Appendix A

Proposed Regulation to Reduce Greenhouse Gas Emissions by Requiring Commercial Businesses to Recycle

APPENDIX A

Proposed Draft Regulation to Reduce Greenhouse Gas Emissions by Requiring Commercial Businesses to Recycle

PROPOSED REGULATION ORDER

Adopt new Article 4, Subarticle 10, sections 95620 to 95625, title 17, California Code of Regulations, to read as follows:

(Note: all of the following is new language to be added to the California Code of Regulations.)

SUBARTICLE 10. MANDATORY COMMERCIAL RECYCLING

§95620. Purpose.

This Article implements the Mandatory Commercial Recycling regulation pursuant to §38561 of the Health and Safety Code. The purpose of this regulation is to reduce greenhouse gas emissions by diverting commercial solid waste to recycling efforts and to expand the opportunity for additional recycling services and recycling manufacturing facilities in California.

Note: Authority cited: Sections 38501, 38510, 38560, 38562, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38562, 39003, 39500, 39600, and 39601, Health and Safety Code.

§95621. Definitions.

(a) Except as otherwise noted, the definitions of this Article supplement and are governed by the definitions set forth in Chapter 2 (commencing with §40100), Part 1, Division 30 of the Public Resources Code.

(b) In addition to the definitions incorporated under subdivision (a), the following definitions shall govern the provisions of this Article.

(1) "Annual Report" means the electronic annual report, submitted annually by a jurisdiction, summarizing its progress in reducing solid waste, as required by §41821 of the Public Resources Code and 14 California Code of Regulations §§18794-18794.6.

(2) "CalRecycle" means the Department of Resources Recycling and Recovery.

(3) "Jurisdiction" means a city, county, city and county, or a regional agency that is approved by CalRecycle pursuant to §40975 of the Public Resources Code.

(4) "Business" means any commercial or public entity, that generates four cubic yards or more of commercial solid waste per week, including, but not limited to, a firm, partnership, proprietorship, joint-stock company, corporation, or association that is organized as a for-profit or nonprofit entity, strip mall (e.g. property complex containing two or more commercial entities), industrial facility, school, school district, California State University, community colleges, University of California, special district or a federal, state, local, regional agency or facility. For purposes of this Article, "business" also includes a multifamily residential dwelling of five units or more that generates four cubic yards or more of commercial solid waste per week.

(5) "Commercial solid waste" means all types of solid waste, including recyclable materials that are discarded, from businesses as defined in subdivision (4), but does not include waste from single family residences or multifamily units of less than 5 units.

(6) "Diversion" or "divert" means activities which reduce or eliminate the amount of solid waste from solid waste disposal for purposes of this division, including Article 1 (commencing with §41780) of Chapter 6 of the Public Resources Code.

(7) "Disposal" has the same meaning as "solid waste disposal" as defined in §40192 of the Public Resources Code.

(8) "Franchise" means any agreement between a jurisdiction and a hauler for transporting commercial solid waste.

(9) "Hauler" means any person, commercial or public entity which collects, hauls, or transports solid waste for a fee by use of any means, including but not limited to, a dumpster truck, roll off truck, side-load, front-load, or rear-load garbage truck, or a trailer.

(10) "Landfill" has the same meaning as "solid waste landfill" as defined in §40195.1 of the Public Resources Code.

(11) "Mixed Waste Processing" means processing solid waste that contains both recyclable and/or compostable materials and trash.

(12) "Recycle" or "recycling" means the process of collecting, sorting, cleansing, treating, and reconstituting materials that would otherwise become solid waste, and returning them to the economic mainstream in the form of raw

material for new, reused or reconstituted products which meet the quality standard necessary to be used in the market place, as defined in §40180 of the Public Resources Code. Recycling does not include transformation as defined in Public Resources Code §40201.

(13) "Recyclables" and "recyclable materials" means materials that can be separated from the solid waste stream prior to disposal and collected for use or reuse in the form of raw materials for new, used or reconstituted products, which meet the quality standard necessary to be used in the market place and that are not landfilled. Recyclable materials can include, but are not limited to, paper (including cardboard), plastics, glass, metals, organics, food waste, and non-hazardous construction and demolition materials.

(14) "Rural jurisdiction" means a city or regional agency as defined in §40183 of the Public Resources Code or a rural county as defined in §40184 of the Public Resources Code.

(15) "Self hauler" or "self hauling" means a business that transports its own waste and/or recyclables rather than contracting with a hauler for that service.

(16) "Source separating" or "source separation" means the process of removing recyclable materials from solid waste at the place of generation, prior to collection, and placing them into separate containers that are separately designated for recyclables.

(17) "Solid waste" means all putrescible and nonputrescible solid, semisolid, and liquid wastes, including garbage, trash, refuse, paper, rubbish, ashes, industrial wastes, demolition and construction wastes, abandoned vehicles and parts thereof, discarded home and industrial appliances, dewatered, treated, or chemically fixed sewage sludge which is not hazardous waste, manure, vegetable or animal solid and semisolid wastes, and other discarded solid and semisolid wastes as described in §40191of the Public Resources Code. "Solid waste" does not include hazardous waste, radioactive waste, or medical waste as described in §40191of the Public Resources Code.

(18) "Transformation" means incineration, pyrolysis, distillation, or biological conversion other than composting, as described in §40201 of the Public Resources Code. "Transformation" does not include composting, gasification, or biomass conversion.

Note: Authority cited: Sections 38501, 38510, 38560, 38562, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38562, 39003, 39500, 39600, and 39601, Health and Safety Code, Sections 40100-40201, 40183, 40184, 40191, 40192, 40975, 40192, 40195.1, 40183, 40184, 40192, 40195.1, 40201, 41780-41786, 41783, 41821, and 41952, Public Resources Code.

§95622. Mandatory recycling of commercial solid waste by businesses.

(a) On or before July 1, 2012, a business, as defined in §95621(b)(4), shall reuse, recycle, compost, or otherwise divert its commercial solid waste from disposal by taking one, or any combination, of the following actions:

(1) Source separating recyclable and/or compostable materials (alone or in combination with other programs, activities or processes that divert recyclable and/or compostable materials) from the solid waste they are discarding and either self-hauling, subscribing to a hauler, and/or otherwise arranging for the pick-up of, the recyclable and/or compostable materials separately from the solid waste to divert them from disposal.

(2) Subscribing to a service that includes mixed waste processing (alone or in combination with other programs, activities or processes that divert recyclable and/or compostable materials from disposal), and yielding diversion results comparable to source separation.

(b) To comply with §95622(a), property owners of multi-family complexes may require tenants to source separate their recyclable materials. Tenants must source separate their recyclable materials if required to by property owners of multi-family complexes.

(c) Each business shall be responsible for ensuring and demonstrating its compliance with the requirements of this Section. The activities undertaken by each business pursuant to §95622(a) shall be consistent with local requirements, including, but not limited to, a local ordinance, policy, contract or agreement applicable to the collection, handling or recycling of solid waste.

(d) Except as expressly set forth in §95622(e)(3), this Section does not limit the authority of a jurisdiction to adopt, implement, or enforce a recycling program that is more stringent or comprehensive than the requirements of this Section. Businesses located in such a jurisdiction must comply with any local requirements that have been enacted.

(e) This Subarticle does not modify or abrogate in any manner any of the following:

(1) A franchise granted or extended by a city, county, city and county, or other local government agency;

(2) A contract, license, or permit to collect solid waste granted or extended by a city, county, or other local government agency as of the effective date of this regulation;

(3) The right of a business as provided by §41952 of the Public Resources Code; or,

(4) The existing provisions of §41783 of the Public Resources Code related to transformation that allow jurisdictions to reduce their per-capita disposal rate by no more than 10 percent. Materials sent to transformation facilities must meet the requirements of §41783(a)(2) of the Public Resources Code regarding front-end methods or programs to remove all recyclable materials from the waste stream prior to transformation to the maximum extent possible.

Note: Authority cited: Sections 38501, 38510, 38560, 38562, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38562, 39003, 39500, 39600, and 39601, Health and Safety Code, Sections 41783 and 41952, Public Resources Code.

§95623. Implementation of commercial recycling program by jurisdictions.

(a) Effective July 1, 2012, each jurisdiction shall implement a commercial recycling program which diverts from disposal commercial solid waste generated by businesses, as defined in §95621(b)(4).

(b) The commercial recycling program shall apply to businesses, as defined in §95621(b)(4), but may also apply to any other commercial entity identified by the jurisdiction as being a source of commercial solid waste.

(c) A jurisdiction may determine the specific material types included in its commercial recycling program, which could include, but are not limited to, paper (including cardboard), plastics, glass, metals, organics, food waste, and non-hazardous construction and demolition.

(d) If, prior to July 1, 2012, a jurisdiction has implemented a commercial recycling program that meets all requirements of this Article, as determined by CalRecycle pursuant to §95624, the jurisdiction will not be required to implement a new or expanded program.

(e) If, in order to satisfy the requirements of this Article, a jurisdiction must implement a new, or expand an existing, commercial recycling program, it shall not be required to revise its source reduction and recycling element nor comply with the requirements of §41800 of the Public Resources Code. The jurisdiction shall include the addition or expansion of a commercial recycling program in its annual report.

(f) The commercial recycling program adopted pursuant to Subdivision (a) may include, but is not limited to, implementing a commercial recycling policy or ordinance requiring businesses, as defined in §95621(b)(4), to recycle, requiring a mandatory commercial recycling program through a franchise agreement or contract, or requiring that commercial solid waste from businesses be sent to a mixed waste processing facility.

(1) As part of developing a commercial recycling program under subsection (f), a jurisdiction shall consider if an exemption is warranted for multi-family complexes that lack sufficient space to provide additional recycling bins.

(g) The commercial recycling program shall include education and outreach to businesses, as defined in §95621(b)(4). The jurisdiction shall determine the types of educational and outreach programs to insure that the program targets the components of the jurisdiction's commercial waste stream.

(h) The commercial recycling program shall include identification and monitoring of businesses, as defined in §95621(b)(4), to assess if businesses are complying with §95622(a). If any businesses subject to these regulations are not in compliance with these provisions, the jurisdiction shall, at a minimum, notify those businesses that they are out of compliance.

(i) The commercial recycling program may also include, but is not required to include:

(1) Enforcement consistent with a jurisdiction's authority, including, but not limited to, a penalty or fine structure that, incorporates warning notices, civil injunctions, financial penalties, or criminal prosecution. Any fees or penalties generated by the enforcement program could, in the jurisdiction's discretion, be used to pay associated program costs;

(2) Building design standards that specify space requirements for storage of recyclables or other purposes that may assist the compliance of businesses, as defined in §95621(b)(4), with the program;

(3) Exemptions deemed appropriate by the jurisdiction such as, but not limited to, zoning requirements, lack of storage space, lack of markets, non-generation of recyclable materials, or current implementation by a business of actions that result in recycling of a significant portion of its commercial waste; or

(4) Certification requirements for self-haulers which may include, but are not limited to, requiring businesses, as defined in §95621(b)(4), to maintain written records demonstrating that all self-hauling activities have been

completed in accordance with the standards imposed by the jurisdiction's commercial recycling program.

(j) Each jurisdiction shall report the progress achieved in implementing its commercial recycling program, including education, outreach, identification and monitoring, and if applicable enforcement efforts, by providing updates in its Annual Report required by §41821 of the Public Resources Code.

Note: Authority cited: Sections 38501, 38510, 38560, 38562, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38562, 39003, 39500, 39600, and 39601, Health and Safety Code, Sections 41800 and 41821, Public Resources Code.

§95624. CalRecycle Review

(a) Commencing August 1, 2013, CalRecycle shall review a jurisdiction's compliance with §95623 as part of its review of the jurisdiction's source reduction and recycling element and household hazardous waste element programs, pursuant to 14 California Code of Regulations §18772 and §41825 of the Public Resources Code.

(b) CalRecycle may also review whether a jurisdiction is in compliance with §95623 at any time that CalRecycle receives information that a jurisdiction has not implemented, or is not making a good faith effort to implement, its commercial recycling program.

(c) During its review pursuant to this Section, CalRecycle shall determine whether each jurisdiction has made a good faith effort to implement its selected commercial recycling program. For this purpose, "good faith effort" means all reasonable and feasible efforts by a jurisdiction to implement its commercial recycling program. During its review, CalRecycle may include, but is not limited to, the following factors in its evaluation of a jurisdiction's "good faith effort":

 (1) The extent to which the businesses, as defined in §95621(b)(4), have complied with §95622(a), including information on the amount of solid waste that is being diverted from disposal by the businesses, if available, and on the number of businesses that are subscribing to service;

 (2) The recovery rate of the commercial waste from the material recovery facilities that are utilized by the businesses, the role of that facility in the jurisdiction's overall waste diversion and recycling system, and all information, methods, and calculations, and any additional performance data, as requested and collected by CalRecycle from the material recovery facilities operators pursuant to 14 California Code of Regulations §18809.4;

(3) The extent to which the jurisdiction is conducting education and outreach to businesses, as defined in §95621(b)(4);

(4) The extent to which the jurisdiction is monitoring businesses, as defined in §95621(b)(4), and notifying those businesses that are out of compliance;

(5) The availability of markets for collected recyclables;

(6) Budgetary constraints; and

(7) In the case of a rural jurisdiction, as defined in §95621(b)(14), the small geographic size, low population density or distance to markets.

A jurisdiction's failure to implement its commercial recycling program may suffice for CalRecycle to issue a compliance order pursuant to §41825 of the Public Resources Code, even if the jurisdiction has met its 50 percent per capita equivalent disposal target as required by §41780.05 of the Public Resources Code.

(d) If, after a public hearing on the matter, CalRecycle finds that a jurisdiction has failed to make a good faith effort to implement a commercial recycling program and meet the requirements of §95623, CalRecycle shall issue a compliance order with a specific schedule for achieving those requirements. CalRecycle shall issue the compliance order within 30 days after making its finding of non-compliance.

(e) The compliance order shall identify the portions of the commercial recycling program which are not being implemented or attained by the jurisdiction, or identify areas of the commercial recycling program which need revision. CalRecycle shall also set a date by which the jurisdiction shall meet the requirements of the compliance order.

(f) Pursuant to §41850 of the Public Resources Code, CalRecycle shall hold a hearing to determine whether the jurisdiction has complied with the terms of the compliance order in §95624(d). If CalRecycle determines that the jurisdiction has failed to implement its compliance order and meet the requirements of §95623, CalRecycle shall take additional enforcement action, including imposition of penalties under CalRecycle's established AB 939 procedures contained in §41850 of the Public Resources Code. CalRecycle shall, within 60 days document its determination that the jurisdiction was found to be out of compliance and was penalized, and forward that documentation to the Air Resources Board.

Note: Authority cited: Sections 38501, 38510, 38560, 38562, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38562, 39003, 39500, 39600, 39601, and 40001(a), Health and Safety Code, Sections 41780.05, 41825, and 41850, Public Resources Code.

§95625. Air Resources Board Oversight and Enforcement

Nothing in this Article limits the Air Resources Board's authority pursuant to Division 25.5 (commencing with §38500 of the Health and Safety Code), to monitor compliance with and enforce this regulation. The Air Resources Board retains its oversight role and will take any further actions necessary to implement this regulation, including but not limited to invoking its enforcement authority as described in §38580 of the Health & Safety Code.

Note: Authority cited: Sections 38501, 38510, 38560, 38562, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38562, 39003, 39500, 39600, 39601, and 40001(a), Health and Safety Code.

Appendix B

Mandatory Commercial Recycling Programs in 46 California Jurisdictions

Local Jurisdictions' Application of Mandatory Commercial Recycling Ordinances

The local government programs that CalRecycle staff has reviewed typically regulate either the commercial generators directly or implement the program through hauler requirements on (contract, franchised, licensed, etc.). Most commonly, commercial generators are required to subscribe to source-separated recycling services through the hauler(s). Alternatively, a couple of programs place specific diversion requirements on the haulers, which may or may not include individual business source reduction efforts. Most of the programs also specifically address self-haul generators.

a. Target Sectors

While the majority of the mandatory commercial recycling programs reviewed target all business sectors; others prescribe distinct requirements by business type. For example, some programs target office buildings and hospitality facilities, and a respective list of materials. Programs also differ in how they deal with multifamily complexes, self-haul, special events, and/or construction and demolition generators, with many placing particular requirements on such accounts or projects. For example, multi-family accounts may be included in the recycling requirement for commercial generators, but limited to cardboard in terms of materials that must be recycled.

b. Thresholds

A number of programs do not specify any threshold for included or covered commercial generators, while others delineate applicability by volume of solid waste generated (3, 4 or 6 cubic yards), square footage of the property, number of the units in a multi-family complex (4 or 5 units), or percentage of waste generation. Additionally, a number of the sector specific requirements are dependent on thresholds. For example, the sector requirements for office buildings may be limited to buildings with more than 20,000 square feet. Similarly, a number of the programs require recycling of construction and demolition materials if the dollar amount or project size meets or exceeds a certain threshold. One such program imposes recycling requirements on industrial loads with 90% or more of asphalt, concrete, land clearing, brush, sand or rock. Such thresholds are generally addressed through definitions and/or exemptions.

c. Target Materials

The majority of the programs reviewed offer a list of recyclable materials from which to choose and use language such as "*including but not limited to* paper, plastics, glass..." Conversely, a couple of programs are specific with respect to the required materials for recycling. These materials may be expressly listed or incorporated by reference in a definition such as "designated" or "covered" materials that are defined by the program manager and/or the collection agreement. In such programs, these specific material types required for recycling may also be considered contaminants with respect to implementation and enforcement.

Again, some mandatory commercial recycling programs target certain types of generators as well as material types. As an example, a couple of the programs have distinct requirements for *hospitality facilities* (all restaurants and taverns, hotels and motels with eating establishments) and the *materials* such generators must recycle (aluminum, cardboard, glass bottles and hard, tin and bi-metal cans and white goods). Organic waste, food waste in particular, and construction and demolition waste are two material types that are most frequently addressed individually, as they typically require specialized collection and processing systems. Food waste for example is only specifically addressed in five of the programs. Construction and demolition wastes are addressed separately in a number of the sample programs, while others did not address the waste type at all.

d. Exemptions

All of the existing programs reviewed by CalRecycle contain some kind of exemption, whether on the generator, covered materials or a required activity. Examples of generator exemptions to recycling requirements include those that:

- Self-haul materials for recycling,
- Subscribe to third-party recycling service,
- Have space limitations for recyclable containers,
- Do not generate covered recyclable materials,
- Have a conflict with municipal zoning regulations or requirements, and
- For which the cost of recycling is prohibitive.

Additionally, one of the existing programs includes an automatic exemption from the recycling requirements for "The United States, State of California, a City, the County, a special district or other local public agency, or any employee or member of the Armed Forces". Another excludes a school district, special district, or agency of the jurisdiction, State or Federal government from the collection of recyclables by the franchisee, as they have the right to contract for separate services if desired.

Specific materials may also be exempted from the mandatory recycling program. Examples of such materials include "wearing apparel, bedding or other refuse from homes, hospitals or other places where highly infection or contagious diseases have prevailed…", highly flammable, or explosive or radioactive refuse and hazardous wastes. Alternatively, a required activity may be exempted. For example, one of the programs requires specific separation of recyclable materials except when they are source-separated by the generator for the purpose of redeeming them at a buy-back recycling center or donating them to a nonprofit or community group conducting recycling programs as a fundraising activity. In such a case, these materials are exempted from the requirement of separation of materials. Another program offers an exemption opportunity for both the generator (multi-family residences and commercial) and the material type (green waste) if the facility's gardener, landscaper, tree trimmer, etc. removes the materials as a part of the total service provided. In most cases, it appears the exemptions are in response to specific local circumstances, such as waste composition, business types, recycling infrastructure, and access to markets.

e. Performance Metrics

Reporting and performance requirements vary widely. Approaches to performance metrics largely depend upon the program goal and who is being regulated (e.g., haulers vs. business generators). For example, in the case of the jurisdiction that regulates haulers to meet a 50% diversion rate (based on source reduction, recycling and composting activities), diversion data is used as the metric for determining compliance. Additionally, these haulers report on numbers of accounts served, providing another metric that can be used to evaluate program effectiveness.

Most of the ordinances or municipal codes addressing mandatory commercial recycling reviewed explicitly outline the associated performance metrics, while others may incorporate these details or expand upon them within the specific service agreement or contract. Examples of performance metrics included in the mandatory commercial recycling programs reviewed include:

- Permit operators, franchised waste haulers, etc. submit scheduled reports (e.g., monthly or annually) to the Director or the jurisdiction's conservation coordinator, specifying the amount of recyclable material collected within the jurisdiction and the location to which the recyclables were taken;
- Some jurisdictions require quarterly, semi-annual or annual reporting by the contract collectors to itemize the types, amounts and charges for services rendered for the purposes of calculating and collecting the franchise fee; and
- Service providers or private collectors may be required to retain, and upon request, make available to the jurisdiction, records, receipts, invoices, and other papers relevant to their private collection service (type of waste generator, amount of volume or weight collected or disposed of, classification of materials as solid waste, recyclables, green waste, etc.).

Again, additional performance metrics may be incorporated into the specific service agreement between the local jurisdiction and the contracted or franchised service provider(s).

f. Implementation

Mandatory commercial recycling program implementation encompasses multiple program and policy areas including existing contracts, franchises, etc., self-haul, funding, education, outreach, enforcement, etc. Depending on the existing local recycling infrastructure, mandatory commercial recycling may be implemented through the contracted/franchised/permitted hauler(s), through the local government itself, or in combination. Many of the programs utilize staff, local enforcement officers, or other personnel, to visit businesses to educate them on the program and to ensure that they are participating. A couple of the programs incorporate mandatory commercial recycling implementation and enforcement with other environmental initiatives serving the same sector for efficiency and cost effectiveness. Within the programs reviewed, there is one known case of a phased-in implementation approach, to provide additional time for education and outreach. In terms of funding, more often than not, franchise fees fund administration, implementation and enforcement of the program. Other funding sources include variable collection/service rates, locally–imposed fees to meet AB939 requirements, and general fund.

Most programs allow generators to use a third-party recycler as long as the service is free. Additionally, the majority of the programs permit businesses to self-haul their recyclables and include a clause regarding the "*Rancho Mirage* case"[1] to allow generators to donate or sell the recyclables. The majority of the programs reviewed also specifically prohibit scavenging of recyclable materials.

g. Education/Outreach

All of the jurisdictions listed in the table below make extensive education and outreach efforts a fundamental part of implementation of the mandatory commercial recycling program. The details of such efforts may be addressed within the related ordinance, municipal code, and/or guidance documents; however, it may also be outlined within the specific recycling collection service agreement/contract(s). Some ordinances require an owner and/or generator to contact commercial accounts to make them aware of recycling requirements, provide containers and service, ensure clear signage and/or offer written recycling requirements on site. Others may require the service provider to offer education and outreach to targeted generators and conduct waste assessments. Though not necessarily addressed in the program requirements (e.g., policy, ordinance, municipal code), most of the jurisdictions also use a web page as a tool for education and outreach along with direct mail, brochures, booklets etc.

h. Enforcement

Most of the existing mandatory commercial recycling programs specifically address enforcement within the ordinance or municipal code (e.g., enforcement, enforcement authority, enforcement/regulatory provisions, implementation and enforcement). Often the program Director (Public Works, Environmental Services, etc.) or designee is authorized to administer and enforce the mandatory commercial recycling provision, often including selecting the designated or covered recyclable materials. Again this may be done through the local government itself, through the service providers or a combination thereof. In some cases, the licensed haulers are responsible for enforcing the ordinance, while in others, the programs employ code inspectors or recycling coordinators to conduct on-site inspections. A number of ordinances also require the regulated businesses to submit a recycling plan or self-haul certification form.

Approaches also vary with respect to how these programs address violations of the requirements. Many of the programs take a technical assistance approach for compliance rather than issuing an immediate notice of violation, citation, penalty/fine, while others build in time (e.g., 60 days after approval of the ordinance, a year) before starting to enforce the requirements. Penalties in terms of the amount of fines vary among jurisdictions (e.g., up to $500 per violation and at least one example of one not to exceed $1000). Another approach to issuing penalties involves the suspension or revocation of business licenses and/or the issuance of a nuisance abatement assessment lien upon a violator.

The following table summarizes the elements of the mandatory commercial recycling programs in 46 California jurisdictions.

