

California Integrated Waste Management Board

SCOPE OF WORK

Lifecycle Assessment of Organic Diversion Alternatives and Economic Analysis of Greenhouse Gas (GHG) Reduction Options

I. INTRODUCTION/OBJECTIVES

In June 2005, Governor Schwarzenegger signed Executive Order S-03-05 establishing climate change emission reduction targets for California. The Secretary for Environmental Protection (Cal/EPA) leads a multi-agency Climate Action Team (CAT) to meet the reduction targets. As an active member of the CAT, the California Integrated Waste Management Board (Board) established target greenhouse gas (GHG) reduction goals, developed work plans, and provided input for the March 2006 CAT Report to the Governor and Legislature.

California's greenhouse gas emission reductions goals were further solidified in September 2006 when the Governor signed Assembly Bill 32. The California Global Warming Solutions Act of 2006 (AB 32) "requires a cap on greenhouse gas emissions by 2020." It also requires "the development of market-based compliance programs to achieve the emissions cap in the most cost effective and technologically feasible manner with the least impact on California consumers and businesses."

As the statewide leader for California's greenhouse gas emission reduction programs, Cal/EPA was directed through Executive Order S-20-06 to coordinate efforts with the Board, CAT, and several other boards, departments, agencies and commissions to implement the recommendations outlined in the March 2006 CAT Report. The report outlines the following three strategies the Board shall implement by 2010 and 2020 to achieve its targeted GHG reduction goals:

Climate Action Mitigation Strategies	Targeted GHG Reduction Goals (Million Metric Tons CO ₂ Equivalent)	
	2010	2020
Achieve 50% Statewide Recycling Goal	3	3
Landfill Methane Capture	2	3
Zero Waste—High Recycling		3

An estimated, three million metric tons CO₂ Equivalent were reduced in 2006 when Californians met the first of these targeted GHG reduction goals by throwing away less and reusing and recycling more than ever. But, an estimated 42 million tons of waste is still sent to the landfill each year. Over 30 percent of California's waste stream consists of compostable organic materials. An additional 22 percent is construction and demolition debris that could be reduced through green building practices. Another 21 percent of the waste stream consists of paper, which could be recycled, composted, or recovered for conversion technologies. As a result, 70 percent of California's waste stream consists of carbon-based organics that could be diverted from the landfill to assist the Board with achieving the remaining targeted GHG reduction goals.

The objectives of this project are two fold: 1) to complete a Life Cycle Assessment to quantify the possible GHG emission reductions of implementing organics diversion alternatives; and 2) to complete an Economic Analysis to quantify GHG emission reductions, associated costs and cost savings, and diversion potential of recycling and implementing organics diversion alternatives. The results of this project should assist the Board to decide on future efforts to achieve its targeted GHG reduction goals while striving towards zero waste.

Greenhouse gas reductions may be achieved when organics diversion technologies are utilized. Current GHG inventory reports and environmental calculators do not appear to take into consideration a full lifecycle assessment and the associated beneficial “offsets” to calculate GHG emission reductions and carbon sequestration related to organic materials. A beneficial “offset” directly or indirectly avoids, displaces, or sequesters GHG emissions. This project would complete a lifecycle assessment (LCA) that quantifies the GHG emission reductions for the beneficial “offsets” using a cradle to cradle approach. For example, this LCA would consider the beneficial “offsets” of reduced water consumption and energy savings by applying compost as a soil amendment. This could also result in additional GHG emission reductions due to a reduced need for chemical fertilizers, fungicides, and pesticides.

Based on input from the LCA phase of the project, the goal of the economic analysis would be to identify cost-effective organics diversion program activities along with recycling strategies that can achieve optimum greenhouse gas (GHG) emission reductions.

II. WORK TO BE PERFORMED

This Contract will result in the completion of a Lifecycle Assessment and Economic Analysis that quantifies which organic diversion alternatives and recycling options are appropriate for specific regions in the State of California to optimize GHG emission reductions in the most cost-effective manner while also striving towards zero waste. This Contract will result in the development of a Customized California GHG Tool that will assist the Board with prioritizing diversion activities and developing strategic directives. The Board can also use the tool to conduct more focused regional analyses to enable local jurisdictions and industry to make informed decisions to prioritize diversion activities to achieve GHG emission reductions.

III. TASKS IDENTIFIED

For each task identified in this Scope of Work (SOW), written approval is needed from the Contract Manager to proceed.

