September 27, 2011

Clerk of the Board
Air Resources Board
1001 I Street
Sacramento, California 95814

Re: Comment Letter on September 2011 Amendments to the Cap & Trade Program Regulation

Via Electronic submittal: http://www.arb.ca.gov/lispub/comm/bclist.php

To Whom It May Concern:

Covanta Energy submits these comments on the California Air Resources Board ("CARB") Proposed Regulation to Implement the California Cap-and-Trade ("C&T") Program (released July 27, 2011). Covanta Energy is a national leader in developing, owning and operating facilities that convert municipal solid waste ("MSW") into renewable energy (energy from waste or "EfW" facilities). EfW or waste to energy ("WTE") facilities provide important waste disposal services to municipalities seeking to avoid or minimize use of landfills, while using MSW as a fuel source for generating renewable energy.

Covanta Energy supports the goals of AB 32 and the efforts to reduce GHG in California; however, we propose that treatment of EfW as a carbon source with its GHG impact determined solely by stack emissions, regardless of the benefit of reduced methane emissions realized by keeping waste out of landfills, is factually incorrect. EfW avoids emissions from landfills, an uncapped sector, resulting in net negative emissions. Without a mechanism to recognize the benefits of EfW, there will be a leakage of GHG emissions to an uncapped sector.

CARB originally agreed with this position after an extensive review of a model developed by the EfW industry (Industry Model) that used CARB's own default values in the 1st order decay model, the most widely used and accepted model, including by CARB, for modeling methane generation and emissions at a landfill. There has been a change in CARB's position based on new assumptions that, quite frankly, have never been proven and assume optimum performance at a landfill for a 90 to 260 year period.

CARB's new conclusion is in stark contrast to the widespread recognition of EfW as a tool to reduce GHG emissions from waste management by the U.S. EPA[1], U.S. EPA scientists,[2] the Intergovernmental Panel on Climate Change ("IPCC"),[3] the World Economic Forum,[4] the European Union,[5,6] and other researchers.[7,8] EfW facilities in developing countries have been approved to generate carbon offset credits under the Kyoto Protocol's Clean Development Mechanism.[9] Here in the U.S., the Lee County facility in Florida has been selling offset credits for over two years under the Verified Carbon Standard ("VCS").[10] The Hillsborough County facility has also been recently validated as a carbon offset project. In California, a recent report prepared for the CIWMB (now CalRecycle), outlined a minimum GHG emissions scenario which relied, in part, on expanded EfW.[11] CARB recognized avoided GHG emissions of 1,200 to 1,700 lb $CO_2e$ / MWh, including avoided landfill methane, in its environmental analysis supporting documentation for the RES.[12] On the federal policy level, the House passed Waxman-Markey Bill, and the corresponding Senate bill passed by the Energy & Natural Resources Committee exempted EfW from the carbon cap.[13, 14]

CARB's position is especially disconcerting given that in July 2011 the agency, after an extensive period of review and consideration of the matter, had excluded direct combustion of municipal solid waste with energy recovery in an existing permitted facility from being in the Cap.[15] Staff provided the following explanation for the exclusion:

> "Including emissions from these facilities in cap-and-trade would cause statewide GHG emissions to increase as a result of diversion of waste to landfills. This exclusion is based on staff's analysis of the potential economic impacts created by a cap-and-trade program and the potential increase in methane emissions resulting from diversion of waste to landfills even after the implementation of early action measures. Staff also believes this provision is consistent with recognition of one facility as Renewable Portfolio Standard eligible and with similar provisions in the European Union Emissions Trading System (EU-ETS) and the Regional Greenhouse Gas Initiative (RGGI) where these facilities have no compliance obligations."[16]

Industry staff worked diligently with CARB staff on the issue over a considerable period of time. An initial version of the Industry Model, that was later made publically available on CARB's website, was provided to CARB staff on March 3, 2010 as a follow up to a February 23, 2010 meeting with staff, providing ample time for agency review and consideration. The final version of the Industry Model was provided to CARB staff in March 2011. In addition, numerous meetings were held with CARB staff to ensure transparency and understanding, culminating in a May 12, 2011 meeting with CARB staff where detailed model assumptions were discussed, including the assumed likely duration of landfill gas collection under the agency's early action measure for landfills. No objections to any of the model inputs were raised by CARB staff.

However, the agency subsequently reversed its decision and included the three EfW facilities in its 1st set of 15 day regulatory changes issued on July 25, 2011. The change in CARB's position was communicated to the industry on July 22, 2011. CARB's revised analysis dated August 17, 2011, used the California Landfill Methane Inventory Model (CALMIM) <u>in a manner for which it was never intended</u>. In fact, CALMIM was never validated *at all* for how CARB used the model. We provided detailed written and verbal comments on CALMIM and CARB's application of the model during a meeting with CARB staff on August 30th.

During the August 30th meeting, CARB staff stated that they did not think GHG emissions would increase as significantly as predicted by the first order decay model after the collection system was turned off. In response, we submitted to CARB an even more conservative analysis of the GHG emissions associated with landfilling on August 31st. This revised analysis assumed that gas collection would extend for 60 years (four times the regulatory minimum) and soil oxidation rates would increase to two to three times CARB's own default after the collection system was turned off. CARB provided no feedback to this analysis.

On September 1st, CARB presented us with a new spreadsheet calculation which supported their decision. During the call, CARB staff characterized the calculation as a bounding analysis intended to quantify an upper bound of landfill emissions expressed on a per ton of MSW basis. However, the spreadsheet calculation uses defaults which nearly universally minimize landfill emissions and misapplies CARB's own Landfill Early Action Measure. The new calculation concluded that landfills will achieve an 83% collection efficiency immediately upon the placement of waste in a landfill and will continue to achieve this standard every day with absolutely no loss in performance for over 90 and up to 260 years. Detailed comments prepared in response to CARB's spreadsheet calculation are attached.

