Attachment E
Technical Evaluation of the Waste Management Sector Plan (June 12, 2013 Version) and Landfilling of Waste Technical Paper (draft June 12, 2013)

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July 12, 2013

1 INTRODUCTION

The Solid Waste Industry for Climate Solutions (SWICS) reviewed CalRecycle's, "Overview of the Waste Management Sector Plan," (Overview) which includes Appendix A: Landfilling of Waste Technical Paper (draft June 18, 2013) and Appendix C: Implementation Plan The agency documents were prepared pursuant to Assembly Bill (AB) 341 and the 2013 AB32 Scoping Plan Update. The documents were presented by CalRecycle and California ARB at the Waste Management Sector Plan Workshop held June 18, 2013[1].

This document provides our initial comments on the Overview and comments on the Landfilling of Waste. Comments on each document are then organized by subject. SWICS may revise this technical paper depending on agency revisions and or additional technical information.

2 OVERVIEW OF WASTE MANAGEMENT SECTOR PLAN

The purpose of the Overview is to "provide guidance and recommendations for developing a Waste Sector Plan for achieving California's GHG and waste reduction goals. It also serves to inform the Waste Sector Element of the 2013 Scoping Plan Update"[2]SWICS believes that a measured approach should be used in evaluating the waste management sector, under AB32, consistent with California Air Resources Board (CARB) Resolutions 11-32 and 12-33. CARB staff is directed under these resolutions to characterize the industry, with consultation of all stakeholders, by lifecycle methods, and ensure "equitable" treatment of all sectors. SWICS is particularly concerned with the proposal to include the waste sector in the Cap-and-Trade program. We believe the supporting information used by the agency is significantly flawed, inconsistent with Board Resolutions and failed to consider other publicly available data.

The Overview does not take a measured approach. It proposes to include the waste sector, including landfills, in the Cap-and-Trade program subject to the reporting and compliance provisions of the program if progress is not made on implementation of AB341. This approach is not consistent with the Board Resolutions that require the industry be evaluated using life cycle approaches. SWICS finds this proposal to include any part of the waste industry, especially landfills, in the Cap-and-Trade program problematic for many reasons.

- First, landfills are an essential public service with little ability to control the amount of waste they must accept. It is important to recognize that landfills only accept those materials that are not economically feasible to reuse, recover or recycle. Once a material becomes economically feasible to reuse, recover or recycling it will no longer by landfilled.
- Second, the imposition of a cap on emissions after reductions have been achieved through both voluntary and regulatory actions unfairly disadvantages landfills in the greenhouse gas (GHG) allowance market. With the adoption of the early action measure to reduce landfill methane emissions, landfills can do little else to reduce emissions, so would have no choice but to close or buy allowances.

[1] http://www.calrecycle.ca.gov/Actions/Documents/77/20132013/900/Agenda.pdf

[2] CalRecycle, "Overview of the Waste Management Sector Plan", June 18, 2013 (draft)

- Third, CalRecycle uses inconsistent comparisons of direct emissions to lifecycle emissions and reporting boundaries which affect the conclusions drawn.
- Finally, and probably the most important, establishing a cap that is based on emissions estimates that cannot accurately be quantified or verified due to their inherently fugitive nature will lead to an unverifiable sector in the GHG reporting program and introduce an unquantifiable pool of emissions to the market.

Below is a very detailed discussion of issues associated with including the waste sector in Cap-and-Trade and an overview of our concerns with the Waste Management Sector Pan review of the waste sector.

2.1 LANDFILLS ARE AN ESSENTIAL PUBLIC SERVICE

Essential public services such as landfills, wastewater treatment plants (WWTP), schools, and hospitals should be excluded from any discussion of Cap-and-Trade under the proposed Scoping Plan Update. Emissions generated by these facilities are tied to population and economic factors that are out of the facility's control to regulate and/or reduce. Specific to landfills, an increase in population will generally result in an increase in the disposed waste stream, which will result in an increase of landfill gas (LFG) generated and ultimately emitted from the landfill. Similar to WWTPs, landfills are mandated by law to accept the waste delivered to it by its customers. And similar to WWTPs, landfills should be excluded from consideration for Cap-and-Trade in the Scoping Plan Update. The CARB recognizes that WWTPs are not viable for Cap-and-Trade, and must be able to manage the amount of wastewater generated and discharged by the communities served. Landfills should be treated no differently. This conclusion was also reached when the South Coast Air Quality Management District (SCAQMD) enacted its Regional Clean Air Incentives Market (RECLAIM) emissions trading program; here, essential public services were excluded. Offset exemptions are provided in many air districts for essential public services, including landfills.

An important distinction with landfills as an essential public service is that in California, landfills receive waste typically after it has gone through some form of recycling that is governed by regulation or in the case of AB341, a policy goal. These regulations that govern recycling and reuse are substantial and increasing, so there is no need to "fix" the system by instituting a cap and trade program.

For essential services with a biogenic component related to LFG collection and destruction, the only proven method to reduce GHG emission would be to close down the facility to stop processing and disposing of waste. Closure would reduce the emissions from the facility, but in truth it would not create an overall GHG emission decrease. The generated waste must be disposed or managed, so it would be accepted at another facility at which emissions would continue to be generated. Landfills and sewer plants do not generate the waste they receive and manage; these wastes are generated by others. Unless the landfill itself is the waste generator, they have very little control of the wastes they legally receive.

