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U.S. Environmental Protection Agency

by the
Center for a Competitive Waste Industry
with Gary Liss & Associates and
Steven Sherman (formerly with ESA)

Beyond Recycling

Composting

Food scraps and soiled paper

January 2010

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ABBREVIATIONS USED IN REPORT

ACWMA	Alameda County Waste Management Authority
AD	Anaerobic digester
ADC	Alternative daily cover
CEQA	California Environmental Quality Act
CF	Cubic feet
CIWMB	California Integrated Waste Management Board
C/N	Carbon-nitrogen ratio
CO_2	Carbon dioxide
CO_2e	Carbon dioxide-equivalent
EPA	Environmental Protection Agency
IPCC	Intergovernmental Panel on Climate Change
LFCR	Less frequent collection of rubbish
LFGTE	Landfill-gas-to-energy
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
ONP	Old newsprint
P&D	Pet waste and throwaway diapers
POTW	Publicly operated treatment works
ROP	Residential organics programs
SSO	Source separated organics
VFA	Volatile fatty acids
VOC	Volatile organic compounds

EXECUTIVE SUMMARY

Many local governments are considering implementing residential collection of organics or expanding existing programs, either by volume or types of material collected. Typical reasons cited are to increase the overall waste diversion rate from landfilling or incineration, or to address specific concerns about impacts of disposal, notably global warming.

To provide information for these communities, this report examines data from the 121 existing Residential Organics Programs (ROP) in the United States and Canada. The study utilized a survey, site visits, and interviews. The report focuses on (1) the economics of various options for collection and processing, (2) the connections among the various program components, (3) operational implications of the volume of material and categories of organics that are collected, and (4) changes needed to increase composting capacity in communities across North America.

Major statistics from surveyed programs

In conducting a survey, the idea was not simply to delineate the status quo, but to analyze the parameters and practices of existing programs so that the industry can move forward. Survey data can be found in the Appendices and is summarized as follows:

- About a third of those responding collected food scraps separately; the rest collected food with yard trimmings, and the latter were generally in climates where yard trimmings are generated and collected year round.
- Only a few programs included pet waste and only one program included diapers.
- Few communities banned organics from trash; more banned them from landfills; three banned plastic bags to collect organics.
- The largest number of respondents indicated that organics are collected separately, on a weekly basis and not collected on the same truck with other materials in different compartments.

KEY POINTS

- ✔ The ability of expanded organics programs to significantly reduce greenhouse gas emissions provides a potent new reason for more communities to become involved, along with the earlier motivations to increase diversion and lessen landfills' threats to groundwater
- ✔ When organics programs capitalize on their synergies to reduce the frequency of trash collection, they can both double diversion and produce savings to offset the cost of the new programs
- ✔ Processing food scraps creates potential odor problems that, ultimately, may require more expensive enclosed systems
- ✔ In 2009, 121 communities in North America had moved beyond recycling to composting

- The largest number of programs included paper, food scraps and yard trimmings together.

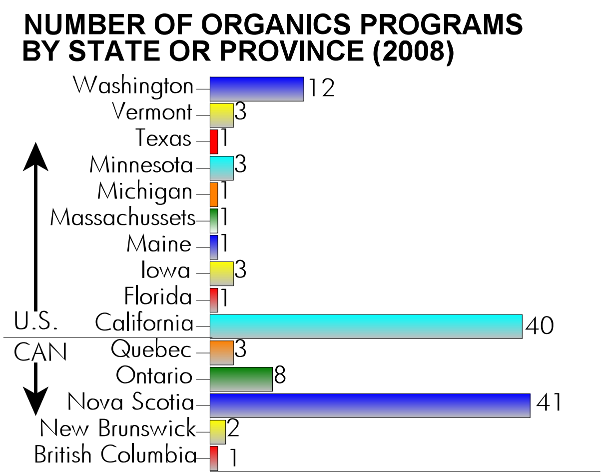
- The total cost of trash, recyclables and organics programs per household ranges from $11 to $33 per household (HH) per month, with an average of $22/HH/month. the range of tipping fees for organics processing varies from $15 to $90 per ton and averages $44 per ton.

- The range of tipping fees for landfilling varies from $16 to $115 per ton and averages $61 per ton.

- The range of tipping fees for the 3 communities reporting the use of incinerators, ranged from $45 to $140 per ton, with an average of $92 per ton.

Findings regarding collection and processing

Once the initial decision is made to divert organics, many decisions must then be made about the scope of the program. Most particularly, the question is whether it is to be an incremental expansion, or a program that from the outset collects a wide range of organics. In general additional categories of organics, especially pet waste and diapers, entail more expensive processing, that is, moving from windrows, to in-vessel processing (including anaerobic digesters for energy capture before composting). Program components are connected, however, and a decision in one area has implications for another, a fact that has implications for long-term costs projections.



A key finding of the study is that if, in addition to recycling, all putrescibles are collected (often including pet waste and diapers), the residual rubbish collection can be reduced to once every two weeks or even once a month. The costs saved from less frequent rubbish collection could offset the additional costs of processing the extra categories of organics. This approach also increases diversion of organics because residents are motivated to put organics in the appropriate container to avoid holding on to them until the next rubbish pick-up. Various strategies are offered regarding how to structure collection, depending on local factors.

Organics programs that expand incrementally will have an easier time to provide processing capacity for their smaller additional loads of food scraps and soiled paper beyond yard trimmings.

Many California composters that accept food scraps had previously been required to upgrade to covers and aerated piles in an effort to keep within air quality standards and community norms. Today, the trend suggests that there may be a gradual shift to in-vessel technologies and possibly anaerobic digesters.

Program decisions must be made at the local level to consider such factors as disposal fees, availability of outside funding such as stimulus grants or cap and trade funds, existing collection vehicles, as well as community support for organics collection and processing. For example:

- In lower tipping fee environments, windrow systems may be cost competitive; if tipping fees are high, more elaborate technologies may be able to be cost-justified.
- Where yard trimmings are not collected year-round, the expanded program should consider keeping yard trimmings separate from food.
- Existing collection vehicles might do double-duty, with co-collection of organics and, at different times, recyclables and rubbish. If communities are cities that have lost sizable manufacturing plant, wastewater treatment plant digesters might have excess capacity and be a resource for processing organics, with the benefit of capturing energy.
- One way to start with residential collection would be a pilot in part of the community for part of the year to minimize capital costs.

Increasing composting capacity

The capacity for processing food scraps is not nearly large enough to handle the material generated. Changes needed to increase the capacity to process organics fall into several categories:

- Policy changes on the state or local level
- Operational changes that will shift the economics of organics processing
- Public awareness efforts to develop political will for collection and siting facilities.

Policy changes are needed, especially to attract business investors. These changes include raising disposal fees; in California, eliminating recycling credit for organic Alternative Daily Landfill Cover; giving carbon trading credits for compost; and streamlining the permitting process. In addition, some changes in operational practices, especially regarding nuisance factors such as odor control will in turn generate public support for composting. ☛

HOW TO LEARN MORE AND NETWORK

Go on-line to www.beyondrecycling.org to learn more, keep current with new developments and network with others interested in expanding diversion programs beyond recycling to also recover organic discards.

1.0 INTRODUCTION

In June 2009, San Francisco passed the first law in the United States mandating household source separation of discarded food as well as recyclables. Many see this law as the herald of a trend in the U.S., following the first major efforts in Canada.

Initially, the extension of recycling programs to expanding composting efforts was motivated by a desire to increase diversion over 50%, and sometimes to avoid reliance on landfills believed to leak. But, with increased awareness and concern over global warming, national attention has turned to the importance of diverting organic material from disposal, because burying our organic discards in landfills creates major volumes of methane, which is an extremely potent greenhouse gas, much of which escapes. Many local governments are considering implementing composting programs or expanding existing programs, either by volume or types of material collected.

Photo Credit: California Integrated Waste Management Board

San Francisco three bin set out

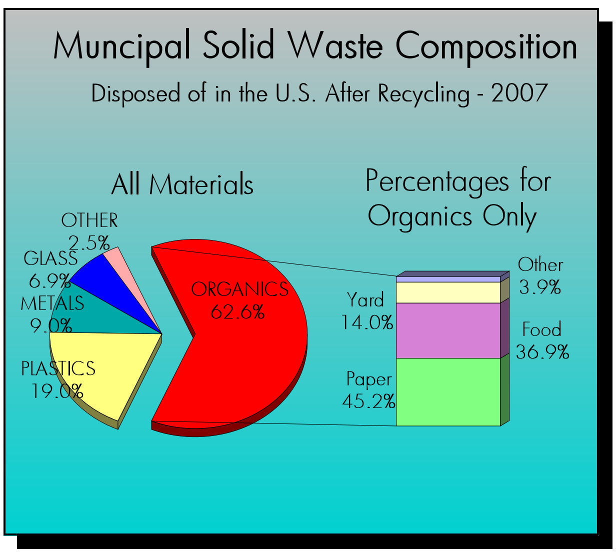
To provide information for communities seeking to initiate or expand residential organics collection and processing, this report examines data from the 121 existing ROPs (Residential Organics Programs) in the United States and Canada.

2.0 BACKGROUND

2.1 History of Earlier Diversion Efforts in U.S.

In 1989, at the onset of the modern recycling movement, there were approximately 1,042 curbside recycling programs diverting 13% of municipal solid waste (MSW) generated. By 2006, 17 years later, there were about 8,510 programs diverting 30% of MSW. Most of these programs separately collected for recycling the aluminum and steel cans, glass and the major plastic bottles, and newspaper and corrugated cardboard. These materials were sorted at a centralized materials recovery facility (MRF), densified for shipping and sold to intermediate or end use markets to be recycled into new packages or products. These first generation programs usually also either stopped collecting, or separately collected, yard trimmings for composting (and in California landfill cover), which accounted for about one-third of the total diversion.[1]

In the last 10 years, highly motivated cities pursued more aggressive efforts to significantly expand traditional recycling by such things as adding collection of mixed paper, offering negative and positive financial incentives and providing more convenient wheeled carts to take the recyclables to the curb. Also, in 11 states, mandatory deposit laws had been passed to provide a financial incentive to return soft drink, and in four of those states, also non-carbonated, polyethylene terephthalate (PET) bottles. By doing these things, diversion from the MSW stream could be increased from 25%-35% to 40%-50%.[2]



Source: EPA Municipal Waste Characterization

FIGURE 1

But, to exceed 50% diversion, something more needed to be done, and attention turned to the organic part of MSW. Before recycling, organics were 72%, and after recycling that recovers half of the paper and paperboard, organics are now about 63% of what is estimated to be landfilled in the U.S. today. See FIGURE 1.[3] This recycling infrastructure, including the fact that residents had become habituated to separate their discards, provided a strong foundation on which to expand beyond recycling to organics.

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1 *BioCycle Magazine*, "State of Garbage in America," 1989-2008.

2 Environmental Protection Agency (EPA), *Cutting the Waste Stream in Half: Community Record-Setters Show How* (EPA-530-R-99-013 June 1999).

3 EPA, Municipal Solid Waste Generation, Recycling and Discards in the United States (EPA-530-7-009-021, 2009), at TABLES 1 and 3.

2.2 New Motivations for Diversion's Next Steps to Expand into Organic Discards

The first residential organics programs were focused on increasing overall diversion above 50%, and in other places, to reduce dependence on landfilling, which was seen as a threat to groundwater supplies. Later, advocates of zero waste saw expanded composting programs as the next step to achieve that objective.

> The climate crisis provides a new and powerful motivation to expand new composting programs beyond efforts by "green" cities.

Most recently, however, the connection between efforts to divert organics and climate change has received attention. To the extent that composting instead of landfilling organic discards is found to reduce the threats of climate change, there would be a powerful motivation to significantly increase these diversion programs. This is because, in the absence of national or state mandates that compels greater diversion, much of the local activity towards expanding composting has come from few communities that prioritize sustainability higher than budgetary constraints. To the extent diversion comes to be seen as a significant local tool to reduce their carbon footprints, and to the extent treaties and legislation increase the price of carbon emissions from wasting, those other communities less concerned with the environmental impacts of their actions may consider, or be required, to divert their households' organic discards for economic and regulatory reasons, as well.

Today, the evidence of significant global warming, the strong likelihood for greater temperature increases in the future, human responsibility for increasing greenhouse gases associated with climate change, and the enormity of the threats to a civilized society that all this poses, are established scientific fact.[4] In addition, the latest comprehensive review of reports on the most recent climate observations has found that warming impacts have accelerated beyond the predicted values in the Intergovernmental Panel on Climate Change's (IPCC) last major review in 2007. Larger than anticipated positive feed back loops now more closely reflect the worst case assumptions from just two years earlier.[5]

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4 IPCC, *Fourth Assessment Report*, Summary for Policymakers (2007), at pp. 2, 7, 9, 10 and 13. EPA, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks* (2002), (EPA530-R-02-006)(June 2002), at p. ES-2. American Association for the Advancement of Science, Statement by Board of Directors on Dec. 9, 2006. American Physical Society Statement by Council on Nov. 18, 2007. American Meteorological Society Statement by Council on Feb. 1, 2007. American Geophysical Union Position Statement on Human Impacts on Climate Adopted by Council Dec. 2007.

5 I. Allison, N. Bindoff, R.Bindoff, R. Bindschadler, P. Cox, N. de Noblet, M.England, J. Francis, N. Gruber, A. Haywood, D. Karoly, G. Kaser, C. Le Quéré, T.Lenton, M. Mann, B. McNeil, A.Pitman, S. Rahmstorf, E. Rignot, H. Schellnhuber, S.Schneider, S. Sherwood, R. Somerville, K.Steffen, E. Steig, M. Visbeck, A.Weaver, *The Copenhagen Diagnosis, 2009: Updating the World on the Latest Climate Science* (The Univ. of New South Wales Climate Change Research Centre, Sydney, Australia, 2009).

Landfills are among the sources of GHGs associated with climate change, because organic discards, if not separated at the source, are most often buried. In the oxygen-starved environment of a sealed landfill, food scraps, soiled paper and other organic matter decompose anaerobically under the influence of methanogenic microbes. These thrive in the absence of oxygen, and create methane as a byproduct of decomposition.[6]

Methane is an especially aggressive greenhouse gas (GHG), whose Global Warming Potential (GWP), which is a convention used to compare other GHGs to carbon dioxide (CO_2) on a CO_2 equivalent basis (CO_2e), is officially weighted 25 times more potent than CO_2 when measured over 100 years. When measured over a shorter 20 year time frame, methane has 72 times the warming potential of CO_2.[7]

Furthermore, methane's residency in the atmosphere before it decays averages 12 to 13 years,[8] which is closely aligned with the short-term horizon when heightened concerns exist about crossing tipping points that may trigger irreversible changes in our climate. [9] Because methane's residency in the atmosphere is focused in the same time frame as key climatic points of no return, scientists recommend that decision-makers establish short-term climate action plans to address the short-lived GHGs distinct from and parallel to the long-term efforts now focused on CO_2. Methane, with its 20-year GWP 72 times CO_2, is a prime example:

> "A growing body of evidence suggests that significant climate changes are no longer a distant prospect and that time spans on the order of decades are increasingly relevant. Observations over the past decade indicate that the climate is changing more quickly than projected by earlier IPCC Assessment reports, that climate impacts occur at lower surface temperatures than previously estimated, and that temperature change will be greater during this century than had been previously projected...

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6 Environmental Protection Agency, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks* (2002), at p. 97.

7 IPCC, *Fourth Assessment Report*: Chapter 2: Changes in Atmospheric Constituents and in Radiative Forcing (2007), at p. 212. Most recently, methane's warming potential has been more extensively investigated and NASA's scientists now consider methane to be 34x CO_2 in the long-term, and 105x in the near term, after factoring in indirect impacts on the formation of aerosols, which is another greenhouse gas. Drew Shindell, "Improved Attribution of Climate Forcing Emissions," 326 SCIENCE 716 (2009).

8 IPCC, *Fourth Assessment Report*: Chapter 2: Changes in Atmospheric Constituents and in Radiative Forcing (2007), at p. 212, Table 2.14.

9 Timothy M. Lenton, et al., "Tipping elements in the Earth's climate system," 105 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 6, at pp. 1786-1793.

"Policy must evolve and incorporate the emerging science in order to be effective. There is a growing need to create a two-pronged framework capable of not only mitigating long-term climate change but also managing the magnitude and rate of change of near-term R[adiative] F[orcing]. Short-lived pollutants (black carbon and tropospheric ozone) and medium-lived pollutants (methane) account for more than half of the positive RF generated in years 1 to 20."[10]

According to climate scientists at the National Aeronautics and Space Administration (NASA), the combination of methane's potency, and its short lifetime in the atmosphere, plays an especially critical role in the near term when we confront those critical tipping points:

"[F]easible reversal of the growth of atmospheric [methane] and other trace gases would provide a vital contribution toward averting dangerous anthropogenic interference with global climate...[Methane] deserves special attention in efforts to stem global warming...Given the difficulty of halting near-term CO_2 growth, the only practical way to avoid [dangerous interference] with climate may be simultaneous efforts to reverse the growth of [methane].[11]

Similarly, Robert Watkins, the co-chair of the IPCC's Third Assessment, recently wrote in the disappointing aftermath of Copenhagen:

"This month's Copenhagen talks focused on the leading climate change culprit: CO_2. But reversing global temperature increases by reducing carbon emissions will take many decades, if not centuries. Even if the largest cuts in CO_2 contemplated in Copenhagen are implemented, it simply will not reverse the melting of ice already occurring ...The most obvious strategy is to make an all-out effort to reduce emissions of methane. Methane's short life makes it especially interesting in the short run, given the pace of climate change. If we need to suppress temperature quickly in order to preserve glaciers, reducing methane can make an immediate impact. Compared to the massive requirements necessary to reduce CO_2, cutting methane requires only modest investment. Where we stop methane emissions, cooling follows within a decade, not centuries. That could make the difference for many fragile systems on the brink."[12]

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10 Stacy C. Jackson, "Parallel Pursuit of Near-Term and Long-Term Climate Mitigation," 326 SCIENCE 526 (2009), excerpted from 526-527. See, also, Alissa Kendall, et al., "Accounting for Time-Dependent Effects of Biofuel Life Cycle Greenhouse Gas Emissions Calculations," *Environ. Sci. Techn*. (August 14, 2009), p. 6907.