**Unintended Consequences of Capping EfW facilities**

California's regulations to reduce and limit greenhouse gas emissions disregard the benefits of EfW as a tool to reduce GHG emissions in the waste sector. The counties and cities that own these facilities will be forced to buy compliance obligations. At a minimum, this will divert funds from municipal recycling, composting and hazardous waste programs. The burden of compliance obligations also means that EfW facilities will be increasingly expensive to operate. Communities will face the difficult decision of either paying higher costs for EfW, or choosing the cheaper route of landfilling with its higher levels of GHG emissions. This policy will serve to incentivize the use of landfills and make the better environmental choice, EfW, more expensive.

**Conclusion**

Inclusion of EfW facilities in the CARB Cap and Trade Program ignores the scientifically recognized GHG benefits of this technology and will ultimately result in more landfilling and more GHG emissions generated in California. Covanta Energy and the communities it partners with support a compliance obligation exemption for the three existing Energy-from-Waste facilities in California. An exemption is consistent with the major cap and trade systems currently in place: energy from waste facilities are not included in either the European Union Emission Trading Scheme or the Regional Greenhouse Gas Initiative (RGGI). Our request is based on the conservative analysis that demonstrates that GHG emissions will increase from landfills if these facilities are included in the cap. Additionally, the communities will lose the electricity revenues generated from the sale of electricity at these facilities. These are revenues that these communities use to fund their recycling programs.

In July 2011, CARB concurred, concluding that inclusion of the three EfW facilities in the cap and trade program could increase state-wide GHG emissions. This was the culmination of an extensive period of work and information sharing on both EfW and landfill lifetime GHG emissions extending over a year. Subsequently, CARB has reversed its assessment, first relying on an unfinished model in a manner completely inconsistent with its intended purpose, and then second relying on a brief spreadsheet calculation that misapplies its own regulation.

CARB's abrupt policy reversal, based on the misapplication of a draft model and a cursory spreadsheet calculation resulting in a position contrary to a significant body of international and domestic policy and research, is, to put it mildly, concerning. As a direct consequence, we sincerely request that CARB defer compliance obligations under AB32 for the three existing municipal waste to energy facilities at least until such time that an external non-conflicted expert panel has provided an approach to calculate the lifetime methane emissions associated with the disposal of municipal solid waste in landfills, taking into consideration CARB's existing analysis and all other relevant available information, and CARB has had an opportunity to apply that approach to satisfy all the risk of leakage resulting from the inclusion of waste to energy facilities in the proposed cap and trade program.

In support of these recommendations, Covanta is pleased to attach our more detailed comments on CARB's recent spreadsheet calculation. Thank you for the opportunity to submit comments and please do not hesitate to contact the undersigned if you have any questions.

Sincerely,

Ellie Booth

Ellie Booth
Director of State Government Relations
Covanta Energy

## Detailed Comments

**The spreadsheet calculation incorrectly assumes that any landfill with a theoretical landfill gas calculated heat input above 3 MMBtu / hr will have a landfill gas collection system in place.**
In making this assumption, staff cited the landfill early action measure regulation. However, the 3 MMBtu / hr standard is only an initial trigger for the Landfill Early Action Measure. Landfills that exceed this trigger are required to follow the surface monitoring procedures outlined in §95471(c)(1) and (c)(2) _If and only if_ the surface monitoring finds surface concentrations of methane in excess of 200 parts per million by volume (ppmv), the landfill operator must comply with §95464 – 95476, the standards for operation of a collection system. If, on the other hand, four consecutive quarters of landfill surface monitoring reveal no concentrations above 200 ppmv, the standards of §95464 – 95470 *no longer apply*. A perfectly compliant landfill, with no measured methane concentrations above 200 ppmv can have significant GHG emissions. For example, at an average surface methane concentration of 25 ppmv, a 100 acre landfill could have annual greenhouse gas emissions of approximately 225,000 tonnes of carbon dioxide equivalents ($CO_2e$) (See Attachment 1 for calculation). CARB's own analysis used to demonstrate an 85% collection efficiency inclusive of soil oxidation, found that the modeled concentration of methane above the surface of the Palos Verde landfill with the collection system turned off was only 4.873 ppmv.[17] CARB has presented absolutely no documentation or justification as to why all of the landfill gas generated prior to the landfill reaching the 3 MMBtu / hr threshold would be subject to collection aside from stating that §95473(b) would allow the agency to require a landfill to demonstrate that it did not meet the eligibility criteria of the regulation. Being subject to the regulation does not in of itself lead to a requirement to install, operate, or maintain a landfill gas collection system.

**This unsupported assumption implies that landfills will collect gas for 93 to 260 years.**
Per the early action measure regulation, the landfill gas heat input is calculated in accordance with Appendix I. The calculation relies on the amount of anaerobically degradable carbon present in the landfill and the 1st order decay equation. The calculated heat input at the Fink Road landfill will not drop below 3 MMBtu / hr for 93 years. For the Puente Hills Landfill, it will take 260 years. It is impractical for landfills to continue to collect gas for this duration. At this threshold, this is equivalent to a landfill gas flow rate of approximately 100 scfm, roughly one-tenth that of a standard whole house fan. At the size of a landfill like Puente Hills, this is equal to approximately 0.15 scfm per acre. It is unclear how landfills will be able to practically collect gas at these flow rates. Furthermore, the concentration of methane in landfill gas decreases over time. Landfills which collect gas for long periods of time may be required to co-fire their flares or other destruction devices with natural gas, generating additional greenhouse gas emissions which must be counted.