Mandatory Commercial Recycling Programs in 46 California Jurisdictions

City	County		Who is regulated?					Materials					Definition of Recycling			Exemptions								
		Exclusive franchise (limited number of haulers)	Commercial generators required to recycle	Includes multi-family dwellings	Sector specific (hospitality, office, etc.)	Threshold (generation tonnage, size of facility, # of units, project costs, etc.)	Includes self-haul	Material types suggested (may include but are not limited to...)	Specific materials required for recycling	Includes green waste/organics	Specifically includes food waste	C&D/industrial generator requirements	Includes transformation	Excludes transformation	Specially includes mixed waste processing facilities	Covered materials are not generated	Materials generated are not readily recyclable	Cost of recycling is unreasonable prohibitive	Site/space constraints	Donating or selling recyclables	Green waste recycled landscaping or gardening service	Jurisdiction-approved alternative	Other government agencies (school district, City, etc.)	Vacancy (e.g., unoccupied for 90+ days)	Addresses market failure/available markets
Alameda	Alameda	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	-	-	-	✓	-	-	-	✓	✓	✓	✓	-	-
Pittsburg	Contra Costa		✓	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
Pleasant Hill	Contra Costa	✓	✓	✓	-	✓	✓	✓	-	✓	-	-	-	-	-	✓	-	-	✓	✓	✓	-	-	-	-
Fresno	Fresno	✓	✓	✓	-	✓	-	✓	-	✓	-	✓	-	✓	-	-	-	-	-	✓	✓	-	-	-	-
Kerman	Fresno	✓	✓	✓	-	✓	-	-	✓	✓	-	✓	-	-	-	-	-	-	✓	-	✓	-	-	-	-
Kingsburg	Fresno	✓	✓	✓	-	✓	-	✓	-	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
Mendota	Fresno	✓	✓	✓	-	✓	-	-	✓	✓	-	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
Calexico	Imperial	✓	✓	✓	-	-	-	-	✓	-	-	-	-	✓	-	-	-	-	✓	-	-	-	-	-	-
Agoura Hills	Los Angeles	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
Arcadia*	Los Angeles	✓	-	-	✓	✓	-	✓	-	-	-	-	✓	-	-	-	✓	✓	✓	-	-	-	-	-	-
Avalon	Los Angeles	✓	✓	-	✓	-	-	-	✓	-	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
Calabasas	Los Angeles	✓	✓	✓	-	✓	-	-	✓	-	-	-	-	✓	✓	-	-	-	-	✓	-	-	-	-	-
El Monte	Los Angeles	✓	✓	✓	-	✓	-	-	-	✓	-	✓	-	-	-	-	-	-	-	✓	✓	-	-	-	-
Gardena	Los Angeles	-	✓	✓	-	✓	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
Norwalk	Los Angeles	✓	✓	✓	-	✓	✓	-	✓	✓	-	✓	✓	-	-	-	-	-	-	✓	✓	-	-	-	-
Pasadena*	Los Angeles	-	-	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
Pomona	Los Angeles	✓	✓	✓	-	-	-	-	-	✓	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
Rancho Palos Verdes	Los Angeles	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	✓	✓	-	-	-	-
Chowchilla**	Madera	✓	✓	✓	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
Huntington Beach	Orange	✓	-	-	-	-	-	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
Citrus Heights	Sacramento		✓	✓	-	✓	✓	✓	-	-	-	-	-	✓	-	✓	✓	-	✓	✓	✓	-	✓	-	-
Elk Grove	Sacramento	-	✓	✓	-	✓	✓	✓	-	-	-	✓	-	✓	-	✓	✓	-	✓	✓	-	-	✓	-	-
City & County of Sacramento	Sacramento	-	✓	✓	-	✓	✓	✓	✓	-	-	✓	-	✓	-	✓	✓	-	✓	✓	-	-	✓	-	-
Rancho Cordova	Sacramento	-	✓	✓	-	✓	✓	✓	✓	-	-	-	-	✓	-	✓	✓	-	✓	✓	-	-	✓	-	-
Carlsbad	San Diego	✓	✓	✓	✓	-	-	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓	-	-	-	✓	-
Chula Vista	San Diego	✓	✓	✓	-	✓	-	✓	-	✓	-	✓	-	✓	✓	-	-	-	-	✓	-	-	-	-	✓
Del Mar	San Diego	✓	✓	✓	✓	✓	-	-	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
Encinitas	San Diego	✓	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
Escondido	San Diego	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Imperial Beach	San Diego	✓	✓	✓	✓	✓		-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
La Mesa	San Diego	✓	✓	✓	✓	✓	-	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lemon Grove	San Diego	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
National City	San Diego	✓	✓	✓	✓	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oceanside	San Diego	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	✓	✓	✓	-	-	-	-
Poway	San Diego	✓	✓	✓	-	-	-	-	✓	✓	-	-	-	-	-	✓	-	-	✓	✓	-	✓	✓	-	-
San Diego City	San Diego	-	✓	✓		✓		-	✓	✓	✓		-	-	-	✓	-	-	✓	✓	-	✓	-	-	✓
San Diego County	San Diego	-	✓	✓	✓	✓	✓	-	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
San Francisco	San Francisco	✓	✓	✓	-	-	-	-	✓	✓	✓	✓	-	✓	-	-	-	-	✓	✓	-	-	-	-	-
Manteca	San Joaquin	-	✓	✓	-	✓	-	✓	-	✓	-	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
Stockton	San Joaquin	-	✓	✓	-	✓	-	-	-	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
SLO IWMA	San Luis Obispo	✓	✓	✓	-	-	✓	✓	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
San Carlos	San Mateo	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-	-	✓	-	✓	-	-	✓	-	-	-	-	-	-
Santa Barbara County	Santa Barbara	✓	✓	✓	-	-	✓	✓	-	-	-	-	-	-	-	✓	-	✓	✓	✓	-	-	✓	-	-
Cotati	Sonoma	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fillmore	Ventura	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-	-	-	✓	-
Ventura County	Ventura	✓	✓	✓	✓	✓	-	-	✓	✓	-	✓	✓	-	-	✓	✓	✓	-	✓	✓	-	-	-	-

*Haulers are required to meet diversion rate. Exemptions for hauler requirements include refusal by a business to cooperate in the recycling programs and/or report internal business recycling. Definition of recycling includes source reduction.

**Greenwaste only for Chowchilla

City of Loomis requires hauler to provide OCC recycling bin and service to businesses, upon request. Otherwise, use mixed waste processing facility.

Huntington Beach uses a mixed waste facility for businesses and MF dwellings, but it is not noted specifically in the ordinance.

City of Palo Alto is developing a recycling and composting ordinance. They are in the process of community meetings.

Mandatory Commercial Recycling Programs in 46 California Jurisdictions (continued)

City	County	Performance Metrics						Enforcement						Funding		Program Information
		diversion tonnage/volume	disposal tonnage/volume	number of accounts served	Generator (in)compliance	Gross receivables (gross monthly receipts)	recycling or waste management plan/report	Jurisdiction (e.g., director or designee)	Assistance/Education/Training	Notice of violation	Fines/Penalty	Suspension/Revocation of permit	includes antiscavenging provisions	franchise/hauler fees	collection service rates	
Alameda	Alameda	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	http://www.cityofalamedaca.gov/Go-Green/Recycling
Pittsburg	Contra Costa	✓	-	-	-	-	✓	✓	✓	✓	✓	-	-	-	✓	http://www.ci.pittsburg.ca.us/index.aspx?page=435
Pleasant Hill	Contra Costa	✓		✓	-	-	-	-	-	-	-	-	✓	-	✓	http://www.pleasanthill.ca.gov/index.aspx?NID=624
Fresno	Fresno	-	-	-	-	-	-	✓	✓	✓	✓	-	✓	-	✓	http://www.fresno.gov/Government/DepartmentDirectory/PublicUtilities/SolidWaste/MultiCommServices/Default.htm
Kerman	Fresno	-	-	-	-	-	-	✓	✓	✓	✓	-	✓	-	✓	http://www.cityofkerman.net/solidwaste.html
Kingsburg	Fresno	-	-	-	-	✓	-	✓	-	-	✓	-	✓	✓	✓	http://www.ca-ilg.org/node/1631
Mendota	Fresno	-	-	-	-	-	-	✓	✓	✓	✓	-	✓	-	✓	http://thecityofmendota.com/utilities.htm
Calexico	Imperial	-	-	-	-	-	-	✓	-	✓	✓	-	✓	-	-	http://www.calexico.ca.gov/index.php?option=com_content&task=view&id=157&Itemid=100
Agoura Hills	Los Angeles	✓	✓	✓	-	✓	-	✓	✓	✓	✓	-	✓	✓	✓	http://www.ci.agoura-hills.ca.us/Index.aspx?page=177
Arcadia*	Los Angeles	✓	✓	✓	✓	✓	-	✓	✓	-	-	✓	-	✓	-	http://www.ci.arcadia.ca.us/home/index.asp?page=857
Avalon	Los Angeles	-	-	-	-	-	-	✓	-	✓	✓	-	✓	-	✓	http://www.lacsd.org/info/solid_waste/recycleinfo/recyclecontacts/RecycFull.asp?C=City%20of%20Avalon
Calabasas	Los Angeles	✓	✓	✓	-	✓	-	✓	✓	✓	✓	✓	-	✓	✓	http://www.cityofcalabasas.com/environmental/recycle.html
El Monte	Los Angeles	✓	✓	-	-	-	✓	✓	-	✓	✓	✓	✓	-	✓	http://www.ci.el-monte.ca.us/Government/PublicWorks/EnvironmentalServices.aspx
Gardena	Los Angeles	✓	✓	✓	-	-	✓	-	-	-	-	-	✓	-	✓	http://www.ci.gardena.ca.us/departments/PublicWorks/recyclingandtrash.html
Norwalk	Los Angeles	✓	-	✓	-	-	-	-	-	-	-	-	-	-	✓	http://www.ci.norwalk.ca.us/environmental.asp
Pasadena*	Los Angeles	✓	✓	✓	✓	✓	-	✓	✓	-	✓	✓	-	✓	-	http://ww2.cityofpasadena.net/publicworks/smiwmll/com_recycling.asp
Pomona	Los Angeles	✓	✓	✓	-	-	✓	✓	✓	-	-	-	✓	✓	✓	http://www.ci.pomona.ca.us/city_departments/public_works/Franchise_Haulers.php
Rancho Palos Verdes	Los Angeles	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	http://www.palosverdes.com/rpv/publicworks/waste-recycle-conservation2.cfm
Chowchilla**	Madera	-	-	-	-	-	-	✓	-	-	✓	-	-	-	✓	http://www.ci.chowchilla.ca.us/pubserv/solid_waste.htm
Huntington Beach	Orange	✓	-	✓	-	-	-	-	-	-	-	-	✓	-	✓	http://www.huntingtonbeachca.gov/Government/Departments/Public_Works/maintenance/solidWaste/recycle.cfm
Citrus Heights	Sacramento	✓	✓	✓	-	-	✓	✓	-	✓	✓	-	-	-	✓	http://www.ci.citrus-heights.ca.us/home/index.asp?page=832
Elk Grove	Sacramento	✓	✓	✓	✓	-	✓	✓	-	-	-	-	✓	✓	✓	http://www.egtrashrecycleservices.org/business-recycling/index.htm
City & County of Sacramento	Sacramento	✓	✓	✓	-	-	✓	✓	✓	✓	✓	-	✓	✓	-	http://www.msa2.saccounty.net/swa/busrecycling/Pages/RecyclingRequirements.aspx
Rancho Cordova	Sacramento	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	-	-	✓	-	http://www.cityofranchocordova.org/Index.aspx?page=439
Carlsbad	San Diego	-	-	-	-	-	-	✓	✓	✓	-	-	✓	-	✓	http://www.carlsbadca.gov/services/environmental/recycling/Pages/default.aspx
Chula Vista	San Diego	✓	✓	-	-	-	✓	✓	✓	✓	-	-	✓	-	✓	http://www.ci.chula-vista.ca.us/clean/EnvironmentalServices/recycling.asp#busguidelines
Del Mar	San Diego	-	-	-	-	-	-	✓	✓	✓	✓	-	✓	-	✓	http://www.delmar.ca.us/faqs/Pages/TrashServiceFAQ.aspx
Encinitas	San Diego	-	-	-	-	-	-	✓	✓	✓	-	-	-	✓	✓	http://www.ci.encinitas.ca.us/Resident/HomeAP/TrashRecycling/
Escondido	San Diego	-	-	-	-	-	-	✓	✓	✓	-	-	✓	✓	✓	http://www.escondidodisposal.com/commercial-collection.html
Imperial Beach	San Diego	✓	-	-	-	-	-	✓	✓	✓	✓	-	✓	-	✓	http://www.edcodisposal.com/services/imperialbeach/index.html
La Mesa	San Diego	-	-	-	-	-	-	✓	✓	✓	✓	-	-	-	-	http://www.edcodisposal.com/commercial/lamesa/recycling.html
Lemon Grove	San Diego	-	-	-	-	-	-	✓	✓	✓	✓	-	✓	-	✓	http://ci.lemon-grove.ca.us/index.aspx?NID=65
National City	San Diego	-	-	-	-	-	-	✓	✓	✓	✓	-	-	-	-	http://www.ci.national-city.ca.us/index.aspx?page=230
Oceanside	San Diego	-	-	-	-	-	-	✓	-	-	-	-	✓	-	-	http://www.ci.oceanside.ca.us/Datarelation.aspx?Content=131
Poway	San Diego	✓	✓	-		-	-	-	✓	-	✓	-	✓	✓	✓	http://poway.org/Index.aspx?page=307
San Diego City	San Diego	✓	✓	-	-	-	-	✓	-	-	-	-	✓	✓	✓	http://www.sandiego.gov/environmental-services/recycling/ro/commercial/index.shtml
San Diego County	San Diego	-	-	-	-	-	-	✓	✓	✓	✓	-	✓	-	-	http://www.sdcounty.ca.gov/dpw/recyclinghome.html
San Francisco	San Francisco	✓	✓	✓	✓	-	-	✓	✓	✓	✓	-	✓	-	✓	http://www.sfenvironment.org/our_programs/topics.html?ssi=3&ti=86
Manteca	San Joaquin	-	-	-	-	-	-	✓	-	-	-	-	-	-	✓	http://www.ci.manteca.ca.us/pwt/swdiv/crecycling.asp
Stockton	San Joaquin	✓	✓	-	-	-	-	✓	-	✓	-	-	✓	-	✓	http://www.stocktongov.com/commercial/index.cfm
SLO IWMA	San Luis Obispo	✓	-	-	-	-	✓	✓	✓	✓	✓	✓	✓	-	✓	http://iwma.com/programs-events/business-programs.html
San Carlos	San Mateo	✓	✓	✓	✓	-	-	✓	✓	✓	✓	-	-	-	✓	http://www.rethinkwaste.org/businesses/mandatory-commercial-recycling
Santa Barbara County	Santa Barbara	-	-	-	✓	-	-	✓	✓	✓	✓	-	-	✓	✓	http://www.lessismore.org/Programs/bsnss_recycling_complete.html
Cotati	Sonoma	-	-	-	-	-	✓	✓	-	✓	✓	-	-	-	✓	http://unicycler.com/commercial/sonoma/cotati
Fillmore	Ventura	-	-	-	-	-	-	✓	-	✓	✓	-	-	-	✓	http://www.fillmoreca.com/resourcemgmt.htm
Ventura County	Ventura	✓	✓	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	http://portal.countyofventura.org/portal/page/portal/PUBLIC_WORKS/wasteManagement/commercial/recycling

Appendix C

Survey of Existing Recycling Programs and Costs of K-12 California School Districts

APPENDIX C -- Survey of Existing Recycling Programs and Costs of K-12 California School Districts

The following table contains pertinant information gathered during the survey of California school districts.

School District	Area	Contact	# of Schools	Total Enrollment	Recycling	How Long	Comments
Piedmont City Unified School District	Bay Area	Michael Brady (510)594-2608	6	2,500	Yes	over 10 years (2.5 years green recycling)	The recycling program as of this year is implemented throughout the district with 100% participation. We began with only the elementary schools (3 schools) and the middle school (1 school) and this year we have brought on board the 2 high schools. Our goal is to have 75% reduction in waste, and we are near meeting that goal. We separate everything including food waste (green waste).
Pleasanton Unified School District	Bay Area	Myla Grasso (925)462-5500 For Cost information call LeeAnn Pomplun (925)426-4335	15	14,900	Yes	at least 8 years	We have 100% participation from our schools. Every school recycles. It has been cost-effective for us. We recycle paper, plastic, cans, cardboard and even food scrap.
Oakland Unified School District	Bay Area	Roland Broach (510) 879-8352	125	Did not know off hand (46,099*)	Yes	A while	Over 80% of Schools participate. Recycling consist of the separation of paper/cardboard in one bin and cans/plastic in another bin. Waste Management has met with custodians at all of the schools.
Parlier Unified School District	Central Area	Bobv Morse (559)646-3316 x1027	7	3,300	Yes (voluntary)		We do recycle but it is not an official recycling program. It is site specifid and not implemented district wide. The schools recycle for fundraising. The recycling in our district is voluntary.
Clovis Unified School District	Central Area	Chris Allen (Secondary Sites) (559)327-9259 Bill Rice (Elementary Sites) (559)327-9252	42	Did not know off hand (38,004*)	Yes		They are working with IWS and are implementing the recycling program for all schools. They will have 100% parciticipation.
Fresno Unified School District	Central Area	John Quinto (559)457-3045	108	73,000	Yes	Since 2002	They do mix recycling. It is separated at the waste management plants. They're doing over 50% recycling.
River Delta Unified School District	North East Area	Wayne Rebstock (707)374-1708	about 13 total, 8 main campuses	2,000	There is a very limited amount of recycling. There is not a full district program in place.		We have been recycling in the district offices for a while, but it has been challenging to develop a recycling program at all of our schools because the district is spread out amongst 6 different communities (Cortland, Isleton, Hood, Clarksburg, Walnut Grove and Rio Vista). Some cities waste disposal management have recycling pickup some don't. There are different waste haulers in each town. We have hired a firm to assist us in developing trash management, but currently it is voluntary and site specific. There is no district wide recycling program. Some schools conduct e-recycling for fundraising opportunity and the district does have a green waste recycling in place by mulching the grass that is mowed from football fields etc. We have had a difficult time generating the interest to recycle. Getting some assistance with outreach and education may speed up the interest of a district wide program.
Folsom Cordova	North East Area	Shirley Churchhill (916) 355-1100 x184	30	Did not know off hand (19,182*)	Yes	over 6 years	The recycling program is implemented throughout the district. We have 100% of the schools are recycling.
Elk Grove Unified School District	North East Area	Lauren Baker (916) 686-7809	65	Did not know off hand (12,985*)	Yes	5 to 7 years	
Sulphur Springs School District	South Area	Maintenance & Operations	9	5,500 to 6,000	Yes	1.5 to 2 years	
Glendale Unified School District	South Area						
Los Angeles Unified School District	South Area	Mr. Soe Aung (213) 241-3199	over 700	Not sure (670,746*)	Yes	3 to 4 years	We have partnered with the city of LA and have implemented a recycling program with schools that are in the boundaries of the LA city. Not all schools participate, but those that do conduct a mix recycling program and recycle paper, cardboard, cans, bottles. We do have a problem with vandilism and stealing anything that has been recycled that has a redemption value. This happens on a nightly basis and usually a big mess is left behind which does not make our custodians very happy. Currently, we (LAUSD) are trying to get 100% participation.
Bonsall Union School District	San Diego Area						
Oceanside Unified School District	San Diego Area	Renee Fernandez or Miguel Valles (760)966-7620	28	(21,122*)	Yes	over 10 years	We have 100% participation from our schools. We provide them with everything to conduct the program, but it is up to the schools to do the recycling. Every school recycles.
San Diego Unified School District	San Diego Area	Janet Whited (619) 725-5506	about 210	around 135,000	Yes	3 to 4 years	Recycling is mix or co-mingle system District wide. It is separated at waste management site. Also, have site specific recycling for student programs. Custodians are not required to empty the recycle cans from class rooms although many of them will do it. At the schools who don't have custodians taking care of this task students are ask to help. We are more successful getting the student involvement at the elementary levels then the middle and high schools.
Gridley Unified School District	North Area	Alda Villalpando (530) 846-4721	5	2,155	Yes	2 years	Recycling program is implemented at all schools. We separate out all paper then the rest is mixed and sepated by waste management. Some bottle/cans are separated by students for student activities.
Paradise Unified School District	North Area	Dan LaVerne (530)872-6495	7 public, 3 charter	(4,581*)	Yes	1year for Public, 2 years for Charter	Yes all classrooms in the elementary level have blue recycle barrels. High schools have the large Recycle Bins for cans/bottlles. We recycle paper/cardboard etc. We have 100% participation in all the schools. We work with the Northern California Recycle and Reuse (WM).
Chico Unified School District	North Area	Randy Salado (530) 895-4179	23	12,000 to 12,500	Yes	A long time	Each school recycles the cans/plastic to benefit student programs. This is considered site specific recycling. Then the district has in place a recycling program for paper/cardboard that is collected by waste management.

*Count taken from ARB Data

Appendix D

Survey of Local Jurisdictions to Estimate Costs of Implementation

CalRecycle and ARB staff prepared and disseminated a survey to solicit information from local jurisdictions to estimate costs for local jurisdiction to implement the education, outreach and monitoring requirements of the proposed regulation. The survey questions focused on the initial start-up costs and annual on going costs for jurisdictions to provide web-based recycling information, printed informational materials, and direct contact with businesses and monitoring of program participation. A copy of the survey questions is provided herein.

Cost Estimates for Mandatory Commercial Recycling Education, Outreach

1. Estimating Costs for Basic Education and Outreach for Mandatory Commercial ...

Answers to questions 1 to 14 below will be used to assess a jurisdiction's implementation costs of an education and outreach program as required by the proposed mandatory commercial recycling regulation. Question #1 provides your contact information. Questions 2 to 5 pertain to costs for developing and maintaining a web page. Questions 6 to 9 pertain to costs for developing, printing, and distributing printed material. And, questions 10 to 14 pertain to costs for direct contact activities in an education and outreach program.

1. Please tell us who you are and where you are from.

Name:

Company:

Address:

Address 2:

City/Town:

State:

ZIP:

Email Address:

Phone Number:

*** 2. Has your jurisdiction developed web content to educate and outreach to businesses on your mandatory commercial recycling ordinance? If no, please skip to Question #5.**

○ Yes ○ No

3. Can you provide an estimate of the cost to develop your mandatory commercial recycling web-page (start-up costs)? If possible, could you also share the annual cost to maintain this information on the web? (Please include PY costs identified in Question 4 in the cost estimates.)

4. Do you have a specific budget for creating and maintaining the web page? How is it funded?

5. Are there associated personnel resources expended to the web page design and maintenance (e.g., how many or what percentage of PYs are dedicated annually to this activity for the mandatory commercial recycling ordinance)?

Cost Estimates for Mandatory Commercial Recycling Education, Outreach

* 6. What types of printed materials (e.g., brochures, factsheets, mailing inserts) has your jurisdiction (or hauler) developed to promote mandatory commercial recycling (program requirements, how to comply, and where to get more information and assistance) and how often are they distributed?

7. Can you provide an estimate of the cost to develop these printed materials to businesses on the mandatory commercial recycling ordinance? If possible, could you also share the annual cost to print and disseminate the printed materials? (Please include PY costs identified in Question 8 in the cost estimates.)

8. Do you have a specific budget for developing and distributing printed materials to promote the mandatory commercial recycling ordinance? How are these development, printing and distribution activities funded?

9. Are there associated personnel resources expended to printed material design and distribution (e.g., how many or what percentage of PYs are dedicated annually to this activity for the mandatory commercial recycling ordinance)?

* 10. Does your jurisdiction (or the hauler) provide education and outreach to businesses regarding the mandatory commercial recycling ordinance through direct contact (e.g., presentations to business forum such as Chambers, providing on-site assistance, waste assessments, etc.)?

○ Yes ○ No

11. What type of direct contact education and outreach activities does your jurisdiction provide?

Cost Estimates for Mandatory Commercial Recycling Education, Outreach

12. Can you provide an estimate of the cost to develop and implement the direct contact education and outreach efforts in support of the mandatory commercial recycling? If possible, could you also share the annual cost to maintain this information? (Please include PY costs identified in Question 13 in the cost estimates.)

13. Does the jurisdiction have a specific budget for this? How is this outreach activity funded?

14. What are the associated personnel resources expended to direct contact outreach activities (e.g., how many or what percentage of PYs are dedicated annually to this activity for the mandatory commercial recycling ordinance)?

Cost Estimates for Mandatory Commercial Recycling Education, Outreach

2. Estimating Costs for Monitoring Regulated Businesses under Mandatory Commer...

Answers to questions 1 to 4 below will be used to assess jurisdiction's implementation costs of a monitoring program as required by the proposed mandatory commercial recycling regulation.

*** 1. Does the jurisdiction or the hauler identify and monitor the regulated businesses to assess if they are subscribing to and participating in recycling services and notifying those businesses that are not in compliance?**

○ Yes ○ No

2. Does the jurisdiction have an estimate of the annual and the initial start-up costs of the monitoring program (please include PY costs identified in Question 4)? If so, can you please share this information?

3. Does the jurisdiction have a specific budget identified for the monitoring of businesses regulated through the mandatory commercial recycling program? How is this activity funded?

4. What are the associated personnel resources expended for this monitoring activity (e.g., how many or what percentage of PYs are dedicated annually to this activity for the mandatory commercial recycling ordinance)?

Cost Estimates for Mandatory Commercial Recycling Education, Outreach

3. General Questions

Answers to questions 1 to 3 below will be used to assess jurisdiction's implementation costs of a monitoring program as required by the proposed mandatory commercial recycling regulation.

*** 1. Approximately how many businesses are subject to the local mandatory commercial recycling ordinance?**

*** 2. Does your jurisdiction have mandatory refuse collection, as well as mandatory commercial recycling?**

- ◯ Yes
- ◯ No

If yes, is there an option for self-hauling recyclables or solid waste with respect to the mandatory commercial recycling ordinance? Also, do you have an estimate number of businesses affected by the mandatory commercial recycling ordinance that self-haul?

3. Please identify the type of solid waste system the jurisdiction utilizes.

- ◯ Exclusive franchise agreement
- ◯ Open market
- ◯ Nonexclusive franchise agreement
- ◯ Other (please specify)

4. Conclusion and Contacts

Thank you so much for you assistance!

If you have any questions about this survey or the mandatory commercial recycling measure in general, please contact Marshalle Graham at 916-341-6270 or marshalle.graham@calrecycle.ca.gov, or Tracey Harper at 916-341-6531 or tracey.harper@calrecycle.ca.gov.

Thanks again!

Appendix E

Localized Traffic Impacts

Appendix E

Localized Impact Case Studies

As part of the environmental impact analysis, five neighborhoods were identified for the case studies to evaluate potential localized impacts in EJ communities. These neighborhoods have been identified and are intended to represent several regions of California. These neighborhoods included: Wilmington, Pacoima, West Oakland, Barrio Logan, and a location close to Arvin (in the Fresno area). It was found that no waste recycling facilities or composting facilities are located in Barrio Logan; therefore, no case study was performed for that neighborhood. There is one material recycling facility each in Wilmington, Pacoima, and West Oakland and these facilities were used in the analysis. For the Arvin neighborhood, no material recycling facility is located in this area. Although there is a composting facility close to Arvin, it was not used in the analysis because the most likely scenario assumes minimal increase in composting. Therefore, a large material recycling facility close by was chosen for the analysis.