11 James Hansen, "Greenhouse gas growth rates", 101 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 46 (November 16, 2004), p. 161094.

12 Robert Watson and Mahamed El-Ashry, "A Fast, Cheap Way to Cool the Planet," *The Wall Street Journal* (December 29, 2009).

The importance of landfills in particular as a source of GHG, however, has been debated. Each year, approximately 137 million tons of solid waste are landfilled in the U.S. In modern landfills, the accumulated annual output of trash generates something in the order of 8 million tons of methane over the site's life,[13] which is equivalent to 244 million metric tons-carbon dioxide equivalent.[14] One of the key unsettled points is how much of the gases generated in landfills is not controlled by the gas collection systems that is installed mostly in the very large sites.

Although there is no actual data on how much gas escapes from landfills,[15] EPA estimates they are responsible for 2.2% of anthropogenic greenhouse gases (GHG).[16] That conclusion is predicated upon an assumption that the gas collection systems are highly efficient, capturing 78% of the gas.[17] Underlying this assumption is the Agency's belief of how well the best operated systems might perform in the short interval of time when they are capable of operating at their peak performance.[18]

That low estimate of landfills' responsibility for GHGs is highly sensitive to that EPA assumption of high gas capture,[19] whose true value, notwithstanding the frequency that the 78% figure has been cited, is actually unknown.[20]

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13 The calculation is performed by multiplying methane quantities by the most recent estimate of its 100-year Methane Global Warming Potential. After accounting for indirect interactions with aerosols, that multiplier is 34 times CO_2. Drew T. Shindell, et al., "Improved Attribution of Climate Forcing Emissions," 326 SCIENCE 716 (2009).

14 Landfilled municipal solid waste in the U.S., or 137.2 million tons in 2007, is from EPA, *MSW Generation, Recycling and Discards in the United States*, at Table ES-1; quantity of gas generated per pound of waste is from EPA, *Turning a Liability Into an Asset* (EPA 430-B-96-0004, 1996), at p. 2-6,and 57 FEDERAL REGISTER 33791(June 21, 1993). More recent reported decreases in assumed gas generation rates (which is the abbreviation "L_o" in the first order decay equations) appear to ignore residual carbon remaining in closed landfills. The most recently IPCC approved 100-year methane GWP of 25 is used to convert methane quantities into CO_2-equivalents.

15 Memorandum to Brian Guzzone, EPA, from Chad Leatherwood, Eastern Research Group, Inc., dated November 18, 2002, re: Review of Available Data and Industry Contacts Regarding Landfill Gas Collection Efficiency (Leatherwood Memo), at p. 2.

16 EPA, *Inventory of U.S. GHG Emissions and Sinks 1990-2007*(2009), at Table ES-2.

17 EPA, *GHG Emissions from Management of Selected Materials in MSW* (EPA 530-R-98-013, 1998), at p. 106; *Solid Waste Management and Greenhouse Gases*, (EPA530-R-02-006, 2002), at p. 108; *Turning a Liability Into an Asset* (EPA 430-B-96-004, September 1996), at p. 2-8. The 78% value is a 75% capture rate plus a 10% oxidation rate.

18 EPA, *Anthropogenic Methane Emissions in the United States* (EPA 430-R-93-003, 1993), at p. 4-11; Leatherwood Memorandum, at p. 2.

19 EPA, *GHG Emissions from Management of Selected Materials in MSW*, *supra*, at p. ES-15.

20 Leatherwood Memorandum, at p. 2.

Most recently, the IPCC examined how the estimate would change if actual lifetime results were considered, instead of using EPA's assumption of what it believes the best operated system might achieve when it is installed and at its peak performance. Because more than 90% of landfill gas is generated before and after the collection systems are operating – when capture rates are zero – the IPCC concluded that *lifetime* performance "may be as low as 20%."[21] EPA Region 9 has recommended to EPA Headquarters that lifetime capture rates be assumed to be 30% in its WARM modeling,[22] and the Massachusetts Department of the Environment, 40%,[23] as has also widely been applied for the instantaneous capture rate used in Europe.[24]

Of note, EPA itself has elsewhere recognized that extended sources of GHGs– that is, those that continue to release gases decades hence from actions taken today – should be considered in evaluating climate impacts, as it illustrated by the time taken for "decomposition on the forest floor" from underbrush.[25] Also, EPA has made other key calculations in its national inventory of the waste sector's responsibility for GHG emissions that are predicated upon recognition of extended impacts into the future following from actions taken today.[26]

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21 IPCC, *Fourth Assessment Report:* Chapter 10:Waste Management (2007), at p. 600, which was based upon the peer review comments by Prof. Hans Oonk, *Expert Review of First Order Draft of Waste Chapter to IPCC's Fourth Assessment Report* (2007).

22 Region 9 EPA, *Ideas for Consideration to Strengthen WARM Model* (2007), at p. 1.

23 EPA, Preamble to Final GHG Reporting Rule, FED. REG. (September 22, 2009), p. 1150.

24 European Commission, *A Study on the Economic Valuation of Environmental Externalities from Landfill Disposal* - FINAL APPENDIX REPORT (October 2000), at p. 144.

25 EPA., *Solid Waste Management and Greenhouse Gases:A Life-Cycle Assessment of Emissions and Sinks* (EPA530-R-02-006, 2002), at p. 12.

26 While EPA Headquarters defines capture rates on a short-term basis, it performs another calculation in its national inventory predicated on long-term impacts in order to compare emissions of one GHG to another gas from various emission sources. Because the most prevalent GHG is CO_2, the other gases are converted into their warming impacts equivalent to carbon dioxide, which is each gas's Global Warming Potential mentioned earlier. To do the calculation that accounts for the fact that each GHG has a different residence time in the atmosphere, a single time period must arbitrarily be assumed over which their integrated radiative forcing is summed. Even though there is no compelling reason to pick any specific period for the calculation over another, the IPCC along with EPA designated a 100-year time frame as the convention for national inventories of GHG emissions. This was also thought to reflect the importance of capturing the lasting impacts of longer-lived gases such as CO_2, which at the time was then thought (erroneously) to typically remain in the atmosphere for approximately 100 years. *GHGs and Global Warming Potential Values: Excerpt from the Inventory of U.S. GHG Emissions and Sinks: 1990-2000* (2002), at pp. 8-9.

Assuming there is a parallel effort to also address unique short term climate concerns, *Parallel Pursuit, supra*, this decision was a reasonable one – so long as the long-term benchmark is consistently applied throughout the calculations. However, that is not what was done. For, in establishing definitions for what will and will not be considered in assessing gas collection efficiency, the EPA arbitrarily excluded recognition of extended decades' long releases from the decomposition of wastes buried today.

(continued...)

A fatal internal inconsistency is the result of recognizing those types of long-term effects elsewhere – when the consequence described in the note is to diminish methane's apparent current warming potential – yet ignoring them in its basis for assuming a gas collection efficiency rate – when the effect is to artificially overstate landfill's performance.

> Landfills' responsibility for GHGs is more than 10%, many times greater than the 2.2% reported in the US GHG Inventory.

If, to correct that internal consistency, and reflect longer-term realities, landfills' lifetime capture rates are utilized instead of their best peak performance, then landfills' responsibility for climate change is multiplied several times from what is shown in the national GHG inventory. For probable collection efficiencies are almost a fourth of the assumptions being used incorrectly.

Landfills' extended impacts are a major factor in causing an increase in gases that are associated with higher mean global temperatures, and even more so when other relevant factors are considered.[27]

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[26] (...continued)
If EPA protocols are to be internally consistent, the long-term approach embedded in the calculation of GWPs needs to be mirrored in the time frame over which gas collection efficiencies are considered. At present, they are inapposite, with the result that landfill emissions are recognized only in the short-run (which has the effect of dramatically reducing fugitive gas estimates), while their impact in the atmosphere is considered over 88 years longer than it actually persists (which has the effect of significantly undercounting its warming potency). Thus, to provide for an internally consistent analysis, gas collection efficiency must be assessed over a similar 100-year period.

[27] There is another factor that further increases landfill emissions above that estimated in the inventory. That is the calculation of the GWP, which is used to compare the warming impact of methane, an extremely aggressive GHG focused in the short-term, to CO_2, a considerably less intense, but more long-lived, GHG. Based on the latest evidence at the time, in 2007 the IPCC found methane to be 25× more potent when compared over a 100-year period to CO_2, and 72× greater in a shorter 20 year-period. However, in its GHG inventory of U.S. GHG emissions, EPA uses the IPCC's now outdated 1996 weighting factor of 21× because this was a compromise intended to produce comparable data from one year to the earlier years before the 2007 correction was known. EPA, *Inventory of U.S. GHG Emissions and Sinks 1990-2007* (2009), at p. ES-3. However, the effect of that compromise is to undercount methane-producing sources today as 16% lower than the 25× that was known to be the case in 2007.

Also, as noted, the most recent evaluation of methane's warming impact in 2009 has shown that, after accounting for atmospheric interactions with aerosols, methane's 100-year GWP increases to 34× CO_2, *Improved Attribution*, *supra*, and, with reference to the critical short-term, a 20-year GWP 105× CO_2. This has led to calls for the imposition of short-term action plans, *Parallel Pursuits*, *supra*. TABLE 1 shows the effect of these corrections to the assumed GWP on landfills' responsibility for GHGs in the event that they are adopted in later IPCC assessments, but does not reflect any changes from EPA's assumed 75% capture rate.

TABLE 1

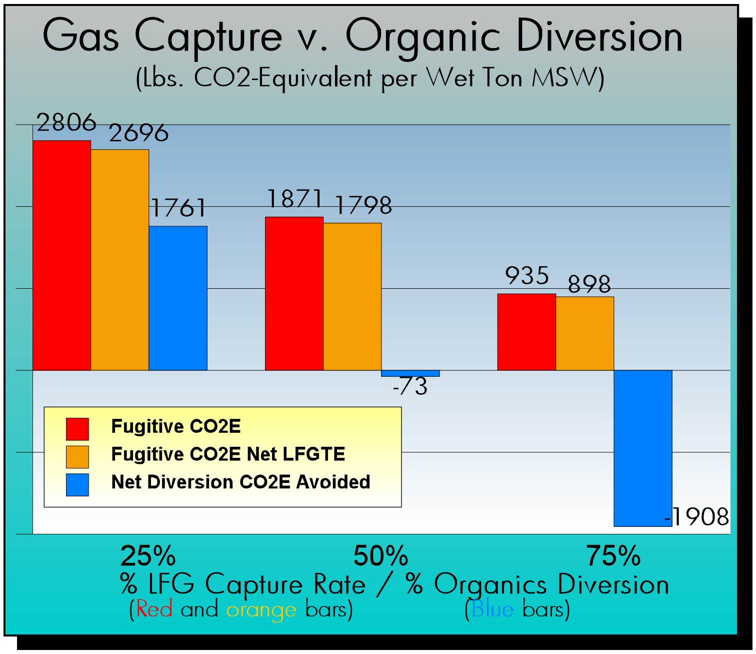
LANDFILLS GHG RESPONSIBILITY WITH DIFFERENT GWPs

Methane's Global Warming Potential

21X	25X	34X	72X	105X
2.2%	2.5%	3.2%	6.1%	8.0%

In light of landfills' poor gas capture performance on a long-term basis, any diversion strategy that keeps organics out of landfills will significantly reduce greenhouse gas emissions. This was one of the reasons why, in 1999, the European Commission ordered phasing out the co-disposal of organic and inert discards by 2016,[28] and why more recent residential organics programs, such as San Francisco's, have been animated by considerations over how to mitigate increases in GHG emissions.

Conversely, were the plane of reference shifted to landfills' short-term impacts, the strong bias for diversion is even greater. For in the next twenty years, methane's warming potential would be 72×, not 25×, times greater than CO_2 (when using the IPCC's 2007 values). Tripling methane's GWP to contemplate the near-term perspective approximates the effects of a 78% to 20% loss in landfill collection efficiency when the long-term horizon was considered. This fact, along with the critical tipping points we confront in 10 to 20 years, means that from either the short or long term perspective, the priorities for climate action plans militates greatly in favor of diversion so long as the analysis is based upon internally consistent values.



Source: Center for a Competitive Waste Industry

FIGURE 2

FIGURE 2 illustrates quantitatively why diverting organics from landfills is a significantly superior strategy to reduce greenhouse gases than improvements in gas capture. It compares the long-term effects on greenhouse gas emissions per ton of MSW from changes in landfill gas collection rates to similar proportionate changes in organics diversion when three scenarios are run from within a range of the most often cited values.[29]

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28 European Community, COUNCIL DIRECTIVE 1993/31EC (April 26, 1999).

29 FIGURE 2 uses mostly EPA assumptions: 1.77 lifetime cubic feet (cf) of landfill gas/pound of MSW; 0.04 as the annual decay rate; 50% methane concentration by volume of landfill gas; 1000 cf methane is 42.28 pounds; 1 cf of methane is 1,000 Btu; 1 kWh is 3,412 Btu; ICE heat rate is 9,492 Btu/kWh; and ICE capacity factor is 2.04 lbs CO_2/kWh. EPA, *AP-42: Municipal Solid Waste Landfills*, Vol. 1 Ch. 2.4; Energy Information Agency, *Assumptions to the Energy Outlook 1998* (1997), at Table 37; and a 25× GWP, IPCC, *Fourth Assessment Report*: Chapter 2 (2007), at p. 212, Table 2.14. Only one non-standard value was used relating to dispatching plants. Since the shift over the last decade from rate base regulation for the utility dispatching power plants to an auction system controlled by an Independent System Operator, the displaced power plant is no longer typically a coal plant, as it was in the 1990s when EPA's avoided emissions data was calculated. Instead, it is now more often a combined cycle natural gas power plant, which EPA calculations were never updated to account for. Estimates of avoided CO2 emissions from LFGTE is now approximately 0.79 pounds of CO_2 per kWh. DOE, EIA, *Assumptions to the Annual Energy Outlook 1996* (1997), at TABLE 2. These estimates were calculated using the (continued...)

Even if gas collection efficiency hypothetically increased from 25% to 75%, causing lifetime fugitive emissions from one ton of MSW to decline from 2,806 to 935 lbs. CO_2e, a 67% decline, there still remains almost 1,000 lbs. CO_2e of climate-changing gases emitted into the atmosphere (looking left to right shown in red bars).

In comparison, increasing diversion along the same range of 25% to 75% provides total GHG reductions per ton of MSW from 935 to 2,806 lbs. CO_2e (shown in the blue bars which are the net values of 1,761 to -1,908 lbs. CO_2e). On a net basis compared to the respective landfill gas emissions, this means that, if there is a parallel increase in both diversion and capture rates from 25% to 75%, composting reduces GHGs by 100%, compared to gas collection's 67% improvement.

Note too that in reality, EPA's data indicates that 51% of aggregate landfill gases are generated at sites without any gas control system, because its rules only cover the largest facilities.[30]

Finally, recovering the energy from landfill gas does not significantly reduce landfills' responsibility for GHG emissions, if at all, because of the fundamental fact that the methane in escaping landfill gas has so much more warming power than CO_2. For the GHG benefits of landfill-gas-to-energy (LFGTE) lies in displacing the need to generate electricity on the utility grid, which avoids those plants' emissions of CO_2. But, per molecule, the avoided CO_2 only has 1% to 3% of the warming potential of the fugitive methane from landfills.[31] The implication that follows is even if only minor amounts of methane escapes from a landfill, that will have significantly outsized impacts in comparison to those avoided CO_2 benefits.

As a result of this gross imbalance between methane's and CO_2's GWP, even if, hypothetically, all landfills had gas collection systems and recovered energy, their GHG emissions, at best, would only be slightly lowered by 3.9% per ton of MSW. That is, from 2,806 to 2,696 lbs. CO_2e at 25% collection efficiency, and from 935 to 898 lbs. CO_2e at 75% capture (shown in the orange bars). While at any capture rate, LFGTE produces, at best, trace reductions in GHGs, separating organics generates magnitudes more. At 25% diversion, it lowers emissions by more than a third and at the 75% level, by a factor of three times, averaging a 100% decline.

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29 (...continued)
simplified first order decay model:

$$\text{Methane / Year} = M \times L_o \times k \times e^{-k \times t_i}$$

Where M is remaining mass, L_o is lifetime gas potential, *k* is annual rate

The model was run and conservatively summed for 20 years, from first waste emplacement of 1 ton of MSW in the first year, in order to conservatively approximate the years when an internal combustion engine hypothetically could be installed and operated. Methane was converted to CO_2e using the 25× GWP multiplier. IPCC, *Fourth Assessment Report*: Chapter 2: Changes in Atmospheric Constituents and in Radiative Forcing (2007), at p. 212, Table 2.14.

30 EPA., *Solid Waste Management and Greenhouse Gases:A Life-Cycle Assessment of Emissions and Sinks* (EPA530-R-02-006, 2002), at p. 108. 40 C.F.R. §60.752.