**The agency has ignored §95467 of the regulation for "Permanent Shutdown and Removal of the Gas Collection and Control System."**

It is unclear why the agency has deviated from a common sense reading of their regulation when assessing the greenhouse gas performance of waste to energy relative to landfilling. In this section, the landfill operator has to demonstrate that it has operated a collection system for 15 years, has achieved compliance with the surface monitoring standards in §95465 while the system is operating, and has submitted the equipment removal report to the agency. However, the agency ignores this section of the regulation, stating instead that it is in fact the 3 MMBtu / hr standard that governs the requirement for a landfill gas collection system. If the agency's interpretation here is valid, it is unclear what purpose §95467 serves. As a consequence, it should be removed from the regulation to ensure clarity.

Landfill industry representatives involved in the regulatory development effort have a different interpretation of the regulation. According to landfill industry representatives, the regulation was intended to allow for the discontinuation of landfill gas collection and control provided that the landfill could demonstrate compliance with the 25 ppm and 500 ppm surface monitoring standards *without* the system in place. Although the regulation and the July 2011 Guidance Document only explicitly require surface monitoring standard compliance with the system in operation, the standards can be used to estimate the expected duration of landfill gas collection. Modeling performed using the MAS/EPA Regulatory Model (AERMOD) and the $1^{st}$ order decay model shows an average duration of collection of 32 years to comply with the 25 ppmv integrated surface monitoring standard.

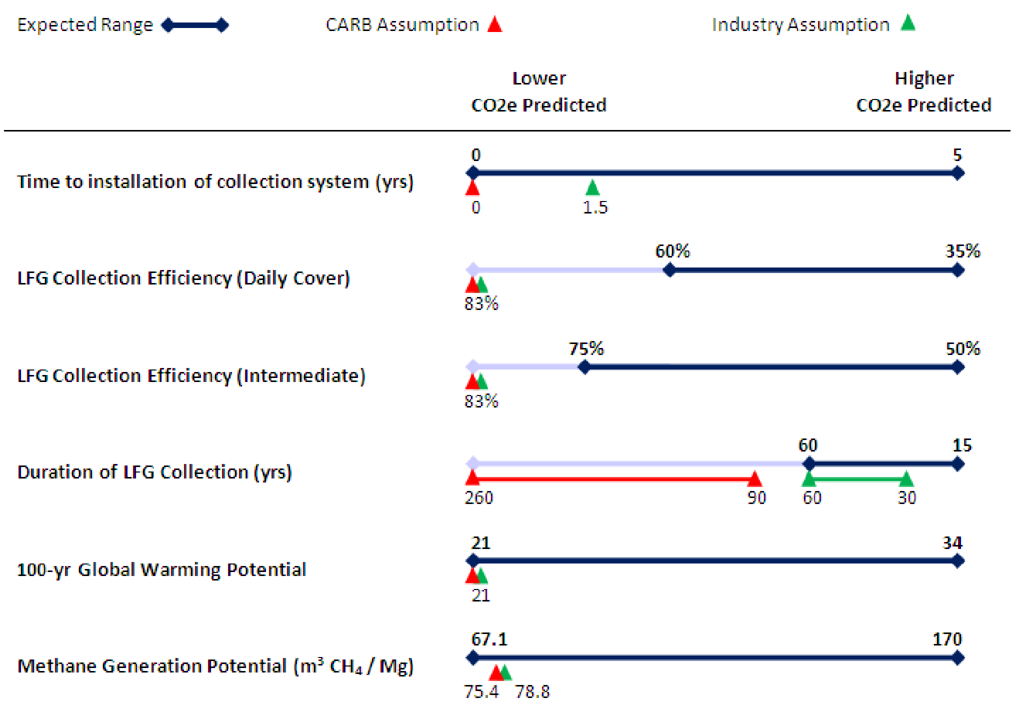
**The agency's spreadsheet is inconsistent with the regulatory methodology for calculating the heat input capacity.**

In its spreadsheet, CARB relies on the regulatory threshold of 3.0 MMBtu / hr of heat input capacity; however, CARB fails to follow the regulatory methodology in its calculations. Landfills without passive collection systems or carbon adsorption systems, such as the Fink Road and Puente Hills Landfills referenced in CARB's spreadsheet calculation, are directed to follow the procedures in Appendix I to calculate the heat input capacity according to §95471(b)(1). Firstly, CARB's spreadsheet calculation uses an assumed landfill gas collection efficiency of 83%. In contrast, Appendix I specifies that 75% be used. Secondly, CARB's spreadsheet assumes a soil oxidation of 10%; however, the calculation required in Appendix I does not account include this figure. <u>CARB's own analysis, when corrected for just these two inconsistencies with their own regulation, finds that the emission factor for the Stanislaus EfW facility is *below* that for the Fink Road Landfill.</u> A copy of the corrected CARB analysis is provided in as Attachment 1.

**Despite being portrayed as a bounding exercise designed to represent the "high end" of landfill emissions, CARB's spreadsheet consistently relies on defaults resulting in lower predictions of methane emissions from landfilling.**

Bounding exercises are commonly done to estimate both the upper and lower bound of a model prediction. Such exercises are very appropriate when dealing with high degrees of variability, such as the variability associated with greenhouse gas emissions from landfills. However, in its "bounding exercise", CARB has consistently used defaults and inputs that can be generally characterized as predicting the low end of landfill gas emissions and, in some cases, that are outside of reasonable expectations and published values (Figure 1). The EfW industry's assessment relied on more typical data inputs. Performing a true bounding exercise designed to estimate the end of $CO_2e$ emissions from a landfill would result in a emission factor of 2.5 t $CO_2e$ / ton MSW, far greater than CARB's "high end" estimate of 0.16 – 0.33 t $CO_2e$ / ton MSW. The industry model resulted in an emission factor range of 0.47 – 0.58 t $CO_2e$ / ton MSW.

