Composting in California: Health impact assessment of the Short Lived Climate Pollutant Strategy to divert organic waste from landfills

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Sequoia Foundation

January 2017

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Acknowledgements

The Sequoia Foundation would like to thank the following organizations and agencies for their contributions to this report: California Department of Public Health, Public Health Institute, California Air Resources Board, California Department of Resources Recycling and Recovery (CalRecycle), and California Department of Food and Agriculture.

CDPH HIA Work Group
A CDPH work group was formed to build staff capacities in HIA practice, and some work group members participated in the screening, scoping, assessment and recommendation phases of this HIA. They provided expertise in a number of public health disciplines, such as environmental health, chronic disease, health equity, and climate change.
As a method of training staff across the California Department of Public Health on the HIA process, an inter-divisional work group was formed and helped identify policies for HIA consideration. CDPH staff working on climate change proposed assessing a strategy to increase composting as a means to reduce greenhouse gas emissions.

This document is supported by a grant from the Health Impact Project, a collaboration of the Robert Wood Johnson Foundation and The Pew Charitable Trusts, with funding from The California Endowment. The views expressed are those of the authors and do not necessarily reflect the views of the Health Impact Project, The Pew Charitable Trusts, the Robert Wood Johnson Foundation, or The California Endowment.

Introduction

Sequoia Foundation, with support from the Public Health Institute and the California Department of Public Health, conducted a Health Impact Assessment (HIA) of a proposed statewide policy to reduce the amount of organics disposed in landfills by 75% by 2025. This HIA examines one of the primary strategies to reach this target, the addition of large capacity composting systems. Composting facilities will be built throughout California and many will be sited in eight Central Valley counties. The Central Valley is home to many of the state's existing landfill and composting facilities; it is also an area that faces significant economic and environmental challenges. This HIA primarily examines broad health impacts the policy will have on the Central Valley so that potential social and health inequities can be addressed before implementation.

The HIA has been proposed to and supported by California Air Resources Board(CARB), California Department of Resources Recycling and Recovery (CalRecycle), and California Department of Food and Agriculture (CDFA). These agencies oversee programs that address composting, food waste, and the implementation of Assembly Bill (AB) 32, the California Global Warming Solutions Act of 2006. AB 32 requires California to reduce greenhouse gas emissions (GHG), such as methane, which is produced when food and other organic materials break down in anaerobic settings like landfills. One of the major goals of diverting green waste from landfills to compost facilities is the reduction in GHG. Sharp rises of GHGs over the last century and a half have led to higher overall worldwide temperatures, reduced snowpack in higher elevations, greater fluctuations of temperature and precipitation, global sea level rise, and more frequent and severe extreme weather events, including hurricanes, heat waves and droughts[1]. Climate change has a direct impact on health. For example, climate change influences accessibility to water, vector borne diseases, food security, and heat related illness and deaths.

Specifically, this HIA examines the health impacts of diverting green waste from landfills to aerated static pile (ASP) composting facilities in California. ASP composting systems are the most technologically advanced and are growing in use. Through implementation of the Short Lived Climate Pollutants Strategy, an estimated 86 ASP facilities will be built and operational in California, with approximately 7-16 sited in eight Central Valley counties by 2025.

ASP composting facilities process compostable materials under a fabric protective covering that traps fluids, odors, and air emissions better than other composting technologies, like open windrow systems. ASP systems use blowers that move air through the churned compost, facilitating efficient breakdown of organic matter. During the composting process, the volume of these materials will be reduced by more than half and their weight reduced by a little less than half, depending on percentage of food in the mix and overall feedstock moisture levels. These systems are designed to meet or exceed permit requirements for air and water quality protection.

About the Proposed Policy

The AB 32 Scoping Plan outlines a variety of comprehensive, multi-year mechanisms to reduce California's GHG emissions. As part of this Plan, CARB proposed a Short Lived Climate Pollutants Reduction Strategy that includes reducing methane emissions through diversion of organic materials from landfills where organics anaerobically break down. The Short Lived Climate Pollutants Reduction Strategy proposes that 75% (10 million tons per year) of organics be diverted from landfills by 2025, drastically reducing the disposal of organics in landfills. Low carbon fuels may be produced in this process and replace fossil fuels, which will reduce GHG even more. CARB has proposed composting, food rescue, and other strategies to reach this target. The Short Lived Climate Pollutants Reduction Strategy will be approved by CARB in late 2016. CARB held online and in-person workshops to present the plan and gather public comment.

While the Short Lived Climate Pollutants Strategy is a statewide policy, siting of composting facilities is initiated at the local level and typically requires the issuance of a conditional use permit by a local authority (e.g., city or county planning department[1]) and a review of potential environmental impacts under the California Environmental Quality Act (CEQA). The CEQA process will identify any potential environmental impacts and specify what additional environmental protections will be required to mitigate the impacts for each site on an individual basis. Some health and safety concerns are addressed in the CEQA analysis, but unlike HIA, it is not comprehensive, and does not explicitly consider issues of vulnerable communities and health equity. Other permits may also be required by other regulatory agencies, such as the regional water quality control board and air pollution control district/air quality management district. Fabric-covered ASP systems prevent water from contacting the active or curing compost piles. Still, the piles are typically built on top of concrete slabs that allow runoff to be channeled into a pond. The State Water Resources Control Board requires that these ponds be lined with an impermeable barrier that prevents groundwater contamination and that they are large enough to withstand a significant storm event. Facilities are required to monitor for leaks on an on-going basis.

Community Profile of Eight Central Valley Counties

California is the country's third largest and most populated state. Its geography varies across 804 miles of coastline; the Sierra Nevada, a robust agriculture industry, and the Mojave dessert.[2] It has a variety of different climates, air quality impacts and water issues. There is also significant variability in socioeconomic status among and within counties. It has a diverse population and has the world's sixth largest economy, with a gross domestic product of $2.5 trillion in 2015.[3]

California's Central Valley is a large, flat agricultural valley that occupies the geographical center of the State and consists of eighteen counties. It has a unique topography and meteorology and is bound by mountains to the west (Coastal Mountain range), the east (Sierra Nevada range), and the south (Tehachapi Mountains). Together with the Valley's

[1] If the local authority has a zoning category where composting is allowed, a conditional use permit may not be required. However, in most cases, a conditional use permit is needed.

topography, the inversion-prone meteorology of the region restricts airflow and favors the accumulation of pollutants. Valley weather patterns are typically characterized by dry summers with moist winters, which often include periods of heavy fog.[4] It is one of the most productive agricultural regions in the world, producing more than half of the fruits, vegetables, and nuts grown in the United States [1].[5] More than 7 million acres of the valley are irrigated via an extensive system of reservoirs and canals.[2][6]

This HIA focuses on eight counties in the Central Valley (the counties of Fresno, Kings, Kern, Madera, Merced, San Joaquin, Stanislaus, and Tulare) that may be disproportionately impacted by the growth of composting facilities compared to other counties within the Valley and throughout the state. There are currently 17 municipal solid waste (MSW) landfills in this eight county region (Central Valley Water Quality Control Board Waste Acceptance List, May 2015).

The eight Central Valley counties face a variety of economic, social, environmental, and health challenges. The following data are taken from the California Office of Environmental Health Hazard Assessment's (OEHHA) CalEnviroScreen. The total population of the eight Central Valley counties included in this assessment is 6,577,064 as of 2014. Thirty-seven percent of the population is Latino. Twelve percent are unemployed, but in one county the unemployment rate is 13.2%. The majority of these counties have median household incomes at or below the US median household income as seen in the map below. Only one county has a median household income greater than $53,000 - $68,000.

Figure 1: Median Household Income

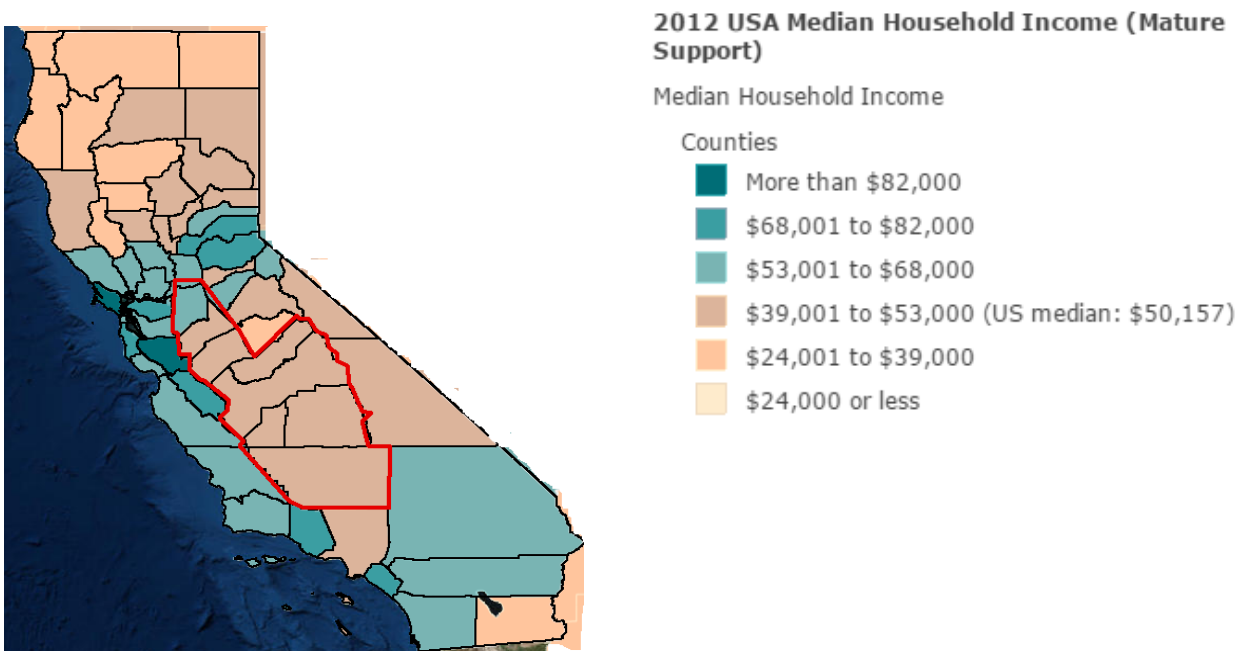


Table 1 presents data on the eight Central Valley counties from the County Health Rankings.[7] Counties in California are ranked from 1-57 on how well they meet specific health criteria (Alpine County is not included in the ranking due to insufficient data). Ranking 1 is the best in the state; ranking 57 is the worst in the state.