31 See NOTE 9 that provides the basis for methane's 100-year GWP of 34 and 20-year of 105.

Furthermore, other factors discussed in the note suggest that correcting key misunderstandings about how energy landfills operate may mean that LFGTE actually increases rather than lessens GHG emissions, even for existing waste-in-place, in contrast to the slightly positive values LFGTE shows in **FIGURE 2**.[32]

In addition, diversion provides two additional benefits for reductions in GHG emissions, as well as other gains, from the compost that is produced to return fertility to the land.

First, compost lessens the need for artificial fertilizers, which are produced from fossil fuels. Due to fertilizers' nitrous oxides emissions, which do not emanate from compost piles, they were responsible for 207.9 million metric tons of CO_2E in 2007.[33]

Second, the latticework in topsoils contains vast amounts of stored carbon, which is one-half of the mass of the soil and, cumulatively, treble that which is in the atmosphere. Unfortunately, modern agriculture's impact on the soil today is not sustainable because we are, in effect, mining our soil, and demanding ever increasing energy inputs to sustain output and mask the impacts. Thirty to sixty percent of the carbon in the United States' farmland has already been lost, and a third of the country's GHG emissions are from soil erosion. Returning humus to the land helps reduce the erosion of topsoils.[34]

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32 For data inputs, see NOTE 29. With regard to new organic discards, **FIGURE 2** demonstrates that, because of methane's extremely high GWP, the diversion of organics, which avoids generating methane in the first instance, overwhelms the benefits of LFGTE, which are measured in units of CO_2. Therefore, if LFGTE is compared to diversion instead of to flaring captured gas, energy recovery will tend to result in substantially greater GHG emissions.

LFGTE's GHG benefits are also uncertain with regard to the wastes that are already in place and can no longer be diverted. The reason for this arises from recent submissions by the Solid Waste Industry for Climate Solutions to the California Air Resources Board and others that suggest LFGTE landfills are operated differently from traditional landfills in order to boost methane generation. Also, those reports indicate the price of artificial augmentation of methane levels is seriously degraded gas collection. Taken together, that major increase in fugitive methane, with its very high GWP, could overwhelm the avoided CO_2 benefits and eliminate, or turn negative, LFGTE's small net benefits shown. Solid Waste Industry for Climate Solutions, *Current MSW Industry Position and State-of-the-Practice on LFG Collection Efficiency, Methane Oxidation and Carbon Sequestration in Landfills* (2007), at 10. See, also, Susan Thornloe (EPA/NRMRL), *Innovative Air Monitoring at Landfills Using Optical Remote Sensing with Radial Plume Mapping* (February 22, 2007), at 4. Debra Reinhart, *First Order Kinetic Gas Generation Model Parameters for Wet Landfills* (EPA-600/R-05/072, June 2005), at p. 2-2. The FIGURE in the text does not account for the operational changes that are common to LFGTE landfills in order to optimize energy recovery, which releases substantially more methane. Therefore it over-accounts for GHG benefits.

33 EPA *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks* (EPA530-R-02–006, 2002), at pp. 67-68. EPA, *U.S. Greenhouse Gas Inventory (2009)*, at TABLE 6-1.

34 Stephen Leahy, "Peak Soil: The Silent Global Crisis," *Earth Island Journal* (2008).

Besides the direct GHG benefits from the reduction in fertilizers and soil erosion, humus also can hold two to 10 times its weight in rainwater, reduces demands on irrigation, improves soil tilth, decreases needs for herbicides and pesticides, decreases salinizaion and improves yields and crop quality.[35]

2.3 A History of Post-Yard Trimmings Organics Diversion Programs

Along with the 23 states that banned yard trimming from landfills beginning in the 1990s, early programs explored collection of commercial food scraps from grocers and other large food service establishments. At these types of sites, the discards were already aggregated in large volumes at each collection point, which made for favorable market economics. However, these had limited reach.

More recently, municipal programs have begun to expand their recycling efforts to also include curbside pickup of food scraps and soiled and contaminated paper from the residential sector, later moving into the commercial sector.

The first fledgling efforts at capturing more organics for composting were constrained by the political need to not add another costly fleet of collection vehicles. To do that, the existing two stream programs, then consisting of separate waste and recycle collection, was restructured instead of adding a costly third collection fleet. As recast, separation was limited to wet (food scraps and soiled paper) or dry (everything else that included inert rubbish as well as recyclables).

The very first wet/dry program began in 1995 in a small town of St. Thomas, Ontario with a population less than 15,000 people. It was followed by a somewhat larger program in Guelph, with a population of almost 50,000, which later faltered due to a fall off in political support necessary to fund maintenance of the infrastructure. Since then, however, there have been only a few other wet/dry programs in the U.S., such as in Hutchinson, Minnesota and in Portolla Valley/Woodside, California.

Most of the programs that followed in the U.S. and Canada provided separate collection, at varying intervals, for rubbish, recyclables, most other organic discards (sometimes including weekly or periodic yard trimmings in addition to food scraps and soiled paper, and other times with no grass collection). The heaviest concentration has been in California's Bay area, and in the Canadian provinces of Nova Scotia, Prince Edward Island and Ontario.

Organic discards constitute between one-third and two-thirds of what continued to be landfilled or incinerated after first generation recycling. Doing this makes it possible to achieve more than 50% recovery. Potentially, depending upon how ambitious the program, 60% - 75% diversion levels may be attained when added to the diversion already achieved with recycling.

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35 Sally Brown, et al., "Greenhouse Gas Balance for Composting Operations," *J. Environ. Qual.* 37:1396 (2009), at p. 1407. Recycled Organics Unit, "*Life-cycle inventory and life cycle assessment for windrow composting systems*," (The University of New South Wales, Sydney, Australia, 2006).

Separated organics are often being composted in traditional windrows, which are turned periodically or subject to forced aeration, or in enclosed bags, and then cured. Sometimes, they are processed in more capital intensive facilities that are enclosed, and in a few cases that recover the methane for energy before composting the digestate.

Although some early pilot programs had initially focused on concentrated commercial sources of food scraps such as super markets, most of these programs are now beginning in the residential sector, which is more homogeneous, and often with just single family homes. From there, they are moving to multi-family units, and later to the commercial sector.

This study focuses on the first stage of expanded composting efforts, residential organics programs (or ROP). In Canada, where there is a more aggressive movement in this direction, the term source separated organics (or SSO) is often used to refer to expanded composting in the residential and commercial sector. Through this study, we identified 121 ROPs, with 66 in the U.S., of which 26 were from within Region 9 (the Pacific Southwest Region of EPA, consisting of California, Arizona, Nevada and Hawaii), and 55 in Canada.

3.0 STUDY DESIGN

3.1 Objectives

Today's typical recycling programs recover bottles, cans and paper, and leave on the lawn or compost yard trimmings. They generally divert approximately 30% from the waste stream. More ambitious communities have increased that to around 40% by collecting lower paper grades, giving more frequent service, providing a more convenient receptacle, offering incentives or using better education.

For a number of years, limited experiments have evolved for recovering food scraps from select commercial food service establishments. Then, beginning in Nova Scotia in 1997, more communities have moved to beyond recycling, which is to also separate the rest of the organics stream from the residential sector for composting. That has always started with food scraps, usually including soiled paper, and sometimes minor amounts of wood and textiles.

Because expanded recovery of organics can play a major role in our new understandings of climate change, as well as in stabilizing landfills, the objective of this study is to understand what can be learned from these early programs to separate all organics from the residential sector in order to encourage and optimize future efforts.

The specific objectives of this study are to:

- Inform recycling managers, other decision makers and concerned members of the public about the potential for the next major advance in diversion;
- Delineate the best policies and methods known to achieve expanded organics recovery, under current conditions found in those communities with residential organics programs;
- Demonstrate the best practices in a new program moving to expanded composting;
- Define impediments to realization of objectives in collection, processing technology and processing siting; and
- Field test less than weekly collection of rubbish as a means of reducing net incremental costs and increasing participation; and
- Publicize the information developed from this study for other communities.

4.0 METHODOLOGY

This study used several methodologies to gather field data on experience with residential organics programs (ROP).

4.1 Surveys

First, we surveyed all ascertainable residential organics programs. We attempted to find every possible community involved in collecting organics besides yard trimmings from the residential sector. This involved a literature search, more than a dozen listserve queries and personal contacts to key actors in the industry that resulted in our initial target list of 188 communities.

Then we prepared a two part survey. The first part, which asked respondents to verify whether they had a residential organics program, was sent to the entire target list. Those who did not reply to the survey were called to determine which ones did not have a ROP.

After excluding those who responded negative to the first part of the survey, or who replied to the call indicating they had no program, we sent a more detailed 35 question survey to the 123 communities. In counties or provinces where many municipalities had ROPs, we surveyed both levels of government.

A summary of the salient responses are in the text, and a copy of the initial and supplemental survey questions can be found in the Appendix.

4.2 Site Visits

To provide a deeper understanding to residential organics programs, and how collection and processing was working, we supplemented the survey with site visits.

We visited San Francisco, Alameda County, Toronto and the province of Nova Scotia. A summary of the site visits are in the text.

4.3 Analysis

We then analyzed the results of the survey, supplemented by the details of how the programs worked from the site visits in order to distill the salient considerations for different local situations and best practices.

5.0 SURVEY RESULTS

As part of the study we first undertook a study of the 188 potential communities with ROPs, confirmed the involvement of 121 of those, from which we asked a series of questions about their programs.

5.1 Communities with Residential Organics Programs

We have identified 121 cities with residential organics programs in North America. Sixty-eight are in the U.S., with 40 in Region 9 and 26 in other parts of the U.S. Fifty-five are in Canada. The names of those cities are listed below by region and demographic information about the major cities is provided in section 5.3.

TABLE 2 shows the ROP programs that we identified in Region 9, which were all in California.

COMMUNITIES WITH RESIDENTIAL ORGANIC PROGRAMS IN REGION 9 (40)		
Alameda (City of)	Livermore	San Francisco
Albany	McFarland	San Juan Bautista
Arvin	Modesto	San Leandro
Berkeley	Morgan Hill	San Lorenzo
Beverly Hills	Newark	Santa Rosa
Castro Valley	North Hollywood	Sebastopol
Cloverdale	Oakland	Sonoma (City)
Cotati	Petaluma	Sonoma County
Dixon	Piedmont	Stockton
Dublin	Pleasanton	Union City
Emeryville	Portola Valley	Walnut Creek
Fremont	Rohnert Park	Windsor
Gilroy	San Fernando	Woodside
Healdsburg		

TABLE 2

TABLE 3 shows the programs outside of Region 9 in the U.S., excluding Canada.

COMMUNITIES WITH RESIDENTIAL ORGANICS PROGRAMS OUTSIDE REGION 9 IN US (26)		
Midwest (4)	Central VT Waste Mgt. District	Bellingham, WA
Ann Arbor, MI		Bothell, WA
Carver County, MN	Greensboro, VT	Carnation, WA
Cedar Rapids, IA	Lewistown, ME	Issaquah, WA
Dubuque, IA	Northeast Kingdom, VT	King County, WA
Hutchinson, MN		Kirkland, WA
Linn County, IA	South (1)	Newcastle, WA
Wayzata, MN	Plano, TX	Redmond, WA
	Sarasota, FL	Sammamish, WA
Northeast (5)		Seattle, WA
Cambridge, MA	Washington (12)	Woodinville, WA
	Bellevue, WA	

TABLE 3

TABLE 4 lists the 55 programs that we identified in Canada.

COMMUNITIES WITH RESIDENTIAL ORGANICS PROGRAMS IN CANADA (55)		
British Columbia (1)	Digby	Trenton
Mission	Greenwood	Victoria County
	Halifax Regional	Windsor
New Brunswick (2)	Hants Co.	Wolfville
Moncton	Inverness Co.	Yarmouth
Fredericton	Kentville	
	Kings County	Ontario (8)
Nova Scotia (41)	Lawrencetown	Bracebridge
Annapolis County	Lunenburg	Caledon
Annapolis Royal	Mahone Bay	Guelph
Antigonish	New Glasgow	Kingston
Argyle	New Minas	Markham
Baddeck	Parrsboro	Niagara Region
Barrington	Pictou Co.	St. Thomas
Berwick	Port Hawkesbury	Toronto
Bridgetown	Queens County	
Bridgewater	Richmond County	Quebec (3)
Cape Breton	River John	Regie Argenteuil,
Chester District	Shelburne	Chertsey
Clare	Town of Amherst	Laval
Colchester County	Town of Berwick	
Cumberland Co.	Town of Oxford	

TABLE 4

5.2 Major Reasons Listed in Survey for Early Adoption of Residential Organics Programs

The survey results provided much useful information. For example, the 12 most common factors listed that led the communities to become early adaptors of ROP are shown below in TABLE 5, which found the most common reason to be meeting higher state recycling goals, or zero waste objectives. The survey was undertaken before public awareness of climate change following the climate records of 2005-2006 and the movie, *An Inconvenient Truth*, had entered the public psyche, and enough time had passed for the complex interrelationships between climate change, composting and landfills to be researched.

12 MOST COMMON REASONS LISTED FOR COMMENCING RESIDENTIAL ORGANICS PROGRAMS	
1	To meet local or statewide recycling, waste diversion and / or Zero Waste goals
2	Response to landfill crisis, to protect groundwater from landfill leachate, community resistance to locating landfill accepting raw organics and / or high landfill costs
3	Franchisee offered as part of contract extension (several contractors added program at no cost to residents)
4	Citizens / customers demanded service
5	Funding and technical assistance provided by regional organization
6	Composting facility nearby
7	Food scraps and food-soiled paper were largest component remaining in waste
8	Political and / or staff leadership and advocacy for sustainability, within communities, and from nearby large cities that implemented programs
9	Recovery of valuable resources
10	Permit change was opportunity to add food scraps to existing yard debris composting at no extra cost
11	"Green" orientation and values of community - it is the right thing to do
12	Voluntary sign-up allowed us to jump-start the program without having to convince politicians to sign off on charging everyone for a service some wouldn't use

TABLE 5

5.3 Demographic Information about Programs

TABLE 6 shows the population, number of single family and multi-family households and median income for the major programs in our survey.

City / County Demographic Information							
Number	City	State or Province	Country	Population	Number of Single-Family Households (estimate)	Number of Multi-Family Households (estimate)	Median household income (estimate)
1	Alameda	CA	USA	73,000	15,000	38,000	$50,000
2	Albany	CA	USA	16,444	3,958	3,290	$54,919
3	Augusta	ME	USA	18,560	4,452	5,028	$29,921
4	Bellingham	WA	USA	75,000	18000	12,000	$45,000
5	Berkeley	CA	USA	102,743	21854	25,021	$44,485
6	Brampton	Ontario	Canada	433,805	290,000	83,000	$72,402
7	Cambridge	MA	USA	101,355	6,539	38,186	$47,979
8	Castro Valley	CA	USA	55,000	12500	3,500	$61,478
9	Charlottetown	PEI	Canada	135,000	43,735	13,087	$40,500
10	Dixon	CA	US	17,800	4,441	706	$54,472
11	Duluth	MN	USA	86,918	23,901	13,099	$33,766
12	Emeryville	CA	USA	8,500	400	4,500	$40,000
13	Fremont	CA	USA	203,413	48703	20,749	$111,000
14	Gilroy	CA	USA	49,000	11,000	2,400	$75,000
15	Guelph	Ontario	Canada	115,000	23,965	20,745	$60,000
16	Halifax	Nov. Scot.	Canada	380,000	130000	40000	$54,129
17	Healdsburg	CA	USA	11,700	3257	895	$48,995
18	Hollister	CA	USA	34,413	7922	2,032	$56,104
19	Kirkland	WA	USA	45,054	11073	10,866	$60,332
20	Lake Forest Park	WA	USA	13,142	4425	818	$74,149
21	Mackinac Island	MI	USA	546	200	100	$24,000
22	Montpelier	VT	USA	8,035	1940	1,959	$37,513
23	Oakland	CA	USA	399,000	95000	54,000	$40,055
24	Portola Valley	CA	USA	4,462	1700	0	$158,000
25	Redmond	WA	USA	45,256	10401	9,895	$66,735
26	San Francisco	CA	USA	750,000	100000	233,000	$57,000
27	San Leandro	CA	USA	79,452	20912	10,388	$51,081
28	Santa Rosa	CA	USA	147,595	39731	17,783	$55,000
29	Sarasota	FL	USA	52,715	14614	12,321	$34,077
30	King County	WA	USA	1,835,300	447166	275,000	$55,000
31	Stockton	CA	USA	280,000	68000	5,000	$44,000
32	Thorold	Ontario	Canada	440,000	140000	40,000	$67,181
33	Toronto	Ontario	Canada	2,500,000	500000	460,000	$59,671
34	Union City	CA	USA	66,869	14312	4,550	$71,926
35	Walnut Creek	CA	USA	42,471	9500	3,900	$95,000
36	Wayzata	MN	USA	4,000	1200	700	$65,000
37	Newark	CA	USA	42,471	10183	2,967	$69,350
38	Seattle	WA	USA	563,374	138827	131,709	$45,736
39	Woodside	CA	USA	5,352	1957	32	$171,126

TABLE 6

5.4 Items Collected Separately

About one-third of respondents collect food scraps separately, and about half collect them with yard trimmings. The programs that collect food scraps and yard trimmings together are generally in areas where yard trimmings are generated and collected year-round. In areas where yard trimmings are only collected for part of the year due to seasonal growth and weather considerations, food scraps are collected separately. Only a few programs included pet waste and only one program included diapers. See APPENDIX B for charts.