**Figure 1. Key Model Inputs and Accepted Ranges**




*Time to Installation of Collection System*

The spreadsheet calculation assumes that waste is immediately subject to collection after its placement in the landfill. This is not required by regulation and is rarely, if ever, followed in practice. In fact, the working face of the landfill is explicitly exempted from surface monitoring standards. Furthermore, although areas of the landfill not part of the working face are subject to surface monitoring standards, there is no regulatory timeline in the Landfill Early Action Measure to install a collection system. Federal NSPS regulations require the installation of a collection system within two to five years. Recent research has shown that delays in installation of collection systems can have a large impact on the lifetime or integrated collection efficiencies necessary to conduct a comparison of waste management practices.[18]

*Landfill Gas Collection Efficiency*

In contrast to GHG inventories, the calculation of GHG emissions from landfills on a per ton of waste perspective must look at how instantaneous collection efficiencies change over time. As described above, collection systems are not installed immediately, therefore the efficiency of collection initially is zero.

Even after the system is installed, collection efficiencies vary. The CARB spreadsheet calculation assumed a constant instantaneous collection efficiency of 83% over the entire collection period of landfill gas collection, based on a CARB assessment of landfill gas collection at a closed landfill with a final cap. [19] The current U.S. EPA default collection efficiency is 75%.[20,21] A constant collection efficiency is very conservative and does not occur in practice. Collection efficiencies are lower in the initial years after waste has been placed in a landfill, because the cover materials allow more methane to escape and their permeability make it more difficult to maintain a consistent vacuum in the collection system. In fact, CalRecycle, recognizing that daily and intermediate covers have greater GHG emissions, called faster installation of the final cap a best management practice to reduce GHG emissions from landfills.[22]

It is important to note that the 83% collection efficiency based on the CARB report is a snapshot in time for a closed landfill with a final cap. This is the best that the landfill will ever perform: collection efficiencies will be lower for intermediate and daily covers, and zero for those periods of time when the collection system is not operating. As a consequence, the amount of landfill gas actually captured, expressed as a percentage of the total methane generation potential, will always be less than the 83% default instantaneous collection efficiency.

*Duration of Landfill Gas Collection*

As described above, it will take between 93 to 260 years before the Fink Road and Puente Hills landfills calculated heat inputs drop below the 3 MMBtu / hr level. CARB's spreadsheet calculation assumes that landfill gas will be collected at an 83% efficiency during this entire time period, starting immediately after waste is placed in a landfill.

The Industry Model assumed a total duration of collection between 30 and 45 years with a sensitivity analysis run at 60 years. This overall range is consistent with a range of 45 to 60 years considered typical by CARB staff[23] and a modeled collection duration of 60 years used by EPA scientists in a recent waste management life cycle comparison.[24] Other published assessments have assumed periods of collection of 38 years.[25,26] After the collection period ends, these studies assume an increase in emissions. Modeling performed using the MAS/EPA Regulatory Model (AERMOD) and the 1st order decay model shows an average duration of collection of 32 years to comply with the 25 ppmv integrated surface monitoring standard. A detailed explanation of the modeling is included in Attachment 2.

*Global Warming Potential*

The global warming potential is used to convert methane into carbon dioxide equivalents. The 100-year $CH_4$ GWP of 21 from the IPCC 2nd Assessment Report was used in both the agency's calculation and the Industry Model, in accordance with the CARB GHG Reporting Rule. The use of the 2nd Assessment Report under reports methane's impact on the climate. After two subsequent revisions, the first in 2001, and then in 2007, the IPCC now reports in the 4th Assessment Report that the GWP of methane is 25, a nearly 20% increase from the 1995 2nd Assessment Report value. Furthermore, recent research published in *Science* by a team of Columbia and NASA scientists has found that, when indirect aerosol effects are included, the 100 year GWP for methane is 34, 62% higher than the value reported by IPCC in 1995.[27]

*$L_o$, Methane Generation Potential*

The methane generation potential is a constant that represents the total amount of methane a megagram ("Mg") or metric tonne of waste will generate in a landfill through anaerobic digestion. The U.S. EPA uses values between 100 – 170 $m^3$ $CH_4$ / Mg MSW.[28] Landfill permits, including those issued in California, are based on a potential to emit value of 170 $m^3$ $CH_4$ / Mg MSW. The value of 78.8 $m^3$ / Mg MSW used in industry's assessment is an average of the methane generation potential calculated from the 2004 and 2008 California Integrated Waste Management Board (CIWMB) waste characterizations,[29,30] adjusted to exclude most construction & demolition (C&D) debris,[31] medical waste, and sludge. No documentation was provided for the agency's assumption for the percentage of anaerobically degradable carbon (%ANDOC), which is equivalent to a Lo value of 75.4 $m^3$ / Mg.

*Soil Oxidation*

When explaining their calculation, agency staff have characterized the 10% soil oxidation factor as being very conservative. However, during development of the landfill early action measure, CARB staff selected a 10% soil oxidation default for landfills, noting that "[The default of] 10 percent for [soil] oxidation fraction has been the object of some debate. Staff recognizes that many values can be found for these factors in the literature and that some site specific measurements and local estimates do exist. However, given the current lack of rigorous, scientifically-based measurement data, staff chose to use the default values established by USEPA."

