90-131

DISPOSAL COST FEE STUDY

FINAL REPORT

prepared for:

California Integrated
Waste Management Board

prepared by:

TELLUS INSTITUTE
89 Broad Street
Boston, MA 02110

February 15, 1991

NOTE: Legislation (SB 63, Strickland, Chapter 21, Statutes of 2009) signed into law by Gov. Arnold Schwarzenegger eliminated the California Integrated Waste Management Board (CIWMB) and its six-member governing board effective Dec. 31, 2009.

CIWMB programs and oversight responsibilities were retained and reorganized effective Jan. 1, 2010, and merged with the beverage container recycling program previously managed by the California Department of Conservation.

The new entity is known as the Department of Resources Recycling and Recovery (CalRecycle) and is part of the California Natural Resources Agency. It is no longer part of the California Environmental Protection Agency (Cal/EPA).

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For information about this publication, contact the CalRecycle Office of Public Affairs by email at opa@calrecycle.ca.gov or call (916) 341-6300.

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CALIFORNIA INTEGRATED WASTE MANAGEMENT BOARD
1020 Ninth Street, Suite 300
Sacramento, California 95814

March 1, 1991

The Honorable Pete Wilson
Governor, State of California
First Floor, State Capitol
Sacramento, CA 95814

The Honorable Rick Rollens
Secretary of the Senate
Room 3044, State Capitol
Sacramento, CA 95814

Chief Clerk of the Assembly
Room 3196, State Capitol
Sacramento, CA 95814

Gentlemen:

Public Resources Code Section 40600 requires the California Integrated Waste Management Board (CIWMB or Board) to submit to the Legislature and the Governor a disposal cost fee report and model legislation for introduction and sponsorship by the Board during the 1991-92 Regular Session for the most effective means of enacting and implementing a disposal cost fee system on goods sold in California.

In compliance with this section, the Board submits the attached Disposal Cost Fee Study Final Report prepared by the Tellus Institute of Boston, Massachusetts under contract to the CIWMB. This report provides the most comprehensive and detailed analysis to date on the subject of a disposal cost fee. However, the CIWMB wishes to make clear that the methodology and data contained in the report represent the work product of the Tellus Institute and not that of the CIWMB.

Regarding the Tellus Report key findings related to the amount of revenues to be raised by a Disposal Cost Fee and how those revenues should be spent, the Board wishes to make clear at the outset its views on these issues.

First, the Board does not in any way advocate or support revenues from the fee at the level of $4 or $5 billion annually as suggested by the Tellus Report. The Board envisions the DCF, if successful, as a method to ultimately reduce the costs of waste management in the State.

Second, the funds collected from a DCF would pay for only those programs or incentives directly related to waste reduction or recycling programs, including offset of the tipping fee surcharge established pursuant to Section 48000. The DCF must be structured so that the fee is not deemed a tax under the relevant provisions of the State Constitution.

With respect to the legislative requirement that the CIWMB submit model legislation in the 1991-92 legislative session, it is the CIWMB's position that due to (1) the complexities of the issue, (2) the short time frame provided to draft such legislation, and (3) the Board's disagreement with some of the key findings of the Tellus Report, the CIWMB respectfully submits the following key principles for inclusion in any disposal cost fee legislation. These principles provide the basis for the development of model legislation which could be sponsored by the CIWMB during this regular legislative session:

1) **POINT OF FEE ASSESSMENT**

- The Board supports levying the fee at the point of first sale in California.
- However, the Board acknowledges that there are tremendous complexities and technical considerations that need to be examined and reviewed in developing this method of collection for the disposal cost fee.
- The Board also has attached a letter from the staff at the Board of Equalization as an appendix to these principles which addresses key issues and complexities associated with administering and collecting these fees. This appendix is attached without endorsement by the CIWMB, but rather as additional information for use in the legislative process.

2) **GOALS OF THE FEE RELEVANT TO THE INTEGRATED WASTE MANAGEMENT HIERARCHY**

- The Board rejects the conclusion of the Tellus Study that source reduction and recycling are mutually exclusive goals of a DCF.

- The Board strongly supports a fee that would encourage both source reduction and recycling, consistent with the waste management hierarchy of Section 40051.
- The fee should seek to influence manufacturer and consumer behavior. However, the CIWMB recognizes that placing the fee at the first point of sale in California has the effect of impacting manufacturer behavior over consumer behavior.
- The Board concurs with Tellus that source reduction should be the number one priority of a DCF.

3) **GOODS AND/OR MATERIALS TO RECEIVE THE FEE**

- The Tellus Report recommends that the DCF should be levied across-the-board on virtually all products in the state; however, the CIWMB believes not all goods or materials should receive the DCF at the outset.
- Rather, the CIWMB recommends that at the outset of this program, the scope of goods and materials covered by the DCF be phased in.
- Additionally, a pilot program or sunset provision may need to be considered in order to assess the effectiveness of the DCF before expanding it to include other goods and materials.
- Goods and materials that could be included at the outset should be those which have the most deleterious affect on landfills or the waste stream.
- The CIWMB suggests that in determining what goods and materials receive the fee, careful consideration be given to avoid unintended incentives that would result in manufacturers changing materials in order to avoid a DCF, and therefore avoid source reduction and/or recycling.

4) **CALCULATION AND ADMINISTRATION OF THE FEE**

- The Tellus Report recommends that the DCF be calculated to meet the total conventional and environmental costs of disposal.

- The CIWMB envisions that the DCF would address a share of the current conventional costs of waste disposal as well as some of the long-term environmental costs.
- An alternative method the Legislature may wish to examine is a fee modeled after the processing fee in the Beverage Container Recycling and Litter Reduction Act.