For an active landfill, methane generation increases over time as the landfill remains open, meaning a landfill which is open and receiving any decomposable waste will continue to generate more methane, even if that waste stream decreases due to diversion. Thus, the only way to achieve reductions to comply with the cap for a landfill already subject to stringent control

regulations would be to close and stop accepting waste or purchase expensive allowances or offsets. This seems patently unfair for an industry whose GHG emissions are already below 1990 levels and are expected to go even lower with the implementation of the AB32 Landfill Methane Rule (LMR).

With regard to economic factors, the principal responsibility for a landfill's compliance with Cap-and-Trade would fall on the owner of the regulated facilities; namely the landfill owners. Thus, the cost of a proposed emissions cap and compliance offset obligation would be passed down from the facility to the community in the form of increased disposal fees or higher costs for alternative waste management options. With landfills under Cap-and-Trade, waste management costs will increase regardless of what is actually done with the waste. In a time when municipalities are struggling with budgets, it is not rational to increase cost unnecessarily. As previously stated, in place regulations in California are driving recycling and reuse in a matter that is reasonable, allowing cost to increase in a measured manner.

2.2 LANDFILL EMISSION INVENTORY TRENDS

Landfills have had a series of Command and Control regulations imposed on them, including the New Source Performance Standards (NSPS) for landfills[3] and the LMR as well as various air district regulations. The U.S. Environmental Protection Agency (EPA) is currently in the process of revising the NSPS, and it is expected to further reduce methane emissions from landfills. The LMR, CARB adopted the AB32 early action measure, is a command and control regulation designed at reducing the emissions from landfills via implementation of stringent monitoring and associated low emissions thresholds. It was always the understanding with CARB staff that this measure would be in lieu of inclusion in Cap-and-Trade program, since GHG reductions in this sector is best accomplished through a command and control regulation strategy. The industry negotiated the LMR with CARB in good faith that the regulation would eliminate the need to include landfills in Cap-and-Trade. The Cap-and-Trade program is customized for incentivizing emissions reductions via purchase of offset obligations. To date, the implementation of command and control regulation has been separate from a Cap-and-Trade program. The Overview would reverse the policy of compounding regulations by proposing that landfills should be subject to both.

Landfills are already a relatively small source of GHG emissions in California. Before the implementation of LMR, landfills accounted for approximately 1.5 percent of statewide GHG emissions. With complete implementation of the LMR and the enhanced methane collection required by the regulation, landfill GHG emissions should decrease further in California. Landfill GHG emissions are dwarfed by other industrial sectors, including refineries, oil and gas, livestock, and farming. Of these sectors, it is the only sector with long term, sustainable GHG emission reductions.

2.2.1 LANDFILL EMISSION REDUCTIONS

The Overview overlooks the fact that the waste and recycling sector is the only industry sector to have reduced emissions from 1990 levels. It is important to recognize that the solid waste industry as a whole represents a very small percentage of total GHG emissions both nationwide

[3] 40 CFR Part 60 Subpart WWW

and within California. The EPA estimates that GHG emissions from landfills are less than two percent of total GHG emissions in the United States[4]. Even that fraction may be an overestimate, in part because of the historical overstatement of fugitive LFG emissions, the lack of consistent recognition of landfills as carbon storage sinks that effectively reduce carbon dioxide (CO_2) emissions, the underrepresentation of methane oxidation in cover soils, and the failure by many analyses to recognize the GHG reduction benefits on a lifecycle basis.

Historical reductions by the solid waste and recycling sector have been significant. An analysis conducted using EPA's Decision Support Tool[5], estimated that the actual level of GHG emission produced by the solid waste management and recycling sector is about 25% of the levels emitted 30 years ago and less than 20% of what would have been emitted if waste management practices had continued along the 1974 technology path. The solid waste industry is the only major industry sector with declining GHG emissions since 1990, despite increases in waste disposal. A summary of GHG reductions accomplished by the waste sector prepared by the National Solid Waste Management Association (NSWMA) is provided in **Attachment C**.

By EPA statistics, landfills have reduced GHG emissions by 27% between 1990 and 2010.[6] This reduction occurred despite the sector managing 24% more refuse since 1970. No other industries can demonstrate similar GHG reductions despite increases in production and throughput over this time period.

The 2050 goal of a 25 percent reduction of direct emissions from 2035 levels inappropriately focuses largely on reductions from landfills, a sector which has already reduced GHG emissions. By stipulating that only direct GHG emissions are a component of the 2050 goal and by neglecting direct emissions from composting, anaerobic digestion (AD), and other alternative waste management technologies, CalRecycle has effectively singled out landfills for further reductions and left other technologies untouched.

2.2.2 COMMAND AND CONTROL WITH CAP AND TRADE

In addition, it is not clear in the documents the levels of baseline estimates to be established for landfills in relation to an emissions cap. Landfills are one of the only sectors to successfully achieve reductions from the 1990 baseline.[7] Landfills have already met an emissions reduction goal that would be determined based on 1990 emission levels. Further, setting an emissions cap based on more recent, post-regulation emissions levels would be both unfair and potentially unobtainable for an industry that has already reduced its emissions significantly, as have landfills.