Based on the results of the transportation/traffic analysis detailed earlier, the potential additional trips to the identified material recycling facilities due to the proposed regulation was calculated by multiplying the total additional number of trips for the region (shown in Appendix H – Traffic Analysis) by the ratio of the material recycling facility's capacity to the total capacity of the region. For the facility in West Oakland, it was estimated that a maximum of one additional trip per month may result from the proposed regulation in 2020. For the facility in Wilmington, it was estimated that a maximum of one additional trip every two days may result from the proposed regulation in 2020. For the facility in Pacoima, it was calculated that two additional trips per day may result from the proposed regulation at full implementation in 2020. Lastly, for the large transfer station in Fresno, it was calculated that 10 additional trips per day may result from the proposed regulation in 2020. A summary of the results is shown in Table E-1. It is important to note that there will be a decrease in traffic to landfills as a result of this regulation. The landfill trips reduced therefore offsets some of the increased traffic to these recycling facilities.

Table E-1. Potential Impacts on EJ Communities

Neighborhoods Considered	Additional Trips per day	VMT (miles/day)	PM 2.5 (pounds/day)	NO_x (pounds/day)	CO_2 (pounds/day)
Barrio Logan	0	0	0	0	0
Wilmington	0.5	5	8.29E-04	0.126	23.2
West Oakland	0.4	4	6.06E-04	0.092	17.0
Pacoima	1.8	19	2.92E-03	0.443	81.8
Arvin/Fresno	9.5	96	0.014	2.21	406.5

The potential increase in emissions of criteria pollutants due to the increased traffic in these neighborhoods was also analyzed based on the associated mileage of the additional trips estimated and shown in table E-1. As shown in the Table E-1, for the transfer station in Fresno, with the potential worst case impact due to about 10 additional trips per day, an additional 96 VMT per day was estimated for the immediate neighborhood near the transfer station. Based on the emissions information detailed in Chapter IV, and shown below in Table E-2, we estimated a potential increase in NOx of 2 pounds per day and the potential increase in PM2.5 of 0.01 pounds per day by 2020. Using the health impact assessment data developed by ARB as part of the Diesel Particulate Matter Control Measure for On-road Heavy-duty Diesel-fueled Residential and Commercial Solid Waste Collection Vehicles rulemaking, the potential cancer risk from diesel PM associated with these emissions would be insignificant (well below 1 chance in a million). This increase will be further reduced in the future by ARB diesel regulations and new diesel engine standards that phase in over time. (ARB, 2010b)

Table E-2. Upper Limit Estimates of Emissions Increases for Scenario 2

Year	VMT/day	PM 2.5 (tons/day)	NO_x (tons/day)	CO_2 (tons/day)
2012	4,420	4.09E-04	0.079	9.6
2013	8,841	7.97E-04	0.151	19.1
2014	13,261	1.16E-03	0.216	28.5
2015	17,681	1.51E-03	0.273	38.0
2016	22,102	1.83E-03	0.323	47.3
2017	26,522	2.14E-03	0.365	56.7
2018	30,942	2.44E-03	0.401	66.0
2019	35,363	2.74E-03	0.432	75.3
2020	39,783	3.02E-03	0.459	84.6

Appendix F

Proposed Method for Estimating Greenhouse Gas Emission Reductions from Recycling

PROPOSED METHOD FOR ESTIMATING GREENHOUSE GAS EMISSION REDUCTIONS FROM RECYCLING

August 1, 2011

Planning and Technical Support Division

California Air Resources Board

California Environmental Protection Agency

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Proposed Method for Estimating Greenhouse Gas Emission Reductions from Recycling

EXECUTIVE SUMMARY

This method quantifies the material-specific greenhouse gas emission reduction benefits associated with recycling. The life-cycle approach used in this method incorporates avoided emissions from manufacturing using recyclables, the use of raw materials in the manufacturing process (i.e., harvested wood), transportation emissions, and recycling efficiency. The following equation is used to calculate each recycling emission reduction factor (except dimensional lumber; RERF):

$$RERF = ((MS_{virgin} - MS_{recycled}) + FCS - T_{remanufacture}) * R_{use}$$

where,

RERF	=	Recycling emission reduction factor ($MTCO_2e$/ton of material)
MS_{virgin}	=	Emissions associated with using 100% virgin inputs for manufacturing the material ($MTCO_2e$/ton of material)
$MS_{recycled}$	=	Emissions associated with using 100% recycled inputs for manufacturing the material ($MTCO_2e$/ton of material)
FCS	=	Forest carbon sequestration ($MTCO_2e$/ton of material)
$T_{remanufacture}$	=	Transportation emissions associated with remanufacture destination ($MTCO_2e$/ton of material)
R_{use}	=	Recycling efficiency (fraction of material remanufactured from ton of recycled material)

The above equation uses an approach similar to one established by the United States Environmental Protection Agency (USEPA). This method modified USEPA's approach to include California-specific data and added a model to evaluate forest carbon sequestration. A summary is shown in Table ES-1.

Table ES-1. Recycling emission reduction factors (RERFs) for each material.

Material	RERF[a]	Material	RERF[a]
Aluminum	12.9	Magazines/3rd class mail	0.3
Steel	1.5	Newspaper	3.4
Glass	0.2	Office paper	4.3
HDPE	0.8	Telephone books	2.7
PET	1.4	Dimensional lumber	0.21
Corrugated cardboard	5.0	Mixed Plastics[b]	1.2

[a] Units are in $MTCO_2e$/ton of material.
[b] The mixed plastics average assumes a mix of 71% PET and 29% HDPE.

A qualitative uncertainty analysis performed for each of the above variables shows that the RERFs used in this method are in an appropriate range (with respect to the sensitivities of each variable) for each material. A literature review indicates each RERF is comparable to other emission factors in existing studies.

1. BACKGROUND

The benefits of recycling are multifaceted and range from the reduction of metal pollutants in leachate[1] to the reduction of greenhouse gas emissions[2-6]. In the past decade, many studies have discussed assigning specific materials greenhouse gas (GHG) emission reduction factors associated with recycling.[4,5,7,8] The GHG emission reduction factors are designed to encourage recycling from a climate change perspective and are typically based on relative emission reduction benefits. In the United States Environmental Protection Agency (USEPA) Waste Reduction Model (WARM), emission benefits of recycling, composting, or combusting wastes are calculated relative to landfilling.[4] Also, USEPA acknowledges that WARM is a planning tool and should not be used to quantify for greenhouse gas emission reductions in an accounting scheme (such as a GHG inventory).[4]

Greenhouse gas benefits from recycling are determined by using a life cycle approach that compares virgin material manufacturing with recycled material manufacturing.[9,10] For inorganic materials (i.e., aluminum, glass, steel, plastics), the manufacturing stage is limited to emissions associated with obtaining raw materials and raw material processing at the manufacturing location.[4,11] The manufacturing inputs for wood-based organic materials (i.e., office paper and newspaper) are similar to inorganic materials, but include a factor to account for forest carbon sequestration.[4] Forest carbon sequestration benefits from recycling result from the avoided emissions associated with tree harvesting and from the additional carbon storage in a tree that would have been harvested in the absence of recycling.[12-15] Forest carbon sequestration is difficult to quantify, leading most analyses to only qualitatively assess the benefit as greater than zero.[14,16] One study, conducted by the USEPA, quantifies the forest carbon sequestration benefit based upon the avoided emissions from mechanical or chemical pulp processing.[4] The results from WARM for forest carbon sequestration employ a stock change approach and are applicable to national-level planning goals for recycling.[4] The greenhouse gas inventory for forests in California uses an atmospheric flow model, which contrasts with the national model.[17]

The purpose of this method is to generate recycling emission reduction factors (RERFs) that are consistent with GHG accounting practices used in California. The RERFs calculated from this method are not intended to replace existing studies. This method estimates RERFs for the following materials: aluminum cans, steel cans, glass, high density polyethylene (HDPE), polyethylene terephthalate (PET), corrugated cardboard, magazines/3rd class mail, newspaper, office paper, phonebooks, dimensional lumber and mixed plastics (mix of HDPE and PET). The emission reduction factors are calculated from the best available data sources and include quantification methods for the process and transportation emissions associated with manufacturing, a forest carbon sequestration factor, transportation emissions associated with moving the recovered material to its point of remanufacture, and a recycling efficiency term. Lastly, a comparison to literature-based studies and a sensitivity analysis will be completed to validate this method in the context of existing work.

2. METHODS

The methods used to determine the RERFs for each material are described in the following section. The boundary,[18] or life cycle stages used to quantify each RERF, for this method defines the emission benefits of recycling, including manufacturing emissions and forest carbon sequestration. In addition, the transportation emissions associated with moving the recycled material to its point of remanufacturing will be considered as well as the recycling efficiency.

2.1 Process and transportation emissions

Life cycle greenhouse gas emissions associated with a manufactured material may be calculated as follows:

$$LCA = MS + US + EOLS \qquad (1)$$

where,

LCA	=	Life cycle greenhouse gas emissions of the material.
MS	=	Emissions associated with the manufacturing stage of the material
US	=	Emissions associated with the use stage of the material
EOLS	=	Emissions associated with the end of life stage of a material

The manufacturing stage includes the emissions associated with the generation of a particular material. This includes emissions from the mining, extraction, processing and transportation of the material inputs. The use stage accounts for the energy required to use the material or transform it into usable product. The end-of-life-stage includes material disposal. End-of-life options include landfilling, recycling, composting, or combusting the material.

When evaluating the life cycle emissions reductions due to recycling, the following equation applies:

$$LCA_{total} = (MS_{virgin} + US_{virgin} + EOLS_{virgin}) - (MS_{recycled} + US_{recycled} + EOLS_{recycled}) \qquad (2)$$

Assuming $US_{virgin} = US_{recycled}$ and $EOLS_{virgin} = EOLS_{recycled}$, then

$$LCA_{total} = MS_{virgin} - MS_{recycled} \qquad (3)$$

where,

LCA_{total}	=	Total life cycle emissions associated with recycling
MS_{virgin}	=	Emissions associated with using 100% virgin inputs for manufacturing the material

US_{virgin}	=	Emissions associated with the use stage of the virgin material
$EOLS_{virgin}$	=	Emissions associated with the end of life stage of the virgin material
$MS_{recycled}$	=	Emissions associated with using 100% recycled inputs for manufacturing the material
$US_{recycled}$	=	Emissions associated with the use stage of the recycled material
$EOLS_{recylced}$	=	Emissions associated with the end of life stage of the recycled material

The manufacturing datasets for each material were obtained from three main sources in Table 1.

Table 1. Material references for upstream process and transportation emissions.

Material	Reference
Aluminum	USEPA (1998)[a], USEPA (2003)[b]
Steel	USEPA (1998)
Glass	USEPA (2003)
HDPE	USEPA (1998), USEPA (2003)
PET	USEPA (1998), USEPA (2003)
Corrugated cardboard	USEPA (1998), USEPA (2003)
Magazines/3rd class mail	USEPA (2003)
Newspaper	USEPA (1998), USEPA (2003)
Office Paper	USEPA (1998), USEPA (2003)
Phonebooks	USEPA (1998), USEPA (2003)

[a] Ref. 10; [b] Ref. 9.

Datasets consisted of process emissions (emissions associated with manufacturing a material) and transportation emissions (emissions associated with transporting the raw inputs to the production site) for the manufacture of a particular material in a closed loop system. A closed loop system implies that recycled products are used to make a similar product (i.e., recycled aluminum cans are used to make more aluminum cans or office paper is used to make more office paper).[19] More detailed calculations for the raw data used to obtain the process and transportation emissions is shown in the Supplemental Spreadsheet. In two cases, the manufacturing process inputs included a recycled material component; virgin steel includes 20% recycled material and virgin cardboard contains 10% recycled material.[10]

With respect to electricity used in manufacturing, a national electricity emission factor was used because the manufacturing stage of each material does not necessarily take place in California.[20,21] Emission factors for various fuel types were obtained from the ARB's Local Government Operations Protocol[22] as a primary option and other sources as a secondary choice.[23,24] For all upstream process and transportation emissions, emissions for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) were calculated, multiplied by their global warming potentials (1 for CO_2, 21 for CH_4 and 310 for N_2O) and summed together in units of carbon dioxide equivalents(CO_2e; see Supplemental Spreadsheet).

Emissions associated with precombustion[25] (i.e., emissions associated with mining the fuels used in the manufacturing stage) were included in this method. Precombustion emissions were omitted for steel due to lack of data for this material. The precombustion emissions come from a single source.[9] The reported process and transportation emissions are an average of the two datasets (when applicable).[9,10]

2.2 Recycling Efficiency Factor

Studies have shown that recycled material is not fully recovered at a recycling facility nor is the recycled material used in a 100% capacity at the remanufacturing facility.[4] In order to account for these collection and use inefficiencies, a material-specific recycling efficiency factor will be applied to the RERF. The recycling efficiency factor is based on a previous study completed by the USEPA (Table 2).[4]

Table 2. Recycling efficiencies of each material.

Material	Recycling recovery efficiency (%) (a)	Recycling remanufacture efficiency (b)	Recycling efficiency (a x b)
Aluminum	100	0.93	0.93
Steel	100	0.98	0.98
Glass	90	0.98	0.88
HDPE	90	0.86	0.77
PET	90	0.86	0.77
Corrugated cardboard	100	0.93	0.93
Magazines/3rd class mail	95	0.71	0.67
Newspaper	95	0.94	0.89
Office Paper	91	0.66	0.60
Phonebooks	95	0.71	0.67

2.3 Transportation Correction Factor

The transportation emissions associated with moving the recycled material to its remanufacturing stage affects the overall RERF. In order to account for this, a correction factor will be applied to the RERF. Studies conducted by the California Department of Conservation,[26] the California Integrated Waste Management Board,[27] and the American Forest and Paper Association[28] produced data used to determine the final destination of the recycled material (Table 3).

Table 3. Remanufacturing distribution of recycled materials in California.

Material	Remanufacturing Destination
Aluminum[a]	99% Southeast, 1% Mexico, Europe, Brazil
Steel[b]	90% Pacific Rim, 10% California
Glass[a]	85 % California, 15% in Mexico, Texas, Colorado, Washington, Oklahoma
HDPE[a]	46 % California, 36 % in China, 18 % Southeast
PET[a]	77% China, 10 % Southeast, 14% California
Corrugated cardboard[c]	36% China, 64% United States mix
Magazines/3rd class mail[c]	36% China, 64% United States mix
Newspaper[c]	36% China, 64% United States mix
Office paper[c]	36% China, 64% United States mix
Phonebooks[c]	36% China, 64% United States mix

[a] Ref. 26. The data from this source is based on recycled beverage containers.
[b] Ref. 27.
[c] Ref. 28. The American Forest and Paper Association does not disaggregate to the state level. For more information, please see: http://paperrecycles.org/stat_pages/recovered_paper_goes.html.

The transportation miles were based on transportation scenarios within California, within North America, and overseas transport (Table 4). The transportation assumptions were based on average distances to each location and was sensitive to non-ocean going vessel transport at the destination site. For example, travel assumption 4 (International: Asia) assumes an average of 60 miles of truck and 300 miles of rail travel in California and 140 miles of truck and 700 miles of rail travel in its destination country. Transport emission factors were applied uniformly to all legs of the trip.

Using the appropriate fuel emission factors, greenhouse gas emissions from transportation were calculated for each transportation type: truck (101 g CO_2/net ton-mile), rail (22 g CO_2/net ton-mile) and ocean going vessel (19 g CO_2/net ton-mile).[29] The truck value is based on a California instate tractor trailer emission factor. Other types of trucks (e.g., drayage trucks or trucks that travel in multi-states) have varying emission factors, but only change the overall emission factor by ~1%.[30] The rail emission factor is based on fuel consumption rates provided by the Association of American Railroads[31] and a diesel emission factor from the Local Government Operations Protocol[22]. The ocean going vessel emission factor was generated from the ARB Marine Model, Version 2.3.[32] For information about the results the Marine Model produces, please see the Emissions Estimation Methodology for Ocean Going Vessels.[33]

Table 4. Transportation assumptions for recycled materials in California.

Destination	Truck miles	Rail miles	Ocean going vessel miles*	Justification
1.California	60	300	0	The majority of recycled materials in California are transported out of state by rail or ocean-going vessel. The major ports in California are located near population centers. On average, the trips in the population centers will have lower truck and rail miles, while transporting recycled goods to their remanufacturing location within in California may have higher truck and rail miles.
2. United States (Southeast)	200	2300	0	Most aluminum smelters that accept aluminum recycled in California are located in the Southeast. The Southeast destination assumes a trip that leaves California and arrives in Alabama as an average trip to the Southeast
3. United States (average)	200	1600	0	The trip mileage in this scenario assumes the average trip ends up in the Midwest.
4. International (Asia)	200	1000	7000	The trip mileage in this scenario accounts for the truck and rail miles associated with getting the recycled material to a port. The destination of the recycled goods is Mainland China and truck and rail mileage is included for transporting the goods in China.
5. International (other)	200	2000	4000	This mileage scenario assumes an average destination between Europe and South America (Brazil). It includes truck and rail transportation in California and the destination country.

*Ocean going vessel miles are based on nautical miles.

2.4 Forest Carbon Sequestration

A chemical composition approach was taken to assign a forest carbon sequestration factor to each wood-based organic material (corrugated cardboard, magazines/3rd class mail, newspaper, office paper, phonebooks, and dimensional lumber). On average, a tree contains about 50 percent carbon on a dry weight basis, with the rest of the elemental composition mainly hydrogen, oxygen, nitrogen, and other trace elements.[34] Additionally, information is available on the amount of harvested wood (not including bark, leaves, small stems, etc.) it takes to make a specific unit of material.[35,36] Table 5 shows the amount of virgin wood required to produce a ton of given paper product.

Table 5. Amount of virgin wood needed to produce one ton of each wood-based organic material.

Product	Amount of wood needed (lbs/ton)
Corrugated cardboard[a]	6,060
Newspaper[a]	4,180
Office Paper[a]	6,940
Magazines/3rd class mail[a,b]	6,940
Phonebooks[a,c]	4,180

[a] Ref. 36.
[b] Amount of wood needed for magazines is the same for office paper due to similar processing methods.
[c] Amount of wood needed for phonebooks is the same for newspaper due to similar processing methods.

When a tree is harvested from a forest, the carbon sequestration potential of the harvested tree is no longer available because it has stopped growing. Recycling a wood-based organic material alleviates the need to harvest trees because recycled wood products are substituted for virgin material. For this reason, the carbon sequestered by a tree due to recycling can be considered to be the growth of a non-harvested tree after the expected year of harvest.

$$\text{FCS} = \text{Carbon sequestered in tree } (\text{MTCO}_2\text{e}) = \sum_{h}^{99} (V_{h+1} - V_h) * d_t * 0.5 * 0.00016636 \quad (4)$$

where:

h	=	year the tree is harvested
V_h	=	volume of the tree in the h^{th} year (ft^3)
V_{h+1}	=	volume of the tree in the $(h+1)^{th}$ year (ft^3)
d_t	=	density of the tree, dry weight basis (lb/ft^3)
0.5	=	factor converting total mass of tree to carbon content
0.00016636	=	factor converting total carbon content to $MTCO_2e$ (includes factor for tree survival rate)[37]

The above equation (4) was used to calculate a forest carbon sequestration for each wood-based organic material.

The Forest Carbon Sequestration (FCS) model represents an average, or "theoretical" tree used in the production of wood products. The theoretical tree consists only of the trunk. The leaves, bark, stems, branches and roots were not considered in this model. The theoretical tree was based upon empirical loblolly pine (*Pinus taeda*) data that consisted of a Site Index of 80 (i.e., average tree height after 50 years is 80 feet for a given stand) for a natural pine plantation that lives 100 years[38,39]. The loblolly pine was chosen because it has a wide range in the Southeastern United States, is the most commercially viable species in this region, and is commonly used for pulp production and dimensional lumber[40,41]. The height of the tree as a function of time was constructed from two different sources and the diameter at breast height (dbh) was calculated using a tree growth rate table.[39,42] It was assumed that the tree had a dendrochronology of approximately 5 incremental growths per inch in its early life phases, which slowed to around 7 as the tree approached 100 years in age.[42] The volume of the tree was calculated by using a bole approach.[43] For this method, the middle portion (above the dbh and below the top section) of the tree was divided into tapered regions (up to 9, depending on height) and the top of the tree was modeled as a cone, while below the dbh was assumed a cylinder.

Once the volume was calculated, the increased growth was calculated by determining the volume increase on a yearly basis (e.g. volume in year 26 minus volume in year 25). The harvest year (h, equation 4) was year 25. The weight of the tree was determined by multiplying the volume by the density. The weight was divided by a factor of 2 to account for carbon content and then converted to units of $MTCO_2e$/tree (Equation 4). Lastly, the tree carbon sequestration value (Equation 4) was then divided by 10 to account for the mortality rate of the tree.[45-47]

2.5 Final recycling emission reduction factor (RERF)

The above four sections describe each variable under consideration for determining the RERF. The emission reductions from recycling occur during the manufacturing stage and the with forest carbon sequestration. The emissions occur during the transportation of the recovered material to its remanufacturing emissions. The sum of these above terms is then corrected by the recycling efficiency term. The final RERF value was obtained using the following equation:

$$RERF = ((MS_{virgin} - MS_{recycled}) + FCS - T_{remanufacture}) * R_{use} \qquad (5)$$

where,

RERF	=	Recycling emission reduction factor ($MTCO_2e$/ton of material)
MS_{virgin}	=	Emissions associated with using 100% virgin inputs for manufacturing the material ($MTCO_2e$/ton of material)
$MS_{recycled}$	=	Emissions associated with using 100% recycled inputs for manufacturing the material ($MTCO_2e$/ton of material)
FCS	=	Forest carbon sequestration ($MTCO_2e$/ton of material)
$T_{remanufacture}$	=	Transportation emissions associated with remanufature destination ($MTCO_2e$/ton of material)
R_{use}	=	Recycling efficiency (fraction of material remanufactured from ton of recycled material)

2.6 Emission reduction factor for dimensional lumber

Recycled dimensional lumber (e.g. 4x4, 2x4, 1x8 etc.) does not exhibit closed loop recycling in California. Instead, recycled lumber is chipped and used for biomass combustion. The recycling emission reduction factor for dimensional lumber was determined using the following equation:

$$RERF_{DL} = DL_b - DL_e \tag{6}$$

where (all units in $MTCO_2e$/ton of lumber)

$RERF_{DL}$	= recycling emission reduction factor for dimensional lumber
DL_b	= avoided emissions associated with recycling dimensional lumber
DL_e	= emissions associated with processing recycled dimensional lumber

Recycling dimensional lumber increases biomass use for electricity generation, which alleviates the need to use fossil-fuel based energy sources. This was simulated by applying a California grid average electricity emission factor as the avoided emissions from using biomass.[22] It was also assumed that 1 dry ton of wood chips is equivalent to 2 green tons of lumber and 1 dry ton of wood chips is able to generate 1 MWh of electricity.[48] This value is conservative due to the drying steps lumber goes through during processing. Emissions from the biomass burning were not included in this calculation. The carbon dioxide emissions from biomass burning are considered biogenic and the methane and nitrous oxide emissions are small (0.006 $MTCO_2e$/MWh) when compared to the overall RERF. The emissions from processing recycling dimensional lumber into wood chip biomass were determined by evaluating the chipping rate from a standard chipper (3.3 dry tons/hour) and emissions (19.8 kg CO_2/hr).[49,50]

3. RESULTS AND DISCUSSION

The results of this method and a discussion that evaluates the validity of the recycling emission reduction factors (RERFs) are presented below. The first five sections focus on the inputs used to determine each RERF. The last sections present a qualitative uncertainty analysis of the method and a comparison of the results with the literature for each material.

3.1 Process and Transportation Emissions

This section evaluates the process and transportation emissions included in the RERF calculations. As described in the methods section, the boundaries for these emissions are restricted to the manufacturing stage of the life cycle. The emissions include all emissions associated with the production of a particular material.

The process and transportation emissions (including precombustion) for each material are shown in Tables 6, 7 and 8. An average of two studies[9,10] was used when available. In some cases, the raw transportation data were not included in the study. In these instances, the overall emission factor included only process emissions or the transportation data from USEPA (1998)[10] were used as a proxy for omitted USEPA (2003)[9] transportation data. Even though the transportation emission data set was not complete for all materials, the contribution of transportation emissions to the overall upstream emission value was generally small.

Table 6. Manufacturing stage emissions for each material.[a]

	Production Using Virgin Material Inputs						
	Process Emissions			Transportation Emissions			
Material	USEPA (1998)[b]	USEPA (2003)[c]	Average[d]	USEPA (1998)[b]	USEPA (2003)[c]	Average[d]	Total Emissions
Aluminum	13.3	14.1	13.7	0.3	0.5	0.4	14.1
Steel	2.0		2.0	0.1		0.1	2.1
Glass		0.34	0.34		0.04	0.04	0.38
HDPE	1.3	1.4	1.35	0.1	N/A[e]	0.1	1.4
PET	2.1	1.4	1.75	0.2	N/A[e]	0.2	2.0
Corrugated cardboard	2.3	2.2	2.25	0.1	0.1	0.1	2.4
Magazines/3rd class mail		2.3	2.3		N/A	N/A[f]	2.3
newspaper	2.0	2.4	2.2	0.1	0.03	0.07	2.3
office paper	4.4	3.1	3.75	0.2		0.2	3.9
phonebooks		2.6	2.6		N/A	N/A[f]	2.6
	Production Using Recycled Material Inputs						
Aluminum	0.36	0.86	0.61	0.003	0.002	0.0025	0.6
Steel	0.35		0.35	0.08		0.08	0.4
Glass		0.21	0.21		0.02	0.02	0.23
HDPE	0.4	0.14	0.27	0.1	N/A[e]	0.1	0.37
PET	0.4	0.14	0.27	0.1	N/A[e]	0.1	0.37
Corrugated cardboard	1.1	0.9	1.0	0.1	0.1	0.1	1.1
Magazines/3rd class mail		2.2	2.2		N/A	N/A[f]	2.2
newspaper	1.3	1.2	1.25	0.05	0.002	0.026	1.3
office paper	1.6	1.3	1.45	0.1	0.06	0.08	1.5
phonebooks		1.4	1.4		N/A	N/A[f]	1.4

[a] All units are in $MTCO_2e$/ton of material.
b Ref. 10.
[c] Ref. 9.
[d] For steel cans, glass, magazines/3[rd] class mail, and phonebooks the average consists of only one value. Even though an n=1 does not constitute an average, this value was placed in this column for consistency purposes.
[e] The transportation data for HDPE and PET were not included in Reference 9. For this reason, the process emissions were averaged but only one transportation value was used.
[f] The transportation data was not included in Reference 9. It is assumed for magazines/3[rd] class mail and phonebooks that the transportation factor contributes negligibly to the overall emission reduction factor.