There is moderate variation in the rankings of the eight Central Valley counties and so we presented the range that captures all eight counties. When possible, we averaged percentages or rates or gave an indication of how the region was doing compared to the rest of the state. The ranges show that some counties are doing better than the state average in low birth-weight, food environment index (proximity to grocery store and food security), diabetic monitoring, and high school graduation rates. In most other categories the state average is better than the Central Valley counties. Kern County ranks the lowest in health factors, a combined indicator that looks at health determinants like access to care, and food security. Kings County ranks lowest in access to clinical care.

The California Health Interview Survey indicates that a little less than half of the population in the Central Valley does not speak English well or at all. Additionally 40% are not able to secure enough food. This region also has a higher burden of chronic diseases (diabetes, high blood pressure, and asthma) and psychological distress as compared to the rest of California. One out of every four residents receives food stamps and less than 25% receive health benefits from their employer. Table 2 lists these health outcomes.

Table 1. Range and Average of Eight Central Valley County[2] Health Scores

	California	County Range	County Average
Health Outcomes[3]		36 – 53	
Length of Life[4]		31 – 44	
Premature Death[5]	5,300	6,300 – 7,500	6,913
Quality of Life[6]		44 – 57	
Poor or fair health	18%	19 – 26%	22%
Poor mental health days[7]	3.6	3.8 – 4.4	4.1
Low birth weight	7%	6 – 8%	7%
Health Factors[8]		45 – 57	
Adult obesity	23%	25 – 32%	29%
Food environment index[9]	7.7	6.9 – 7.3	7.1
Clinical Care[10]		38 – 57	
Uninsured	19%	19 – 23%	21%
Mental Health Providers	360:1	380 – 840:1	614:1
Preventable hospital stays[11]	41	48 – 63	54
Diabetic monitoring[12]	81%	73 – 87%	81%
Mammography screening[13]	59%	51 – 61%	58%
High school graduation	85%	82 – 92%	86%
Un-employment	7.5%	10.6 – 13.2%	11.6%
Children in poverty	23%	24 – 38%	33%
Physical Environment[14]		35 – 55	48.5
Air pollution particulate matter[15]	9.3	8.9 – 10.3	9.4
Drinking water violations?		Yes	Yes

Note: Blank values reflect unreliable or missing data

[2] Includes Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare counties.
[3] Number represents rank out of California's 57 counties. Ranking based on summary score of Length of Life and Quality of Life.
[4] Ranking based on Premature Death.
[5] Years of potential life lost before age 75 per 100,000 population (age adjusted).
[6] Ranking based on summary score of Quality of Life and Poor Birth Outcomes
[7] Average number of mentally unhealthy days reported in the past 30 days (age adjusted).
[8] Ranking based on summary score of Health Behaviors, Clinical Care, Social and Economic Factors, and Physical Environment.
[9] Index of factors that contribute to a healthy food environment, 0 (worst) to 10 (best).
[10] Ranking based on summary score of Access to Care and Quality of Care.
[11] Number of hospital stays for ambulatory-care sensitive conditions per 1,000 Medicare enrollees.
[12] Percentage of diabetic Medicare enrollees ages 65-75 that receive HbA1c monitoring.
[13] Percentage of female Medicare enrollees ages 67-69 that receive mammography screening.
[14] Ranking based on summary score of Air and Water Quality and Housing and Transit.
[15] Average daily density of fine particulate matter in micrograms per cubic meter (PM2.5)

Table 2: Health Determinants and Outcomes in Eight Central Valley Counties[16]

Indicator	San Joaquin Valley	California
Demographics:		
Speak English not well/ not at all	43.3% (37.8-48.8)	36.7% (34.6-38.8)
Not able to afford enough food (food insecure)	40.9% (33.8-48.0)	38.4% (35.8-40.9)
Chronic Diseases:		
Diagnosed with Diabetes	10.7% (7.6-13.8)	8.9% (8.1-9.7)
Has/had high Blood Pressure	31.2% (27.2-35.2)	28.5% (27.1-29.8)
Has Asthma	16.4% (13.9-18.8)	14.0% (13.1-14.8)
Mental Health:		
Likely has serious psychological distress	10.6% (7.4-13.8)	7.7% (7.0-8.4)
Benefits		
Employer didn't offer health benefits	23.3% (17.7-28.9)	20.4% (18.6-22.1)
Currently receiving Food Stamps	25.1% (19.9-30.4)	18.1% (16.1-20.0)

[16] Source: 2014 California Health Interview Survey, accessed via http://ask.chis.ucla.edu/AskCHIS

Health Impact Assessment Process

HIA is done to examine the health benefits and negative impacts of a proposed policy or plan. It engages stakeholders and partners to identify health questions for analysis and provides recommendations to enhance positive impacts while mitigating potential negative health outcomes. These recommendations are shared with decision-makers and their implementation is monitored over time. HIAs consist of the following six steps: screening; scoping; assessment; recommendations; reporting; and monitoring and evaluation. A description of each step is provided in Table 3.

Table 3: HIA Process[8]

Screening	Determine whether an HIA is needed and likely to be useful
Scoping	In consultation with stakeholders, develop a plan for HIA, including the identification of potential health risks and benefits
Assessment	Describe the baseline health of affected communities and assess the potential impact of the decision
Recommendations	Develop practical solutions that can be implemented within the political, economic, or technical limitations of the project or policy being assessed.
Reporting	Disseminate the findings to decision makers, affected communities, and other stakeholders
Monitoring/Evaluation	Monitor the changes in health or health risk factors and evaluate efficacy of the measures that implemented the HIA process.

Stakeholder Engagement

Stakeholder involvement is very important to HIA. Different types of stakeholders participated during different steps of this process. Stakeholders representing CARB, CalRecycle, and CDFA participated in the scoping and assessment phases and acted as content experts. A team of colleagues from the California Department of Public Health HIA Work Group (Work Group) participated in the screening, scoping and assessment phases.

Other stakeholders participated in public meetings convened by CARB where strategies, including the increase in composting facilities were described. All comments that related to composting were considered during the scoping and assessment phase of this HIA. Additionally, we reviewed public comments submitted for a proposed ASP facility to better understand local concerns and impacts. Stakeholder comments ranged from support for an increase in composting, recommendations to focus on food rescue as a diversion strategy, concerns about water safeguards, and concerns about the ability to reach the diversion target with complex permitting requirements. Issues raised during public comment periods that are addressed here were limited to those the authors deemed most likely to re-occur at composting sites throughout the state.

Composting in California

This HIA examines potential health changes if California diverts 75% of green waste into ASP composting facilities instead of disposing that green waste in landfills.

The remainder of this report includes the first five steps of an HIA on organics composting. The sixth step, monitoring and evaluation, would be conducted after a facility has been permitted, constructed, and operational. The assessment phase of this HIA, perhaps the most important part, is divided into sections, each describing a potential health influence associated with a new facility. Each section contains information on current conditions, expected environmental changes, relevant health studies, and potential health impacts. A list of recommendations to lessen negative health impacts and promote positive health impacts is provided at the end of each section and as a full list at the end of the report. Some recommendations fall under the jurisdiction of a different agency; these recommendations contain additional information on which jurisdiction has authority to implement the recommendation. The assessment includes the following sections:

- Air quality (emissions and transportation)
- Water quality/availability
- Stress and mental health
    - Odor and noise
    - Employment
    - Food security
- Agricultural Practices (compost processing and use in farming)

Methods

Screening

In the winter and early spring of 2016, HIA practitioners at the Sequoia Foundation and CDPH approached the Air Resources Board to assess the usefulness and feasibility of performing an HIA for the proposed composting strategy. The Air Resources Board brought CalRecycle and Department of Food and Agriculture into the conversation and agreed that the composting strategy outlined in the Short Lived Climate Pollutants Strategy was ideal for an HIA. Initially, we thought the HIA would center around the entire AB 32 scoping plan, but after several meetings with agency stakeholders, we decided that the compost strategy outlined in the Short-Lived Climate Pollutants Strategy was more targeted and appropriate for HIA. Given the potential for the HIA to analyze health issues that may not be otherwise considered in the decision-making process, the HIA was deemed of value. The timeline of the decision-making process was also considered, since the funder, the Health Impact Project, prefers HIAs that can inform decision-makers before a decision is made. This HIA has strong stakeholder participation and addresses comments raised by the public. Its recommendations were presented to CARB prior to the Short Lived Climate Pollutants Strategy's final approval.

The final HIA report will be delivered to CARB, CalRecycle and CDFA for their consideration in future facilities siting decisions.

Scoping

Together, the Work Group, CARB, CalRecycle, and CDFA decided that the geographic scope of the HIA should be the Central Valley Region where it is expected that many ASP composting facilities will be built. The HIA questions the Work Group considered were: What are potential positive and negative health implications of adding 7-16 new composting facilities to California's Central Valley by 2025? Given these potential impacts, what steps can be taken to increase positive health outcomes and decrease any negative health outcomes?

The list of health determinants generated by the Work Group and other agency staff in parallel scoping meetings, and a final set of scoping pathways for further analysis, were agreed upon, including, as mentioned above:

- Air quality (emissions and transportation)
- Stress and mental health
    - Odor, and noise
    - Employment
    - Food security
- Water quality/availability
- Agricultural Practices

Housing prices, and injury risks were two health determinants raised, but not prioritized during the scoping phase due to the lack of data. We also excluded impacts associated with construction of landfills or composting facilities. The analysis only includes impacts associated with operation of these facilities and the end use of produced compost. A summary of assumptions and limitations of the analysis is provided below:

Assumptions and limitations for analysis:

- New ASP facilities will not process biosolids.
- Comparison for analysis: organic waste diverted to new ASP facilities (other composting methods are not assessed) versus organic waste disposed in landfills as currently done.
- Scientific literature and baseline data are limited or unavailable for some pathways.
- Case studies from two approved ASP facilities are used to extrapolate health impacts for the additional 7-16 ASP facilities proposed.
- This HIA does not assess health effects associated with the construction phase of ASP facilities
- The analysis considers use of currently existing landfills and does not include construction of new landfills during the next eight years.

Assessment

To complete the assessment, we gathered and analyzed relevant scientific literature, statewide and local reports about landfill and composting sites (existing and proposed), attended public meetings, interviewed subject matter experts, and attended presentations on composting and landfill technology with CDFA, CARB and CalRecycle staff.

The assessment is described in four sections. Each section has a diagram of the pathways that were explored for the HIA, a set of the questions we were hoping to answer, a description of current conditions, an estimate of environmental changes the policy will cause, and a prediction of how those changes influence health. The characterization of effect chart (see legend below) summarizes the key findings in each section. Lastly, recommendations for CARB, CalRecycle, or the local agencies overseeing these sites are listed.