5) **EXPENDITURE OF FEE REVENUES RAISED**

- The Board believes the DCF revenues should be targeted at programs that will contribute to greater source reduction and recycling consistent with the waste management hierarchy established pursuant to Section 40051.
- In keeping with this goal, the CIWMB supports DCF revenues be utilized for all of the following purposes:
    - Education programs to inform manufacturers and the public about strategies related to source reduction and recycling;
    - Market incentives to encourage source reduction and the use of recycled materials;
    - An offset of the tipping fee surcharge currently collected by waste haulers and local governments to fund the state integrated waste management program;
    - Local planning costs incurred due to the initiation of the integrated waste management program; and
    - Costs associated with administration of the DCF program.

The CIWMB has communicated with the author of Section 40600, Assemblyman Byron Sher. He has expressed his interest in the CIWMB's submission of its key principles in lieu of model legislation so that the CIWMB, the author, and other interested legislators can together develop specific legislation.

Therefore, the CIWMB respectfully submits the attached Report and transmits its key principles for full disposal cost fee legislation in compliance with Public Resources Code Section 40600, and looks forward to continued participation in the legislative process.

Sincerely,

Michael R. Frost
Chairman

Attachment

cc: Willie L. Brown
David Roberti
Byron Sher
James M. Strock

STATE OF CALIFORNIA

STATE BOARD OF EQUALIZATION
1020 N STREET, SACRAMENTO, CALIFORNIA
(P.O. BOX 942879, SACRAMENTO, CALIFORNIA 94279-0001)

(916) 322-4020

February 19, 1991

Mr. George Larson
Chief Executive Officer
California Integrated Waste
Management Board
1020 9th Street, Suite 300
Sacramento, CA 95814

Dear Mr. Larson:

I am writing in response to your request for comments regarding the draft final report of the disposal cost fee study prepared by Tellus Institute. The recommended system is to be a fee assessed at the point of first sale. Quoting from Tellus' comments on page 8-2 of their January 16th final draft, they specified that they "prefer a fee at the point of first sale in part for its administrative simplicity." They also state in the same paragraph that "many small retailers cannot be expected to report such data" as would be required under this system. They also state that this system must be a weight-based fee.

My comments shall be limited to responding to the recommendations made in the report. I am not offering an opinion as to whether an advanced disposal fee system is the best way to go. I shall point out what I believe to be some of the shortcomings in the proposed system, and raise some questions, by way of several scenarios, which I believe have not been adequately addressed in the report.

Registered Feepayers

If the administrative simplicity referred to by Tellus is the result of their assumption that the taxpayer base would be substantially fewer than the number of taxpayers registered under the Board's sales tax program, this assumption is false. The taxpayer base would be at least as large as our current Sales Tax taxpayer base because virtually everyone registered under sales tax would also have to be registered under the disposal cost fee program. In addition, those companies who do not have sales of tangible personal property subject to sales tax, but would be subject to this fee, would also have to register under the program. Some examples of these feepayers are: sellers of produce items that come in packaging material; publishers of newspapers not currently registered under the sales tax program; and companies who publish magazines. In general, none of these types of businesses are currently required to be registered under the sales tax program.

There is also another group of potential feepayers which may not be included in our current sales tax base. This is due to the fact that Tellus defines "sale" to include gift. The implication is that this is intended to include companies that are primarily engaged in selling services or providing services free of charge. Businesses distributing catalogs free of charge, and telephone companies supplying directories are two examples that come to mind. These industries could account for a sizeable volume of paper product. If this type of gift is intended to be included within the definition of sale, it would greatly increase the taxpayer base having to pay this fee.

Feepayer Exemptions

While Tellus is recommending that those companies with a total sales volume of less than $25,000 would be exempt from the fee, it is doubtful that the elimination of these small companies would even begin to approach the number of companies who would be subject to the fee who are not currently in our Sales Tax taxpayer base. It also does not cover the problem where a large retailer with a very large volume of sales, who only imports a small volume from outside the state, would still have to report even though the tax consequences would not be very great.

Changing the system to exempt people based on the volume of tax that they pay tends to complicate the system more by removing some people from paying the tax, thereby having an unequal treatment for the same type of products sold by two different companies. This would also encourage the purchase of items outside the state. In order to maintain the integrity of the fee program, it would be necessary to register all potential feepayers, regardless of whether they would owe a fee.

Basis for Fee

Let me now turn to some of the specifics of the recommended fee system. While total detail is not given, it is clear that Tellus is recommending a system that would have, in their words, a thousand or fewer separate fee categories for manufactured products imported from out-of-state. The thousand categories would be in addition to the raw material categories used for in-state manufacturing. It is my understanding that each category would have a separate fee rate. This would mean that any return required to be filed under this system would have to include all of the thousand product codes and fee categories so that the same return could be mailed to all feepayers. A decision would have to be made whether to have one return for all feepayers, with a thousand categories, or different returns for different types of companies. This greatly increases the administrative problems as well as the associated costs.

Potential Problems with This Approach

To try to understand how this system would apply to given situations, let me outline at least three different scenarios where we can explore the complications of implementing this type of system.

The first scenario concerns a food product. The fee does not apply to the product itself. The product is contained in a metal can with a paper label. The product is shipped in a cardboard container, and the metal container also has a plastic lid used for resealing the can after it is opened. Examples of this type of product are cans of coffee or shortening. As long as the company purchased the can, the plastic lid, the paper label and the cardboard container from manufacturers within California, this company would have no liability to report on its return. However, they would have paid the fee when purchasing the materials from their supplier. If they ship some of the product outside of the state they would now have items which had already been taxed or fee paid, and which are now being handled in a way that would be exempt from the fee. They would then have to claim a credit on their return, or have to file a claim for a refund to be reimbursed for the fee that had already been paid to the state.