Table 7. Precombustion emissions for the manufacturing stage of each material.[a,b]

Material	Primary Production (virgin material)	Secondary Production (recycled material)
Aluminum	0.53	0.07
Steel[c]	N/A[d]	N/A[d]
Glass	0.12	0.03
HDPE	0.21	0.06
PET	0.43	0.06
Corrugated cardboard	0.03	0.03
Magazines/3rd class mail	0.07	0.07
Newspaper	0.16	0.09
Office Paper	0.04	0.06
Telephone books	0.11	0.06

[a] Units are in $MTCO_2e$/ton of material.
[b] The precombustion emissions were generated from Ref. 9.
[c] Precombustion emissions for steel was not included in Ref. 9.
[d] N/A = not available.

Table 8. Summary of the manufacturing emission reductions (sum of process and precombustion) for each material.[a,b]

Material	Primary production (virgin material) (a)	Secondary production (recycled material) (b)	Total manufacturing emission reductions (a-b)	Percent Reduction (%) ((a-b)/a)
Aluminum	14.6	0.7	14.0	95.9
Steel[c]	2.1	0.4	1.7	81.0
Glass	0.5	0.26	0.2	40.0
HDPE	1.6	0.43	1.1	68.8
PET	2.4	0.43	2.0	83.3
Corrugated cardboard	2.4	1.1	1.3	55.3
Magazines/3rd class mail	2.4	2.3	0.1	4.2
Newspaper	2.5	1.4	1.0	40.0
Office Paper	3.9	1.6	2.4	61.5
Telephone books	2.7	1.5	1.2	44.4

[a] Units are in $MTCO_2e$/ton of material, unless noted.
[b] The reported numbers from (a) and (b) may not sum together due to rounding.
[c] Steel does not have emissions from precombustion included.

The final emission reduction values vary for each material. The material with the highest reductions associated with recycling instead of using virgin material is aluminum (14.0 $MTCO_2e$/ton) while the lowest is magazines/3rd class mail (0.1 $MTCO_2e$/ton). The reason for the large discrepancies in each material type is due to the varied production mechanisms that occur. Aluminum refining requires a large electricity input while the production of glass (0.2 $MTCO_2e$/ton) does not require such an intensive use of electricity.

3.2 Transportation Correction Factor

Using the assumptions for recycled product distribution (Table 3) and miles travelled to reach that destination (Table 4), the overall transportation emissions associated with each material is shown in Table 9. This value specifically addresses the transportation associated with moving the recycled material from the location it was recovered to its remanufacturing destination. In many cases, this information may also be included in the transportation emissions that are included in the 100% recycled data (Table 6). However, the recycling transportation data listed in Table 6 does not disaggregate the transportation emissions from moving the recycled material from the total transportation emissions needed to remanufacture the recycled material.[10] For this reason, the $T_{remanufacture}$ term is included in the method, with the assumption that the recycling transportation term in the manufacturing stage (Table 6) may overlap with this term. This assumption leads to a more conservative RERF (by about 3%, on average).

Table 9. Destination assumptions used and $T_{remanufacture}$ for each material.

Material	Assumptions[a]	Emissions[b,c]
aluminum	2, 5	0.07
steel	1, 4	0.16
glass	1, 3	0.02
HDPE	1,2, 4	0.08
PET	1, 2, 4	0.14
corrugated cardboard	3, 4	0.10
magazines/3rd class mail	3, 4	0.10
newspaper	3, 4	0.10
office paper	3, 4	0.10
phonebooks	3, 4	0.10

[a] The assumption number corresponds to the mileage assumptions in Table 4 and are based upon the data accumulated in Table 3.
[b] The emission factors associated with the forms of transportation are: trucks - 101 g CO_2/net ton-mile, rail – 22 g CO_2/net ton-mile; and ocean going vessels – 19 g CO_2/net ton-mile (See Methods section for a list of references). The total transportation emission value was generated by multiplying the proportion of materials transported to each destination (i.e., California, etc.) by the amount of miles associated with each trip leg.
[c] Unit are in $MTCO_2e$/ton of material.

The destination values used for aluminum are based on a qualitative description because an exact number was not available.[26,51] Additionally, the value used for wood-based organic materials is a United States average number.[28] Due to the small magnitude of the emissions from $T_{remanufacture}$, the majority of the RERF value will be determined by the manufacturing emission savings and forest carbon sequestration (for wood-based organic materials only).

3.3 Forest Carbon Sequestration

The theoretical tree model was designed to compute the forest carbon sequestration potential for recycling each type of wood-based organic material. The model only includes the marketable component of the tree (i.e., trunk) and does not include any leaves, stems, roots or branches in the calculations. While carbon storage does occur in other parts of the tree besides the trunk,[52] a conservative approach is used in this study. The trunk of the tree was modeled based on *P. taeda* (loblolly pine) and the trunk dbh (Figure 1) and height (Figure 2) as a function of age were generated from previous studies.[38,39]

The dbh was determined from a study that showed an average loblolly pine dbh is 5.9 inches at a height of 35 feet and 11 inches at 66 feet.[38] This experimental information was combined with tree growth charts that estimated growth from the number of tree rings in the outer inch of the trunk.[39,42] To match the height curve, it was estimated that the growth in the diameter at breast height (dbh) was 3% from year 41-60, 2.2% from year 61-70, 1.2% from year 71-85 and 0.5% from year 85-100 (about 7 rings in the outer inch of the trunk). The height curve was consistent with a study completed by the Cooperative Extension Service at the University of Georgia.[39]

Figure 1. Graph showing the dbh of a tree as a function of age.

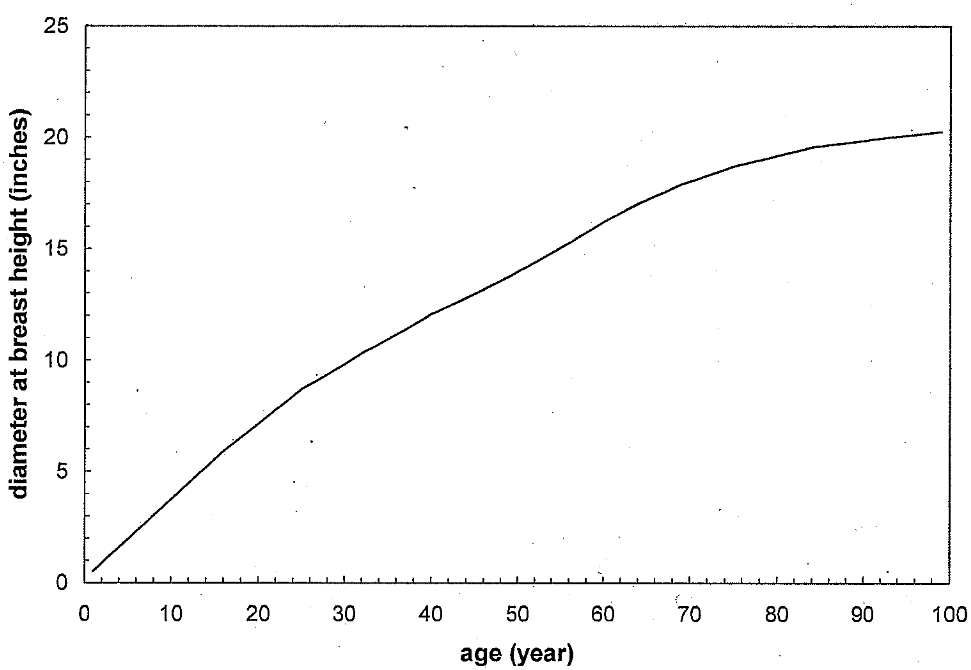
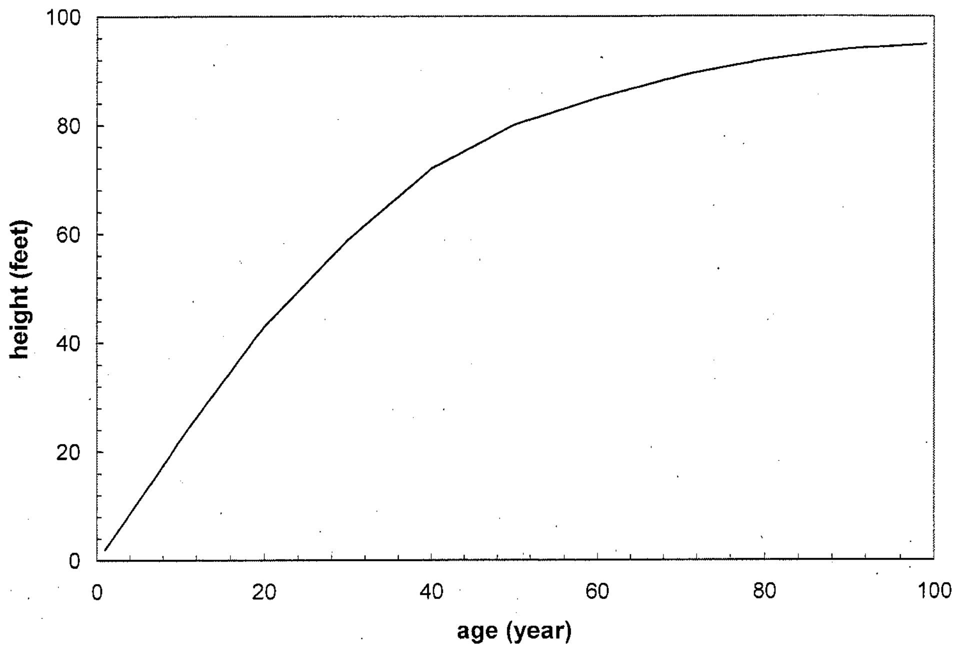
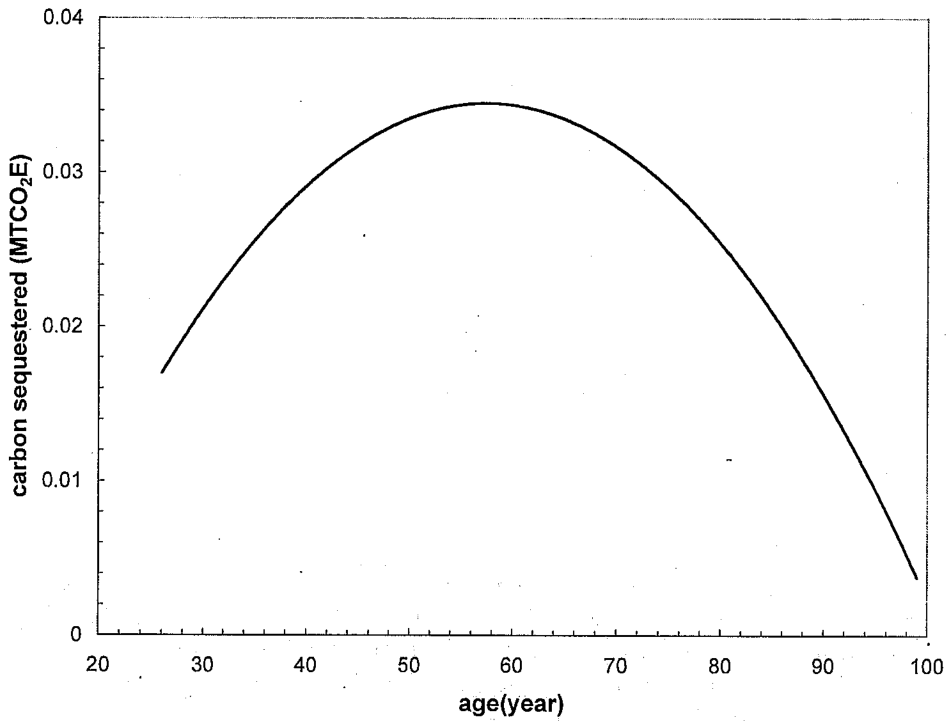


Figure 2. Graph showing the height of a tree as a function of age.



The incremental carbon storage per year (years 26-100) is shown in Figure 3. The growth curve is consistent with the slope of the curves for height and dbh (Figures 1 and 2). The sum of the incremental carbon storage from years 26-100 was 1.90 $MTCO_2e$/tree. Assuming an exponential death/harvest rate,[47] coupled with two experimental data points,[38] only 10% of the original trees survived to year 100. Because of this survival rate, the amount of carbon stored per tree was divided by ten to account for trees standing at 100 years. Therefore, the carbon storage value on a per tree basis is 0.19 $MTCO_2e$/tree.

Figure 3. Graph indicating the amount of incremental carbon stored ($MTCO_2e$/year) over the lifetime of a tree that was not harvested at year 25 due to recycling. The value at each year increment was generated using the theoretical tree model. The area under the curve was summed and divided by 10 to determine the overall amount of carbon sequestered in a single tree to year 100.



At year 25, the theoretical tree is harvested with a weight of 274 lbs. By year 100, the tree has attained a weight of 2594 lbs that equates to a volume of 2.5 m^3, assuming a density of 29.33 lb/ft^3.[44] Utilizing the data from Table 5 and the weight of tree at harvest, an average number of trees/ton per material produced and a forest carbon sequestration factor were generated (Table 10).[35,36]

Table 10. Amount of trees used to produce one ton of wood-based organic material and the corresponding forest carbon sequestration.

Material	Tree equivalents (trees/ton of material produced)[a]	Forest carbon sequestration factor ($MTCO_2e$/ton of material)[b]
Corrugated cardboard	22.1	4.2
Magazines/3rd class mail[c]	2.5	0.5
Newspaper	15.3	2.9
Office paper	25.3	4.8
Phonebook paper	15.3	2.9

[a] The amount of wood used from Table 5 was divided by the weight of a tree (274 lbs.) generated from the theoretical tree model.
[b] This value was determined by multiplying the number of tree equivalents by 0.19 $MTCO_2e$/tree.
[c] Only 10% of recycled magazines are used in secondary production .[9] In order to compensate for this discrepancy, 90% of virgin wood use for magazine production subtracted from the full value.

The forest carbon sequestration values were compared to existing literature studies to evaluate the validity of the assumptions.[52,53] The first source, published by the United States Department of Agriculture –Forest Service (USDA-FS), indicates that the volume of a loblolly-shortleaf pine stand on forest land 90 years after clearcut harvest in the Southeast is 299.6 m^3/ha.[52] Assuming a value of 123.6 trees/ha (based on an original planting of 500 trees/acre) and a volume of 2.37 m^3/tree for the theoretical tree model, the volume of the stand is 292.9 m^3/ha. This shows that the theoretical tree model predicts forest volume within 2% of the USDA-FS estimates.[52] Additionally, a book published by Thompson (1992), references a calculation attributing 24 trees used per ton of office paper produced, a value consistent with the theoretical tree model results presented in Table 10.[54]

3.4 Dimensional lumber

The recycling emission reduction factor for dimensional lumber, as discussed in the methods section, is not recycled in a closed loop in California. Instead, the recycled lumber is converted into wood chips, dried and used for electricity generation via biomass combustion. The emissions and emission benefits are calculated as follows:

$$DL_e = 19.8 \text{ kg } CO_2\text{/hr} / (3.3 \text{ dry tons/hour} * 2 \text{ green tons/1 dry ton}) = 3 \text{ kg } CO_2e\text{/ton}$$

$$DL_b = (1 \text{ dry ton/2 green ton})*(1\text{MWh/1 dry ton})*(418.9 \text{ kg } CO_2e\text{/1 MWh}) = 209 \text{ kg } CO_2e\text{/ton}$$

$$RERF_{DL} = DL_b - DL_e = 209 \text{ kg } CO_2e\text{/ton} - 3 \text{ kg } CO_2e\text{/ton} = 206 \text{ kg } CO_2e\text{/ton} = 0.21 \text{ MTCO}_2e\text{/ton}$$

3.5 Overall Results

The final RERF was determined using equation 5 (section 2.5). A summary of the inputs into the equations the final RERF values are shown in Table 11.

Table 11. Summary of recycling emission reduction factors (RERFs) for each material.

Material	Total Upstream Emission Reductions[a] (a)	Remanufacture Transportation Emissions[a] (b)	Forest Carbon Seq.[a] (c)	Recycling Efficiency (d)	RERF[a] (a-b+c) *d
Aluminum	14.0	0.07	0	0.93	**12.9**
Steel	1.7	0.16	0	0.98	**1.5**
Glass	0.2	0.02	0	0.88	**0.2**
HDPE	1.1	0.09	0	0.77	**0.8**

PET	2.0	0.15	0	0.77	**1.4**
Corrugated cardboard	1.3	0.10	4.2	0.93	**5.0**
Magazines/3rd class mail	0.1	0.10	0.5	0.67	**0.3**
Newspaper	1.0	0.10	2.9	0.89	**3.4**
Office paper	2.4	0.10	4.8	0.60	**4.3**
Telephone books	1.2	0.10	2.9	0.67	**2.7**
Dimensional lumber	N/A	N/A	N/A	N/A	**0.21**
Mixed Plastics[b]	1.7	0.13	0	0.77	**1.2**

[a] Units are in $MTCO_2e$/ton of material.
[b] The mixed plastics average assumes a mix of 71% PET and 29% HDPE.[27]

3.6 Uncertainty Analysis

The following section gives an overview of the uncertainty associated with each step of the RERF determination. This will not be a quantitative uncertainty assessment due to the nature of many of the data sources used in this study. The qualitative assessment will serve to illuminate particular uncertainties and explain their impact on the overall RERF.

3.6.1 Process and Transportation Emissions:

The two most prevalent sources of error within this section are the reliability of the material life-cycle data and the representativeness of the emission factors to accurately portray the process emissions. The material life-cycle data used in this study[9,10] is relatively old when compared to the timescale technological development. For example, in a related study,[57] the mass of a computer was assigned a value of 70 pounds. As technology has advanced in the past five years, the weight of computer has declined, which would lead to different assumptions about its manufacturing stage in a life-cycle calculation. While most materials in this study do not change technologies as quickly as a computer, the overall data used to generate the emissions from manufacturing may need updating. Because industrial technology usually does not increase the energy inputs, the overall emissions for the upstream energy component of the RERF would more than likely decrease. However, the magnitude of this decrease is not known.

The emission factors used in this study were specific to either California (i.e., goods movement) or the United States (i.e., electricity use). However, in many cases, steps in the material manufacturing process and transportation emissions take place in countries that may have different emission factors. Specifically, the electricity grid may vary from the United States average and the vehicle fleet used in another country may be different. Of these two factors, the electricity component will play a larger role in the energy emissions because transportation emissions are negligible in comparison to process emissions (Table 6). After evaluating the electricity needs for virgin and recycled production (Supplemental Spreadsheet) of each material, aluminum would be most impacted by a varying electricity emission factor. Assuming the cleanest fuel mix would be all renewable is not likely. Therefore, assume a natural gas source for electricity generation as the cleanest and a coal source as the dirtiest. According to WRI, a coal-fired plant in China (including Hong Kong) generates 910.5 kg CO_2/MWh and a gas fired plant in China emits 387.9 kg CO_2/MWh.[56] In this method, a value of 676 kg CO_2/MWh was used.[20] Applying the gas and coal-sourced electricity generation as a low and high bound, respectively, sets the aluminum electricity requirement between 6.3 and 14.8 $MTCO_2e$/ton of material. The value used in this study (10.6 $MTCO_2e$/ton of material) is the median of the high and low estimate. The other materials did not significantly vary in electricity use between virgin and recycled material production.

3.6.2 Transportation Correction Factor:

The errors associated with these calculations mainly occur due to the lack of understanding in the goods movement process at the international level and the uncertainties that surround the fleet efficiency. In general, a shipping crate is transported, first by truck and/or rail to a port where it is loaded onto a ship and transported to another port where the crate is unloaded and transported via truck and/or rail to its final destination.[57] Each of the five transportation assumptions used in this study take these steps into account (when applicable, Table 4).

An incomplete understanding of the distance travelled during the goods movement process may lead to an underestimation of the transportation emissions associated with each RERF. For example, in the current study, it is assumed that there is an average of 100 truck-miles travelled to get the recycled material to a rail station or port and an average of 100 truck-miles travelled to get the recycled material to its point of remanufacture. Assuming these values were closer to 500 miles in each direction would increase the overall transportation emissions 0.1 $MTCO_2e$/ton of material. This equates in some cases to a large contribution to emissions (e.g. glass, magazines), but in most cases (at an average of 2.0 $MTCO_2e$/ton) it equates to a 5% or less decrease in the overall RERF. Increasing the rail or ocean going vessels miles travelled by 1000 miles increases the overall transportation by 0.02 $MTCO_2e$/ton, which is a negligible amount.

Uncertainties in the fleet efficiency can lead to over or underestimation of the transportation emissions. An efficient, modern fleet can have low emissions, while an old fleet with inefficient energy consumption can have high emissions. A study compared California in-state tractors trucks to drayage vehicles near the ports and found that, on average, the drayage vehicles are slightly less efficient by 3 g CO_2/net ton-mile.[30] This uncertainty has a negligible effect on the overall transportation emission component of the RERF. Because the rail and ocean going vessel factors are much smaller, even doubling the emissions under the most extreme conditions increases the transportation emission factor by 2% (assuming an additional 2300 rail-miles) and 7 % (assuming an additional 7000 nautical-miles), respectively (Table 4).

3.6.3 Forest Carbon Sequestration:

The theoretical tree model has many sources of error that can change the overall forest carbon sequestration value. Possible errors include modifications to the growth rate, height, dbh, density and mortality rate. Changing either of these variables in the model would either increase or decrease the amount of carbon sequestered in the theoretical tree. However, because this model is based on a loblolly pine and the assumptions match macroscale approximations,[52] small changes in the above variables would not play a large role in the overall results.

The largest area of uncertainty lies in the choice of the loblolly pine. Although ubiquitous in the Southeast United States, it is not common in other parts of the country. Other pine and fir species are used to produce lumber and paper products. In order to evaluate the range of possible forest carbon sequestration values using other tree species, macroscale growth predications for pines and firs around the country were evaluated using Smith et al (2006).[52] For the comparison, the mean timber volume from Tables A7, A12, A17, A18 A19, A20, A22, A24, A27, A28, A30, A32, A33, A37, A38, A40, A41, and A47 were summed together at year 90 (year 100 was not available for all species) and averaged.[52] The average value between these 18 tables was 318 m^3/ha with a range between 1088 m^3/ha (Douglas Fir, Pacific Northwest, West) and 116 m^3/ha (Ponderosa Pine, Rocky Mountain, South). The difference between the average volume value from Smith et al and this method is 7.7%.[52] Applying the 7.7 % to the theoretical tree model-generated forest carbon sequestration value adds 0.015 $MTCO_2e$/tree onto the 0.19 $MTCO_2e$/tree factor. This would increase the overall forest carbon sequestration for different materials by a maximum of 0.38 $MTCO_2e$/ton of material (e.g. office paper with a value of 25.3 tree equivalents/ton (Table 10)). Additionally, for office paper, this results in a 5% change in the overall RERF (Table 11).

3.7 Comparison to existing studies

The following section evaluates the RERF of each material compared to other studies completed in the literature or by government agencies. Table 12 compares the RERF values generated in this study to the Waste Reduction Model (WARM)[4] developed by the United States Environmental Protection Agency and the Greenhouse Gases Calculator for Waste Management (GGCWM)[5] developed by Environment Canada. The WARM and GGCWM values listed in Table 12 are not relative to other waste alternatives (as described in the background section). Instead, the listed values in Table 12 reflect only the recycling component of each tool.

The section is designed to verify that the RERFs in this method are consistent with existing literature; in situations when this is not the case, the differences will be evaluated. The differences in RERFs may be due to electricity mix, industrial location, life-cycle boundaries, or other factors.

Table 12. Comparison of RERFs to other recycling studies[a]

Material	This method	WARM[b]	GGCWM[c]
Aluminum	12.9	13.67	8.75
Steel	1.5	1.8	1.07
Glass	0.2	0.28	0.09
HDPE	0.8	1.4	2.06
PET	1.4	1.55	3.29
Corrugated cardboard	5.0	3.11	2.96
Magazines/3rd class mail	0.3	3.07	2.90
Newspaper	3.4	2.8	2.49
Office Paper	4.3	2.85	2.90
Telephone books	2.7	2.66	2.97
Dimensional lumber	0.21	2.46	NA[d]
Mixed Plastics[e]	1.2	1.52	1.63

[a] All units are in $MTCO_2e$/ton of material
[b] WARM = Waste Reduction Model
[c] GGCWM = Greenhouse Gases Calculator for Waste Management
[d] The GGCWM did not report a value for dimensional lumber.[5]
[e] The mixed plastics average assumes a mix of 71% PET and 29% HDPE (Ref. 27).

3.7.1 Inorganic materials

The inorganic materials (e.g. aluminum, steel, etc.) are generally consistent with the WARM and GGCWM models, however, the wood-based organic materials vary in many cases (Table 12). For example, the magazines/3rd class mail category varies by an order of magnitude between this method and WARM.