The Overview's reasoning is even more flawed when it concludes that a cap and trade program should be imposed on landfills in 2020-2035. The logic behind cap and trade is based on a belief

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[4] http://www.epa.gov/climatechange/ghgemissions/gases/ch4.html

[5] Weitz, Keith A., et al. (September 2002). *The Importance of Municipal Solid Waste Management on Greenhouse Gas Emissions in the United States*.

[6] http://epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2012-Chapter-8-Waste.pdf

[7] ARB Emissions Inventory- Landfills Scoping Plan Category (6.256 MMTCO2e 1990; 6.70 MMTCO2e 2010) (http://www.arb.ca.gov/cc/inventory/inventory.htm)

that the marketplace can drive GHG emissions reductions. GHG allowances are provided to generators who effectively find the most cost effective sources of GHG reduction. However, the GHG marketplace does not function if the baseline for GHG reductions is artificially lowered by Command and Control regulations.

2.3 EMISSION BOUNDARIES/LIFECYCLE AND DIRECT EMISSIONS

The Overview and supporting documents frequently transition between statements of lifecycle emissions and direct emissions, but the documents never make any distinction between the two. In fact, CalRecycle implies that it is possible for the solid waste sector to have emissions less than zero and states this as the goal for 2050. The goal indicates CalRecycle may not understand either the difference between direct emissions and lifecycle emissions or how the annual statewide GHG inventory is calculated. CalRecycle implies that GHG emission reductions can come from alternative waste management options for organic waste, including AD and composting, states the expected emission reductions associated with these disposal options. However, the emission reductions claimed by CalRecycle, including reduced water and fertilizer use, would never be included in the waste sector emissions by the CARB GHG inventory because they rely on reductions in unrelated industries not under the operational control of the solid waste sector.

2.3.1 EMISSION BOUNDARIES

The Overview and supporting documents use inconsistent boundaries when evaluating GHG emissions from waste disposal options. By way of example, one of the components overlooked in the evaluation of landfilling in the Overview and supporting documents is the fact that landfills are carbon sinks due to carbon storage of sequestered organic carbon in the form of primarily woody wastes that contain cellulose, hemi-cellulose and lignins. On the other hand, the supporting documentation does consider carbon storage in compost[8]. The supporting documentation describes the GHG reduction calculation boundaries for composting to include reduced emissions from several impacts of composting. Some of these impacts are secondary impacts, while others are separated from the composting by several degrees. The effects included in evaluating composting include decreased water use, decreased soil erosion, reduced fertilizer use, and reduced herbicide use, as well as carbon storage. Greenhouse reductions associated with these indirect consequences are likely to be tabulated and accounted by others. Decreased water use means decreased demand for electricity or fuels to pump and treat the water. Those reductions will be accounted in the electrical or fuel sectors, not the composting sector.

While it may be appropriate to include these factors in a lifecycle analysis of waste stream emissions, CalRecycle cannot be inconsistent in application. Such indirect factors must be included for all management options to be accurate and representative. Unfortunately, the documents are inconsistent.

Furthermore, these boundaries are not appropriate considerations in the scope of a Cap-and-Trade evaluation discussion. Cap-and-Trade considers direct emissions from a facility or entity.

[8] Method for Estimating Greenhouse Gas Emission Reductions from Compost from Commercial Organic Waste (CARB, 2011)

As such, indirect emissions and reductions, such as reduced water or fertilizer use, should not be considered. The reduced emissions from these sectors should be attributed to the associated sectors (agricultural and fertilizer manufacturing) and not composting or other indirectly associated waste management options. However, carbon storage is a direct emission offset. Therefore, carbon storage in landfills or the carbon stored in compost would be an appropriate consideration for a Cap-and-Trade discussion, because that reduction is directly associated with the waste management facility.

The Overview's goal of a net-zero waste sector is not a realistic goal unless the inventory boundaries include either carbon storage or indirect impacts that would be reported under other sectors of the California GHG inventory. In addition, it is not appropriate to propose this goal without developing a baseline of where we are today and what boundaries are to be used. CARB/CalRecycle should develop a comprehensive life cycle analysis to figure out the industry's net emissions. Then, and only then, can future goals be evaluated. The 2050 goal of a 25 percent reduction from this net-zero emission level requires that indirect reductions and carbon storage be considered in the evaluation. If indirect GHG reductions are to be considered, those impacts should be set up similarly for all waste management sections. The most appropriate indirect reductions to consider are electricity generation from LFG and AD biogas to energy benefits, where the beneficial product (renewable energy) is created at the facility itself.

2.3.2 LIFECYCLE AND INVENTORY GHG EMISSIONS

Several times CalRecycle states waste sector emissions based on facility emissions used in the CARB GHG inventory. These landfill emissions are contrasted with reductions from AD and composting. This comparison is inappropriate because it compares direct emissions to lifecycle emissions. Direct emissions are not comparable to lifecycle emissions. Both estimates may be appropriate to separately evaluate GHG emissions, but direct and lifecycle emissions are not directly comparable. Direct emissions include only what is emitted to the atmosphere from a facility itself, while lifecycle emissions include related emission changes which can occur several degrees of separation from the emitter, in different sectors or even different states or countries.

