by, thus mitigating the increase in emissions at the facility in terms of regional air quality.

General Regulatory and Permit Requirements and Challenges

Permits allow a district to more easily carry out application and enforcement of prohibitory rules. Permitting requirements provide a mechanism for siting a new source or modifying an existing source without causing a new, or exacerbating an existing, violation of an air quality standard. With regard to emissions of nonattainment pollutants, one of the primary reasons for a permitting program is to prevent emissions from new and modified sources from countering gains in emissions reductions from existing sources through control measures in the local air quality plan.

District Evaluation of a Project

SJVAPCD and SCAQMD have rules that directly regulate composting operations. Other air districts, while not having compost-specific rules, permit composting operations under general permitting requirements. Still other, mostly small rural air districts generally do not require an air quality permit. This is because emissions from composting operations may not significantly contribute to local air quality issues, or are considered fugitive emissions. Fugitive emissions are those emissions that are not technologically or cost effectively capable of being collected and controlled. However, as composting operations increase in number and the technology to capture and control VOC emissions is more widespread, it is anticipated that more air districts will begin to regulate them.

For projects requiring air quality permits, districts perform an engineering analysis to assess emissions and air quality impacts, as well as to document compliance of the project with all applicable local, state, and federal requirements. This analysis demonstrates that the composting operation and related equipment will not prevent or interfere with the attainment or maintenance of any applicable air quality standard.

In addition, since approvals are conditional, the analysis supports the decision of whether or not to issue authority-to-construct (ATC) permits for proposed equipment. Conditions on the ATC will limit emissions and ensure proposed equipment will comply with all applicable air quality regulations.

The Permitting Process

Although the permitting process differs by district, there is a fair amount of inter-district consistency. The permitting process starts with the submittal of an application. The required contents of an application are normally listed in the district rules and regulations, or a list of such contents is available upon request from the district.

After defining the project and specifying proposed equipment, the applicant must calculate emissions from each individual component source and the total emissions from the project to determine the applicability of various permitting requirements.

If NSR requires it, the applicant must propose BACT in the permit application. The applicant may be required to conduct a survey to determine what methods, measures, or control technologies are available for control of emissions. In some cases, alternative basic equipment, processes, and fuels will be considered in addition to emissions control technologies. The analysis would also include a justification that the applicant's proposed technology meets BACT.

The applicant must submit to the district the required data with the appropriate forms and fees. Per state law, the district has 30 days to determine if the application is complete. If the application is deemed incomplete, the 30-day clock is stopped, and the district informs the applicant of what deficiencies make the application incomplete. The applicant can either provide this information, which would restart the 30-day clock, or submit a new application to the district. If a new application is submitted, the 30-day clock is reset, and the district has another 30 days to complete its evaluation.

After the district deems an application complete, it has, by state law, up to six months to process the application, though actual processing time may be much shorter. During the application review period, many districts will prepare an engineering analysis that includes emissions calculations, an analysis of whether the project will meet district, state, and federal air quality regulations, assumptions used to evaluate the acceptability of the project, and required conditions of design and operation to achieve and maintain compliance. If a project meets all applicable requirements, the district will then generate an ATC permit, which authorizes construction, but not operation, of proposed equipment. If the project is large (per district definition), a 30-day public review and comment period is also required before the district will issue an ATC. If public review and comment is required, the engineering analysis and proposed permits are made available to the public and, in some cases, other air quality regulatory agencies.

After consideration of all comments, the district may publish a decision to either approve the project application, issue final authorities to construct, or deny the application. Once an ATC is issued, the applicant may begin construction, and may even be authorized to conduct an operational shakedown of equipment. Normally, construction has to be completed within the life of the ATC.

Once the equipment is built, and the district is satisfied that it can operate in compliance with its regulations, permits to operate can be issued.

New Source Review

New Source Review regulates emissions from new construction of, and/or modifications to, industrial sources which emit, or will emit, air pollutants. In California, local air districts have the primary responsibility for implementation of the NSR program.

The California NSR permit program is derived from the California CAA. NSR requirements arising from California CAA are codified in the California Health and Safety Code at Division 26. Specific to NSR, each air district must include in its attainment plan a stationary source control program designed to achieve no net increase in emissions of nonattainment pollutants or their precursors for all new or modified sources that exceed particular emissions thresholds.

In addition, most new and modified stationary sources are required to use BACT, which is synonymous with the federal term LAER.

Each of the 35 air districts in California has its own NSR program. The stringency of each NSR program depends on the air district's non-attainment status.

SB 288 and NSR

The Protect California Air Act of 2003 (SB 288, Sher; Health and Safety Code sections 42500 through 42507) was enacted in response to federal regulations that weakened the federal NSR program. It was intended to maintain California's technology-based air quality program, prevent any weakening of the state's current NSR programs as a result of the federal amendments, and ensure progress towards attainment and maintenance of both state and national ambient air quality standards. The Act requires CARB to ensure that District NSR rules and regulations are at least as stringent as those that existed on December 30, 2002, and to undertake a public process to adopt rules necessary to maintain stringency if they are not.

SB 288 is essentially a "no backsliding" statute and establishes that, except in defined and limited circumstances, an air district may not amend its NSR rules to be less stringent that those that existed on December 30, 2002. The Act clarifies this general prohibition by specifying the elements of an air district's NSR rules, which include:

1. The applicability determination for NSR (i.e., the sources to which the NSR rules apply).
2. The definitions of "modification," "major modification," "routine maintenance," and "repair or replacement."
3. The calculation methodology, thresholds, or other procedures of NSR, and the methodology for determining baselines, calculating emissions changes, and offset amounts required.
4. The definitions and requirements of NSR regulations, which include requirements to obtain offsets.

The rule elements listed above may not be amended if doing so would "exempt, relax, or reduce the obligations of a source" with regard to the following requirements:

1. Any requirement to obtain a permit prior to construction.
2. Any requirement to apply BACT.
3. Any requirement to perform an air quality impact analysis.
4. Any requirement for monitoring, recordkeeping, and reporting if these would be less representative, enforceable, or publicly accessible.
5. Any requirement for regulating any air pollutant covered by the NSR rules, which includes the requirement to obtain offsets.
6. Any requirement for public participation prior to permit issuance.

Districts may amend their NSR rules, including revisions to the elements of the rules described above, if the amendments do not relax source obligations with regard to the listed requirements, or if the amendments make the rules more stringent.

Individual Air District Regulatory Approaches

Table 5 summarizes each air district's permitting approach, including relevant BACT requirements. More detailed information on each district's approach to permitting composting facilities can be found in Appendix G.

As of August 2018, SCAQMD and SJVAPCD require air quality permits for some composting operations and have adopted composting facility-specific rules to complement the requirements of their NSR rules. While the other air districts listed in Table 5 do not have composting facility-specific rules, other general permitting rules may be applicable to composting operations based on the size and emissions of the composting facility. In addition, San Diego County APCD (SDCAPCD), Bay Area AQMD (BAAQMD), and Ventura County APCD (VCAPCD) are currently developing composting facility-specific rules in anticipation of CalRecycle's organics diversion regulation.

Table 5. Individual Air District Regulatory Approaches

Air District	Relevant Rules[1]	VOC Offset Thresholds for New or Expanding Facilities	BACT Requirements
SCAQMD	Rule 1133.2 (co-composting with biosolids and/or animal waste), Rule 1133.3 greenwaste only; NSR Regulation XIII, Rules 1304, 317	>4 tpy VOC threshold after BACT	70% reduction by weight for existing operations, and 80% reduction by weight for new operations for VOCs and NH_3 (Rule 1133.2); 80% reduction by weight for VOC and NH_3 (Rule 1133.3)
SJVAPCD	Rule 4565 (animal manure, biosolids, poultry litter) & 4566 (organics); NSR Rule 2201	>10 tpy of VOC	Mitigation measures based on wet-tons of material processed to achieve reductions of 19%, 60%, 80% VOCs. Guidelines 6.4.7, 6.4.8, 6.4.9, & 6.4.11
BAAQMD	NSR Regulations 2, 2-1, 2-2, and 2-5; Other Regulations 6-1, 6-6, 8-2, and 11-18	≥ 10 tpy of VOC (small sites may qualify to use small facility banking account, if total site PTE is < 35 tpy)	
Sacramento Air Quality Management District	Rule 201; NSR Rule 202, Nuisance Rule 402, Dust Rules 403, 404, 405	>10 tpy of VOC	
MBARD	Rule 200 (ASP only); NSR Rules 207, 1000	≥137 pounds VOC per day and ≥ 10 tpy of VOC	
SDCAPCD	Rule 67.25 in development; NSR Rules 20.1, 20.2 and 20.3, 1200	> 50 tpy VOC (only required if permitted as a major source)	
VCAPCD	Rule 74.32 in development; NSR Rule 26, Nuisance Rule 51	≥5 tpy of VOC	

[1] Does not include relevant rules for portable equipment. Not all rules may apply.

VI. Key Issues in Permitting Composting Facilities

As discussed previously, there are many requirements to consider when permitting a composting facility, whether expanding an existing facility or building a new facility. This chapter details some of the key issues, including emissions offsets requirements, fugitive emissions, use of emission factors (EFs), and NSR thresholds. This chapter also includes additional topics related to permitting such as the general permit process timeline, financial considerations, interaction with CARB's AB 617 program and disadvantaged community requirements, and odors and other nuisances.

VOC Emissions Offsets

The need to offset VOC emissions is perhaps the most significant permitting challenge to expanding existing composting capacity throughout the State of California. Offsets help ensure that the air district is implementing a "no net emissions increase" program as required by state and federal law by "offsetting" emissions increases in one location with emissions decreases in another location. Formal recognition of these emissions decreases are called emission reduction credits (ERCs). In the context of composting operations, a facility owner may be required to make a one-time purchase of sufficient ERCs to offset projected emissions from processing organic feedstocks at new or expanded compost facilities in order to comply with NSR requirements. See Chapter V for a detailed discussion on NSR requirements.

How Emission Reduction Credits are Generated

ERCs can be created when a source shuts down or voluntarily reduces its emissions beyond those reductions that are required by air district, state, or federal rules and regulations. In addition to being voluntary (or surplus), these emissions reductions need to be real, permanent, quantifiable and enforceable, as defined by air district rules, to qualify as an ERC.

Twenty-five of the 35 air districts have ERC rules. Of these, SJVAPCD has a community bank for ERCs and sets aside ERCs for projects, and SCAQMD and BAAQMD have small facility banks, and SCAQMD exempts or has set-aside offsets for certain types of projects.

Factors That Determine the Amount of ERC Offsets Needed

The amount of ERCs needed to offset emissions is dependent on the following:

- NSR VOC Offset Trigger Threshold: What the air district's threshold for purchasing offsets is (and accompanying ERC rules),
- Compost VOC Emission Factors: What EFs are used to determine emissions from the piles of material at the composting facility (feedstock, active, and curing),
- Offset Factor: ERCs in excess of the increase are required to ensure a net air quality benefit or,
- Distance Ratios: ERCs are based on the distance between where the ERC was created and the new source of emissions' location, or
- Whether or not windrows are considered permitted units by the respective air district and, correspondingly, if windrow emissions have to be offset.

See Appendix G for specific air district approaches to determine the number of ERCs needed.

NSR VOC Offset Thresholds

As discussed previously, NSR requires emissions increases from new and modified facilities above certain levels, called offset thresholds, to be mitigated or "offset." Air districts with poor air quality will have lower offset thresholds, depending on the severity of their non-attainment status (See Appendix J for NSR thresholds). SJVAPCD and SCAQMD, for example, are both classified as "extreme" non-attainment districts for federal ozone standards. These districts have VOC offset thresholds of ten and four tpy, respectively. In comparison, VCAPCD, which does not have as severe air quality challenges, is classified at a lesser "serious" non-attainment status, and has a VOC offset threshold of 15 tpy. Most air districts have a threshold of 25 or 40 tpy, and one has a 50 tpy threshold and an air basin within another has a 100 tpy threshold.

Compost VOC Emission Factors

Emission factors are used to estimate VOC emissions from a compost facility. These EFs can be difficult to determine, especially for sources with high variability of material types and environmental conditions such as those that compost piles might experience. A few air districts have derived EFs for the three main components of the composting process:

- Feedstock stockpiles: Emissions from these piles only last a few days while operators gather the material before creating an active composting pile;
- Active compost pile: The main composting activity occurs here and emissions can last throughout the duration of the composting process, but the majority of emissions have been determined to occur in the first two weeks of composting,[70] and
- Curing piles: These piles are for finishing the product after active composting and have minimal emissions.

SCAQMD and SJVAPCD have published EFs for composting operations (See Appendix A for additional details). BAAQMD has been permitting facilities based on CARB's EF report from composting facilities,[71] and is now exploring ways to improve its capacity to estimate the rate and speciation of emissions from feedstock piles, active processing piles, and curing piles.

ERC Offset Factor or Distance Ratio

When purchasing ERCs, the amount of credits needed to offset emissions is also affected by a distance ratio or an offset factor. The distance ratio refers to the location where the ERCs were generated compared to where the ERCs will be used to offset emissions. The distance ratio can range from 1:1 (that is, for every one pound of VOC emissions over the offset

[70] Kumar et al., 2011.

[71] CARB. March 2, 2015. ARB Emissions Inventory Methodology for Composting. Facilities. https://www.arb.ca.gov/ei/areasrc/Composting%20Emissions%20Inventory%20Methodology%20Final%20Combined.pdf.

threshold, the project proponent will need to purchase one pound of VOC ERCs) up to 2:1 for projects utilizing ERCs that were generated a long distance from the project site. Variability exists in offset distance ratio between air districts that depends on the district's attainment status, meteorology, and other factors. An offset factor is applied such that the ERCs are greater than the emissions increase from a project to ensure a net air quality benefit.

Availability of VOC ERCs

CalRecycle conducted an analysis in 2017 to determine if sufficient VOC ERCs exist to permit the number of new compost facilities needed by 2025 based on the landfill diversion requirements of SB 1383. Although the results from this analysis are limited, some important insight was gained. In the analysis, facility sizes were assumed to be capped at 60,000 tpy (note that facilities larger than 60,000 tpy may exceed NSR VOC offset thresholds). Assumptions also included other specific scenarios, such as composting operations in SCAQMD would be open windrow and not covered

ASP systems, since there are fewer regulatory requirements for open windrow composting operations in SCAQMD. Limitations to the analysis include: facility size (larger facilities would require more VOC ERCs), material type (EFs were used for mostly greenwaste, not other feedstock types like food waste and manure which may generate more VOCs), and cost of VOC offsets was not a determining factor.

Using the projections of the number of new compost facilities needed by 2025 from Chapter 3, CalRecycle staff estimated VOC emissions by air district based on three EF scenarios (see below) to determine if sufficient VOC ERCs might be available to meet the increased demand for permitting these facilities.

Three EF scenarios:

1. High EF Scenario: 55.6 tpy[72]
2. Moderate EF Scenario: 35.1 tpy [73]
3. Low EF Scenario: 23.5 tpy[74]

In the first part of the analysis, staff determined whether NSR would likely trigger the need to purchase ERCs in any given air district to permit a facility. As demonstrated in Figure 4, this varies depending on what EF is assumed. Two factors contribute to determining whether compost operations in an air district would require ERCs in order to permit new facilities: first, the amount of newly diverted material, and second, the threshold for VOCs in that air district. In the majority of air districts (27 out of 35) only one facility with 60,000 tpy or less throughput

[72] Based on data supplied by Carol Allen of BAAQMD at May 2017 Inter-Agency Waste Working Group Meeting (145 tpy VOC emissions from 156,000 tpy feedstock throughput facility scaled down to 60,000 tpy feedstock facility).

[73] Use SCAQMD VOC EF for all districts (midrange open windrow emissions), and do control calculation for 75 percent control of emissions from ASP for an EF of 1.17 pounds per wet ton of feedstock (1.17 lbs. VOC emitted per wet ton/2000 lbs./ton * 60,000 tpy feedstock). As noted above, some have achieved greater reductions in VOCs, such as the solar-power ASP system in Tulare.

[74] Based on actual VOC offsets purchased to obtain permit in SJVUAPCD.

of feedstock may be required (Appendix E, Table E-3). While only one small to average sized facility would be needed to process the newly diverted organic waste materials, some of these air districts still have low NSR thresholds, therefore, the EF used to determine VOC emissions from the compost operations plays an important role in determining whether ERCs would need to be purchased in order to permit a facility. For example, in the high EF Scenario (no transportation of organic waste material across air district boundaries), compost operations in 15 air districts would exceed their NSR threshold in comparison to the low EF Scenario in which compost operations in seven air districts would exceed the air district NSR thresholds, and require the purchase of ERCs to permit the facility (Appendix E, Table E-4).