The U.S. EPA has also been skeptical of higher rates of soil oxidation. In response to comments advocating for the use of higher soil oxidation figures in the GHG reporting rule, the U.S. EPA responded as follows:

> "We have also reviewed the [Solid Waste Industry for Climate Solutions] protocol for soil oxidation, which provides suggested oxidation factors ranging from 0.22 to 0.55 depending on the soil cover type. We have several concerns with these factors. First, the values were calculated using arithmetic means which appear to be biased high due to a few high oxidation factors; the median values were generally significantly lower than the average values suggested. Second, the recommended values included laboratory test values, which always

> yielded higher oxidation fractions. The percent of methane oxidized at the landfill surface is highly dependent on the velocity of gas flow. While areas of low flow are expected to have significant oxidation, areas of high flow will have little to no oxidation. Landfill gas will generally flow to the surface in fissures and channels that offer the least resistance to flow. Consequently, a significant portion of the landfill gas is likely to exit the landfill in a limited number of areas under much higher flow rates than other locations. These high volume flows will not have significant oxidation."[32]

Furthermore, the 10% soil oxidation default is consistent with international and domestic precedents and is used by the CARB Landfill emissions tool[33] and the CARB Local Government Operations Protocol.[34] Use of the 10% figure is also required by the US EPA for its GHG Reporting Program.[35] The 10% default is used by the U.S. EPA GHG Inventory[36], the Clean Development Mechanism of the Kyoto Protocol[37], the Climate Action Reserve Organic Waste Digestion[38] and Organic Waste Composting Project Protocols[39], and the U.S. EPA Waste Reduction Model (WARM). The Intergovernmental Panel on Climate Change, recommends that a value of 10% be used for well-managed landfills to estimate both diffusion through the cap and the escape of methane through cracks / fissures in the cap.[40]

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[1] USEPA, Air Emissions from MSW Combustion Facilities webpage, accessed July 26, 2011 http://www.epa.gov/epawaste/nonhaz/municipal/EfW/airem.htm#6

[2] Kaplan, P.O, J. DeCarolis, and S. Thorneloe, 2009, Is it better to burn or bury waste for clean electricity generation? *Environ. Sci. Technology* 43 (6) pp1711-1717. Available at: http://pubs.acs.org/doi/abs/10.1021/es802395e

[3] EfW identified as a "key mitigation measure" in IPCC, "Climate Change 2007: Synthesis Report. Contribution of Work Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change" [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp. Available at: http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

[4] EfW identified as a key technology for a future low carbon energy system in World Economic Forum. *Green Investing: Towards a Clean Energy Infrastructure.* January 2009. Available at: http://www.weforum.org/pdf/climate/Green.pdf

[5] EU policies promoting EfW as part of an integrated waste management strategy have been an overwhelming success, reducing GHG emissions over 72 million metric tonnes per year, see European Environment Agency, *Greenhouse gas emission trends and projections in Europe 2009: Tracking progress towards Kyoto targets* *http://www.eea.europa.eu/publications/eea_report_2009_9*

[6] European Environmental Agency (2008) Better management of municipal waste will reduce greenhouse gas emissions. Available at: http://www.eea.europa.eu/publications/briefing_2008_1/EN_Briefing_01-2008.pdf

[7] Weitz, K., Thorneloe, S., Nishtala, S., Yarkosky, S., and Zannes, M. (2002). "The impact of municipal solid waste management on greenhouse gas emissions in the United States." *J. Air Waste Manage.Assoc.*, 52, 1000–1011.

[8] Thorneloe, S., Weitz, K., and Janbeck, J. (2005). "Moving from solid waste disposal to materials management in the United States." *10th Int. Waste Management and Landfill Symp., International Waste Working Group, Padova, Italy.*

[9] Clean Development Mechanism Executive Board: "Approved baseline and monitoring methodology AM0025: Avoided emissions from organic waste through alternative waste treatment processes." Available at: http://www.cdm.unfcc.int/methodologies/DB/3STKBX3UY84WXOQWIO9W7J1B40FMD

[10] Verified Carbon Standard, Lee County Waste to Energy Facility 2007 Capital Expansion Project VCU, *The VCS Project Database,* accessed April 28, 2011. Available at: https://vcsprojectdatabase1.apx.com/mymodule/ProjectDoc/EditProjectDoc.asp?id1=290

[11] RTI International (2009) *Life Cycle Assessment and Economic Analysis of Organic Waste Management and Greenhouse Gas Reduction Options*, prepared for California Integrated Waste Management Board. Available at: http://www.calrecycle.ca.gov/climate/Organics/LifeCycle/Reports/default.htm

[12] California Air Resources Board (CARB 2010a) *Proposed Regulation for a California Renewable Electricity Standard, Staff Report: Initial Statement of Reasons, Appendix D: Supporting Documentation for the Environmental Analysis*, Available at: http://www.arb.ca.gov/regact/2010/res2010/res10d.pdf

[13] U.S. House of Representatives, 111th Congress (2009) H.R. 2454 *American Clean Energy and Security Act of 2009*, Available at: http://www.gpo.gov/fdsys/pkg/BILLS-111hr2454eh/pdf/BILLS-111hr2454eh.pdf

[14] Committee on Energy and Natural Resources, U.S. Senate, 111th Congress (2009), *American Clean Energy and Leadership Act of 2009,* Available at: http://www.gpo.gov/fdsys/pkg/CRPT-111srpt48/pdf/CRPT-111srpt48.pdf

[15] See §95852.2(s) of July 2011 Discussion Draft of *California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms*

[16] California Air Resources Board, July 2011, Notice of Public Availability of Cap-and-Trade Discussion Draft and Workshop

[17] CARB 2010a

[18] Hamid R. Amini, H.R., D. R. Reinhart, K. R. Mackie, Determination of first-order landfill gas modeling parameters and uncertainties, Accepted for publication September 2011.

[19] California Air Resources Board (CARB 2009b), *Staff Report: Initial Statement of Reasons for the Proposed Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills, Appendix D: Evaluation of Landfill Gas Collection Efficiency,* May 2009. Available at: http://www.arb.ca.gov/regact/2009/landfills09/isor.pdf

[20] U.S. EPA (1997) *Emission Factor Documentation for AP-42 Section 2.4 Municipal Solid Waste Landfills, Revised* August 1997, Research Triangle Park, North Carolina. Available at: http://www.epa.gov/ttn/chief/ap42/ch02/bgdocs/b02s04.pdf

[21] U.S. EPA (2008) *Background Information Document for Updating AP-42 Section 2.4 for Estimating Emissions from Municipal Solid Waste Landfills*, September 2008, EPA/600/R-08-116. Available at: http://www.epa.gov/ttn/chief/ap42/ch02/draft/db02s04.pdf

[22] California Integrated Waste Management Board (2008) *Technologies and Management Options for Reducing Greenhouse Gas Emissions from Landfills*, Sacramento, CA.