Analyses are presented together for odor, noise, food security and employment as they all pertain to quality of life and community mental health.

Within each chapter, we characterize the health outcomes or determinants by whether or not they will improve health, to what extent, and how likely, both at a regional and local (site specific) level. We also identify, which communities (e.g., workers) are most likely to be impacted. Lastly, we describe the source of evidence gathered to support each finding.

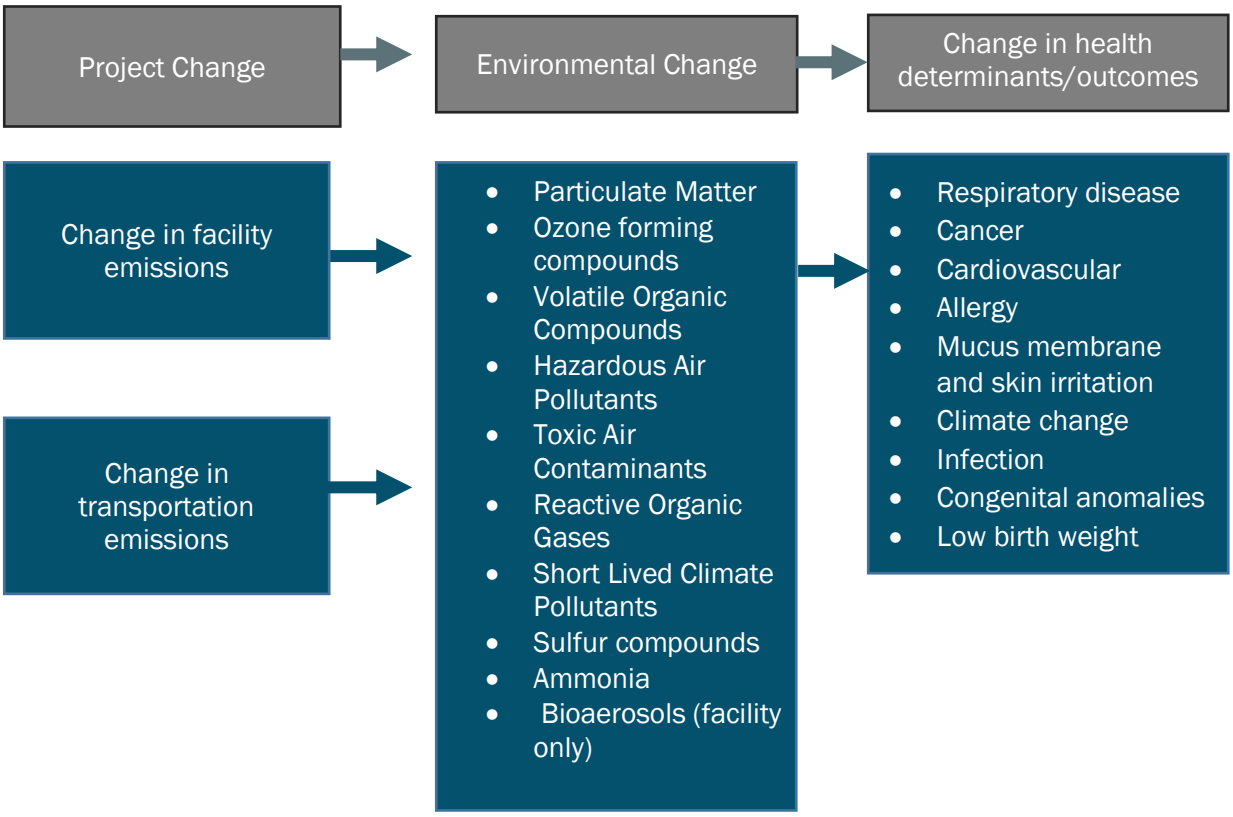
Health impacts will vary from facility to facility due to specific location, capacity, and operating features. For example, facilities that include a food rescue program will have a greater impact on nutrition status in low-income communities. Others may use zero emission vehicles reducing exposure to air pollutants in surrounding communities. The following analysis reflects this variability and in some instances means the direction and extent of health impacts cannot be determined. This report should be used as a framework for considering health impacts as this policy is implemented in each community.

Table 4. Characterization of Effect Legend

Health Outcome/ Determinant	Lists the specific health determinant or outcome being assessed
Impacts	Regional: Impacts will affect the eight county region in the Central Valley Site: Impacts will affect each compost site and their surrounding communities
Direction and Extent	Does health improve or worsen? ▲or ▼= Low: positive or negative health effects would not be perceptible and/or any changes would impact few people ▲▲or ▼▼ = Moderate: positive or negative health effects could result in minor changes in health for some households, and these changes would be reversible ▲▲▲or ▼▼▼= High: positive or negative health effects would accrue across the entire impacted community and would result in permanent changes in health
Likelihood	Unlikely: There is little evidence that the impacts will occur as a result of the project or limited plausibility given the existing conditions Possible: Health effects are logically plausible, but limited data and/or consensus exist to suggest a substantial risk for positive or negative impacts above existing baseline conditions Likely: Health effects are logically plausible, and there is strong evidence to suggest that a change in health risks or health effects will occur Uncertain: Evidence is inadequate to judge the certainty of project impact/health effect
Distribution	Describes the expected impact on various population subgroups based on location and demographic characteristics (e.g. workers, a neighborhood)
Source of Evidence	* 1 article and/or expert opinion ** 2 articles and/or expert opinions *** 3 articles and/or expert opinions **** 4 or more articles or expert opinions

Air Quality (Facility Emissions and Transportation)

Figure 2: Air quality pathways



The proposed policy will impact air quality through two main pathways: change in emissions, both at landfills and new composting facilities, and change in transportation emissions related to hauling landfill and compostable waste. These changes will impact a number of air pollutants that influence several physiological systems and health outcomes listed in the right column of figure 2.

The policy to divert green waste from landfills to composting facilities is intended to reduce short-lived climate pollutants statewide. Nevertheless, air quality (AQ) is an important consideration in the development of new sites that will be receiving, processing, and distributing compost materials. The communities where new compost facilities are sited are directly impacted by site emissions and facility related traffic. Since the San Joaquin Air Basin in the Central Valley experiences some of the most challenging air quality conditions, and this is where many new sites will be located, much of this assessment focuses on the AQ impacts in the region. Specifically, this assessment explores current air quality conditions, including those at landfills, and how these conditions will be impacted by new composting facilities and related truck traffic.

Current Conditions

The eight counties included in this assessment (Fresno, King, Kern, Madera, Merced, San Joaquin, Stanislaus, Tulare) are the same eight counties that comprise the San Joaquin Valley Air Pollution Control District (SJVAPCD). The SJVAPCD is the second largest air quality basin in California. Air quality in the San Joaquin Valley has been steadily improving since 2002. In 2015 the district recorded the greatest number of good air quality days in one year in its 35-year history. However, even with much improvement, the district still experiences some of the poorest air quality in California and at times, the nation.[9] Both human-related activities and natural activities contribute to air pollution in the district. Sources of human-caused emissions include various types of industrial activities, agricultural activities and on-road and off-road vehicles. In addition, population growth has increased traffic, which has been exacerbated by urban sprawl that increases commuter-driving distances. In addition, the natural bowl-shaped topography (mountains bound the valley to the west, the east, and the south) prevents pollutants from moving out of the valley. Temperature inversions, characteristic of Mediterranean climates, create an effect in the atmosphere similar to a lid, trapping pollutants at lower altitudes.[10]

CARB and the U.S. Environmental Protection Agency (EPA) have established outdoor air quality standards. The EPA has established seven air quality standards: ozone 8-hour, particulate matter (PM) of 10 microns in diameter or less, PM of 2.5 microns or less, carbon dioxide, lead, nitrogen dioxide, and sulfur dioxide. CARB has established standards for the same pollutants and hydrogen sulfide that are visibility-reducing particles.[11] Transportation, agriculture, and industry are typical sources of these pollutants.[12]

Areas where the measured air quality exceeds the health-based standards are designated as "nonattainment" areas, and areas where the measured air quality is below the health-based standards are designated as "attainment" areas.[13] Table 5 presents the 2015 status of the San Joaquin Valley air quality by both federal and state standards.

Table 5: SJVAPCD Attainment Status 2015

Pollutant	**Designated Classification**	
	Federal Standards	**State Standards**
Ozone-One hour	Revoked in 2005	Nonattainment/Severe
Ozone- Eight hour	Nonattainment/Extreme	Nonattainment
PM 10	Attainment	Nonattainment
PM2.5	Nonattainment/Moderate	Nonattainment
Carbon Monoxide	Attainment/Unclassified	Attainment/Unclassified
Nitrogen Dioxide	Attainment/Unclassified	Attainment
Sulfur Dioxide	Attainment/Unclassified	Attainment
Lead (Particulate)	No Designation/Classification	Attainment
Hydrogen Sulfide	No Federal Standard	Unclassified
Sulfates	No Federal Standard	Attainment
Visibility Reducing Particles	No Federal Standard	Unclassified
Vinyl Chloride	No Federal Standard	Attainment

Source: San Joaquin Valley Air Pollution Control District, #20

Municipal solid waste (MSW) landfill gasses are composed of methane and carbon dioxide and many other gases at smaller amounts. By volume, landfill gas will typically consist of 45% to 60% methane, 40% to 60% carbon dioxide, 2% to 5% nitrogen, and less than 1% of trace gases such as ammonia, sulfides, hydrogen, carbon monoxide, and non-methane organic compounds.[14]

Methane and carbon dioxide are significant greenhouse gases. Methane is the more potent greenhouse gas, responsible for about 20% of current climate change, and contributes to the creation of ozone.[15] By diverting organic wastes to compost facilities, methane emissions from landfills are reduced.[16] Reducing the amount of methane released in the air will reduce California's greenhouse gas emissions and assist in reducing levels of ozone, resulting in improved air quality.