3.7.1.1 Aluminum

The calculated process and transportations emissions for aluminum were 14.0 $MTCO_2e$/ton (Table 8) in this method and 13.67 $MTCO_2e$/ton in WARM (value after multiplying by the R_{use} variable)[4]. The overestimate of emissions in this method compared to WARM may be due to the nature of the emission factors employed in the study. The GGCWM model uses a Canadian electricity emission factor which is much lower than the United States electricity emission factor, which leads to a lower emission value.[5]

The RERF for aluminum was also compared to other aluminum studies. A recent paper by McMillan and Keoleian indicated that a global average emission factor for aluminum production in 2005 was 13.3 $MTCO_2e$/ton primary ingot, which is comparable to this method.[7] A study completed in China found that aluminum process emissions were 19.6 $MTCO_2e$/ton for China, which were about 70% higher than the global average of 11.5 $MTCO_2e$/ton (value is dependent on electricity mix).[58] Another study on the Indian aluminum industry indicated that their average emissions are on the order of 20.4 $MTCO_2e$/ton.[59]

3.7.1.2 Steel

The RERF for steel is consistent with the factors from WARM and GGCWM (Table 12). Small discrepancies in the overall values can be attributed to the emission factors used and the electricity mix used in this method. An evaluation of the steel-making capacity in Russia indicates that it requires about 3.4 $MTCO_2e$/ton of steel production.[60] While this value is higher than the RERF, the discrepancy may be due to higher emission factors for electricity use and different, less efficient steel-making mechanisms in Russia. A study by Gorgolewski (2006) indicates that 600 kg of coal/tonne is avoided by recycling steel (544 kg/ton).[61] Using an aggregate emission factor for coal,[22] this equates to an emission reduction of 1.1 $MTCO_2$/ton.[61]

3.7.1.3 Glass

The RERF generated in this method is consistent with WARM and GGCWM (Table 12). A paper that evaluated the energy inputs needed to make a 200 g glass jar indicated that it took about 73 g CO_2e/200 g glass jar. Assuming there are 4536 glass jars in a short ton, the total manufacturing emissions are 0.33 $MTCO_2e$/ton.[62] This is comparable to the results from this method for the emissions associated with producing a ton of glass from virgin materials (Table 8).

3.7.1.4 High Density Polyethylene (HDPE)

The RERF for HDPE is lower by about a factor of 2 when compared to the WARM and GGCWM studies, respectively (Table 12). This rather large discrepancy may have occurred due to the data source availability. The data used in this method for the energy process and transportation emissions for virgin production is consistent with a study completed by Franklin and Associates assigns a value of 1.34 $MTCO_2e$/ton of material to the emissions from virgin HDPE resin production (for comparison, see Table 8, 1.6 $MTCO_2e$/ton of material).[63] The results from this method are also consistent with a study completed by Boustead.[64] This study, funded by PlasticsEurope, indicated that the GHG emissions associated with producing one ton HDPE resin was 1.45 $MTCO_2e$.[64] Other studies by PlasticsEurope indicate the emissions for HDPE are higher as greater production is involved. For example, the production of HDPE bottles is 2.36 $MTCO_2e$/ton, indicating that the boundaries assumed in this method and WARM may vary.[4]

3.7.1.5 Polyethylene Terephthalate (PET)

The PET RERF is consistent with WARM, but underestimated by a factor 2 when compared to GGCWM (Table 12). The study from FAL (2007)[65] indicates that emissions for PET are 2.3 $MTCO_2e$/ton for virgin material production, which is consistent with this method (Table 8, 2.4 $MTCO_2e$/ton of material). The PlasticsEurope study uses an average of PET amorphous (2.54 $MTCO_2e$/ton) and PET bottle-grade (2.63 $MTCO_2e$/ton) resin to generate a total of 2.50 $MTCO_2e$/ton, which is slightly higher.[65,66] When compared to PET bottle production, the emissions are 3.72 $MTCO_2e$.[67]

3.7.2 Wood-based organic materials

Unlike the materials discussed above, the wood-based organic materials RERF include a forest carbon sequestration component. The forest carbon sequestration factor accounts for the incremental carbon sequestered in a tree that would not have occurred if the tree would have been harvested. The comparisons below reflect the existing literature for wood-based organic materials.

3.7.2.1 Corrugated cardboard

The RERF for corrugated cardboard is about 1.7 times higher in this method compared to WARM and GGCWM (Table 12). The discrepancy occurs in the manufacturing stage emissions (a difference of ~1.3 $MTCO_2e$/ton) and the forest carbon sequestration (a difference of ~1.2 $MTCO_2e$). According to WARM,[4] the manufacturing stage emissions for corrugated cardboard is ~ 0. This is in contrast to this method (Table 8) which calculates an emissions benefit of 1.3 $MTCO_2e$/ton. Additional information on this issue can be viewed in the Supplemental Spreadsheet. The manufacturing emissions from corrugated cardboard were also calculated by the Paper Task Force (2002).[36] In this study,[36] the manufacturing emissions were 1.4 $MTCO_2e$ (relative to recycling), which is consistent with this method.

WARM assigns a forest carbon sequestration value for corrugated cardboard of 3.0 $MTCO_2e$/ton.[4] While the WARM value is slightly different than this method (Table 12), the method used to calculate the forest carbon sequestration is markedly different. While this method employs a microscale, single tree approach, the USEPA(2006)[4] study uses a macroscale, stock change approach that is consistent with other methods utilized at the national level.[68]

3.7.2.2 Magazines/3rd Class Mail

The RERF for magazines/3rd class mail was only 0.3 $MTCO_2e$/ton in this method, compared to a much higher values in the WARM model (Table 12). The discrepancy in values is mainly due to the forest carbon sequestration factor. According to a manuscript by USEPA,[9] magazines only use 10% of recycled material in recycled magazine paper. The remaining 90% comes from primary groundwood fiber. For this reason, 90% of the weight of virgin wood (Table 5) for magazines/3rd class mail was subtracted out of the forest carbon sequestration factor. Because of the different methods used by WARM[4] in their determination of the forest carbon sequestration factor, this method has a much lower value for this product.

3.7.2.3 Newspaper

The newspaper RERF is slightly higher in this method compared to WARM and GGCWM (Table 12). The manufacturing emissions in the WARM model are 0.7 $MTCO_2e$[4] compared to 1.0 $MTCO_2e$ in this method (Table 8). Research from the Paper Task Force (2002)[36] indicates that the upstream energy emissions are 2.7 eton. Additionally, the forest carbon sequestration value is also higher in this method than WARM.[4] The tree equivalents used in this method are consistent with a calculation performed for *Recycled Papers: The Essential Guide.*[53]

3.7.2.4 Office Paper

The office paper RERF in this method is higher than WARM and GGCWM (Table 11). The forest carbon sequestration factor is consistent with WARM,[4] but the manufacturing emissions are much higher than WARM (2.4 $MTCO_2e$/ton in this method vs. -0.20 $MTCO_2e$/ton in WARM). The reason for this large discrepancy may be due to an added assumption that was not made in this study but assumed in WARM.[4]

Two previous studies have evaluated the upstream energy benefits of recycling office paper. The Paper Task Force[36] determined the upstream energy emissions from recycling to be 1.36 $MTCO_2e$/ton, which is an intermediate value between WARM and this method. Additionally, Counsell and Allwood[8] calculated a value of 4.4 $MTCO_2e$/ton. This value was determined by summing together the avoided emissions associated with forestry, pulping and landfilling. After completing this review, it is evident the upstream emission benefits from recycling office paper have a wide range. The results range from positive emissions to over 4 $MTCO_2e$/ton of benefits.

3.7.2.5 Telephone Books

The RERF value for this method is consistent with existing studies (Table 12). Both the upstream energy and forest carbon sequestration component are similar to WARM.[4]

3.7.2.6 Dimensional Lumber

The RERF value for this method is not similar to the WARM study (Table 12). The difference is due to the methods used to determine the value. In the WARM study, it was assumed that recycled dimensional lumber was remanufactured into more lumber while in this method, it is assumed that lumber is chipped and used at biomass facility.

4. SUMMARY

This method estimates recycling emission reduction factors for various recyclable materials. The recycling factors are based on the emission benefit of using recycled material over virgin inputs in the manufacturing stage, forest carbon sequestration, the transportation associated with moving the recycled material to the point of remanufacturing and the recycling efficiency. The data sources relied upon in the study are well-documented and the methods used are clearly defined. This method does not evaluate the associated avoided landfill methane (CH_4) benefits of recycling. Fugitive CH_4 emissions are accounted for separately as part of the California greenhouse gas inventory.[17]

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Appendix G

Proposed Method for Estimating Greenhouse Gas Emission Reductions of Compost from Commercial Organic Waste

PROPOSED METHOD FOR ESTIMATING GREENHOUSE GAS EMISSION REDUCTIONS FROM COMPOST FROM COMMERCIAL ORGANIC WASTE

August 1, 2011

Planning and Technical Support Division

California Air Resources Board

California Environmental Protection Agency

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Proposed Method for Estimating Greenhouse Gas Emission Reductions from Compost from Commercial Organic Waste

EXECUTIVE SUMMARY

This document explains a life-cycle method to quantify the California-specific greenhouse gas emission reductions from using compost and the greenhouse gas emissions associated with compost management. Compost application to agricultural fields increases soil health while providing multiple co-benefits. Compost application reduces the amount of synthetic fertilizer needed, reduces the amount of water used, decreases soil erosion, increases soil carbon storage and reduces the use of herbicides. Composting material also causes greenhouse gas emissions during the collection of the initial feedstock and delivery of the compost, the use of energy and water to manage the compost pile, and as microorganisms convert the initial feedstock to compost. The following equation is used to calculate the compost emission reduction factor (CERF):

$$CERF = (CS_b + ((W_b + E_b + F_b + H_b) * C_{use})) - E_{total}$$

where,

CERF	=	Compost emission reduction factor ($MTCO_2e$/ton of feedstock)
CS_b	=	Emission reductions associated with the increased carbon storage in soil ($MTCO_2e$/ton of feedstock)
W_b	=	Emission reductions due to decreased water use ($MTCO_2e$/ton of compost)
E_b	=	Emission reduction associated with decreased soil erosion ($MTCO_2e$/ton of compost)
F_b	=	Factor to account for the reduced fertilizer use ($MTCO_2e$/ton of compost)
H_b	=	Factor to account for the reduced herbicide use ($MTCO_2e$/ton of compost)
C_{use}	=	Conversion factor used to convert from tons of compost to tons of feedstock
E_{total}	=	Emissions due to the composting process ($MTCO_2e$/ton of feedstock)

The above equation uses an approach similar to one established by the United Environmental Protection Agency (USEPA). This method modified USEPA's approach by quantifying the greenhouse gas composting benefits due to decreased fertilizer use, decreased water use, decreased soil erosion, and decreased herbicide use and by applying California-specific data where feasible. The CERF generated for this method is **0.42 $MTCO_2e$/ton of feedstock** (wet weight) and applies to food scraps, yard trimmings, grass, leaves, branches, and organic municipal solid waste (MSW).

1. BACKGROUND

In the past 17 years, the amount of organic waste composted in the United States has increased over 400 percent from about 4 to 20 million tons.[1] Composting is a decomposition process that converts an initial feedstock of organic waste (i.e. food scraps, yard trimmings, branches, leaves, grass, and organic municipal solid waste) into an organic-rich soil mixture called compost. Compost application to soil systems has many benefits, which include, but are not limited to, increased soil carbon concentrations, decreased density, increased porosity, increased resistance to erosion and pests, and decreasing the use of synthetic fertilizers.[2-7] In recent years, efforts have begun to quantify the above compost benefits in terms of greenhouse gas reductions.[8-12]

The quantification of greenhouse gas (GHG) emission reductions from compost application requires a life-cycle approach. A life-cycle approach accounts for emissions or emission reductions at the manufacturing, use or end-of-life stages for a single product.[13] Composting is unique because using its end-product reduces energy requirements in other products' life cycle stages. For example, applying compost can reduce the amount of water needed to irrigate a crop and thus the energy required to move the water to a particular field. It can also decrease the amount of industrially produced fertilizer. In the proposed method, the greenhouse gas (GHG) emission reductions are quantified with respect to the addition of compost as an amendment to an agricultural soil system. Additionally, emissions associated with the composting process, such as transportation, machinery use, and water use will be quantified.

This life-cycle method is consistent with other recent compost analyses in the literature. The United States Environmental Protection Agency (USEPA) Waste Reduction Model (WARM) quantifies the compost GHG benefit by accounting for the net emissions from the composting process and summing them with the benefit of soil carbon storage.[14] Studies by Martinez-Blanco et al (2009) and Blengini (2008) assess similar parameters as the WARM model, but also include fertilizer benefits.[15-16] However, these studies do not attempt to quantify the GHG benefits associated with a decline in water use, soil erosion and pesticide use, which may lead to a more conservative view of the benefits of compost.

This method evaluates the emission reduction benefits and emissions associated with the composting process and the agricultural use of its end-products. The emissions considered will be transportation (feedstock collection and delivery of finished product), process emissions (feedstock manipulation during the production of compost, including water use), and fugitive emissions (CH_4 and N_2O emissions from the composting material). The greenhouse gas emission benefits will include increased soil carbon storage, reduced soil erosion, reduced water use, and a decrease in fertilizer and herbicide use. Whenever feasible, studies from California composting operations and compost application will be used. The quantification of each of these variables will lead to a compost emission reduction factor (CERF) that will be applicable to food scraps, yard trimmings, grass, leaves, branches, and organic municipal solid waste (MSW).

2. METHODS

The boundary,[17] or life-cycle stages used to quantify the compost emission reduction factor (CERF), for this method establishes the greenhouse gas emission reductions of compost application and greenhouse gas emissions from composting organic waste. This section describes the emissions from the composting process and secondly discusses the emission reductions associated with using compost as an agricultural amendment that were considered in this method. If compost is used as an agricultural amendment, all of the benefits discussed below are applicable. A survey completed by CalRecycle indicates that the majority (~ 75%) of compost application in California occurs for uses that would benefit from all of the variables discussed below (see section 2.2).[18] These include agricultural, landscape, and nursery applications.

2.1 Composting Emissions

There are three main emission sources that occur during the composting process: transportation emissions occurring from the collection of the initial feedstock and delivery of the finished compost; energy and water emissions from the composting management process; and fugitive emissions from the anaerobic decomposition of the composted materials. The significance of each emission is important because it detracts from the overall emission benefit of compost use. The emissions that are discussed in this method are consistent with the emissions in studies evaluating the GHG emissions from composting.[15,16,19] Biogenic carbon dioxide (CO_2) emissions from the degradation of organic material (i.e. branches and food scraps) during the composting process are not counted to maintain consistency with IPCC, USEPA, and ARB inventory accounting.[9,14] The overall emissions from composting are represented by the following equation:

$$E_{total} = T_e + P_e + F_e \qquad (1)$$

where,

E_{total} = Total emissions from composting ($MTCO_2e$/ton of feedstock)
T_e = Transportation emissions from composting ($MTCO_2e$/ton of feedstock)
P_e = Process emissions from composting ($MTCO_2e$/ton of feedstock)
F_e = Fugitive emissions from composting ($MTCO_2e$/ton of feedstock)

2.1.1 Transportation Emissions (T_e)

The transportation emissions (fossil fuel CO_2 emissions from diesel) associated with composting occurs during the collection of the organic feedstock to the composting facility and the delivery of the finished compost to the end user. The total distance travelled (inbound and outbound), in combination with an emission factor that indicates the amount of greenhouse gas emitted per distance travelled (g CO_2/ton mile), gives an approximation of the emissions for transportation. The inbound and outbound distances vary across the state and depend on the collection method and customer proximity to the composting facility. Discussions with CalRecycle staff led to the identification of six geographically representative compost facilities across the state.[20] Average transportations distances were obtained from a survey of Northern, Central and Southern California composters. The emission factor used was generated from Appendix G of the ARB's Statewide Truck and Bus Regulation (101 g CO_2/ton mile).[21]

2.1.2 Process Emissions (P_e)

Process emissions from the composting process were from the energy required to grind material (electricity), turn and manage the compost pile (diesel) and the emissions associated with water use on the compost pile. California-specific data sources for this parameter were obtained from a personal communication with CalRecycle staff.[20]

2.1.3 Fugitive Emissions (F_e)

Fugitive emissions arise from methane (CH_4) and nitrous oxide (N_2O) releases during the composting process. Methane is produced in anaerobic pockets of a compost pile, while nitrous oxide is a product of nitrification or denitrification.[22] Even though the overall emissions of these two GHGs is low relative to carbon dioxide, their emissions are significant because their global warming potential (GWP) is 21 and 310 times greater than CO_2 for CH_4 and N_2O, respectively.[23] Numerous research articles discuss the release of CH_4 and N_2O emissions from composting. The list of studies include both manure[24-26] and organic waste[27-29] composting piles. However, manure is not normally contained in a commercial organic waste stream, so data from these studies were not used for this analysis. The values from the remaining papers that discussed CH_4 (n=7) and N_2O (n=4) emissions were averaged together.

2.2 Compost Emission Reductions

The greenhouse gas emission reduction benefits come from the agronomic use of compost and are calculated based on the finished compost product. The final reduction benefit is reported by converting the compost application benefit to units of initial organic feedstock. The addition of compost to soils produces many benefits that contribute to soil and plant health. While this analysis evaluates five benefits from a GHG perspective,[3] more benefits may occur from composting (such as increased crop yield), but existing data does not allow for their GHG quantification. The composting application benefits described in this method are listed in the equation below:

$$B_{total} = CS_b + ((W_b + E_b + F_b + H_b) * C_{use}) \qquad (2)$$

where

B_{total} = Total emission reduction benefit due to compost use ($MTCO_2e$/ton of feedstock)

CS_b = Emission reductions associated with the increased carbon storage

		in soil ($MTCO_2e$/ton of feedstock)
W_b	=	Emission reductions due to decreased water use ($MTCO_2e$/ton of compost)
E_b	=	Emission reduction associated with decreased soil erosion ($MTCO_2e$/ton of compost)
F_b	=	Factor to account for the reduced fertilizer use ($MTCO_2e$/ton of compost)
H_b	=	Factor to account for the reduced herbicide use ($MTCO_2e$/ton of compost)
C_{use}	=	Conversion factor used to convert from tons of compost to tons of feedstock.

2.2.1 Increased Soil Carbon Storage (CS_b)

Compost increases the soil carbon content when it is applied to a soil with low concentrations of organic matter.[9,10,14] Over time, the reactive carbon content of the applied compost decreases due to plant and bacteria metabolism. The unreactive portion of carbon compounds, known as humic substances, remain in soil systems for long periods of time.[14] The carbon that remains in the soil system is considered stored because it is not degrading and releasing CO_2 into the atmosphere. Few studies have been completed that evaluate the impact of compost on soil carbon storage.[6,30,31] For this reason, a study from USEPA that evaluated soil carbon storage due to compost application was used to quantify the emission benefit in this method.[14] The USEPA study evaluated the soil carbon storage benefit from year 1 through year 30.[14]

2.2.2 Decreased Water Use (W_b)

Compost application decreases the density of soil due to an increase in soil porosity.[32-34] Increases in porosity and surface area creates more binding spots for water, leading to higher water retention rates when compared to an unamended soil.[33,34] The physical characteristics that allow for the increased water retention are directly due to the carbon content of the compost.[4] A decay pattern similar to carbon loss in compost was therefore used for modeling the water use benefits.[14]

A study conducted by the University of California – Riverside addresses the water retention benefits from compost application.[35] The data collected from this paper was converted into gallons saved/ton of compost and averaged. The average value was inputted into year 1 of the compost decay graph and plotted out to 30 years after compost application for consistency with carbon storage. The sum of water benefits was considered for this emission factor because every year a water benefit would be realized. The compost application benefit in this case is the reduced energy needed to transport water to the compost-amended soil. The emission factor for water use was 1.5 $MTCO_2e$ per acre-foot (AF).[36] This value is based on a statewide embedded energy in water value of 3.2 MWh/AF.[37]

2.2.3 Decreased Soil Erosion (E_b)

When mixed into soil, compost has the ability to decrease erosion and is widely used as an erosion control device at construction sites, along highways and in agricultural applications.[4,32,38] Compost decreases erosion because of its ability to absorb and retain water in its pore holes. This method evaluated the erosion control benefits from agricultural applications. This benefit was quantified by accounting for the emissions associated with replacing eroded soil with compost. Erosion control is also related to carbon content, density and water retention so a decay pattern similar to carbon loss in compost was used for erosion control.

A study completed by the University of California-Riverside was used to evaluate the soil erosion.[35] This study evaluated two sites: a site damaged by a fire and a construction site. The construction site used seeded compost, but the researchers noted that there was no seed growth during the sampling events so the seeded compost mimicked unseeded compost.[35] An average erosion between the construction site and fire affected site was used in the calculation. The difference in soil retention between the control and compost-amended site was considered the soil benefit. The experimental plot values were extrapolated to represent a hectare of application and converted to a unit representative of soil saved per ton of compost. The emission factor for replacing one ton of eroded soil was 0.114 $MTCO_2e$/ton of feedstock (Section 3.1). The emission factor represents the emissions associated with producing compost to replace the soil lost to erosion.

2.2.4 Reduced Fertilizer Use (F_b)

The nitrogen content of compost, along with phosphorous and potassium contributions, provide an opportunity to reduce the amount of fertilizer applied to agricultural systems.[39-42] Other studies have shown that the use of compost does not entirely alleviate the need to apply fertilizers to agricultural soils.[43] The greenhouse gas benefit for this variable was quantified as the avoided synthetic nitrogen, potassium, and phosphorous production from compost use.

The nitrogen, potassium and phosphorous contents of fertilizer degrade more rapidly than carbon.[10] A study by Favoino and Hogg (2008) indicated that nitrogen from compost is used over a 10-year time period.[10] The study also assumed that nitrogen was "conserved" in the soil over time so the available nitrogen over a 10-year time period was actually greater than the initial nitrogen content.[10] Instead of assuming a 30% decay rate as Favoino and Hogg (2008),[10] this method used a value to 38% over a period of 10 years to ensure the nitrogen availability did not include the "conserved" nitrogen content. It was assumed that the decay of potassium and phosphorous were similar to nitrogen.

Data was obtained from an independent compost lab that tested nutrient and trace metal concentrations from compost in California.[44] The 10-year decay curve was applied to this data set. The emission factor used for each type fertilizer (N, P, or K) was based on the avoided life cycle emissions from fertilizer production that would have occurred in the absence of compost use. The emission factors for N, P, and K are 8.9, 1.8 and 0.96 kg CO_2e/kg, respectively.[9,45]

2.2.5 Reduced Herbicide Use (H_b)

Herbicide use in agricultural fields prevents weeds from growing in unwanted areas. Studies indicate that compost replaces the use of herbicide by forming a crust over the top of the soil, making it difficult for weeds to penetrate the surface.[46] These benefits are limited and may last only one year, but allow for the reduced use or alleviation of herbicide use.[47]

Reduced herbicide use was determined from a study from Roe et al (1993).[46] The herbicide benefit quantified by this study was multiplied by an emission factor for a pesticide (A life-cycle analysis was not available for a herbicide, so a pesticide was used as a proxy).[48] Other studies were found that dealt with reduced herbicide use and composting, but were not applicable because the data was not sufficiently quantitative.[49,50]

2.2.6 Conversion Factor (C_{use})

The composting benefits were quantified in terms of $MTCO_2e$ reduced per ton of applied compost. The conversion factor was used to convert from compost applied to original feedstock composted. This conversion factor is based on numerous studies that report the initial amount of feedstock composted and final amount of composted material.[9,16,28]

2.3 Compost Emission Reduction Factor (CERF)

The compost emission reduction factor (CERF) is the sum of compost process emissions (E_{total}) and compost application emission benefits (B_{total}):

$$CERF = B_{total} - E_{total} \quad (3)$$

where,

CERF	=	Compost emission reduction factor ($MTCO_2e$/ton of feedstock)
E_{total}	=	Total emissions from the composting process ($MTCO_2e$/ton of feedstock)
B_{total}	=	Total emission benefits due to the application of compost ($MTCO_2e$/ton of feedstock)

3. RESULTS AND DISCUSSION

This section presents the emissions from the composting process and the emission reduction benefits from applying compost to a non-amended soil. Included in this section will be an analysis of the sensitivity of these values in the context of determining an accurate CERF for use in California.

3.1 Composting Emissions

Composting emissions are calculated in three different categories: emissions from transportation (inbound (collection) and outbound (delivery)), process emissions (turning, etc.) and fugitives (pile management). The calculated values are reported below.

3.1.1 Transportation Emissions (T_e)

Transportation emissions occur when the compost is collected (inbound) and when the finished product is distributed (outbound). Table 1 shows the location of composting facility and inbound and outbound transportation averages obtained from six representative compost distributors across the California.[20]

Table 1. Feedstock collection (inbound) and compost delivery (outbound) transportation distances.

Location	Inbound (miles)	Outbound (miles)
Oxnard	5	15
Rancho Cucamonga	30	30
San Jose	37	26
Northern California (various locations)	50	50
San Diego	108	N/A
Southern San Joaquin	55	20
Average	**47.5**	**28.2**
Sum	**75.7**	
Emissions	**0.008 $MTCO_2$/ton**	

The sum of the inbound and outbound travel miles was multiplied by an emission factor of 101 g CO_2/ton-mile.[21] The resulting average transportation emissions for the collection of feedstock and delivery of compost to the end user are **0.008 $MTCO_2e$/ton of feedstock**. Two European studies reported inbound distances of nine[15] and sixteen[16] miles. These values are slightly lower than the values used in this method and represent a 0.003 $MTCO_2e$/ton of feedstock deviation (on the lower side).

3.1.2 Process Emissions (P_e)

Composting is completed under varying conditions with specific physical parameters. Data from a Central Valley compost facility indicates that there is about 0.29 gallons of diesel and 250 gallons of water used per ton of initial feedstock for an outdoor windrow (Table 2).[20] The data reported in Table 2 represents the overall fuel and water use per ton of feedstock (activity column of Table 2). Each activity was multiplied by the corresponding emission factor. The water use emission factor is due to the embedded energy required to transport water in the California.[36] The overall emission contributions were summed and averaged to obtain the final emission value (Table 2, last column).

Table 2. Process emissions from compost production.