The second scenario concerns the same product, however the company purchased most, but not all, of the materials from in-state firms. For example, the plastic lids are purchased from outside of the state. The company would now have to report the weight of the lids and have a liability for that part of the item. They would then have to file a claim for refund, or take a credit against the amount that was owed on the lid, for the other items on which tax had already been paid and handled in an exempt manner.

If we assume that they purchased all of the items from outside of the state they would then have to keep track of the weight of the can, the weight of the plastic lid, the weight of the paper labels and the weight of the cardboard containers separately, and would have four different categories in which to pay a fee, claiming an exemption for that portion that went out of state.

If we follow this product down the distribution chain, we encounter some other problems. Now that the fee has been fully paid on all of the components of the product, the product is sold and resold to a series of distributors, wholesalers, jobbers and retailers, each of whom sells some of that product out of the state. Each person who handles that product would have to keep track of the weight by the four different items included in the product to file a claim for refund based on the rate applied to each one of those items. Alternately, they would have to use an average figure that would even complicate the case more, since some of the product could be in different sized containers and a different ratio would apply to each container.

What may be more confusing is the question of who is entitled to claim the refund of the fee. As an example, under Sales Tax Law, the jobber would not be able to claim the refund since he did not pay the fee to the state. The jobber would have to seek a refund from the distributor, the distributor would have to go to the manufacturer, and so on up the line back to the person who paid the fee to the state. That person would have to claim the refund, therefore, record keeping would have to be detailed enough so that the person responsible for the fee would be able to determine when the product is ultimately handled in an exempt manner.

If we move this all the way down to the retail level and make the assumption that some of this type of product is purchased from manufacturers within the state of California, and some is purchased directly from suppliers outside of the state of California, you can begin to see the problem that the retailer is going to have in keeping track of the various products. For example, a store like Raley's Drug and Super Market carries at least 5,000 different products. They would have to determine whether each product was purchased outside of the state, and for each out-of-state purchase, segregate the weight of the different items in each product into the thousand different weight categories. They would undoubtedly have items that would fall into most of the rate categories. It is incomprehensible to imagine the problem the retailer is going to have in segregating these, as well as the audit problem we will encounter when we verify the retailer's reporting.

I have purposely not gone into a product containing multiple products, but you can envision the problem inherent in the example cited by Tellus of the automobile. The point being that we have an extremely complicated, intricate system that would need to be implemented.

Costs of Implementing the Proposed System

Let's now turn to the possible cost of such a system. There are some statements in Tellus' analysis that I agree with. One being "that administrative costs increase as the complexity of the taxing formula increases." This is a quote directly from page 8-5 of their report. This is definitely true. It is not only true for the administrative costs of the fee collecting agency, it is also true for the feepayer's administrative costs of keeping track of such a system. It is also true that estimating the costs of such a system is impossible until various issues have been decided. Therefore we are unable to give any exact costs because, as Tellus states, you need to have a precise list of materials that are subject to the fee; the exemptions; and the various details of how these fees will apply.

Allow me to make some comments in regards to the costing projected by Tellus. They have obtained the basic cost data from our approved 1990-91 budget, representing the costs to administer the Sales and Use Tax Program. It is broken down into four components totalling approximately $156,000,000. Please keep in mind the sales tax program is a program with one tax rate that applies to every product. A relatively simple program. There are, however, various exemptions incorporated in the law which complicate that system, thereby increasing the cost.

In applying these costs to the three different scenarios used by Tellus, there were certain assumptions made. When costing for the point of last sale, they have assumed that the number of permits would be the same as for the sales tax. I agree that there would be <u>at least</u> that number. Tellus assumes under scenarios A and B, for costing at point of first sale, that the number of taxpayers would be either 500,000 or 100,000, respectively. This is not consistent with my earlier comments, since I believe there would be at least as many feepayers under either of these scenarios as there are under the sales tax program, despite the cost estimates made by Tellus.

Since many of the feepayers are currently registered under the sales tax program, it is reasonable to assume that the cost of registration could be greatly reduced. However, this system would have to pay its proportionate share of the ongoing costs of registering under the sales tax program. It would be false to assume that the entire cost burden should be borne by the sales tax with only the incremental increase borne by this fee. Therefore, the cost of registration should somehow be divided between sales tax and this new fee system. It would need to be scaled upwards from the $5.5 million that is estimated by Tellus. The exact figure would depend on how the registration cost is apportioned between the two systems.

Assuming that the $5.5 million estimated by Tellus is the additional cost of registering feepayers not currently registered under the sales tax program, we should add to that the proportionate cost of maintaining the current feepayers on an ongoing basis. We need to keep in mind that the $25,000,000 shown under sales tax is not initial registration, rather, it is the cost of ongoing, registration maintenance under the sales tax program.

Next we turn to processing costs. Tellus states on page 8-6 that the "processing costs were assumed to remain the same as for the sales tax, based on the argument that every return from the sales tax would also have to be processed on the disposal fee." On the one hand this is a reasonable assumption, and yet they use $20,000,000 for processing costs under the fee system when the processing costs under the sales tax program are $38,000,000. They also make the same statements in regards to audits, however, they only use $14,000,000 instead of the $71,000,000 shown under the sales tax program. Both of these tend to greatly understate the costs that would be incurred to administer this type of system.