People who live close to municipal solid waste (MSW) landfills could be exposed to landfill gas containing methane, carbon dioxide, hydrogen sulfide and other contaminants including volatile organic compounds, particulate matter and bioaerosols, or to contaminated soil and water.[17] A number of studies suggest that living near a landfill increases health risks, but the effect may be weak.[18] In one meta-analysis, the strongest health risk for populations living within two kilometers of landfills was a 2% increased risk for congenital anomalies, and a 6% increased risk for low birth weight.[19]

In a 2016 study, living within five kilometers of a landfill was associated with mortality from lung cancer and respiratory diseases and with hospitalizations for respiratory diseases, both in adults and in children.[20] Excess mortality for some cancers (e.g. liver, pancreas, kidney, larynx) and non-Hodgkin lymphoma was noted in some studies of people living close to landfills,[21] [22] [23] but the results have not been confirmed in other investigations.[24] [25]

Expected Environmental change

Currently there are 126 active landfills in California (17 in the eight county Central Valley area). Based on a 2013 statewide population of 38,160,000 and a per capita disposal rate of 4.4 pounds per resident per day. California has 55 years of landfill capacity remaining, or 1,728 million tons of landfill capacity assuming that the population and per capita disposal rate do not increase.[26] If organic waste can be diverted to compost facilities and additional waste reduction efforts are successful in reducing disposal in landfills by 75%, the estimated statewide landfill capacity is extended nearly 30 years. This would result in fewer emissions of landfill-related gases, such as methane.[27] As a result of fewer short lived climate pollutants, we would anticipate reductions in climate change severity and less climate change health impacts.

Research indicates that compost can emit air pollutants. Compost facilities have the potential to emit organic-based dusts (bacteria and fungi), ozone, particulate matter, volatile organic compounds, hazardous air pollutants, and strong odors that can be potentially harmful to human health, especially to workers or residents living near a compost facility.[28] [29] However, when proven technologies, such as fabric protective coverings are used, and best practices that control potential air emissions are implemented with ASP composting, risks to public health may be significantly reduced. Best practices also include personal protective equipment to limit worker respiratory and dermal contact with compost, and limiting the time compost is uncovered.

Occupational

Workers at compost sites could be exposed to increased levels of bioaerosols (organic dust) and volatile chemicals. Exposure to bioaerosols has been associated with respiratory disease, infectious disease, allergies, and cancer.[30] Studies have reported that bioaerosol concentrations were the greatest during compost agitation activities (turning, screening, and shredding).[31] However, at the proposed CalRecycle expansion sites, the facilities are covered rather than turned; thus, this exposure is not likely.

Community

The ASP compost processes at the CalRecycle expansion sites are expected to be enclosed aerobic digestion processes. To increase efficiency air will be pumped through the enclosed compost heap. Compost-related methane exhaust will be captured, purified, converted to compressed natural gas for use as fuel and burned via flaring. Air models estimating potential ozone forming compounds (nitrogen oxides, sulfur oxides, carbon gases) and PM, at a similar ASP covered facility in Sonoma County estimated that air emissions would not exceed air quality standards. VOCs could be the largest potential contributor.[32] The proposed projects will include a fabric protective covering, which demonstrates a 98 percent or better ability to reduce VOCs emissions. In addition, it should be noted any emission to the ambient air will require air permits from the SJVAPCD. Air permits are designed to ensure there is minimal potential risk to human health.[33]

By year 2025, an estimated 26,108 additional truckloads per year will be needed to transport compost to new facilities in the Central Valley in order to meet the 75% reduction goal.[34] Compost loads are transported using diesel-powered trucks that emit PM, and ozone related compounds.[35] Given that the location of a new facility is not known (will it be the same distance from the sources; or will it be further than the landfill from the sources?), it is unknown exactly how far the trucks will travel.[36] While it is not possible to estimate what the overall impact will be from the increased truck trips, it might be presumed that any composting facility near a landfill will result in a small net change in truckloads and driving distances. It is unknown at this time if compost from large urban areas located outside of the Central Valley, such as the greater Los Angeles and San Francisco Bay areas, will be diverted to the proposed facilities in the Central Valley. CalRecycle will ensure that compost will be diverted to the nearest facility to minimize potential transportation impacts. In addition, siting new compost facilities at or near one of the current transfer facilities located in the Central Valley would decrease delivery distance considerably (see figure 3). Overall, the potential impact due to emissions from truck transport is not quantifiable at this time.

Figure 3: Transfer stations in California. Map showing all permitted and active transfer stations in California in 2014. Data from FacIT. Source: http://www.calrecycle.ca.gov/Publications/Documents/1524/20151524.pdf

Another potential source of vehicle emissions is from off-road vehicles that will be used to separate the compostable waste from the non-compostable waste. Off-road vehicles may include front-end loaders, excavators, or water trucks, as additional sources of PM and ozone forming contaminants. However, these vehicles are subject to regulations (CARB requires EPA-certified lower emitting engines).

Potential Health Impacts

Facility emissions

There will be a reduction of methane, CO_2, and bioaerosols at landfills when green waste is diverted to ASP composting facilities. This will create better air quality around these facilities, and will lessen the health impacts related to climate change. Broadly, climate change can have a negative impact on respiratory disease, cardiovascular disease, vector

borne infections, and allergy. Fewer airborne irritants and bioaerols will reduce the likelihood of infections, allergies and skin and mucus membrane irritation for workers at landfill facilities. Some of the risk associated with bioaerosol exposures (infection) is transferred to workers at ASP facilities, although to a lesser extent due to the use of fabric covers.

Staff at landfills and composting facilities and nearby residents will have some exposure to vehicle emissions on site, and therefore could have diesel-related health impacts. This is especially true among sensitive individuals or those exposed over a long period of time. Diesel related health impacts include respiratory disease, cardiovascular disease, low-birth-weight, and cancer. The extent that overall risk will change for these outcomes is unknown since vehicle emissions can vary greatly from site to site.

Transportation emissions

If, with the addition of ASP facilities, diesel truck traffic does not drastically change on a statewide and regional level, there will be limited change in traffic-related health outcomes like cardiovascular disease, respiratory disease, and cancers.[37] However, at the local level, emissions from diesel-fueled trucks could increase these health risks in certain areas of the Central Valley.

Table 6: Characterization of effects from changes in facility emissions (including on-site vehicles and equipment)					
Health Outcome/ Determinant	**Impacts**	**Direction and Extent**	**Likelihood**	**Distribution**	**Source of Evidence**
Respiratory disease[1]	Regional	▲	Possible	Residents susceptible to respiratory diseases	****
	Site specific	▼	Possible	Workers at facilities could be impacted by vehicle emissions	***
Cancer	Regional	▲	Unlikely	Little change in risk for general population	****
	Site specific	▼	Unlikely	Workers and communities in close proximity to facilities	****
Cardiovascular disease	Regional	▼	Unlikely	Communities near large facilities and increased truck traffic	*
	Site specific	▼	Possible	Workers at facilities could be impacted by vehicle emissions	*
Allergy	Regional	▲	Likely	Sensitive community members	*
	Site specific	▼▼	Possible	Sensitive workers could be allergic to compost matter	*
Mucus membrane and skin irritation	Regional	▲	Unlikely	Sensitive residents near facilities	*
	Site specific	▼▼	Possible	Workers	*
Climate change	Regional	▲▲▲	Likely	All will benefit from climate change mitigation	****
	Site specific	▲	Unlikely	Residents and workers	*
Infection	Regional	▲▲	Possible	All residents may benefit from climate mitigation that reduces vector borne infections	**
	Site specific	▼▼	Unlikely	Workers could be exposed to airborne infectious agents	*
Congenital anomalies and low birth weight	Regional	▲	Unlikely	Diversion of organics will benefit communities near landfills	*
	N/A				

[1] *Interpreting this table: For example, the first row demonstrates that the health impacts associated with respiratory disease may possibly improve at the regional level for susceptible residents. However, at each ASP site, workers will possibly experience worsening respiratory health.*

Table 7: Characterization of effects from changes in off-site transportation emissions					
Health Outcome/ Determinant	**Impacts**	**Direction and Extent**	**Likelihood**	**Distribution**	**Source of Evidence**
Respiratory disease[1]	Regional	▲	Possible	Communities near existing landfills will have less truck traffic	**
	Site specific	▼▼	Possible	Workers (drivers and facility staff) and residents	**
Cancer	Regional	▼	Uncertain	Communities with a large increase in truck traffic	*
	Site specific	▼	Possible	Workers (drivers and facility staff) and residents	*
Cardiovascular disease	Regional	▼	Uncertain	Communities with a large increase in truck traffic	*
	Site specific	▼	Possible	Workers (drivers and facility staff) and residents	*
Allergy	Regional	▲	Unlikely	Residents	*
	Site specific	▲	Unlikely	Residents near facilities	*
Mucus membrane and skin irritation	Regional	▲	Unlikely	Residents near facilities	*
	Site specific	▼	Possible	Workers	*
Climate change	Regional	▼	Likely	If there is an increase in truck traffic	***
	Site specific	▼	Unlikely	Workers	***

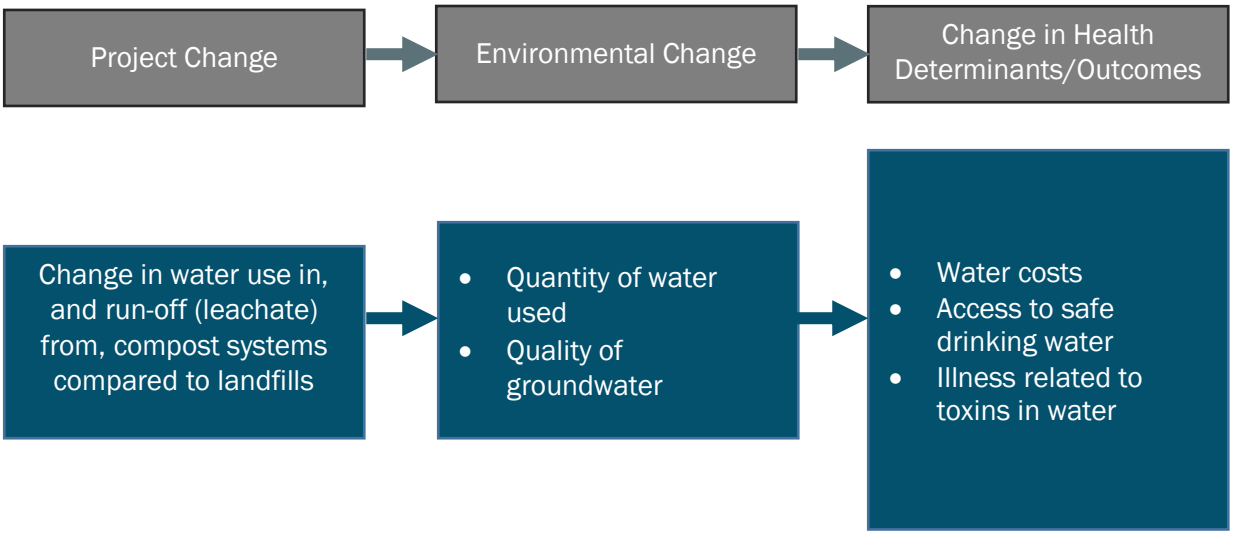
[1]*Interpreting this table: For example, the first row demonstrates that the health impacts associated with respiratory disease may possibly improve at the regional level, especially communities near existing landfills. However, residents near new ASP facilities and workers may possibly experience worse respiratory health.*

Recommendations

1. Composting facilities should be sited as near as possible to waste transfer facilities or landfills to reduce delivery distances and truck emissions.
2. Prior to the construction of a new facility, the cancer risk due to emissions from additional truck transport should be calculated and considered.
3. If mixing compost waste, workers should wear dust masks and eye protection to reduce exposure to organic dust (bioaerosols).
4. The fabric covering on compost piles should be regularly inspected for gaps and tears to ensure its ability to limit emissions and odors. It should be replaced or repaired if found to have defects.