Facility	**Activity**	**Emission Factor**	**Emissions ($MTCO_2e$/ton of feedstock)[a]**
Outdoor windrow #1			
	0.29 gal diesel/ton	10.2 kg CO_2e/gal[b]	0.003
	0.0008 AF/ton	1.5 $MTCO_2e$/AF[c,d]	0.001
Outdoor windrow #2			
	0.24 gal diesel/ton	10.2 kg CO_2e/gal[b]	0.002
Outdoor windrow #3			
	0.56 gal diesel/ton	10.2 kg CO_2e/gal[b]	0.006
	7.2 kWh/ton	0.419 kgCO_2e/kWh[e]	0.003
	0.0006 AF/ton	1.5 $MTCO_2e$/AF[c,d]	0.001
		Average	**0.008**

[a] In order to obtain the total value, an average for each process emission type was taken, when applicable. For example, the average diesel fuel use was taken between outdoor windrow samples 1-3 while, the electricity value from outdoor windrow 3 was only used. [b]Reference 51 [c] Reference 36; [d] AF=acre-foot. [e] Reference 51. Uses the 2007 California grid average electricity emission factor.

The values used for the process emissions in this method were compared to multiple studies completed in Europe.[9,15,16] These studies indicate that direct diesel emissions from shredders, front loaders, and turning equipment is generally in the range of 0.03 -1.4 gallon/ton of feedstock.[9] This range is consistent with the above diesel emissions shown in Table 2. The water emissions during the composting process ranged from 0.0002-0.00007 AF/ton of feedstock.[15,16] These values are low when compared to this method, but it should be noted that both of these studies evaluated indoor composting processes.[15,16]

3.1.3 Fugitive Emissions (F_e)

Fugitive CH_4 and N_2O emissions were compiled from various studies and averaged together for this method.[15,19,22,27-29,52] The majority of the studies were taken from a study completed by the Intergovernmental Panel on Climate Change (IPCC), but additional studies were added to take into account more recent data from green waste composting studies from Mediterranean climates (which are similar to California weather conditions).[15,29,53] Table 3 shows each study used generate the average for methane and nitrous oxide emissions from a compost pile.

Table 3. Fugitive CH_4 and N_2O emissions from composting.

CH_4			
	Reference	**Feedstock**	**Emission factor (g_{CH4}/kg)**
	Beck-Friis et al (2003)[a]	Household organics	3.6
	Beck-Friis et al (2000)[b]	Household organic mixed with coarsely chipped branches and bushes	11.9
	Hellmann et al (1997)[c]	Organic MSW with bush, leaves and grass clippings	0.172
	Hellebrand (1998)[d]	Green waste and grass	5.1
	Martinez-Blanco et al (2009)[e]	Organic MSW and pruning waste	0.38
	Amlinger et al (2008)[f]	Green waste, sewage sludge and biowaste	0.21
	Manios et al (2007)[g]	Mixture of olive branches, leaves, and mill sludge	7
		Average	**4.1**
			0.078 $MTCO_2e$/ton
N_2O			**(g_{N2O}/kg)**
	Beck-Friis et al (2000)[b]	Household organic mixed with coarsely chipped branches and bushes	0.1
	Hellmann et al (1997)[c]	Organic MSW with bush, leaves and grass clippings	0.022
	Hellebrand (1998)[d]	Green waste and grass	0.1
	Amlinger et al (2008)[f]	Green waste, sewage sludge and biowaste	0.13
		Average	**0.09**
			0.025 $MTCO_2e$/ton

[a] Reference 52; [b] Reference 22; [c] Reference 28; [d] Reference 27; [e] Reference 15; [f] Reference 19; [g] Reference 29

The values used in this method for fugitive methane and nitrous oxide emissions are consistent with other literature values. For example, the IPCC reports that

CH_4 emissions are 4 g CH_4/kg of compost and N_2O emissions are 0.3 g N_2O/kg of compost.[53] The N_2O value is slightly lower than the IPCC values and may be due to the feedstock types used in this method compared to the IPCC. When composting certain feedstock, such as manure, N_2O emissions were higher than this method.[24-26]

3.1.4 Summary of Emissions

Table 4 presents the total emissions (E_{total}) from the composting process.

Table 4. Summary of composting emissions (E_{total})

Emission type	Emission ($MTCO_2e$/ton of feedstock)
Transportation emissions (T_e)	0.008
Process emissions (P_e)	0.008
Fugitive CH_4 emissions (F_e)	0.078
Fugitive N_2O emissions (F_e)	0.025
Total	**0.119**

3.2 Compost Use Emission Reductions

Emission reductions occur when the composted product of organic municipal solid waste (MSW) is applied to an agricultural field. Numerous benefits may occur from compost applications, such as increased soil carbon storage, increased soil water retention, reduced fertilizer use, reduced herbicide use, decreased soil erosion, increased crop yield, and increased microbial activity. Quantifying these benefits in terms of greenhouse gas savings requires numerous approaches. In some cases, the benefits are not quantifiable from a greenhouse gas perspective.[39]

The section below quantifies the greenhouse gas benefit of applying compost to a soil system. Instead of presenting a single value, a range for each benefit (when possible) will be given.

3.2.1 Increased Soil Carbon Storage (CS_b)

There are three main types of carbon in composts with regard to carbon decay kinetics: fast, slow and passive. The fast and slow carbon, otherwise known as active carbon, degrades due to bacterial and fungal use of carbon compounds in the soil. The passive carbon content is made of humic substances, large organic macromolecules formed during the thermophilic stage of the composting process.[4] Passive carbon decays extremely slowly, if at all. In this method, a study that quantified the soil carbon storage separately for the active and passive carbon was used.[14]

The active portion of carbon in compost follows a first-order decay pattern. The study completed by USEPA used the CENTURY model to predict the active carbon decay.[14] The CENTURY model generated carbon storage scenarios for various applications of compost to an unamended soil. The carbon content was forecasted to 30 years beyond the compost application to evaluate the decay pattern of carbon in compost. The results indicated that the carbon storage of the active carbon phase due to compost application was 0.073 $MTCO_2e$/ton of feedstock.[14]

The passive carbon phase was completed out to a 30-year time series. The upper and lower bounds of carbon storage were determined by evaluating the amount of carbon that decayed slowly or was passive. The carbon storage value obtained for the passive carbon phase was 0.183 $MTCO_2e$/ton of feedstock. Combined together the overall carbon storage value was **0.256 $MTCO_2e$/ton of feedstock.**[14]

The fast carbon decay from the active soil phase was summed with relatively constant passive carbon phase to generate a 30-year decay graph for compost (see Figure 1). This curve was utilized for the water retention (W_b) and soil erosion (E_b) benefits described below.

A study completed by ICF International (2005) used the same numbers as described above to determine the soil carbon storage component of a composting emissions reduction factor for Canada.[54] Other studies have shown that the soil carbon storage is slightly lower. A study by Boldrin et al (2009)[9] estimates soil carbon storage in a range of 0.002-0.072 $MTCO_2e$/ton, while Blengini (2008) uses a range of 0.133-0.213 $MTCO_2e$/ton.[16] Other studies have qualitatively evaluated the soil carbon storage rates and concluded that it is occurring, even though quantification did not occur.[8,12]

3.2.2 Decreased Water Use (W_b)

Water benefits from applying compost to a soil system are due to the increased porosity and permeability of the soil. The California-specific study by Crohn (2010) indicates that compost applied to increase water retention on a fire affected site is 185 gallons/ton of compost and 678 gallons/ton of compost for the construction site for a one year time period.[35] The 30-year decay curve is presented in Figure 1. Studies have indicated that humic substances are a major contributor to increased surface water absorption, which allows the soil carbon decay curve to have applicability towards water retention.[4] Over 30 years, this equates to a benefit of 3550 and 13000 gallons/ton of compost for the fire affected and construction sites, respectively.[35] Converting gallons per ton of compost to acre feet (AF) and multiplying by the water use emission factor (1.5 $MTCO_2e$/AF) leads to a range of 0.015-0.065 $MTCO_2e$/ton of compost and an average of **0.04 $MTCO_2e$/ton of compost**. A series of other studies report a range of 118-810 gallons/ton of compost,[32-34] which is consistent with the numbers reported for this method. In addition to the above studies, it is important to note that other manuscripts report an increase in water retention and available water to plants due to compost application.[55-57] However, these studies did not report the variables necessary for inclusion into the above calculations.

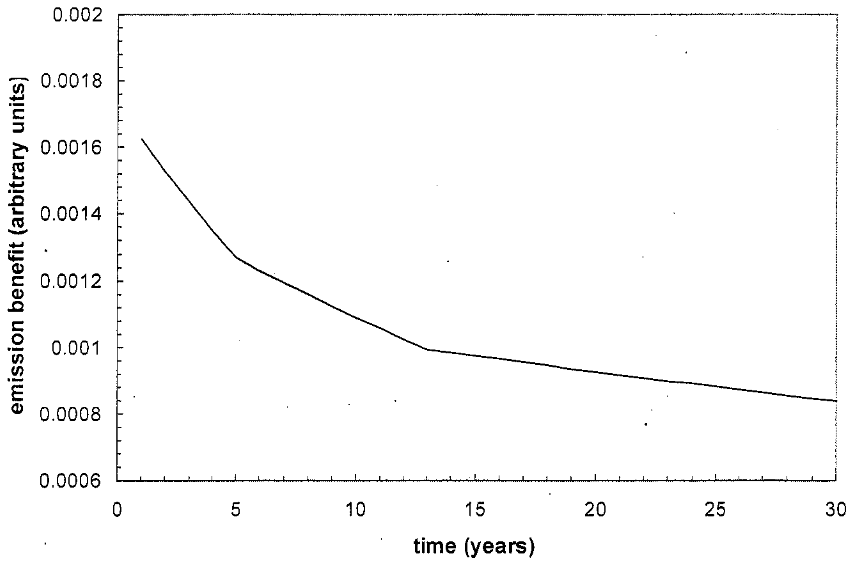

Figure 1. Decay curve used for the water retention (W_b) and decreased erosion benefits (E_b) of composting.

3.2.3 Decreased Soil Erosion (E_b)

Decreased erosion from addition of compost to soils is directly related to carbon content and water retention rates.[31] The curve in Figure 1 was used to determine the erosion capacity of compost. For initial inputs to the decay curve, the California-specific study by Crohn (2010) was used.[35] Compost applied to the fire affected site and construction site reduced soil erosion by 91 and 328 lbs/ton of compost on a 1-year timescale, respectively. This corresponds to a 30-year soil retention benefit of 1750 and 6300 lbs of soil/ton of compost for the fire affected and construction sites.

The emission factor used for this production was generated from the emissions associated with the composting process (Table 4). The emission factor is 0.119 $MTCO_2e$/ton of soil, which equates to an average savings of **0.25 $MTCO_2e$/ton of compost** and a range of 0.1-0.39 $MTCO_2e$/ton of compost (after being multiplied by the pounds of soil saved) over a 30-year time period.

The values used in this method are slightly higher than two other studies.[32,38] The values in the existing studies range from 33-64 lbs/ton of compost on the 1-year timescale.[32,38] However, these studies simulated single rain events, while the study by Crohn (2010), looked at multiple rain events over a longer time period.

3.2.4 Decreased Fertilizer Use (F_b)

Fertilizer use in non-compost amended agricultural fields is often costly and leads to deleterious effects on soil health.[3] Amending a soil with compost has the ability to decrease the fertilizer requirement, but not totally eliminate the application.[43] Table 5 presents the NPK fertilizer benefits from compost application.

Table 5. Fertilizer benefit from compost application.[a]

	Percent weight (%)	Mass, 1-year (kg/ton of compost)	Mass, 10-year (kg/ton of compost)	Benefit, 10-year ($MTCO_2e$/ton of compost
Nitrogen (avg)[b]	1	9.1	24	0.21
Nitrogen (range)[c]	0.4-1.5	4.0-13.6	10.6-35.9	0.094-0.32
Phosphorous (avg)[d]	0.8	7.3	19.3	0.035
Phosphorous (range)[c]	0.0-1.6	0.1-14.5	0.3-38.3	0.0005-0.07
Potassium (avg)[e]	0.8	7.3	19.3	0.02
Potassium (range)[c]	0.3-1.3	2.7-11.9	7.1-31.4	0.007-0.03
			Average	**0.26**
			Range	**0.1-0.42**

[a] Reference 44. [b] n = 1215. [c] Range is based on a confidence level of 68% or one standard deviation (1σ). [d] n = 1356. [e] n = 1354.

The results from this method compare well with existing literature studies. The average fertilizer benefit from these studies was 0.17 $MTCO_2e$/ton of compost with a range of 0.14-0.32 $MTCO_2e$/ton of compost.[9,10,16]

3.2.5 Decreased Herbicide Use (H_b)

The quantitative results from a study that evaluated the effectiveness of compost at weed suppression were used. In this study, a glyphosate spray was applied to a bell pepper field and compared to other field plots that used compost or no amendment (control). The results indicated that compost was as effective as the herbicide.[46] Assuming a 100% replacement of herbicide by compost, the herbicide reduction value was multiplied by an emission factor that quantified the emissions associated with herbicide production.[46,48] This produces a measurable, but highly uncertain greenhouse gas benefit (< 0.001 $MTCO_2e$/ton of compost) due to the large amount of compost needed to achieve the same benefit as a small amount of herbicide. In terms of the overall contribution to the CERF, this benefit is negligible.

3.2.6 Conversion Factor (C_{use})

The conversion factor is used to convert from tons of compost to tons of initial feedstock. This conversion was done on a wet weight basis and is consistent with the method used for the composting emissions from section 3.1. Table 6 summarizes the studies used to determine this value.

Table 6. Conversion factor inputs.

Reference	Feedstock	Initial mass (kg)	Final mass (kg)	Conversion factor
Hellmann et al (1997)[a]	Organic MSW, yard waste	31,520	20,890	0.66
Blengini et al (2008)[b]	Organic MSW	16,000,000	4,500,000	0.28
Boldrin et al (2009)[c]	Food waste, green waste	1,000	550	0.55
			Average	**0.50**
			Range	**0.28-0.66**

[a] Reference 28; [b] Reference 16; [c] Reference 9.

3.2.7 Summary of Emission Reductions

Table 7 presents the overall emission benefits from using compost.

Table 7. Summary of composting benefits (B_{total}).

Emission reduction type	Emission reduction ($MTCO_2e$/ton of compost)	Conversion factor	Final Emisson reduction ($MTCO_2e$/ton of feedstock)
Increased Soil Carbon Storage	N/A	N/A	0.26
Decreased Water Use	0.04	0.5	0.02
Decreased Soil Erosion	0.25	0.5	0.13
Decreased Fertilizer Use	0.26	0.5	0.13
Decreased Herbicide Use	0.0	0.5	0.0
		Total	**0.54**

3.3 Compost Emission Reduction Factor

The CERF is determined by subtracting the composting emissions (0.119 $MTCO_2e$/ton of feedstock) from the composting emission reductions (0.54 $MTCO_2e$/ton of feedstock).

This leads to a CERF of **0.42 $MTCO_2e$/ton of feedstock**.

3.4 Variability Analysis

The studies used to calculate each variable that contributed to the CERF were spread over a wide range of values. For instance, the fugitive CH_4 emissions ranged from 0.172 to 11.9 gCH_4/kg (Table 3) and the fertilizer benefits ranged from 0.08-0.30 $MTCO_2e$/ton of compost (Table 5). This wide range illustrates the uncertainty associated with each of these factors due to variability in the compost processing and in the physical properties of the soil to which the compost is added. In order to assess the possible range of CERF values, the following equation was used:

$$CERF_{range} = CERF_L \text{ to } CERF_H \quad (4)$$

$$CERF_L = ((\Sigma B_{totL}) \times C_{useL}) - E_{totH} \quad (5)$$

$$CERF_H = ((\Sigma B_{totH}) \times C_{useH}) - E_{totL} \quad (6)$$

where,

$CERF_{range}$	= Possible range of the CERF based on evaluation of the lowest and highest compost emissions and benefits ($MTCO_2e$/ton of feedstock)
$CERF_L$	= Lowest possible CERF ($MTCO_2e$/ton of feedstock)
$CERF_H$	= Highest possible CERF ($MTCO_2e$/ton of feedstock)
B_{totL}	= Sum of compost benefits based on the lowest values from this method ($MTCO_2e$/ton of compost) = 0.22 $MTCO_2e$/ton of compost
C_{useL}	= 0.28 ton of feedstock/ton of compost
E_{totH}	= Sum of compost emissions based on the highest values from this method ($MTCO_2e$/ton of feedstock) = 0.28 $MTCO_2e$/ton of feedstock
B_{totH}	= Sum of compost benefits based on the highest values from this method ($MTCO_2e$/ton of compost) = 1.39 $MTCO_2e$/ton of compost
C_{useH}	= 0.66 ton of feedstock/ton of compost
E_{totL}	= Sum of compost emissions based on the lowest values from this method ($MTCO_2e$/ton of feedstock) = 0.017 $MTCO_2e$/ton of feedstock

Applying the values for each variable, the $CERF_{range}$ is -0.22 to 0.90 $MTCO_2e$/ton of feedstock. In order to use the correct units for the soil carbon storage variable, the 0.26 $MTCO_2e$/ton of feedstock value reported in Section 3.2.1 was multiplied by two to account for the feedstock to compost conversion for B_{totH} and the 0.002 $MTCO_2e$/ton of feedstock (from Reference 16) was multiplied by two for B_{totL}. The average between $CERF_L$ and $CERF_H$ is 0.34 $MTCO_2e$/ton of feedstock. This value is slightly lower than the CERF (0.42 $MTCO_2e$/ton of feedstock).

The CERF obtained from this method has uncertainties due to the lack of general scientific understanding of some physical processes of compost application, absence of literature articles, and reliance on non-California specific study locations.

The application of compost to a non-amended soil provides soil benefits (benefits were discussed in this method). Uncertainties occur when researchers attempt to link a specific compost benefit to a modification of soil properties. For example, soil type plays a large role in the magnitude of a compost benefit. It is unclear what factors (type, size, pH, etc) of the mineral composition of the parent soil impact the compost benefit.

Current compost literature focuses mainly on the fugitive emissions[15,19,20,27-29] that occur during the composting process. Few studies evaluate the process emissions or the benefits from the end uses of compost. The most prevalent composting benefits discussed in the literature was increased soil carbon storage[9,14,16] and decreased fertilizer use[9,10,16,44]. Additionally, the erosion and water use results were extrapolated from laboratory-scale experiments as opposed to macroscale field methods. Extrapolating the data may skew the results, depending on the physical properties of the compost. The herbicide results are based on only one study.[46] It was difficult to obtain reliable results from a single experiment, plus life-cycle information on herbicides was difficult to obtain and a pesticide life-cycle was used as a proxy.[48]

This method was able find some California-specific compost studies to use for quantification (process emissions, transportation emissions, reduced water use, reduced soil erosion, and reduced fertilizer use). The other studies came from the United States (soil carbon storage and reduced herbicide use) or well-reputed international sources (fugitive emissions were modified from IPCC data).

As additional research is completed, the uncertainties will diminish. In the interim, it is important to understand the shortcomings of this quantification method and apply them in a judicious manner.

4. SUMMARY

This method presents a compost emission reduction factor (CERF) for composting in California. This method accounts for the emissions (transportation, process, and fugitive) from the composting process and the benefits of applying (increased carbon storage, reduced water use, reduced soil erosion, decreased fertilizer use, and decreased herbicide use) compost as a soil amendment. A summary of the emissions and emission reductions are shown in Table 8.

Table 8. Summary of compost emission reduction factory (CERF).[a]

Emissions			
		Emission type	*Emission ($MTCO_2e$/ton of feedstock)*
		Transportation emissions (T_e)	0.008
		Process emissions (P_e)	0.008
		Fugitive CH_4 emissions (F_e)	0.078
		Fugitive N_2O emissions (F_e)	0.025
		Total	*0.119*

Emission reductions			
Emission reduction type	*Emission reduction ($MTCO_2e$/ton of compost)*	*Conversion factor*	*Final Emisson reduction ($MTCO_2e$/ton of feedstock)*
Increased Soil Carbon Storage (Cs_b)	N/A	N/A	0.26
Decreased Water Use (W_b)	0.04	0.5	0.02
Decreased Soil Erosion (E_b)	0.25	0.5	0.13
Decreased Fertilizer Use (F_b)	0.26	0.5	0.13
Decreased Herbicide Use (H_b)	0.0	0.5	0.0
		Total	*0.54*
		Overall	***0.42***

[a] The CERF was determined by subtracting the emissions from the emission reductions.

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Appendix H

Traffic Analysis

Appendix H – Traffic Analysis (Scenario 2)

This traffic analysis includes a general description of existing transportation conditions and evaluation of potential impacts associated with implementation of the proposed mandatory commercial recycling regulation. As mentioned in earlier chapters, four (4) different recycling scenarios were originally established by HF&H for its Cost Study on Commercial Recycling. For purposes of this analysis, Scenario 2 is used as it was selected as the most likely scenario to be implemented. Scenario 2 illustrates implementation of programs that jurisdictions could develop for traditional recyclables and construction & demolition wastes.

Implementation of the proposed regulation would not likely cause an increase in traffic which is substantial in relation to existing traffic loads and street systems or exceed level of service standards established by county congestion management agencies for designated roads or highways. Implementation of the proposed regulation is expected to result in minor increases to traffic load and level of service at a local level (statewide average of an additional 4-5 vehicle trips per day per facility). Traffic impacts, although minimal, could be mitigated by requiring additional vehicle trips to take place during hours of low traffic load. This analysis does not address out-of-state transportation, such as shipping of recyclable materials to other countries, only traffic to the port or state boundary. Statewide, regional, and countywide estimates are made.

Methodology

This traffic analysis uses assumptions and estimates on transportation in the HF&H Cost Study on Commercial Recycling and information collected from solid waste management companies. For each scenario, the Cost Study estimates the number of vehicles needed to (1) collect and transport the commercial sector's solid waste to the landfill (baseline) and (2) collect and transport to market the amount of material required to meet the 5 MMTCO2E reduction goals as well as collect and transport the remainder of this material to the landfill (implementation). Available tons vary under each scenario. For scenario 2, over 4 million tons of material is estimated to be available for recycling, and recycling of about 1.8 million tons of this would meet the 5 MMTCO2E reduction goals. The collection segment includes all vehicles used to collect and supervise collection of solid waste and recyclables, including front end loaders, roll off vehicles, container delivery vehicles and supervisor vehicles. Also, the Cost Study estimates the number of vehicles required to transport recyclable materials from solid waste facilities to processors or to port for shipment abroad.

Information was gathered from waste haulers on vehicles used for collection of solid waste and recyclable materials. Data collected includes average vehicle miles travelled and trips per vehicle. This analysis includes estimates of additional vehicle miles travelled and additional trips for two segments, collection to solid waste facility and solid waste facility to market for implementation of Scenario 4. A rough estimate is made of additional vehicle trips and mileage to individual sites. The estimates of traffic impacts are limited by uncertainties in the number and location of recycling facilities, routes taken to these facilities, tonnages processed by in-state recycling facilities, and tonnages shipped out-of-

state. CalRecycle's contractor for the Baseline Inventory and Information Management Framework Project is conducting a comprehensive inventory of California's solid waste handling, diversion, and market infrastructure, including primary processors, secondary processors, emerging technology facilities, and end users. Preliminary data from this project is used to estimate the number of facilities in California that could be impacted by the regulation. Accurate information on these facilities is difficult to collect as there is no mandated requirement for owners and operators of recycling facilities (with certain exceptions, such as can and bottle recyclers) to supply information to CalRecycle.

a. Existing Conditions

The state's existing transportation infrastructure is used to transport mixed solid waste, source separated materials, and recyclable commodities to solid waste facilities, processing facilities, manufacturers, and ports. The existing transportation system is comprised of all roadways, including local streets, arterials, highways, and freeways. On the state's roadways, the existing average annual daily traffic volumes and level of service vary considerably.

b. Project Impacts

The existing transportation infrastructure is assumed to be sufficient to accommodate the additional volume of materials that will need to be processed and delivered to markets as a result of implementation of the mandatory commercial recycling regulation. This is reasonable considering the minimal increase in average annual daily traffic volumes expected to result. However, implementation of the regulation would result in changes to transportation patterns. This analysis focuses on expected changes to traffic patterns, including additional vehicle miles travelled and additional vehicle trips. Statewide, regional, and local traffic impacts are discussed below.

i. Statewide

Statewide, implementation of the proposed regulation is expected to result in an additional 10.3 million vehicle miles travelled per year or 40,000 miles per day and an additional 680,000 one-way vehicle trips per year or 2,600 trips per day. Statewide traffic impacts are estimated for the market segment by using estimated county tonnages and miles to market data in the HF&H Cost Study on Commercial Recycling. Transfer vehicles are assumed to haul 23 tons per one-way trip and to back haul material on the return trip. Estimates for the collection segment are made by using scenario 2 data in the HF&H Cost Study on Commercial Recycling. The estimated number of vehicles needed to implement the regulation is subtracted from the number of existing vehicles (i.e., baseline) used to collect the commercial sector's solid waste. Vehicles on the road per day are estimated by subtracting spare vehicles, which differ by region, from total vehicles. Several solid waste haulers provided averages for vehicle mileage and trips per day. Vehicles are assumed to operate 260 days per year. It is estimated that a majority of the material to be diverted under scenario 2 will be processed outside the state.

ii. Regional

Additional vehicle miles travelled and additional one-way vehicle trips required to implement the regulation are estimated for each of the seven regions in the HF&H Cost Study on Commercial Recycling.

iii County

Additional vehicle miles travelled and additional one-way vehicle trips required to implement the regulation are estimated for each county. These are estimated by adding tonnages for each county in the following categories of materials: export commodities, glass, and wood waste. These material categories are used in the Cost Study and represent the materials recycled under Scenario 2. These tonnages are divided for each county by the regional tonnage, and multiplied by regional estimates for vehicle miles travelled and trips per day and per year.

iv. Local

Implementation of the proposed regulation is expected to result in minor increases to traffic load and level of service at a local level. Assuming there are about 600 recycling facilities in California, it is estimated that the regulation could result in an average of an additional 4-5 vehicle trips per day to each site. This is estimated by dividing the additional number of trips per day by the estimated number of recycling facilities located within the State.

