Assessing Waste & Recycling Pricing Alternatives in Alameda County

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Executive Summary

Project Motivation

Increasing recycling and composting among residential and commercial sectors is an important policy goal in California's Alameda County. Efforts to improve diversion of easily recyclable materials from landfills is accomplished through education, outreach and establishing the appropriate pricing mechanisms to incentivize recycling behavior.

Across Alameda County, nearly every municipality uses rate setting to improve waste diversion. Incentives in the price structure encourage subscribers to sort out recyclable and compostable materials. By doing so, the subscriber can reduce the size of their garbage bin and pay a lower monthly bill. This socially optimal outcome is not without consequence. Waste and recycling collection services depend on a steady stream of revenue paid by subscribers. As recycling continues to increase, whether the outcome of sustainability campaigns or price incentives, significant financial pressures are imposed on service providers attempting to maintain a profitable business, and on municipal governments that use compensating revenues from waste collection for general fund spending.

The county's waste management authority, StopWaste.org, asked us to investigate the alternatives to existing fee and pricing mechanisms used by its member municipalities. Specifically, StopWaste.org requested that we determine if pricing systems can be developed to maintain high diversion rates without comprising financial sustainability. StopWaste.org asked that we determine how continued price increases affect waste production and recycling behavior.

Analytical Criteria

To evaluate service fee increases in the residential sector of Alameda County, we analyzed two quantitative variables using County-level data:

1. To what extent does the policy change affect *system-wide revenues*?
2. To what extent does the policy change affect the amount of *waste generated*?

Further, we analyzed three qualitative variables from County-level data, past research and interviews:

3. Does the policy purposely or inadvertently raise *distributional equity* problems?
4. From the perspective of customers, how *acceptable* is the service fee increase?
5. What are the *political and legal feasibility* concerns of such a policy change?

These analytical criteria are then applied to two cities, Livermore and Fremont, with four prospective fee increases: 5% and 10% increases in existing rate plans, flat rate increases on each subscription of $.5, and an additional fee added to the existing rate structure.

Recommendations

Short-term: In the short run, municipalities are able to use annual rate increase clauses to ease immediate budget burdens, as well as provide time for renegotiation of possible rate structure changes with stakeholders. The quantitative results of this analysis provide estimations of what effect on revenues and waste diversion these changes will have.

Long-term: In the long run, the ultimate goal of this analysis is to provide County and municipal decision makers a thorough and balanced framework for vetting prospective solutions to balancing continued waste diversion with revenue stability. Municipalities still pursuing ambitious diversion goals are likely to be better served by the ongoing use of conservation rate structures, while cities at or near their diversion goals should consider the benefits of incremental pricing in stabilizing revenue and aligning service costs.

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1. Introduction

Problem Definition

In Alameda County, pricing mechanisms for waste and recycling collection services incentivize subscribers to sort out recyclable and compostable waste. As solid waste volume declines, subscribers can reduce the size of their garbage bin and lower their monthly bill. In the aggregate, increased recycling and downsized waste volume places substantial financial pressure on service providers and municipalities. Therefore it is necessary to determine how municipalities can optimally formulate pricing systems to meet ambitious recycling goals, while maintaining program solvency.

Motivation

Increasing recycling and composting among residential and commercial sectors is an important policy goal in California's Alameda County. Accordingly, the county established a waste management authority, StopWaste.org, to monitor and assess recycling policy goals and local waste management programs.

As part of its mission, StopWaste.org seeks to reduce the county's waste stream destined for landfills and improve recycling efforts throughout its member cities. High recycling rates yield socially and environmentally optimal outcomes, but efficiency gains and cost savings can also be captured in the process. For example, high levels of household and commercial recycling reduce the amount of sorting necessary at transfer stations, and many of these captured materials can be resold as inputs to other production processes. Fewer landfills also reduce the risk of filters degrading and introducing ground and surface water pollution.

One method to improve recycling trends is developing fee and pricing mechanisms for waste collection that offer economic incentives to begin recycling, or to recycle more. These incentives, alongside social trends Nearly every city in the county deploys some type of fee system that harnesses these incentives to increase recycling, most notably, by assessing service fees solely based on the size of a subscriber's waste container. And as the size of a subscriber's waste container increases, so does its cost.

However, these pricing systems also introduce financial vulnerability at very high levels of recycling. Higher marginal costs encourage "downshifting" to smaller waste containers, as commercial and residential consumers sort their recyclable and compostable waste into the appropriate bins and capture lower monthly rates. In the aggregate, significant movement among subscription sizes and downshifting movements, put pressure on both service providers and municipalities to forecast appropriately.

These pressures are particularly acute for service providers that face very high fixed costs to run waste collection programs. Not unlike providers, cities and local governments depend on franchise fees and/or revenue sharing for general fund spending. Therein lays the fundamental tension between expanding economic incentives to improve recycling and to maintain revenue targets. The primary method of correcting this imbalance is to continually increase service fees. However, fee increases perpetuate this cycle, as the cost of waste collection increases, subscribers downshift to smaller bins, lower their monthly bills—necessitating yet another fee increase.

Outline of this Report

StopWaste.org asked us to investigate this problem and offer solutions or analysis of how continued price increases affect waste production and revenues. We were also asked to evaluate alternative pricing systems that could mitigate or alleviate some of the tension between revenues and recycling goals.

In this report, we focus our analysis on the effects of continued short term price increases on the residential sector—data on the commercial sector was difficult to access, very heterogeneous and insufficient for data analysis at the time of this report. Firstly, we describe the benefits and shortcomings of conventional fee systems used throughout the county. Thereafter we lay out the key criteria to evaluate four price increases, 5% and 10% increases to existing rate structures, $.5 increase on all residential subscribers, and an additional fee added to the existing rate structure. We then analyze both the quantitative and qualitative variables in the context of two representative cities, Livermore and Fremont. At the end of the report we synthesize our findings into short and long term recommendations, and include a discussion of the leading alternatives to current fee and pricing systems, such as advance disposal fees.