5.5 Items Banned from Trash

Only a few of the leading-edge programs, such as San Francisco, ban items from being collected as trash. The most common items banned are leaves, grass, brush, branches and other yard trimmings. Three programs banned the use of plastic bags to collect organics. See APPENDIX B for charts.

5.6 Items Banned from Landfill

A few more programs ban items from the landfill than ban them from collection. The total number of the leading edge programs that ban organics from the landfill is still very small. The most bans are for grass, followed by leaves, brush, branches, and other yard trimmings. See APPENDIX B for charts.

5.7 Organics Trucked with Other Materials

The largest number of respondents indicated that organics are collected separately, on a weekly basis and not collected on the same truck with other materials in different compartments. See APPENDIX B for charts.

5.8 Cost Per Household

The total cost of trash, recyclables and organics programs ranges from $11 to $33 per household (HH) per month, with an average of $22/HH/month. The cost of trash ranges from about $4 to $20/HH/month, for those that break out costs separately, with an average of $11/HH/month. The cost of recyclables and organics both range from $1 to $11/HH/month with an average of $5/HH/month. See ATTACHMENT B for charts.

5.9 Costs for Processing and Disposal

The range of tipping fees for organics processing varies from $15 to $90 per ton and averages $44 per ton. The range of tipping fees for landfilling varies from $16 to $115 per ton and averages $61 per ton. The range of tipping fees for the 3 communities reporting the use of incinerators, ranged from $45 to $140 per ton, with an average of $92 per ton. See ATTACHMENT B for charts.

5.10 Tonnage Per Year at a Central Site

The largest category (15) is for programs that include paper, food scraps and yard trimmings together, composting an average of 19,418 tons per year. Almost as many communities (12) composted yard trimmings separately, composting an average of 34,843 tons per year. Most of the programs that composted yard trimmings separately from food scraps were located in northern climates, where yard trimmings are only collected seasonally. See ATTACHMENT B for charts.

5.11 Strategies Considered by Different Programs

TABLE 7 lists which programs have considered or adopted key strategies for implementing residential organics programs, such as mandates and bans.

Cities that Considered or Adopted Different Strategies		
Policies	Adopted	Considered
Required residential source-separation of organics	• Halifax, Nova Scotia • Regional Municipality of Niagara, Ontario • Region of Peel, Ontario	• Duluth, MN Western Lake • Superior Sanitary District • Newark, CA • Toronto, Ontario
Landfill ban on yard trimmings	• Halifax, Nova Scotia • Regional Municipality of Niagara, Ontario • Region of Peel, Ontario	• Newark, CA • Toronto, Ontario
Landfill ban on other organics	• Duluth, MN Western Lake Superior Sanitary District • Regional Municipality of Niagara, Ontario	• Halifax, Nova Scotia • Region of Peel • Toronto, Ontario
Ban of expanded polystyrene food containers	• Berkeley, CA • Emeryville, CA • Oakland, CA • San Francisco, CA	• City of Alameda, CA • Castro Valley Sanitary District, CA • Toronto, Ontario
Required use of reusable, recyclable or compostable food service ware	• Emeryville, CA • Oakland, CA • San Francisco, CA	• City of Alameda, CA • Castro Valley Sanitary District, CA • Toronto, Ontario

TABLE 7

6.0 SITE VISITS

Surveys can provide an overview of what is happening. However, because not every program has all of the useful data at its fingertips, because managers only have so much time to respond to surveys, and because so much more critical information is only available when on site, physical visits to the major different kinds of programs is an important component in a complete analysis.

To supplement the information from the surveys we conducted site visits to most of the major residential organics programs in Region 9. We also visited the leading sites in Canada, because that is where some of the first, and leading, work is being done. We sat down with the planners to download their experience base. Then, we went into the field, driving typical routes on collection day to view the set outs, followed the collection vehicles and talked with the drivers. We also visited the processing facilities, and spent a substantial time with the operators to probe their experience and lessons that they have learned.

6.1 City and County of San Francisco

TABLE 8 shows the report of the site visit to the City and County of San Francisco, which, as most programs, was motivated to increase diversion above 50% and also to reduce the city's carbon footprint by reducing the organic discards in landfills. San Francisco also learned from its initial voluntary program that a mandatory program was necessary to reach the city's potential.

SAN FRANCISCO, California (USA)	
Community description	San Francisco (estimated population: 750,000) Small lots predominate in this densely-populated city on the Pacific Ocean.
Program history	San Francisco has the largest, most mature residential organics recovery program in the United States. The collection of residential organics for food scraps and soiled paper, in addition to yard trimmings, was tested through a series of pilot programs in 1998 and 1999, after the commercial sector expanded to include most organic discards. A pilot program in the commercial sector had began earlier in the wholesale produce district in 1996 and expanded throughout the city. The residential organics began to expand from the pilot tests in 1997-1999. The residential expansion process took four years to implement throughout the city, building upon the success of the city's commercial organics collection program. In 2009, the voluntary residential program was made mandatory, and is being expanded to apartments, where 60% of the population resides. Surveys show high degree of satisfaction with program.
Collection	• San Francisco has a three stream collection program for the residential sector: compostable organics, single stream recyclables and rubbish. • Organics: are collected weekly on a year-round basis to all individual households, in a specialized packing organics collection truck. Also, weekly, on a split bodied, side loading compactor, single stream recyclables are co-collected on one side, with rubbish on the other side of the vehicle. • To separate compostables in the home, the City of San Francisco has distributed two types of kitchen containers: (a) a solid, two-gallon pail with attached lid, and more recently (b) a 5.5 liter vented pail, which requires a liner. The City instructs residents to use only biodegradable liners, such as paper bags or compostable plastic bags which are widely sold in San Francisco food, hardware, and drug stores. Because of educational efforts by the City recycling staff with supermarkets to provide convenient options for residents, compostable liner bags, certified by the Biodegradable Products Institute, are available at more than 80 retail outlets in San Francisco and can be used as part of the City's residential organics collection program.

Processing	• Collected organics are brought to the transfer station operated by its franchise residential hauler, Recology, which is located in the southern end of San Francisco. At the transfer station, the material is top-loaded into "possum belly" long-haul trailers, and delivered to Recology's Jepson Prairie Organics Composting Facility. This facility is located approximately 70 miles from San Francisco, in a rural part of Solano County. • At the processing facility, the material is composted using a two-stage system. First, the feedstock is processed in covered, aerated windrows system for one month. Second, it undergoes a month or more of open-air windrowing and curing. After screening, the finished compost is marketed to landscapers and farmers. • The City and its hauler publicize that some of the finished compost is used by farmers to grow food and wine grapes that grace the tables of fine restaurants and popular farmers' markets in San Francisco. This image (food è food scraps è compost è food) effectively links the concept of materials cycling and recycling for program participants.
Performance	Currently, participation in the residential organics program is voluntary. Participation is estimated to be 35-40%. The capture rate for the non-yard trimmings fraction of the residential organics stream is estimated to be approximately 400 pounds per participating household per year, or about 8 pounds of food / soiled paper per participating household per week. According to a 2006 study conducted by Environmental Science Associates, over 40% by weight of disposed single-family residential waste was food. An additional 6% was compostable soiled paper.
Lessons learned	The program has been an excellent learning experience, but the results from a voluntary program clearly did not achieve the total diversion desired. The City decided to make the program mandatory by stating that organics accepted in the residential organics program cannot be placed in residential trash containers or otherwise inappropriately disposed. Distribution of compostable bags, including placement in stores, helped increase participation. Apartment composting can work but requires more effort to establish. The City is closely examining examples of public policies that require the source-separation of certain types of materials from trash, such as enacted by the City of Seattle and bi-weekly rubbish collection in Toronto.
Contact	Kevin Drew, San Francisco, 415-355-3732

TABLE 8

6.2 Alameda County

TABLE 9 provides the findings of the trip report to the East Bay area in Alameda County, which was motivated to encourage ROPs in order to increase diversion above 50% and become more sustainable.

ALAMEDA COUNTY, California (USA)	
Community description	Alameda County, consisting of 20 municipalities, is a large county on the East Bay, west of San Francisco, with a population of 1.45 million. The County has approximately 300,000 single-family households. The average household size (including multi-family dwellings) in Alameda County is 2.8 people per household. Most residents in Alameda County, are able to participate in their local government's residential organics collection program through their municipality. The 13 jurisdictions that have done so include: Alameda (City), Albany, Berkeley, Castro Valley (Sanitation District), Dublin, Emeryville, Fremont, Livermore, Newark, Oakland, Pleasanton, San Leandro, and Union City. Three jurisdictions do not yet have curbside collection of residential organics.

Program history	Many communities within Alameda County were early adopters of residential organics collection for several reasons. First, four composting facilities within 100 miles of Alameda County had obtained permits to handle a broad range of organics, including food scraps of animal origin. These facilities sought these permit changes in large part in response to emerging commercial organics recovery programs in San Francisco, Berkeley, Oakland, San Jose, and San Mateo County. Second, Alameda County's Measure D of 1990 provided a local financing structure for extensive and sustained investment in waste reduction and recycling activities at the county and city levels. The Alameda County Waste Management Authority and the Alameda County Source Reduction and Recycling Board (together known as "StopWaste.Org") support residential organics collection programs. They fund the purchase and distribution of kitchen containers for food scraps, provide public outreach and education campaigns, and provide funds for the purchase of additional program-related items. They also analyze the effectiveness of the efforts in each community. Third, several communities within Alameda County have adopted landfill diversion goals that exceed the State of California mandate, which in 1990 was set at 50% by 2000. These communities have recognized that to reach their goals, they need to address the recovery of organics more comprehensively than has been done so far in nearly all other parts of the country. Fourth, all of the communities already offered residential yard trimmings collection year-round using a wheeled, lidded cart (64-gallon or 96-gallon usually). As such, adding food scraps and soiled paper was viewed, with some exceptions, as a minor adjustment to an existing program. The typical exception was found in communities which did not already have weekly collection of yard trimmings. For example, as mentioned above, the City of Berkeley needed to adjust its collection frequency. As such, within the context of Alameda County, the City of Berkeley was a late adopter.

Collection	• Each offers weekly collection of residential organics on a year-round basis. • Alameda County organic programs include yard trimmings, food scraps (vegetative and animal-origin) and soiled paper • Some programs have converted from bi-weekly collection of yard trimmings on a year-round basis using carts to weekly collection of residential organics. Others already had weekly collection of yard trimmings in carts, and were readily able to add more types of organics at nominal cost. • Kitchen Containers and Liners. Various types and brands of lidded kitchen containers (typically around 2-gallon capacity) for food scraps have been distributed to most participants in most of the jurisdictions, with funding assistance often provided by the Alameda County Waste Management Authority. • Compostable plastic liners are allowed by some of the jurisdictions, depending on their processor's specifications. For example, certain compostable plastic liners are allowed in in Berkeley's program, but not in Pleasanton's or Livermore's.
Processing	Processing is done with windrows. The haulers who service the jurisdictions utilize various permitted compost facilities. These facilities include: Allied Waste's Newby Island Facility in Milpitas, Grover Landscaping, Inc. in Modesto, and Z-Best Composting in Gilroy. All within 100 miles of Alameda County
Performance	Approximately 53,000 tons collected per year from among 1,450,000 people. The average weekly participation rate is estimated to be 17%-23%, with considerable variation above and below this range. The average yield of food scraps per set-out is approximately 6-8 pounds (weekly collection). By contrast, ACWMA estimates that single-family households set out approximately 30 pounds (weekly collection). These figures are expected to rise through a combination of outreach, recognition and awards programs, advertising, and local government policies. Contamination levels typically range from 2% to 10% by weight. Several jurisdictions estimate that their residents' trash consists of approximately 35-40% food scraps and soiled paper by weight.
Lessons learned	Siting composting facility can be extremely difficult.
Contact	Brian Mathews, StopWaste, (510) 891-6500

TABLE 9

6.3 City of Toronto

TABLE 10 is the results of the site visit to Toronto, Canada, which had a strong environmental ethic, that dovetailed with an equally strong economic motivation after the local landfill closed.

CITY OF TORONTO, Ontario Canada	
Community description	Metropolitan Toronto, located at 43° 40' N latitude and comprising 245 square miles, was formed in 1998, under pressure from the Provincial government, by adding East York, Etobicoke, North York, Scarborough, York to the former city of Toronto. The entire urbanized region, consisting of 6 million people, is called the Golden Horseshoe. Toronto Metro has a population of 4.7 million, half of whom were born outside of Canada. The climate is continental, with an average temperature of 24° F in the winter and 71° F in the summer, with an average of 25" of rain and 55" of snow annually.
Program history	In 2002, Toronto's last city-owned Keele Valley landfill closed down because too many people had sprawled out around it. Most of the city's garbage had to be hauled by truck,10 hours each way, to Republic's Charlton Farm landfill in Michigan. This increased disposal costs by more than 300% and created significant political opposition from the U.S., including the possibility that the border would be closed. In anticipation of that closing date, the city first considered a proposal to haul its waste 400 miles to an abandoned gold mine in northern Canada that fell through. In 2001 Toronto, which then recycled and composted 24% of its household trash, changed course and set a goal of zero waste by 2010, with intermediate goals of 30% diversion by 2003 and 60% by 2006. Strong citizen participation was a significant factor in moving in this direction. To realize these goals, a mandatory "Green Bin Program" to separately collect all organics, added to yard trimmings that has previously been diverted, began in 2002. It was later rolled out across the City through 2005. Today all 510,000 single family households are part of the residential organics program and pilot tests are underway to test organics programs in apartments.
Collection	•Toronto has a three stream collection program: almost all organics, single stream recyclables and rubbish. • With regard to the organics stream, Toronto collects almost all organics beyond yard trimmings, including: all food scraps, coffee grounds, filters, tea bags, soiled paper, paper packaging, household plants, as well as soil, diapers, sanitary products, animal waste, bedding (e.g. from bird / hamster cages and kitty litter. Dimensional wood is excluded. • Households are provided with a kitchen catcher and a 16 gallon latched and wheeled green cart to place their organics. They are permitted to use any plastic bag to line the containers. • Organics are collected weekly in a split compacting collection vehicle, with the other compartment used on alternating weeks for single-stream recyclables and rubbish. Thus, Toronto is using less-than-weekly, bi-weekly, collection for rubbish. • Yard trimmings are collected separately on a variable schedule depending upon the time of year in a separate vehicle. • Collection is largely done through private franchise agreements.

Processing	• Yard trimmings are composted at their own windrow compost facilities, separate from source-separated organics, because their processing costs are so much less than mixed organics. • Numerous experiments were done with different types of static box in-vessel composting systems in an effort to minimize odor problems. Ultimately, the City is focusing on digesters because the other new organic materials are varied and contaminated, including with substantial plastic bags and diaper liner that are approximately 20% by weight. These must be pre-processed first with a sophisticated hydro-pulper to effectively remove those contaminants. After extensive experimentation, Toronto is moving to two major 55,000 tons per year facilities that will first produce methane anaerobically, and then compost the remaining digestate. The task of getting adequate separation of contaminants and controlling odors have been a problem and are not yet fully resolved. • Processing is done at city owned and operated facilities. • The digesters produce about 110 kWh / wet ton and compost the digestate after adding wood chips into 0.5 tons / wet ton of compost used in such things as golf course greens.
Performance	• 90% of the single family homes participate in the Green Bin program • The average household sets out about 10 pounds of organics, in addition to any yard trimmings, each week • 72% of the targeted organic discards are estimated to be captured • 28% of the discard stream is recovered in the Green Bin (35% is recycled and 37% is rubbish), for a total diversion rate of 72% • Adding expanded composting to recycling / yard trimmings increased diversion by 80% • Approximately 18%of the total recyclable or compostable paper remained with the rubbish • In total, 127,600 tons of Green Bin organics are diverted from the landfill each year, in addition to the 161,400 tons recycled.
Lessons learned	• Collecting rubbish bi-weekly has a significant impact in increased capture rates • Odor problems at processing facilities have been a significant problem, but are coming under effective control as part of a learning curve to manage mixed organics streams • Processing all organics is complex and may be better performed by the private sector
Contact	Rob Orpin, Director of Solid Waste Operations, 416-392-8286, rorpin@toronto.ca

TABLE 10

6.4 City of Halifax

TABLE 11 records the field trip to Halifax is situated on an island with groundwater conditions that make it all but impossible to safely site even lined landfills. It was strongly motivated to eliminate the major source of landfill failures, the organic fraction that keeps the site biologically active essentially forever.

CITY OF HALIFAX, Nova Scotia Canada	
Community description	Nova Scotia is an island with 55 municipalities on the eastern coast of Canada with 900,000 people, a third of whom live in Halifax, the capitol.
Program history	In the early 1990s, the Upper Sackville landfill experienced a catastrophic failure, exacerbated by the underlying fractured bedrock, leading to pollution of the river. Attempts to construct incinerators instead were rejected after citizen objections, as were attempts by Waste Management to open a new private landfill. This led to 500 citizens to step forward to develop alternatives. In response to concern about the threats that both open dumps and lined landfills posed to groundwater, in 1995 the Province began plans for diverting at least 50% from disposal, combined with a ban, effective in 1998, on landfilling organics. Halifax began its program in 1999, and today, all 41 municipalities in the province is provided SSO service.
Collection	• Separate collection is provided bi-weekly for organics, in a green cart; recycling (in blue bags for containers and in grocery bags for paper); refuse in a bag or can. • Regarding organics, the program accepts as food scraps fruit, vegetable, meat and fish scraps, dairy products, cooking oil, coffee grinds, filters and tea bags and egg shells. As unrecycled and soiled paper, it takes cereal, cracker and cookie boxes, along with shoe boxes, paper towels and rolls, napkins, tissues and other soiled paper. Sawdust and wood shavings are also accepted. • Excluded are corrugated cardboard, including pizza boxes, soil and biodegradable plastic bags. • Kitchen mini-bins are provided to hold day's food scraps pending transfer to green cart. • No plastic bag liners are permitted; boxboard liners are recommended instead.
Processing	Halifax decided to split its processing between two private composters using somewhat different approaches. •One is Miller Composting, which uses the Ebera system, processes about 21,000 tons per year. Pickers remove contaminants, mostly plastic, a magnet removes metals, and a shredder with finger blades reduces particle size to <2". The system consists of a 75' x 200' box, through which a paddle blade rotates through every 8 to 10 hours, and maintained under negative pressure with biofilters to control odors. Residence time is about six weeks. They find 5% residue at the front, and 3% at the rear end. Final curing takes 30-90 days, and fines are used for bulking final compost product. •The other is New Era, which is moving away from aerated boxes, which it found did not sufficiently aerate the material, to Hot Rot, a rotating cylinder system.