APPENDIX H

Traffic Collection and Market Summary (Scenario 2)

Additional Vehicle Trips and Vehicle Miles Travelled - Scenario 2

1	Northern California A (Urban)	Collection				MRF-to-Market				Total			
County	**County Tons**	**Add. Vehicle Trips/Year**	**Add. Vehicle Trips/Day**	**Add. VMT per Year**	**Add. VMT per Day**	**Add. Vehicle Trips per Year**	**Add. Vehicle Trips per Day**	**Add. VMT per Year**	**Add. VMT per Day**	**Add. Vehicle Trips per Year**	**Add. Vehicle Trips per Day**	**Add. VMT per Year**	**Add. VMT per Day**
Alameda	58,081	12465	48	133747	514	2525	10	25715	99	14990	58	159463	613
Contra Costa	37,114	7965	31	85465	329	1614	6	35846	138	9579	37	121311	467
Marin	9,153	1964	8	21077	81	398	2	11562	44	2362	9	32639	126
Sacramento	48,505	10410	40	111696	430	2109	8	150146	577	12519	48	261842	1007
San Francisco	25,815	5540	21	59446	229	1122	4	19693	76	6663	26	79139	304
San Joaquin	30,371	6518	25	69938	269	1320	5	84175	324	7838	30	154113	593
San Mateo	28,458	6107	23	65532	252	1237	5	31000	119	7345	28	96533	371
Santa Clara	59,202	12705	49	136329	524	2574	10	115003	442	15279	59	251332	967
Santa Cruz	8,087	1736	7	18623	72	352	1	24467	94	2087	8	43090	166
Solano	16,857	3618	14	38818	149	733	3	21590	83	4351	17	60408	232
Sonoma	17,378	3729	14	40018	154	756	3	48591	187	4485	17	88608	341
Stanislaus	12,490	2680	10	28762	111	543	2	40134	154	3224	12	68895	265
Total	**351,511**	**75438**	**290**	**809450**	**3113**	**15283**	**59**	**607922**	**2338**	**90721**	**349**	**1417372**	**5451**

2	Northern California A (Rural)	Collection				MRF-to-Market				Total			
County	**County Tons**	**Add. Vehicle Trips/Year**	**Add. Vehicle Trips/Day**	**Add. VMT per Year**	**Add. VMT per Day**	**Add. Vehicle Trips per Year**	**Add. Vehicle Trips per Day**	**Add. VMT per Year**	**Add. VMT per Day**	**Add. Vehicle Trips per Year**	**Add. Vehicle Trips per Day**	**Add. VMT per Year**	**Add. VMT per Day**
Napa	5,477	2523	10	25517	98	238	1	10665	41	2761	11	36182	139
Yolo	7,478	3444	13	34839	134	325	1	21213	82	3769	14	56053	216
San Benito	14,927	6875	26	69544	267	649	2	53765	207	7524	29	123309	474
Total	**27,882**	**12842**	**49**	**129900**	**500**	**1212**	**5**	**85644**	**329**	**14054**	**54**	**215544**	**829**

3	Northern California B (Urban)	Collection				MRF-to-Market				Total			
County	County Tons	Add. Vehicle Trips/Year	Add. Vehicle Trips/Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day
Butte	9,011	6208	24	65726	253	392	2	63361	244	6600	25.38479	66118	254
Colusa	1,066	734	3	65726	253	46	0	5126	20	781	3.003017	65772	253
Fresno	38,564	26569	102	281284	1082	1677	6	273136	1051	28246	108.6382	282961	1088
Merced	10,722	7387	28	78206	301	466	2	52031	200	7853	30.20483	78672	303
Monterey	17,387	11979	46	126820	488	756	3	71069	273	12735	48.98073	127576	491
Placer	11,292	7780	30	82363	317	491	2	45960	177	8271	31.81057	82854	319
Tulare	15,907	10959	42	116025	446	692	3	140610	541	11651	44.81143	116717	449
Total	**103,949**	**71617**	**275**	**816151**	**3139**	**4520**	**17**	**651292**	**2505**	**76137**	**292.8336**	**820670**	**3156**

4	Northern California B (Rural)	Collection				MRF-to-Market				Total			
County	County Tons	Add. Vehicle Trips/Year	Add. Vehicle Trips/Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day
Alpine	93	93	0	1089	4	4	0.02	1	0.00	97	0.4	1090	4
Amador	1,549	1549	6	18142	70	67	0.26	7548	29.03	1616	6.2	25690	99
Calaveras	1,723	1723	7	20180	78	75	0.29	9908	38.11	1798	6.9	30088	116
Del Norte	852	852	4	9979	38	37	0.14	12404	47.71	889	3.4	22382	86
El Dorado	5,058	5058	21	59239	228	220	0.85	38520	148.16	5278	20.3	97759	376
Glenn	920	920	4	10775	41	40	0.15	5745	22.10	960	3.7	16520	64
Humboldt	3,010	3010	13	35253	136	131	0.50	33397	128.45	3141	12.1	68650	264
Lake	2,120	2120	9	24829	95	92	0.35	9339	35.92	2212	8.5	34168	131
Lassen	962	962	4	11267	43	42	0.16	11029	42.42	1004	3.9	22295	86
Madera	5,637	5637	23	66020	254	245	0.94	33891	130.35	5882	22.6	99912	384
Mariposa	556	556	2	6512	25	24	0.09	3534	13.59	580	2.2	10046	39
Mendocino	2,839	2839	12	33250	128	123	0.47	14209	54.65	2962	11.4	47459	183
Modoc	308	308	1	3607	14	13	0.05	4453	17.13	321	1.2	8060	31
Nevada	2,441	2441	10	28589	110	106	0.41	13789	53.04	2547	9.8	42378	163
Plumas	892	892	4	10447	40	39	0.15	8323	32.01	931	3.6	18770	72
Shasta	7,281	7281	30	85275	328	317	1.22	61569	236.80	7598	29.2	146844	565
Sierra	120	120	0	1405	5	5	0.02	900	3.46	125	0.5	2306	9
Siskiyou	1,408	1408	6	16490	63	61	0.24	17839	68.61	1469	5.7	34329	132
Sutter	2,971	2971	12	34796	134	129	0.5	13623	52.4	3100	11.9	48419	186
Tehama	1,930	1930	8	22604	87	84	0.32	14099	54.23	2014	7.7	36704	141
Trinity	349.00	349	1	4087	16	15	0.06	3669	14.11	364	1.4	7757	30
Tuolumne	1,880	1880	8	22018	85	82	0.31	9070	34.88	1962	7.5	31088	120
Yuba	2,971	2971	12	34796	134	129	0.5	14439	55.54	3100	11.9	49236	189
Total	47,870	47870	199	560650	2156	2081	8	341298	1313	49951	192	901948	3469

5	Southern California A (Urban)	Collection				MRF-to-Market				Total			
County	County Tons	Add. Vehicle Trips/Year	Add. Vehicle Trips/Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day
Los Angeles	560,293	165455	636	1811061	6966	24361	94	226771	872	189815	730	2037832	7838
Orange	180781.00	53385	205	584347	2247	7860	30	261511	1006	61245	236	845858	3253
Riverside	117,172	34601	133	378741	1457	5094	20	326670	1256	39695	153	705411	2713
San Bernadino	109,692	32392	125	354563	1364	4769	18	378142	1454	37161	143	732705	2818
San Diego	192,894	56962	219	623500	2398	8387	32	256033	985	65348	251	879533	3383
Ventura	49,063	14488	0	158589	610	2133	8	173330	667	16621	64	331918	1277
Total	1,209,895	357282	1318	3910800	15042	52604	202	1622456	6240	409886	1576	5533256	21282

6	Southern California B (Urban)	Collection				MRF-to-Market				Total			
County	County Tons	Add. Vehicle Trips/Year	Add. Vehicle Trips/Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day
Santa Barbara	14,975	7604	29	88692	341	651	3	78067	300	8255	32	166760	641
San Luis Obispo	8,394	4262	16	49715	191	365	1	75703	291	4627	18	125418	482
Kern	28,168	14303	55	166831	642	1225	5.00	152824	588	15528	60	319654	1229
Imperial	8,461	4296	17	50112	193	368	1.00	38438	148	4664	18	88550	341
Total	59,998	30465	117	355350	1367	2609	10.00	345032	1327	33074	127	700382	2694

7	Southern California B (Rural)	Collection				MRF-to-Market				Total			
County	County Tons	Add. Vehicle Trips/Year	Add. Vehicle Trips/Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day
Inyo	628	441	2	5299	20	27	0.11	7993	31	468	2	13291	51
Kings	4,221	2961	11	35613	137	184	1	33835	130	3145	12	69448	267
Mono	1,092	766	3	9213	35	47	0.18	15583	60	814	3	24797	95
Total	5,941	4168	16	50125	193	258	0.99	57410	221	4426	17	107535	414

Statewide		Collection				MRF-to-Market				Total			
		Add. Vehicle Trips/Year	Add. Vehicle Trips/Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day	Add. Vehicle Trips per Year	Add. Vehicle Trips per Day	Add. VMT per Year	Add. VMT per Day
		599682	2306	6632426	25509.33	78567	302	3711054	14273	678249	2609	10343480	39783

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Appendix I

Economic Technical Appendix

APPENDIX I

Economic Technical Appendix

Background

In January 2009, CalRecycle entered into a contract with Hilton Farnkopf & Hobson (HF&H), to estimate the costs, cost savings, and net costs to collect, haul, process, and market varying amounts of targeted recyclable materials with high lifecycle GHG impacts. The cost assessment provides information on costs and cost-effectiveness of the proposed regulation by evaluating various types of recycling programs that could be implemented based on four different recycling scenarios, named: Scenario 1, 2, 3 and 4. Each of these scenarios is based on a set recycling pattern and collection rate for achieving the 5 MMTCO2e emissions reduction goal were developed. The recyclables included in each Scenario were:

Scenario 1 - Traditional Recyclables: these materials include: paper, cardboard, metals, plastics, and glass
Scenario 2 - Traditional recyclables and Construction & Demolition (C&D), predominately wood waste
Scenario 3 - Traditional recyclables and Organics (green and food wastes)
Scenario 4 - Traditional recyclables, C&D, and Organics

During the September 21, 2010 and the January 19, 2011 stakeholder workshop, a number of stakeholders expressed concern that the cost projections overestimated the cost of the proposed regulation and requested that HF&H, CalRecycle, and ARB re-evaluate several of the underlying economic assumptions. In response to this request, the following alternative economic assumptions were evaluated:

- That the recovery rates of high value commodities would exceed the recovery rate of low value commodities as businesses are likely to try and maximize revenue and minimize costs incurred from recycling;

- That business are likely to self-haul or back-haul a modest percentage of the high value commodities in order to capture revenue from the sale of recyclables;

- That the costs of disposal will increase in future years (2015 – 2020) due to new landfill regulations; and;

- That many businesses will respond to the regulation by implementing waste reduction or "zero waste" programs and realize significant cost savings.

CalRecycle, ARB, and HF&H technical staff worked together to evaluate the alternative economic assumptions and determine the reasonableness of the alternative assumptions based on how the solid waste management system responded to the AB 939 requirements and how businesses have reacted to local government recycling requirements in California. Through this exercise, staff identified the following four possible alternative economic assumptions:

1. **Material-Specific Recovery Rates.** The model could be adjusted to differing levels of recovery for various material types to reflect that high-value commodities are likely to be recycled in higher quantities than low-value commodities.

2. **Increase in Self-Haul or Back-Haul of High-Value Commodities.** The model could be adjusted to reflect a modest increase in the self-hauling or back-hauling of their own recyclable materials by businesses that are recovering the high-value commodities. Businesses could self-haul or back-haul their recyclables using the same infrastructure that is used to deliver products to them. This is a common strategy used by larger businesses (e.g. Safeway, Wal-Mart, Toyota, etc.) that receive large tractor-trailer volume shipments of products from a distribution center and then use the empty tractor trailer that is returning to the distribution center to "back haul" the packaging waste from those products for recycling. Self-hauled or back-hauled materials are typically fairly homogeneous (i.e. only cardboard, only metal, only plastics) and do not require significant processing costs that are often associated with "single stream" mixed recyclables. Stakeholders have stated that self-haul or back-haul of high value commodities is a common strategy used by smaller businesses who would like to recycle without incurring the cost of "single-stream" recycling programs.

3. **Disposal Cost increases.** The model could be adjusted to increase the cost of disposal during the projection period. Some stakeholders stated that there are recent regulatory requirements on landfills that may increase their costs. Those regulatory requirements include post-closure financial assurances and methane capture requirements.

4. **Zero Waste.** Stakeholders stated that the regulation was likely to result in more businesses adopting waste reduction or zero waste programs and realizing associated cost savings.

Upon review, CalRecycle, ARB, and HF&H found that sufficient evidence and data were available to support modeling changes for items 1, and 2 above; it was acknowledged that some level of informed assumption would be required to conduct model runs using the alternative economic assumptions.

Regarding Item 3 above, when staff reviewed the available data relative to disposal cost increases resulting from new regulations, the data provided conflicting indicators both with regard to the specific regulatory requirements as well as the marketplace for disposal in recent years. As a result of this, staff determined that it was not appropriate to adjust the model to reflect an increase in disposal costs. Staff also reviewed available data relative to zero waste programs and determined that the increase in education and outreach to businesses resulting from the regulation was likely to increase the number of businesses implementing zero waste strategies and realizing associated cost savings. However, based on the available data, staff was not able to determine the cost savings from implementing zero waste programs on a statewide basis.

Some studies of individual businesses are included at the end of the technical appendix to illustrate the additional benefits and associated cost savings potential on a case-specific basis which supports the validity of the alternative economic assumptions above.

The results of utilizing these alternative economic assumptions in the model are presented below as Scenarios 2.1 and 2.2. Both Scenario 2.1 and 2.2 incorporate material-specific recovery rates and assume that recovery rates will be greater for high-value commodities. In addition, Scenario 2.1 represents a modest increase in the back-haul or self-haul of plastics (PET & HDPE), aluminum, and cardboard while Scenario 2.2 represents an additional incremental increase in the back-haul or self-haul of those same materials.

Methodology

The methodology and model used to evaluate Scenarios 2.1 and 2.2 is the same as the methodology and model that were used by HF&H to evaluate Scenarios 1 through 4 as documented in the report; "Cost Study on Commercial Recycling" dated January 11, 2011. Compared to the original model assumptions, only two assumptions were modified for Scenarios 2.1 and 2.2: 1) the material-specific recovery rates and the associated volume of each material type recovered; and 2) the tons of high-value commodities that would be recovered via self-haul or back-haul.

Material-Specific Recovery Rates

Scenarios 2, 2.1, and 2.2 recover Traditional Recyclables and Construction/Demolition Debris and result in a reduction of approximately 5 $MMTCO_2E$. Both Scenario 2.1 and 2.2 assume an increase in the recovery of high-value commodities (e.g., HDPE, PET, aluminum cans, and cardboard) and a corresponding decrease in the recovery of low-value commodities (e.g., glass, magazines & catalogs, newsprint, office paper, and phone books) relative to Scenario 2. The decrease in the recovery of low-value commodities was assumed in order to achieve a $5MMTCO_2E$ reduction in GHG emissions, the overall goal of the proposed regulation.

Numerous studies have investigated the recovery rate for recyclable commodities but there is no consensus on typical recovery rates for various materials. CalRecycle's Beverage Container Program reported that the overall recycling rate for calendar year 2010 was 82 percent[1]. The recycling rate for aluminum was 94%, glass 85%, PET 68%, and HTPE 92%. According to the American Forest and Paper Association, the recovery[2] rate of old corrugated containers (OCC), which is driven by both domestic and export demand, resulted in a recovery rate for OCC of 85.1 percent in 2010, up from 82.0 percent in 2009. The assumed recovery rates utilized in the alternative economic analysis are reasonable based on the available data.

Table 1 illustrates the material-specific recovery rate assumption for each targeted material type and the resulting emissions reductions at full implementation in 2020. This alternative economic assumption results in the recovery of approximately 56,000 additional tons of recyclables, or 3% increase in total tons of recyclables in Scenario 2.1 and 2.2 relative to Scenario 2.

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1 http://www.calrecycle.ca.gov/bevcontainer/Rates/BiannualRpt/default.htm
2 http://paperrecycles.org/index.html

Table 1 – Material-Specific Recovery Rates*[3]

Material Type	RERF/ CERF	Available Tons	Emissions Reduction Potential	Material Recovery Rate	Recovery Tons	Expected Emissions Reduction
		Commercial Waste Stream		*Scenario 2.1 & 2.2*		
HDPE	0.80	132,448	105,958	64%	84,767	67,813
PET	1.40	99,747	139,646	64%	63,838	89,374
Aluminum Cans & Nonferrous Metals	12.90	76,560	987,621	80%	61,248	790,097
Steel Cans & Ferrous Metals	1.50	863,524	1,295,286	64%	552,656	828,983
Glass Containers	0.20	248,597	49,719	10%	24,860	4,972
Cardboard & Paper Bags	5.00	1,355,399	6,776,996	40%	542,160	2,710,798
Magazines & Catalogs	0.30	143,803	43,141	14%	20,132	6,040
Newsprint	3.40	265,656	903,230	14%	37,192	126,452
Office Paper	4.30	518,331	2,228,821	14%	72,566	312,035
Phone Books	2.70	16,192	43,720	14%	2,267	6,121
Dimensional Lumber	0.21	647,752	136,028	43%	278,533	58,492
Total Tons Available for Recovery		**4,368,010**	**12,710,168**	**Total Tons Recovered**	**1,740,218**	**5,001,178**
Total Tons Managed[1]		**27,882,502**		**Total Tons Managed**	**27,882,502**	

*Total tons managed are equal to the tons available for recovery plus the tons that continue to be landfilled from the commercial sector.

These are the key formulas used in Table 1:

1. Total Managed Tons = Landfilled Tons + Recovered Tons;
2. Recovery Tons = Available Tons * Material Recovery Rate;
3. Emission Reduction Potential = RERF/CERF $_{Material}$ * Available Tons $_{Material}$

__Increase in Back-Haul or Self-Haul of High-Value Commodities__

Scenario 2 assumes that all materials that were collected by a commercial hauler and delivered to a landfill under the Business as Usual Scenario would continue to be hauled by a commercial hauler but that a portion of the recyclable material would be delivered to a Single-Stream or Mixed C&D Processing Facility for recovery. Similarly, Scenario 2 also assumes that the self-haul materials under the Business as Usual Scenario would continue to be self-hauled with relatively small percentage of high-value commodities being recovered by businesses back-hauling or self-hauling to comply with the regulatory requirement. Scenarios 2.1 and 2.2 utilize an alternative economic assumption and estimate the cost impact of a modest increase in the recovery of high-value commodities by businesses self-hauling or back-hauling.

CalRecycle, ARB, and HF&H conducted two model runs using two distinct assumptions regarding the quantity of high-value commodities that are likely to be recovered by businesses self-hauling or back-hauling. These two model runs provide a reasonable range of the cost impacts that are likely to result from a modest increase in the self-haul or back-haul of high-value commodities. Table 2 illustrates the increased quantity of high-value commodities recovered via back-haul or self-haul, under Scenario 2.1 and 2.2.

[3] Scenario 2 assumed a flat recovery rate of 39.4% for all material types.

Table 2 – Scenario 2.1 and 2.2 increase in tons recovered via Self-Haul or Back-Haul over BAU

Scenario	HDPE (Tons)	PET (Tons)	Aluminum Cans (Tons)	Cardboard (Tons)	% Increase in Total Tons Managed via Self-haul
S2.1	16,181	12,529	9,667	93,560	1.6%
S2.2	32,362	25,055	19,334	140,340	2.7%

The increased quantity of high-value commodities recovered via self-haul or back-haul impacts multiple cost categories as follows:

- **Collection.** The collection cost estimates reflect a ***reduction*** in the quantity of material recovered by a commercial hauler.
- **Single-Stream Processing.** The processing cost estimates reflect a ***reduction*** in the amount of material processed through Single-Stream Processing.
- **Source-Separated Processing.** The processing cost estimates reflect an ***increase*** in the amount of material processed through Source-Separated Processing. The Source-Separated Processing cost reflects both the processing costs and the costs incurred by businesses, if any, from managing their recyclables via self-haul or back-haul.

Results

The results of the revised modeling are summarized below on a statewide basis. Scenarios 2.1 and 2.2 result in an approximate 2% increase in costs relative the baseline or business as usual scenario.

Scenario 2.1 Summary:

- Implementation period cost ***savings*** = $408 million (2012-2020).
- Cost in 2020 (full implementation) = $41.7 million, or 1.6% ***increase*** over BAU.
- $8 per MTCO2E reduction in 2020.

Scenario 2.2 Summary:

- Implementation period cost ***savings*** = $585 million (2012-2020).
- Cost in 2020 (full implementation) = $20.2 million, or 0.8% ***increase*** over BAU.
- $4 per MTCO2E reduction in 2020.

Table 3 – System Cost Comparison between Scenarios for 2020

Scenario	Recovered (Million Tons)	System Cost (Millions $)	System Cost Over BAU (Millions $)	% Increase in System Cost Over BAU
BAU	N/A	$2,726	N/A	N/A
S2	1.68	$2,803	$142	5.3%
S2.1	1.74	$2,702	$42	1.6%
S2.2	1.74	$2,681	$20	0.8%

Table 4 – Total Regulation Cost Comparison between Scenarios for 2020 (in Millions)[1,2]

Scenario	Cost Over BAU			% Increase in Total System Cost Over BAU
	System Cost	Jurisdiction Implementation Cost	Total Regulation Cost	
BAU	N/A	N/A	N/A	N/A
S2	$142	$12	$154	5.8%
S2.1	$42	$12	$53	2.0%
S2.2	$20	$12	$32	1.2%

1. Values are rounded
2. In 2010 dollars

The overall sequence of cost impacts for these 3 summaries shows that:

- Recovery rate of high-value commodities increases from S2 to S2.1 and S2.2
- Percent of high value recyclables self-hauled increases as follows: S2 < S2.1 < S2.2
- Total system cost increase over BAU: S2 (5%), S2.1 (2%), S2.2 (1%)

Table 5 illustrates that, in general, Scenarios 2.1 and 2.2 result in a significant cost savings relative to Scenario 2 as a result of the alternative economic assumptions that were discussed earlier.

Table 5 – Scenarios 2, 2.1, and 2.2: Changes in Cost Relative to Baseline

Year	Baseline Costs (Millions $)	Changes Over Baseline Costs (in Millions $)		
		Scenario 2	Scenario 2.1	Scenario 2.2
2012	$2,365	($30)	($123)	($141)
2013	$2,402	($12)	($107)	($125)
2014	$2,444	$8	($87)	($106)
2015	$2,468	$28	($69)	($88)
2016	$2,507	$48	($49)	($68)
2017	$2,545	$70	($28)	($48)
2018	$2,584	$94	($5)	($26)
2019	$2,622	$118	$18	($3)
2020	$2,661	$142	$42	$20
Total 2012-2020	$22,598	$465	($408)	($585)

Savings in early years come from the extra capacity in the collection infrastructure created by the disposal tonnage reduction between the base year of 2008 and the implementation date of 2012 and as recyclables are shifted out of the disposal stream into recycling. In addition to those cost efficiencies, there are increased revenues as the commodity value of recyclables is realized in the marketplace.

Estimated Costs to Businesses

The number of businesses impacted by the proposed regulation is estimated at 320,000, based on the 2007 Census of Business data. Under the current economic conditions, there is no strong basis for adjusting the estimated number of businesses impacted by the proposed regulation for the 2012-2020 time periods. Estimating the number of business impacted by the proposed regulation is necessary to determine the average monthly cost to businesses in California. The following table presents average monthly costs to individual businesses, derived from the annual costs shown in Table 4 and Table 5.

Table 6 – Scenarios 2, 2.1, and 2.2: Incremental Monthly Cost Per Business

	Incremental Cost (in 2010$) Per Month, Per Business		
Year	Scenario 2	Scenario 2.1	Scenario 2.2
2012	($6)	($30)	($35)
2013	($1)	($26)	($30)
2014	$3	($22)	($27)
2015	$8	($17)	($22)
2016	$14	($11)	($16)
2017	$20	($5)	($11)
2018	$27	$1	($4)
2019	$33	$7	$2
2020	$40	$14	$8

For the Scenario 2, as well as the Scenarios 2.1 and 2.2, the initial years show an average cost savings. However, the savings for the Scenarios 2.1 and 2.2 are significantly greater than for Scenario 2. In S2.1 and S2.2, the initial savings of $30 to $35 per month, in the first year, reflect the excess capacity of the existing recycling infrastructure. In subsequent years, as this excess capacity in vehicles and facilities is fully utilized, expenses for additional infrastructure will require investment. This is reflected in the expected net cost increase by 2020, of $8 to $14 per month, per business.

Table 7 - Estimated Average Cost to Businesses at Full Implementation in 2020 (2010$)

Category	Scenario 2	Scenario 2.1	Scenario 2.2
Business Compliance Costs (Million $)	$142	$42	$20
Jurisdictions Implementation Costs (Million $)	$12	$12	$12
Total Cost to Impacted Businesses (Million $)	$154	$53	$32
Number of Impacted Businesses	320,000	320,000	320,000
Average Costs per Impacted Business ($/year)	$481	$166	$99
Average Cost per Impacted Business($/month)	$40	$14	$8

Assumptions Reasoning

It is anticipated that businesses will look for the most cost effective methods to implement the regulation. For example, "right-sizing" bins, implementing zero-waste policies and back-haul – self-haul their own materials or employing independent recyclers.

- "Right-sizing" garbage bins: Because haulers typically charge more for garbage collection than recycling, businesses may be able to reduce their garbage bins size and the frequency of collection; thus reducing their collection costs.

- Targeting material types with high-value redemption: Businesses can actually earn money while reducing their trash collection fees. This is illustrated in the redemption rates of California beverage containers. In 2010, the recycling rate for aluminum was 94%, PET 68% and HDPE was 92%. The recovery rate of old corrugated containers (OCC) was 85.1% in 2010, up from 82% in 2009.