Project Ambitions

It is our hope that StopWaste.org, through its member cities, will address this problem by modeling anticipated responses to changes in existing pricing systems. The data resulting from this analysis can help decision makers to tailor new pricing options to the specific political and economic climates of their respective cities.

- Anticipated output: A useful and accessible advisory tool to assist StopWaste.org and its member agencies to make pricing decisions for trash, recycling, and composting services.
- Anticipated outcome: Municipalities use the tool to reformulate pricing systems that continue to incentivize recycling and composting while producing adequate revenue flow.
- Anticipated impact: Improve financial stability of municipal waste and recycling programs, while improving the ability of StopWaste.org to continue its work on waste diversion with increased self-sufficiency into the future.

2. Overview of the Current Rate Structures

National Trends

As one of its "Conservation Tools" the United States Environmental Protection Agency (EPA) has issued the Pay-As-You-Throw (PAYT) guidelines to advise municipalities on trash pricing and waste minimization (USEPA, 1999). The PAYT guidelines' main focus is on the importance of pricing trash services in accordance with resident generation, thus creating incentives to minimize trash and increase recycling. Its recommended rate structures are widely used throughout Alameda County:

- Proportional: creates a direct relationship between trash amount and price, such that each unit, whether by volume or weight, is assessed the same price.
- Variable: charges differential prices for each unit of garbage produced. Prices may increase at higher levels of waste, or be lower, depending on the goals and ambitions of the program.
- Two- or Multi-Tiered: consist of a base "flat fee" and additional variable or proportional fees.

Implementation of rate programs differs substantially across the country. Some municipalities use unit-pricing bags while others employ subscribed cans or bins. As of 2006, more than 7,095 localities nationwide utilized PAYT pricing structures. In 1999, five of the top ten largest programs were located in California, with Oakland as the ninth-largest PAYT category program in the country (USEPA, 2006).

Current Rate Structures in Alameda County

Municipalities in Alameda County contract directly with service providers, generally private corporations, for waste and recycling removal services. Rates are set through negotiations between municipalities and service providers. Each provider contracts with residents to assess user fees, and pays negotiated compensation to the city. These local compensation fees, including franchise fees, generally fund the waste and recycling program of each city. The exact structure of fees varies across cities. Some are charged as a percentage of revenue earned by providers (the percentage reaches as high as 24% although it is more commonly around 10%), while others are charged as a fixed amount paid annually to the municipality, and is not linked to revenue levels. There are also mixed systems in which a combination of these and other ways of calculation.

Each municipality sets different rates for single-family, multi-family and commercial units. There is significant variation in the rates for both multi-family and commercial sectors in terms of service options and levels, while subscription options for single-family units are largely uniform across the county. Specifically, nearly all municipalities in Alameda County employ a bin-based system for single-families, and the vast majority (12 out of 16) offer four size options of bins, 20-gal, 32-gal, 64-gal and 96-gal, with some exceptions. The user fees are structured as variable rates, and these rates can be further categorized into two general systems:

- *Conservation Rates* levy rates on residents that are proportional or nearly proportional to waste generated, as measured by size of bin to which a resident subscribes. Rates generally have roughly linear relationships with bin sizes.
- *Incremental Costs of Service* levy higher initial rates on small bins, which then increase at a slower (linear or graduated) rate as bin size increases. Thus, the total price for a larger bin is not proportionally more than that of a lower bin.

Presently, most municipalities opt for conservation rates as a rate for single-families, with just a few cities including Fremont utilizing incremental systems (see Appendix A). The general characteristics of the two structures can be described as:

- *Conservation rates* in theory give stronger incentives to residents to choose smaller bins and recycle more through a linear pricing structure. They also represent a more equitable system, in that residents pay in proportion to the waste they generate. As waste diversion increases with more residents subscribing to smaller bins, however, these rates could lead to substantial revenue decline.
- *Incremental rates* disproportionately burden residents generating little waste, and as such, are generally expected to provide weaker incentives for diversion efforts by consumers. Their non-linear form, however, are more effective at reflecting the financial costs of waste collection, which involves significant fixed costs. This may be regarded as another form of equity in that residents pay for the cost of service they use. Consequently, in jurisdictions with high existing rates of diversion, these rates may be superior at generating stable revenue streams.

Rate Adjustments

All current service agreements allow for annual (or bi-annual) rate increases by the provider without renegotiation of the service agreement. Each agreement sets a maximum annual increase, the magnitude of which vary slightly but are generally about 5%. As noted below, Livermore's recently updated agreement allows for a maximum annual increase of 9% (in addition to dramatically raising base rates). Annual rate adjustments do not allow for changes to the pricing structures themselves.

A Closer Look at Two Cities: Fremont and Livermore

In our later analysis, we will focus Fremont and Livermore for the application of proposed pricing scenarios. These municipalities are not only demographically diverse, but also provided a significant amount of data to analyze. They also possess differences in rate structures that together account for much of the variation in the County.

- Livermore employs conservation rate structures, while Fremont uses incremental pricing. Their subscription levels clearly demonstrate the tradeoff between conservation rates and incremental costs discussed above. In Livermore, the majority of residents opt for smaller bins while in Fremont more than two thirds opt for larger bins. Also, it is noteworthy that Fremont creates a price kink between the largest bin (96 gallon) and the second largest bin (64 gallon), and that seems to be affecting the low subscription level for 96 gallon bins as well.
- Livermore restructured its service agreement last year. The maximum annual rate increase for services is 9%.
- Livermore and Fremont collect proportional franchise fees of 16% and 11%, respectively.