I can find no discussion supporting Tellus' arrival at the collection portion of the costs. They have used a figure that is roughly 20% of the collection cost under the sales tax program. Whether this is based on direct revenue figures or another method is unclear. It is also not known if this would be a reasonable amount to use. My comments regarding the adequacy of the estimated costs of the preceding program elements also apply to these costs.

Considering that we are discussing the administering of a fee program with one thousand fee rates, and the cost estimates are based on the sales tax program, which has a single rate, the implication is that this program's ongoing administrative costs could far exceed the costs of the sales tax program. This conclusion is supported by Tellus' original statement that costs increase as the complexity of the taxing formula increases.

As for the start up cost estimate, I can find no basis to support the $4.35 million cost. A detailed analysis would have to be made once the size of the database necessary to maintain the program has been determined. It is reasonable to assume that a fee system somewhere in the neighborhood of a thousand different rates would require such a large data base in a computer system, that a whole new computer system would have to be obtained. I have no idea whether $4 million would be sufficient to cover such an administrative cost.

As can be seen from the detail currently available, it is next to impossible to estimate what the administrative costs would be. My best estimate is that they would be at least $100 million, up to somewhere around $200 million. I would be inclined to project that they would be on the higher side simply due to the fact that the proposed system is monumentally more complicated than the sales tax program. Therefore, it is reasonable to assume that most costs would be substantially larger than the current sales tax system.

While to this point I have limited my comments to the content of the report, I would like to offer my opinion that, if the Integrated Waste Management Board adopts this report's recommendation to administer this fee as a front-end fee, the point of first sale option is the preferable method of collection. The advantage to this option is that for the products which are manufactured in the state, the majority of the fees will be collected from a smaller number of feepayers.

I would also like to point out that the Board of Equalization does have some experience in collecting a front-end fee. We currently collect the Tobacco Products Tax which was instituted by Proposition 99. This tax is based on the wholesale value at the time of first sale in California. The tax is collected from every distributor and wholesaler in the state, as well as all retailers who purchase their products directly from sources outside the state.

Please contact me if you have any further questions.

Sincerely,

E. V. Anderson
Administrator, Excise Taxes

EVA:LEF:lef

cc: Mr. Wesley Chesbro
Member, California Integrated Waste Management Board

Mr. Sam Egigian
Member, California Integrated Waste Management Board

Mr. Michael Frost
Member, California Integrated Waste Management Board

Mr. Jesse R. Huff
Member, California Integrated Waste Management Board

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Mr. Lou Feletto

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TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

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EXECUTIVE SUMMARY

CHAPTER 1 - WHY A DISPOSAL FEE?

California throws out a mountain of trash: roughly 50 million tons annually, and growing larger every year. Yet as the quantities of solid waste increase, the landfills that receive most of this waste are fast filling up. Owing to urbanization, rising land values, and heightened environmental concerns, it has become increasingly difficult to site new landfills.

The collision between rising waste volumes and diminishing landfill space is all too easy to foresee. Unless something new can be done, many areas of the state will run out of disposal capacity over the next few years -- resulting in skyrocketing costs for long-distance waste transport and disposal.

Bold new initiatives are required to handle California's waste stream in the coming era of landfill scarcity. In 1989 the legislature passed a landmark bill, Assembly Bill 939, which completely revised the state's procedures for the management of solid waste. This study presents one of the initiatives called for in A.B. 939, a proposal for a disposal cost fee on goods sold in California. The goal of the disposal cost fee, and of other solid waste management programs, is to increase the reliance on reduction, reuse, and recycling, and to decrease the amount of waste handled in landfills or transformation facilities.

The disposal cost fee is part of the solution to the waste management problem in two different ways. First, it provides a market incentive for source reduction. The fee sends a price signal to consumers and producers, automatically telling them the cost of disposal of each good on the market. Second, the fee generates substantial revenues, based on the real costs of solid waste disposal. Currently billions of dollars are being paid for solid waste services, but those costs are dispersed and hidden in the budgets of households, businesses, and municipalities throughout California. By collecting a significant fraction of those costs in advance, the disposal cost fee makes it possible for the state to finance new programmatic initiatives in source reduction, recycling, and composting.

Why a Disposal Fee?

Solid waste management is not free. It imposes a variety of costs, including both the direct monetary costs of collection and disposal and the indirect health and environmental effects of disposal activities. These costs are involuntary and, for the individual, uncontrollable. None of us can refuse to pay for waste disposal, whether we pay directly or through our local government. Nor can we escape the indirect costs of water supplies polluted by landfill leachate, or air polluted by landfill gases, and garbage trucks.

Economic theory and common sense agree that it is only fair to ensure that the "polluter pays." Those responsible for solid waste management costs, namely the consumers and producers who generate solid waste by their consumption choices, should pay the costs their activities impose on society. Moreover, if consumers must pay the cost of disposal when they buy waste-generating commodities, they will have an incentive to change their consumption patterns. This change will in turn affect the nature of the goods produced and the materials used in them. Ultimately, this will lead to the use of goods that have a lower disposal cost, including environmental impacts.

The generality of the fee is itself a source of fairness and impartiality, in at least two distinct ways. First, because it addresses virtually all materials sold in California, it does not single out any one product as "the" problem. It is not solely a newspaper fee, or a packaging fee, or a plastics fee; it applies to all these, and to many more products, in proportion to their waste disposal costs.

Second, it is a disposal cost fee, not a recycling fee. It is based on the full cost of waste management, including the cost of recycling for those items that are recycled. In many cases recycling is a low-cost option, especially when environmental costs are considered; however, if exotic materials are being recycled at very high cost, then the fee should reflect these high costs. In such cases source reduction may be important to reduce the volume of material being recycled or landfilled.