Water Quality

Figure 4: Water pathway



Water quality and availability will be impacted by diversion of green waste from landfills and growth of composting facilities in California. For one, the make up and quantity of liquid run off from both landfills and compost piles, known as leachate, will change in both types of facilities which can impact groundwater. Secondly, there will be an impact on water usage. Some water is used in the production of compost, but this is offset by reduced irrigation needs in agricultural and community settings where compost product is used to enhance soil. Water conservation related to compost use will be described in in greater detail in the Agricultural Practices section.

Changes in water usage and groundwater quality directly affect water costs and the safety of drinking water, which are associated with health outcomes and determinants listed in figure 4.

Current Conditions

Leachate: Leachate from landfills contains organic and inorganic chemicals and heavy metals that can be harmful to waterways and human health.[38] There are regulations requiring leachate from landfills to be captured, treated and monitored; composting facilities are also required to capture leachate to protect groundwater. These regulations limit the impacts leachate from these facilities will have on health and the environment.[39] However, there is always the possibility during the lifetime of a landfill that linings will leak, impacting nearby groundwater.[40] Historically, there have been water quality impacts from landfills. Due to the high moisture content of green waste, disposing of these materials in landfills results in more leachate.

Water use and conservation: Water use is an important consideration in drought stricken California, especially in the Central Valley where the impacts of drought are greatest and agricultural water demands are high. It is difficult to quantify actual use, but minimal water is used at landfills to control dust. Water is, however, necessary to process compostable materials.

Expected Environmental Changes

Leachate: Feedstock in compost piles will be limited to food and other green waste; the resulting leachate will contain fewer contaminants than landfill leachate. Furthermore, there are steps in place to limit contaminants such as plastics and metals at the beginning of compost processing at ASP facilities, which will result in relatively clean leachate. Like landfills, there are strict regulations for managing leachate at ASP composting facilities. For example, at the Mid-Valley disposal site in Kerman, CA, leachate from compost piles is expected to be minimal (roughly 5 gallons per 250 tons of material composted); it is captured with cement flooring and stored in a tank. It is used to moisten future feedstock as it is prepared for the composting process resulting in a zero discharge leachate system.[41]

Water use and conservation: Water is necessary to process compostable materials. ASP systems with fabric covers are the most efficient, using approximately 60 gallons of water per ton of compost produced. That number goes down to 50 or 45 gallons with more food waste added. However, California is a hot and dry climate, and water will be needed for product curing and storage. CalRecycle estimates water use at 80-100 gallons per ton of finished compost. This compares favorably to other composting systems. An open windrow system can use as much as 800 gallons of water per ton of finished product. ASP compost systems without fabric covers are estimated to use somewhere in the neighborhood of 200-300 gallons per ton.[42]

Synthesis of health and environmental outcomes

Diverting green waste from landfills to composting facilities will have a positive effect on water conservation and quality. Neither landfill nor composting facilities use a significant amount of un-recycled water, but the produced compost associated with ASP facilities has water saving (retaining) properties that will conserve water in agriculture, landscaping, and other applications. It will also support erosion control, further reducing impacts on local waterways. These benefits can be shared with disadvantaged communities when compost is available for community use, or when food grown with compost is made available to them.

Human and animal exposure to leachate contaminants will likely remain low with the increased practice of composting because leachate in landfills and compost facilities is heavily regulated and managed. However, if there were to be a leak in a facility, a leak at a landfill would likely have a greater impact on groundwater due to the heavier chemical burden in its leachate.

Potential Health Impacts

It is unlikely that leachate from composting facilities or landfills will have significant impact on health because of the controls in place to prevent leachate from contaminating groundwater and water systems. If anything, the required controls, and the reuse of recycled leachate at composting facilities will be health protective. Groundwater protections and conservation will help keep water costs down. This is especially important in low-income, disadvantaged communities. Using compost in community restoration projects, and making it available to residents for their own gardens, will increase conservation benefits and cost savings will be felt more directly by residents. There are additional benefits of using compost for erosion control and flood prevention; these benefits will be discussed in the Agricultural Practices section.

Characterization and Effect

Table 8: Characterization of effects of changes in water quality and use

Health Outcome/ Determinant	Impacts	Direction and Extent (of the health impact)	Likelihood	Distribution	Source of Evidence
Community water costs [1]	Regional	▲	Possible	Greatest impact on low income households	**
	Site specific	▲	Unlikely	Same	*
Access to safe drinking water	Regional	▲	Unlikely	Groundwater users	**
	Site specific	▲	Unlikely	Groundwater users	**
Illness related to toxins in water	Regional	▲	Unlikely	Groundwater users	**
	Site specific	▲	Unlikely	Workers at sites coming into contact with leachate	*

[1]*Interpreting this table: For example, the first row demonstrates that the health impacts associated with community water costs will possibly improve at the regional level for low-income households. There is unlikely to be much change in health impacts related to water costs due to an individual ASP facility.*

Recommendations

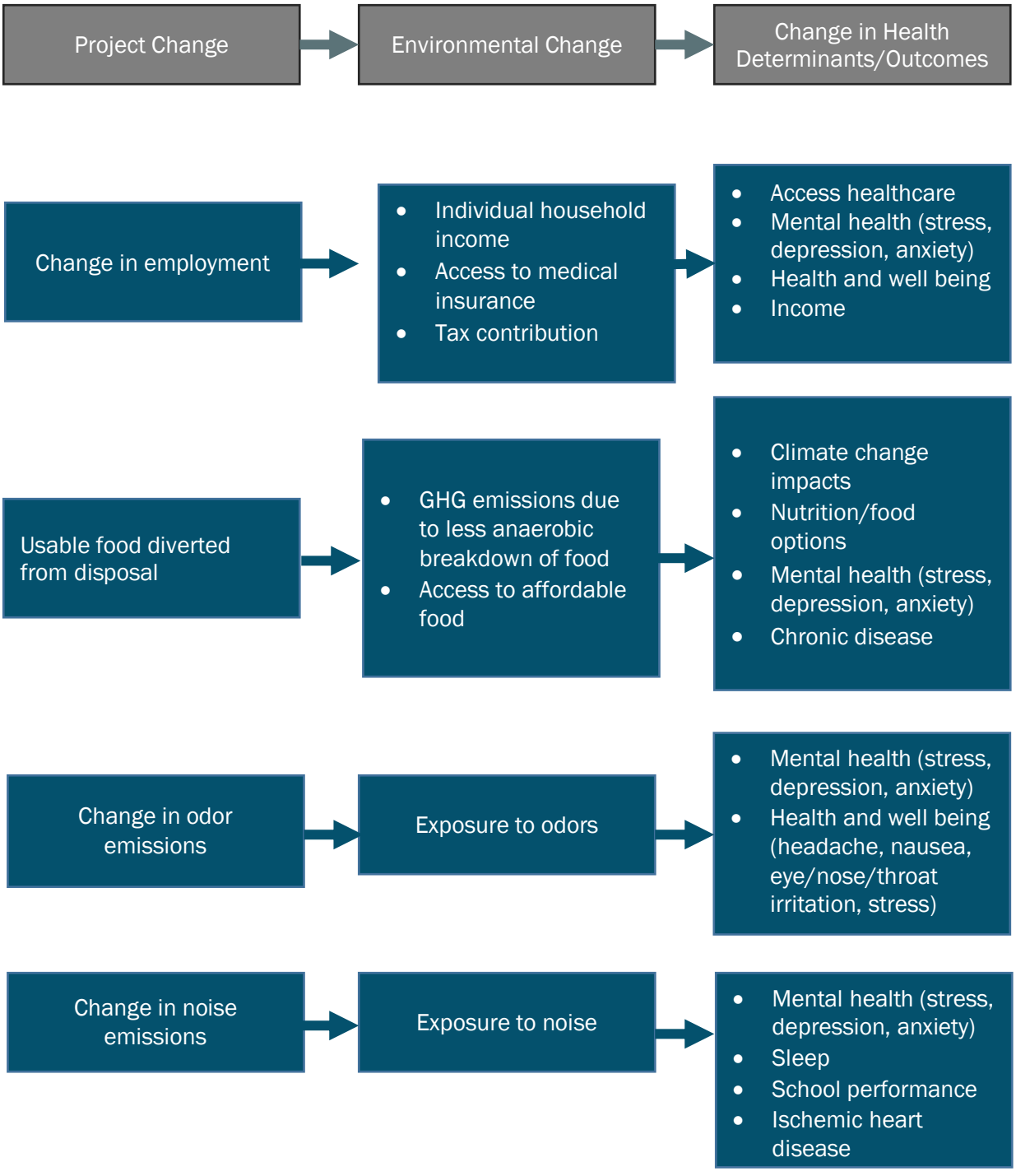
1. Leachate monitoring is already part of landfill and compost site regulations. In addition to monitoring, sites should also be required to share findings with the community in proximity to each site to assure the community about the safety of these facilities and groundwater.

2. Promote the use of compost product in agriculture and community landscaping as a strategy to improve water conservation and subsequent cost savings. Require some percent of compost product to be available to nearby residents and disadvantaged communities to assist in the creation of water conserving home gardens.

3. Provide education to individuals using compost product on its water conserving benefits so that water usage can be altered appropriately. Make sure education to community members is written at a low-literacy level and provided in appropriate languages.

Mental Health and Stress

Figure 5. Stress and Mental Health Pathways



This chapter assesses the unintended health consequences associated with employment, food security, odor, and noise, which can impact stress levels and mental health status.