3. Framework of Evaluation

Focus of the analysis

This project analyzes the effects of several different rate structures. We restrict our focus to the single-family sector. As mentioned above, the single-family sector has the least variation in rate structures and was thus the best starting point for analysis. Also, we obtained access to more consistent data for the single-family sector. It is our belief that the principles of this analysis can be expanded to investigate the effects of rate changes on multi-family and commercial sectors.

Also, this analysis will be conducted based on the four-size bin system, which is employed by the majority of cities within the county. While much more fundamental changes could be conceived to improve the situation, changing the current four-size bin system would require significant investments and political support. We chose to use the current system in our analysis to address how rate changes could potentially affect outcomes. We attempt to determine what would happen under the current system if fee increases are introduced.

Our analysis also focuses on user fee structures. Certainly, user fees are just one of many complex variables which affect the waste diversion and the total revenue streams of the program. Revenues of municipalities are determined by local franchise fees and other fee rates, and in some cases where cities charge flat fees, changing user fee rates have no direct impact on their revenues. However, we would like to emphasize that ensuring a sustainable user fee structure would be a necessary condition to allow service providers to operate and thus sustain the program itself in the long-run. Adjusting local franchise fees would also be important, but that presupposes that there is an appropriate user fee structure beforehand.

Finally, this project does not aim to prescribe which specific and definitive rates would work optimally in each municipality, but rather tries to show a more general model of how we should evaluate different rates in the long-run. Real rate setting involves a much more complicated process of examining and evaluating actual costs, and should also reflect the different political and administrative priorities of each municipality. Current social trends and political priorities suggest increased waste diversion in the future, and it is therefore important that each municipality accounts for that likelihood in setting future policy.

Proposed Scenarios

Based on the price sensitivity analysis to follow, we test three major price change scenarios:

- *Across-the-board price increase:* This will maintain current price ratios for the four bins.
- *Flat fee increase:* This fee, levied on all consumers, will lower the relative price of larger bins, making the rate structure more "incremental." That is, prices will consequently increase at a decreasing rate.
- *Imposition of an additional proportional fee:* This will be added to the basic rates as a separate fee parceled out from typical monthly fees.

The main reason we propose these scenarios as changes to current rates is that our interest is not in providing a one-fit-for-all rate structure, but in showing how adjusting the current rates would work for each municipality's individual situation. Since the expected effects will necessarily vary from city to city, we compute and analyze the predicted outcomes for the two example cities, Fremont and Livermore. Our hope is that this portion of our analysis will supplement the existing cost-benefit considerations for these rate structures by providing specific numerical examples of potential impact on revenues.

Evaluation Criteria

The effects of each proposed scenario are evaluated on the following quantitative and qualitative criteria:

- *Change in revenues:* Increases in waste diversion have had negative effects on revenues at the municipal, county, and service provider levels. A main criterion for evaluating a prospective scenario is the degree to which it can increase or stabilize revenues.
- *Effect on the amount of waste generated:* Any change in a municipality's pricing model should avoid substantially disrupting current incentives that have contributed to high rates of county-wide waste diversion.
- *Distributional equity:* As proposed scenarios necessarily involve price increase to address both incentives and revenue stability, it is important to consider equity among subscribers.
- *User acceptability:* The perception that changes in rates are transparent and necessary are important to the success of an alternative system in achieving necessary results in revenue and waste diversion.
- *Political and legal feasibility:* Current pricing systems are governed by long-term franchise agreements between service providers and municipalities. Changes to rate structures must be acceptable to all parties, as well as politically feasible to elected officials and agreed upon within the context of amending a long-term contractual agreement.

4. Evaluation of Criteria: Change in Revenue and Disposal

Overview

In this section, we focus on two of the five evaluation criteria, changes in revenue and disposal, and quantify these factors under each of the three alternative pricing models. Predicting how different rate structures affect waste diversion and revenues of municipalities and service providers requires measurements of how consumers respond to changes in trash pricing. Though research in this area has slowed in recent history, several large-scale studies on consumer sensitivity were conducted between the late 1990s to the early 2000s . One such study estimated that, given a 10% increase in waste collection fees, disposal subsequently decreased by 2.6% (Kinnaman, 2006). The majority of these sensitivity studies, however, were conducted at the household level using survey data. In our analysis, we desire to know how price changes interact with aggregate subscription levels by bin size. Because of these differential research designs, we could not directly apply the results of past research, despite it being a strong benchmark for suspected price sensitivity. To overcome this challenge, we constructed several econometric models to determine sensitivity.

The strength of these models is in their ability to demonstrate the general effects of rate structures observed across jurisdictions within the county. We are consequently able to predict how different rate structures result in different levels of disposal in the county according to the past subscription data, and can accordingly evaluate the fiscal impact of each price change alternative.

Methodology

i. Regression model

In predicting the change in subscription levels, there are two main factors that affect an individual's decision in selecting a bin size. The first is monthly rate. If the price of a given bin increases, subscribers will consider downgrading the size of their subscription—bin size—to mitigate the impact of the absolute price increase. The second factor is the *relative prices* between smaller and larger bin sizes. That is, if the price ratio changes between different sizes of bin, people might consider switching to a "relatively cheaper" bin.