The Overview uses shifting GHG analyses throughout its discussion and evaluation of waste industry GHG emissions. The Landfilling of Waste document incorporated into the Overview states that the solid waste sector accounts for one percent of California's GHG emissions. This value is based on direct emissions from solid waste facilities. Similarly, facility emissions presumably would be the GHG inventory reported to CARB and the basis for a Cap-and-Trade obligation. This facility-based reporting differs significantly from the GHG reduction estimation methodologies used in the evaluation of AD and composting, where emissions from off-facility sources is included among the reductions. The indirect emission reductions included in the AD and compost evaluations would include some emission reductions from facilities either outside of California or already subject to Cap-and-Trade, and it is not appropriate to include those indirect reductions in the discussion of reductions from alternative technologies without first determining whether those emissions would occur outside of California or if they are already included in Cap-and-Trade. We are simply requesting that all of these sources of emissions be treated equally from a technical perspective.

2.4 INCONSISTENT EVALUATION OF WASTE HANDLING OPTIONS

SWICS recommends that it would be appropriate to provide a consistent evaluation of all waste handling options (including solid waste thermal technologies) including all of the benefits and negative impacts of each. At the very least, the evaluation should establish the same boundaries for each process. This approach would be consistent with CARB Board direction that requires life cycle approaches to the evaluation.

2.4.1 CARBON STORAGE

In addition to the minimal GHG emissions from landfills, carbon is stored in the anaerobic environment of a landfill and a significant portion of the carbon content is prevented from forming and emitting CO_2. Landfill storage of carbon reduces the amount of biogenic CO_2 that would have otherwise been emitted. In the waste and recycling sector, storage of carbon can be maximized by state-of-the-art landfilling and storage of soil carbon using composting. The amount of landfill-stored carbon each year can help offset the fugitive methane emissions from landfills as discussed in the attached document[9]. Carbon storage makes landfilling a way to help reduce carbon and should be included as a component of the evaluation of landfilling as a waste handling solution.

The Overview overlooks the fact that a significant amount of carbon is removed from the carbon cycle during landfilling. In this manner, landfills functions as a carbon sink. The impact of storage of carbon within landfills should also be included the evaluation. This carbon storage can help to offset the landfill GHG emissions to achieve a net-zero emissions. Inclusion of this sink is appropriate since it occurs at the landfills themselves rather than as a secondary or tertiary, as in the case of reduced water or fertilizer use from composting which was included in the evaluation. Also, carbon storage in applied compost is included in the calculation of GHG benefit.

2.5 LANDFILL EMISSIONS IN CAP AND TRADE

CalRecycle gives no consideration of the challenges that would be involved in integrating landfills into the Cap-and-Trade program. The Cap-and-Trade program relies on the markets confidence that reported emissions are accurate and verifiable. The primary source of GHG emissions at landfills is fugitive methane which cannot be accurately measured or reported.

An emissions cap is an enforceable limit on the amount of emissions a facility can release. Mass emissions must be measurable for each facility subject to Cap and Trade requirements. There are currently no measurement tools or methodologies that can accurately establish an enforceable emissions cap for a landfill or consistently measure landfill emissions to determine compliance with the cap. Landfill emissions do not meet these basic rules of Cap and Trade.

CARB has established a rigorous system of facility based GHG reporting and verification. Under the CARB program, a reporter must have emissions verified by a third-party verifier annually to

[9] Freed, R. et al (2007, October 10). *Landfill Carbon Storage and Greenhouse Gas Inventories*, White Paper

confirm that reported emissions meet the accuracy requirements of the CARB regulation. Verification is accomplished by reviewing fuel purchase information, meter calibration data, electricity transaction records, and similar documentation. The type of documentation required by the verification process does not exist for fugitive landfill emissions.

Existing GHG reporting methodologies for landfills utilize either a waste decomposition model and subtracted collected methane to determine fugitive methane, or estimate the collection efficiency at a site and calculate methane generation based on methane recovery. These methods can result in emissions that differ by orders of magnitude and could never meet the five percent accuracy requirement of other reporters in the CARB Cap-and-Trade program. Adding this unknown quantity of emissions to the existing market will be disruptive to the system. Furthermore, the cost of Cap-and-Trade is not justified for landfills when **the fugitive methane emissions from landfills contribute merely one to two percent of California's total GHG emissions.**

3 LANDFILLING OF WASTE

As stated in the draft technical paper, the primary focus is to "identify opportunities, challenges, and potential solutions to achieve greenhouse gas (GHG) and co-pollutant reductions from landfills"[10] The technical paper acknowledges that fugitive methane emissions from landfills account for between one and two percent of California's total GHG emissions. The CalRecycle evaluation of the GHG emissions from the landfilling of waste includes several assertions that are thinly sourced or without stated basis.

3.1 EMISSIONS AND RECENT REDUCTIONS

In its evaluation of GHG and co-pollutants, CalRecycle reaches to the conclusion that organic material diversion will reduce methane emissions. The discussion minimizes the fact that improved LFG management procedures, including compliance with the LMR, already have significantly reduced landfill methane emissions. CARB has estimated that the LMR will improve LFG collection from 75 percent to 85 percent in its evaluation and justification of the LMR. CalRecycle cannot simply dismiss CARB's imposition of the strictest methane collection and monitoring requirements in the nation with a single reference to a single LFG emission study. The emissions reductions from the LMR are substantial, and the compliance burden on landfills is high.