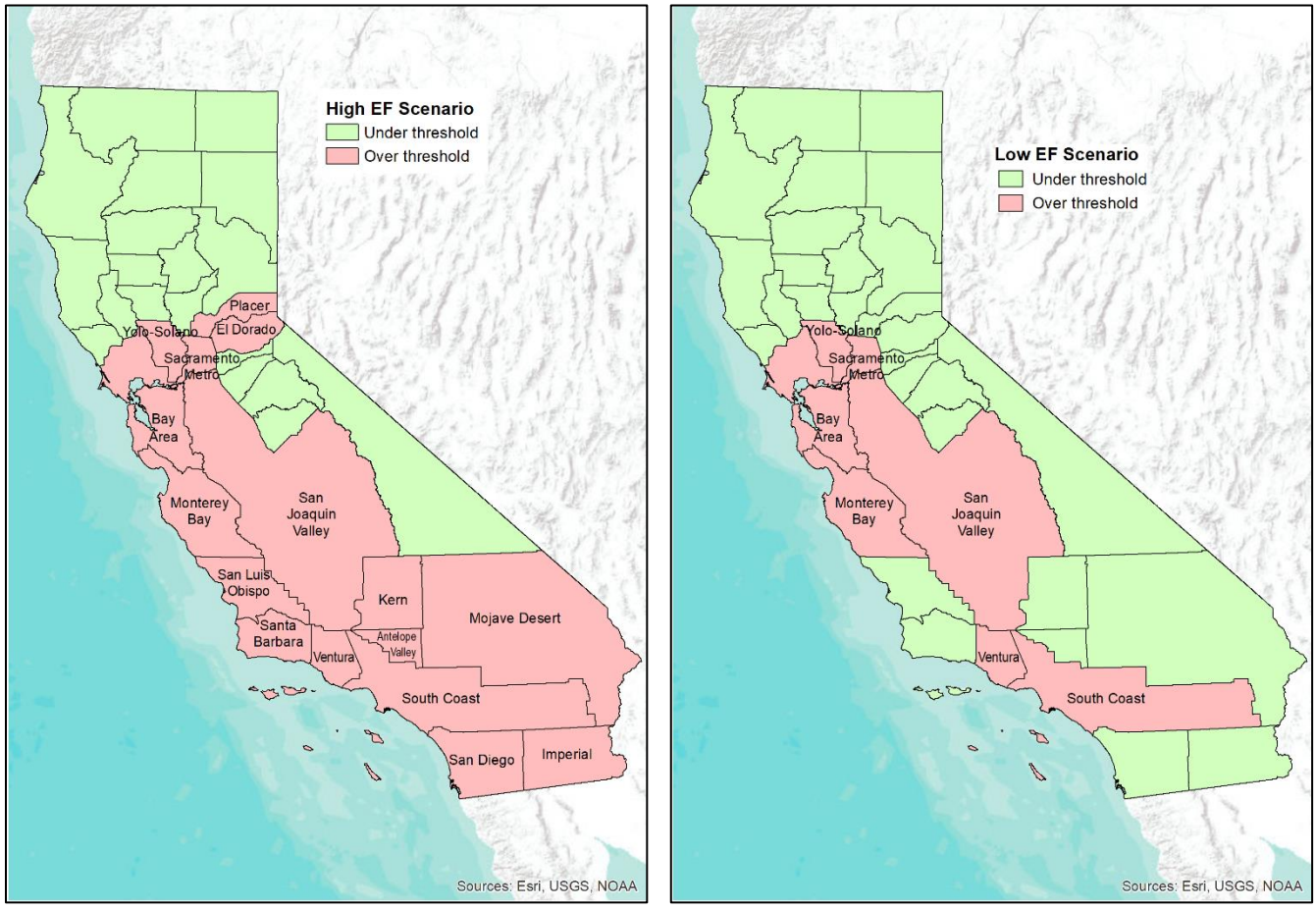

Figure 4. Air districts that will exceed the NSR threshold for requiring VOC ERCs to offset increased emissions from composting facilities for two potential scenarios.

The NSR threshold determines when emissions offsets will be required. Small facilities, typically handling 60,000 or less tpy, will likely not exceed the NSR offset threshold that triggers the need to purchase ERCs. Additional financial analyses are needed to determine if facilities of this size have sufficient economies of scale for a successful business plan.

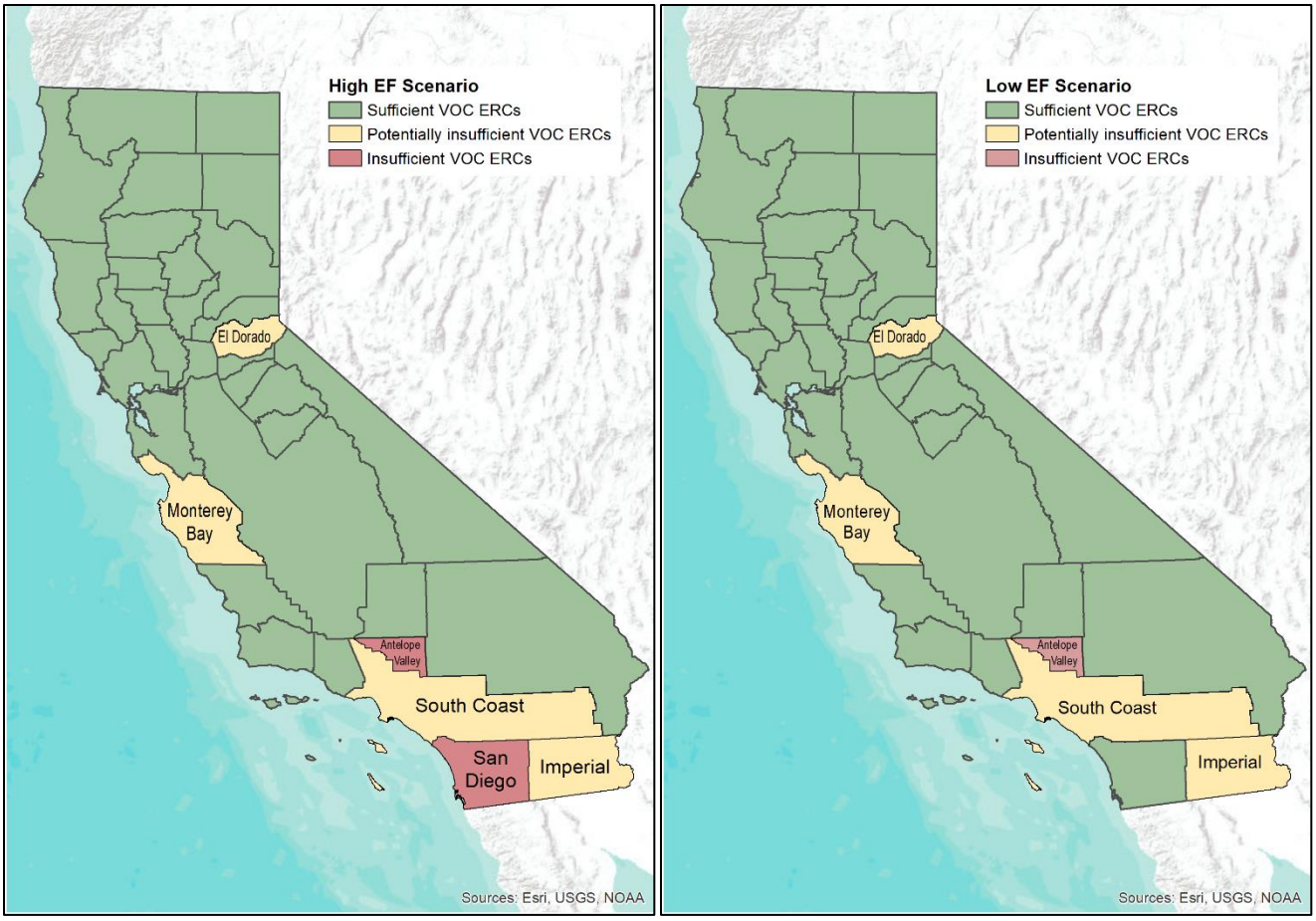

Figure 5. Determination of whether sufficient VOC ERCs exist for air districts to permit compost facilities for two potential scenarios.

The next step of the analysis was to determine which air districts had sufficient VOC ERCs in their general banks (privately-held ERCs) to cover the projected VOC emissions increases for new composting operations. In an analysis using a 1:1 ratio of ERCs available to ERCs needed, we determined that two air districts (shown in red in Figure 5 (left map)), AVAQMD and San Diego APCD (SDAPCD), would not have sufficient ERCs in the high EF Scenario, where all material created within an air district's boundaries is processed in that air district (Figure 5; see Appendix E, Table E-5 for scenario 2 results). Because AVAQMD is within Los Angeles County, and we assumed a blanket Los Angeles County diversion of 75 percent of the material, we assumed that waste would move out of the SCAQMD. For the purposes of this calculation, if this assumption is incorrect, the importing of waste from SCAQMD into AVAQMD and SDCAPCD could push projects in either of these districts over the offset threshold. Our projections predict that, in SDCAPCD, between seven and ten facilities will be needed to process the increased organic waste materials diverted from landfills. SDCAPCD's NSR threshold is higher than average (50 tpy VOC emissions). However, if larger facilities are proposed that require offset purchases, then the ERC transaction may be difficult, as the ERCs in San Diego County are primarily held by the military, which may be interested in retaining

their ERCs for future projects. In contrast, in the low EF Scenario (Figure 5), only Antelope Valley (in red) that has less than one VOC ERC available, does not have sufficient ERCs.

Four air districts are shown in yellow (to represent that they may not have sufficient VOC ERCs) in the high EF and low EF scenarios in Figure 5. Two are in yellow because we have no data on the size of their ERC banks (Imperial and El Dorado County), but they would need VOC ERCs to offset VOC emissions from new compost facilities. Monterey Bay Air Resources District (MBARD) was put in the yellow category as well, because some wineries have sought VOC ERCs for several years now through the general bank of privately-held ERCs, and it appears that all entities in possession of those ERCs are holding onto the credits for future use. Furthermore, SCAQMD may not have sufficient VOC ERCs available, but because of SCAQMD's compost rules, as long as compost facilities meet BACT and comply with feedstock ratios, SCAQMD does not require ERCs for permitting open windrows. Other air districts may also warrant being in the yellow range, because ERCs are privately-held in the general VOC ERC banks, and this does not predict whether a proposed facility would be able to finalize an ERC transaction. Since the transaction is dependent on the entity holding the ERC being willing to sell the offset, and the two parties coming to an agreement on the price (e.g., the distance, discussed above, factor may be considered in the price), this may also be the case in other air districts than the ones highlighted above.

Additionally, this analysis does not consider what percentage of the general bank's VOC ERCs would be used in order to permit these facilities. In the air districts that don't exceed their banks (discussed above), the percentage of total air district ERCs needed averaged between 19 and 36 percent for the 1:1 VOC ERC purchase scenarios (Appendix E, Table E-6), and 29 and 54 percent for the 1:2 VOC ERC purchase scenarios (Appendix E, Table E-8). Note that one facility's offsets could use a large portion, if not all, of the bank's available credits.

SCAQMD does not require VOC ERCs for traditional windrow compost facilities processing only yard waste materials and up to 20 percent manure, by volume, and up to 5000 tpy of food waste. Only compost facilities processing outside these upper bounds would need to purchase VOC ERCs to offset their emissions.

Differences in offset thresholds between air districts may incentivize movement of organic materials to adjacent regions, if insufficient ERCs exist, or if the ERCs are not available to purchase at a reasonable price within the region where organic materials are generated. Movement of materials to different regions could increase vehicle emissions unless the adjacent region were closer to compost markets.

Financial Considerations

Many unknown financial factors warrant further exploration. Determining the capital and operation and maintenance costs in relation to ability to recoup costs is key to understanding if potential owners or operators may be willing and able to build and operate new facilities.

CalRecycle has contracted for a market analysis for compost and other new organics recycling infrastructure development. The analysis will explore progress in reducing regulatory barriers to siting organics recycling facilities and the timing and effectiveness of policies to facilitate permitting of organics recycling facilities, among other issues, by July 2020.

One consideration is the cost of state-of-the-art composting facilities that can meet air and water quality protection[75] standards. Such a facility can cost over $15 million (Table 6)[76]). While some funding is available through grant and loan programs to help construct compost facilities, such as through CalRecycle's Organics Grant Program,[77] concern exists that insufficient money will be available to offset the costs of construction.

The funding source for CalRecycle's Organics Grant Program comes from the Greenhouse Gas Reduction Fund, which is funded by Cap-and-Trade proceeds as part of the California Climate Investments program. Through three funding cycles (fiscal years 2014-2015, 2016-2017, and 2017-2018), CalRecycle has helped fund 15 compost facilities through this program. It may be difficult to build 75 to 100 new composting facilities throughout California over the next seven years without increased program funding, or decreased capital costs of constructing modern facilities.

Table 6. Estimated Cost of a Representative New Compost Facility (CARB, 2017)

Gore Positive ASP Compost Facility	
Facility Component	**Capital Investment**
Permitting*	$900,000
Infrastructure	$11,500,000
Equipment	$3,900,000
Land	$200,000
Total Cost	**$16,500,000**

AB 617 and Disadvantaged Communities

AB 617 (Garcia, C., Chapter 136, Statutes of 2017) requires new community-focused and community-driven action to improve air quality and reduce exposure to CAPs and TACs in disproportionately burdened communities. The bill provides additional tools to target actions in these communities through community-focused air monitoring and emissions reduction programs, and includes new requirements for accelerated retrofit of pollution controls on industrial sources, increased penalty fees, and greater transparency and availability of community-scale air quality and emissions data.

AB 617 requires that CARB select initial communities for first-year action by October 1, 2018, with review and recommendations of additional communities annually. Assessment and identification of the disproportionately burdened communities will be based on a compilation of data sources and factors characterizing cumulative exposure to CAPs and TACs within communities. Selected communities will receive additional focus from CARB and the local air

[75] State Water Resources Control Board. August 4, 2015. Order WQ 2015-0121-DWQ, General Waste Discharge Requirements for Composting Operations. https://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2015/wqo2015_0121_dwq.pdf.

[76] CARB. 2017.

[77] CalRecycle. Greenhouse Gas Reduction Grant and Loan Programs Webpage. http://www.calrecycle.ca.gov/climate/grantsloans/.

district through additional community outreach, air quality monitoring, and emissions reduction planning, which may include new, and revisions to, district rules, changes to stationary source permitting, and increased enforcement. Existing and future proposed composting facilities in AB 617 focus areas should participate accordingly to understand additional requirements applicable to their facility.

Technology Clearinghouse

Under state law, regional air districts have been delegated the authority to issue permits to stationary sources, allowing them to operate within emission limitations. Permit programs limit emissions from facilities by setting a threshold of allowable emissions that a facility must not exceed in order to continue to operate. Prior to issuing a permit, air districts confirm that the facility and all emitting equipment are in compliance with applicable rules and regulations. Permit limits are usually updated every time a facility installs new equipment or modifies their existing equipment. Permitting requirements vary by location based on the facility and equipment type, the allowable amount of emissions, consideration of state and local air toxics programs, and each air district's national and state ambient air quality standards attainment designation status.

New facilities or facilities modifying equipment that emit air pollutants over specific air district emissions thresholds are subject to stringent emissions control requirements. Air districts determine the best-achievable emissions limit for each equipment type over these emissions thresholds based on the cleanest technology available at that time (i.e., BACT). Other BACT "determinations" for a specific equipment type must be considered by air district staff during the permitting of a new or modified facility.

More information on CARB's Community Air Protection Program, the program CARB established in response to AB 617, is available on the Program's webpage at: https://ww2.arb.ca.gov/our-work/programs/community-air-protection-program-ab617. (See Appendix I for more detailed information on AB 617).

Odors and Other Nuisances Associated with Poor Operation

One challenge to permitting new compost facilities is the possibility of future enforcement issues. While not a permitting issue, per se, determining the BMPs to avoid future odors for permitting purposes is an aspect of permitting that air districts have attempted to address. For example, BAAQMD is attempting to understand what BMPs they will require to minimize odors as part of their permit process. As well, SCAQMD and SJVAPCD already have BMPs in place through their compost regulations to minimize odors.

While air districts often receive odor complaints associated with compost facilities, they do not have enforcement authority over odors as a nuisance from composting facilities per Section 41705 of the Health and Safety Code. The LEA has enforcement authority over odors from composting facilities. The regulatory tool developed to address odors at compost facilities is the Odor Impact Minimization Plan (OIMP). The OIMP regulatory requirements (14 CCR 17863.4[78]) have been developed to allow an operator to aggressively devise an operational

[78] http://www.calrecycle.ca.gov/Laws/Regulations/Title14/ch31.htm#Article3.

plan to prevent odors from occurring, and to plan in advance the mitigation measures that should be taken if odors do occur. The OIMP also contains the site's complaint investigation procedures, which should include a 24-hour phone hotline for receipt of odor complaints, notification to the LEA,[79] and emergency procedures for the cease and desist of any operations that are causing odor impacts. If the operator is not following the procedures in the OIMP, the LEA may issue a Notice and Order to require the operator either to comply with the OIMP, or to revise it. If the OIMP is being followed, but the odor impacts are still occurring, the LEA may issue a Notice and Order requiring the operator to take additional reasonable and feasible measures to minimize odors. An OIMP is required for all compostable materials handling operations and facilities, with the exception of agricultural operations without odor complaints."[80]

Management practices can have a large impact on minimizing odors. In March 2007, a Comprehensive Compost Odor Response Project (C-CORP) was developed under contract by San Diego State University for CalRecycle.[81] Pages 123-133 of the C-CORP contain an Odor Mitigation Strategy Menu (OMSM), which is a comprehensive listing of possible design and operating techniques that can be used to prevent and minimize odors from composting facilities. The OMSM lists mitigation strategies for odors generated for every phase of the composting process from receipt of material through to the curing phase. The OMSM should be referenced for odor and nuisance solution strategies related to composting.

VII. Options Considered for Addressing Permitting and Regulatory Challenges

A number of potential options exist for addressing permitting and regulatory challenges for the establishment of the necessary number of compost facilities statewide to achieve SB 1383's organic waste materials diversion goal. These options listed in Table 7 include employing regional air quality modeling; co-location of compost facilities at landfills (without regional air quality modeling); numerous potential options to address ERC offset requirements; and processing less organic waste material at each facility. Many of these options may not be viable in all air districts or to all potential facility owners due to their specific situations, but they have been explored and are discussed below.

[79] Enforcement agency – This is typically the local county or city permitting agency that has authority to enforce.

[80] CalRecycle. Compostable Materials - Odor Impact Minimization Plan Webpage. http://www.calrecycle.ca.gov/swfacilities/compostables/odor/OIMP/default.htm.

[81] CalRecycle. 2007. Comprehensive Compost Odor Response Project. Publication No. 442-2007-0001. http://www.calrecycle.ca.gov/Publications/Detail.aspx?PublicationID=1241.