Under these assumptions, we constructed the following regression model (see Appendix B):

$$subscription_i = \beta_0 + \beta_1 monthly_i + \beta_2 larger_i + \beta_3 smaller_i + \beta_4 u_{ij} + \varepsilon$$

- i refers to bin size; (24-, 32-, 64-, and 96-gal)
- *subscription* indicates the fraction of subscription accounts for each bin size ($0 < subscription < 1$).
- *monthly* is the monthly rate of each bin size. The coefficient reveals to what extent the fraction of subscriptions would change when the monthly rate increases by one dollar.
- *larger* is the price ratio between the monthly rate and the next larger bin ($larger > 1$). The coefficient reveals how much the fraction of subscriptions would change when relative prices change, with regard to the larger bin.
- *smaller* is the price ratio between the monthly rate and the next smaller bin ($smaller < 1$). The coefficient reveals how much the fraction of subscriptions would change when relative prices change, with regard to the smaller bin.
- u_{ij} is a dummy variable which represents a city fixed effect (0, 1). By including fixed effects, we can control many confounders that would otherwise invalidate the usefulness of this analytical technique. For example, population growth, income variables, social attitudes, and so on. If these variables were not purged away from the model, it would be increasingly difficult to isolate the relationship between price and subscription levels, as they are likely to be determined or co-determined by these vary factors.

ii. Data

We obtained 15 samples from six cities, and organized the data in spreadsheet format; see Appendix C.

iii. Scenarios

With the regression model specified, we used it to estimat the changes in aggregate subscription levels, and then calculated change in revenue and disposal under following four scenarios (see Appendix D):

- Across-the-board price increase: 5% and 10% price increases
- Flat fee price increase: $0.5 flat increase
- Additional fee: imposition of a new monthly fee

Under the additional fee scenario, we assumed that subscribers would not change the size of their current bin, since people are less responsive to a new (relative) fixed cost than to monthly rate increases. We focused our analysis on two cities, Livermore and Fremont, to demonstrate how the generalized findings from the model can be applied and used in the context of a specific city. We selected Livermore and Fremont based on data availability and diversity between them in demographic characteristics and current pricing structure.

Findings

Appendix E shows the results of the regression analysis. Coefficient β_1, in theory, is expected to be negative, since the higher the monthly rates, the more incentive people should have to downgrade the size of bin to mitigate the price increase. For 32-, 64-, and 96-gal bins, the coefficients were estimated to be negative, and its effect is stronger as the size of bin decreases. On the other hand, the estimated coefficient of 20-gal was estimated to be positive. We hypothesize that due to price increases, there is significant downward movement to the 20-gal bin size, while those who were originally subscribing 20-gal have nowhere to downgrade.

Coefficients β_2 and $\beta_3$also showed different patterns among the four bin sizes. Both coefficients are expected to be positive, since the bigger the relative price to larger bin is, there should be more incentive for subscribers of larger size of bin to downgrade to the smaller bin; as a result, the subscription number will increase by accepting people downsizing from a larger bin. This is also the case in relation to smaller bin; the higher the price relative to the smaller bin,the more the subscription number of the size will increase, since subscribers of smaller size of bin can now move to a larger bin with less additional rate, and therefore, the rate now looks 'cheaper' for them. As you can see from the table, coefficients for the 32-gal bins demonstrated a positive sign, as was expected, while others were estimated to be negative. This might be demonstrating a strong preference for the 32-gal bin size, in the sense that many households have difficulty reducing waste beyond this point. On the other hand, it might also be possible that our regression model is not estimating those coefficients precisely. In our datasets, relative prices between different bin sizes were almost constant within each city. With minimal variation in the explanatory variable, the estimation of coefficients tends to be less precise. In order to confirm the precision of our estimate, additional analysis utilizing more complete data is necessary.

Based on estimated regression models, we then calculated changes in revenue and disposal (see Appendix G). The results are shown in Appendix F. With regard to revenue changes, under across-the-board price increase scenarios, revenues are predicted to increase in both 5% and 10% increase scenarios. For example, under the 5% price increase scenario, the revenue for Livermore is calculated to increase 2.29%, while it is 5.62% for Fremont. This is also the case for the flat fee increase scenario and additional fee scenario. Under the flat fee scenario, more than 10% revenue increase is expected in both cities, though the impact is larger for Livermore. Under the recycling fee scenario, we can expect 8.33% (1/12) increase of revenue. This is primarily due to our aforementioned assumption that migration between cart sizes would not occur.

On the other hand, impacts on the amount of disposal are different among four scenarios. First of all, under the across-the-board 5% and 10% price increase scenarios, both cities can anticipate decreased disposal levels. For Livermore, the decrease is -2.38% and -4.76%, respectively, and -0.92% and -1.85% for Fremont. Under the flat fee scenario, the amount of disposal was predicted to increase by nearly more than 10% in both cities. Under the additional fee scenario, there was no change. Again, this is due to our simplifying assumption that there would be no migration in container size.

Summary of Results

In this section, we quantified changes in revenues and disposal under fourprice change scenarios. We conclude from this analysis:

- Under across the board increases, we anticipate both increase of revenue and decrease of disposal.
- Under flat fee increases, the amount of disposal and revenue are both expected to increase.
- A fixed additional (proportional) fee might be useful to increase revenue without increasing disposal. However, there remains uncertainty due to our simplifying assumption about consumer response.

Limitations of the Analysis

The precision of sensitivity estimates depend on accurate and comprehensive data. In this analysis, we could obtain only 15 samples, and most of those data are those from the past few years. In particular, there was only limited variation in relative prices among different container sizes, by city, as used in our analysis. This may have resulted in an imprecise estimation of migration. As a result, although we are confident about capturing general trends, our economic model may be inaccurately predicting the change in revenue and disposal under the flat fee scenario, where relative prices change. Once more data is available, we can expect greater precision in our estimations. Data gathering efforts may be difficult, especially in reclaiming data from earlier years, but we recommend that cities should use the common form included in the appendix to systematically collect data for future analysis.

Also, in our analysis, we estimated the amount of disposal by multiplying the estimated number of subscriptions by the capacity of each size of bin (20, 32, 64, and 96 gallons), assuming that subscribers would fill trash containers to capacity. Therefore, the amount of disposal may be overestimated in our analysis. The validity of the calculation could be tested by conducting field research and generating averages on capacity and volume produced.