3.1.1 LANDFILL EMISSION REDUCTIONS

The Landfilling of Waste Document states that the LMR will reduce GHG emissions from landfills by 1.5 million metric tons of CO_2 equivalent ($MTCO_2e$). This reduction exceeds the goal of 1 million $MTCO_2e$ for reductions in the 2008 Scoping Plan. These reductions are on top of waste sector reductions from 1990 emissions. This reduction makes the solid waste sector the only sector to have reduced emissions from 1990 levels, even before the implementation of the LMR. SWICS agrees that the emissions reductions from the LMR should be evaluated and the cost of the reductions should also be part of the evaluation.

[10] CARB and CalRecycle, Landfilling of Waste, June 18, 2013 (draft).

CalRecycle indicates that landfill emissions will increase from one percent of statewide emissions to two percent when CARB increases the global warming potential (GWP) of methane used in the evaluations. This statement is speculative and misleading. CARB has not indicated that it has any plans to change the GWP for methane. In fact, such a change would disrupt the infant allowance market that is a critical part of the Cap-and-Trade program. The statement implies that landfill emissions are actually twice the value reported in the CARB inventory, but the change is really a rounding difference creating the illusion that landfills are twice the GHG emitter that they are reported. The actual increase, in the speculative even that CARB were to adopt the higher GWP, is only 20 percent, not 100 percent as the Landfilling of Waste document implies. In addition, SWICS suspects that CARB's methane inventory for landfills has not been adjusted correctly for the recession where solid waste generation and disposal significantly decreased; no associated dip is observed in the inventory.

3.1.2 LANDFILL EMISSION INVENTORY METHODOLGIES

GHG emissions from landfills are substantially overstated by current CARB and CalRecycle analyses. SWICS has done substantial research and development of improved landfill GHG inventory methodologies, including refining collection efficiency estimation, methane oxidation in the landfill cover, and carbon storage estimation[11,12]. This research includes studies of more than 800 measurements from more than 20 sites. As such, it is more comprehensive and representative of overall landfill emissions than the single-site comparison CalRecycle relies on to conclude that landfill emissions are under reported. . If CalRecycle desires to conduct a more comprehensive assessment of LFG collection efficiency, it must review all of the available data and research, particularly those involving direct measurement of California landfills operating under the LMR.

The CARB GHG inventory methodology assumes that sites with LFG collection have a collection efficiency of 75 percent. This 75 percent value has its origin in a 2002 memo prepared for by EPA[13], which later became the basis for the current AP-42 values. However, no quantitative estimates of collection efficiency were generated to support this document. While this judgment may be quite reasonable, it is difficult to defend.

CalRecycle Conclusions about Collection Efficiency

SWICS agrees with CalRecycle when it states that LFG emissions from landfills are difficult to estimate and are based on substantial uncertainty. However, we disagree with CalRecycle when it states that landfill methane emissions may be higher than previously estimated based on an evaluation performed using measurement studies and using the California Landfill Methane Inventory Model (CALMIM). CalRecycle has taken a single report, *Measured and Modeled Methane Emissions at Closed MSW Landfills without Gas Collection* (2012) (Fink Road Report), removed it from all context, and used it to justify sweeping generalizations about landfills in

[11] SWICS, Current MSW Industry Position and State-of-the-Practice on LFG Collection Efficiency, Methane Oxidation, and Carbon Sequestration in Landfills. 2009.

[12] SWICS 2.2 Methane Oxidation Addendum 2012.

[13] *Review of Available Data and Industry Contacts Regarding Landfill Gas Collection Efficiency*, Draft Memorandum to Brian Guzzone, Meg Victor, U.S. EPA, October 24, 2002.

California. In addition, CalRecycle appears to ignore qualifying statements in the CALMIM report that site-specific analysis may show lower emissions and that ongoing research is such that any conclusions in the CALMIM report should be revisited. The Fink Road Report itself contains caveats that the collection efficiencies in the report have significant uncertainty, calls for additional research to understand landfill methane emissions, and the estimations in the paper warrant reevaluation as new studies become available.

The Fink Road Report comparison is based on an evaluation performed on a single landfill. That landfill was not subject to either the NSPS or LMR at the time of the evaluation, thus it was not required to be highly controlled at that time. As such, it only represents a small portion of California landfill emissions, is not representative of post-LMR landfills in California, and should not be used as the basis for such a sweeping statement about LFG capture that would be representative of all California landfills. The site in question (Fink Road Landfill) is now subject to the LMR, including additional LFG capture and monitoring. The pre-LMR Fink Road Landfill is not representative of California landfills after the LMR became effective in California and should not be used to make broad conclusions that all landfills may be emitting more than previously thought. Even if that single site were subject to NSPS and LMR, SWICS would be concerned about the overreliance on a single study to make sweeping generalizations about LFG collection throughout the state, despite numerous other studies showing higher collection efficiencies[14,15].