[23] Per Renaldo Crooks, May 12, 2011 Meeting between CARB Staff and EfW Industry Representatives, Sacramento, CA.

[24] Kaplan *et al* (2009)

[25] Manfredi, S., T. H. Christensen, 2009, Environmental assessment of solid waste landfilling technologies by means of LCA-modeling, *Waste Management*, 29 (2009) 32-43.

[26] Camobreco, V. *et al.* Life-cycle inventory of a modern municipal solid waste landfill, *Waste Management & Research* 1999, 17: 394. http://wmr.sagepub.com/content/17/6/394

[27] Shindell, Drew T., Greg Faluvegi, Dorothy M. Koch, Gavin A. Schmidt, Madine Unger, Susanne E. Bauer, Improved Attribution of Climate Forcing to Emissions, *Science*, **326**, 716-718. Available at: http://www.sciencemag.org/content/326/5953/716.abstract

[28] Current U.S. EPA AP-42 uses a mixed MSW Lo of 100 $m^3$ / Mg, based on data from at 40 landfills. In the latest draft revision to AP-42, the 100 $m^3$ / Mg value is corrected through a factor of 1.3 to account for uncollected gas in the original study, resulting in an effective Lo of 130 $m^3$ / Mg. The U.S. EPA Landfill Gas Emission Model ("LandGEM"),

uses a default Lo of 100 $m^3$ / Mg for inventory purposes. U.S. EPA Clean Air Act regulations use 170 $m^3$ $CH_4$/Mg MSW as a potential-to-emit value. The USEPA's 2006 solid waste greenhouse gas life cycle report uses a value of 168 $m^3$ $CH_4$/Mg MSW (Exhibit 6-3 of U.S. EPA, 2006, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, 3rd edition, Available at: http://www.epa.gov/climatechange/wycd/waste/SWMGHGreport.html)

[29] California Air Resources Board (CARB 2010b), Methane Emissions from Municipal Solid Waste Landfills, *California Code of Regulations*, Title 17, Subchapter 10, Article 4, Subarticle 6, §95460 - §95476

[30] Detailed composition from Table 50 of California Integrated Waste Management Board (CIWMB 2009), *California 2008 Statewide Waste Cauterization Study* was adopted to the waste categories contained in CARB (2009).

[31] Lumber, a significant portion of C&D debris is included. This may not accurately reflect the waste stream encountered on the tipping floor of energy from waste facilities, as much of the lumber is likely diverted. However, inclusion of lumber is conservative: when lumber is excluded, calculated methane generation potentials are slightly higher for both 2004 and 2008.

[32] See page 56336 of U.S. EPA, Mandatory Reporting of Greenhouse Gases, Final Rule, *Federal Register* **74**, 209 (October 30, 2009): 5620-56519.

[33] CARB, 2010, California Air Resources Board's Implementation of IPCC's Mathematically Exact First-Order Decay Model, Version 1.2, Release date June 3, 2010. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/landfill_emissions_tool_v1_2_2010-06-03.xls

[34] CARB, California Climate Action Registry, ICLEI – Local Governments for Sustainability, The Climate Registry, 2010, *Local Government Operations Protocol: For the quantification and reporting of greenhouse gas emissions inventories,* Version 1.1, May 2010. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

[35] 40 CFR§98.343(c)(1)

[36] See page 8-4 of U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2009.* EPA 430-R-11-005, Washington, D.C. Available at: http://epa.gov/climatechange/emissions/usinventoryreport.html

[37] Clean Development Mechanism Executive Board *Methodological tool "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (Version 05.1.0)* http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v5.1.0.pdf

[38] Climate Action Reserve, *Organic Waste Digestion Project Protocol*, Version 2.0, June 29, 2011. Available at: http://www.climateactionreserve.org/wp-content/uploads/2011/07/OWD_Project_Protocol_V2.0.pdf

[39] Climate Action Reserve, *Organic Waste Composting Project Protocol*, Version 1.0, June 30, 2010. Available at: http://www.climateactionreserve.org/wp-content/uploads/2011/07/Organic_Waste_Composting_Project_Protocol_V1.0_071211_Package1.pdf

[40] Pipatti *et al*. *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3: Solid Waste Disposal*. Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf

**Attachment 1**

**CARB Calculation Spreadsheet Corrected for Heat Input Calculation of Appendix I**

| | | | | | |
|---|---|---|---|---|---|
| | **CH4** | | | Landfill Reg | |
| BTU/SCF | 1012 | @ 60 F | MMBTU/Hr | 3.0 | |
| BTU/CF | 1070 | @ 32 F | BTU/Year | 26,280,000,000 | |
| Liters/Mole | 22.414 | @ 32 F | GWP (CH4) | 21 | |
| Liters/CF | 28.31685 | | | | |
| Grams/Mole | 16.04246 | | **Threshold for 3.0 MMBTU/Hr collected gas** | | |
| | | | | | |
| BTU/Gram | 52.77617498 | | Grams (CH4)/Year | 497,951,964 | Collected |
| | | | MTCH4/Year | 498 | Collected |
| | **C** | | Collection % | 75% | 83% |
| Grams/Mole | 12.0107 | | Oxidation % | 0% | 10% |
| | | | Destruction % | 99% | |
| | **H** | | MTCH4/Year | 664 | |
| Grams/Mole | 1.00794 | | Decomposed Carbon to Methane % | 50% | |
| | | | MTC (Decomposed) | 994 | |
| | 98.81422925 | | k | 0.02 | |
| | | | ANDOC (MT) | 50,206 | |
| | | | ANDOC % | 7.52% | |
| | | | MSW (Short Tons) | 735,585 | In Place |