Mental health and stress are important considerations that are rarely examined when environmental policies or land use planning decisions are debated. We examine several determinants that have an impact on an individual's or community's level of stress and mental health:

1) Does the diversion of organics from landfills to new composting facilities increase the number of jobs with benefits? How do these new jobs affect overall health and household income?
2) What are the impacts of food rescue programs and their influence on health and nutrition?
3) How will increased noise and odor from new ASP facilities impact quality of life and mental well-being? Will there be reduced noise and odor at landfills?

Employment

Current conditions: Seven of the eight Central Valley counties included in this assessment have a median household income of $39,001 to $53,000, which is roughly $7,000-$20,000 below the median household income of California. While the average high school graduate rate across the San Joaquin Valley Counties is comparable to that of California (81.5%), some cities have much lower rates. Almost 12% of persons living in the Central Valley are unemployed, more than 4% above California's unemployment rate of 7.5%. The county of Tulare has the highest unemployment rate in the region (13.2%).[43]

Expected change: Each new ASP facility will employ approximately two additional workers; these positions will have medical benefits.[44] While there may be new jobs related to the construction and operation of new facilities, additional workers may also educate residents and end users about composting. Other jobs may be created for the distribution and sales of the end product.[45] It is difficult to quantify the total number of jobs created with this policy, but most new jobs will likely be local and will therefore benefit the Central Valley counties. Individuals that are newly employed will have an increase in household income, and will likely have improved access to healthcare care and improved mental health. No new driving jobs are expected for hauling organic waste to the ASP facility.

Food Security

Current conditions: Lack of healthy and affordable food is another stressor for families. Almost 41% of San Joaquin residents report not having enough food (food insecure) and 25% are currently receiving Food Stamps.[46] While data on the food environment (for example, access to a grocery store) for each Central Valley county is comparable to that of the state, individual communities may suffer larger burdens associated with access to food and insurance benefits.[47]

Expected change: Food rescue programs associated with compost facilities can help address this need and are a priority described in the Short Lived Climate Pollutant Strategy.[48] According to the Natural Resource Defense Council, more than half of all fruits and vegetables go uneaten in the United States. While it is not a requirement, some compost facilities integrate food rescue efforts into their work. They work with food banks and farmers to refrigerate, and transport food to disadvantaged communities.[49] A well-advertised, well-designed program could have the potential to impact the number of food insecure households in communities where composting facilities will be sited; however this type of program is not a requirement for new ASP facilities.[50] Public comments made during

meetings about the Short Lived Climate Pollution Strategy support food rescue initiatives. In addition to feeding disadvantaged communities, diverting food from landfill and ASP facilities reduces the release of methane, a contributor to climate change. See air quality section for more health effects of climate change.

Odor and Noise

Current conditions: Baseline community data on odor and noise are difficult to find. The sources of odors from current landfills are mostly due to the degradation of organics resulting in methane release. Current landfill facilities have to comply with their municipal general plan, which sets levels for odor and noise for new projects. Research indicates that noise levels about 40 and 60 dBA may interfere with sleep; levels above this range (65 to 70 dBA) have been associated with decreased school performance and ischemic heart disease.[51]

Expected change: Research on aerated static pile compost systems found that aeration reduced concentrations of ammonia (by 72%) formic acid (57%) and acetic acid (11%). Dimethyl sulfide, carbon disulfide, and sulfur dioxide concentrations were reduced to below detection limits.[52] If facilities are built using aeration techniques, health effects associated with odor will be less than that associated with landfills. ASP facilities with fabric covers are less likely to have odor issues than open systems. In the case of ASP systems, large blowers (fans) would push and/or pull the air through the piles. These blowers (fans) may operate 24 hours per day, although positive pressure systems (push fans) can be very intermittent with long off cycles. It is reported that blowers are not expected to be as loud as other equipment in use on site, such as grinders or loaders. Additionally, all new facilities will have to ensure noise levels adhere to their county general plan noise element. Siting facilities away from residential areas, noise and odor should have limited impacts on community residents and sensitive communities.

Potential Health Impacts

Employment: Because there is an increase in employment, there will be positive impacts on health through increases in standard of living and income, reductions in stress, and opportunities for personal growth and social relationships. Conversely, unemployment can lead to increased stress, depression, and anxiety, and contributes to cardiovascular disease.[53] Low-income has been associated with increased risk of low birth weight babies, injuries, violence, some cancers, and chronic disease.[54] Uninsured adults have less access to recommended care, receive poorer quality of care, and experience worse health outcomes than insured adults.[55] [56]

Food Security: Access to healthier food options will increase nutritional status and improve mental health and chronic diseases such as diabetes. Diversion of food from waste will reduce the release of methane, a large contributor to climate change.

Odor & Noise: Decreased odor levels will improve mental health (stress and increase quality of life. Increased noise levels will negatively impact mental health and general health and well-being (headache, nausea, eye/nose/throat irritation). An increase in noise will negatively impact mental health (stress, depression, and anxiety), sleep, school performance, and ischemic heart disease.

Characterization of Effects

Table 9: Characterization of effects of changes in employment					
Health Outcome/ Determinant	**Impacts**	**Direction and Extent (of the health impact)**	**Likelihood**	**Distribution**	**Source of Evidence**
Access to healthcare[1]	Regional	▲	Possible	Workers (and potentially family members)	**
	Site specific	▲	Possible	Workers (and potentially family members)	**
Mental Health (stress, depression, anxiety)	Regional	▲	Unlikely	Workers (and potentially family members)	*
	Site specific	▲	Possible	Workers (and potentially family members)	*
Income	Regional	▲	Possible	Workers (and potentially family members)	*
	Site specific	▲	Possible	Workers (and potentially family members)	*

[1] *Interpreting this table: For example, the first row demonstrates that the health impacts associated with access to care may possibly improve for workers and their families both at the regional and site level.*

Table 10: Characterization of effects of changes in food diversion					
Health Outcome/ Determinant	**Impacts**	**Direction and Extent (of the health impact)**	**Likelihood**	**Distribution**	**Source of Evidence**
Climate change impacts [1]	Regional	▲	Possible	All will benefit from climate change mitigation	**
	Site specific	▲	Possible	All will benefit from climate change mitigation	**
Nutrition/food options	Regional	▲	Unlikely	Communities with food desserts	*
	Site specific	▲	Unlikely	Communities with food desserts	*
Chronic Disease	Regional	▲	Unlikely	All will benefit from food diversion	*
	Site specific	▲	Unlikely	All will benefit from food diversion	*
Mental health (stress, depression, anxiety)	Regional	▲	Unlikely	Communities with food desserts	*
	Site specific	▲	Unlikely	Communities with food desserts	*

[1]*Interpreting this table: For example, the first row demonstrates that the health impacts associated with climate may possibly improve for all at the regional and site level.*

Table 11: Characterization of effects of changes in odor					
Health Outcome/ Determinant	Impacts	Direction and Extent (of the health impact)	Likelihood	Distribution	Source of Evidence
Mental health (stress, depression, anxiety) [1]	Regional	N/A			
	Site specific	▼▼	Possible	Communities near facilities	*
Health and well- being (headache, nausea, eye/nose/throat irritation)	Regional	N/A			
	Site specific	▼▼	Possible	Communities near facilities	**

[1]Interpreting this table: For example, the first row demonstrates that mental health may possibly worsen for community members near composting sites due to potential odor from composting sites.

Table 12: Characterization of effects of changes in noise					
Health Outcome/ Determinant	Impacts	Direction and Extent (of the health impact)	Likelihood	Distribution	Source of Evidence
Mental health (stress, depression, anxiety)[1]	Regional	N/A			
	Site specific	▼▼	Possible	Communities near facilities	*
Sleep	Regional	N/A			
	Site specific	▼	Possible	Communities near facilities	*
School Performance	Regional	N/A			
	Site specific	▼	Unlikely	Communities near facilities	*
Ischemic Heart Disease	Regional	N/A			
	Site specific	▼	Unlikely	Communities near facilities	*

[1]*Interpreting this table: For example, the first row demonstrates that mental health impacts may possibly worsen for communities near compost sites due to noise. Changes in noise levels will not change mental health at the regional level.*

Recommendations

Employment:

1. To be eligible for state funding, new ASP facilities should provide benefits to all employees (health insurance and paid sick days) to all employees.

2. Prioritize funding ASP facilities that propose hiring local residents who live near proposed facility sites.

Food Security:

3. Encourage new facilities to include a food rescue program as part of facility operations. Prioritize integration of food diversion into CalRecycle grant programs.

Odor and Noise:

4. Handle all municipal solid waste inside the building to reduce odor and noise in neighboring communities.

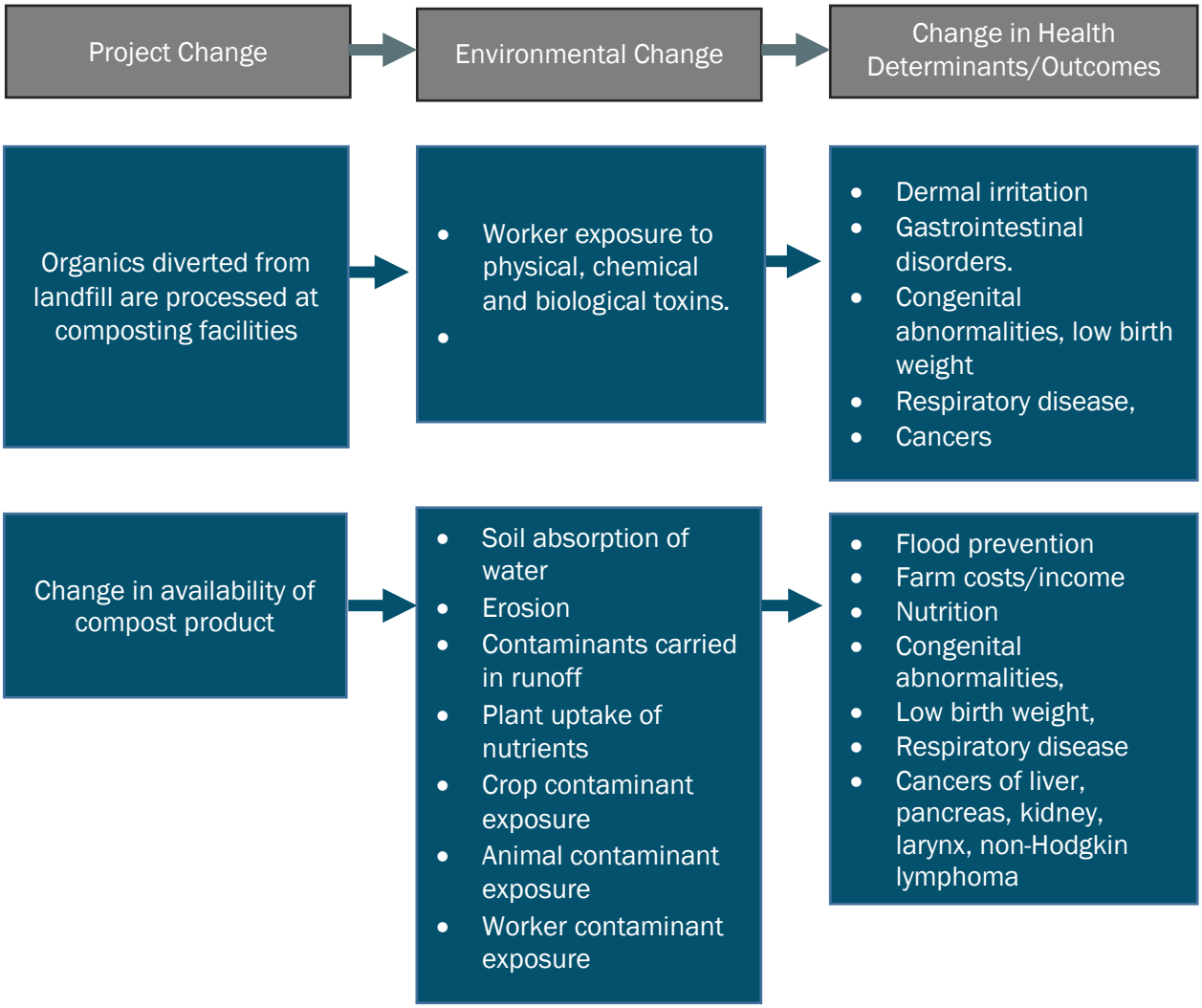
5. Process all organic material into the covered composting system or off site as soon as possible (i.e., within 48 hours).