Table 7. Feasibility of Potential Options.

ERC Offset Option	Feasibility Scale	Next Step(s)
Low reactive nature of VOCs from compost facilities	Infeasible at this time	None at this time; however, CARB commits to initiating discussions with U.S. EPA to revisit the concept of incorporating reactivity as a regulatory approach
Consideration of regional air quality modeling	Potentially feasible	CARB will explore to determine cost, additional data needs, and benefit of analysis
Landfill ERCs creation	Potentially feasible	Study regulatory and technical aspects, assess additional data needs, would need a state regulation
VOC Emission Factors and Differentiation of Feedstock	Feasible	Research to determine best emission factors, tools/measurement techniques for range of feedstocks and other variables
Redesignate facilities as essential public services (EPS)	Feasible for some air districts	Determine if individual air districts would benefit from establishing EPS for permitting composting facilities, and research the nuances of existing various EPS rules and develop guidance document on how to set up EPS rules for composting facilities.
Co-location of compost facilities at landfills	Potentially feasible	Further explore concept within existing permitting requirements
Small Distributed Facilities	Potentially feasible	Determine NOx versus VOC emissions trade-off of siting small facilities close to generation sources versus larger facilities further away with more available ERCs

Regional Air Quality Modeling

As mentioned previously, SB 1383 will create a paradigm shift that will restructure organic waste management in the state, mandating a 75% reduction in the amount of organics disposed in landfills by 2025, and resulting in a doubling of the composting infrastructure. This will shift over five million tpy of existing compostable materials to new composting facilities. With a shift of this scale, regional air quality modeling may be an appropriate way to examine the air quality impacts of the new composting infrastructure compared to the existing air quality impacts of landfilling. If the new composting infrastructure is reducing regional air quality impacts compared with landfilling, then it becomes important to consider whether and how to develop a permitting pathway for individual compost facilities that recognizes that outcome. Additionally, if the new composting infrastructure is reducing air quality impacts over landfilling, then the need for offsets might be reduced.

Modeling the impact of new/expanded composting facilities on air basin ozone and/or $PM_{2.5}$ concentrations would require three-dimensional photochemical modeling similar to what is done during SIP development. Modeling outcomes are strongly based on existing ambient air quality conditions for each air basin (i.e., regions outside of the South Coast are generally NO_x-limited), so small changes in VOC emissions should not affect ozone formation. Therefore, modeling outcomes are also dependent on the locations of the new composting facilities as well as the locations of the landfills where the organic materials are currently being managed. Because of these variables, it is possible that changes in VOC emissions associated with new composting facilities would not have a significant impact on ozone formation.

There are also possible implications for secondary organic aerosol (SOA) formation. If transport of organic materials to new compost facilities exceeds existing transport distances to landfills, there would be additional NO_x vehicle emissions to consider that could increase ozone formation in the region, depending on the level of NO_x emissions. However, it is unlikely there would be a substantial change in ozone unless the additional NO_x emissions were significant.

Depending on the number of new/expanded facilities, it is quite possible that modeling the impact of a single facility would show only a small effect on ozone, but that modeling all facilities at once would show an appreciable effect. Fully assessing the implications of new and/or expanded composting facilities on regional ozone and $PM_{2.5}$ would require annual modeling.

Co-location of Compost Facilities at Landfills (without regional air quality modeling)

Emissions netting is the accounting of potential emissions reductions and emissions increases from activities within the same stationary source. Emissions netting may decrease the amount of ERC offsets required for a composting operation co-located at a landfill if it can be shown that emissions from the landfill will decrease because of waste diversion efforts. However, this option has not been well explored since air districts' NSR rules may define how ERCs are generated and netting is performed differently; we believe it merits further exploration.

Potential Options to Address ERC Offsets Challenges

State agencies and the local air districts have examined several potential options to address offset challenges. While the feasibility of each option varies, these options, included scaling the quantity of offsets that need to be purchased based on the low reactive nature of VOCs from composting to create ground level ozone; creating landfill emission reduction credits based on the diversion of these VOC-offgassing materials to compost facilities; tailoring VOC emission factors to better account for feedstock variability; redesignating compost facilities as essential public services (EPSs) to take advantage of accessing potentially lower cost banks established to ensure that EPSs can operate; and locating compost facilities at landfills so as to not create new sources of emissions. In this section, we summarize these options, analyze their potential viability, and suggest where further study is needed.

Compost Facility VOC Reactivity

The need to purchase VOC ERCs to offset the point source increases in VOC emissions from new or expanded compost facilities is one of the significant challenges in implementing SB1383's mandate, because of the number of facilities that need to be permitted and the limited availability of ERCs in some air districts. ERCs are needed to offset these emissions because districts that are in non-attainment for state and federal air quality standards are required to implement a no-net-increase permitting program. Offsetting emissions increases ensures that total emissions in an air district do not rise.

Many of the VOCs emitted from composting operations tend to have a lesser ability to form ozone than VOCs from other sources; therefore, a logical approach might be to discount offset requirements based on the reactivity of the VOC emissions. According to one study, over 70 percent of emissions from composting are low-ozone forming alcohols with MIR of 1.53 or less (higher MIR values represent greater potential for ozone formation (see Appendix H for details). In addition to discounting offset requirements, another option might be to completely exempt very low reactive VOCs from regulation, including not requiring their emissions to be offset.

However, extensive discussions with the air districts, ARB, and U.S. EPA have revealed that there is no flexibility within the CAA to allow this approach, as a VOC's reactivity is not considered when determining applicable regulatory requirements. While there exist mechanisms within the CAA to exempt VOCs if they do not contribute to the formation of ozone, those that do, even to a lesser degree, are regulated in the same manner as VOCs with high reactivity. This is because while relatively low reactive VOCs do not form ozone as readily as higher reactive VOCs, they do still contribute to some appreciable degree. For areas of California that are already severely impacted by air pollution, any additional ozone generated, even relatively small amounts, exacerbates the air pollution problem and can adversely affect the health of people living in the air basin. As such, the process to exempt low reactive VOCs requires significant study and data to ensure a complete understanding of a VOC's reactivity before doing so, and the ability to discount offset requirements based on MIR values or other scaling mechanisms is nonexistent at this time, and would require a legislative change to the CAA to accomplish.

Nonetheless, CARB commits to initiating discussions with U.S. EPA to revisit the concept of incorporating reactivity as a regulatory approach.

Creation of Landfill Emission Reduction Credit Offsets

Landfill owners and operators may be able to create ERCs based on the diversion of organic materials from landfill feedstocks, as diversion will reduce the amount of VOCs being emitted at the landfill. Depending on how ERC generation and offset requirements are defined in each air district, these landfill emission reductions could be used to offset VOC emissions from composting operations.

However, one issue arises when trying to quantify the baseline of VOC emissions from landfills. To date, little research has been conducted to determine actual VOC emissions from landfills, especially from the active face that is covered daily and which does not yet have an operational active landfill gas control system in place. Testing over a two-year time period is required to create an ERC. In addition, testing is needed to establish a better baseline than is currently used by air districts for landfill VOC emissions. The current landfill VOC baseline appears to primarily be based on the landfill gas emissions modeling program (LANDGEM)[82], which does not account for VOC emissions from the active face of the landfill. From the VOC emissions profiles from the degradation of organic materials (both on the ground in mulch form)[83] and in compost piles, the majority of these VOC species are not accounted for in the LANDGEM model (see Appendix F). From our comparison between the VOC species in the Kumar et al (2011) study and LANDGEM, we determined that less than 20 percent of these VOC species were accounted for in the LANDGEM model.

This would make sense given that LANDGEM is intended to represent emissions that occur after steady-state has been achieved in the landfill (i.e., intermediate cover, two plus years later when the landfill gas collection systems begin capturing emissions), and from emissions testing from compost facilities and from the application of organic waste materials as a mulch of up to 12" (also known as direct land application), it would appear that the majority of VOC emissions from these types of materials are completed in the first few months of processing/application, if not in the first few weeks . In other words, LANDGEM does not account for the early VOC emissions from organic waste materials from the active face or daily covered area of a landfill that are now being accounted for at compost facilities.

Through joint CARB-CalRecycle funded research, CalPoly SLO is measuring VOCs from landfills similar to the ones modeled in LANDGEM version 3.02[84] as well as VOC species typically found during the degradation of organic waste materials at compost facilities that we hypothesize are emitted during the early stages of landfilling from the active face (See Appendix K for list of VOCs being measured in landfill gas study). While these results will not be available until the 2020 timeframe, they will develop a much-needed landfill emission

[83] Burger et al. 2015.

[84] US EPA. May 2005. Landfill Gas Emissions Model (LandGEM) Version 3.02 User's Guide. EPA-600/R-05/047. https://www3.epa.gov/ttncatc1/dir1/landgem-v302-guide.pdf.

baseline, and likely serve as valuable data, potentially for creation of landfill ERCs. The results will also be useful in the regional modeling alternative, or possibly to scale emissions at compost facilities to create landfill ERCs that could be used by compost facilities.

VOC Emissions Factors and Differentiation of Feedstock

In the process of permitting facilities, each air district uses different VOC emission factor values for various blends of feedstocks, e.g., yard waste, food, biosolids, and digestate. This is noteworthy because a high emissions factor can result, in turn, in a high offset requirement and dramatically affect the facility's ability to purchase VOC offsets. For example, EFs used by air districts can result in VOC emissions that range from 23.5 tpy to 55.8 tpy for the same greenwaste composting facility processing 60,000 tpy in a covered ASP system.[85] These VOC emission calculations, with a range over 130 percent, can make a significant difference in the number and cost of VOC offsets needed to permit the facility.

Given the variability of emissions within and between feedstock types, piles, and operating conditions, it is prudent to recommend that research be conducted to accurately determine the appropriate EFs for different feedstocks and conditions. In addition, identification of the most appropriate, least costly testing method to help air districts and potential owner/operators alike conduct source tests or otherwise determine expected VOC emissions from a proposed composting facility during the permitting process.

Essential Public Service Designation

One option that has been suggested to help facilitate the permitting of compost facilities is to redesignate these facilities as EPS. EPS are facilities considered essential to public health and safety, and in some cases this designation could result in the facility's owner/operator not being required to offset the facility's emissions. A limitation that should be understood with this approach, however, is that those facility emissions still need to be accounted for, even if the owner/operator is not required to purchase ERCs to offset them. However, these facilities could continue to operate and emit pollutants (e.g., ozone precursors like VOCs, NOx) during smog episodes. Of the 35 air districts, 21 have an EPS definition in their district rules. Twelve districts include landfills (in two air districts facilities only qualify as EPS if they are publicly-owned and operated). Seventeen air districts include wastewater treatment facilities as EPS, 12 of which are included as EPS only if they are publicly-owned and operated. Air districts have the authority to determine the definition of EPS for their district through a public rulemaking process.

Potential benefits of EPS designation: EPS designation for compost facilities include access to a community bank/priority reserve of ERCs specifically for EPS projects; a reduced or free cost of these credits; and/or a higher threshold for requiring ERCs.

Special ERC bank access: Sixteen of the thirty-five air districts have a community bank/priority reserve rule. In general, between five and ten percent of the ERCs generated from a given facility are deposited in ERC banks for use by EPS and other priority projects. Sometimes there is a bank within a bank designated for EPS projects. For example, the Imperial County

[85] See Appendix E for description of how these EFs were derived.

Air Pollution Control District sets aside ten percent of the community bank funds exclusively for EPSs, and SCAQMD funds their priority reserve on a quarterly basis.

Reduced or free cost of ERCs: Because these special credits are owned by the air districts themselves, and not individually owned by the facilities that created them by voluntarily reducing their emissions, the air districts may provide these ERCs for EPS facilities at a free or reduced rate with District Board of Directors' approval.

Higher threshold for requiring offsets purchases: In Ventura County APCD, EPSs are subject to a higher (25 tpy) VOC ERC offsets threshold than those for non-EPS facilities (5 tpy). Therefore, if the new compost facility were emitting greater than 5-tpy and less than 25 tpy of VOCs, and was designated an EPS, it would not trigger the need to buy offsets. Ventura is the only air district currently considering allowing publicly-owned compost facilities to be designated EPSs.[86]

Potential Issues With EPS Designations

Air districts in California already face significant challenges to attaining national and state ambient air quality standards, and may be restricted in their ability to set aside ERCs for an EPS bank. Further, considering that organic waste material may be imported from outside the air district raises the question of whether composting operations can be considered an EPS, as direct benefits to an air district's local communities may not be realized. This brings up the question of whether EPS designations should only be for composting facilities handling organic waste material generated within that air district's boundaries.

The point of defining these facilities as EPSs would be to ensure that essential services could be permitted in a district where VOC offsets may be limited. However, most districts have very few, if any, credits available in their ERC community banks (Table 8). Aside from Ventura and the Bay Area, most districts have only enough credits, if any at all, to permit perhaps one or two facilities, and these air districts might need to reserve these credits for other non-profit making EPSs, like schools, and firefighting.

[86] Ventura County APCD. 2018. Ventura County Air Pollution Control District Rule Development Calendar January 2018 through December 2018. http://vcapcd.org/pubs/Rules/2018-VCAPCD-Rule-Development-Calendar.pdf.

Table 8. Inter-agency Waste Working Group Survey by California Air Pollution Control Officers' Association in May 2017 of Air District Emission Reduction Credit Banks.

Air Districts[1]	Air District New Compost Facility Survey Results (Distributed by Yolo-Solano)					
	Subject to permit(s) and offsets?	Offset threshold (tpy)	Total VOC ERCs in the general bank (tons)	ERC bank for EPS?	Size ERC VOC EPS bank (tpy)	Eligible for EPS ERC Bank?
AVAPCD	Yes	25	0.16	No	N/A	N/A
BAAQMD[2]	Yes	10	3147	No	N/A	N/A
Butte	Yes	25 or 40	85.6	Yes	60	No
Colusa	No		135.37	Yes	17.32	No
Feather River	Yes (APCO Discretion)	25 or 100	273.8 Non-Fed 69.8155 Fed	Yes	14.48	No
Lake County	Yes (for permits)	~25	No offset program			
Mojave Desert	Yes	25 or 40	105.24 All Fed	No		
MBARD	No	~25	94.206	Yes	43.69	Yes[3]
No. Sonoma	Yes	N/A	0	No	n/a	n/a
Placer County	Yes	25	120	Yes	32	No
Sacramento Metro[4]	Yes	25	Community/ Military: 494; Private ERCs: 318	Yes	20.3	No
SDCAPCD	Yes	25 or 50	281.54	No	N/A	N/A
SJVAPCD	Yes	10	5000	No	N/A	N/A
San Luis Obispo	Yes	25	55.4	Yes	31.9	APCO discretion
Santa Barbara	No	25	106	No	n/a	n/a
Shasta	Yes	25	360.5	No	n/a	n/a
SCAQMD[5]	Yes	4	98.89	Yes	22.8	No
VCAPCD[6]	No	5	593.8	Yes	198	No
Yolo-Solano	Yes	10	196.3	Yes	17.1	No

[1] Sixteen out of 35 air districts responded. These districts did not respond to the survey: Amador, Calaveras, Colusa, Eastern Kern, El Dorado, Glenn Cty, Great Basin, Imperial, Lassen, Mariposa, Mendocino, Modoc Cty, North Coast, Northern Sierra, Siskiyou, Tehama, Tuolumne.

[2] Instead of and EPS bank, BAAQMD maintains a small facility bank for sites emitting < 35 tpy.

[3] MBARD EPS eligible if operator is an EPS, but not in definition (covering WWTP and landfills currently). At the time of the drafting of this document (August 2018), this subset of the general bank contained 406 tpy of VOC ERCs.

[4] Sac Metro permits only required if operation involves machines, equipment, or other contrivance which emits air contaminants.

[5] SCAQMD permit/offset requirement seems similar. They charge fees for EPS credit use, but does not charge fees for priority reserve offsets.

[6] Ventura's EPS threshold is 25 tpy, and is considering changing to requiring a permit with the possibility of an EPS/small facility exemption.

Potential SIP Issues: This designation might impact an air district's ability to attain goals set forth in their state implementation plan for achieving CAA National Ambient Air Quality Standards for ground-level ozone unless these emissions that would otherwise stem from landfills are sufficiently accounted for and may entail reopening SIPs in order to address this issue.

Small Distributed Facilities

One option that some project proponents might consider is to ensure that potential emissions from their facilities are minimized to the maximum extent possible by limiting the amount of material they process in addition to using BACT (e.g., covered ASP). This could avoid the triggering of NSR offsetting requirements, and minimize the amount of emissions that need to be offset. Smaller facilities may be subject to a shorter permitting process than major sources. Lower emitting facilities that process less organic waste material will reduce potential exposure of air pollutants to neighboring communities. By processing less material, the facility may require a smaller footprint, potentially allowing a facility to be sited closer to locations generating the organic waste materials. For air districts with low NSR thresholds for VOCs, and few available VOC ERCs, this may be an important consideration when designing a new compost facility.

Appendix J shows the major source thresholds and the NSR VOC offset purchase threshold for each air district. Air districts that are in attainment for ozone typically have higher thresholds than air districts in non-attainment. Air districts in extreme non-attainment have the lowest thresholds. Therefore, both facility emissions and which air district it is located in are important variables in determining if a new facility may need to purchase VOC ERCs.

VIII. Recommendations to Advance Potentially Viable Options

This paper is the first step in a collaborative process to aid air districts and potential owner/operators alike. Some initial general recommendations are listed below as a springboard for further discussion among all stakeholders to find ways to successfully and swiftly permit compost facilities throughout California to divert 75 percent of organic waste materials by 2025.