Supplementary Data Analysis

The most important issue to address with this model is that of the likely differences in incentives created by conservation rates and incremental costs of service. At this time, the limited availability of data unfortunately did not allow the model to clarify the exact impact of incremental price increases. Therefore we briefly discuss some data which suggest that incremental costs of service might not necessarily disrupt incentives for waste diversion. Appendix H shows in-county waste disposal comparison for 2008. A closer look at the per-capita residential disposal amounts allows us to see that Fremont which has the most typical incremental rate system is generating

257.7kg/year, which is approximately the average level of the county (a standard statistical significance test reveals there is no significant difference). This is especially notable because the Fremont rate for a 64 gallon container is one of the lowest within the county and, accordingly, its low (absolute) price makes it an attractive and very popular subscription level.

We also looked at the data for 1990 (see Appendix I) which is before Fremont introduced its current incremental rates, and found that the waste level of Fremont (again for residential) was just slightly less than average but with no statistical significance, which could suggest that Fremont's relative level of disposal did not change substantially before and after the rate change. We also compared figures for Piedmont and Pleasanton, which also ultilize incremental rate structures, and observed no significant difference between the disposal level of these three cities and that of the other cities with conservation rates. We should be prudent in drawing conclusions without examining greater details, but this simple analysis still demonstrates that, at least within the county so far, we do not always observe statistically higher levels of waste disposal for cities with incremental rates, a fact that we believe merits further analysis using our model.

5. Recommendations

General recommendations: Weighing benefits

StopWaste.org and its partner municipalities have made notable strides in their pursuit of waste diversion. In balancing this success with the emerging need for revenue solutions, parties must weigh the benefits of each against their own local concerns. Here, we expand upon the findings of our numerical analysis to incorporate qualitative criteria in a holistic comparison of pricing alternatives. Our ultimate goal is that parties are able to use the outcomes of our models with respect to key criteria in determining the best path to long-term sustainability.

<u>Conservation rate structures:</u> Conservation pricing systems have notable benefits, not least of which is their existence as the status quo in most Alameda municipalities. As such, annual rate increases allowed by most service agreements represent a quick and relatively simple means of increasing revenue. Our model provides an estimate of the effects of these types of increases to conservation rates–as well as those of greater magnitude–on the criteria of revenue generation and waste diversion.

<u>Incremental rate structures:</u> As our model demonstrates, certain subscription levels are less sensitive to price increases, a fact that translates well to incremental pricing systems. This is likely the result of households' limited ability to reduce waste generation past certain points, even in the face of economic penalties. Additionally, the non-proportional structure of incremental pricing provides more subtle incentives to consumers, potentially meaning increased revenues in high diversion areas without substantial risk to diversion goals. Finally, incremental rate structures can "capture" reduced consumer sensitivity to generate stable revenue that more accurately reflects the true costs of waste and recycling collection.

Clearly, each model has its strengths. Below, we provide an analysis of how they compare under key criteria:

- *Incentives for waste diversion:* Under proportional conservation rate structures, price increases present consumers with unambiguous incentives to move to lower bins. With relative prices remaining constant in the face of an increase, there is generally no added "penalty" to keeping a larger bin. Nonetheless, increases (sometimes substantial ones) have obvious effects in terms of absolute costs to consumers, and the pay-as-you-throw philosophy of this method has certainly been an effective driver of waste diversion in many instances.

With incremental pricing, a price increase presents the consumer with a more nuanced set of incentives; one is driven to downsize in terms of absolute price, but incremental pricing makes the savings of such a transition a lower proportion of total price paid than under conservation structures. As a result, a consumer who can easily downsize (i.e. one who is "wastefully" generating trash) may well do so for the absolute savings without eliminating revenue proportionally, while one who is already making strong diversion efforts will be less extremely penalized by price increases. Further, because a higher subscription level remains more costly, it is unlikely that consumers will move to a *larger* bin as a result of incremental structures in any but the most extreme examples.

Thus, while there is a clear difference in apparent incentives between the systems, there may be reason to believe areas with high diversion rates can expect increased and stable revenue under incremental structures without placing diversion goals at substantial risk. In the case of Fremont, as mentioned above, significant gains in diversion have been made even after the move to incremental pricing, leaving its per capita disposal rate statistically equal to the average for Alameda County (see Appendix H and I).

- *Implementation:* The political and legal feasibility of rate changes, either in amount or in structure, are a vital consideration for any municipality. Conservation rates, as the status quo in most municipalities, have considerable advantages in implementation. For smaller increases, which are usually built into service agreements, no formal renegotiation or political decision-making is needed. Even for larger increases as part of contract negotiation, however, the technical simplicity of across-the-board increases and the perceived fairness of proportional pricing will likely encourage acceptance.

  Should municipalities decide to pursue incremental rate structures, there are two general paths to a new structure via renegotiation of service agreements. The first, an overhaul of prices at every subscription level, may well be unduly confusing to public decision makers and politically untenable with consumers. The complexity of a systemic overhaul is one reason; the perceived "unfairness" of a non-linear pay-as-you-throw program to many may well be another.

  The second option for implementing an incremental pricing system, the institution of a flat fee across all subscription levels, would accomplish the same economic goals and incentives while being simpler to implement. Further, categorizing this flat fee as a "recycling fee" or a "waste diversion fee" may or may not be more readily accepted, but could potentially be justified as representative of the real situation facing municipalities and providers.

  Regardless of internal implementation challenges and consumer acceptability, the institution of flat fees to alter pricing structures faces considerable legal obstacles. The passage of several ballot propositions in California, designed to prevent governments from circumventing tax increases with arbitrary "fees", have severely constrained the implementation of even legitimate fees designed to cover real service costs.

  As diversion has increased, consumer have seen their costs lower at a rate much faster than real service costs; as such, if sustainability is the goal, the responsibility of consumers in supporting services must align more closely with these costs.