The long-term goal is not simply to promote recycling, though recycling is usually desirable. The goal is to minimize the total monetary and environmental costs of the state's waste management system.

CHAPTER 2 - RELEVANT EXISTING AND PROPOSED LEGISLATION ON SOLID WASTE DISPOSAL FEES

Many states have adopted or proposed legislation concerning disposal fees. None provide exactly appropriate models for California's disposal fee, but many provide important background to the current study.

Survey of legislation

Three states have imposed fees on **motor vehicle batteries**. Two states charge $5 per new battery, which is rebated if an old battery is returned for recycling; another charges $1 per battery. At least 10 states, including California, have set fees on **tires**, ranging from 25 cents in California to $2 per tire, or in one state, 1% of the purchase price.

Rhode Island has placed fees on several categories of **hazardous waste**, including tires, motor vehicle oil, antifreeze, and organic solvents. Connecticut has banned the use of several toxic metals in packaging, unless there is no available substitute.

At least three states have considered fees on **disposable diapers**, ranging from 1 cent to 10 cents per diaper; none have yet been adopted.

Maine has an advance disposal fee of $5 on new major **appliances** (clothes dryers and washers, dishwashers, refrigerators, etc.), major **furniture, bathtubs,** and **mattresses.**

"Bottle bills" providing for deposits and refunds on beverage containers are in effect in 10 states including California. Deposits range from two to five cents, generally applied only to soda and beer; Maine's law was extended to cover milk, wine, juice and bottled water containers beginning in 1991. Distributors receive a handling fee, usually one to three cents per container; funds remaining from unclaimed deposits, less handling fees, usually revert to the state government.

An alternative approach to beverage container fees, used in several other states, is a **beverage litter fee**. Such fees are set at relatively low amounts per container, and are not tied to deposit/refund mechanisms; they are primarily sources of revenue for litter control efforts.

Broad-based packaging fees have been discussed in a number of states, but to date adopted only in Florida. Although already passed, the Florida legislation does not take effect until 1992. At that time, a one cent per container fee will be placed on containers made from plastic, aluminum, other metals, or plastic-coated paper; materials which have achieved 50% recycling will be exempt. In 1995 the fee will rise to two cents per container.

Florida also has a ten cent per ton disposal fee on **newsprint**, scheduled to rise to 50 cents per ton unless 50% of the newsprint used in the state is made from recycled fiber by October 1992.

Landfill surcharges are used in a number of states, including California, with fees generally ranging from $0.50 to $2.50 per ton. **"Variable can rates"** -- per-can or per-bag charges for waste collection and disposal -- are used in Seattle and several smaller communities.

At least five states have **litter control taxes**, often expressed as a (very low) percentage of sales. Like the beverage litter fees, these are designed to raise revenues for litter control, not to modify consumer or producer behavior.

In a different approach to environmentally targeted tax policy, Rhode Island exempts biodegradable and returnable products from state sales tax.

Analysis of legislation

Most existing legislation targets specific products, setting per-unit fees on sales. The exceptions are Florida's fee on several packaging categories and on newsprint, the low-rate litter control taxes, and the landfill surcharges and variable can rates.

Many existing fees are so low that they could not have significant effect on consumer or producer behavior; they function solely as revenue sources. An exception are the deposit/refund systems for beverage containers, and for motor vehicle batteries. Such systems can obtain substantial recovery rates, although the administrative expense, as well, is substantial.

Almost all existing fees are levied on a per-item basis. It is clear that this approach simplifies administration of a single-product fee, but it does not readily generalize to an across-the-board fee on many disparate products.

Hazardous wastes are in almost all cases regulated by bans and restrictions. Rhode Island is apparently unique in placing fees on several categories of household hazardous materials, assessed on a volume basis (fees per quart, per gallon, etc.)

The fee level is important in two ways, both in determining the incentive for source reduction or substitution of environmentally preferable materials, and in generating revenues for public spending on waste management. Of the two effects, the incentive effect is more difficult to measure. In the best-researched case, bottle bills do not create much reduction in use of containers, or shift to reusable containers, but they do cause very high rates of return to obtain the refunds.

Fees imposed at landfills and other disposal facilities often reflect only a modest increase in total disposal costs per ton, and are sources of revenue rather than effective incentives for behavioral change.

Existing fees vary widely in the use of funds. In the deposit/refund systems, anything remaining after paying administrative costs may go to the state's general fund (Massachusetts, New York), to fund recycling programs (California, Maine's battery law), or in one case for alcoholism treatment (Iowa). Many other fees on specific products are reserved for waste disposal, recycling, or source reduction programs; in some cases the funds are distributed directly to localities.

Litter taxes are almost always reserved for litter prevention and cleanup. Landfill fees, and other solid waste facility fees, are generally reserved for disposal facility costs such as landfill remediation and closure, or for recycling initiatives.

In terms of point of collection, almost all specific-product fees reviewed here are collected at the retail level. Some proposed disposal diaper fees specify imposition at the point of "first sale" within the state. Beverage container deposits are usually collected by the distributor or wholesaler. Landfill fees are collected at landfills, while variable can rates are collected by municipalities or haulers at the point of collection. Litter taxes are in some cases collected from manufacturers, distributors, wholesalers, and retailers, based on value of sales at each level; thus despite very low rates at each stage, some products could be taxed three or four times.

The existing and proposed legislation discussed here is listed in summary form in Table 2.1 at the end of Chapter 2.