Businesses Save Money Recycling

There is a perception by some that recycling will be a cost burden for California businesses. There are many examples of businesses, large and small, that have saved and even earned money by recycling. The recycling industry is expanding and the value of recycled material is increasing.

The Waste Reduction Awards Program (WRAP) is administered by the California Department of Resources Recycling and Recovery (CalRecycle). WRAP provides an opportunity for California businesses and nonprofit organizations to gain public recognition for their outstanding waste reduction efforts and lets the community know the business takes waste reduction seriously. Many of the WRAP participants report significant savings; for example the 285 businesses that participated in 2010 reported a diversion of 2.3 million tons from the landfill and a savings of $180 million.

Here are a few notable WRAP businesses:

Anheuser-Busch, Inc., Fairfield Brewery

In 2009, the brewery recycled 99.83 percent of its solid waste generated. This equaled 60,331 tons of materials which were reclaimed or recycled in 2009 and amounted to more than $6 million in landfill cost avoidance and recycling revenue.

Remo, Inc.

Located in Valencia, CA, Remo, Inc. is the world's largest manufacturer of percussion instruments. In 2009, Remo, Inc. was able to recycle various scrap materials amounting to 368 tons from a total waste stream of 561 tons, achieving a 66 percent recycling rate. The recycled materials contributed $33,109 to the company's bottom line, including $22,955 in reduced waste hauling and landfill disposal fees and $10,154 in income from the recycled products.

The Shops at Mission Viejo - Simon Property Group

The Shops recycled more than 160 tons of cardboard, paper, plastic, aluminum, and newspaper in 2009. It also reduced waste hauling costs by more than $12,000 in 2009.

Vestar Property Management

VESTAR Property Management, a privately held real estate company, develops and manages retail and entertainment destinations including The Tustin District. Opened in 2007, The Tustin District has a comprehensive recycling program for almost 70 businesses. All tenants can recycle their paper, cardboard, plastic, glass, and aluminum just by setting it outside of their back door. The tenants recycled more than 310 tons of recyclable material in 2009, saving more than $40,000 in waste hauling costs.

Many websites share stories of California businesses saving money with recycling:

CoolCalifornia.org:

Nomad Café

In this small but cozy corner café, drinking coffee is good for both you and the environment. Since the business opened in May 2003, Nomad implemented environmentally-friendly product and material uses as well as solid waste reduction strategies, energy efficiency measures, operation conservation measures, and vehicle pollution prevention policies. Nomad Café literally wastes no waste and has implemented a "zero-waste-over-the-counter" policy. Their proactive waste reduction programs have diverted 29 tons of waste from local landfills and save the business over $12,000 each year.

Seton Medical Center Coastside

This rural hospital, located on the California coast in Moss Beach, California, is home to a 116-bed Skilled Nursing Facility, a five-bed Acute Care Unit and an Emergency Department. Seton Coastside saved approximately $8,000 to $10,000 through waste reduction efforts and diverted more than 25 tons of materials from California's over- loaded landfills in fiscal year 2005/2006.

The Central Contra Costa Solid Waste Authority:

Hyatt Hotel, San Francisco, CA

The Hyatt Hotel at Fisherman's Wharf has an active employee and client education program, consisting of bulletin board notices in employee areas and informational door hangers on guests' doors. The Hyatt has donated used linen and uniforms to the Salvation Army and building materials to the City's Homeless Task Force. The Hyatt has recycled more than 40,000 pounds of cardboard and mixed paper, and has saved more than $26,000 on disposal fees.

Dura-Metrics, Inc., Santa Rosa, CA

Dura-Metrics, a dental laboratory, has reduced its landfill waste by more than 50 percent over the last 12 months by recycling office paper, cardboard, newspaper, plastic, fluorescent tubes, and aluminum cans. Surplus plastic buckets are donated for reuse to schools, and other businesses. Dura-Metrics' waste reduction program has enabled the company to cut its weekly trash pickups in half, saving over $3,000 a year.

Californians Against Waste

The world renowned *Hotel Del Coronado*, in San Diego, implemented an internal recycling program in 1993. In the programs first year they recycled more than 200 tons of glass, cardboard, paper and metal, resulting in an avoided disposal cost savings to the hotel of $20,000.

The 34-story *Transamerica Center* in Los Angeles established an aggressive wastepaper recycling program that in just two years reduced trash hauling costs from $116,850 to $39,000. The sale of recyclable materials added an additional $13,180 in revenue, for a total cost reduction of over 90 percent.

Institute for Local Government

Since mandatory commercial recycling became effective, the Salinas Valley Solid Waste Authority reports that in the City of Greenfield, businesses increased the tons of recycled materials collected by 152 percent between 2009 and 2010. At the same time, businesses reduced the amount of solid waste being disposed with commensurate cost savings. One county-wide property, multi-family apartment manager saved $72,000 in the first full year after implementing a recycling program to comply with the ordinance.

Zero Waste Programs

Some stakeholders said the proposed regulation will result in more businesses adopting zero waste programs and saving money.

According to the Zero Waste International Alliance,

- "Zero Waste is a goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use.
- Zero waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them.
- Implementing Zero Waste will eliminate all discharges to land, water or air that are a threat to planetary, human, animal or plant health."
- Businesses and communities that achieve over 90% diversion of waste landfills and incinerators are considered to be successful in achieving Zero Waste, or darn close."

Source: www.zwia.org/standards

The following businesses practice zero waste (>90% Waste Diversion):

- Anheuser-Busch, Fairfield, CA
- Apple Computer, Elk Grove, CA
- Del Mar Fairgrounds
- Fetzer Vineyards
- Frankie's Bohemian Café, SF
- Greens Restaurant SF
- Hewlett Packard, Roseville CA
- Mad River Brewery
- Pillsbury
- Playa Vista, LA, CA
- Ricoh Electronics, Inc.
- Toyota
- San Diego Wild Animal Park
- Scoma's Restaurant, SF
- Vons-Safeway
- Xerox Corp
- Yost Printer, Monrovia, CA

Source: www.green.org

Toyota is cited as one example of success. Toyota has ten plants that have reduced 95% of the waste to landfill from a 1999 baseline. One headquarters and five distribution centers are "zero waste to landfill" while 12 distribution centers have surpassed a 90% recycling rate. In 2009 Toyota reached a milestone reducing more than recycling. 35.5 million pounds were reduced while 22.5 million pounds were recycled with 1.3 million pounds landfilled. These practices have resulted in a savings of $1.3 million on waste management. Returnable shipping modules saved 9.4 million pounds of cardboard, 25.9 million pounds of wood and over $12.3 million in costs.
Source: www.toyota.com/about/environment

Sierra Nevada Brewing Company

The brewery is committed to leaving the smallest carbon footprint possible. Sierra Nevada Brewing Co. has been the proud recipient of the WRAP Award annually since 2001. In 2009, Sierra Nevada Brewing Co. diverted 34,345 tons of material from landfills through creative reuse, recycling, and composting efforts. In that same time, the brewery only sent 166 tons to the landfill and achieved a 99.5 percent diversion rate while avoiding $4.6 million in waste disposal fees. The latest addition to their program features a closed loop, waste reduction composting element called the HotRot, a large in-vessel composting system. This allows waste from the brewery and food scraps from the restaurant to be used as feedstock to create compost that is used onsite. This composting system helps them close the loop on discarded organics and prevents these materials from ending up in a landfill. It is an example of a zero waste program.

Back-Haul – Self-Haul & Independent Recyclers

As stated in the HF&H Cost Study, many large businesses develop their own strategies for collecting, aggregating, and managing their own discards. One common practice is demonstrated by big-box stores, grocery stores, and wholesalers that generate significant quantities of cardboard or food wastes and also have trucking fleets. These businesses will frequently make use of empty trucking capacity to "back-haul" their waste material to a central location.

Another method is for the business owner or the employees to self-haul discards to a processor or landfill. According to CalRecycle's 2008 Waste Characterization Study, the self-hauled waste sector accounts for approximately 20 percent of California's municipal solid waste stream, with commercial self-haul accounting for approximately 17 percent. The vehicle survey responses indicate that commercial self-hauled waste from construction, demolition, roofing and landscaping activities represents 9 percent of the total waste stream. Other miscellaneous commercial activities generate commercial self-hauled waste that represents approximately 8 percent of the overall waste stream. Independent recyclers typically collect material in pick-up trucks or other small vehicles and do not incur the costs of sophisticated equipment or overhead that are incurred by larger franchised haulers. According to stakeholders, businesses will sell or donate OCC where a robust infrastructure exists. All of these methods can save the business money in collection costs.

CalRecycle conducted a brief phone survey to confirm that the following businesses practice back-haul, self-haul or use independent recyclers.

- Safeway, Albertson's, Bel Air, Lucky, Nob Hill, Raley's back-haul cardboard, plastics and organics.
- Target back-hauls cardboard and other recyclables.
- Wal-Mart and Sam's Club backhaul cardboard and other recyclables.
- Stater Bros Markets backhaul recyclables .
- Mollie Stone's Markets back-haul cardboard and plastic .
- Home Depot backhauls cardboard .
- Crate and Barrel backhauls recylcables.

The following businesses in California do not back-haul, but use independent recyclers to collect their recyclable materials.

- Costco
- Lowes

Impacts of Mandatory Commercial Recycling on Businesses in San Jose

San Jose is transitioning from an open competitive market with regards to commercial hauling and recycling to an exclusive franchise system. There exists a large range of costs for each service depending upon the service provider in the existing open competitive market. The cost for a 4 yard bin of garbage varies from $50 to $612.50 per month. For recycling, the costs range from $56 to $160 for a 4 yard bin. As can be seen, businesses can save money through recycling versus disposal. According to the staff report dated April 5, 2011, small businesses will likely see decreases as their relatively high current rates are made consistent with what all businesses will pay for the same level of service. http://www.sanjoseca.gov/clerk/Agenda/20110405/20110405 0701.pdf

When the City of San Jose negotiated with the chosen service provider for a rate impact forecast, they categorized businesses (small, medium, and large) in terms of the volume of solid waste generated. Allied, the new service provider, produced a table of the best estimate of average rates, moving from a competitive non-exclusive environment to a franchised, exclusive environment. Rates will vary by material stream, service type, level and frequency.

Allied estimates rates will decrease by 5% to 10% for small businesses, while large customers might see up to a 12% increase. The rates are expected to be in-line with rates charged elsewhere in the Bay Area. Cities included: Santa Clara County Cities (Santa Clara, Milpitas, etc), San Francisco, Fremont, Oakland, etc. (Rates vary widely from city to city.)

Larger businesses have more leverage. City staff believes they may be able to negotiate better deals than smaller businesses in the current open market system. In the new system, small businesses will likely see decreases as their relatively high current rates are made consistent with what all businesses will pay for the same level of service.

Customer Size	***Average Rate Percentage Increase/Decrease***
Small (<150 cu yd/mo)	*-10% to -5%*
Medium (151-400 cu yd/mo)	*-3% to 8%*
Large (>400 cu yd/mo)	*0%-12%*

San Jose will continue to negotiate the agreements with Allied; the City will be setting the rate ceiling but not the floor thus enabling the service provider to offer lower rates to encourage high performing recyclers while ensuring that even the smallest companies are charged equitable rates.

Appendix J

ARB Phone Survey

Appendix J – Business Phone Survey

ARB Business Survey

The ARB staff conducted a phone survey of a variety of commercial businesses in order to obtain information on their recycling practices. The staff conducted this survey to gain a better understanding of recycling practices employed by California businesses and to better assess potential compliance practices due to the proposed regulation. The phone survey was developed with a broad set of 12 questions related to recycling activities and potential costs. The survey questions are shown in Figure J-1. However, it was not possible to follow the scripted questions in many situations due to the level of knowledge of the contact and the willingness to participate in the survey. As a result staff had to "improvise" to obtain as much information as possible.

The phone survey focused on businesses in ten jurisdictions with existing commercial recycling programs and/or ordinances. The jurisdictions were Agoura Hills, Alameda, Calabasas, Chowchilla, El Monte, Imperial Beach, Kingsburg, Sacramento, San Carlos, and San Francisco. These jurisdictions were chosen to represent a cross section of California's commercial recycling programs based on their geographic locations and population. A list of randomized contact information for businesses within these jurisdictions was used and was separated into five employee size categories. The employee size categories were: 5-9, 10-19, 20-49, 50 99, and 100+. These were then further separated into two sub-categories: restaurants and non-restaurants. Effort was made to obtain responses from each of the categories and sub-categories for each of the jurisdictions.

Over 700 phones calls were made with about 200 responses obtained. Although some inferences can be made based on the survey results, there are several limitations. The first problem noticed by staff is the difficulty in reaching the right person within each business that can provide answers to the questions. Answers that were hardest to obtain were the ones related to specific cost information and bin sizes for waste and for recyclables. Therefore, staff focused effort in getting responses to four key areas. These included: 1) Whether the business was recycling, 2) if the business was recycling, what kinds of material are being recycled, 3) how are the recyclables being collected, and 4) whether recycling saved or cost the business money.

As shown in Table J-1, the survey results show that there is a high level of participation (about 86% of the businesses) in recycling within the jurisdictions that have an existing commercial recycling program or ordinance. Most of the operators of the impacted businesses (about 82%) felt that recycling has saved the business money. Based on responses to what materials were being recycled we concluded that high value recyclable (metal, plastics, and cardboard) were being targeted by 55 to 79 percent of the businesses. From this, we concluded that the recycling rate for high value material was much greater than the 40 percent recycling rate assumed in Scenario 2 and supported the recycling rates range assumed in Scenarios 2.1 and 2.2. Finally, 30 percent of the respondents reported using self-haul to handle recyclables.

The results for these four key areas from the survey are summarized in Table J-1

Table J-1. ARB's Phone Survey Results

Four Areas Covered	Phone Survey Responses
Level of Participation in Recycling (% Recycling)	86% had a recycling program
Impact on Business Costs	82% said that they were saving money with their recycling program
Targeted Materials	55% to 79% said they were targeting at least one of the high value recyclables: metal, plastics, and cardboard
Self-Haul Activity	30% said use recycling services that are performed by parties other than the local government or franchise waste hauler

Figure J-1. ARB Phone Survey Questions

1. Do you have a recycling program at your business?
   - ☐ Yes. Are you required to recycle by ordinance ☐, is this voluntary ☐, or other ☐?
     Go to next question (No 2).
   - ☐ No. Do you plan on recycling in the future? ☐ Yes ☐ No

     Do you know if your recyclable material is being pick-up by private recyclers or someone you don't have a contract with? ☐ Yes ☐ No

     What is the size of your waste bin? ___________
     ☐< 4 CY(cubic yard) ☐ 4-8 CY ☐ 8-12 CY ☐ >12CY
     What is the frequency of pickup? ___________
     ☐ Daily ☐ Weekly ☐ Bi-Weekly ☐ Monthly
     About how much do you pay for your waste to be picked-up? (**Cost information will be kept confidential.**)

☐ Daily	☐ Weekly	☐ Bi-Weekly	☐ Monthly
☐ < $20	☐ < $20	☐ <$20	☐ <$20
☐ $20 - $50	☐ $20 - $50	☐ $20 - $50	☐ $20 - $50
☐ $50 - $100	☐ $50 -$100	☐ $50 - $100	☐ $50 - $100
☐ > $100	☐ > $100	☐ > $100	☐ > $100

Go to last question (No.12).

2. How long have you been recycling?__________

   Do you separate your recyclables? ☐ Yes ☐ No

   If yes, what are your labor costs to separate recyclables? ($/wk.)

   If no, do you put waste and recyclable material in the same bin? ☐ Yes

3. What type of material do you recycle:

   ☐Plastic ☐ Aluminum ☐ Other Metal ☐ Glass
   ☐Paper ☐ Cardboard ☐ Construction and Demolition
   ☐Compostable (i.e. grass, food) ☐ Other ______________________

4. What size bin do you use for your waste?

   ☐ < 4 CY ☐ 4-8 CY ☐ 8-12 CY ☐ >12 CY

   What size bin do you use for your recyclables?

   ☐ < 4 CY ☐ 4-8 CY ☐ 8-12 CY ☐ >12 CY

5. Did you use a different size waste bin before you started recycling?

   ☐ Yes ☐ No

   If yes, size of bin? , ☐ <4 CY ☐ 4-8 CY ☐ 8-12 CY ☐ >12 CY

6. What is the frequency of pickup for your waste?

   ☐ Daily ☐ Weekly ☐ Bi-Weekly ☐ Monthly

   What is the frequency of pickup for your recyclables?
   ☐ Daily ☐ Weekly ☐ Bi-Weekly ☐ Monthly

7. How is your recyclable material collected?

   ☐ Commercial hauler
   ☐ Self-hauled
   ☐ Back-hauled
   ☐ Private recycler (or, non-contracted recycler)

8. Has recycling reduced your waste collection costs? ☐ Yes ☐ No

9. What were your waste collection costs before you started to recycle? (All cost information given will be kept confidential).

☐ Daily	☐ Weekly	☐ Bi-Weekly	☐ Monthly
☐ < $20	☐ < $20	☐ <$20	☐ <$20
☐ $20 - $50	☐ $20 - $50	☐ $20 - $50	☐ $20 - $50
☐ $50 - $100	☐ $50 -$100	☐ $50 - $100	☐ $50 - $100
☐ > $100	☐ > $100	☐ > $100	☐ > $100

10. What were your waste and recycling material collection costs after you started to recycle?

☐ Daily	☐ Weekly	☐ Bi-Weekly	☐ Monthly
☐ < $20	☐ < $20	☐ <$20	☐ <$20
☐ $20 - $50	☐ $20 - $50	☐ $20 - $50	☐ $20 - $50
☐ $50 - $100	☐ $50 -$100	☐ $50 - $100	☐ $50 - $100
☐ > $100	☐ > $100	☐ > $100	☐ > $100

11. Taking into consideration the cost of separation and collection, do you know how much your recycling program has cost or saved you?

Cost

☐ Daily	☐ Weekly	☐ Bi-Weekly	☐ Monthly
☐ < $20	☐ < $20	☐ <$20	☐ <$20
☐ $20 - $50	☐ $20 - $50	☐ $20 - $50	☐ $20 - $50
☐ $50 - $100	☐ $50 -$100	☐ $50 - $100	☐ $50 - $100
☐ > $100	☐ > $100	☐ > $100	☐ > $100

Saved

☐ Daily	☐ Weekly	☐ Bi-Weekly	☐ Monthly
☐ < $20	☐ < $20	☐ <$20	☐ <$20
☐ $20 - $50	☐ $20 - $50	☐ $20 - $50	☐ $20 - $50
☐ $50 - $100	☐ $50 -$100	☐ $50 - $100	☐ $50 - $100
☐ > $100	☐ > $100	☐ > $100	☐ > $100

12. From your business experience, do you think recycling saves or costs money?

- ☐ Saves money
- ☐ Costs money

Appendix K

ARB/Cal Recycle MOU

**MEMORANDUM OF UNDERSTANDING
BETWEEN
THE CALIFORNIA AIR RESOURCES BOARD
AND
THE DEPARTMENT OF RESOURCES RECYCLING AND RECOVERY**

This Memorandum of Understanding (MOU) is entered into by the California Air Resources Board (ARB) and the Department of Resources Recycling and Recovery (CalRecycle).

Background

Pursuant to Health and Safety Code section 38561, ARB approved a Scoping Plan for achieving reductions in greenhouse gas emissions. Included in the Scoping Plan are various tasks related to Waste Handling and Recycling that are to be implemented by CalRecycle, formerly the California Integrated Waste Management Board (Board). For some of these tasks, CalRecycle does not have independent authority to adopt regulations regarding matters within the jurisdiction of ARB. (Public Resources Code (PRC) §43020.) The Scoping Plan calls for CalRecycle to implement those tasks because they are within the expertise and experience of CalRecycle, rather than ARB. Allowing CalRecycle to implement these tasks would be a more efficient and practical use of the resources of both agencies.

Scope

This MOU is intended to embody the arrangement regarding those tasks in the Scoping Plan that CalRecycle is to implement, but which lie within the authority of ARB.

ARB/CalRecycle Cooperation to Date

The AB 32 Scoping Plan designates CalRecycle as the lead agency to further a Mandatory Commercial Recycling measure. However, in the absence of statutory authority to adopt and implement the regulations as a greenhouse gas reduction measure, to complete the tasks assigned to it under the Scoping Plan, CalRecycle worked with the ARB to develop a joint rulemaking and implementation plan. This plan was approved by CalRecycle in December 2009 under the previous Board. Under the plan, CalRecycle staff, in collaboration with the ARB staff, has assumed the lead role in developing the mandatory commercial recycling regulation, with the ARB Board scheduled to adopt the regulation through its rulemaking authority. This process is similar to that ARB used to adopt the discrete early action greenhouse gas regulation for methane control at landfills.

ARB/CalRecycle Roles and Responsibilities

ARB will continue to assist CalRecycle as needed in developing the commercial recycling regulation for ARB Board approval and to meet all Administrative Procedures Act and Office of Administrative Law requirements. Following adoption of the mandatory commercial recycling regulation, CalRecycle will be the lead for implementation, program review, and compliance determination proceedings. This will allow the mandatory commercial recycling regulation to be integrated into CalRecycle's existing AB 939 (PRC §40000 et seq.) program while at the same time maintaining ARB's authority and its duty to monitor compliance with and enforce the regulation.

CalRecycle and ARB staff have developed the following working timeline for adoption, implementation, and enforcement of the measure:

- October 2011—ARB Board hearing to consider the adoption of the commercial recycling regulation.
- January 1, 2012—Effective date of the commercial recycling regulation (as planned for proposal September, 2011).
- July 1, 2012—Effective date for jurisdictions and businesses to implement commercial recycling programs (as planned for proposal September, 2011).
- August 2014—First review of jurisdictions' implementation of the regulation with reviews conducted every biennial or quadrennial review cycle thereafter.
- 2014 and 2019—CalRecycle staff conducts comprehensive waste characterization studies to measure the commercial recycling disposal and emission reductions at the statewide level.

Specific Tasks

CalRecycle:

As part of implementing the regulation, CalRecycle will provide all necessary technical assistance, such as training, model ordinances and contracts, decision making tools, and other supporting resources to local jurisdictions. Additionally, CalRecycle staff has also crafted the proposed regulatory language to be consistent with the current jurisdiction reporting and review process for determining jurisdiction compliance with established AB 939 diversion mandates. Under the proposed regulation, jurisdictions will be required to report on mandatory commercial recycling program implementation beginning with the 2012 Annual Report. CalRecycle staff would then evaluate program implementation efforts as part of each jurisdiction's overall AB 939 program evaluation. For those jurisdictions on a two-year cycle, the evaluation would begin in 2014 and continue every two years, and for jurisdictions on a four-year cycle, the evaluation would begin in the year 2016 and continue every four years, thereafter. Also, if CalRecycle staff finds that a jurisdiction is not implementing a program in compliance with the regulation, CalRecycle may choose to conduct a compliance review anytime outside of the two and four-year review cycles. CalRecycle will inform the ARB of all jurisdictions placed on compliance order status and those jurisdictions which are assessed a penalty for non-compliance. CalRecycle will also conduct waste characterization studies in 2014/2015 and 2019/2020 to determine if the greenhouse gas reduction goal has been met, and will report those findings to the ARB.

ARB:

To ensure the successful implementation of the regulation, ARB will maintain ultimate authority and responsibility for oversight of the regulation, including, if necessary, taking the enforcement actions described in section 38580 of the Health and Safety Code.

Agreement

1. CalRecycle will conduct workshops, draft documents, seek public input, and generally develop draft regulations as necessary to implement its tasks under the Scoping Plan.

2. ARB will formally adopt those regulations.

3. Once approved, CalRecycle will implement ARB's adopted regulations, including necessary compliance tasks and imposition of penalties under CalRecycle's established AB 939 procedures.

4. ARB will conduct any further enforcement procedures it determines necessary to implement the regulations.

5. ARB may periodically review CalRecycle's implementation efforts and may seek regulatory amendments in consultation with CalRecycle.

Dispute Resolution

It is the desire of the parties to establish a speedy, efficient, and informal method for the resolution of interagency disputes. Disputes between ARB and CalRecycle which can not otherwise be informally resolved, will be referred to the Executive Officer of ARB and the Director of CalRecycle.

To assist the parties in resolving disputes, one staff person will be appointed each by the Executive Directors of ARB and CalRecycle to represent the interests of their agency. Any disputes regarding the jurisdiction of these agencies, provisions of this MOU, or similar issues shall first be discussed by these representatives in order to determine if an informal resolution is possible. .

Administrative Considerations

1. This MOU represents a voluntary understanding between ARB and CalRecycle.

2. The terms of this MOU may be changed at any time by the parties by a written, signed amendment.

3. The MOU may be terminated upon 30 days written notice by either party.

4. No rights, duties, obligations, or liabilities enforceable at law are created by this MOU.

5. This agreement does not alter, modify, abridge, or in any way affect any rights, duties, obligations, or liabilities of any person under the laws of the State of California.

6. In the event that individual or several portions of this MOU are found to be in conflict with either state or federal law, regulations, or policies, and therefore, of no effect, the agreement will remain in effect without those provisions unless either party notifies the other in writing that the entire MOU is terminated.

7. Any action to modify, amend, or terminate this MOU shall be done in writing and may only be taken by ARB and by CalRecycle, or their designees to whom this authority is specifically delegated.

8. This MOU shall become effective on the date both parties have signed it and shall continue in effect until modified or terminated by the parties.

Communication

Communication between the parties regarding this agreement should be directed to the following individuals or as modified in writing:

Richard Corey, Chief Air Resources Board Stationary Source Division Air Resources Board 1001 I Street Sacramento, CA 95812	Howard Levenson, Deputy Director California Department of Resources Recycling and Recovery Materials Management and Local Assistance Division 1001 I Street Sacramento, CA 95812

Signed

California Air Resources Board

8/22/2011

James N. Goldstene
Executive Officer
California Air Resources Board
1001 I Street
Sacramento CA 95812

Date

Signed

Department of Resources Recycling and Recovery (CalRecycle)

Mark Leary
Acting Director, California Department
Of Resources Recycling and Recovery
(CalRecycle)

8/17/2011
Date