Communication and Workplan

Task 1) Quarterly Meetings

The Contractor shall meet initially with the Contract Manager and continue to meet at least once (1) per quarter. The Contractor shall be available to make presentations to the Board if necessary.

Task 2) Quarterly Progress Reports

The Contractor will submit quarterly progress reports to the Contract Manager for the duration of the contract. The quarterly progress reports will summarize work-to-date, identify completed

milestones, and highlight any significant preliminary findings. The progress report will not exceed five (5) pages in length (not including tables, graphs, and appendices).

Task 3) Detailed Workplan

Subject to approval by the Contract Manager, and where required, the Contractor will refine the initial Workplan submitted as part of the Contractor's proposal. Any or all parts of the initial Workplan shall be revised by the Contractor as directed by the Contract Manager including, but not limited to a refinement of the analytical model(s) or modeling techniques. The Contractor shall submit the final detailed Workplan for approval by the Contract Manager. The Contractor will not proceed with any subsequent work until the Workplan is approved by the Contract Manager.

The Contractor shall be responsible for completing the tasks outlined in the final approved Workplan. The Contractor shall organize and be responsible for any sub-contractor's efforts. The Contractor will implement the detailed final Workplan, adhering to the milestones, review criteria, timeline and deliverables as approved by the Contract Manager.

Life Cycle Assessment

Task 4) Life Cycle Assessment Screening Phase

Evaluation of LCA Tools: Gather information on existing LCA tools that are specific to waste disposal and materials management. Evaluate LCA tools and describe the variations between the models including the capacity to quantify beneficial "offsets" related to organic materials. Beneficial "offsets" that directly or indirectly avoid, displace, or sequester GHG emissions for organic materials may include avoided fossil fuel use, biofuels, energy savings, water savings, carbon sequestration, and reduced virgin inputs. This assessment shall include but not be limited to the WARM model, CCP Software, MSW Decision Support Tool, and CENTURY. The Contractor shall recommend specific model features from each of these LCA tools that should be included in the structure of the customized California LCA Tool. The Contractor shall also provide recommendations for beneficial "offsets" for the customized California LCA tool that may not be included in these existing LCA tools.

Organic Diversion Alternatives: Work with Contract Manager to define organic diversion alternatives that may result in GHG emission reductions. For example, carbon-based organic materials could be diverted from the landfill and turned into compost. When compost is applied to crops, one beneficial "offset" is that water is conserved. This in-turn has the effect of less electricity needed to pump the water, which results in less GHG emissions generated from electricity production. Additional beneficial "offsets" of composting would include reduced pesticide, herbicide, and chemical fertilizer inputs and carbon sequestration.

As an alternative diversion option, these same carbon-based organic materials could also be used in gasification to electricity. Beneficial "offsets" for this organic diversion alternative would include avoided fossil fuel and energy savings. This screening phase is important to determine the relative GHG emission reductions and beneficial "offsets" between organic diversion alternatives. This task would evaluate a list of organic diversion alternatives and show the order of magnitude between the strengths and weakness of each alternative on a per ton basis. This screening phase shall include the largest rate of return of GHG emission reductions for every ton of material diverted for the various organic diversion alternatives using extreme assumptions for

beneficial “offsets.” For example, the Contractor would determine the beneficial “offsets” if all the carbon-based organic materials in the state were diverted for gasification to produce electricity. See Table 1 for examples of the organic diversion alternatives. The Contractor shall provide recommendations for further focus to complete the LCA based on relative GHG emission reductions.

Table 1: Organic Diversion Alternatives

Organic Diversion Alternatives	Feedstock Material	Beneficial "Offsets"					
		Avoided fossil fuel	Biofuels	Energy Savings	Water Savings	Carbon sequestration	Reduced Virgin Inputs
Acid Hydrolysis to Ethanol	Compostable Organics, C&D Lumber, and Paper	X	X	X			
Gasification to Electricity	Carbon-Based Organic Materials	X		X			
Anaerobic Digestion to Electricity and Soil Amendment (SA)	Compostable Organics and Paper	X		X	X (SA)	X (SA)	X (SA)
Windrow Composting for Soil Amendment	Compostable Organics			X	X	X	X
Chipping/Grinding for Mulch	Wood Waste			X	X		
Processing into Animal Feed and/or Fertilizer	Food Waste			X			X
Biomass Conversion (Hog Fuel) to Electricity	C&D Lumber, Other Wood Waste, and Agricultural Prunings	X		X			

Task 5) Lifecycle Assessment (LCA) Model

An LCA Model will assist the Board, local governments, and industry in making the next generation of waste management decisions in California. The LCA Model shall be able to conduct a “cradle to cradle” LCA that will quantify the GHG emission reductions, associated beneficial “offsets,” and diversion potential for organic diversion alternatives. The model shall allow for both statewide aggregate analysis as well as more focused regional analyses. One

deliverable shall include a manual describing how Board staff can manipulate key variables of the model on a regional basis.