- *Reflecting Real Financial Costs:* As discussed above and in other sections of this report, the service costs of waste and trash collection are not linear; rather, costs related to facilities and vehicles are high and largely fixed. Additionally, variable costs like labor and fuel are not proportionally lessened by reductions in waste generated by consumers. As a result, while conservation rates possess an obvious internal logic and a perceived fairness to consumers, it may be the case that those with larger bin sizes subsidize the service of smaller subscriptions.

Incremental pricing systems do a superior job of reflecting the actual costs of service provision by applying a flat amount of every subscription level toward these fixed costs, while still allowing for variation in pricing that reflects proportional costs such as landfill tonnage. In this sense, incremental trash pricing resembles services like utilities, where customers pay a certain amount of their monthly bill towards the upkeep of infrastructure, and pay for actual use at a proportional rate on top of that. Municipalities may wish to consider whether, having made great strides in waste diversion, long-term sustainability of services would be aided by a pricing system that better reflects these costs.

Pricing Structure Option	Implementation	Benefits	Shortcomings
Ongoing Increases to Conservation Rates	- Smaller annual increases possible within current agreements - Larger across-the board increase w/ agreement update	- Provide clearer incentives to reduce waste - "Fairness" in pricing proportionally to waste generation	- More susceptible to shifts in revenue - May require more frequent adjustment - Over time, may result in extreme costs at ends of distribution
Transition to Incremental Pricing	- Generally require updates to existing service agreements - Can involve restructuring of all rate levels or implementation of a flat fee	- May insulate revenue flow from violent changes in waste generation - "Fairness" in better reflecting the actual financial costs of providing waste and recycling services	- May provide weaker incentives to further reduce waste (Further investigation required) - Political and legal barriers to implementation, especially via flat fees

<u>Selecting an option:</u> The complex costs and benefits associated with each option make blanket prescription impossible. Fundamentally, however, it is the recommendation of this analysis that municipalities prioritizing large ongoing increases in diversion are better served by conservation rate systems, as proportional price increases are the most likely to spur downward shifts in bin size. For other municipalities, some of which are approaching 75% diversion, a move to incremental pricing is expected to stabilize revenues over time by reducing consumer volatility and more closely aligning prices to true provision costs.

Additional Countywide Data Gathering:

Aiding in this project's analysis was the extensive online database system recently developed by StopWaste.org. Containing municipality-specific, browseable data on service agreements, user fee rates, and other vital information, it should remain the cornerstone of County-level information aggregation efforts.

In designing and adjusting our models, however, it has also become clear what vital data is missing. As consumer activity – along with its effects on revenue and waste diversion – is at the center of our study's concerns, we recommend that, at minimum, the following categories be added annually to the existing database across all County municipalities (see Appendix J).

a. Subscription numbers (single-family/multi-family/commercial) for each level of service
b. Total amount of solid waste produced
c. Total amount of recyclables collected
d. Total amount of organics collected
e. Diversion rate (as currently calculated)
f. Total revenue (or expense) for each category
g. Expenditures for service providers
h. Balance

Addition of these important and useful data categories, as well as ongoing updates to the database on an annual basis, will help the County and its partners holistically track area trends in consumer movement and effect on revenue. Examination of this data will make evaluation of specific future pricing initiatives much easier.

Alternative waste pricing

Needless to say, there exist a near-infinite number of pricing strategies, small and supplemental to revolutionary and comprehensive. Therefore, in the interest of completeness, we note the following points from existing research literature that are worth considering but on which we do not to elaborate in this report.

1. Is the (generally) standard bin-based pricing the most effective?

Although there would be huge administrative costs and infrastructure costs in changing the current bin-based system, there are many different PAYT-style options already proposed and practiced inside and outside the U.S. Some of these include trash bags, trashcans, trash stickers and tags, all of which might potentially increase the flexibility of the program. Also, the rates do not necessarily have to be measured in volume, but can also be measured by the weight (in the event that weighing waste during collection is feasible). Many of these options allow for continuous pricing, which might further increase control over public incentives, and potentially reduce revenue volatility.

2. Should disposal and recycling costs be levied directly on customers?

The problem of extended producer responsibility and the discussion over the "3 R's" suggest that, ideally, producers themselves bear the costs of disposal and recycling at the initial production process. This demand-side approach also leads to questions about how we might think about incentivizing the innovation of industries and technologies to a level of zero non-recyclable byproducts.

In the process of researching options to adjust service pricing mechanisms, we encountered several novel policy solutions to efficiently price waste. Many center around the concept of the Advance Disposal Fee All (ADP). Under the ADP, consumer goods are assessed at the time of purchase a fee reflective of the cost to properly dispose of that good's packaging. The fee could be determined on a per-good basis, based on weight, or simply a levied as sales tax on certain categories of good (akin to fees increasingly being levied on plastic shopping bags). Garbage and recycling would then be collected at no cost. This pricing system ensures revenues are collected for goods that are not disposed of properly.

6. Conclusion

The fundamental goal of this analysis is to provide County and municipal decision makers a thorough and balanced framework for vetting prospective solutions.

While our econometric model currently lacks the power to make exact predictions of consumer sensitivity and revenue generation, partly as a result of data limitations, it is methodologically valid and largely unique to the body of research surrounding the economics of waste service provision. California in general, and Alameda County in particular, are at the forefront of waste diversion efforts nationally; as a result, the exact nature and magnitude of the related revenue issue is still emerging. As such, it is our hope that the model can help provide a useful approximation of revenue consequences in the near term, and that its mechanisms and design might compliment consideration of political and philosophical criteria going forward.

Short Term

In the short term, these models may inform measures that cities can use to raise revenues in the face of turbulent trends in waste diversion. These measures may be as subtle as instituting pre-approved rate increases, or as involved as using mid-contract negotiations to make introduce multi-tiered systems.