CHAPTER 3 - CALIFORNIA WASTE STREAM ANALYSIS

The goal of this report is the development of an appropriate disposal fee for California. This requires a quantitative characterization of the state's municipal solid waste stream, including estimates of total waste generation, quantities and composition of the residential and commercial portions of the waste stream, and levels of recycling, incineration, and landfilling of wastes.

Since comprehensive statewide data was generally not available, we developed our own estimates. A survey of all California counties, and of data sources available in Sacramento, produced usable information from 23 counties and from the city of Los Angeles. This data provided the basis for our detailed waste stream estimates.

Some counties did not report separately on commercial waste quantities or composition; in those cases we used Census Bureau data on county business patterns, and typical commercial waste generation factors (per unit of economic activity) from studies in other parts of the country.

We estimate the state recycling rate to be just under 11% of the solid waste stream, including the beverage containers handled under A.B. 2020. This is based on information from counties which provided detailed reports on their recycling tonnages. Other counties which did not provide detailed information often reported higher overall recycling rates, as do a number of industries. Thus further investigation of actual recycling rates is appropriate, as better data becomes available. However, we believe our 11% estimate reflects the best available information on local recycling throughout California, as of the end of 1990.

The total waste stream is roughly 50 million tons annually, of which 27.5 million is residential and 22.5 million is commercial waste. Over half of this waste is generated in Los Angeles, Orange, and San Diego Counties; one third of the statewide total comes from Los Angeles County alone.

The state's three operating waste-to-energy facilities have the capacity to burn just under 2% of the total waste stream. Thus in all, we estimate that 87% of the state's waste is landfilled, 11% is recycled, and 2% is burned.

In 1989, household hazardous wastes (HHW) were collected in 19 counties and 21 cities; about 2.5% of the population participated in these collection programs. This need not imply that 2.5% of the state's total quantity of HHW was collected; little information is available on the subject of HHW diversion rates. It seems clear that the great majority of California HHW ends up mixed with other solid waste in the state's landfills. Paint, household and motor vehicle batteries, and used motor oil make up the majority of collected HHW. Over half of the HHW collected by counties, and over one third of the HHW collected by cities, is recycled.

CHAPTER 4 - DISPOSAL PATHS OF MATERIALS

In this chapter we analyze further the waste stream data developed in Chapter 3. The result of this analysis is the calculation of the "disposal path" -- the percentage recycled, burned, and buried -- for each material in the waste stream. Table 4.4, presented in the text and also reproduced here, shows these disposal paths. In Table 4.4, the percentages on each row sum to 100%.

TABLE 4.4 DISPOSAL PATHS OF EACH WASTE STREAM MATERIAL

Materials	% Recycled	% Landfilled	% Incinerated
Paper:			
Newspaper	26.25%	71.89%	1.86%
Cardboard	24.00%	74.79%	1.22%
Mixed Paper	11.25%	85.39%	3.36%
High Grade	26.97%	72.67%	0.36%
Other	0.00%	99.71%	0.29%
Plastics:			
HDPE	0.26%	98.15%	1.59%
PET	0.31%	98.95%	0.75%
Glass	2.02%	96.22%	1.76%
Metals:			
Aluminum	20.05%	78.76%	1.20%
Ferrous	37.98%	60.44%	1.58%
Organics:			
Yard Waste	2.80%	94.15%	3.05%
Wood Waste	1.03%	96.91%	2.06%
Food Waste	2.60%	95.48%	1.92%
Tires	6.09%	93.52%	0.40%
Textiles	4.20%	93.27%	2.54%
Non-Compost	22.33%	74.99%	2.68%
Other Wastes:	13.73%	86.27%	0.09%

Alternatively, the same underlying data can be used to calculate the percentage distribution of the waste stream entering each type of facility. These calculations are presented in Table 4.5, which appears in the text and is reproduced in this summary. In Table 4.5, the percentages in each column sum to 100%.

TABLE 4.5 RANKING OF MATERIALS IN LANDFILLS AND WASTE-TO-ENERGY FACILITIES

Material	% of total waste in landfills	% of total waste recycled	% of total waste WTE
Paper:			
Cardboard	7.02%	17.91%	5.34%
Mixed Paper	7.29%	7.63%	13.39%
Newspaper	5.30%	15.37%	6.40%
High Grade	1.10%	3.23%	0.26%
Other	13.40%	0.00%	1.79%
Plastics:			
HDPE	0.79%	0.02%	0.60%
PET	0.28%	0.05%	0.10%
Film	2.68%	0.00%	3.71%
Other	4.01%	0.02%	2.75%
Glass:			
Recyclable	5.58%	5.03%	4.77%
Non-recyclable	1.13%	0.00%	0.87%
Metals:			
Aluminum	0.32%	2.45%	0.23%
Other metals	4.04%	20.14%	4.92%
Yard Waste	16.97%	4.00%	25.71%
Organics:			
Food Waste	8.29%	1.79%	7.79%
Organic Non-Compostables	2.93%	6.93%	4.90%
Textile	2.31%	0.82%	2.93%
Tires	1.72%	0.89%	0.34%
Wood Waste	4.50%	0.38%	4.48%
Other Waste:			
HHW	0.88%	1.11%	0.26%
Other Waste(inert solids)	8.75%	11.06%	0.00%
Other Special Waste(other inorganics)	0.73%	1.15%	8.47%
TOTAL	100.00%	100.00%	100.00%

Source: Table 3.8

CHAPTER 5 - METHODOLOGY FOR IDENTIFYING GOODS AND MATERIALS WITH POTENTIAL FOR ENVIRONMENTAL DEGRADATION

In this chapter we measure the air emissions and water effluent from solid waste management activities, and then allocate these pollutants to the goods and materials in the waste stream. This involves estimation of total pollutant loadings from lined and unlined landfills, incinerators, and collection vehicles; recycling and composting facilities are briefly discussed as well. The final product of the chapter is a set of "pollutant vectors" for each material in the waste stream, showing the loadings per ton of the material handled in landfills, incinerators, and collection vehicles.