Delineation of System Boundaries: The system boundaries shall be the existing state of solid waste management for the State of California with a cradle to cradle consideration of beneficial “offsets.” The Contractor shall define the regional areas that will be used to conduct the regional/local analyses. At a minimum, the regional analyses shall include the San Francisco Bay Area, Central Valley, and Los Angeles Basin. The Contractor shall provide a detailed description of the system boundaries specific to these regions, beginning with waste collection methods/infrastructure, landfills and their capacities, composting and conversion technology facilities, waste throughput, and waste stream characterization. Delineation shall include site locations for combination facilities (e.g., co-location of a materials recovery facility and transfer station at a landfill) as well as the site locations of stand-alone facilities. The Contractor shall create a GIS map overlaying the system boundaries.

Development of Algorithms: The Contractor shall develop algorithms that estimate aggregate statewide changes in GHG emission reductions as a result of implementing specific organic diversion alternatives in California. Algorithms shall also be developed for each regional area. These algorithms would estimate GHG emission reductions when X tons of organic materials are diverted to Y organic diversion alternative. The Contractor shall provide full disclosure of the calculations. These algorithms will provide the model with the ability to predict which combination of organic diversion alternatives can achieve at least 3 million metric tons CO₂ equivalent to assist the Board in achieving the zero waste climate action mitigation strategy.

Task 6) Life Cycle Assessment and Data Collection

Methodology: Provide a detailed description of the methodology that will be used to conduct an LCA including all stages in the waste management system from collection, transportation, and materials recovery to conversion, recycling, composting, or land filling for various end-uses of feedstock materials. Describe the methodology that will be used to collect data. The Contractor shall ensure that the methodology used is compliant with the International Organization of Standardization’s (ISO) 14040 Series for conducting LCAs.

Finalize Organic Diversion Alternatives: Work with Contract Manager to finalize which organic feedstock materials and end-uses will be analyzed through the LCA. This decision shall include the largest rate of return of GHG emission reductions for every ton of material diverted for the various organic diversion alternatives using educated assumptions for beneficial “offsets.”

Data Collection: Collect, analyze, and input California-specific data for the final organic diversion alternatives. Where data is unavailable for specific unit processes, the Contractor shall use surrogate data that is most applicable to the specific process and feedstock material being modeled, subject to approval of the Contract Manager.

Task 7) Life Cycle Impact Assessment

Assessment: The Contractor shall conduct a Life Cycle Impact Assessment (Assessment) of the final organic diversion alternatives using a statewide and regional approach for the system boundaries outlined in Task 5 including, but not limited to, the following beneficial “offsets:”

- a) GHG emission reductions;
- b) Carbon sequestration;
- c) Energy requirements and production (e.g., energy balance); and
- d) Tons diverted from the landfill.

LCA Documentation: Upon completion of the Assessment, the Contractor shall document the results of the Assessment, including descriptions of methodology, systems and boundaries analyzed, and assumptions made in performing the Assessment. The Assessment shall include a menu of organic diversion alternatives that can achieve at least 3 million metric tons CO₂ equivalent to assist the Board in achieving the zero waste climate action mitigation strategy. This documentation shall be included in the Final Report.

Task 8) Interpretation of Life Cycle Impact Assessment

The Contractor shall interpret (i.e., identify, quantify, check, and evaluate information) the results of the Assessment. This Life Cycle Interpretation (Interpretation) shall provide information on several organic diversion alternatives that could achieve three million metric tons CO₂ equivalent with information on the amount of diversion achieved. The Interpretation shall include the GHG emission reductions achieved when X tons of organic materials is diverted from the landfill. For example, composting of X tons at Y GHG emissions/ton could achieve Z overall emissions. An estimate shall be completed for several organic diversion alternatives. The Interpretation shall include a recommendation for which combination of organic diversion alternatives can achieve at least three million metric tons CO₂ equivalent to assist the Board in achieving the zero waste climate action mitigation strategy. The Interpretation shall also specify facility infrastructure improvements (e.g. 50 new material recovery facilities) to achieve these GHG emission reductions. It will include a brief analysis of the market potential of products (e.g. ethanol, electricity, soil amendment, mulch, fertilizer) that could be generated by the organics diversion alternatives.