Long Term

Looking to the future, this report stresses the importance of coupling rate structure changes with ongoing data gathering by StopWaste.org and its municipal and service provider partners.

As Alameda County continues to lead the way in waste diversion, decision makers must weigh the benefits of current systems against the structural risk of systems in which revenue is so closely linked to volume of waste generation. The research supplied here provides some theoretical and research-based analysis of what these risks and benefits might be. Together with the insights gained from our econometric model, this analysis provides new ways to reconsider traditionally held beliefs concerning diversion incentives and the role of waste collection and recycling in municipal and county services.

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8. Appendices

Appendix A. Single-family rates of each jurisdiction in Alameda County

Municipality	Type	20 gallon	32 gallon	64 gallon	96 gallon	Note
Alameda	conservation	59	92.86	155	216.5	
Albany	conservation	22.13	24.77	42.82	60.87	
Berkeley	conservation	17.23	27.56	55.1	82.62	13-gal ($11.22) and 45-gal ($38.75) also available
Castro Valley	conservation	19.92	30.89	53.65	76.45	
Dublin	conservation	-	-	33.04	48.09	
Emeryville	conservation	7.13	11.81	23.61	35.41	10-gal ($4.71) also available
Fremont	incremental	25.18	25.71	28.16	41.44	
Hayward	conservation	16.45	24.03	42.87	61.67	
Livermore	conservation	11.56	19.29	42.4	70.36	
Newark	conservation	18.79	20.89	36.99	53.08	
Oakland	conservation	20.3	27.68*	60.36	93	*35-gal
Oro Loma	conservation	6.09	12.15	24.34	36.49	
Piedmont	incremental	45.48	47.71*	55.7**	65.26***	*35-gal; **65-gal; ***95-gal
Pleasanton	incremental	-	29.13*	-	34.57**	*35-gal; **90-gal
San Leandro	conservation	18.63	23.22	38.64	54.05	
Union City	conservation	22.08	27.61*	55.25	82.86	*35-gal

Source: Stopwaste.org database

Appendix B. Definition of variables in the regression model

Variable name	Definition
subscription$_i$ (β1)	Fraction of subscription accounts for each size of bin (i = 24-, 32-, 64-, and 96-gal) (0 < *subscription* < 1).
monthly (β_2)	Price ratio between the monthly rate and the next larger bin (*larger* > 1).
smaller (β_3)	Price ratio between the monthly rate and the next smaller bin (*smaller* < 1).
u_{ij} (β_4)	Dummy variable which represents a city fixed effect (0, 1).

Appendix C. Data input sheet for econometric analysis

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	City	Year	20gal			32gal			64gal			96gal			Total subscription	
2			mrate	subscription	fraction	mrate	subscription	fraction	mrate	subscription	fraction	mrate	subscription	fraction		
3																
4																
5																
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Appendix D. Method of calculation for change in revenue and disposal

(1) Create datasets

- Fraction of subscription: Calculated for each size of bin based on total accounts of subscription in each city
- Current monthly rate: Monthly rates of each bin in each city
- Relative price between larger/smaller bin: Calculated based on monthly rates for each size of bin

(2) Run regression model for each size of bin using STATA, and obtain estimated coefficients.

(3) Predict subscription fraction of each size of bin for each city under different scenarios, using estimated regression model.

(4) Based on predicted subscription fraction, calculate change in revenue and disposal

- Subscription number: subscription fraction * current total subscription number
- New monthly rate: calculated based on different scenarios
- Expected revenue: predicted subscription number * New monthly rate * 12months
- Current revenue: subscription number under status quo * Current price * 12months
- Change in revenue: expected revenue - Current revenue
- Total revenue change: sum of change in revenue for all four bins under each scenario
- Current total revenue: current revenue for all four bins
- Percentage of change: total revenue change / Current total revenue
- Expected total gallons: predicted subscription number * gallons for each size of bin * 12months
- Current total gallons: subscription number under status quo * gallons for each bin * 12months
- Change in gallons: expected total gallons - current total gallons

Percentage of change: change in gallons / current total gallons

Appendix E. Results of regression analysis for each bin size

Size of bin	β_0	β_1	β_2	β_3	Livermore	Fremont
20-gal	10.20**	0.025**	-9.48	N/A	5.46	-1.11
32-gal	-19.83	-0.0089*	3.29	17.00	3.23	0.11
64-gal	28.40	-0.0067**	-12.87	-16.92	1.14	6.82
96-gal	0.25	-0.00077**	N/A	-0.28	-0.013	-0.0069

* $p < 0.1$

** $p < 0.05$

Appendix F. Simulation sheet for econometric analysis

Simulation

Current data

City	Year	20gal monthly rate	20gal subscription	20gal fraction	32gal monthly rate	32gal subscription	32gal fraction	64gal monthly rate	64gal subscription	64gal fraction	96gal monthly rate	96gal subscription	96gal fraction	Total subscription
Fremont	2010	25.18	1058	0.02463387	25.71	13368	0.311252881	28.16	27697	0.64488114	41.44	826	0.01923211	42949

Coefficients

	mrate	smaller	larger	constant	city
20 gal	0.0247412		-9.476831	10.20446	-1.110389
32 gal	-0.0088317	16.99333	3.289724	-19.83273	0.1071518
64 gal	-0.0066581	-16.92103	-12.87164	28.40318	6.817854
96 gal	-0.0007652	-0.2805841		0.2493541	-0.0068437