Performance	Participation rates for organic carts are over 80%; but no data exists on the recovery rate for the targeted organics.
Lessons learned	Motivated and engaged citizenry was essential to development and implementation of program; fall off in interest over time is a concern.
Contact	Jim Bauld, 902-490-7172

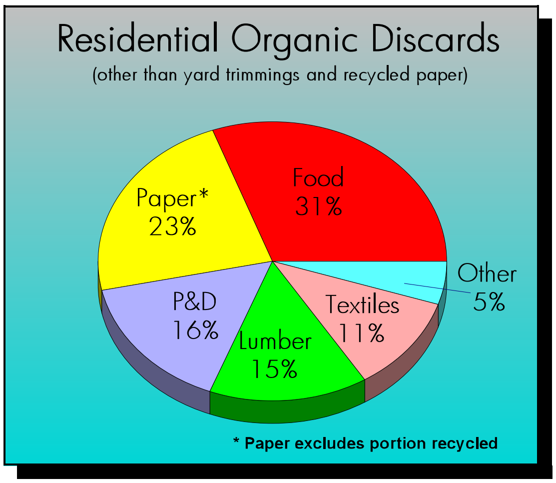
TABLE 11

7.0 LESSONS LEARNED

There are few "best practices" that can be gleaned from existing programs to apply to all others to come, because residential organics programs are relatively new, the goals pursued by different communities are divergent, the various program components interrelated (a change in one affects others), and the performance of some technologies are still uncertain. There are lessons to be learned, however, keeping in mind the parameters of particular programs, and the ways in decisions regarding one program component may impact others.

7.1 Types of Organics and Rate of Expansion

There are two prerequisite questions for a community seeking to initiate or expand a residential organics project:



Source: Center for a Competitive Waste Industry

FIGURE 3

- How many types of the remaining organic discards to include?
- How rapidly to expand the residential collection program?

Decisions regarding containers, collection, processing and markets will follow from these initial global decisions. Most ROP programs have focused on food scraps and soiled paper. These are sometimes referred to as source separated organics (SSO). As shown in FIGURE 3, these are approximately 54% of the pool of organic discards, after subtracting yard trimmings handled elsewhere and recyclable paper that ought to be managed separately.[36] Toronto's program is an example of one that also accepts pet waste and diapers (P&D), which are another 16% of the available organics for ROPs.

7.2 Incremental or Full Expansion

#Incremental. The goal may be to increase overall waste diversion beyond 50% (the percentage mandated in California) by expanding organics collection beyond yard trimmings. This typically involves the addition of all food scraps, including meat, often coupled with soiled and contaminated paper, which is generally referred to as "source separated organics" or "SSO." In general, programs following the incremental path are diverting approximately 30% of SSOs. A moderate effort to capture SSOs can often achieve the 50% overall diversion objective if a strong underlying recycling program is already in place.

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36 Note that this FIGURE subtracts from the total discarded paper fraction an estimate of paper discards that are recyclable in order to estimate the quantity of soiled paper that might be expected in an SSO programs. It also uses different characterization studies than EPA's that better sort for pet waste and diapers in the residential sector. For these reasons, this data does not directly correspond to that shown in FIGURE 1.

Most ROP communities are currently embarked on this path. San Francisco has taken an incremental approach, though coupled with a long-term goal of 100% overall waste diversion, not 50%.

#Full Expansion. A full expansion approach seeks to maximize diversion as soon as possible because of the various environmental impacts of disposal, notably the volumes of climate-changing methane generated and released from landfills as a result of burying organic material. Those following this path have shown it is possible **to** divert 70% or more of a larger variety of organic discards, including diapers and pet waste, possibly followed by wood and textiles. That represents a tripling in overall organics diversion between the two approaches.

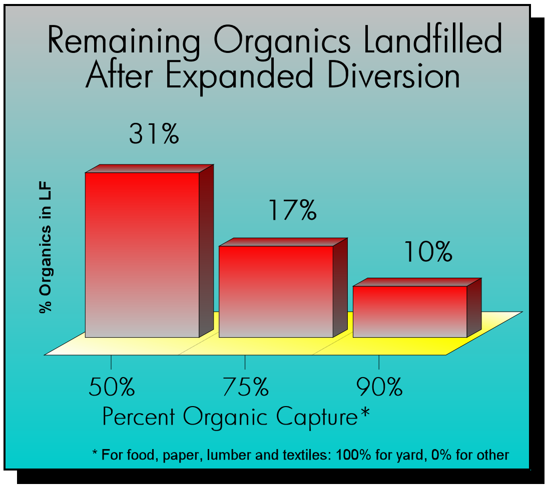


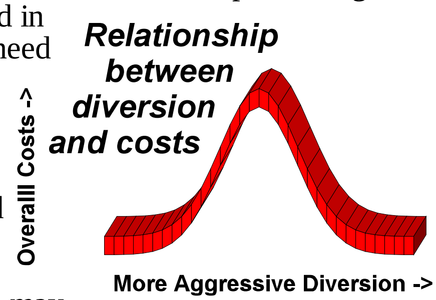
FIGURE 4

FIGURE 4 illustrates the reduction in the amount of organics remaining in new landfills as a function of how many types of organic discards are accepted, and how effective diversion is. Existing programs in states that have banned yard trimmings from landfills have already demonstrated that most is diverted. If 50% of food, paper, lumber and textiles are also diverted, then organics as a fraction of landfilled discards falls from 66% to 31%. At a higher 75% diversion, the remaining organics in that landfill falls to 17%, and, at 90%, to 10%.

Canadian cities tend to be ahead in aggressive efforts to maximize organics diversion. Toronto's program accepts nearly a third more organics than programs in the U.S. and have deployed collection strategies that increase residents' participation. Of course, nothing precludes a community from starting small, and later moving to more ambitious programs as it gathers experience and wider support. San Francisco illustrates this trajectory.

7.3 Costs Implications of Program Scope

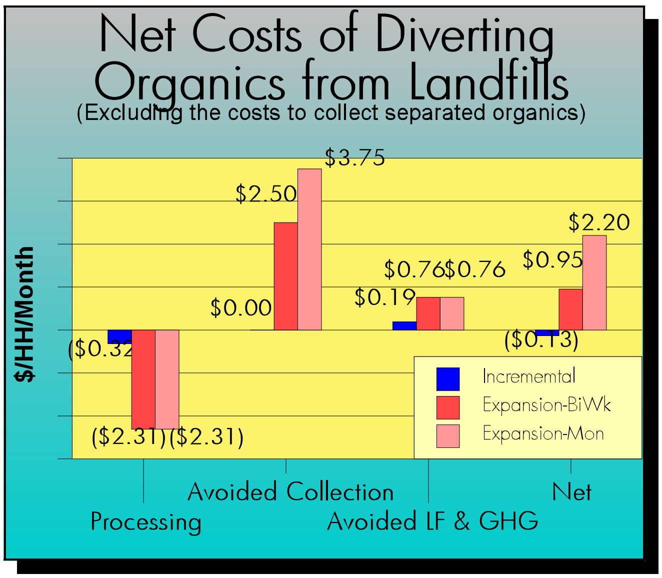
Communities contemplating programs that maximize organics recovery need to understand the cost implications, capital requirements, and management challenges that follow from that choice. The interrelated changes in collection and processing associated with the two respective paths are discussed in more depth in the sections that follow, including the need to use digesters to process the organic loads, and single stream material recovery facilities (MRFs) to process recyclables.



However, the resulting bottom line costs need to be addressed at the outset, though adding more organics does not always mean more net costs if synergies are exploited. For that reason, net expenses may follow a bell-shaped curve (see graph alongside) when the synergies that substantial organics diversion makes possible are captured.

At first, costs are seen to rise as the program expands if windrows are not sufficient to treat the larger, more varied, and more contaminated loads. Contaminants may include a substantial quantity of plastic used to line the kitchen catchers or carts and, if diapers and pet wastes are picked up with the organics collection, the plastic and other synthetic material used for liners and containment.

But, costs soon peak and then may decline, because one of the effective strategies for high recovery rates, especially in larger communities, involves LFCR (less frequent collection of rubbish). Under LFCR programs, organics, and usually recyclables too, are collected weekly, while the remaining inert residual material is collected every other week (and later that might be extended to monthly collection). As a result, those who fail to separate organics from the rubbish must retain the rotting material in their home longer-a powerful incentive to place organics in the appropriate container. In addition to providing the environmental benefit of more diversion of organic material, LFCR programs also avoid half or three-quarters of the costs of collecting rubbish. Because most of the costs for diversion are related to collection, when the resulting collection savings are so large, overall costs can go down even more significantly.



Source: Center for a Competitive Waste Industry

FIGURE 5

LFRC programs may need to offer to accept pet waste and diapers along with food scraps, however, because residents are not likely to be willing to keep those items in the house for more than a week, and public health authorities may not allow LFRC unless all such items are removed weekly.

In the chart alongside, the greater expense (expressed in dollars per household per month) to process more tons and more categories of organics is shown in the first set of three bars to the left (Processing), with the incremental approach (weekly rubbish collection) shown in blue, bi-weekly rubbish collection in red and monthly pickup in pink. Modest programs (food scraps only) add 32¢/month for a household, while the greater volumes and more expensive processing costs of the expansive programs add $2.31/month. Most of that processing cost difference between low and high intensity programs, though, is due to the tripling in volumes separated. If the two approaches were normalized to reflect the same quantity separated, the expansive programs would only cost 26¢ more per month due to higher processing costs, not the $1.99 (i.e. $2.31 - $0.32) suggested by FIGURE 5.

Those programs able to utilize LFRC because of the absence of rotting material in the trash can realize an offsetting collection savings, while the incremental programs that continue weekly trash pickup do not necessarily do so. That savings is shown in the second set of bars, whose effect dominates the calculations.

Also, note that the avoided trash collection costs shown here do not account for the possibility that garbage trucks on the remaining week of rubbish collection may be more efficiently rerouted when diversion is so successful that the set outs at each stop are much less. That may eliminate the mid-day's trip off route to unload because the fill-rate per stop is less. Only the LFRC programs capture this gain, $2.50/month for moving rubbish to bi-weekly pickup, and $3.75/month for monthly.

Of course, any more diversion also further reduces landfilling costs. When climate cap and trade plans are mandated, there are also some additional savings for reducing greenhouse gas emissions. The next to last set of bars (Avoided LF & GHG) reflect this, with 19¢/month for the incremental programs and 76¢/HH/month for the full expansion ones. Currently are no carbon trading regulations in the U.S. to monetize CO2's value; all but a penny or two of those savings come from the lower tip fees.

> Expanded composting programs may be able to offset their costs by reducing the frequency of trash collection since so little is left, and of that, the putrescibles are removed.

The final set of bars (Net) on the right shows the net effect of these several interacting factors, with the incremental programs increasing the costs of processing and its related considerations by 13¢/HH/month.

7.4 Carts

With the addition of another separated discard stream, including putrescibles, care must be taken in the selection of containers and carts for the kitchen and garage that will work in conjunction with the type of collection and processing used.

#Food scraps. A key element in designing systems to handle household food scraps is providing containers that allow residents to isolate discarded food, which can soon rot, smell and attract bugs, especially in warmer climates. If these unpleasant side effects occur, public support for the program can collapse.


Photo Credit: Center for Competitive Waste Industry
Kitchen catcher

Most programs provide both a small bucket with a lid for the kitchen to hold each day's leavings, and also a wheeled cart, to take the source separated organics from the house or garage to the curb on collection day. Food scraps are usually heavier than regular garbage, making it a candidate for automated collection.

Note that in those cases where recycling and composting streams are collected on the same truck (see Collection below), then a split toter for recyclables on one side and organics on the other may be considered, so that both can be loaded onto the truck with one lift.

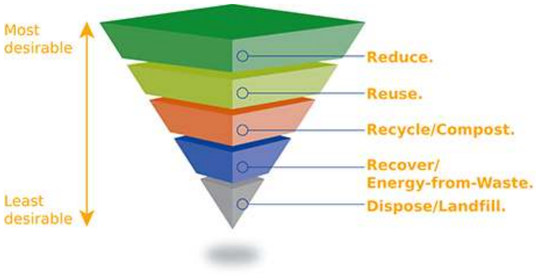
The kitchen catcher is usually about 1-2 gallons in size, with a sealable lid, that residents can use to place each day's food scraps. The wheeled cart is usually about 12 gallons, for programs that only include SSOs, and 64 gallons for programs that combine yard trimmings and food scraps. Remembering that SSO programs, unlike backyard composters, usually include meat, latches are also often added to the cart to keep out raccoons and dogs.

Photo Credit: Center for a Competitive Waste Industry

Cart for food scraps

For sanitary reasons, and to overcome the "yuck" factor, many programs also provide designated plastic bags to line one or both containers, or permit households to use any plastic bag. However, adding plastic film into the organics stream increases contamination that will need to be managed in processing. For that reason, some programs attempt to restrict plastic liners to biodegradable plastic. However, these bags tend to cost more, and also compete against the free plastic bags people receive for carrying home groceries or goods when they shop. For that reason, other programs believe that attempts to dictate biodegradable bags will not succeed. In either event, if and to the extent that significant non-biodegradable bags enters the organics stream, the processing system has to be designed to cope with that level of contamination (see Processing below).

#<u>Paper.</u> Most SSO programs tend to focus on food scraps, but paper has even greater importance. The paper that remains after recycling largely consists of either soiled or otherwise contaminated paper, and the recyclable mixed paper (from junk mail to cereal boxes) that many programs either do not collect or do so incompletely. Together these can be approximately 150% more than the food scraps by weight. Like food scraps, most of the paper fraction that is soiled paper should be easily captured, because it is usually generated in the kitchen right where the compost containers are located. Recyclable mixed paper, however, can be generated in any other part of the home, depending upon an individual's habits. Unlike newspaper and corrugated cardboard boxes, mixed paper is generally not bulky. A scrap of paper is all too easy to be inadvertently tossed into a trash can in the bathroom or bedroom, which may be too remote from the kitchen, where the separate containers are usually located, for all household members to make the trip.



Recycling is higher on the Integrated Waste Hierarchy than composting. This is because recycling also recovers a good deal of the energy and other inputs that went into the paper's production. Also, for maximum diversion of organics from landfills and concomitant global warming benefits, diverting almost all of the discarded paper in a home is essential.

#Rubbish in clear bags. Another possibility for improving program performance is the use of clear plastic bags instead of the black bag, can or cart, as the container for rubbish (which is the technical definition of discards from which putrescibles have been removed). This provides a way for the collector on the route to insure that there are no visible SSOs or recyclables in the rubbish receptacle at the curb. Thirty of the 55 municipalities in Nova Scotia have adopted clear bags for this reason.

While clear rubbish bags seem to be a useful alternative strategy to ramp up incremental-level capture rates for organics, clear bags may raise public ire. For this reason, program managers in Halifax, where this idea arose, have been unable to get their Council to adopt the necessary implementing ordinances. Also, cities already committed to automated collection using carts would have to use on-board cameras for this purpose. In Halifax the clear bags have been most successful in small towns (<15,000) rather than cities.

In any event, the overall concept of visually inspecting rubbish loads idea warrants testing to assess how effective it is compared to, for example, less frequent rubbish collection. While clear rubbish bags would not provide the concomitant savings in reduced rubbish collection, neither would it potentially require including pet waste and diapers in the organics program, which possibly might avoid the need for expensive digesters.

7.5 Collection

Only three of the existing residential organics programs we studied collect two streams (wet/dry, as discussed in Background). The great majority of programs are collecting three streams (recycling/organics/rubbish), instead of two (recycling/garbage). There are myriad variations for how to collect three streams, and much depends upon local parameters.

7.5.1 Options for collecting three streams

The material is collected in a combination of separate fleets, one or both of which divide the vehicle into two compartment to collect two streams separately on the same truck body in order to avoid the need for three fleets of trucks.

These split-bodied, or co-collection, trucks are usually compacting vehicles with a dividing wall separating the box into two lengthwise compartments, with a wall front to back. Typically both compartments are compacted to increase the time on-route before filling up, but oftentimes the compaction ratio for recyclables is lowered in order to minimize glass breakage.

Photo Credit: Center for a Competitive Waste Industry
Split body collection vehicle

Note that use of split-bodied trucks, in turn, has necessitated collecting all recyclables in one compartment, and therefore processing recyclables at a materials recovery facility (MRF) capable of single stream processing. In single stream MRFs, all the recyclables come out of the same compartment commingled. The separation of containers from paper, previously done by the participant in the home, has to be done centrally instead. The collection savings from avoiding a third fleet are greater than the additional processing costs from combining recycled containers and paper into one stream.