Regional Air Quality Modeling

Further explore the option of regional air quality modeling to determine if the new composting infrastructure will be reducing regional air quality impacts compared with existing landfilling of organic materials. If composting reduces regional air quality impacts, then determine how to develop a permitting pathway for composting facilities that is consistent with that outcome and is within the CAA and the authority of individual air districts. Possible steps might include:

1. CalRecycle in conjunction with composting and landfilling industries to provide data for regional modeling.
2. Additional research may be needed to fill data gaps. CARB, CalRecycle, and, where feasible, air districts work on funding joint research projects.

3. CARB and CalRecycle work collaboratively to run several regional air quality modeling scenarios.
4. If modeling shows reduced regional air quality impacts for composting, engage CAPCOA and air districts in discussion on potential permitting pathways.
5. CARB and CalRecycle help to fund regional air quality modeling at the district level to ensure emissions benefits are being realized.

Landfill Emission Reduction Credits

Determine if the creation of Landfill ERCs is a viable option for the needed VOC offsets for new composting facilities. Possible next steps might include:

1. Complete the CalPoly research on landfill emissions; and
2. ARB and CalRecycle use data from the research study to analyze whether landfill emission reductions are real, permanent, and enforceable in order to qualify as an ERC.

Essential Public Service Designation

Conduct additional evaluation on the potential of EPS designation to facilitate composting facility permitting for specific air districts in which an EPS definition might be a viable option.

1. Determine if individual air districts would benefit from establishing EPS for permitting composting facilities; and
2. Research the nuances of existing various EPS rules and develop guidance document on how to set up EPS rules for composting facilities.

Determine Further Research Needs

Support the air districts with additional research to better understand landfill and composting emissions. In conjunction with the air districts, CARB, CAPCOA, and CalRecycle, should formulate a research list that would be supportive of air permitting compost facilities. This may include:

- Gathering additional VOC data to support a more refined range of VOC emission factors for various blends of feedstocks (e.g., yard waste, food, biosolids, and digestate);
- Simplifying source test protocol to reduce cost of source testing;
- More in-depth testing of feedstock and curing piles for VOC emissions;
- If warranted, after the completion of the CalPoly SLO landfill gas study, pursue additional research on landfill VOC emissions to support creation of landfill ERCs;
- Modeling NOx emissions from transportation of organic waste materials to processing facilities; and
- Quantifying compost application air quality benefits from the reduction of pesticide and synthetic fertilizer usage.

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Appendices

Appendix A. VOC Emission Factors

SCAQMD[87] and SJVAPCD[88] both determined different VOC emission factor methodologies for quantifying the emissions from compost piles in conjunction with their rules. ARB then compiled these emission factors and other emissions testing results in a more recent document.[89] Due to the variability of feedstock types, mixes of feedstock, composting practices, and environmental variables, it is difficult to accurately, and consistently, quantify the emissions from composting. While flux chambers have been historically used to capture air emission samples, they do not well capture the variability of emissions from the piles over time (throughout the variability of emissions during the lengthy composting process) and space (extrapolating from a number of samples to determine overall pile emissions can over or under estimate emissions due to inherent variability of emissions of feedstock mixes and environmental factors).

BAAQMD's permitting department has been estimating emissions for VOCs, NH_3, and PM based on CARB's EF report for composting facilities. However, the EFs in this report averages data from a small number of source tests that have substantial variability in the magnitude of emissions per ton of material processed. The source tests were also conducted on open composting in windrows, which BAAQMD does not anticipate treating as BACT. As a result, BAAQMD has limited confidence in these EFs and has begun a process of improving our capacity to estimate emissions. BAAQMD has developed a source test protocol for composting operations, and is collecting data on the rate of VOC and TAC emissions from feedstock piles, active processing piles, and curing piles.

As part of this effort, BAAQMD is also looking at a range of factors potentially shaping emissions. For example, SCAQMD and SJVAPCD have EFs based on different categories of organics that do not account for the range of materials listed in CalRecycle's draft definition of "organic waste."

Limited understanding about how pile composition affects emissions makes it is hard to determine how much available management practices, such as more granular source separation upstream of a composting pile, can reduce emissions and the need for offsets. Without more information, air districts may need to use more conservative EFs and may have fewer BACT and BMP options for reducing emissions. The end result could be higher costs for

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[87] South Coast Air Quality Management District. December 2013. Guidelines for Calculating Emissions from Greenwaste Composting and Co-Composting Operations. http://www.aqmd.gov/docs/default-source/planning/annual-emission-reporting/guidecalcemisgrwastecompoperdec135C4C417694C4.pdf.

[88] Clements, B.; Norman, R.; Chan, K. Sept. 15, 2010. San Joaquin Valley Air Pollution Control District - Compost VOC Emission Factors. http://valleyair.org/Workshops/postings/2010/9-22-10-rule4566/SJVAPCD%20Compost%20VOC%20EF%20Report%209-15-10.pdf.

[89] California Air Resources Board. 3/2/2015. ARB Emissions Inventory Methodology for Composting Facilities. https://www.arb.ca.gov/ei/areasrc/Composting%20Emissions%20Inventory%20Methodology%20Final%20Combined.pdf.

new composting facilities, fewer value-adding options along the supply chain, and a potentially less economically robust recovery system.

Appendix B. Listing of Air Quality Management and District Rules and Regulations Related to Compost Operations

Applicable BAAQMD Rules and Regulations:

- Regulation 2. Permitting http://www.baaqmd.gov/rules-and-compliance/current-rules
  Reg 2-1. General Requirements
  Reg 2-2. New Source Review
  Reg 2-5. New Source Review of Toxic Air Contaminants
- Regulation 6. Particulate Matter
  Reg 6-1. General Requirements
  Reg 6-6. Prohibition of Trackout
- Regulation 8. Organics Compounds
  Reg 8-2. Organic Compounds, Miscellaneous Sources
- Regulation 11, Rule 18. Reduction of Risk from Air Toxic Emissions at Existing Facilities
- Regulation 13. Methane
  Reg 13-1. Significant Methane Release (preparing for release in draft)
  Reg 13-TBD. Organic Materials Handling (under development)
  Reg 13-TBD. Composting (under development)

Applicable MBARD Rules and Regulations:

- Rule 200 – Permits Required https://www.arb.ca.gov/drdb/mbu/curhtml/R200.HTM
- Rule 201 – Sources Not Requiring Permits
  https://www.arb.ca.gov/drdb/mbu/curhtml/R201.PDF
- Rule 207 – Review of New or Modified Sources
  https://www.arb.ca.gov/drdb/mbu/curhtml/R207.PDF
- Rule 215 – Banking of Emission Reduction
  https://www.arb.ca.gov/drdb/mbu/curhtml/R215.PDF
- Rule 300 – District Fees https://www.arb.ca.gov/drdb/mbu/curhtml/R300.PDF
- Rule 301 – Permit Fee Schedules https://www.arb.ca.gov/drdb/mbu/curhtml/R301.PDF
- Rule 1000 – Permit Guidelines and Requirements for Sources Emitting Toxic Air Contaminants https://www.arb.ca.gov/drdb/mbu/curhtml/R1000.PDF

Applicable SDAPCD Rules and Regulations:

- Rule 11 – Exemptions from Rule 10 Permit Requirements
  https://www.sdapcd.org/content/dam/sdc/apcd/PDF/Rules_and_Regulations/Permits/APCD_R11-2016.pdf
- Rule 20.1 – New Source Review (NSR) – General Provisions
  https://www.sdapcd.org/content/dam/sdc/apcd/PDF/Rules_and_Regulations/Permits/APCD_R20-1.pdf

- Rule 20.2 – New Source Review (NSR) – Non-Major Stationary Sources https://www.sdapcd.org/content/dam/sdc/apcd/PDF/Rules_and_Regulations/Permits/APCD_R20-2.pdf
- Rule 20.3 – New Source Review (NSR) – Major Stationary Sources and Prevention of Significant Deterioration (PSD) Stationary Sources https://www.sdapcd.org/content/dam/sdc/apcd/PDF/Rules_and_Regulations/Permits/APCD_R20-3.pdf
- Rule 40 – Permit and Other Fees https://www.sdapcd.org/content/dam/sdc/apcd/PDF/Rules_and_Regulations/Fees/APCD_R40-2017.pdf
- Rule 1200 – Toxic Air Contaminants – New Source Review https://www.sdapcd.org/content/dam/sdc/apcd/PDF/Rules_and_Regulations/Toxic_Air_Cotaminants/ACPD_R1200.pdf
- Rule Development Webpage (for information on Rule 67.25 in development) https://www.sdapcd.org/content/sdc/apcd/en/Rule_Development/Rule_Development.html
- Open Performance website https://performance.sandiegocounty.gov/stat/goals/kkaw-h9fm/

Applicable SMAQMD Rules and Regulations:

- Rule 201 – General Permit Requirements http://www.airquality.org/ProgramCoordination/Documents/rule201.pdf
- Rule 202 – New Source Review http://www.airquality.org/ProgramCoordination/Documents/rule202.pdf
- Rule 203 – Prevention of Significant Deterioration http://www.airquality.org/ProgramCoordination/Documents/rule203.pdf
- Rule 214 – Federal New Source Review http://www.airquality.org/ProgramCoordination/Documents/rule214.pdf
- Rule 205 – Community Bank and Priority Reserve Bank http://www.airquality.org/ProgramCoordination/Documents/rule205.pdf
- Rule 301 – Permit Fees – Stationary Source http://www.airquality.org/ProgramCoordination/Documents/rule301.pdf
- Rule 402 – Nuisance http://www.airquality.org/ProgramCoordination/Documents/rule402.pdf
- Rules & Regulation Webpage http://www.airquality.org/Businesses/Rules-Regulations

Applicable SJVAPCD Rules and Regulations:

- Rule 2201 - New and Modified Stationary Source Review Rule http://www.valleyair.org/rules/currntrules/Rule22010411.pdf
- Rule 3010 - Permit Fee http://www.valleyair.org/rules/currntrules/R3010.pdf

- Rule 3020 – Permit Fee Schedules
  http://www.valleyair.org/rules/currntrules/R3020.pdf
- Rule 4565 - Biosolids, Animal Manure, and Poultry Litter Operations
  http://www.valleyair.org/rules/currntrules/r4565.pdf
- Rule 4566 - Organic Material Composting Operations
  http://www.valleyair.org/rules/currntrules/Rule4566CleanRule.pdf
- Rule 8011 - General Requirements
  http://www.valleyair.org/rules/currntrules/r8011.pdf
- Rule 8021 - Construction, Demolition, Excavation, Extraction and Other Earthmoving Activities
  http://www.valleyair.org/rules/currntrules/r8021.pdf
- Rule 8031 – Bulk Materials
  http://www.valleyair.org/rules/currntrules/r8031.pdf
- Rule 8041 - Carryout and Trackout
  http://www.valleyair.org/rules/currntrules/r8041.pdf
- Rule 8051 – Open Areas
  http://www.valleyair.org/rules/currntrules/r8051.pdf
- Rule 8061 - Paved and Unpaved Roads
  http://www.valleyair.org/rules/currntrules/r8061.pdf
- Rule 8071 – Unpaved Vehicle/Equipment Traffic Areas
  http://www.valleyair.org/rules/currntrules/r8071.pdf
- Public Resources Code 21000-21177: California Environmental Quality Act (CEQA) http://www.valleyair.org/transportation/ceqa_idx.htm
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Applicable SCAQMD Rules and Regulations:

- Rule 219 – Equipment Not Requiring a Written Permit Pursuant to Regulation II http://www.aqmd.gov/docs/default-source/rule-book/reg-ii/rule-219.pdf?sfvrsn=8
- Rule 222 – Filing Requirements For Specific Emission Sources Not Requiring a Written Permit Pursuant to Regulation II http://www.aqmd.gov/docs/default-source/rule-book/reg-ii/rule-222.pdf?sfvrsn=8
- Rule 301 – Permitting and Associated Fees http://www.aqmd.gov/docs/default-source/rule-book/reg-iii/rule-301.pdf?sfvrsn=4
- Rule 1133-Composting and Related Operations – General Administrative Requirements http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1133.pdf?sfvrsn=4
- Rule 1133.1-Chipping and Grinding Activities http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1133-1.pdf?sfvrsn=4
- Rule 1133.2 – Emission Reductions from Co-Composting Operations http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1133-2.pdf?sfvrsn=4
- Rule 1133.3 – Emission Reductions from Greenwaste Composting Operations http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1133-3.pdf?sfvrsn=4
- Regulation XIII – New Source Review http://www.aqmd.gov/home/rules-compliance/rules/scaqmd-rule-book/regulation-xiii
  - Rule 1302 – Definitions http://www.aqmd.gov/docs/default-source/rule-book/reg-xiii/rule-1302-definitions.pdf?sfvrsn=4

    - Rule 1303-Requirements http://www.aqmd.gov/docs/default-source/rule-book/reg-xiii/rule-1303-requirements.pdf?sfvrsn=4
    - Rule 1304 – Exemptions http://www.aqmd.gov/docs/default-source/rule-book/reg-xiii/rule-1304-exemptions.pdf?sfvrsn=4
- Rule 1401 New Source Review of Toxic Air Contaminants http://www.aqmd.gov/docs/default-source/rule-book/reg-xiv/rule-1401.pdf?sfvrsn=4
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Applicable VCAPCD Rules and Regulations:

- Rule 23 – Exemptions from Permit http://www.vcapcd.org/Rulebook/Reg2/RULE%2023.pdf
- Rule 26.1 – New Source Review – Definitions http://www.vcapcd.org/Rulebook/Reg2/RULE%2026.1.pdf
- Rule 26.2 – New Source Review – Requirements http://www.vcapcd.org/Rulebook/Reg2/RULE%2026.2.pdf
- Rule 26.7 – New Source Review – Notification http://www.vcapcd.org/Rulebook/Reg2/RULE%2026.7.pdf
- Rule 29 http://www.vcapcd.org/Rulebook/Reg2/RULE%2029.pdf
- Rule 42 – Permit Fees http://www.vcapcd.org/Rulebook/Reg3/RULE%2042.pdf
- Rule 51 – Nuisance http://www.vcapcd.org/Rulebook/Reg4/RULE%2051.pdf
- Rule Development Webpage (for future information on Rule 74.32 in development) http://www.vcapcd.org/rules_division.htm
- VCAPCD Website Permitting Statistics http://www.vcapcd.org/pubs.htm#Permits
- VCAPCD Air Toxics Review of Permit Applications Policy http://www.vcapcd.org/pubs/Engineering/permits2000/AirToxicsReviewOfPermitApplications.pdf
- VCAPCD BACT Implementation Permitting Policy http://www.vcapcd.org/pubs/Engineering/permits2000/BACTPolicy111009.pdf
- VCAPCD Cost of ERCS 2017 http://www.vcapcd.org/pubs/Engineering/permits2000/Forms/ERC-cost-2017.pdf

Appendix C. Emission Reduction Credit Summary Table

Emission reduction credits are constantly changing for each air district as new ERCs are created and used. In general, few ERCs can be created due to the stringent requirements to create them. "ERCs are only issued for reductions of actual emissions that are quantifiable, enforceable, permanent, and surplus.[90]" As such, it is our assumption that the VOC ERCs available by air districts will not increase over the next seven years during which time compost facilities seeking to get permitted will need to purchase ERC offsets to permit their facilities.

The California Air Resources Board tracks the sales price of each ERC[91], but the air districts need to be contacted to determine ERC availability. A recent survey (May 2017) of available ERCs by air district is below.

Table C. Interagency Waste Working Group Survey Results. May 2017. Administered by Paul Hensleigh, Yolo-Solano Air Quality Management District.

Air District	New composting facility subject to permit(s) and offsets?	Total VOC ERCs in general bank (tons per year, except as noted)	ERC bank for 'Essential Public Services (EPS)'?	Total VOCs in the EPS bank (tons)	Would a new composting facility be eligible to use the EPS account (if exists)?
AVAQMD	Yes	0.16	No		
BAAQMD[1]	Yes	3147	No	0	N/A
Butte County AQMD	Yes	85.6	Yes	60	No
Feather River AQMD	Yes (APCO discretion)	273.8 Non-fed 69.8155 Fed	Yes	14.48	No
Lake County AQMD	Yes (for permits)	No offset program			
Mojave Desert AQMD	Yes	105.24 (all FONA)	No		
MB BARD[2]	Yes	68	Yes	44	No
No. Sonoma County APCD	Yes	0 - In attainment	No	N/A	N/A
Placer County APCD	Yes	120	Yes	32	No

[90] Santa Barbara Country APCD. June 29, 2018. A Guide to Emission Reduction Credits (ERCs) System. https://www.ourair.org/erc-guide/

[91] California Air Resources Board. May 26, 2016. New Source Review - Emission Reduction Credit Offsets. https://www.arb.ca.gov/nsr/erco/erco.htm

Table C. (continued) Interagency Waste Working Group Survey Results. May 2017. Administered by Paul Hensleigh, Yolo-Solano Air Quality Management District.

Air District	New composting facility subject to permit(s) and offsets?	Total VOC ERCs in general bank (tons per year, except as noted)	ERC bank for 'Essential Public Services (EPS)'?	Total VOCs in the EPS bank (tons)	Would a new composting facility be eligible to use the EPS account (if exists)?
Sac Metro AQMD[3]	Yes	318	Yes	20.3	No
SDAPCD	Yes	281.54	No	N/A	N/A
SJVAPCD	Yes	5000	No	N/A	N/A
San Luis Obispo APCD	Yes	55.4	Yes	31.9	APCO discretion
Santa Barbara APCD	No	106	No	N/A	N/A
Shasta County AQMD	Yes, and if >25 tpy	360.5	No	N/A	N/A
SCAQMD[4]	Yes	98.89 tpd	Yes	22.8	No
VC APCD[5]	No	593.8	Yes	198	Not at this time
Yolo-Solano AQMD	Yes	196.3	Yes	17.1	No

[1]BAAQMD: New compost facilities are subject to permits and offsets (offsets are triggered when POC (VOC) $\geq$ 10 TPY site-wide). They don't have EPS designation or bank, but they do have a small facility banking account for sites emitting < 35 TPY of POCs (VOCs). Total POCs (VOCs) in small facility banking account is 195 tpy, but this amount is updated on an ongoing basis. A compost site could use this small facility banking account as long as total site-wide PTE for POC (VOC) < 35 tpy.