Scenario		New rate	New fraction	New subscription	New revenue	Current revenue	New total revenue	Current toral revenue	Total change in revenue	% of change in revenue	New total gallons	Current total gallons	Total change in gallons	% of change in gallons
status quo	20 gal	25.18	0.04	1,750.21	528,842	528,842	14,179,766	14,179,766	0	0.00%	2,288,686	2,288,686	0	0.00%
	32 gal	25.71	0.29	12,609.52	3,890,289	3,890,289								
	64 gal	28.16	0.64	27,611.96	9,330,634	9,330,634								
	96 gal	41.44	0.02	864.71	430,001	430,001								
5% increase	20 gal	26.44	0.07	3,088.03	979,734	528,842	14,976,831	14,179,766	797,064	5.62%	2,267,534	2,288,686	-21,152	-0.92%
	32 gal	27.00	0.28	12,121.91	3,926,845	3,890,289								
	64 gal	29.57	0.63	27,209.33	9,654,307	9,330,634								
	96 gal	43.51	0.02	796.61	415,946	430,001								
10%	20 gal	27.70	0.10	4,425.86	1,471,049	528,842	15,783,283	14,179,766	1,603,517	11.30%	2,246,381	2,288,686	-42,305	-1.85%
	32 gal	28.28	0.27	11,634.31	3,948,358	3,890,289								

Appendix G. Estimated change in revenue and disposal

Scenario	Livermore		Fremont	
	% change revenue	% change gallon	% change revenue	% change gallon
Status quo	0.0%	0.0%	0.0%	0.0%
5% increase	2.29%	-2.38%	5.62%	-0.92%
10% increase	4.32%	-4.76%	11.30%	-1.83%
$0.5 flat increase	21.37%	19.91%	10.76%	9.36%
recycling fee*	8.33%	0.0%	8.33%	0.0%

*In this model, this is a new fixed fee whose amount is equal to the monthly subscription rate for each household.

Appendix H. In-County Waste Disposal Comparison 2008

Jurisdiction	Population	Residential (annual ton)	Per-capita residential (kg)	Non-Residential (annual ton)	Per-capita non-resid (kg)	Total (annual ton)	Per-capita total (kg)
Alameda	74,015	15,601	210.8	27,447	370.8	43,048	581.6
Albany	16,152	2,747	170.1	3,221	199.4	5,968	369.5
Berkeley	106,498	20,163	189.3	70,845	665.2	91,008	854.6
Castro Valley	NA	15,642	NA	11,923	NA	27,566	NA
Dublin	46,859	9,382	200.2	22,241	474.6	31,623	674.9
Emeryville	9,712	2,957	304.5	11,296	1,163.1	14,253	1,467.6
Fremont	213,124	54,929	257.7	114,615	537.8	169,544	795.5
Hayward	148,935	42,812	287.5	78,283	525.6	121,095	813.1
Livermore	83,451	35,957	430.9	66,333	794.9	102,290	1,225.7
Newark	43,793	11,486	262.3	24,659	563.1	36,145	825.4
Oakland	419,095	107,176	255.7	161,633	385.7	268,809	641.4
Oro Loma	NA	21,879	NA	12,600	NA	34,479	NA
Piedmont	11,079	2,534	228.7	1,211	109.3	3,745	338.0
Pleasanton	69,324	21,519	310.4	70,418	1,015.8	91,937	1,326.2
San Leandro	81,841	26,457	323.3	61,203	747.8	87,660	1,071.1
Union City	73,269	15,795	215.6	32,031	437.2	47,826	652.7
Unincorporated	NA	125	NA	9990	NA	10,115	NA
County Total	1,537,719	407,161	264.8	779,946	507.2	1,187,111	772.0

Source: Stopwaste.org

Population: RAND California Population estimates

Appendix I. In-County Waste Disposal Comparison 1990

Jurisdiction	Population	Residential (annual ton)	Per-capita residential (kg)	Non-Residential (annual ton)	Per-capita non-resid (kg)	Total (annual ton)	Per-capita total (kg)
Alameda	72,500	31,806	438.7	64,577	890.7	96,383	1,329.4
Albany	16,350	7,024	429.6	11,459	700.9	18,483	1,130.5
Berkeley	103,000	33,094	321.3	67,191	652.3	100,285	973.6
Castro Valley	NA	19,416	NA	36,059	NA	55,475	NA
Dublin	23,450	7,924	337.9	33,783	1,440.6	41,707	1,778.6
Emeryville	5,750	2,682	466.4	24,134	4,197.2	26,816	4,663.7
Fremont	172,700	77,037	446.1	208,287	1,206.1	285,324	1,652.1
Hayward	111,300	47,484	426.6	168,353	1,512.6	215,837	1,939.2
Livermore	56,400	23,380	414.5	57,241	1,014.9	80,621	1,429.5
Newark	37,850	15,740	415.9	42,558	1,124.4	58,298	1,540.2
Oakland	372,300	163,323	438.7	419,975	1,128.1	583,298	1,566.7
Oro Loma	NA	27,490	NA	70,688	NA	98,178	NA
Piedmont	10,600	3,889	366.9	5,597	528.0	9,486	894.9
Pleasanton	50,700	24,309	479.5	81,383	1,605.2	105,692	2,084.7
San Leandro	68,300	49,274	721.4	91,508	1,339.8	140,782	2,061.2
Union City	53,700	22,510	419.2	50,103	933.0	72,613	1,352.2
Unincorporated	NA	3,585	NA	11,352	NA	14,937	NA
County Total	1,154,900	559,967	484.9	1,444,248	1,250.5	2,004,215	1,735.4

Source: Stopwaste.org

Population: RAND California Population estimates

Appendix J. Recommended template for data collection for each city

Year	

Diversion rate	Total amount of waste	Total amount of recycles	Total amount of organics

Total revenue	Total expenditure	Balance

Service Type	Container Type	Container Volume	Container Volume Units	Collection Frequency	Monthly rate	Subscription number
Single family	Cart	20	gallons	1		
Single family	Cart	32	gallons	1		
Single family	Cart	64	gallons	1		
Single family	Cart	96	gallons	1		