TABLE 12 shows the different configurations that are being used in different locations in order to achieve separate collection of organics.

Different Collection Strategies for Separate Collection of Source Separated Organics				
	Material Streams			Collection Frequency
I	Wet (Food, soiled paper and other wet contamination) ↔		*Dry (Recyclables and rubbish)	Weekly
II	Rubbish	Recyclables ↔	Organics**	Weekly
III	Rubbish			Biweekly
		Recyclables ↔	Organics**	Weekly
IV	Rubbish ↔	Recyclables		Biweekly
			Organics**	Weekly
V	Rubbish ↔	Recyclables ↔	Organics**	Biweekly

TABLE 12

* "↔" indicates the two streams share the same split bodied truck in collection.

** Collection of the yard trimmings component of organic discards also varies. Some collect grass as well as leaves and include that in the green cart. Others do not collect grass curbside, requiring either mulching landmowers or drop off, and collect leaves and brush only in season on a less frequent schedule on another truck.

Thus, for example, San Francisco collects all three streams weekly, with recyclables and organics on different compartments of the same truck; Toronto alternates rubbish and recyclables on the same truck in which SSOs are collected weekly, and Halifax collects each stream biweekly, with recyclables and organics sharing the same vehicle.

7.5.2 Key Factors

Five key issues, arising from the case studies in this report, must be considered tor determine optimal collection arrangements for a specific locality: the size of the streams; the frequency of rubbish collection; grasscycling; and flexible compartment dividers.

7.5.2.1 Size of the streams

In conducting a site-specific study it's important to project the size of the different streams and how much variation there is around the mean based upon how much material will wind up in each stream once the program is in place, diversion is increased and rubbish is decreased. Variables include whether grass clippings are collected or eliminated; what potential exists for backyard composting; whether diapers and pet waste are accepted Also, consideration should be given to determine which combination of variables makes it possible to eliminate the typical mid-day trip off-route to unload the vehicle when it tops off. Fifteen to twenty percent of routing requirements ride on that question, and this is always a significant cost-driver in system design.

7.5.2.2 Less frequent rubbish collection

When organics and recyclables are collected, little material is left for the trash truck to collect, and even less that will be putrescible. There is no reason, then, to continue collecting the small volume of inert material remaining each week. If the related processing issues can be managed for pet wastes and diaper discards, one way to both minimize overall costs and maximize organics diversion is to collect rubbish less frequently, either bi-weekly or monthly.

- The cost of trash collection is dramatically reduced because the garbage truck routes are cut nearly in half or by four. This effect is so influential on costs that the expanded program could conceivably pay for itself, notwithstanding the fact the organics may require expensive processing.

- Capture rates can be tripled because residents have a new incentive to put their putrescibles in the designated container: to avoid having their rotting discards hang around the house that much longer.

There may be conflicting factors to consider, however:

- Bi-weekly rubbish collection will not be possible unless pet waste and diapers are included in organics collection. Health Departments will need to be aware of the separate organics collection and support the effort.

- Since a digester may be needed to process the organics, and a single-stream MRF will be needed to process the recyclables, the opportunity is only available for larger communities (or smaller ones acting jointly) who have the necessary resources and are strongly committed to residential organics separation.

- There may significant savings to also shifting to less-frequent collection for recyclables as well as for rubbish. It will no longer, be necessary to maintain a single compartment compacting vehicle for the rubbish collection and another split body truck for recyclables and organics. In this example, every truck is a split body unit, which collects organics on one side each week, but on the other side, alternates weekly between rubbish and recyclables, both of which are collected biweekly. By reducing the types of trucks needed to serve a community from two to one, which will all be split-body trucks, there are significant savings in the need for fewer spare trucks and more efficient maintenance.

- On the other hand, going even further and moving all of the three streams to bi-weekly collection, which may be an option in colder climates, is problematic. It effectively removes the incentive for residents to separate organics to avoid having putrescibles hang around longer. For instead of rubbish being collected less frequently than organics, collection for both is now pushed off to less-than-weekly.

- Finally, if recycling collection is not made less frequent along with rubbish collection, then consideration may be given to developing a split totter that can be loaded with one lift onto the collection vehicle to reduce the time at each stop loading twice.

7.5.2.3 Grasscycling

> Eliminating separate grass collection, and substituting 'grasscycling,' can save money to fund the diversion of food scraps and soiled paper

Some cities have made a decision not to collect grass and instead encourage "grasscycling," or leaving the grass clippings on the lawn.

As long as the clippings are not to long they begin to decompose almost immediately, with the following benefits:

- It is an easier maintenance practice.

- There are less polluting truck trips to collect and also to distribute the material to end markets.

- It is less costly than collecting and processing clippings. In temperate regions, this reduces yard collections to seasonal leaf collection and intermittent chipping for brush.

- There is no opportunity for the grass clippings to go anaerobic in bags on the route, releasing uncontrolled ammonia and possibly methane, before its destination.

- All of the nutrients are returned to the soil without losses from premature volatization.

- The need for fertilization is reduced.

Possible conflicting considerations include:

- In semi-arid, but irrigated, climates like much of California, a third collection is already provided for yard trimmings year-round. In some communities it is not politically feasible to eliminate grass pickups due to residents' expectations for high levels of service.

- If green wastes are already being collected in a sufficiently large wheeled cart, there may be no need for an entirely new pickup. However, be aware that if food and yard trimmings are collected together, they will both have to be taken to a facility that can handle the most difficult to process of the two or more organic fractions, which will very significantly increase processing costs.

7.5.2.4 Pivoting compartment dividers

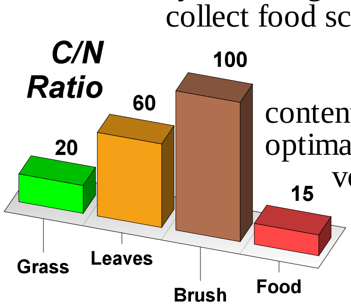
Co-collecting two discard streams in different compartments on the same vehicle has one significant downside. As presently designed, the dividing wall between the two compartments is usually fixed at the factory, while the relative proportions of each stream on a given day's route can vary. Consequently, one compartment will tend to top out before the other fills, and the truck will have to go off-route to unload with the other side partially empty. A new design is needed in which the dividing wall is fixed only at one end to a pivot so that it can adjust on-route to daily variations in the flow of materials in each stream, or one where the dividing wall moves laterally. This is especially important when one of the compartments on the same split body truck is alternatively used with different discard streams, which means the fixed wall can only be set to match the average of the first and second streams, and not the third.

7.6 Processing

After the food scraps and soiled paper have been separately collected, they must be processed at a composting facility capable of managing the challenges that the food scraps in SSO programs present.

7.6.1 Composting Basics

To understand the capabilities and limitations of each type of composting system in light of the new challenges posed by the implementation of programs that collect food scraps, some basic principles need to be reviewed.



Composting relies upon a balance between the carbon and nitrogen content in the organic feedstock, along with other conditions, in order to optimally regulate the rate of decomposition. That balance also avoids volatizing pollutants or odors into the atmosphere, while providing cellular structure and nutrient value to the bacteria and fungi that makes up the humus returned to the land.

Composters strive for a ratio of carbon to nitrogen (C/N) in the range of 20:1 to 30:1. With more carbon than a ratio of 50:1, the rate of decomposition slows significantly. A ratio of less than 15:1 will generate ammonia and other volatile organic compounds (VOCs), creating air quality and odor problems.

Composting also requires at least 5% oxygen distributed throughout the mass of organic material to prevent anaerobic conditions that worsens air quality concerns, as well as moisture levels between 40%-60%, in order to optimize decomposition and reach peak temperatures of about 140°F that will destroy pathogens and weeds and provide an environment for the heat-loving bacteria that produce the healthiest humus.

When food scraps in the organic stream are significantly increased, the nitrogen component is magnified, which lowers the C/N ratio, rapidly accelerating the rate of decomposition, along with the tendency to turn anaerobic, and with major odor problems. These are the problems that SSO programs have to properly manage.

7.6.2 Types of Processing Systems

The selection of an existing, or construction of a new, processing facility for SSO programs turns on many factors as to which will:

- Be located within a reasonable distance from the collection routes
- Not create air quality or odor problems
- Have sufficient capacity and residence times to handle the program's thoughputs
- Produce a marketable product
- Be reasonably priced

But, while there are workarounds for most of the issues, *the* limiting condition is the prevention of odor problems, which risks compromising an entire program, and in parts of California, such as the South Coast and San Joaquin Valley regions, that applies to VOC emissions as well. That is the reason why the paramount decision in planning a program is the type and operator of the processing facility, and their capacity to properly manage high nitrogen food scraps.

HOW TO FIND A COMPOSTER IN YOUR AREA

Go on-line to Find-A-Composter, which is maintained by the Biodegradable, BioCycle and Greenscapes, to find the location of composters, including those which accept food scraps, in your area.

The wide array of technologies in use commercially to process SSOs can be categorized into three groups – windrows, in-vessel and anaerobic digesters. They reflect a continuum of greater costs, complexity and capabilities to manage food scraps. The first two, which process material either outdoors or in a building, both use aerobic decomposition, and the third uses anaerobic decomposition, which is always enclosed, and is followed by aerobic composting of the residual digestate.

As one moves from open air and covered windrows to in-vessel silos, containers, channels and drums, and finally to enclosed anaerobic digesters, the costs and the complexity of the systems will increase significantly. At the same time, so will the system's capabilities increase to process more material, higher nitrogen ratios and volatile fatty acids, very low porosity and more contamination, and to do so more quickly and using a smaller footprint.

In general, most residential organics programs in the U.S., with the exception of San Francisco and San Jose that are investigating anaerobic digesters, are primarily still using windrows. The more developed Canadian programs are widely using several in-vessel technologies, and, in the case of Toronto, anaerobic digesters. See TABLE 13.

MAJOR GROUPS OF ORGANIC PROCESSING SYSTEMS			
	Aerobic		Anaerobic
	Windrows	In-Vessel	Digesters
Types	➢ Open turned piles ➢ Static aerated piles ➢ Covered -Pod ➢ Covered - Fabric	➢ Shipping container ➢ Silo ➢ Tunnel ➢ Channel ➢ Rotating drum	➢ Sewage plant digesters ➢ Wet digesters ➢ Dry digesters
General Description	Elongated piles of organics, usually yard trimmings and sometimes sludge, laid out on the ground, or on concrete slabs. The piles can be either open or covered, and aerated manually with end loaders by turning or with forced aeration through piping.	Organics, more often including food scraps and soiled paper, are placed in either shipping containers, in rotating drums, or, in an enclosed building, in tunnels or channels where forced aeration or moving paddles are used to bring oxygen to the material.	The part of the organics primarily consisting of food scraps and soiled paper are first placed in an enclosed anaerobic digestor to generate methane for energy, and then the remaining digestate is composted using conventional aerobic processes

TABLE 13

7.6.3 Existing Windrow Composting Capabilities

Almost all existing composting operations in the U.S. are windrows-based systems, whose variations are explained in more detail later on page 56. In these facilities, the organic material is laid out into elongated piles, monitored for temperature and sometimes for oxygen content, watered periodically, and turned mechanically or aerated in static piles.

Photo Credit: San Francisco

Covered windrows at Recology's Jepson Prairie

Windrow operators are usually quite skilled at their jobs. For years, they have successfully balanced piles of yard trimmings, with its grass, leaves and brush components, and each stream's different C/N ratios and seasonal characteristics, by calibrating the mixture to be balanced.

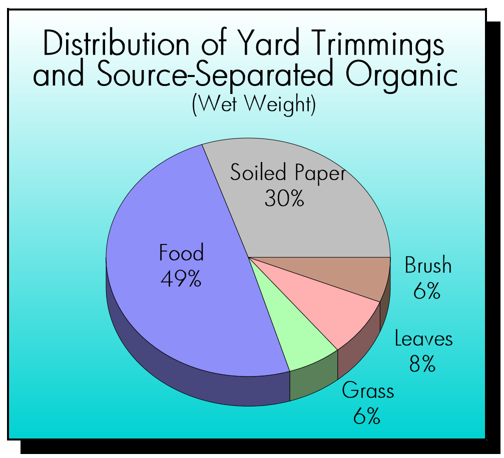
WHERE WINDROW COMPOSTERS CAN FIND BEST PRACTICES TO PROCESS FOOD SCRAPS

Go on-line to Best Practices, which was prepared by the U.S. Composting Council to assist traditional windrow composters of yard trimmings in adding food scraps.

These strategies have involved mixing in the correct proportions of grass, which is high in nitrogen, with leaves and brush, which are high in carbon and naturally include bulking material. Sometimes sawdust or sludge may be added to tune the mix, and one or the other material might be stockpiled during seasons when it is plentiful for later seasons when it is not. When more recycling programs expand to include high nitrogen food scraps, however. traditional windrow operations will tend to face these challenges from food scraps that:

- Have very high nitrogen content that may decompose so rapidly that they will loose their nutrient value, outgas VOCs and ammonia and smell before there is time to finish composting
- Is also dense and moist without any natural bulking material, which means its porosity, essential to permit thorough aeration, is very low
- Can contain volatile fatty acids (VFA), which impedes composting

Fortunately, composters have developed more sophisticated mixing strategies for phasing in food diversion programs. These involve a combination of mixing one community's nitrogen rich food scraps with another's leaves to add carbon, accompanied by the introduction of bulking agents to add porosity. This strategy has been able to produce an appropriate C/N balance that can be adequately aerated. Composters report that a mixture consisting of approximately 75% leaves and brush and up to 25% food scraps, along with bulking agents, can be managed in windrows.

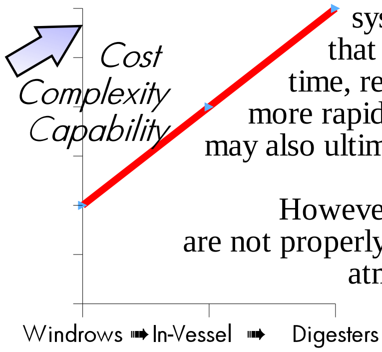


Source: Center for Competitive Waste Industry

FIGURE 6

However, once the number of SSO programs in an area served by a windrow facility ramp up, the mixing strategy among communities with and without SSO programs will become significantly more challenging. Eventually, the leaves from those other communities, which had been used to mix with the food scraps from the programs of the early adopters, will be called back in an attempt to balance the organic material from the later adopting programs. As illustrated by FIGURE 6, there is not sufficient high carbon leaves and brush relative to the high nitrogen food in order to meet all of the surrounding communities' carbon requirements if several of them expand their organics diversion efforts.[37]

37 EPA, *MSW Generation, Recycling and Disposal in the U.S.* (2009), TABLE 3. The breakdown between soiled paper and the *un*contaminated fiber fraction not shown, is 50%/50% based upon waste composition studies performed by the Center for a Competitive Waste Industry. The breakdown of yard trimmings between grass, leaves and brush is from Cary Oshins,
(continued...)



Program managers will then have to give enclosed systems more serious consideration out of necessity, notwithstanding the greater costs those systems entail. Adding impetus for more advanced processing is the fact that the curing period for windrows, with their months' long residence time, requires a much larger site footprint than more advanced systems with more rapid throughputs of just a few weeks. In urban areas, space constraints may also ultimately add the impetus for a transition to enclosed models.

However, although odor and air quality issues are always looming if open sites are not properly managed, the release of the greenhouse gas methane into the atmosphere does not tend to be significant among the byproducts of aerobic composting, even if in improperly managed sites the center of the piles sometimes become oxygen-starved, for the following reasons:

- Not enough water is usually added to windrows to provide sufficient moisture for methanogenesis
- There is usually insufficient time to pass through the two phases to reach methanogenesis
- The surrounding organic mass will tend to oxidize any methane from the localized pockets where the necessary biological and chemical process that produces methane might intermittently occur

7.6.4 Concerns with Enclosed Systems

At the same time that there is an understanding of the strengths windrow systems in the short-term, and limitations in the long-term, the more advanced processed systems also have concerns that need to be recognized. They ought not be considered a panacea.

7.6.4.1 In-Vessel Composting Systems

The next level of organics processing systems are the enclosed operations discussed in more detail on page 59 that can be nearly double the cost of windrows. In essence, they combine two features. The first is a fixed enclosure to better control processing and odors using negative pressures and biofilters. While they have the technical capability to control odors when operated within their design parameters, actual performance depends upon proper and careful management.

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[37] (...continued)
"Feedstock Composition at Composting Sites," *Biocycle* (September 2000), TABLE 2 at p. 33. Note that this breakdown of organic discards adds back yard trimming generation to illustrate the relative distribution of all separated organics destined for composters. Therefore, it is not comparable to FIGURE 3.

The other feature of in-vessel systems is some mechanism intended to provide better aeration than has been feasible in windrow operations. These aerating strategies primarily include several variations on forced aeration and bulking agents to slowly moving paddles in a channel to shift the loads.

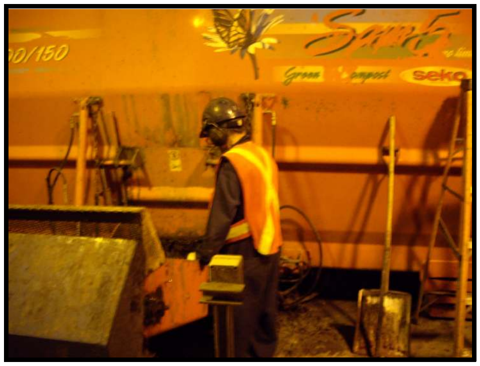


Photo Credit: Center for a Competitive Waste Industry

Enclosed container

While there is little doubt but in-vessel systems do aerate food rich loads better than most windrow facilities, a question that is hotly disputed is whether one or the other provides adequate thorough aeration to prevent anaerobic hot spots, and how serious an issue that is.