[2]Data updated August 2018.

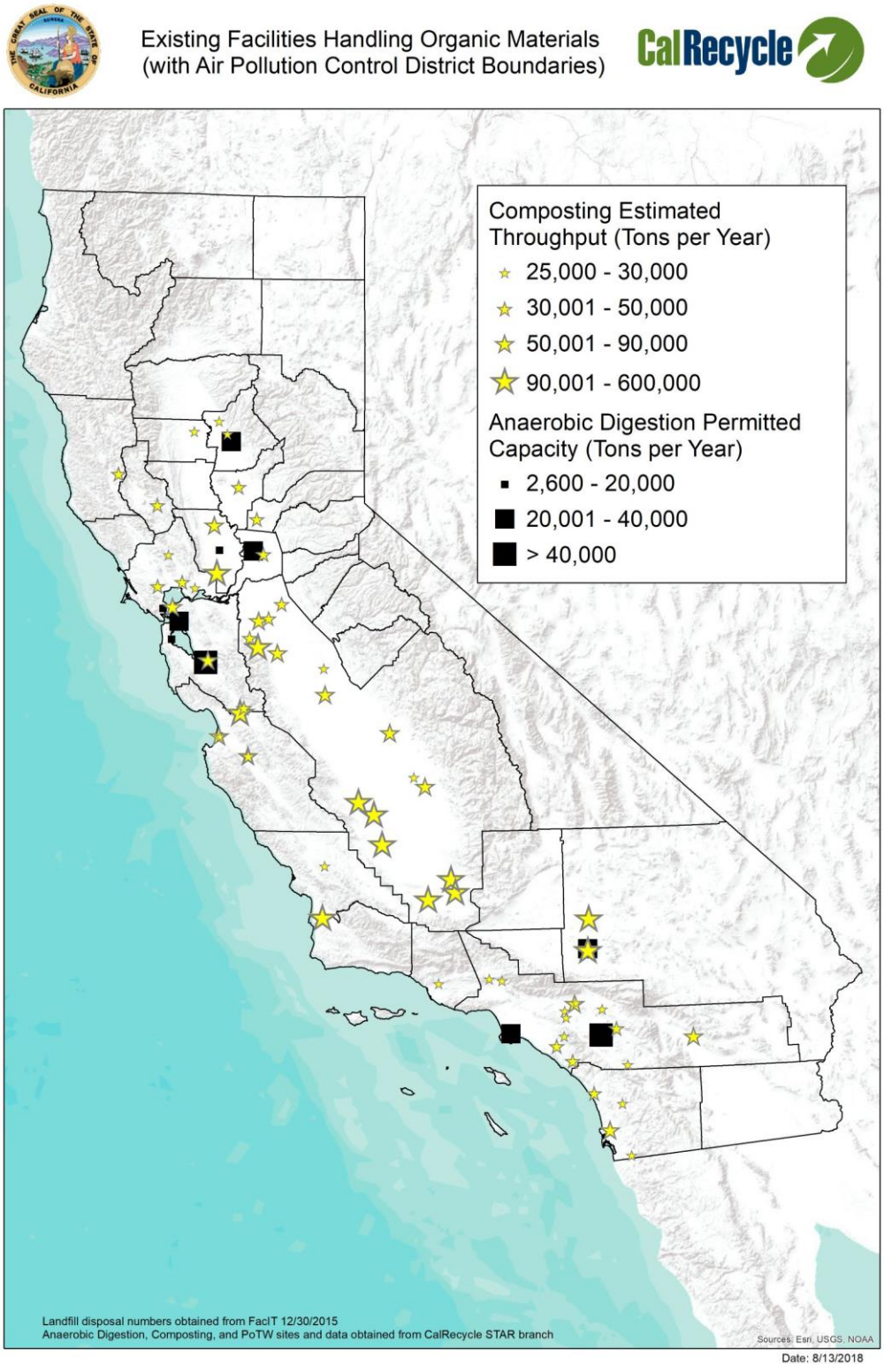
[3]Sacramento Metro AQMD: Note: permits only required if operation involves machines, equipment, or other contrivance, which emits air contaminants. They also have a Community/Military Bank with 494 tons of VOC ERCs in it.

[4]SCAQMD requires permits for ASPs, processing equipment such as screens and grinders and their associated non-road engines, but not for windrows.

[5]Ventura County APCD: No permit required at this time, but considering changing this to require a permit. May have a small source exemption.

*No response from Amador County APCD, Calaveras County APCD, Colusa Country APCD, Eastern Kern APCD, El Dorado AQMD, Glenn County APCD, Great Basin Unified APCD, Imperial Country APCD, Lassen Country APCD, Mariposa County APCD, Mendocino AQMD, Modoc Country APCD, North Coast AQMD, Northern Sierra AQMD, Siskiyou County APCD, Tehama Country APCD, and Tuolumne APCD.

Appendix D. Existing Facilities Diverting Organic Materials from Landfills (2017)



Appendix E. CalRecycle 2025 Disposal Projections Analysis (2017)

The 2025 disposal quantity estimate by county is a business as usual projection that shows what disposal may be, if historical conditions persist. There is no sure way to project future disposal as many factors influence the amounts of waste generated and ultimately disposed. Fluctuations in the economy, the introduction of new waste laws, and the implementation of waste disposal programs will undoubtedly have an impact on the amount of waste disposed. This business as usual disposal projection is based on ten years of historical data, and California's projected population growth. Building upon California Department of Finance's (DOF) regularly updated population estimates and projecting future population totals at the state and local levels, we projected population growth out to 2025. Starting with the 2015 disposal plus disposal-related total, we increased the projected disposal amount by the projected population percent increase for each year. The percent change in population did not stay constant, varying from year to year.

This method gave us California's expected statewide disposal totals, if the average per person disposal, as seen over the last ten years, remains unchanged and population grows at the anticipated rate.

We calculated the average per capita disposal rate of disposal plus disposal-related material, for the ten-year period of 2006 through 2015, to be 5.9 pounds per person per day (ppd), where disposal plus disposal-related is traditional disposal plus alternative daily cover, AIC, other beneficial reuse, transformation, and waste-derived fuel (waste tire-derived fuel estimates used).

This estimate assumed California's population growth rate would slow over time. See Table E-1 for disposal-related projections below.

Table E-1. Total Disposal-related Projections for California.

Year	Disposal-Related Projections (million tons)
2016	42.3
2025	45.7

Based on these disposal rates, we made additional assumptions for our calculation of organic waste material flow to compost, anaerobic digestion and chip and grind facilities. With the assumption that 75 percent of organic materials must be processed by one of these three facility types by 2025 to meet SB 1383 requirements, we made the following additional assumptions of how the organic material would be broken down into six distinct categories with unique distribution to the three main organic materials processing facility types:

- Food waste – We assumed 2.5 percent of food waste would be rescued off the top—this could also increase in the future due to SB1383 requirements on edible food prevention/rescue. Of the remaining food waste 25 percent would go to directly to composting and 75 percent would go to anaerobic digestion (AD). Digestate from AD systems is considered to be reduced in mass by 50 percent, and therefore we assumed 50 of that original 75 would still need to be composted for sanitation before it could be land applied. None is assumed to go to landfills. Other portions of the

waste stream are assumed to be processed by AD in addition to food waste (see below). All AD materials (feedstocks and residual digestate) are assumed to remain within the county of their origin. Since digestate has already been pre-processsed before being composted, the mass from digestate is not included in the VOC tonnages. However, the mass of digestate is considered in the number of needed compost facilities.

- Yard waste (Leaves, grass, pruning and trimmings) – We assumed 100 percent would go to composting as this material is ideally suited for composting.
- Manure – We assumed 50 percent would go to AD and composting, respectively.
- Branches and stumps – We assumed 50 percent would go to compost and chip and grind, respectively.
- Remainder/composite organics – We assumed 50 percent would go to compost and AD, respectively.
- Lumber – We assumed 100 percent would go to chip and grind to create mulch.

Additionally, existing chip and grind facilities had sufficient capacity to process 100 percent of materials we expect will be diverted in 2025. New compost facilities will process 60,000 tons of material annually. New AD facilities will process 75,000 tons of material annually. Finally, that the import or export between air districts or counties may occur. In one set of scenarios, we assumed some larger metropolitan areas would not be able to process all of their organic waste materials. Table E-2 represents what such an import/export scenario might look like.

Table E-2. Potential Movement of Material Across Air District Boundaries.

Departing County (Air District)	**Receiving County (Air District)**				
Northern California	San Joaquin (SJVUAPCD)	Stanislaus (SJVUAPCD)	Merced (SJVUAPCD)		Stay in County
Contra Costa (BAAQMD)	25%	-	-		75%
Alameda (BAAQMD)	25%	25%	-		50%
Santa Clara (BAAQMD)	-	25%	25%		50%
Southern California	Kern (Eastern Kern APCD)	San Bernardino (Mojave Desert AQMD)	Riverside (Mojave Desert AQMD)	Imperial (Imperial APCD)	Stay in County
Los Angeles (SCAQMD/Antelope Valley)	25%	25%	25%		25%
Orange (SCAQMD)	10%	25%	25%	10%	30%
SDUAPCD (SDUAPCD)	-	-	25%	25%	50%

Table E-3. Number of New Compost Facilities Needed Meet SB 1383's 75 Percent Diversion Goal by 2025.

Air District	Annual tons of organic materials accounts for existing capacity including digestate (tpy)		New composting facilities needed (assume average size 60,000 tpy capacity) to meet SB 1383 75% 2025 diversion goal	
	No import/export (I/E) across counties	Inc. I/E from densely populated counties	No I/E across counties (Includes digestate)	Inc. I/E from densely populated counties (Includes digestate)
Amador	4,401	4,401	0.1	0.1
Antelope Valley	57,916	28,926	1	0.5
Bay Area	885,258	726,511	14.8	12.1
Butte	26,863	26,863	0.4	0.4
Calaveras	7,794	7,794	0.1	0.1
Colusa	3,480	3,480	0.1	0.1
El Dorado	24,012	24,012	0.4	0.4
Feather River	18,575	18,575	0.3	0.3
Glenn	3,356	3,356	0.1	0.1
Great Basin Unified	8,326	8,326	0.1	0.1
Imperial	43,058	200,482	0.7	3.3
Kern (Eastern)	-430	47,069	0	0.8
Lake	8,729	8,729	0.1	0.1
Lassen	2,699	2,699	0	0
Mariposa	892	892	0	0
Mendocino	4,386	4,386	0.1	0.1
Modoc	845	845	0	0
Mojave Desert	34,822	138,132	0.6	2.3
Monterey Bay	44,012	44,012	0.7	0.7
North Coast Unified	16,436	16,436	0.3	0.3
Northern Sierra	13,476	13,476	0.2	0.2
Northern Sonoma	6,353	6,353	0.1	0.1
Placer	36,137	36,137	0.6	0.6
Sacramento Metro	225,807	225,807	3.8	3.8
San Diego	592,648	389,949	9.9	6.5
San Joaquin Valley	282,707	701,342	4.7	11.7

Table E-3. (continued) Number of New Compost Facilities Needed Meet SB 1383's 75 Percent Diversion Goal by 2025.

Air District	Annual tons of organic materials accounts for existing capacity including digestate (tpy)		New composting facilities needed (assume average size 60,000 tpy capacity) to meet SB 1383 75% 2025 diversion goal	
	No import/export (I/E) across counties	Inc. I/E from densely populated counties	No I/E across counties (Includes digestate)	Inc. I/E from densely populated counties (Includes digestate)
San Luis Obispo	38,493	38,493	0.6	0.6
Santa Barbara	44,266	44,266	0.7	0.7
Shasta	23,852	23,852	0.4	0.4
Siskiyou	4,935	4,935	0.1	0.1
South Coast	2,622,196	2,285,764	43.7	38.1
Tehama	10,804	10,804	0.2	0.2
Tuolumne	5,715	5,715	0.1	0.1
Ventura	144,857	144,857	2.4	2.4
Yolo-Solano	50,010	50,010	0.8	0.8
Grand Total	**5,297,686**	**5,297,686**	**88.3**	**88.3**

Using these assumptions and facility projections from Chapter III, staff made a number of additional assumptions in order to derive the VOCs that might be emitted by facility and then by air district, in order to determine if sufficient VOC ERCs might be available to meet the increased demand for permitting these facilities. Below are the assumptions staff made for the calculation:

- Assume all new compost facilities will use ASP systems.
- Three EF scenarios:
    1. High EF Scenario: Based on data supplied by Carol Allen of BAAQMD at May Inter-Agency Waste Working Group Meeting (145 tpy VOC emissions from 156,000 tpy feedstock throughput facility scaled down to 60,000 tpy feedstock facility).
    2. Moderate EF Scenario: 1.17 lbs. VOC emitted per wet ton/2000 lbs. per ton * 60,000 tpy feedstock. Use SCAQMD VOC EF for all districts (midrange open windrow emissions), and do control calculation for 75 percent control of emissions from ASP for an EF of 1.17 pounds per wet ton of feedstock. As noted above, some have achieved greater reductions in VOCs, such as the solar-power ASP system in Tulare.
    3. Low EF Scenario: 23.5 tpy, based on actual VOC offsets purchased to obtain permit for compost facility in SJVAPCD.

Table E-4. Determination of Whether Air District NSR Threshold Triggers the Need to Purchase ERCs to Offset VOC Emissions for Four Different Scenarios.

Air District	NSR VOC Offset Purchase Threshold (tpy)	Tons per year of VOCs emitted per facility			
		High EF (no I/E)	Low EF (no I/E)	High EF (w I/E)	Low EF (w I/E)
Amador	100	5.56	2.35	5.56	2.35
AVAQMD	25	55.6	23.5	27.8	11.75
BAAQMD	10	55.6	23.5	55.6	23.5
Butte	100	22.24	9.4	22.24	9.4
Calaveras	100	5.56	2.35	5.56	2.35
Colusa	25	5.56	2.35	5.56	2.35
El Dorado	10	22.24	9.4	22.24	9.4
Feather River	25	16.68	7.05	16.68	7.05
Glenn	25	5.56	2.35	5.56	2.35
Great Basin Unified		5.56	2.35	5.56	2.35
Imperial	25	38.92	16.45	55.6	23.5
Kern (Eastern)	25	0	0	44.48	18.8
Lake	~25	5.56	2.35	5.56	2.35
Lassen	45.6	0	0	0	0
Mariposa	100	0	0	0	0
Mendocino		5.56	2.35	5.56	2.35
Modoc		0	0	0	0
Mojave Desert	25	33.36	14.1	55.6	23.5
MBARD	137 lbs/day and 10 tpy	38.92	16.45	38.92	16.45
North Coast Unified	25	16.68	7.05	16.68	7.05
Northern Sierra		11.12	4.7	11.12	4.7
Northern Sonoma	N/A	5.56	2.35	5.56	2.35
Placer	25	33.36	14.1	33.36	14.1
Sacramento Metro	10	55.6	23.5	55.6	23.5
San Diego	50	55.6	23.5	55.6	23.5
SJVAPCD	10	55.6	23.5	55.6	23.5
San Luis Obispo	25	33.36	14.1	33.36	14.1
Santa Barbara	25	38.92	16.45	38.92	16.45
Shasta	25	22.24	9.4	22.24	9.4
Siskiyou		5.56	2.35	5.56	2.35
SCAQMD	4	55.6	23.5	55.6	23.5
Tehama	25	11.12	4.7	11.12	4.7
Tuolumne		5.56	2.35	5.56	2.35
Ventura	5	55.6	23.5	55.6	23.5
Yolo-Solano	10	44.48	18.8	44.48	18.8
Grand Total		15 ADs over	7 ADs over	16 ADs over	7 ADs over
Color key:		Over threshold		Under threshold	

Table E-5. Determination if Sufficient VOC ERCs are Available in General Bank to Permit Facilities at a 1:1 Ratio (Assuming All ERCs in the Bank are Available for Purchase).

Air District	NSR VOC Offset Purchase Threshold (tpy)	Total VOC ERCs in the general bank (tons)	High EF (no I/E) tpy VOC emitted per facility	Low EF (no I/E) tpy VOC emitted per facility	High EF (w I/E) tpy VOC emitted per facility	Low EF (w I/E) tpy VOC emitted per facility
AVAPCD	25	0.16	55.6	23.5	13.9	5.875
BAAQMD	10	3147	822.88	347.8	672.76	284.35
El Dorado	10		22.24	9.4	22.24	9.4
Imperial	25		38.92	16.45	55.6	23.5
Mojave Desert	25	105.24	33.36	14.1	55.6	23.5
MBARD	137 lbs/day and 10 tpy	94.206	38.92	16.45	38.92	16.45
Placer	25	120	33.36	14.1	33.36	14.1
Sacramento Metro	10	318	211.28	89.3	211.28	89.3
SDCAPCD	50	281.54	550.44	232.65	361.4	152.75
SJVAPCD	10	5000	261.32	110.45	650.52	274.95
San Luis Obispo	25	55.4	33.36	14.1	33.36	14.1
Santa Barbara	25	106	38.92	16.45	38.92	16.45
SCAQMD	4	98.89 tpd	2429.72	1026.95	2118.36	895.35
VCAPCD	5	593.8	133.44	56.4	133.44	56.4
Yolo-Solano	10	196.3	44.48	18.8	44.48	18.8
Color key:		Not enough		Potentially not enough		Enough ERCs

Table E-6. Percentage of General VOC ERC Bank Used to Permit Compost Facilities by Air District for 1:1 VOC ERC Purchase Scenario.