| | Fink Rd. Landfill (2020) | Puente Hills Landfill (2013) | |
|---|---|---|---|
| Estimated ANDOC Remaining (MT) | 289,980 | 8,164,075 | |
| Estimated MSW Remaining (Short Tons) | 4,248,564 | 119,613,620 | |
| | Stanislaus WtE Plant | Commerce WtE Plant | Long Beach (SERRF) WtE Plant |
| Emission Factor (MTCO2E/Short Ton MSW): | 0.3419 | 0.2931 | 0.3077 |
| **Comparison Results** | | | |
| Landfill Emission Factor (MTCO2E/Short Ton MSW) | 0.3510 | 0.1614 | 0.1614 |
| WtE Plant Emission Factor (MTCO2E/Short Ton MSW) | 0.3419 | 0.2931 | 0.3077 |
| Assumed MSW Amount Burned (Short Tons) | 239,644 | 102,995 | 474,341 |
| WtE Plant Emissions (MTCO2E) | 81,931 | 30,186 | 145,932 |
| Landfill Emissions (MTCO2E) | 84,119 | 16,622 | 76,552 |
| **WtE Plant - Landfill (MTCO2E)** | **-2,188** | **13,564** | **69,380** |
| ***(WtE Plant - Landfill) / Landfill [%]*** | ***-3%*** | ***82%*** | ***91%*** |

**Attachment 2**

**Introduction**

The ability to shut down a landfill gas (LFG) collection and control system under CARB's early action measure titled Methane Emissions from Municipal Solid Waste Landfills is driven by the results of surface methane monitoring testing. The MAS/EPA Regulatory Model (AERMOD) can be used to determine the methane emissions flux through the plane of the landfill surface that will generate a given concentration of methane above the surface of the landfill. AERMOD is a regulatory air dispersion model that has been used by CARB to determine the landfill gas collection efficiency of a closed landfill with a final cap to ascertain the likely collection efficiency attainable after implementation of the Landfill Early Action Measure. Once the flux is determined, the 1st order decay equation can be used to predict the time at which a landfill's uncontrolled methane flux will drop below the regulatory standard.

Currently, there is disagreement between CARB staff and representatives from the landfill industry as to which standard effectively governs the duration of landfill gas collection. Landfill industry representatives interpret §95467 for Permanent Shutdown and Removal of the Gas Collection and Control System as requiring landfills to be able to meet the 25 ppm integrated and 500 ppm instantaneous standards *without* the system operating. Landfill industry representatives state that this interpretation was shared by CARB staff during development of the Rule. In addition, CARB staff referenced this requirement during a discussion of the duration of collection at an August 30th meeting between CARB staff and WTE industry representatives.

In contrast, CARB staff's interpretation as of September 8, 2011, is that §95473(b), which allows the Executive Officer to "request any owner or operator to demonstrate that a landfill does not meet the applicability criteria specified," allows CARB to require a landfill to re-install or re-activate a collection system that has been previously permanently removed in accordance with §95467. Ignoring the contradiction inherent in requiring the subsequent operation of a collection system that has been permanently removed, the regulation *could* require the installation of a collection system <u>if and only if</u> the calculated heat input capacity is greater than 3.0 MMBtu / hr and there is any measured concentration of methane of 200 ppmv or greater from the surface of the landfill. There is no integrated methane concentration that triggers installation of a collection system.

Given the differences in interpretation, there are two possible methane concentration standards that apply: a single 200 ppmv instantaneous standard, or a combined 25 ppmv integrated and 500 ppmv instantaneous standard. A single 200 ppmv instantaneous standard could allow for a greater overall concentration of methane over the surface of the landfill, therefore, the 25 ppmv standard was used to assess the likely duration of collection.

**AERMOD Analysis**

A series of AERMOD scenarios at different surface methane fluxes were run to establish the relationship between the surface methane concentration measured 2 inches above the landfill surface and the methane flux for both urban and rural dispersion conditions. All scenarios were run for a hypothetical landfill in the area of the current Puente Hills landfill using 2005 meteorological data from the La Habra weather station. Meteorological data was used for the first six months of 2005, and was screened to ensure compliance with CARB regulations regarding wind speeds during surface monitoring. A total of 5 days were excluded from the analysis for having average wind speeds above the 5 miles per hour standard of §95471(c)(1)(2). Key model input parameters are presented in Table 1.

The size of the landfill cell was calculated based on the average depth and density of waste in California landfills and the annual waste currently managed at the Commerce and Long Beach waste to energy (WTE) facilities. In its August 2011 spreadsheet calculation, CARB assumed that the waste currently managed at the Commerce and Long Beach landfills could be landfilled at the Puente Hills landfill. Key parameters for the hypothetical landfill are presented in Table 2.