Landfills

Landfills emit leachate (polluted water) and landfill gas. These emissions contain a wide range of organic and inorganic pollutants. Landfill chemistry is complex, and still incompletely understood, so it is often difficult to allocate specific organic pollutants to individual materials in the waste stream. Where specific information is lacking, we have allocated pollutants in proportion to the quantities of waste in the landfill.

We examined two generic types of landfills: old landfills with no liners, and no leachate or gas collection systems; and new landfills, controlled with liners, leachate collection, and gas collection systems. Lacking actual California data on leachate generation, we used a US EPA computer model to estimate leachate quantities that would be produced under California conditions. Roughly two-thirds of landfilling was assumed to happen under southern California's extremely dry conditions, and the remaining one-third under the somewhat less dry conditions of northern California. (Because northern California conditions would lead to better liners on new landfills, the amount of leachate escaping from a new landfill is actually greater in southern California. However, leachate levels are in general low compared to those seen in wetter parts of the country.) On a statewide average basis, leachate generation is estimated at roughly 3 gallons per ton of waste.

Since no data is available on the chemical composition of leachate from California landfills, we used national data on the concentration of pollutants per gallon. These figures were multiplied by the gallons of leachate per ton of waste. The result is the total leachate loadings per ton of waste in the landfill, shown in Table 5.7 for old, uncontrolled landfills, and in Table 5.8 for new, controlled landfills. (Earlier tables present the preliminary steps leading up to this result.)

We then allocated the pollutants per ton of waste to the specific materials in the waste stream. This allocation was based on the chemical composition ("ultimate analysis"), reactivity of material in a landfill, and quantity of the material in the waste stream; details of the allocation procedure are presented in the text and footnotes. Our calculation of leachate pollutants per ton of each specific waste material is presented in Tables 5.11 and 5.13, for uncontrolled and controlled landfills, respectively.

A similar procedure was followed for analysis of landfill gas emissions. In this case, the California Air Resources Board has analyzed and reported the concentrations in landfill gas of methane and ten potentially hazardous organic pollutants found in trace quantities. For concentrations of other landfill gas pollutants, US EPA data were used.

To estimate total quantity of landfill gas per ton of waste, we used median reported California landfill gas generation rates, and assumed gas collection systems are 60% efficient (the rate assumed by the Air Resources Board). Multiplying gas quantity per ton of waste by the pollutant concentrations, we obtained gas pollutant loadings per ton of waste. These results are shown in Table 5.19 for uncontrolled landfills, and Table 5.20 for a landfill which collects the gas and uses it to run a gas turbine.

The next step is to allocate the pollutant loadings to the individual materials in the waste stream. In this case the biodegradability, and degradable carbon content, of the individual materials is a critical factor to consider; details of the allocation procedure are presented in the text and footnotes. Our results are shown in Tables 5.24 (uncontrolled) and 5.26 (controlled), presenting landfill gas pollutant loadings per ton of each individual material in the waste stream.

Incinerators

California's three operating solid waste incinerators burn about 2% of the state's waste stream. All three are mass-burn waterwall furnaces. Emission controls at each of the three facilities include a spray dryer, fabric filter, and Thermal $DeNO_x$. Thus all three would be expected to produce similar pollutant loadings.

Pollutant loading data is available for test burns at the three incinerators, although one facility's data is incomplete. We used an average of the available test data, as shown in Table 5.30, for total air pollutant loadings per ton of waste.

Allocation of incinerator air pollutant loadings to individual waste materials is a complex process. For pollutants contained in the incoming wastes, such as heavy metals, we relied on the chemical composition of the waste materials. For pollutants whose direct precursors are contained in the wastes, such as volatile organics, dioxins, and others, we allocated pollutants to those wastes containing the precursors. For pollutants formed in the process of combustion, such as carbon monoxide, particulates, and nitrogen oxides, we allocated them evenly across all waste materials. Details of the method for many different pollutants are presented in the text; Table 5.34 presents the resulting pollutant loadings per ton of individual materials incinerated.

Incinerator ash, another important form of pollution, is codisposed jointly with ordinary solid waste in California landfills. Since ash accounts for such a small fraction of the state's landfilling, it is impossible to separate its effects from those of landfilling in general. Thus no calculations are presented for incinerator ash impacts.

Composting and Recycling Facilities

All facility emissions should be considered in examining the environmental degradation associated with waste management. If mixed waste composting facilities become important in the future, their emissions will need to be analyzed; substantial carbon dioxide emissions, smaller quantities of organic pollutants, and perhaps traces of heavy metals from contaminants, can be expected. The precise levels depend on the technology employed. (As discussed in Chapter 7, yard waste and food waste will be exempt from the disposal cost fee; thus composting facilities restricted to these waste types need not be considered.)

Environmental impacts of recycling facilities may include air emissions of heavy machinery, and particulates from processing operations such as glass crushing. Most emissions are local in nature, perhaps presenting in-plant (occupational health) issues but causing minimal external effects.

One of the few sources of quantitative data on recycling facility air emissions is a report by the Center for the Biology of Natural Systems (CBNS) on a two-day test at a small facility in Connecticut. The reported air emissions, shown in Tables 5.37 and 5.38, apparently result from sorting and dumping of wastes, collection truck and front-end loader emissions, machinery operations, and contaminants in containers brought in with recyclables. Since these data are very low, and are not strictly comparable to other emissions data used in this report, we have not attempted to estimate emissions from California recycling facilities.