An estimate of aggregate statewide changes in GHG emissions shall be provided. The Interpretation shall also include an estimate of what is needed to assist local jurisdictions and businesses to assess specific opportunities for GHG emission reductions on a regional basis. The regional Interpretation shall also include information on the short-term and long-term capacity for each region to handle organic materials. The Interpretation shall include other significant issues and evaluate the completeness, sensitivity, and consistency of the data and results. This Interpretation shall be included in the Final Report.

Economic Impacts and Analysis

Task 9) Capital and Operating Costs

The Contractor shall determine the economic impacts of implementing the organic diversion alternatives statewide and regionally as outlined in the Interpretation. This task includes calculating the capital and operating cost of recycling, composting, and conversion technology facilities. The Contractor shall provide a range of costs including upper, lower, and best estimates to help the Board identify the uncertainties of the cost estimates. Capital costs shall include equipment, land, permitting, and any other capital outlay associated with siting and constructing the facility(s). Operating costs can include maintenance, insurance, labor, energy, depreciation, feedstock, and any other input that fluctuates with throughput over the life of the facility. The capital and operating cost data will be presented annually in 2005 dollars through the life of the equipment. Cost data will also be presented on an annual per ton basis (over the life of the equipment). This task shall also include calculating the cost of a default scenario in which facility(s) are not constructed and materials continue to be sent to the landfill. Regional characteristics will be considered for the default scenario such as accounting for varying regional landfill capacities when developing the cost to landfill, which should include closure/post closure maintenance costs.

The Contractor shall specify the level and degree of infrastructure required for recycling, composting, and conversion technology facilities. For example, how much infrastructure is required to accommodate the increase in the quantity of paper (including cardboard), plastic, metal, and glass diverted from the landfill? Will the existing infrastructure be sufficient? Or will the construction of 5, 10, 20, or 50 material recovery facilities be required to facilitate the increase in recycling. What other additional infrastructure will be required? For example, would the construction of a glass beneficiation facility or paper recycling plant be necessary? Will additional collection infrastructure be needed?

Task 10) Cost Savings

The Contractor shall determine the annual cost savings of implementing the organic diversion alternatives statewide and regionally as outlined in Task 8. The Board is interested in identifying environmental benefits and related cost savings associated with specific beneficial “offsets.” Cost savings shall be quantified and include, but are not limited to the following examples: cost savings from reduced fossil fuel energy and electricity production (report the expected changes in energy units rather than expected cost impacts), avoided tipping fees when materials are not sent to the landfill, decreased water usage by using compost and mulch in landscapes and in agriculture and cost savings from not needing to purchase herbicides and pesticides when compost and/or mulch is applied to crops and landscapes. An explanation of who would pay the costs or benefits from the savings should be provided. The Contractor is expected to present other cost savings associated with the implementation of organic diversion alternatives outlined in Task 8. For example, the Contractor shall provide the cost savings relative to composting of X tons at Y GHG emissions/ton to achieve Z overall emissions.

Task 11) Cost Effectiveness Assessment

The Contractor shall provide a recommendation in the Final Report that explains which organic diversion alternatives should be pursued statewide, as well as regionally, based on the most cost effective options that result in the greatest GHG emission reductions. This task should consider for each facility: GHG emission reductions, capital and operating costs, and cost savings.

Task 12) Economic Impacts

Economic impacts shall include but are not limited to Primary employment impacts such as the increase in the number of new jobs created with the construction of each new facility(s). Economic impacts can also include secondary impacts such as business creation and its associated employment. It is expected that other businesses will respond to the siting of specific facilities. For example, a chip and grinding or bagging operations facility would be sited near composting facilities. The Contractor is expected to present other economic impacts associated with the implementation of organic diversion alternatives statewide and regionally as outlined in Task 8. Please note this task will not estimate any health based benefits from improvements in either air or water quality. One of the requirements is to report the information in a format that is consistent with the requirements of the Air Resources Board climate change guidance document.

Task 13) Customized California GHG Tool

The Contractor shall develop a Customized California GHG Tool that considers the optimization of GHG emission reductions, diversion and cost statewide and on a regional basis. The first step in developing a Customized California GHG Tool is the completion of an economic model that would be imbedded into the LCA Model. The development of an economic model will enable the tool to complete a statewide and regional economic assessment that will incorporate a full systems approach. The Board could also use the tool in future years to conduct more focused regional analyses to enable local jurisdictions and industry to make informed decisions to prioritize diversion activities to achieve GHG emission reductions.