Air District)	Total VOC ERCs in the general bank (tons)	High EF (no I/E) tpy VOC emitted per facility	Low EF (no I/E) tpy VOC emitted per facility	High EF (w I/E) tpy VOC emitted per facility	Low EF (w I/E) tpy VOC emitted per facility
AVAPCD	0.16	34750%	14688%	8688%	3672%
BAAQMD	3147	26%	11%	21%	9%
El Dorado		Unknown	Unknown	Unknown	Unknown
Imperial		Unknown	Unknown	Unknown	Unknown
Mojave Desert	105.24	32%	13%	53%	22%
MBARD	94.206	41%	17%	41%	17%
Placer	120	28%	12%	28%	12%
Sacramento Metro	318	66%	28%	66%	28%
SDCAPCD	281.54	196%	83%	128%	54%
SJVAPCD	5000	5%	2%	13%	5%
San Luis Obispo	55.4	60%	25%	60%	25%
Santa Barbara	106	37%	16%	37%	16%
SCAQMD	98.89 tpd	Unknown	Unknown	Unknown	Unknown
VCAPCD	593.8	22%	9%	22%	9%
Yolo-Solano	196.3	23%	10%	23%	10%
AVERAGE %:		**34%**	**21%**	**36%**	**19%**

Table E-7. Determination if Sufficient VOC ERCs are Available in General Bank to Permit Facilities at a 2:1 Ratio (Assuming All ERCs in the Bank are Available for Purchase).

Air District (AD)	Total VOC ERCs in the general bank (tons)	High EF (no I/E) tpy VOC emitted per facility	Low EF (no I/E) tpy VOC emitted per facility	High EF (w I/E) tpy VOC emitted per facility	Low EF (w I/E) tpy VOC emitted per facility
AVAPCD	0.16	111.2	47	27.8	11.75
BAAQMD	3147	1645.76	695.6	1345.52	568.7
El Dorado	Unknown	44.48	18.8	44.48	18.8
Imperial	Unknown	77.84	32.9	111.2	47
Mojave Desert	105.24	66.72	28.2	111.2	47
MBARD	94.206	77.84	32.9	77.84	32.9
Placer	120	66.72	28.2	66.72	28.2
Sacramento Metro	318	422.56	178.6	422.56	178.6
SDCAPCD	281.54	1100.88	465.3	722.8	305.5
SJVAPCD	5000	522.64	220.9	1301.04	549.9
San Luis Obispo	55.4	66.72	28.2	66.72	28.2
Santa Barbara	106	77.84	32.9	77.84	32.9
SCAQMD	98.89 tpd	4859.44	2053.9	4236.72	1790.7
VCAPCD	593.8	266.88	112.8	266.88	112.8
Yolo-Solano	196.3	88.96	37.6	88.96	37.6

Color key: Not enough | Potentially not enough | Enough ERCs

Table E-8. Percentage of General VOC ERC bank used to permit compost facilities by air district for 2:1 VOC ERC purchase scenario.

Air District	Total VOC ERCs in the general bank (tons)	High EF (no I/E) tpy VOC emitted per facility	Low EF (no I/E) tpy VOC emitted per facility	High EF (w I/E) tpy VOC emitted per facility	Low EF (w I/E) tpy VOC emitted per facility
AVAPCD	0.16	69500%	29375%	17375%	7344%
BAAQMD	3147	52%	22%	43%	18%
El Dorado		Unknown	Unknown	Unknown	Unknown
Imperial		Unknown	Unknown	Unknown	Unknown
Mojave Desert	105.24	63%	27%	106%	45%
MBARD	94.206	83%	35%	83%	35%
Placer	120	56%	24%	56%	24%
Sacramento Metro	318	133%	56%	133%	56%
SDCAPCD	281.54	391%	165%	257%	109%
SJVAPCD	5000	10%	4%	26%	11%
San Luis Obispo	55.4	120%	51%	120%	51%
Santa Barbara	106	73%	31%	73%	31%
SCAQMD	98.89 tpd	Unknown	Unknown	Unknown	Unknown
VCAPCD	593.8	45%	19%	45%	19%
Yolo-Solano	196.3	45%	19%	45%	19%
AVERAGE %:		**54%**	**29%**	**53%**	**31%**

Appendix F. Comparison of Landfill and Compost VOC Emissions

Table F. Comparison of Landfill and Compost VOC Emissions.

Gases measured/modeled	LANDGEM Version 3.02	Compost Kumar et al. (2011)	Overlap LANDGEM/ Kumar
1,1,1,2-Tetrafluoroethane (CH2FCF3 (HFC-134a))			
1,1,1-Trichloroethane (CH3CCl3; methyl chloroform)	x		
1,1,2,2-Tetrachloroethane	x		
1,1-Dichloroethane (ethylidene dichloride)	x		
1,1-Dichloroethene (vinylidene chloride)	x		
1,2-Dichloroethane (ethylene dichloride)	x		
1,2-Dichloropropane (propylene dichloride)	x		
2 Butanol		0.39%	
2 Butene		0.17%	
2 Methyl 1-propene		0.41%	
2-Propanol (isopropyl alcohol)	x		
3 Methyl butanoic acid		0.28%	
Acetaldehyde		0.14%	
Acetic acid		5.94%	
Acetone	x	0.47%	0.47%
Acrylonitrile	x		
Alpha pinene		1.36%	
Benzene	x		
Bromodichloromethane	x		
Butane	x		
Butanoic acid		1.35%	
Camphene (monoterpene)		0.24%	
Camphor		1.18%	
Carbon dioxide	x		
Carbon disulfide	x		
Carbon monoxide	x		
Carbon tetrachloride	x		
Carbonyl sulfide	x		
Chlorobenzene	x		
Chlorodifluoromethane (CHClF2 (HCFC-22))	x		
Chloroethane (ethyl chloride)	x		
Chloroform (CHCl3)	x		
Chloromethane (CH3Cl)	x		
Dichlorobenzene	x		

Table F. Comparison of Landfill and Compost VOC Emissions (continued).

Gases measured/modeled	LANDGEM Version 3.02	Compost Kumar et al. (2011)	Overlap LANDGEM/ Kumar
Dichlorodifluoromethane (CCl2F2 (CFC-12))	x		
Dichloromethane (CH2Cl2, methylene chloride)	x		
Dimethyl sulfide (methyl sulfide)	x		
Ethane	x		
Ethyl alcohol (Ethanol)	x	18.16%	18.16%
Ethyl mercaptan (ethanethiol)	x		
Ethylbenzene (1 Methyl, 3-1-methyl)	x	0.23%	0.23%
Ethylene dibromide	x		
Fluorotrichloromethane	x		
Hexane	x		
Hydrogen sulfide	x		
Isopropyl alcohol		42.31%	
Isovaleraldehyde		0.15%	
Limonene (monoterpene)		2.27%	
Mercury (total)	x		
Methane	x		
Methyl alcohol (methanol)		12.79%	
Methyl butylacetate		0.14%	
Methyl ethyl ketone (2-butanone, Liu study)	x		
Methyl isobutyl ketone	x		
Methyl mercaptan	x		
Methyl propionic acid		0.26%	
Naphthalene		0.50%	
Others		9.36%	
Pentane	x		
Perchloroethylene (tetrachloroethylene)	x		
Pinene Isomers		0.60%	
Propane	x		
Propene		0.22%	
Propionic acid		0.53%	
t-1,2-Dichloroethene	x		
Terpineol		0.35%	
Toluene	x		
Trichloroethylene (CHClCCl2; trichloroethene)	x		
Undecane		0.20%	
Vinyl chloride	x		
Xylenes	x		
TOTAL	**-**	**100%**	**18.86%**

Appendix G. Individual Air District Approaches Input

Bay Area Air Quality Management District

The Bay Area Air Quality Management District (BAAQMD) currently regulates composting facilities using general permitting requirements for stationary sources, as established in our Regulation 2. To date, BAAQMD has not adopted a rule specific to composting operations. Instead, BAAQMD has limited emissions from compost operations using general prohibitory regulations (i.e., Regulations 6-1 and 8-2) and new source review for new and modified facilities. On a case-by-case basis our permits have required use of Best Available Control Technology (BACT) and limits on health risks. Early on, permits focused on limiting particulate emissions from material handling activities, size reduction equipment, and diesel-powered engines. New permits for composting facilities now limit emissions of volatile organic compounds, particulate matter, and air toxics (e.g., acetaldehyde, ammonia, isopropanol, methanol, and naphthalene). The permitting process may also limit combustion and air toxic emissions from associated processing equipment used at a facility.

Two thresholds oblige a facility to obtain a permit from BAAQMD. One threshold is its total annual biomass processing: if a composting operation processes 500 tons per year or more of feedstock biomass, it must obtain an operating permit. State law exempts agricultural facilities (but not silvicultural operations) if their composting feedstocks contain only biomass generated on site or an incidental amount of biomass from off-site or from non-agricultural operations. However, once an agricultural facility processes 500 tons per year or more of biomass from off-site or non-agricultural operations, it loses its exemption and must obtain a permit from BAAQMD. A second threshold condition for agricultural composting operations is the facility's total point-source emissions. If an agricultural facility emits 50 tons per year or more of any regulated air pollutant, excluding fugitive dust and greenhouse gases, Federal Title V permitting applies. In that case, the agricultural facility must obtain BAAQMD permits for all stationary sources that are not otherwise exempt from BAAQMD permitting requirements. Permits cover stationary sources and portable sources that remain at one facility for twelve months or more. An engine used to both propel a vehicle and run a tub grinder is considered a motor vehicle, and motor vehicle sources are excluded from BAAQMD permit requirements.

Emissions estimation for composting is based on emission factors in CARB's "Emissions Inventory Methodology for Composting Facilities." BAAQMD estimates that 90 percent of emissions occur in the active phase of composting, that 10 percent occurs in the curing phase, and that composting in a covered aerated static pile reduces 80 percent of the volatile organic compound emissions and 53 percent of the ammonia emissions in the active phase. Stockpiles receive separate emission estimates. A health risk assessment may be required to assure that health risks from a composting operation comply with the project health risk limits in our Regulation 2-5 (i.e., a cancer risk less than 10 in a million, chronic hazard index less than 1, and acute hazard index less than 1). Best Available Control Technology for Toxics (TBACT) may be required.

Although BAAQMD does not yet have a composting-specific rule, the air district is developing a strategy for organics recovery operations and new rules for composting facilities as part of a basin-wide strategy for reducing methane emissions. These rules will apply to commercial-scale operations found at material recovery facilities, landfills, stand-alone facilities, agricultural

facilities processing organics generated off-site, and any other sites where the scale of processing has the potential to create public nuisance, odor complaints, or significant criteria or toxic pollutant emissions. A first rule under consideration is expected to track the flow and composition of material and establish best practices in material handling and pile management to minimize emissions from “inadvertent composting" or biodegradation under anoxic conditions. This rule would apply to passive piles (e.g., transfer piles, sort piles, feedstock piles, etc.) and would be required at operations across the organics recovery supply chain (e.g., chip-and-grind operations, material recovery facilities, composting facilities, anaerobic digesters, etc. and related operations at landfill). A second rule under consideration would establish Best Management Practices (BMP) and Best Available Retrofit Control Technology (BARCT) for composting operations to minimize emissions from active composting (e.g., open windrows, static composting piles, curing piles, etc.). Covered aerated static piles with biofilter emission controls is a leading candidate for BARCT in this rule.

VII. Air Permitting and Regulatory Requirements for New and In-Use California Composting Facilities

A. Key Issues in Permitting New and Expanded Facilities

The emissions threshold that triggers Title V permitting is 50 tons per year of any regulated air pollutant. Fugitive emissions are not included in this total unless an operation is included in a list of twenty-eight types of PSD facilities. Agricultural facilities are not a type of facility for which fugitive emissions must be included when making Title V applicability determinations. The exclusion of fugitive emissions from composting facilities creates a perverse incentive: a better-controlled source processing the same amount of biomass could be required to obtain a permit while its higher-emitting analog would not. For example, emissions from composting in open windrows do not come from a point source; therefore, they would be considered fugitive emissions and not counted toward the 50 ton-per-year threshold. By contrast, emissions from composting using a lower-emitting covered aerated static pile with a biofilter for emissions control would count toward the 50 ton-per-year threshold.

i. General Permit Process Timeline

BAAQMD permit processing timelines are specified in our Regulation 2-1. BAAQMD has 15 working days after receipt of an application to determine whether an application is complete. A complete application includes payment of all fees and submittal of all information needed to calculate emissions and assess compliance with all applicable regulations, including California Environmental Quality Act (CEQA) requirements. If an application is deemed incomplete, BAAQMD typically allows the Applicant 30-60 days in which to submit the necessary data.

Once an application is deemed complete, BAAQMD has 35 working days to make a final decision on the application. This period may be extended if the application is subject to public noticing requirements, or if CEQA compliance is not final. New large compost facilities often trigger public noticing, which can add 45-60 days to the processing time. In addition, the application processing time may be extended by mutual agreement between the Applicant and the Air District, such as during permit condition discussions or when a project needs to be modified to meet Air District requirements.

Total BAAQMD permit processing time from receipt of an application to issuance of the Authority to construct is typically less than three months. However, compost facility permits

typically take three to six months and sometimes longer due to the complexity of compost facility permits and the usual need for public noticing.

ii. New Source Review: Best Available Control Technology (BACT) and Offsets
Any source that emits more than 10 pounds per highest day of precursor organic compounds (POC), nitrogen oxides (NOx), carbon monoxide (CO), particulate matter (PM10/2.5), or sulfur dioxide (SO2) must meet BACT requirements for that pollutant. BACT for POC emissions from a new or modified compost operation include, as a minimum, covered aerated static piles and may include collection and control of all POC emissions. New open windrow composting operations will only be allowed for very small operations that do not trigger BACT.

BAAQMD has been classified as marginal and designated in non-attainment for the 2015 ozone NAAQS. New or modified compost facilities that have a site-wide potential to emit 10 tons per year or higher of either precursor organic compounds (POCs) or nitrogen oxides (NOx) will trigger offsets for that pollutant.

Based on our best emission estimates, composting facilities that process more than 12,500 tons per year of biomass would trigger offsets. If a facility's potential to emit is greater than 10 tons but less than 35 tons per year for POC or NOx, BAAQMD requires a facility to offset its total emissions at a 1 to 1 ratio. Sites processing less than 44,000 tons per year of biomass per year would likely emit less than 35 tons per year of POC. BAAQMD is able to provide offsets for these operations from a "small facility bank" that we maintain under NSR.

If a facility's potential to emit is greater than 35 tons per year, the facility is required to offset its full emissions at a 1.15 to 1 ratio. Based on our best emission estimates, composting facilities meeting these requirements are those that process more than 44,000 tons of biomass per year. These facilities are obliged to obtain emission reduction certificates from the private market.

iii. Essential Public Service Designation
BAAQMD does not have an essential public service designation.

iv. Co-location vs. Separated Waste Facilities
Compost facilities that are co-located at landfills are likely to exceed the small facility emissions threshold of 35 tons per year. Therefore, these sites will likely need to purchase POC and NOx offsets from the private market. Compost facilities that are separate from landfills or other sites could potentially keep the sitewide POC and NOx emissions below the small facility bank threshold. In this case BAAQMD would provide the required offsets, if available, at no cost.

v. Relative Emissions Impacts Associated with Organics Transport Between Air Basins or Air Districts
Currently, it is not uncommon for organic materials to be transported out of the Bay Area for composting. BAAQMD has recently received applications for a number of compost operations proposed at existing landfills or transfer station sites but very few applications for new separate compost sites. It is not clear whether these new compost operations will provide enough capacity to reduce transport to out-of-District compost facilities.

vi. Cost Effectiveness, Facility Costs, Funding
Due to the high cost of living in the Bay Area, labor costs for Bay Area facilities may be higher than other California locations. It is unclear at this time whether these higher labor costs would be outweighed by other factors, such as the low offset costs for small facilities, access to funding sources, high demand for compost, etc.

vii. AB 617 and Disadvantaged Communities
BAAQMD anticipates considering land use and siting concerns around organics recovery facilities as proposals for new facilities are received and as we move forward with community selection, community monitoring plans, and community action plans.

viii. Odors and Nuisance Associated with Poor Operation
BAAQMD Regulation 7 places general limitations on odorous substances and specific emission limitations on certain odorous substances. State law exempts composting operations from these provisions. However, BAAQMD is still obliged to respond to public complaints about nuisance odors. One site in our jurisdiction with adjacent organics recovery facilities received nearly three thousand complaints in a single year. BAAQMD has been engaging with facilities at this site and with the CalRecycle-delegated local enforcement agency to identify and address these odors, but odor source identification and rectification are still ongoing.

At this time BAAQMD is reviewing Regulation 7 and considering revisions to its odor detection procedures and its complaint policy.

Monterey Bay Air Resources District (MBARD)

Currently (May 2018), MBARD has no rule or permit requirements specific to composting operations. Historically, MBARD has not permitted windrow composting facilities. However, it light of SB1383 MBARD is considering permitting windrow operations and enforcing BMPs. MBARD currently permits stationary equipment used in composting operations (such as screens and tub grinders). Equipment powered by any IC engine rated at 50 hp or greater would require a permit for both the engine and the fugitive particulate matter generated by equipment activities. If the equipment was powered by an IC engine < 50 hp or other power source, MBARD would still permit the equipment due to the fugitive particulate matter emissions. MBARD does not permit windrow machines, since the machines meet the definition of a motor vehicle.

At this time, MBARD does not plan to develop a rule specific to composting operations. MBARD is attainment for the federal ozone standard and is approaching attainment for the state ozone standards. Finally, this type of measure has not been evaluated for implementation in MBARD's triennial state ozone plan.