The collection efficiencies shown in Table 1 of the Fink Road Report include significant periods with no LFG collection. To compare these collection efficiencies to collection efficiencies used in CARB GHG inventory fails to understand that the CARB GHG inventory only assumes LFG collection for sites with LFG collection. CalRecycle is comparing lifecycle collection efficiencies at Fink Road Landfill for periods without LFG collection to collection efficiencies during periods with LFG collection for each given inventory year. This comparison is inherently flawed. For the comparison to be reasonable, CalRecycle must compare collection efficiencies only for periods with LFG collection before concluding that emissions may be higher than estimated. Even if the collection efficiency comparison is done properly, that comparison must include more than a single site and be representative of post LMR sites throughout California.

In the referenced 2012 study, CalRecycle combines the CALMIM results with first order decay (FOD) modeling results in modeling the collection efficiency. The FOD model models methane generation, while CALMIM models methane flux. Those two approaches are fundamentally different. Combining the approaches creates an incongruity in the methane emissions that serves to illustrate how disparate the results can be when combining two fundamentally different approaches[16].

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[14] Goldsmith, C. D., Chanton, J., Abichou, T., Swan, N., Green, R., and Hater, G. (2012). Methane emissions from 20 landfill across the United States using vertical radial plume mapping. Journal of the Air & Waste Management Association, 62(2):183-197.

[15] Shan, et al. Estimation Of Landfill Gas Emissions And Collection System Efficiency Using Surface Flux Chamber Technology -- A Case Study Of Puente Hills Landfill. Solid Waste Management Department, Los Angeles County Sanitation Districts. 2012.

[16] Comments on the CalRecycle Review of Waste-to-energy and Avoided Landfill Methane Emission Report. Roger Green, Jean Bogner, and Morton Barlaz.

The FOD methodology was developed as a simple uniform methodology for estimating national emissions in both developed and developing countries for Intergovernmental Panel on Climate Change (IPCC) reporting. When applied to a specific site, FOD model parameters (L_0 and k) need to be calibrated for that specific site to reduce the very high uncertainties associated with the method[17]. The FOD model used in the Fink Road Report uses a single value for the methane generation potential (L_0 or degradable organic carbon [DOC]) and decay rate constant (k). The standard practice, including the IPCC and EPA Mandatory Reporting Rule (MRR) modeling approaches, includes a multi-phase gas generation model with multiple L_0 and k values. This calibration was not done for the Fink Road Report.

The Fink Road Report references studies performed at three North Carolina landfills to assess landfill emissions in California. These landfills have significant differences from most California landfills and should not be used to draw inferences about California landfills. The three North Carolina landfills are wet climates, which have significantly higher rates of waste decomposition than most California landfills. Further, inclusion of the EPA report results artificially lowers the collection efficiency and increases the estimated emissions primarily due to one test at Landfill B which the EPA report mentions was poorly operating and that the site upgraded the gas collection and control system after the field study. Most California landfills are arid and produce methane at approximately a third of the rate of the North Carolina landfills. Furthermore, North Carolina landfills do not have to meet strict LMR methane monitoring and collection requirements.

The Fink Road Report notes one study of California showing methane abatement efficiencies of 81 to 92 percent[18], and another with flux measurements from five California landfills[19], but the Landfilling of Waste Document ignores these reports showing high collection efficiencies and low fluxes at California landfills to draw a contrary conclusion, which relies on only modeled emissions and unrepresentative sites. Given the availability of reports using methane measurements in California, it is inappropriate to rely on a single report developed using modeled methane emission rates as the basis for sweeping generalizations about the methane emissions from California landfills.

It is not appropriate to draw conclusions about the collection efficiencies of landfills statewide based on modeled emissions and collection efficiencies when measured data are readily available. While SWICS believes CALMIM may be an improvement over old default collection efficiency based or FOD models, it is still only a model and should not be used in place of actual methane emission measurements.

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[17] Intergovernmental Panel on Climate Change (IPCC) (2006), IPCC Guidelines for National Greenhouse Gas Inventories, Hayama, Japan. [Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/.]

[18] Green, Roger, Hater, Gary, Goldsmith, C. Douglas, Chanton, Jeffrey, Swan, Nathan, Abichou, Tarek. (2009). Estimates of Methane Emissions from Three California Landfills using Two Measurement Approaches. Extended Abstract # 89 Journal of the Air & Waste Management Association (A&WMA) First International Greenhouse Gas Measurement Symposium held March 22-25, 2009 in San Francisco, CA.

[19] Goldsmith, C. D., Chanton, J., Abichou, T., Swan, N., Green, R., and Hater, G. (2012). Methane emissions from 20 landfill across the United States using vertical radial plume mapping. Journal of the Air & Waste Management Association, 62(2):183-197.

SWICS Method and Methodology Improvements

The SWICS method for collection efficiency is dependent on the site cover, LFG collection system coverage, and collection system effectiveness to estimate LFG collection. SWICS proposes to use the weighted collection efficiency for sites with LFG collection per the SWICS guidance as a means to assess the site-specific collection efficiency. This methodology has the advantage of allowing sites with good LFG collection practices to consider those practices and show resulting lower GHG emissions. The current CARB inventory practice of assuming a default collection efficiency actually hurts sites which improve gas collection and increase the amount of methane recovered. For sites in compliance with the LMR in California, the SWICS guidance would show site-specific collection efficiency ranging from 70 to 95 percent for an active site, and possibly greater than 95 percent for a closed landfill with final cover. This high collection efficiency is supported by the technical literature and CARB's own analysis for implementation of the LMR[20].