Final Report

Task 14) Draft Final Report

Under the direction of the Contract Manager and a focus group, the Contractor shall prepare a Draft Final Report. The Draft Final Report shall include an executive summary and describe the screening phase; Customized California LCA Tool; methodology, assumptions, and data used for the LCA; Assessment; Interpretation; Economic Analysis; and Customized California System Analysis Tool. The report shall include a description of the limitations of the Lifecycle Assessment and Economic Analysis. The Draft Final Report shall quantitatively assess the ability of regional markets to absorb increases in composting, biomass to energy, fuels, and electricity infrastructure. It must also include general regional barriers to penetrate those potential markets. The report shall include a manual describing how one can use the Customized California System Analysis Tool including how the customized tool can be modified for local governments with varying feedstock and organic diversion alternatives.

Task 15) Final Report

The Contractor shall prepare a Final Report that documents all aspects of the Life Cycle Assessment and Economic Analysis. The report shall include the following four outputs; cost/ton diverted, cost/GHG reduction, amount of GHG reduction, and amount of material diverted. It must also include a description of the best combination of organic diversion and recycling alternatives that can achieve at least 3 million metric tons CO₂ equivalent to assist the

Board in achieving the zero waste climate action mitigation strategy. Submit the Final Report for approval by the Contract Manager.

The Final Report shall adhere to the Board Publications Guidelines and shall be reviewed by the Board technical editor. The Contractor will not receive final payment until the Final Report has been approved by the Contract Manager. The Final Report shall be printed double-sided, on 100% recycled-content paper.

Specific pages containing full-color photographs or other ink-intensive graphics may be printed on photographic paper. The paper should identify the postconsumer recycled content of the paper (i.e., "printed on 100% postconsumer paper"). When applicable, the contractor shall provide the contract manager with an electronic copy of the document and/or report for the Board's uses. To the greatest extent possible, soy ink instead of petroleum-based inks should be used to print all documents

The Contractor shall be aware that if the Final Report contains copyrighted work in print (tables, graphics, or photographs), or other materials taken from copyrighted sources, the Contractor shall cite the copyrighted material in the Final Report and obtain permission to use the copyrighted material. Contractor shall secure express written permission from the copyright holder or the holder's licensing representative. Contractor will include letters of permission to use copyright material as an Appendix in the Final Report. If contractor does not secure permission to use copyrighted material, said material will not be used in the final report.

IV. CONTRACT/TASK TIME FRAME*

SCHEDULE OF DELIVERABLES		
TASK(S)	DELIVERABLE	DEADLINE
One – Three	Communication and Workplan	June 29, 2007
Four – Eight	Life Cycle Assessment	January 15, 2008
Nine – Thirteen	Economic Impacts and Analysis	July 31, 2008
Fourteen – Fifteen	Final Report	January 30, 2009

*Deadlines may be extended upon written approval of Contract Manager.

V. COPYRIGHT PROVISION

The Contractor assigns to the State any and all rights, title, and interests to any copyrightable material or trademarkable material created or developed in whole or in any part as a result of this Agreement, including the right to register for copyright or trademark of such materials. Contractor shall require that subcontractors agree that all such materials shall be the property of the State. Upon written request by the Contractor, the CIWMB may give, at the Executive Director's sole discretion, written consent to the Contractor to retain all or any part of the ownership of these rights.

The State through the CIWMB hereby grants to the Contractor a royalty-free, nonexclusive, nontransferable license to reproduce, translate, and distribute copies of the materials produced pursuant this Agreement, for nonprofit purposes, and to have or permit others to do so on the Contractor behalf.

VI. WASTE REDUCTION AND RECYCLED-CONTENT PRODUCT PROCUREMENT

In the performance of this Agreement, Contractor shall use recycled content, used or reusable products, and practice other waste reduction measures where feasible and appropriate.

Recycled Content Products: All products purchased and charged/billed to the CIWMB to fulfill the requirements of this contract shall be Recycled Content Products (RCPs), or used (reused, remanufactured, refurbished) products. All RCPs purchased or charged/billed to the CIWMB to fulfill the requirements of the contract shall have both the total recycled-content (TRC) and the postconsumer content (PC) clearly identified on the products. Specific requirements for the aforementioned purchases and identification are discussed in the Terms and Conditions of the Contractual Agreement under Recycled-Content Product Purchasing and Certification.