6. Develop communication protocols with nearby communities to assess and mitigate odor and noise problems as they arise.

7. Incentivize the purchase of low-noise machinery in a noise–sensitive area such as residences, schools, churches, hospitals, etc,

Agricultural Practices

Figure 6. Agricultural Practices Pathways



Most of this HIA focuses on the health impacts associated with landfills and ASP composting facilities, but one of the main benefits associated with the proposed increase is composting food and other green waste, is the use of compost product as a soil enhancer. This section explores the health impacts associated with processing compost materials and the use of compost in agricultural settings. The Agricultural Practices pathway (figure 6) explores possible health risks for workers who are exposed to compost material and lists the possible changes that will occur when compost is regularly used as a soil enhancer. It will impact use of pesticides, herbicides, nutrient uptake in plants, and the level of contaminants in field run off. These changes will impact health determinants such as flooding and farming costs, as well as direct health outcomes including cancers, respiratory disease, congenital abnormalities and nutritional status.

Current Conditions

Unlike other sections of this report that compare conditions that exist at landfills to ASP composting facilities, this section examines conditions associated with producing compost as well as agricultural conditions with and without the addition of compost as a soil enhancer.

Compost Production—Conditions for Workers

There are processes in place to limit contaminants in compost production and its final product as much as possible. Still, workers come into close contact with compost and it is possible for them to be exposed to low levels of contaminants through dermal contact and inhalation. Composting will expand with this policy, but the conditions that currently exist for workers in ASP facilities are likely to be same. The following describes these conditions.

Compared to solid waste workers, workers in composting facilities are likely to have less exposure to chemicals and pathogens. There is evidence that solid waste workers are exposed to substantial levels of physical, chemical, and biological toxins.[57] Solid waste workers commonly experience injury related to heavy machinery, but also experience diseases including skin and gastrointestinal disorders that may be related to pathogens, volatile compound, and chemical exposures.[58] Whereas, a meta-analysis of solid waste management practices and health found little evidence on potential health problems resulting from environmental or occupational exposures from composting or recycling.[59]

Contaminants are heavily regulated in composting facilities. California compost facilities are permitted in accordance with state law and CalRecycle regulations, and are inspected by a network of local enforcement agencies. Additionally, compost facilities selling to organic food producers are inspected annually by the CDFA.

Composting operators are required by statute to clean and sort materials as they arrive to get the cleanest feedstock possible. The finished compost is cleaned again after composting and residual contaminants are removed using electric trammel screens and sent to the landfill.[60] There is a contamination standard of a maximum of .5% on physical contaminants (solids such as glass/plastic).[61]

Compost facilities must test for contaminants, metals and pathogens and have been meeting standards for many years. All finished compost must be tested for nine heavy metals and the pathogens Salmonella and E Coli. The composting process kills human and animal pathogens, and exposure-related infectious disease from primary pathogens among compost workers has not been documented. Testing for pharmaceutical traces is not part of the standard panel of tests.[62] CalRecycle recently completed an update of composting regulations, so new facilities built in coming years will need to conform to more stringent requirements.

Agriculture Conditions

It is hard to estimate the quantity of compost currently used in agriculture, but this policy will make it widely available. The current conditions described are based on more commonly used conventional farming practices that use fertilizers, herbicides, and pesticides rather than compost. Current water use for irrigation is also described.

In 2007, California accounted for 23% of all agricultural pesticides used in the U.S.[63] In 2010, over 160 million pounds were applied in California.[64] Pesticide use can vary greatly over time, as new pesticides are introduced and old pesticides are phased out, agricultural methods change, and pest populations shift. Because agricultural pesticides are dispersed in an outdoor environment, they are subject to variable conditions that may affect their transport, persistence, and chemical decomposition in the environment.

Nitrogen is necessary for crop growth and development, and thus nitrogen fertilizer use supports California's robust agricultural economy. Plants do not take up 100% of the nitrogen in soil; therefore excess is often applied. Applying nitrogen in excess has been linked to water and air pollution, depletion of the ozone layer, climate change and numerous human health concerns. Current use of nitrogen fertilizers is difficult to quantify because of the way data are collected. [65,66]

Approximately nine million acres of farmland in California are irrigated, representing roughly 80% of all water used for businesses and homes. Higher revenue perennial crops—nuts, grapes, and other fruit—have increased as a share of irrigated crop acreage (from 27% in 1998 to 32% in 2010 statewide, and from 33% to 40% in the southern Central Valley).[67] Economists estimate that in 2014, the drought cost farmers about $2.2 billion through lost crops and increased water costs.[68] The Central Valley is especially impacted by drought, as it is California's largest farming area.

Expected Conditions

Compost Use in Agriculture

The previous section describes the possible exposure to contaminants faced by workers in composting facilities and agriculture who handle compost product. The following describes some of the same contaminants and their impacts on plants/food when used as a soil enhancer.

Pathogens

Composting facilities must meet standards for pathogen reduction and testing of final product. Human and animal pathogens of concern include viruses, bacteria, protozoan, and helminth parasites.[69] Furthermore, it is expected that proposed sites, will be similar to sites like Mid-Valley Disposal's ASP site, where processed feedstock will include municipal and commercial green waste, but not biosolids more likely to contain pathogens.[70] "Secondary pathogens" - fungi and other micro-organisms produced during the composting process on the other hand, are of greater concern. However, in ASP facilities, it is expected that if not all, nearly all bacteria, fungi and protozoa will be destroyed.[71] Workers are also less likely to be exposed in ASP facilities if an impenetrable fabric cover is used to contain pathogens during compost production.[72]

Heavy metals

Composting processes inherently reduce metal availability compared to other organic waste stabilization methods. Therefore, risks to the environment, human health, crop quality and yield, and soil fertility from heavy metals in source-segregated municipal solid waste or green waste-compost are minimal.[73] Fewer metals in the compost feedstock means fewer metals in the finished compost, demonstrating the importance of careful pre-sorting as called for in CalRecyle regulations.[74]

Chemicals

There are a wide variety of potential chemical contaminants in compost. There are numerous studies that have examined compost for various classes of chemical contaminants. While the strict regulations on sorting and minimal threshold on contaminants in compost product will minimize chemical contaminants, some of the following chemical contaminants have been found in compost. These findings are not specific to ASP compost systems. There could be less contamination with this newer technology.

- Adhesives, paints, and solvents including acetone, toluene, dichloromethane, trichloroethylene, xylene, ethylbenzene, and tetrachloroethylene.[75]
- Dioxins/furans, polychlorinated biphenyls and polycyclic aromatic hydrocarbons resist biological decomposition and volatilization.[76]
- Pesticides are widely used in lawn care and agriculture in the US and around the world. Feedstock may include yard trimming and agriculture residues that were potentially treated with pesticides.
- Wood preservatives from treated wood
- Pharmaceutical traces may remain in compost if they are not broken down.

Despite the possibility of the above chemicals being found in compost, it is unknown if the trace amounts would have impact on food products and human health. Composting, when used as an agricultural soil enhancer, reduces the need for fertilizers, herbicides and pesticides thereby reducing human and animal exposure to these chemicals through ingested food. Research has highlighted the environmental benefits of compost use for improving soil quality, including: 1) incorporating organic matter, nutrients and electrolytes into the soil, 2) reducing the need for fertilizer, pesticides and peat use, 3) improving soil structure, density and porosity, which increases water retention capacity and reduces erosion and nutrient leaching, and 4) enhancing carbon storage capacity in the soil, thus, reducing global warming.[77] [78] [79] [80]

Water Conservation

The use of compost as a soil enhancer both in agriculture and other applications reduces irrigation needs, and limits erosion and sedimentation. These changes will have impacts on human and environmental health.

The use of compost product in agriculture and other applications will result in water conservation, although it is difficult to quantify.[81] Compost product increases water-holding capacity of soil resulting in less irrigation and less run off. Reducing agricultural water needs can also result in a financial benefit as water costs are reduced.

Compost product used in agriculture and community settings will reduce soil erosion and sedimentation. This will effectively prevent sediment filling up storm drains and catch basins that carry water away from roads and homes, reduce sediments in water sources, limit irrigation systems clogging, provide natural filtration of runoff, and prevent alteration of water flow and flooding. Using compost will also reduce pollutants in runoff (i.e., heavy metals, nutrients, oil, etc.).[82] [83]

Furthermore, the use of compost in agriculture reduces the amount of contaminants in runoff from fields, which improves water quality. It is difficult to quantify the reduction in the amount of fertilizer, pesticides and herbicides used when all prospective compost facilities are operating capacity. However, nearly 10 million tons of feedstock will be processed each year and the primary use for compost will be agriculture application near the facility where it is produced. Therefore, farms in the Central Valley stand to use a majority of the compost produced, reducing chemical exposure of farmworkers and local consumers of food grown in the region. The Central Valley will also benefit from reduced chemicals in runoff that reach ground water, which is has been impacted by drought conditions.