VII. Air Permitting and Regulatory Requirements for New and In-Use California Composting Facilities

A. Key Issues in Permitting New and Expanded Facilities – Monterey Bay Air Resources District (MBARD)

i. New Source Review, General Permit Process Timeline

MBARD

Currently (May 2018), uncontrolled composting facilities do not require permits for the composting operation. However, MBARD has been approached by a local source regarding installing a covered aerated static pile composting system. MBARD would permit this type of composting operation in accordance with Rule 200 because equipment would be installed which would reduce or control the issuance of air contaminants. In all cases, controlled or uncontrolled, ancillary equipment such as grinders or screens, are subject to permitting.

A controlled composting operation would be subject to MBARD's New Source Review requirements (Rules 207). These requirements include Best Available Control Technology (BACT), emissions offsets, and public noticing. Additionally, these project would be subject to Rule 1000 (Permit Guidelines for Sources Emitting Toxic Air Contaminants), to evaluate if any health risk impacts would be associated with the project.

BACT for composting operations has not yet been established by MBARD, however, the District uses South Coast Air Quality Management District's BACT Guidance. If BACT was triggered, MBARD would require the applicant to submit a BACT cost-effectiveness analysis. BACT would be required if deemed to be cost-effective. If BACT were not cost-effective and depending on the level of emissions, the operation could then be subject to offsets. However, sources which emit less than ten tons per year are exempt from the offset requirement.

Prior to submitting an application, a source should contact the District to obtain a fee estimate for processing the application and application forms. Once a permit is issued, annual permit fees and an emissions fee will be required. Fees are described in Rule 300 and 301.

ii. Offsets

Offsets are required for stationary sources with the potential to emit more the 137 pounds VOC or NOx per day (Rule 207). However, sources which emit less than 10 tons per year are exempt from the offset requirement. The District does have offset thresholds for other pollutants such as SO_x, PM, and PM_{10}, but does not expect a composting operation would trigger these thresholds.

iii. Essential Public Service Designation

Rule 215 defines essential public services to be a sewage treatment plant which is publicly owned and operated, a prison, jail, or correctional facility, a police or fire fighting facility, a school operated by a local school district, a hospital which is publicly owned or operated or which receives public funds or construction and operation of a publicly owned and operated landfill gas control or processing facility. Composting operations are not defined to be essential public services.

Sacramento Metro Air Quality Management District

Currently (May 2018), SMAQMD has no specific prohibitory rule for composting operations. Composting operations are subject to permitting by District Rule 201, and are subject to New Source Review (Rule 202), nuisance requirements including health risk assessment (Rule 402), fugitive dust (Rules 403, 404, and 405). Additionally, equipment used in composting operations (such as screens, tub grinders, and internal combustion engines) are subject to permitting requirements.

Information on how to participate in the rule development process can be found at the rule development section of the District's website listed in Appendix B.

VII. Air Permitting and Regulatory Requirements for New and In-Use California Composting Facilities

A. Key Issues in Permitting New and Expanded Facilities – Sacramento Metropolitan Air Quality Management District (SMAQMD)

i. New Source Review, General Permit Process Timeline

SMAQMD requires composting facilities to obtain a permit. SMAQMD rule 201 does not exempt composting facilities from the requirement to obtain a permit. Existing facilities were required to obtain a Permit to Operate many years ago and were permitted based on their existing capacity. New source review requirements (BACT and offsets) were not triggered for existing facilities.

Any new sources, or any existing sources proposing to modify or expand operations that will increase air emissions, will need to apply for and receive an Authority to Construct (ATC) before building or modifying the operation. Such applications will be subject to the District's New Source Review requirements (Rule 202 or 214). These requirements include Best Available Control Technology (BACT), emissions offsets, CEQA, public noticing, and evaluation of any health risk impacts that would be associated with the project.

BACT for composting has not yet been established by the SMAQMD. In evaluating BACT, all operational methods and add-on controls will be evaluated, and the highest level of control achieved in practice or determined to be technologically feasible and cost-effective will be required.

Most composting facilities will trigger offsets for VOCs. Offsets are discussed in more detail in section ii.

Prior to submitting an application, a source should contact the District to obtain a fee estimate for processing the application. Once a permit is issued, annual permit renewal fees will be required as per Rule 301. In addition, composting facilities may also be subject to Air Toxics "Hot Spots" fees (Rule 306) and Community Bank or Priority Reserve Bank Renewal Fees (Rule 205).

ii. Offsets

Offsets are required for sources in Sacramento County exceeding emission thresholds of 10 tons per year of volatile organic compounds as specified in Rule 202 – New Source Review. Offsets will be required for emissions increases at or above this threshold, and will be determined during processing of an application. There are currently approximately 270 tons of VOC Emission Reduction Credits (ERC) in the community bank that can be used for offsetting purposes.

Sources can apply to receive a community bank loan from the District, as provided in Rule 205 – Community Bank and Priority Reserve Bank, and requests longer than 5 years or over 900 pounds per quarter are subject to Board of Director approval.

iii. Essential Public Service Designation

Rule 205 defines essential public services to be sewage treatment operations which are publicly owned and operated, prison, jail, correctional facility, police or fire fighting facility, school or hospital, solid waste management systems including landfill gas control or processing systems, water delivery operations, and environmental cleanup operations. Composting operations are not defined to be an essential public service, even if co-located at a facility that meets this definition.

San Diego Air Pollution Control District

Currently (March 2018), SDAPCD has no rule or permit requirements for composting operations. Additionally, equipment used in composting operations (such as screens and tub grinders) are specifically exempt from permits (Rule 11 (d)(10)(v)); however, any IC engine powering this equipment would require a permit if the engine was 50 hp or greater (Rule 11 (d)(2)(i)).

SDAPCD is in the process of developing Rule 67.25 to address volatile organic compound (VOC) emissions from composting operations, with plans to take this rule to our Governing Board in late 2018 or early 2019. As with similar rules in other air districts, Rule 67.25 will have an exemption threshold below which a source will not be subject to the rule, and will have different best management practices (BMP) / control requirements depending on the size of the operation and if the operate is existing or a new or modified operation. Sources subject to the rule will also be required to submit applications for a Permit to Operate upon adoption of the rule. Tub grinders and trommel screens will remain exempt from permits.

Information on how to participate in the rule development process can be found at the rule development section of the District's website listed in Appendix B.

VII. Air Permitting and Regulatory Requirements for New and In-Use California Composting Facilities

A. Key Issues in Permitting New and Expanded Facilities – San Diego County Air Pollution Control District (SDAPCD)

i. New Source Review, General Permit Process Timeline

Currently (March 2018), composting facilities do not require permits, but this will change once Rule 67.25 is adopted. At that point, existing facilities will be issued a Permit to Operate, based on their existing capacity, and will only require compliance with Rule 67.25.

After the rule is adopted, any new source, or any existing source proposing to modify or expand operations that will increase air emissions, will need to apply for and receive an Authority to Construct (ATC) before building or modifying the operation. Such applications will be subject to the District's New Source Review requirements (Rules 20.1, 20.2 and 20.3). These requirements include best available control technology (BACT) / lowest achievable emission rate (LAER), emissions offsets, Ambient Air Quality Impact Analysis and public noticing. Additionally, these applications are subject to Rule 1200 (Toxic Air Contaminants – New Source Review), to evaluate if any health risk impacts would be associated with the project.

BACT has not yet been established in San Diego County. In evaluating BACT, all operational methods and add-on controls will be evaluated, and the highest level of control that is also cost-effective will be required of the source. However, if a source is considered a Major Source (per Rule 20.1(c)(35)), the application may be subject to LAER, and then what is considered Achieved in Practice (AIP) will be the minimum control level required, and if a higher level of control is cost-effective, then that will be required.

If a source's emissions exceed the Ambient Air Quality Impact Analysis thresholds (per Rule 20.2(d)(2) or Rule 20.3(d)(2)), modeling will be conducted to determine the effect of the source on ambient air quality, and a public notification will be required.

Prior to submitting an application, a source should contact the District to obtain a fee estimate for processing the application. Once a permit is issued, annual permit fees and an emissions fee will be required. All fees are described in Rule 40.

SDAPCD is committed to working with applicants and processing applications in a timely manner. Average processing times can be found at the Open Performance webpage listed in the appendices.

ii. Offsets

Offsets are not required for sources in San Diego County, unless the source is a Major Source. For Major Sources, offsets may be required for emissions increases, and will be determined during processing of an application. There are currently approximately 280 tons of VOC Emission Reduction Credits (ERC) that can be used for offsetting purposes.

iii. Essential Public Service Designation

Rule 20.1(c)(25) defines essential public services to be water, wastewater and wastewater-sludge treatment plants, or solid waste landfills and solid waste recycling facilities, provided they are publicly owned or are public-private partnerships under public control, and don't treat or process hazardous waste. Composting operations are not defined to be essential public services, even if co-located at a facility that meets this definition.

San Joaquin Valley Unified Air Pollution Control District

SJVAPCD Rule 4565 (*Biosolids, Animal Manure, and Poultry Litter Operations*) and Rule 4566 (*Organic Material Composting Operations*) provide requirements for new and existing composting operations and related activities. Rule 4565 requires reductions of volatile organic compounds (VOC) emissions from biosolids (sewage sludge or wastewater), animal manure, and poultry litter composting and co-composting (biosolids/manure/litter mixed with other materials) operations. Rule 4566 requires VOC emission reductions from organic material (food, green, or a mixture thereof) composting operations. In addition to reducing VOC emissions, the measures and practices required by District Rules 4565 and 4566 also reduce ammonia (NH_3) emissions.

Per Rule 4565, mitigation measures, for both the active and curing composting phases, are aiming at reducing VOC emissions from biosolids, animal manure, or poultry litter composting

operations. The number of mitigation measures required depends on the facility's annual feedstock throughput.

Composting of up to 20,000 wet-tons/year are required to implement at least three Class One mitigation measures;

Composting between 20,000 and 100,000 wet-tons/year are required to implement at least four total mitigation measures (either four Class One measures or three Class One measures and one Class Two measure);

Composting of 100,000 wet-tons/year or greater are required to implement four or five mitigation measures (depending on the measures chosen).

A list of all mitigation measures can be found in Table 2 of District Rule 4565.

Per Rule 4566, mitigation measures are aiming at reducing VOC emissions from organic material composting during the active phase. The number of mitigation measures required depends on the facility's annual feedstock throughput.

Composting of less than 200,000 wet-tons/year are required to implement two mitigation measures or an alternative measure that demonstrates at least 19% VOC reduction.

Composting between 200,000 and 750,000 wet-tons/year are required to implement either three mitigation measures or an alternative measure that demonstrates at least 60% VOC reduction.

Composting 750,000 wet-tons/year or greater are required to implement a mitigation measure that demonstrates at least 80% VOC reduction.

A list of all mitigation measures can be found in District Rule 4566

SJVAPCD: New Source Review and General Permit Information

Facilities that were in operation prior to the loss of permit exemption date (8/1/02 for biosolids composting and 11/6/07 for all other types of composting) are considered grandfathered sources and receive "In-house Permits to Operate" or "In-house PTOs". The District also considers emissions from these grandfathered facilities fugitive and do not include them in Major Source determination calculations. Any modification to a grandfathered facility to increase daily or annual throughputs or Potential to Emit (PE) would be evaluated under District Rule 2201 (*New and Modified Stationary Source Review Rule*), and the facility would be subject to all subsequent requirements, such as Best Available Control Technology (BACT), offsets, Major Source, public notice, etc. Furthermore, any increase in emissions would be evaluated to determine the health risk impacts associated with the project.

Facilities permitted after the loss of permit exemption date are considered new stationary sources and are also subject to District Rule 2201. The emissions from these facilities are considered non-fugitive and included towards the Major Source determination calculations. Increases in emissions are subject to BACT, offsets, public notice, and are also evaluated to determine the health risk impacts associated with the project.

Pursuant to District Rule 2201, add-on emission control devices may be required if a new or modified composting/co-composting operation triggers BACT.

The District has establish numerous BACT guidelines that apply to specific source categories, such as:

BACT Guideline 6.4.7 - Co-Composting with Biosolids Operations

BACT Guideline 6.4.8 - Manure Composting Operations

BACT Guideline 6.4.9 - Co-Composting Operations

BACT Guideline 6.4.11 - Co-Composting with Green and Food Materials and Manure

For instance for a co-composting with biosolids operation, Achieved-in-Practice (AIP) BACT requires the installation of a negatively aerated static piles (ASP) with engineered, under pile, grid aeration system venting to a control device with greater than or equal to 80% control efficiency, for the active phase. Another example for a manure composting operation, AIP BACT requires the facility to implement Class One mitigation measures from District Rule 4565.

The above BACT guidelines also identify Technologically Feasible control options (such as requiring enclosed ASPs vented to control devices for both the active and curing phases). Depending on the cost effectiveness determination for the specific project, Technologically Feasible options may be required to be installed.

If the composting operation is determined to be non-agricultural (see Commercial Operation Designation below), Regulation VIII requirements may apply and would require the facility to reduce fugitive PM_{10} emissions. These include the following: District Rule 8011 *General Requirements*, 8021 *Control, Demolition Excavation, Extraction, and Other Earthmoving Activities*, 8031 *Bulk Materials*, 8041 *Carryout and Trackout*, 8051 *Open Areas*, 8061 *Paved and Unpaved Roads*, and 8071 *Unpaved Vehicle/Equipment Traffic Areas*.

In addition to VOC and NH_3 being emitted from the active and curing compost phases, PM_{10} is emitted from feedstock receiving, transportation, and the formation of the compost piles. Feedstock grinding and screening is also another source of PM_{10} emissions.

NO_x, SO_x, PM_{10}, CO, and VOC may be emitted from other equipment operated on-site as part of the composting facility, such as stationary and transportable IC engines.

Mobile emissions caused by off-road vehicles, water trucks, front-end loaders, and self-propelled engines that are necessary for the operation are permit-exempt and are not included in the facility emissions. However, as previously mentioned, equipment such as grinders, trommel screens, stationary and transportable IC engines that are operated as part of the composting facility are subject to SJVAPCD permits and those emissions are included as part of the facility emissions.

In addition to permit processing fees, composting facility owners/operators must pay annual operating emission fees pursuant to District Rule 3010 *Permit Fee*. Pursuant to District Rule 3020 *Permit Fee Schedules*, composting facilities are subject to the *Miscellaneous Schedule* regardless of annual throughput size.

ii. California Environmental Quality Act (CEQA)

The facility will need to address CEQA requirements through an environmental review document prepared by the Lead Agency, such as the City or County. The District may be the Lead Agency if no other agency has broader statutory authority. The District will not be able to issue an Authority to Construct (ATC) permit until the requirements of CEQA have been satisfied by the Lead Agency.

iii. Offsets

Offsets may be required if the facility's emissions exceed any of the following thresholds:

14.6 tpy-PM_{10} (29,200 lbs/year) or

10 tpy-VOC (20,000 lbs/year).

The specific quantity of offsets will be determined through the ATC permitting process. If offsets are required, the facility must own Emission Reduction Credits (ERCs) that will cover the amount of offsets required or must have a signed purchase agreement in place before an ATC permit can be issued.

The SJVAPCD ERC bank currently has over 10.5 million pounds (5,000 tons) of VOCs and over 2.6 million (1,300 tons) pounds of PM_{10} credits potentially available.

iv. Essential Public Service Designation

The SJVAPCD does not have a definition for "essential public service."

v. SJVAPCD: Commercial Operation Designation

In some situations, composting operations may be located at a dairy operation (an agricultural operation) and have common ownership. However, if the finished compost is sold commercially, the composting operation is a major step in producing a commercial product (finished compost) and is not a connected process, common process, or an incidental part of the existing agricultural operation. This determination is based on the court case, *Egg City vs Ventura Air Pollution Control District* (1981) (http://law.justia.com/cases/california/court-of-appeal/3d/116/741.html). Therefore, pursuant to District Rule 2201, the composting operation is not considered the same stationary source as the dairy operation located at the same time.

South Coast Air Quality Management District

SCAQMD 1133 series rules provide requirements for composting and related activities. Rule 1133.2 requires reductions of volatile organic compounds (VOC) and ammonia (NH_3) emissions from co-composting, while Rule 1133.3 requires emission reductions from greenwaste composting. For co-composting process, biosolids (i.e., wastewater treatment plants sludge) and manure are mixed with bulking agents. For greenwaste composting, it includes three types of feedstock materials – greenwaste-only, greenwaste mixed with foodwaste, or greenwaste with up to 20% manure, by volume.

New co-composting operations require all active co-composting to be conducted within an enclosure with inward face velocity and opening area limitations, and no increased VOC or NH3 emissions increases shall occur above background levels outside the enclosure as per Rule 1133.2. Add-on emission control devices are also required for new co-composting operations to reduce VOC and NH3 emissions as per Rule 1133.2. These add-on control devices are required to have an overall emission reduction of 80%, by weight, for VOC and NH_3, respectively, from baseline emission factors. Existing co-composting operations are required an overall emission reduction of 70%, by weight, for VOC and NH3, respectively, from baseline emission factors. The baseline emission factors are 1.78 pounds of VOC per ton of throughput and 2.93 pounds of NH_3 per ton of throughput from the overall composting operation including both active and curing phases of composting.

Either best management practices (BMPs) or add-on emission control devices are required to reduce VOC and NH_3 emissions from greenwaste composting windrows (elongated piles) as per Rule 1133.3, depending on the facility's feedstock throughput of foodwaste. Composting of up to 5,000 tons per year (tpy) of foodwaste throughput requires BMPs for the first 15 days of the active phase of open windrows. Composting of greater than 5,000 tpy of foodwaste throughput requires an add-on emission control device that has an overall system control efficiency of 80% or higher for VOC and NH_3 during the active phase (at least 22 days) of composting containing more than 10% foodwaste, by weight. The overall system control efficiency is determined from a source test and the baseline emission factors are 4.25 pounds of VOC per ton of throughput and 0.46 pounds of NH_3 per ton of throughput for the active phase of composting only.