**Table 1. AERMOD Input Parameters**

| | |
|---|---|
| Model Release | 11103 |
| Dispersion Options | Flat Terrain, Concentration Output,<br>Rural *and* Urban |
| Source Type | Area (150 m x 150 m) |
| Receptor Grid | 10 m grid (256 receptors) |
| Receptor Height | 0.0508 m (2 in.) |
| Surface Meteorological Data | La Habra, CA |
| Upper atmosphere Meteorological Data | La Habra, CA |
| Meteorological Data Time Period | January – June 2005 |
| $CH_4$ Background Concentration | 1.841 ppmv |

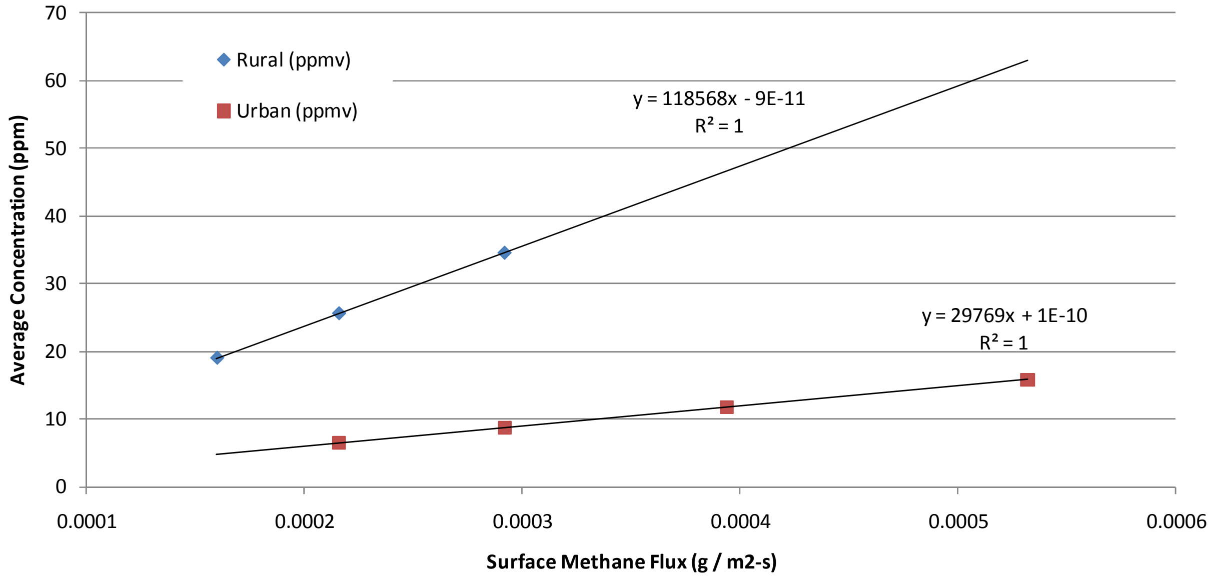
**Table 2. Key Landfill Parameters**

| | |
|---|---|
| First Order Decay Rate | 0.02 / yr |
| % Anaerobically Degradable Organic Carbon | 6.73% |
| Waste Density[1] | 730 kg / $m^3$ |
| Waste Depth[2] | 36 m |
| Soil oxidation | 10% |

**Results**

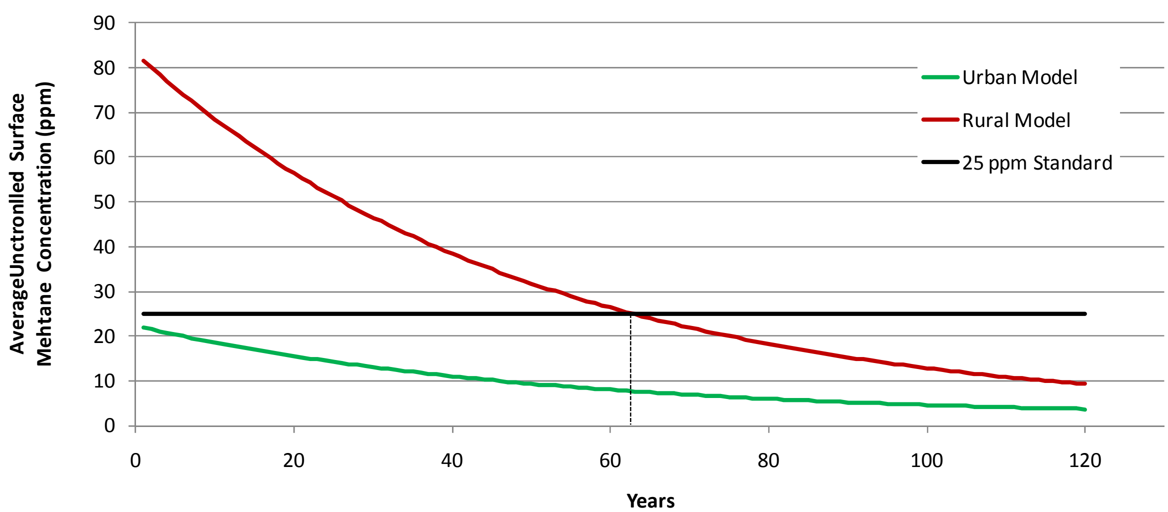
Based on the AERMOD scenarios, two linear relationships were developed between average surface concentration measured 2" above the landfill surface and methane flux, one for the urban dispersion model, and one for the rural dispersion model (Figure 1).

**Figure 1. Average Surface Methane Concentration as a Function of Methane Flux**




Using the first order decay model and the landfill parameters in Table 2, the average flux was calculated over time. The linear relationships between flux and surface methane concentration developed using AERMOD were then applied to the average flux over time to determine at which point the predicted surface concentration would drop below the 25 ppmv integrated surface concentration standard, taking into account background concentrations of methane. For the rural scenarios, this occurred at 63 years. For the urban scenarios, more applicable to the Puente Hills area, methane concentrations were never predicted to be above 25 ppmv, peaking initially at 21.9 ppmv. Based on this analysis, an assumed collection period of between 30 and 60 years conservatively estimates the duration of time required, on average, for a landfill to meet the surface monitoring standard of 25 ppmv. The average period of collection for the rural and urban dispersion conditions is 32 years.

**Figure 2. Average Uncontrolled Surface Concentration as a Function of Age**



[1] Themelis, N.J., P.A. Ulloa, 2007, Methane generation in landfills, *Renewable Energy*, **32:** 7, 1243 – 1257, doi:10.1016/j.renene.2006.04.020

[2] Themelis & Ulloa (2007)