Previously, a default methane oxidation value of 10 percent in landfill cover has been used for all sites, regardless of methane flux or type of cover. The 10 percent value was first proposed at an IPCC workshop in Washington, DC in 1995. At an internationally attended meeting in Chicago in 1997, it was agreed to use 10 percent as a standard value. The results of the comprehensive studies, which had been conducted in New Hampshire, were just becoming widely disseminated. The earliest government document referring to 10 percent value for landfill methane oxidation is EPA's *Greenhouse Gas Emissions from Management of Selected Materials in Municipal Solid Waste* (1998), in which the EPA cites the New Hampshire studies and included seasonally averaged annual values of 10 percent methane oxidation. Due to the uncertainty involved and the lack of a standard method for the determination of oxidation rate, the EPA recommended the default factor of 10 percent methane oxidation for landfill cover soils.

It is critical to note that the New Hampshire studies were conducted at a landfill with no gas collection that was rather poorly maintained. According to Czepiel[21], "no landfill gas control systems were in place at the time of sampling." The site was characterized by "sparse or dead surface vegetation (which) was a reliable visual indicator of significant localized CH_4 emissions." "Erosion and slumping of the cover material along the south edge of the MSW landfill has exposed a section of waste approximately 2m high and 10 m long." Substantial research has been done since the Czepiel studies, and SWICS has compiled the data to demonstrate that methane oxidation is substantially higher than 10 percent in almost all cases. The adoption of the 10 percent default value based on a very limited number of studies highlights the danger of drawing sweeping conclusions from a very limited number of studies, as CalRecycle attempts to do with the CALMIM comparison at Fink Road Landfill.

SWICS also proposes the use of methane flux rate in the landfill surface to determine the methane oxidation rate in the landfill cover. This flux-based approach has similarities with the approach used by the CALMIM model, but has the advantage of transparency and simplicity for

[20] SWICS, Current MSW Industry Position and State-of-the-Practice on LFG Collection Efficiency, Methane Oxidation, and Carbon Sequestration in Landfills. 2009.

[21] Czepiel, P.M., Mosher, B., Harriss, R.C., Shorter, J.H., McManus, J.B., Kolb, C.E., Alwine, E., and Lamb, B.K. 1996. Landfill methane emissions measured by enclosure and atmospheric tracer methods. J. Geophysical Research 101:16711-16719

individual site inventories. This approach represents a substantial improvement in the accuracy of GHG emission calculations from landfills.

Using the SWICS method, sites calculate the methane flux through the landfill cover then assign an oxidation rate based on the flux. Facilities with high flux (greater than 70 grams per square meter per day [$g/m^2/day$]) would use an oxidation rate of 12.4 percent. Sites with low flux (less than 10 $g/m^2/day$) would use an oxidation rate of 38.4 percent. Sites with moderate flux would use an oxidation rate of 27.4 percent. Note that the low oxidation value of 12.4 percent is consistent with the oxidation rate from the Czepiel studies. The EPA has indicated that it intends to use this flux-based oxidation rate approach in its proposed changes to its Mandatory GHG Reporting Rule (MRR)[22] which would include oxidation rates of up to 35 percent. This more accurate methane oxidation value will result in a significant reduction in calculated landfill methane emissions and increase the accuracy of the reported emissions. Clearly the 10 percent value is outdated, inaccurate, and should no longer be used. The EPA has recognized this in their recent draft rulemaking on the federal GHG MRR.

Thus, contrary to CalRecycle assertions that methane emissions from landfills may be higher than previously thought, based on the CALMIM evaluation of one landfill, the preponderance of data that has been collected in recent years suggests that landfill GHG emissions have been overestimated. Landfill GHG emissions, are likely lower than previously thought.

3.2 LIFECYCLE AND DIRECT EMISSIONS/INVENTORY BOUNDARIES

SWICS agrees with CalRecycle that Landfill Gas to Energy (LFGTE) uses should be promoted. LFG can be combusted in engines or turbines for energy recovery and provide electricity to the grid without the combustion of fossil fuels. Other states allow the injection of treated LFG to natural gas pipelines, displacing natural gas use. LFG can also be treated to generate liquid natural gas (LNG) or compressed natural gas (CNG) for vehicles and other uses. CalRecycle correctly notes that a significant reduction in the organic material landfilled would adversely impact beneficial LFG use projects, but then states that "reducing the amount of organic waste being landfilled would also result in significant GHG reductions" without providing a basis for the sweeping statement or consideration of the secondary benefits from beneficial use of the LFG. The evaluation of emissions from landfilled waste used by CalRecycle does not factor in energy generation benefit from LFG, while they do include indirect benefits from composting and AD. The boundaries that include indirect benefits for composting and AD but not landfills cannot provide a reasonable basis for comparing overall GHG emissions.