Composting BMPs use the combination of at least 6 inches of finished compost cover and water application to the 3 inches depth from the pile surface or an alternative mitigation measure, which demonstrates via source test control efficiencies of 40% VOC and 20% NH_3 emissions, by weight. Finished compost is a material that results from at least 62 days of combined active and curing phases of composting and can be either screened or unscreened. Compost overs (i.e., large pieces left after screening) are also acceptable as cover material.

VII. Air Permitting and Regulatory Requirements for New and In-Use California Composting Facilities

A. Key Issues in Permitting New and Expanded Facilities

i. Equipment Requiring a Permit

A permit is not required for open windrow composting as windrows are not considered equipment or a permit unit which may cause or reduce or control the issuance of air contaminants. Aerated static pile (ASP) composting is considered to be equipment or a permit unit which may cause the issuance of air contaminants, as are chippers, grinders, trommel screens, and non-self-propelled IC engines that are part of a stationary source; therefore they require permits prior to construction. An emission control device would require a permit prior to construction. An applicant for a permit should check SCAQMD Rules 219 and 222 and the SCAQMD Engineering & Permitting Division to determine if the equipment is exempt from

requiring a SCAQMD permit or is subject to filing requirement. Fees for processing of permit applications, permit renewal fees, and annual operating fees are shown in SCAQMD Rule 301.

** *Please consult E&P for general permit process timeline.* **

ii. New Source Review-BACT

Any relocation or any new or modified source which results in an emission increase of any non-attainment air contaminant, ozone depleting compound, or ammonia shall employ BACT. SCAQMD has interpreted the BACT provision as a 1.0 lb/day increase in emissions from all sources subject to NSR. Minor Source BACT requires compliance with SCAQMD Rule 1133.2 for composting. Aerated static pile (ASP) composting with an appropriate emission control device may be considered as BACT.

iii. New Source Review-Offsets

Emission increases for new sources and new total emissions for modified sources shall be calculated using a calendar monthly emissions divided by 30 for determination of the required amount of offsets. SCAQMD provides emission offsets through their internal bank for new facilities that have a potential to emit less than 4 tpy and modified facilities that have a post-modification potential to emit less than 4 tpy, pursuant to Rule 1304(d).

iv. Essential Public Service Designation

SCAQMD Rule 1302 defines that essential public service includes (1) publicly owned or operated sewage treatment facilities which is consistent with an approved regional growth plan; (2) prisons; (3) police facilities; (4) fire fighting facilities; (5) schools; (6) hospitals; (7) construction and operation of a landfill gas control or processing facility; (8) water delivery operations; and (9) public transit. As per Rule 1302, greenwaste composting operations are not considered essential public services. Certain greenwaste composting facilities may be located at the same facility where a landfill gas processing facility is constructed and operated. The composting facility, however, is not considered an essential public service because the composting operation does not control or process landfill gas, even though it is co-located at the landfill site.

Ventura County Air Pollution Control District

Currently (May 2018), VCAPCD has no rule or permit requirements for composting operations. Composting piles have been historically considered to be exempt from permit pursuant to Rule 23.B.1 (material stock piles). Additionally, equipment used in composting operations (such as screens, tub grinders, and wood chippers) are specifically exempt from permits (Rule 23.B.5); however, any IC engine powering this equipment would require a permit if the engine was 50 brake horsepower or greater (Rule 23.D.6) and not providing propulsion (Rule 23.D.1).

VCAPCD is in the process of developing Rule 74.32 to address volatile organic compound (VOC) emissions from composting operations, with plans to take this rule to our Governing Board in 2019. As with similar rules in other air districts, Rule 74.32 will have an exemption threshold below which a source will not be subject to the rule, and will have different best management practices (BMP) / control requirements depending on the size of the operation and if the operate is existing or a new or modified operation. Sources subject to the rule will

also be required to submit applications for a Permit to Operate, upon adoption of the rule. Tub grinders, wood chippers, and trommel screens (particulate matter emissions) will remain exempt from permit pursuant to Rule 23.B.5.

Information on how to participate in the rule development process can be found at the rule development section of the District's website listed in Appendix B.

VII. Air Permitting and Regulatory Requirements for New and In-Use California Composting Facilities

A. Key Issues in Permitting New and Expanded Facilities – Ventura County Air Pollution Control District (VCAPCD)

i. New Source Review, General Permit Process Timeline

Currently (May 2018), composting facilities do not require permits, but this will change once Rule 74.32 is adopted and Rule 23 is revised. At that point, existing facilities will be issued a Permit to Operate based on their existing capacity times 1.2 as described in Rule 29.B.3.a, and will only require compliance with Rule 74.32. VCAPCD expects to exempt "small" composing facilities from permit, but not necessarily exempt small composting facilities from Rule 74.32.

After the rule is adopted, any new source, or any existing source proposing to modify or expand operations that will increase air emissions, will need to apply for and receive an Authority to Construct (ATC) before building or modifying the operation. Such applications will be subject to the District's New Source Review requirements (Rule 26). These requirements include Best Available Control Technology (BACT) which is equivalent to federal Lowest Achievable Emission Rate (LAER), emissions offsets, Ambient Air Quality Impact Analysis and public noticing as applicable. Additionally, these applications are subject to Rule 51 (Nuisance) and the VCAPCD policy for "Air Toxics Review of Permit Applications", to evaluate if any health risk impacts would be associated with the project.

BACT (= LAER) has not yet been established in Ventura County for composting operations. In evaluating BACT, all operational methods and add-on controls will be evaluated, and the highest level of control that is achieved in practice for the "emissions unit category" will be required of the source in accordance with the VCAPCD "BACT Implementation Permitting Policy".

If an Ambient Air Quality Impact Analysis is required pursuant to Rule 26.2.C, modeling will be conducted to determine the effect of the source on ambient air quality.

Public notice is required for larger emission sources as detailed in Rule 26.7.

Prior to submitting an application, a source should contact the District to obtain a fee estimate for processing the application and issuing the initial permit. Once a permit is issued, annual permit fees will be required based on permitted (potential) emissions. All fees are described in Rule 42.

VCAPCD is committed to working with applicants and processing applications in a timely manner. Average processing times can be found on the VCAPCD webpage listed in the appendices. However, large composting projects make take a longer time to process as

compared to the average permit application. VCAPCD rules allow up to 180 days to process a complete permit application for large sources.

ii. Emission Offsets

Offsets are required for sources in Ventura County when the stationary source permitted emissions are greater than or equal to 5 tons per year of ROC. This threshold is one of the lowest in the state of California. There are currently approximately 570 tons of VOC Emission Reduction Credits (ERC) that can be used for offsetting purposes. However, at the current cost of approximately $60,000 per ton, a new 20 tons per year source would face an emission offset cost of about $1,200,000.

iii. Essential Public Service Designation

Rule 26.1.12 defines essential public services to be jails, police or fire fighting facilities, schools, hospitals, ambulance services, landfill gas control or processing equipment, publicly owned biosolids processing facilities, publicly owned sewage (wastewater) treatment facilities, and publicly owned or nonprofit water delivery operations. Composting operations are not defined to be essential public services at this time, even if co-located at a facility that meets this definition.

Appendix H. Compost Reactivity Data

Table H. Maximum Incremental Reactivity (MIR, relative reactivity) and Percent of Weighted Average Compost Pile Emissions. Adapted from Table 4 (Kumar et al., 2011). Weighted average based on an estimate of the approximate relative duration of each type of emissions profile: one week as a fresh tipping windrow, one week as a young windrow, and four weeks as an older windrow.

Volatile Organic Compound	MIR	% VOC Emissions
Acetone	0.36	0.47%
Camphor	0.49	1.18%
Isopropyl alcohol	0.61	42.31%
Undecane	0.61	0.20%
Methyl alcohol	0.67	12.79%
Acetic acid	0.68	5.94%
Methyl butylacetate	1.09	0.14%
Methyl propionic acid	1.2	0.26%
Propionic acid	1.22	0.53%
Ethyl alcohol	1.53	18.16%
Butanoic acid	1.82	1.35%
2 Butanol	2.4	0.39%
Naphthalene	3.34	0.50%
Pinene Isomers	3.52	0.60%
3 Methyl butanoic acid	4.23	0.28%
Alpha pinene	4.51	1.36%
Camphene	4.51	0.24%
Limonene	4.55	2.27%
Terpineol	4.63	0.35%
Isovaleraldhyde	4.97	0.15%
1 Methyl, 3-1-methyl ethyl benzene	5.49	0.23%
2 Methyl 1-propene	6.29	0.41%
Acetaldehyde	6.54	0.14%
Propene	11.66	0.22%
2 Butene	14.24	0.17%
Others	N.A.	9.36%
Total		**100%**

Appendix I. AB 617

Overview

Assembly Bill (AB) 617 (Garcia, C., Chapter 136, Statutes of 2017) requires new community-focused and community-driven action to improve air quality and reduce exposure to criteria air pollutants and toxic air contaminants in disproportionately burdened communities. This legislation recognizes that while California has seen tremendous improvement in air quality, some communities still suffer greater air quality impacts than others. These communities require special attention and accelerated action. The bill builds on the foundation of existing air quality legislation and programs, providing additional tools to target actions in communities that bear the greatest burdens and includes new requirements for accelerated retrofit of pollution controls on certain large industrial sources, increased penalty fees, and greater transparency and availability of community-scale air quality and emissions data. To implement the bill, the California Air Resources Board (CARB) has established the Community Air Protection Program (Program). One statutory requirement of the Program is for CARB to select communities for community air monitoring and/or community emissions reduction programs. Additionally the bill requires CARB to establish a statewide uniform system of annual emissions reporting for certain categories of sources, and establish and maintain a technology clearinghouse to identify the cleanest emissions control technologies in the state.

Identification and Selection of Communities for Community-focused Action

AB 617 requires that CARB select initial communities for development of community air monitoring and/or emissions reduction programs by October 1, 2018, with review and recommendation of additional communities annually. CARB is proposing a strong science-based foundation to identify communities that experience high cumulative exposure burdens. This will include bringing in the knowledge and expertise of air districts and community members. Assessment and identification of the most heavily burdened communities will be basedon a compilation of data sources and factors characterizing cumulative exposure to criteria air pollutants and toxic air contaminants within communities.

Emissions Inventory Reporting

Emissions inventory data are the foundation of multiple elements of the Community Air Protection Program. A robust system for the collection and retrieval of emissions inventory data provides a sound technical basis for understanding emissions source contributions, assessing the impacts of emissions control and process changes, improving transparency and accessibility of emissions data to communities, and tracking the implementation of community emissions reduction programs. New requirements under AB 617 will work hand-in-hand with efforts underway as part of AB 197[1] and include: annual reporting of criteria air pollutant and toxic air contaminant emissions for specified stationary sources, development of a statewide uniform emissions reporting system (e.g., methods, reporting), and the option to require that sources certify or verify the accuracy of annual emissions reports.

CARB staff is proposing a phased implementation approach of these reporting requirements to inform the community identification process and community emissions reduction programs in the near-term, as well as develop a comprehensive emissions reporting system longer-term. The frequency of reporting criteria air pollutant and toxic air contaminant emissions data varies

between air districts. Many large air districts collect criteria air pollutant and toxic air contaminant emissions data annually, while smaller districts may only report emissions once every three or four years, depending on the size of a facility. CARB staff is working through the details of developing the statewide database and it is anticipated that CARB's Governing Board will vote on the new emissions reporting regulation for criteria air pollutants and toxic air contaminants in the late 2018/early 2019 timeframe.

Technology Clearinghouse

Under state law, regional air districts have been delegated the authority to issue permits to stationary sources, allowing them to operate within emission limitations. Permit programs limit emissions from facilities by setting a threshold of allowable emissions that a facility must not exceed in order to continue to operate. Prior to issuing a permit, air districts confirm that the facility and all emitting equipment are in compliance with applicable rules and regulations. Permit limits are usually updated every time a facility installs new equipment or modifies their existing equipment. Permitting requirements vary by location based on the facility and equipment type, the allowable amount of emissions, consideration of state and local air toxics programs, and each air district's national and state ambient air quality standards attainment designation status.

New facilities or facilities modifying equipment that emit air pollutants over specific air district emissions thresholds, are subject to stringent emissions control requirements. Air districts determine the best-achievable emissions limit for each equipment type over these emissions thresholds based on the cleanest technology available at that time (this is called best available control technology, or BACT). Other BACT "determinations" for a specific equipment type must be considered by air district staff during the permitting of a new or modified facility.

Existing stationary sources in non-attainment areas are subject to best available retrofit control technology (BARCT) requirements. BARCT rules are adopted periodically by air districts to reduce emissions from existing sources of a particular source type. These requirements are set considering feasibility, cost-effectiveness, and the nature and severity of the air quality challenge.

AB 617 requires CARB to establish and maintain a statewide clearinghouse of criteria air pollutant and toxic air contaminant emissions performance levels for stationary sources. The Technology Clearinghouse will include the data necessary to support new air district BACT, BARCT, and best available control technology for toxic air contaminants (T-BACT) determinations, as well as other air district rules. In addition to housing these emission control requirements for stationary sources, the new Technology Clearinghouse will include information on the best rules and measures governing emission limits for mobile and area-wide sources as well as forward-looking information on the next generation of ultra-low or zero emissions technologies to support continued emissions control technology advancement. It will be a useful tool to identify the best control technologies, rules, and measures for use in controlling emissions and will foster continued technology advancement by highlighting next generation technologies. The Technology Clearinghouse will also provide increased transparency and access to community-level information by linking to CARB's emissions inventory and Pollution Mapping Tool. Once completed, the Technology Clearinghouse will be

a consistent resource for use in selecting the best approaches for controlling emissions within community emissions reduction programs.

Appendix J. Major Source Threshold and New Source Review VOC Offset Purchase Threshold

Table J. Major Source Thresholds and NSR VOC Offset Purchase Thresholds by Air District.

Air District	Ozone Attainment Status	Major Source Threshold (tpy)	NSR VOC Offset Purchase Threshold (tpy)
Amador	Non-Attainment	N/A	100
Antelope Valley[1]	Non-Attainment	100	25
Bay Area	Non-Attainment	40	10
Butte	Non-Attainment	100	100
Calaveras	Non-Attainment	100	100
Colusa	Attainment		25
Eastern Kern[1,2]	Non-Attainment		25
El Dorado	Non-Attainment	25	10
Feather River	Non-Attainment Transitional	100	25
Glenn	Attainment	100	25
Great Basin	Non-Attainment	~27	
Imperial[1,2]	Non-Attainment	100	25
Lake County	Attainment	~25	~25
Lassen	Attainment		45.6
Mariposa	Non-Attainment	100	100
Mendocino	Attainment	N/A	
Modoc County	Attainment	~40	
Mojave Desert[1,2]	Non-Attainment	25	25
Monterey Bay	Non-Attainment Transitional	100	137 lbs/day and 10 tpy
North Coast	Attainment		25
Northern Sierra	Unclassified	100	
No. Sonoma	Attainment	N/A	N/A
Placer County	Non-Attainment	25	25
Sac. Metro	Non-Attainment	25	10
San Diego[3]	Non-Attainment	50	50
San Joaquin V.	Non-Attainment (Extreme)	10	10
San Luis Obispo	Non-Attainment	100	25
Santa Barbara	Non-Attainment Transitional	100	25
Shasta	Non-Attainment	25	25
Siskiyou	Attainment	N/A	
South Coast[4]	Non-Attainment	10	4
Tehama	Non-Attainment		25
Tuolumne	Non-Attainment	N/A	
Ventura	Non-Attainment	25	5
Yolo-Solano	Non-Attainment	25	10

Appendix K. CalPoly SLO Study

Table K. List of Gases to Be Analyzed including Biogenic VOCs (Source: Document for Landfill Gas Study Modification entitled "Status to Modify Scope of Landfill Gas Emissions Project to Include Biogenic VOCs; Authors Jim Hanson, Nazli Yesiller, CalPoly SLO, January 2018).

Methane	Carbon dioxide	Nitrous oxide
Ethane	Ethene (Ethylene)	Acetylene (Ethyne)
Propane	Propene	n-Butane
i-Butane	1&i-butene	trans-2-butene
cis-2-butene	n-Pentane	i-Pentane
1-Pentene	Isoprene	Benzene
Toluene	o-Ethyltoluene	m-Ethyltoluene
1,2,4-Trimethylbenzene	o-Xylene	m&p-Xylene
Ethylbenzene	Carbonyl sulfide (OCS)	Dimethyl sulfide (DMS)
Dimethyl disulfide (DMDS)	CH2FCF3 (HFC-134a)	CHClF2 (HCFC-22)
CBrClF2 (H-1211)	CCl3F (CFC-11)	CCl2F2 (CFC-12)
CCl2FCClF2 (CFC-113)	CH3Cl	Carbon tetrachloride (CCl4)
CH3CCl3	CHClCCl2	CH2Cl2
CCl2CCl2	CHCl3	Methyl Nitrate
Ethyl Nitrate	n-Propyl Nitrate	i-Propyl Nitrate
2-Butyl Nitrate	2 Methyl 1-propene	Acetone
2 Butanol (if possible)	Ethyl alcohol (ethanol)	Isopropyl alcohol
Methyl alcohol (methanol)	Terpineol (if possible)	Acetaldehyde
Isovaleraldehyde (if possible)	Hexane	Undecane (if possible)
Camphor (if possible)	1,2-Dichloroethane (ethylene dichloride)	Chloroethane (ethyl chloride)
Ethylene dibromide (1,2 – dibromoethane)	Trichloroethylene (CHClCCl2; trichloroethene)	Methyl ethyl ketone (if possible)
Methyl isobutyl ketone (if possible)	Alpha pinene	Camphene
Limonene (monoterpene)	Pinene Isomers	Carbon disulfide (if possible)
Ethyl mercaptan (ethanethiol) (if possible)	Bromodichloromethane	