For that reason, some argue that only in vessel continuously rotating drums are adequate to the task to completely compost food scraps. The controversy is so intertwined in the profitability of the vendors offering the different systems that an objective conclusion is elusive.

7.6.4.2 Anaerobic Digesters

The most advanced system for processing source separated organics is anaerobic digesters (AD), discussed in detail on page 63, that are as much as triple the cost of windrows (before accounting for the potentially large collection cost savings described on page 48). Like the other in-vessel systems, ADs are enclosed. They are also the only processing system that handles the organic material anaerobically in a digester to produce energy, before the residual digestate is later composted conventionally in windrows or silos so that both the energy value in nitrogen rich organic streams and residuals are recovered.

Photo Credit: Center for a Competitive Waste Industry

Anaerobic digester

However, odors are inherently a significantly greater problem with anaerobic than aerobic decomposition. While European AD facilities are reported to function as designed without odors, the first efforts to import them to North America in Toronto have had operational problems. Securing competent management for an AD facility is even more critical than for the aerobic in-vessel systems. In 2009, three cities in North America are actively pursuing development of AD projects: Toronto, San Francisco's private hauler, Recology, and San Jose's hauler, Green Waste Recovery.

7.6.9 Technologies for Processing

The following three tables provide more details about the three broad groupings of compost technology available to handle source separated organics from households that include food scraps and soiled paper, in addition to yard trimmings. The first two, windrows and in-vessel systems compost aerobically, and the last, digesters, generate electricity anaerobically followed by aerobic composting of the digestate that remains.

TABLE 14 describes the four types of windrow based systems, two of which are open piles (turned piles and static aerated piles) and the other two are covered piles (pods and fabric).

Composting systems **Windrows**				
	Open		Covered	
	No aeration / Turned		Aeration / Static	
	Manually Turned Piles	Static Aerated Piles	Pod	Fabric
Description	Feedstocks are formed into piles, monitored for temperature and sometimes for oxygen content, watered periodically, and turned mechanically based on a regular schedule or on review of temperature and / or oxygen readings. The most common shape is a windrow (elongated pile); another configuration for the composting mass is a trapezoid.	Active aerated static piles achieve air circulation through the use of passive or active aeration using perforated piping. In municipal-scale systems, active aeration, by which air is forced through the composting mass, is more common than the passive method. Active aeration often depends on computerized monitoring systems, which control the amount, frequency, and duration of oxygen to be delivered to the composting mass.	The pod system of covering piles is essentially a static aerated pile encased in a tub or sock made of LDPE plastic, typically 5-12 feet in diameter and about 200 feet long. The tube is "stuffed" with a hopper or mixer using a ram or auger. Upon filling both ends are closed and blowers provide positive aeration with vents for exhaust air.	The fabric system for covering piles uses a plastic sheet pulled over windrowed material approximately 40 feet wide and 175 feet long.
Costs	$15-$40 / ton	$25-$60 / ton	$55-$65 / ton	$55-$65 / ton

Composting systems **Windrows**				
	Open		Covered	
	No aeration / Turned		Aeration / Static	
	Manually Turned Piles	Static Aerated Piles	Pod	Fabric
Pros	Relatively simple to operate; lowest cost; greatest operational experience; and if minor volumes of food scraps and soiled paper are involved and can be mixed with yard trimmings from other communities, existing facilities may be able to handle some additional residential organics during field testing without major upgrades.	More controlled environment, during initial phase of composting; low water input; relatively rapid throughput time; may meet more easily with community and regulatory approval than adding residential organics to existing outdoor turned pile systems. Less space consumed for wide aisles to facilitate turning piles.	Somewhat greater, but not significantly more complex than uncovered piles, and simple way to reduce vector attaction and emissions, and, to a lesser extent, odors, though possibly not sufficiently in states with strict air quality rules. Less space consumed for wide aisles to facilitate turning piles.	Low complexity, and simple way to reduce vector attaction and emissions, and, to a lesser extent, odors, though possibly not sufficiently in states with strict air quality rules. Also, cover can be retracted and the material turned to a limited extent that does not impact the aeration pipes to hasten degradation. Less space consumed for wide aisles to facilitate turning piles.

Composting systems Windrows				
	Open		Covered	
	No aeration / Turned		Aeration / Static	
	Manually Turned Piles	Static Aerated Piles	Pod	Fabric
Cons	Least likely to be able to properly manage any serious volumes or proportions of food scrap and soiled paper, in terms of keeping the material adequate aerated for thorough aerobic decomposition. Questions have been raised whether the oxygen from occasional manual turning is quickly consumed long before the next time the pile is turned. Also, may have difficulty complying with states that have strict air quality programs.	May encounter anaerobic pockets within the composting mass, resulting in incomplete or insufficient processing; may involve a second stage of composting using an outdoor turned pile method, which could result in similar challenges as presented by the outdoor turned pile method itself. While aeration is usually better than turned piles, questions remain about its ability to cope with significant volumes of food and soiled paper and air emissions, although less so than turned piles.	Because there is no agitation from turning, decomposition may be slower in colder climates. Also, water cannot be easily added to optimize decomposition. Again, aeration is usually better than turned piles, but questions remain about its ability to cope with significant volumes of food and soiled paper and air emissions, although less so than turned piles.	Again, aeration is usually better than turned piles, but questions remain about its ability to cope with significant volumes of food and soiled paper and air emissions, although less so than turned piles.
Time	Three months	Three months	Three months	Two to three months

Composting systems Windrows				
	Open		Covered	
	No aeration / Turned		Aeration / Static	
	Manually Turned Piles	Static Aerated Piles	Pod	Fabric
Supplier	N / A	N / A	Ag Bag, CTI	Gore Cover

TABLE 14

TABLE 15 describes the five forms of in-vessel composting systems in which the composting operation is contained inside a rigid physical structure. The first two, silos and containers, are static systems in which the piles are not moved, and the other three involve some continuous mechanical form of agitation. Agitation physically moves the organic material by a variety of means more thoroughly, frequently and regularly than occasional manual turning of piles and is intended to achieve more aeration than forcing air through a static pile.

Composing systems

In-Vessel

	Aeration / Static			Agitation	
	Silos	Containers	Tunnel	Channels	Drums
Description	Similar to those used on the farm, silos are usually used for composting when space is at a premium. Aeration is usually done passively with hot air rising, and the units are usually 6 feet around at the base and about 25 feet high. Material is fed from the top with a conveyor and harvested out the bottom.	Closed intermodal shipping containers holding from 20 to 55 tons container, modified with temperature probes, forced aeration and biofilters.	Enclosed version similar to container in the form of a tunnel running across a building. Sizes range from 12' H x 9' W x 25' D to 18' x 21' x 100'. Also uses temperature probes, aeration and biofilters.	Channels in enclosed building ranging in size from 3' to 8' H and 200' to 300' long separated by concrete walls. A turner that resembles a paddle rides each channel kicking the material back as it slowly progresses from the beginning to the end of the channel and discharging a 5' to 10' at the head to provide room for more material.	A cylindrical drum ranging from 4' to 12' in diameter and 50' to 175' in length that very slowly rotates continuously.
Costs	$95-$105 / ton	$95-$105 / ton	$95-$105 / ton	$80-$100 / ton	$90-$110 / ton

Composting systems

In-Vessel

	Aeration / Static			Agitation	
	Silos	Containers	Tunnel	Channels	Drums
Pros	Can be sited on small sites when space is at a premium and residence is less than windrows and passive aeration provides energy savings.	Not excessively complex. The same container can be used to compost and ship organics	Also not excessively complex. Easier to move material through system.	Greatly improved aeration especially important with dense food scraps without as much bulking agents. Separate channels enable specialized treatment for different types of organic streams.	Provides for the most complete decomposition of the aerobic systems and shortest residence time.
Cons	Aeration is not as effective as agitation	More cumbersome to load and unload and may require bulking agents such as shredded tires or car bumpers to provide adequate pathways for air to flow especially when processing wet and dense food scraps.	Also may require bulking agents to provide adequate pathways for air when processing food. High head space increases the air flow to be biofiltered.	Least scalable. Watering system may be required. Large buildings increase volume of air to be biofiltered.	Highest capital costs for in-vessel systems
Time	7 to 14 days	14-28 days	10-21 days	14 to 21 days	5 to 10 days

Composting systems In-Vessel					
	Aeration / Static			Agitation	
	Silos	Containers	Tunnel	Channels	Drums
Supplier	Teg Environmental	Naturetech Green Mountain ECS	Christian Bros. Orgaworld	Transform Composting Systems IPS Siemens Longwoods	Hot-Rot ICC X-Act

TABLE 15

TABLE 16 shows the three types of anaerobic digestion in which the significant energy value in nitrogen rich food streams is recovered, and then the remaining digestate is composted. Because digesters optimize energy generation with the food fraction of organics, and because digesters are relatively expensive, they are optimized when processing only the food, soiled paper and, if collected, grass fraction of organic discards, and not leaves and brush. There are Publicly Owned Treatment Works (POTW) Digesters and anaerobic digestors designed to process solid organics, which can be operated dry or by adding moisture and at lower or higher temperatures.

Composting systems

Anaerobic Digesters

	Digesters for POTWs	Digesters for Solid Organic Discards			
		Wet	Dry	Low Temp	High Temp
Description	Many POTW, or sewage treatment plants, have previously installed digesters to process and sometimes recover the energy from the biosolid effluents that they manage. In some cities, these digesters in POTWs had been sized long ago for a larger number of industrial users than remain today after several decades of manufacturing losses in the U.S. Some cities with ROPs, such as San Francisco, are exploring whether this provides a lower cost entry point into digesting their food and soiled paper fractions.	Digesters have four phases – ❶A hydropulper is usually used to remove contaminants, including the significant level of plastics. ❷ The actual digester where a methane forming seed is added to the liquified organics to produced methane from anaerobic digestion in an enclosed vessel that is all captured. ❸ The methane is typically used to power an engine that generates electricity. ❹ The solid organic residual that remains, called digestate, is composted aerobically using standard windrows or silos.			
		Moisture is added in order to facilitate operation of the hyrdropulper to separate out contaminants (total solids <5%), but at the loss of organic volatile solids that reduces energy value, and also the imposition of more parasitic load losses.	Similar to wet digesters, but, by using less moisture (total solids <20%), lose less organic volatile solids and require less parasitic loads for pumping, all of which increases useful energy generation but at the cost of less effective removal of contaminants	Lower temperatures (mesophillic) can be used, with longer residence times and lower energy production.	Higher temperatures (thermopillic) can be used, with shorter residence times and greater energy production.
Costs	Not yet determined	$110-$150 / ton			

Composing systems

Anaerobic Digesters

	Digesters for POTWs	Digesters for Solid Organic Discards			
		Wet	Dry	Low Temp	High Temp
Pros	Provides a low cost opportunity for cities to investigate and test the feasibility of digesting. Where there are idled digesters, then capital costs may be minimal.	In addition to the subtleties of the different varieties of digesters noted above, digesters as a class require less space, produce green energy and have the greatest capacity to remove contaminants.			
Cons	POTW digesters are optimized for higher liquid ratios and do not include hydropulpers, which are necessary to remove feedstocks from communities that produce significant levels of contamination	Digesters are the most costly, less flexible and experience challenging odor requirements.			
Time			See ➜	15-30 days	12-14 days
Supplier	N / A	Most vendors are European. BTA from Germany is the one used to date in North America. Others include Kompogas, Dranco, Linde, Biopercolat, ISKA, Valorga, APS, Biocoverter, Arrowbio, Waasa, Line, Enec, RosRoca and Hasse.[38]			

TABLE 16

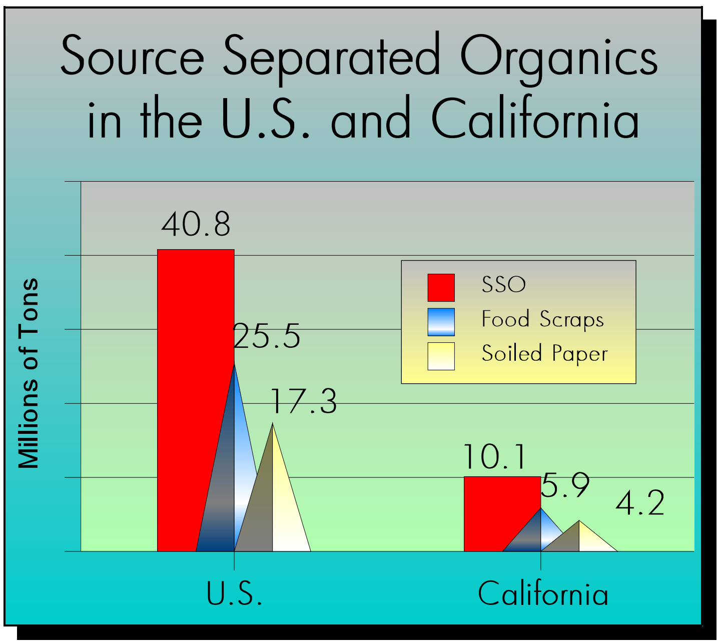
38 The California Integrated Waste Management Board has commissioned a study of digesters to serve as the basis for transferring the European technologies to the U.S. Department of Biological and Agricultural Engineering, University of California at Davis, *Current Anaerobic Digestion Technologies Used for Treatment of Municipal Organic Solid Waste* (March 2008).

8.0 INCREASING ORGANICS PROCESSING CAPACITY

8.1 The Problem

In the U.S., EPA estimates that 29.7% of landfilled discards, or about 40.8 million tons, are food scraps and soiled paper. After adding in the other organic discards – including yard trimmings, lumber, textiles and miscellaneous items – total organics landfilled in the U.S. is approximately 66.3% of all discards.[39]

In California, SSOs constitute approximately 25.1%, or 10.1 million tons, of California's discarded municipal waste, of which about 58% is food and 42% is paper. In that SSO total, 3.6 million tons are residential volumes, of which 61% is food, and 39% soiled paper. Total organic discards are twice that, approximately 51.5%, or 20.7 million tons.[40] See FIGURE 7 along side.



Sources: EPA and CIWMB Waste Characterizations

FIGURE 7

Unfortunately, the existing composting infrastructure permitted for and accepting food scraps is far more limited than the 41 million ton potential for the streams of SSO nationwide, and 10 million tons in California, were it all diverted.

BioCycle's nationwide survey of composters accepting food scraps found 143 such facilities as shown by region on the next page in TABLE 17, of which only 70 had more than 1,000 tons/yr. capacity.[41] Moreover, those totals are almost entirely windrow operations. As the number of SSO programs increase, and the ability to mix food feedstocks with other communities' leaves declines, today's generation of windrow facilities will be challenged to manage nitrogen rich streams. A new generation of more sophisticated operations may eventually be needed.

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39 EPA, MSW Generation, Recycling and Discards in the United States (2009), at p. 37. Soiled, or contaminated paper, is assumed to be one-half of discarded paper, based upon data from composition studies by the Center for a Competitive Waste Industry that specifically sorted contaminated paper.

40 Cascadia Consulting Group, *Statewide Waste Characterization Study* (2004), at p. 6. Soiled, or contaminated paper, is assumed to be one-half of total discarded paper.

41 Cristina Olivares, Nora Goldsetin and Rhodes Yepson, "Food Composting Infrastructure," *BioCycle* (August, September, October, November and December 2008).

In California, a survey conducted in 2003-2004 for the Integrated Waste Management Board (CIWMB) identified 117 "green waste" composting facilities.[42]

FOOD COMPOST FACILITIES IN U.S.

	Number	Large
NEW ENGLAND	16	9
CT	1	2
ME	3	1
MA	5	5
NH	4	0
VT	3	1
NORTHEAST	15	2
DE	1	0
MD	1	1
NJ	2	0
NY	4	1
PN	4	0
VA	3	2
SOUTHEAST	13	4
FL	1	1
GE	3	1
KY	0	0
NC	5	0
SC	2	0
TN	2	0
UPPER MIDWEST	17	18
IL	1	1
IN	0	1
MI	3	3
MN	5	7
OH	4	4
WI	4	2
CENTRAL MOUNTAIN	27	12
AR	1	0
CO	3	1
IA	4	2
KS	2	0
MO	4	0
MT	1	1
NM	2	0
SD	1	1
TX	8	1
UT	0	0
WY	1	6
WESTERN	45	25
AK	2	0
AZ	1	1
CA	20	13
NE	3	3
OR	8	2
WA	11	6
TOTAL US	133	70

TABLE 17

But, only about 10% of the permitted composting facilities in California can accept residential food scraps, and their total capacity is less than one million tons per year. Also, in windrows operations, much of that capacity must be set aside for yard trimmings to mix with food scraps. Moreover, California's strict air quality rules may soon necessitate enclosed systems to comply.

Unless altered, the existing regulatory structure in California's 14 CCR §§17852 and 17857.1 creates challenges to improvement in processing options in the near term. The state's administrative rules impose additional burdens on siting and permitting organics processing facilities that are greater than for yard trimmings.

Organics processing facilities need to obtain numerous permits, from local, state, and sometimes federal authorities. In addition, compost facilities in California are subject to the California Environmental Quality Act (CEQA), which requires extensive public review before a project can be approved. The time, effort, and cost of obtaining a permit revision can be substantial, often taking upwards of a year at a six-figure cost. This can be a significant barrier.