Potential health impacts

During compost processing

People that stand to have health impacts (potential receptors) include workers at landfills and compost facilities, those living near landfills and compost facilities, users of compost, and consumers of foods grown with compost added to soil.

Impermeable fabric covers commonly used at ASP facilities dramatically reduce the risk of exposure to potential contaminants during the composting process for most people. For workers, potential inhalation exposures exist when covering is removed (cover is removed at various points, but primarily at the termination of the compositing process) and/or if there is a tear in the cover. Dermal exposure is limited due to mechanization of composting techniques. However, it is possible that at the final stage when compost is loaded on trucks or bagged for consumer distribution that there may be worker dermal exposure. Potential health issues that can result from inhalation or dermal exposure include:

- red and irritated eyes;
- runny nose and nausea; and
- inflammation and congestion.[84]

Agricultural Use of Compost

While farmers applying compost from new facilities may not follow all organic methods, a reduction in the use of fertilizers will have some of the benefits of organic farming. There is evidence of higher levels of phytonutrients in foods grown organically (using compost instead of chemical inputs), and less or no pesticide residues on organically-grown food. Researchers have also found organic foods to have higher concentrations of vitamin C, total antioxidants and total omega-3 fatty acids, and higher omega-3 to -6 ratios.[85] The application of compost reduces plant uptake of toxic heavy metals such as cadmium, and thus reduces health harms from these heavy metals to consumers.[86]

Farmworkers will experience less chemical exposure with increased use of compost. The evidence suggested that farmworkers who are exposed to chemical pesticides and fertilizers have more health problems than people not exposed to these substances, as would be the case if working exclusively on organic farms. Studies have shown that exposure to pesticides and other agrochemicals can affect nervous system functioning, increase inflammatory markers, renal disease, and bladder cancer.[87] Occupational exposure to either insecticides or herbicides is also linked to increased risk for Parkinson's disease.[88] Latino children of farmworkers in an orchard community were at increased risk from

organophosphate pesticide exposure- associated deficits in learning and neurobehavioral performance, particularly in motor function.[89] Given the reduction in these chemicals, farmworkers should see a decrease in these health conditions.

Synthesis of potential health outcomes

Compost production and its increase use in agriculture will, for the most part, have positive effects on health determinants and outcomes in workers, community members, and consumers of agricultural products.

Workers at composting facilities - especially ASP compost facilities that use an impenetrable fabric cover– have significantly lower risks of death, injury and illness than do workers at landfills. Similarly, there is no evidence that residents living in proximity to ASP compost facilities suffer harmful health impacts from the facilities, while there is evidence that residents living near landfills suffer adverse health impacts. Health impacts such as exposure to secondary pathogens and allergens found in open compost facilities are less likely to impact workers in ASP facilities due to the protective cover. Greater availability of compost in agricultural displaces or reduces application of chemical fertilizers and pesticides to food crops by increasing the health of soil and plants.

Diverting green waste from landfills to composting facilities will have a positive effect on water conservation, quality, and costs. With regard to compost production, neither landfill nor composting facilities use a significant amount of unrecycled water. Therefore compost production will have a minimal impact on water usage. However, the produced compost associated with ASP facilities has water retaining properties that will conserve water in agriculture, landscaping, and other applications. It will also promote erosion control. It is difficult to measure the amount of water that will be diverted from irrigation, but it stands to be significant. Water diverted from irrigation will ensure more water for priority uses, like drinking water and other household uses. Access to clean and sufficient water is critical for hydration, hygiene, cooking, and the prevention of waterborne disease. Compost use on farms can reduce the cost of producing food by reducing irrigation costs and possibly increasing yield. Farmers and consumers can experience cost savings, which will make healthy foods more accessible. The prevention of erosion and sediment can also impact health by reducing water contaminants such as heavy metals and soil bacteria in runoff.[90]

Outside of agricultural uses, additional benefits of composting include helping with vegetation establishment or re-establishment in soils that have been damaged by fires, erosion, etc. Vegetation (trees, flowers, grasses, etc.) provides health benefits that include stress reduction, improved mental health and functioning, faster healing times, increased social capital, increased physical activity (from improved physical environments), increased property values.[91]

Characterization of Effect

Table 13: Characterization of effects from processing organics at compost facilities					
Health Outcome/ Determinant	**Impacts**	**Direction and Extent**	**Likelihood**	**Distribution**	**Source of Evidence**
Dermal irritation	Regional	N/A			
	Site specific	▲	Possible	Facility workers[1]	**
Gastrointestinal disorders	Regional	N/A			
	Site specific	▲▲	Possible	Facility workers[1]	****
Congenital abnormalities and low birth rate	Regional	NA			
	Site specific	▲	Possible	Facility workers[1]	*
Respiratory disease	Regional	N/A			
	Site specific	▲	Possible	Facility workers[1]	**
Cancers	Regional	N/A			
	Site specific	▲	Possible	Facility workers[1]	**

[1] *Compared to landfill workers, compost workers will have a decrease in this health effect*

[2] *Interpreting this table: For example, the first row demonstrates that the health impacts associated with dermal irritation may possibly improve for workers at the site level. However, no dermal impacts are likely at the regional level.*

Characterization of effects from change in availability of compost product					
Health Outcome/ Determinant	**Impacts**	**Direction and Extent**	**Likelihood**	**Distribution**	**Quality of Evidence**
Flood prevention	Regional	▲▲	Likely	Residents surrounding farms using compost	****
	Site specific	▲	Possible	Farms, depending on their topography	****
Farm costs/income	Regional	▲▲	Likely	Farm owners in Central Valley	***
	Site specific	▲▲	Likely	Farm owners in Central Valley	***
Nutrition	Regional	▲▲	Likely	All consumers of food grown in Central Valley	***
	Site specific	N/A			
Congenital abnormalities and low birth weight	Regional	▲	Unlikely	All consumers of food grown in Central Valley	**
	Site specific	▲	Possible	Farmworkers	**
Respiratory diseases	Regional	▲	Possible	Residents surrounding farms	**
	Site specific	▲▲	Possible	Farmworkers	**

[1]*Interpreting this table: For example, the first row demonstrates that the health impacts associated with flood prevention are likely to improve at the regional level and may possibly improve at individual farms depending the farms topography.*

Recommendations

1. CalRecycle should assess the feasibility of requiring testing for adhesives, paints, and solvents, dioxins/furans, PCBs, PAHS, pesticides and pharmaceuticals in finished compost, and, if detected, develop a regulatory standard governing levels of these compounds.
2. As compost destined for certified organic producers is held to a higher standard than other compost, consider requiring all compost facilities to meet organic standards for all finished compost that may be applied to agriculture or to home or commercial gardens.
3. As use of composted municipal solid waste is generally considered safe for agricultural or home garden use, and application of compost may displace or reduce chemical pesticide or fertilizer use, and thus pose lower health risks to farmers, gardeners and consumers, guidelines or programs should be established so that residents in the vicinity of the compost facilities enjoy the benefit of the finished compost. Examples of such guidelines include requirements for facilities to offer free compost to residents of the zip code in which the facility is located.

Recommendations Summary

The HIA findings indicate numerous benefits of increasing composting capacity in California and diverting organic waste from landfills. The following recommendations, if implemented, would maximize the health benefits of this policy and will minimize negative health impacts. These recommendations are fairly generalized. As indicated within each section, some of the health impacts will vary from site to site and should be considered during the planning phase of each site.

General Recommendation

8. Projects such as compost or municipal solid waste facilities must serve the local community. An essential element of serving the community is providing ample opportunities for community engagement and decision-making regarding the siting, size, type, and other aspects of the facility. Engagement opportunities must be provided early, when input can meaningfully change the scope of the project, and be accessible to residents (eg., be held in the evening, with child care, dinner and Spanish interpretation provided, and by different media including meetings, focus groups, via Internet and telephone, and at existing events such as school events, cultural celebrations, etc.).

Air Quality

9. Composting facilities should be sited as near as possible to transfer facilities or landfills to reduce delivery distances and truck emissions.

10. Prior to the construction of a new facility, the cancer risk due to emissions from additional truck transport should be calculated and considered.

11. If mixing compost waste, workers should wear dust masks and eye protection to reduce exposure to organic dust (bioaerosols).

12. The fabric covering on compost piles should be regularly inspected for gaps and tears to ensure its ability to limit emissions and odors.

Water Quality

13. Leachate monitoring is already part of landfill and compost site regulations. In addition t o monitoring, sites should also be required to share findings with the community in proximity to each site to assure the community about the safety of these facilities and groundwater.

14. Promote the use of compost product in agriculture and community landscaping as a strategy to improve water conservation and subsequent cost savings. Require some percent of compost product to be available to nearby residents and disadvantaged communities to assist in the creation of water conserving home gardens.

15. Provide education to individuals using compost product on its water conserving benefits so that water usage can be altered appropriately. Make sure education to community members is written at a low-literacy level and provided in appropriate languages.

Stress/Mental Health

Employment:

16. To be eligible for state funding, new ASP facilities should provide benefits to all employees (health insurance and paid sick days) to all employees.

17. Prioritize funding ASP facilities that propose hiring local residents who live near proposed facility sites.

Food Security:

18. Encourage new facilities to include a food rescue program as part of facility operations. Prioritize integration of food diversion into CalRecycle grant programs.

Odor and Noise:

19. Handle all municipal solid waste inside the building to reduce odor and noise in neighboring communities.

20. Process all organic material into the covered composting system or off site as soon as possible (i.e., within 48 hours).

21. Develop communication protocols with nearby communities to assess and mitigate odor and noise problems as they arise.

22. Incentivize the purchase of low-noise machinery in a noise–sensitive area such as residences, schools, churches, hospitals, etc,

Agricultural Practices

23. CalRecycle should assess the feasibility of requiring testing for adhesives, paints, and solvents, dioxins/furans, PCBs, PAHS, pesticides and pharmaceuticals in finished compost, and, if detected, develop a regulatory standard governing levels of these compounds.

24. As compost destined for certified organic producers is held to a higher standard than other compost, consider requiring all compost facilities to meet organic standards for all finished compost that may be applied to agriculture or to home or commercial gardens.

25. As use of composted municipal solid waste is generally considered safe for agricultural or home garden use, and application of compost may displace or reduce chemical pesticide or fertilizer use, and thus pose lower health risks to farmers, gardeners and consumers, guidelines or programs should be established so that residents in the vicinity of the compost facilities enjoy the benefit of the finished compost. Examples of such guidelines include requirements for facilities to offer free compost to residents of the zip code in which the facility is located.

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