The statement that more markets for recycled, reprocessed, and remanufactured goods are needed within California to achieve GHG and waste reduction goals presupposes that the reduced emissions come from California. California imports a significant amount of manufactured goods, and the emissions from the manufacture of those goods would not be included in the California GHG emission inventory. Reduced GHG emissions are an overall

[22] USEPA 2013. 2013 Revisions to the Greenhouse Gas Reporting Rule and Proposed Confidentiality Determinations for New or Substantially Revised Data Elements Docket No. EPA-HQ-OAR-2012-0934.

positive, but it is not appropriate to claim such emissions as part of the reductions to California's GHG inventory. Those reduced emissions would not be assigned to the solid waste sector under any existing GHG inventory methodology used by the IPCC, EPA, or CARB.

3.3 OTHER COMMENTS

The Landfilling of Waste evaluation states that "LFG that is not captured, combusted, or treated in controlled systems can either be released into the atmosphere as fugitive emissions or migrate underground to cause groundwater contamination, explosive gas hazards in structures and utilities, or adversely impact nearby agricultural crops." While most of this statement is technically true, it misses an important fact. LFG impacts on groundwater and as an explosive hazard are already significantly mitigated through existing monitoring and LFG control measures. The statement that LFG impacts agricultural crops appears without basis and is not considered to be a significant impact of LFG. LFG impacts on crops are regulated and mitigated by existing LFG migration monitoring and mitigation requirements and no documentation has been provided which demonstrates that LFG has impacts on crops. Finally, none of these impacts have any impact on GHG emissions from landfills.

CalRecycle notes that landfills are allowed by law to remove a LFG collection system 15 years after site closure, but for most California landfills, this timeframe will be significantly longer. SWICS notes that while that is the statutory minimum post-closure period, there are several factors that can require the collection of LFG for a period significantly greater than 15 years. Command and control regulations, such as LMR, will not allow landfill to "time out" on compliance, unless emissions are low enough that they do not exceed surface emissions thresholds. No landfill will be allowed to decommission their GCCS unless they can meet this standard. SWICS understands this requirement to be one of the primary sources of GHG reductions attributed to LMR.

In addition, the documents misrepresent regulations of surface emissions covered by the LMR. CalRecycle's discussion of the need for a more stringent surface standard discussion fails to take note that in fact CARB determined the instantaneous standard of 500 parts per million (ppm) limit should remain due to concern that a lower standard could lead to landfill fires. This was not a case of a standard being made less stringent; rather it was a case of leaving an existing standard in place to avoid adverse consequences. Beyond the instantaneous standard, landfills also have had to implement integrated surface emissions monitoring (SEM) at a 25 ppm standard, which added stringent requirements and expense to LMR compliance. CARB indicated that the integrated standard was a better and more comprehensive standard than changing the instantaneous standard, so it is misleading to state that landfills somehow received a less stringent standard. Furthermore, there is no basis to support the assertion that a lower instantaneous monitoring standard will result in lower emissions than the current combination of the 500 ppm instantaneous standard and the 25 ppm integrated standard. Instead, the current standard in the LMR was as strict and more appropriate. It is equally important to recognize that the LMR SEM standard is more stringent than surface monitoring regulations anywhere in the United States.

4 SUMMARY

In conclusion, SWICS has many significant concerns with the Overview and the underlying documents. These concerns need to be addressed before the Overview or the Landfilling of Waste documents should be used to develop policy.

CalRecycle must clearly define the boundaries of the analysis before making any comparisons between waste management options. Lifecycle emissions and direct emissions are not directly comparable, as CalRecycle has attempted to do. Similarly, lifecycle collection efficiency is not comparable to annual collection efficiency. CalRecycle must establish justification for the inclusion of indirect GHG emission reductions within the solid waste sector before claiming those reductions. Once that justification is established, the boundaries must be applied similarly for all waste management options. These boundaries should include carbon storage for landfills as well as composting.

CalRecycle should consider the steps the solid waste industry has taken toward GHG reductions already. The solid waste industry has lowered GHG emissions from 1990 levels despite increased waste generation. The recent implementation of the LMR is expected to drive solid waste industry emissions down further, exceeding initial GHG reduction goals for the Early Action Measure.

The CalRecycle documents fail to consider the implications of bringing landfills into a Cap-and-Trade program. Adding a source category to the Cap-and-Trade program after GHG emission reductions have already been reduced through command and control regulations like the NSPS and LMR puts that category at a competitive market advantage and defeats the purpose of using a Cap-and-Trade program to achieve GHG reductions. Furthermore, it does not appear that CalRecycle has considered the implications of bringing in a source category with unverifiable fugitive emissions.

CalRecycle must evaluate all impacts from all waste management options in a comprehensive life cycle analysis, consistent with the direction provided in CARB Board Resolutions. The Overview omits adverse impacts from composting and AD but neglects discussion of the financial impacts on residents and landfill owners of bringing landfills into Cap-and-Trade or requiring additional diversion of organic waste.

Before establishing goals of net zero GHG emissions by specific time, a comprehensive life cycle analysis should be performed to determine the baseline net waste sector GHG emissions.

Finally, CalRecycle must consider all available data before making sweeping statements. In basing broad statements about landfill collection efficiency on the Fink Road Report, CalRecycle is removing the report from its original context and relying on a single data point to make broad claims about all California landfills. The error in relying on a single data point is especially egregious given the availability of research measuring emissions from California landfills.

SWICS hopes that a revised Overview can provide a more comprehensive picture of solid waste industry GHG emissions that can be used to meet California's GHG reduction goals.