Moreover, while modifying permits at existing sites is less burdensome, they may be required to make costly facility upgrades, in order to obtain their new permits or permit revisions. Examples of facility upgrades include increasing the impermeability of the site surface, enhancing leachate collection systems, enclosing operations, and making or improving on-or off-site roads.

Finally, California's recovery policies artificially increase the costs that cities will perceive in expanding their organics diversion efforts.

42 CIWMB, Organics Summit Background Discussion Paper (2007).

While over twenty states have banned the landfilling of some portion of the yard trimmings stream, California has not. Under AB 939 that created the California Integrated Waste Management Board, California statutes allows residential and commercial yard trimmings and clean scrap wood, minimally processed, to be used as alternative daily landfill cover (ADC) at California landfills.

COMPOSTING FACILITY SITING PROBLEMS

In 2001 the Alameda County Waste Management Authority (ACWMA) began pursuing the development of a large-scale composting facility in the less-populated eastern part of Alameda County (unincorporated Sunol). This facility would have accepted residential and commercial organics. The facility was designed to handle 600 tons per day, for processing into landscape products.

Initially, the facility was proposed as an open-air windrow system. For yard trimmings, this system is standard in the industry.

After receiving numerous written responses that expressed concerns about emissions (mainly odor and particulates) from the proposed facility, the project proponent changed the processing system to an aerated static pile with plastic cover. This change did not mollify most opponents of the facility, however.

After undergoing a highly contentious CEQA process, a proposed facility in Sunol was rejected, in the face of local opposition from residents and, because of an additional issue over open space as a protected watershed particular to this site, from environmental groups. The County Board voted, on a straw poll basis, to reject any requests for a Conditional Use Permit from ACWMA. This essentially doomed the project, and ACWMA's own board of directors chose to remove the project from consideration without certifying the final impact statement. It is estimated that more than $1 million in staff salaries and benefits and consulting costs were expended during the EIR process, which lasted over four years.

ADC is qualified to meeting part of the State of California's 50% landfill diversion requirements. In 2005, approximately three million tons of yard trimmings generated in California was used as daily cover at landfills. This ADC practice has significantly affected the state's composting industry by depriving it of essential feedstock, and diminishes efforts to return processed materials to the economic mainstream through what generally is regarded as actual recycling.

California's ADC practice also will act to create another economic hurdle for residential organics programs because, when food scraps are included with yard trimmings, the mix is no longer eligible for ADC treatment, which many communities rely upon.

8.2 The Solutions

There is currently processing capacity for communities to incrementally explore residential organics programs in those parts of the county where existing windrow facilities are already permitted for food scraps, or would be willing to make the modifications in pads and covers necessary to secure the necessary permit amendments to do so. Also, as San Francisco has shown, larger cities committed to organics diversion control sufficient volumes to entice the marketplace to respond with major investments in new capacity capable of properly managing food scraps. Other than those conditions, the lack of adequate specialized capacity for composting a significant fraction of the nation's food scraps and soiled paper needs to be addressed with new policy initiatives.

This situation is familiar to communities seeking to expand their diversion efforts. In the years immediately following 1989, when the Mobro Garbage Barge finally ended its long journey that inspired an upsurge in recycling efforts. The number of curbside programs ramped up from about 1,000 to more than 8,000, and the fraction of our recovered discards grew from slightly above 10% to more than 30%,[43] even as the amount of wastes generated had increased by approximately 25% over that decade.[44]

But, at the time, there was a major roadblock that impeded progress. Approximately two-thirds by weight of the mix of recoverable materials sought to be recycled curbside was old newsprint (ONP). Yet, the installed de-inking capacity at existing paper mills to recover the reusable fibers was woefully inadequate to absorb the supply of ONP that these new programs were generating. Ultimately, the fact that 28 states legislated mandatory or voluntary minimum recycled content in new newspapers provided entrepreneurs with the confidence that their investments in new de-inking capacity would have a market and earn them a reasonable return.[45] After the initial flood of new ONP supply overwhelmed and collapsed the market in 1996, which led to those legislative enactments, the new investments that the new policies encouraged helped increase the price of old newspapers from $20 per ton to $100 ton by 2007.[46] The combination of policy incentives for entrepreneurs to make the investments, and targeted improvements in the recovery process to produce a clean end-product at lower costs, was a success then and it provides a template to replicate now.

The changes needed to bring about the necessary expansion of residential organics composting fall in several categories:

- Policy changes on the state or local level
- Operational changes that will shift the economics of organics processing
- Public awareness efforts to develop political will for sustainability and combating climate change.

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43 *Biocycle Magazine*, "State of Garbage in America," 1989-2008.

44 EPA, *MSW Generated, Recycling and Disposal in the United States* (2008), at FIGURE 10.

45 Miller Freeman, "Paper Grades: Newsprint," *Pulp & Paper* 1998 North American Factbook, at p.184.

46 *Office Board Markets* for no. 8 news from 1995-2007.

8.2.1 Policy changes

#Raise Disposal Fees: It is difficult to for residential organics composting programs to flourish in states where landfill tip fees are low. Nationwide, landfill tip fees averaged slightly under $35 per ton. The average tip fee in Region 9 is somewhat below the national average. By contrast, European landfill tip fees typically exceed $100/ton, and can reach as high as triple that amount. Not surprisingly, numerous European cities collect residential "biowaste" (residential organics) for composting or anaerobic digestion.

The cost equation can be changed, however, through public policy. One policy measure would be to establish or increase the surcharge on landfill disposal, and to use the revenues to support waste reduction, composting, and recycling efforts. These surcharges can be placed at the state level and at the local level. For example, in California, there is a $1.40 per ton surcharge on landfill disposal. In San Jose, California, the combination of state and local landfill surcharges is $13 per ton and Alameda County's landfill surcharge is $6/ton.

Another policy measure would be to require landfill owners to account for the full cost of the post-closure period, including bearing the cost of risk of landfill liner failure well into the future. In addition, local governments that own landfills could choose to price their use at the discounted value of future landfill capacity at a new landfill, rather than at the current operating cost.

#Eliminate Recycling Credit for Alternative Daily Landfill Cover. By eliminating the recycling credit currently attributed to the use of yard trimmings as alternative daily landfill cover (ADC), the State of California could stimulate greater interest in the composting of yard trimmings, and, by extension, residential organics. As indicated earlier, in 2005, approximately three million tons of yard trimmings and scrap wood was used as ADC in California.

CARBON OFFSETS AND COMPOSTING

The advent of programs intended to address climate change have raised the prospect that there will be financial incentives for composting food scraps and soiled paper. There may also be incentives for yard trimmings in states that do not presently ban them from landfills.

These incentives are called carbon offsets. Offsets permit regulated sources of greenhouse gas emissions to meet their mandated carbon reductions in their emissions by purchasing eligible carbon reductions achieved by others. Composting is an example of eligible carbon offsets because composting decomposes organic materials aerobically so that the formation of methane, an extremely aggressive greenhouse gas, can be minimized or eliminated, whereas in the airless environment of a landfill the decomposition of organics results in methane emissions.

1) An "additionality" test must be met. The composter must demonstrate that regulations are not in place that already require organics to be managed in a way that eliminates the generation of methane. This is intended to reduce the chance of the subsidy flowing to remedial activities that would have occurred without the incentive.

2) The amount of the incentive is calculated by the amount of methane avoided relative to the assumed baseline methane emissions from landfilling the material. The difference between the two is multiplied by the market value of the carbon offset. That market value is determined by what companies that are required to reduce their carbon emissions are willing to pay to purchase a carbon offset rather than to directly reduce emissions from their own facilities.

3) Independent third party verification of additionality and avoided carbon emissions are required and must be paid for by the composter.

Carbon offsets for composters is an evolving field. For the latest developments on which carbon exchanges may provide composters with benefits, please go to Beyond Recycling on the web.

#Streamline Permit Process for Compost Facilities. California, in particular, could reduce regulatory complexity and uncertainty in obtaining permits to operate organics composting facilities.

#Give carbon trading credits for compost. At present, EPA does not assign a carbon trading value for compost, even though it displaces artificial fertilizer, which requires energy to produce and releases nitrous oxides, another greenhouse gas, into the atmosphere. EPA has declined to do because the applicable carbon values are not precise, even though landfill gas to energy systems, which are based upon capture assumptions that have been challenged, are given credit.

Similarly, if carbon caps are imposed that reflect landfills' correct responsibility for greenhouse gases – or if major reforms were made in the present woefully inadequate financial assurance rules – then the cost of competing landfills would rise closer to the costs that they impose on society. Then expanding composting would be more economically attractive.

#Regulatory Flexibility. Promote on-farm composting of organics by allowing greater regulatory flexibility for an initial permit period of two years. If it is operating well, it could be granted an exemption without having to obtain a full solid waste facilities permit. If it is not being operated well, it could be shut it down either by regulatory authority or by not renewing the permit.

#Obtain Professional Expertise on Local Land Use and Public Process Issues. Local governments that seek to site compost facilities need to have CEQA and land use expertise available to it at the outset of the siting and permitting process. In public/private partnership cases, local governments should also have or retain business and business law expertise. For key leadership positions, waste management agencies might consider the efficacy of hiring environmental, business, or real estate attorneys as senior staff, rather than only hiring career bureaucrats, former elected officials, or former waste management industry staff.

8.2.2 Operational Changes

#Restructuring collection to reduce costs. As as been described, there may be significant savings in costs and increases in volume of organics diverted by reducing the frequency of collecting the rubbish that remains after recycling and organics separation. If a pilot indicates that diverting organics can be less expensive than landfilling due to those offsetting collection savings, then the market will tend to move to expand organics recovery programs even without mandates.

#Enclose Composting Operations. By enclosing composting operations, and using forced aeration systems, facilities can reduce air emissions, leachate, and use of potentially scarce water resources. Enclosures can include, among others: plastic covers or elongated bags; metal boxes; drums; or indoor concrete bays. The use of "breathable" plastic covers, such as deployed at two organics composting facilities in Washington State, is expected to become a standard technology for processing minor volumes of source-separated organics, as is the use of plastic bags (similar to silage bags) that enclose windrows. For those incremental programs, these systems are generally reported by users to be lower in cost and easier to operate than more mechanized in-vessel composting technologies for minor food volumes.

#Consider Anaerobic Digestion at POTWs. Another approach that might obviate some of the siting and permitting challenges would be to add food scraps to anaerobic digesters at publicly-owned treatment works (waste water treatment facilities). Because residential organics may have too much contamination, and only commercial loads are likely to be accepted there, dedicated digesters may be considered, especially in either programs with less frequent rubbish collection or areas where disposal costs are high.

8.2.3 Public Awareness

#Emphasize Resource Conservation. The framework for waste reduction, recycling, and composting over the past 30 years has been based on diverting materials from disposal in landfills and incinerators. Opinion leaders need to put greater emphasis on recycled municipal organic materials' role in soil conservation and water conservation. The application of mulch and compost can greatly reduce the need for watering, and helps to hold soil in place. This is particularly important for arid Region 9 areas, which chronically suffer periodic drought conditions and erosive heavy rain events.

#Use Appropriate Terms. Given the negative reaction among most people to the term "waste", it is important to re-define "yard waste" as "yard trimmings" (or landscape trimmings) and "food waste" as "food scraps" or "discarded food." These slight semantic differences act to change the general impression of what these natural resources are. Moreover, changing the definition of certain materials from being included in "municipal solid waste" to being source-separated resources can, in some circumstances, increase competition for collection by non-franchised haulers. The City of Oakland, California took this course with respect to commercial recyclables and food scraps, with positive benefit for the City's landfill diversion rate and the services that businesses receive.

9.0 NEXT STEPS

9.1 Research Needs

9.1.1 Processing

Europe and Canada have had experience with in-vessel and anaerobic digestor systems. However, the U.S. has not yet installed and vetted the in-vessel units nor, apart from sewage treatment plants and manure digestors, organic waste anaerobic digestors.

Qualified operators need to visit functioning sites in order to be trained in how to design, install and operate these more sophisticated processing systems in the U.S.

9.1.2 Collection

Efforts to expand residential recycling programs to include organics has, to date, been driven by environmentally motivated cities seeking very high diversion rates over 50%. But increased costs are likely when engrafting this new activity on top of existing programs. There are the additional collection vehicles and the complications in processing, as well as the fact that competing landfill tipping fees are low. At a time when most cities are under severe budgetary pressure, and are already juggling a surfeit of other challenges, the prospects for expanded composting are limited.

We propose a pilot project to address the cost issue by exploiting some synergies that flow from residential organics collecting and processing. The program would include two major changes:

- The categories of organics accepted would be expanded to include diapers and pet wastes
- The pick-up of rubbish (residual discards after organics and recyclables have been removed) would be reduced to a bi-weekly (twice a month) pick up.

If all of the putrescibles have been removed, and the remaining volume is less than one-third of total waste generation, logically there would not seem to be any longer a compelling reason to collect that residual rubbish weekly. Instead, recyclables and organics could be collected weekly, and rubbish, less-than-weekly.

By doing so, the cost of less frequent rubbish collection, as compared to weekly solid waste collection, could be substantially less, and the savings could be utilized to offset the additional costs of handling source-separated organics. That may be something especially critical to extending the reach of all-organics diversion programs beyond the Bay Area where cost factors are given greater consideration.

In addition, an internalized incentive is created for the resident to cooperate in order to avoid putrescibles remaining in the home for longer than one week. The results from our survey and site visits strongly support the hypothesis that this incentive can significantly increase organics diversion.

The specific objective of this pilot test is to determine whether the change in collection frequency in all-organics residential programs will--

- Be achievable in practice;
- Significantly reduce the overall net costs of adding all organics collection;
- Constructively encourage residents to cooperate in order to avoid leaving putrescibles in the home for that additional length of time.

We plan to conduct this pilot in a city in Region 9 that is interested in working cooperatively to explore this exciting area of research and assisting other communities seeking help with less frequent rubbish collection.

9.1.3 Commercial Sector

As residential systems for organics programs become established, the next step will be to extend these program to multi-unit apartments and to the commercial sector. Efforts in other cities such as Toronto intended to involve commercial establishments should be evaluated, and a range of alternative approaches developed and pilot tested.

9.2 Public Support

After decades of desultory local activity, the first widespread generation of community diversion programs involving recyclables was motivated at the end of the 1980s in part by the public attention that the Mobro Garbage Barge brought to the issue.

For this next step after recycling to be encouraged, it, too, needs a crisis to animate support from policy makers and the public. There remains the general need to move to more sustainable strategies, but global warming provides a unique moment in time of far greater significance that was the garbage barge. Diverting organics from landfills provides a significant means to significantly reduce greenhouse gas emissions, especially of the type critical in the short-term that we face tipping points.

The public and policy makers should be educated to these facts.

CONCLUSIONS

The larger themes distilled from this report for the reader to take-away are these–

- There has already been widespread activity to move to the next step after recycling, which is to also divert the organic stream from landfills. Already, 121 communities across North America, both large and small, are involved in that enterprise. Eventually, these new efforts have the potential to double diversion, and, in the process, also significantly reduce the source of harmful gas emissions from and long-term biological activity in landfills.

- The recent scientific conclusions about the fact and severity of global warming presents one of the most significant crises in modern times, and there is an urgent need to dramatically reduce emissions of greenhouse gases, especially aggressive and intense ones such as methane, in the critical short-term that we confront several key tipping points.

- Landfills are a major generator of methane, and most of that gas escapes. Diverting organic discards from landfills means that methane will not be generated from the waste sector in the first instance, thereby providing a key component of short-term climate action plans intended to avoid creating irreversible positive feedback loops. In the process, composting those diverted organics also means that fertility can be returned to our depleted soils to better retain stored carbon.

- Finally, diverting organics from landfills is eminently doable because the largest segment, yard trimmings has been demonstrated can be completely diverted by state landfill bans. Also, unlike containers, many of which are consumed away from home and elude recycling systems, all food is prepared in a single room in the house. That is why techniques such as less frequent collection of rubbish that incentivize non-cooperators have demonstrated that upwards of three-fourths of those scraps can be captured. Because of the reduction in trash trucks, there is a possibility this may be accomplished without significantly increasing net costs.

- At the same time as the potential exists for composting to rapidly grow in response to the climate crisis, many impediments remain to be addressed, including refining the appropriate level of composting technology to the challenges of nitrogen rich feedstocks, expanding the capacity to process new food scrap programs, and adjusting collection routes to capture the synergies created when organic diversion is added to recycling. Carefully designed small scale pilot projects to test the alternatives should be coordinated, commenced and disseminated as soon as is possible. ❐

ATTACHMENTS

A - List of Respondents

B - Detailed Charts from Surveys

ATTACHMENT A

Residential Organics Project Survey Respondents

<u>Initial Survey Respondents</u>
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Brian Van Opstal, Toronto, Canada
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Dwight Mercer, Regina, Canada
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Larry Alexander, Sarasota, FL
Josh Marx, Metro King County, WA
Ken Dominie, Dept. of Envt. Newfoundland, Canada
Bob Kenny, Nova Scotia Environment and Labour

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Karen Anderson, Duluth, MN
Lisa Jensema, Gilroy, CA
Mark Gagliardi, Oakland, CA
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Martha Jensen, Dixon, CA
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Solid Waste Agency, Marion, IA
Jack Macy, San Francisco, CA
Larry Alexander, Sarasota, FL
Josh Marx, Metro King County, WA
Ken Pianin, Fremont, CA
Ken Wells, Sonoma County, CA
Lisa Jensema, Gilroy, CA
Mark Gagliardi, Oakland, CA
Martha Jensen, Dixon, CA

ATTACHMENT B

Residential Organics Project Survey Responses