Waste Collection

We used US EPA and California Air Resources Board data for recycling and garbage truck air emissions. In all, eight air pollutants were identified in these sources, and are reported in Table 5.39. Emissions factors are reported in pounds of pollutants emitted per ton-mile; we converted them to volume-based measures (pollutants per cubic yard of waste per mile), based on standard recycling and garbage truck capacities. The volume-based measure is more appropriate for assessing collection impacts because trucks fill up by volume, not by weight.

To allocate these pollutants to individual waste materials, we estimated in-truck volumes of each material (different for recycling and garbage trucks because garbage trucks compact the wastes), and distance travelled to and from facilities. Adjustments were made for the large amounts of engine idling time spent while collecting materials. The calculations depend on a number of assumptions about collection efficiency, waste stream quantities, and participation levels.

Our resulting estimates of collection truck air emissions per ton of individual materials are presented in Table 5.40 for recycling trucks and Table 5.41 for garbage trucks.

CHAPTER 6 - ASSESSING THE FULL COST OF WASTE MANAGEMENT

In this chapter, we develop a method for quantifying the full marginal cost of waste management in California. We distinguish two categories of costs: conventional, monetary costs of waste management -- the costs of collection vehicles, recycling and disposal facilities, etc. -- and environmental damages caused by waste management activities -- resulting from landfill leachate and gas emissions, truck exhaust, etc. Both categories are real costs imposed on society; both must be paid, directly or indirectly, as a result of waste disposal.

Although some environmental values are not susceptible to monetization, the treatment of the environment is a matter of public policy, competing with other claims on scarce resources. Such claims are generally expressed in monetary terms; thus it seems appropriate to express environmental claims in the same manner, rendering implicit valuations more explicit.

In order to give the correct signal to the production and consumption decisions that affect the magnitude and character of waste generation, the disposal fee should reflect the true marginal cost of waste management. The fee system is intended to express the true costs *caused by* new waste generated by goods produced and consumed. The changes in waste disposal costs that may result from these activities are changes at the margin: the next increment in landfill capacity utilization, the construction and use of new disposal facilities, etc. Thus it is marginal waste management costs which provide the appropriate cost basis for the fee.

While long-run marginal costs, reflecting anticipated future changes in programs and capacity costs, would be theoretically appropriate, calculation of such future changes is extremely complex and uncertain. We therefore use current marginal costs for disposal, and the current mix of disposal methods. Changes in these factors should be reflected in the periodic updates of the disposal fee system, as discussed in Chapter 8.

Even in the same facility, both conventional and environmental costs of disposal will vary by material. For this reason, our calculations attempt to track the differential pattern of costs imposed by handling the full range of waste materials in each program and facility.

Conventional Costs

Garbage and recycling collection costs are based on the volume of materials to be collected. Trucks have fixed capacity, and thus have approximately constant costs per cubic yard. When translated into costs per ton, this implies that the least dense materials have the highest collection costs per ton, and vice versa.

Landfill costs are based on a previous Tellus study of California landfills, performed for the Waste Management Board. Costs are differentiated for new and old landfills (with and without pollution controls), and for northern and southern California, where different rainfall levels imply different liner costs. These costs are summarized in Table 6.8.

As with collection vehicles, conventional landfill costs should be roughly constant per cubic yard of material (in any given landfill). Thus costs by material will again be inversely proportional to density. Densities and per-ton costs of landfilling individual waste materials are presented in Table 6.9.

Costs were derived for California's three operating and one planned incinerator; revenues are based on BTU content of each material, and residue disposal costs are based upon ash content. Results are shown in Table 6.11.

Recycling facility costs are based on a range of different types of facilities, reflecting varying program designs around the state; national data is used for costs in many cases, since little California cost data was available. Revenues by material type are based on late 1990 California conditions. Note that A.B. 2020 materials are excluded from this study, and A.B. 2020 revenue levels may not be appropriate for other recycling programs.

Environmental Costs

Our methodology for environmental cost calculation values environmental costs at the cost of abatement, or pollution control. The rationale for selecting this method is discussed in Section 6.4.1, and in Appendix I to Chapter 6. Given limited information, this meant in practice that most environmental costs were based on costs of landfill remediation and control. Those costs were allocated to the range of pollutants resulting from solid waste in proportion to relative health hazards and quantities produced. Details of the allocation process are explained in Section 6.4, and in Appendix II to Chapter 6. Our estimated prices per pound of pollutants are presented in Table 6.18; note that this table includes seemingly astronomical prices **per pound** on extremely hazardous substances which are produced only in trace amounts.

We then allocate the pollution resulting from each waste management activity to the individual waste materials. Pollutants in truck exhaust from collection vehicles, for example, are allocated in proportion to the volume of materials carried. Pollutants from incinerators and landfills are allocated in a more complex fashion, reflecting the (often limited) current state of knowledge about chemical transformation within these facilities.

Then we multiply the pollutants per ton of each material handled in each collection program or facility, by the prices per pound of each pollutant. The result is the environmental cost of handling each waste material in each collection program or facility. The detailed data are presented in Tables 6.19 through 6.23.

Environmental costs of handling each material in the full range of waste management activities are summarized in Table 6.24; conventional and environmental costs are combined to yield the full costs of waste management, per ton of each material, in Table 6.25. Note that in Table 6.25, as in earlier tables, A.B. 2020 materials are excluded; recycling rates for containers are the estimated rates for non-A.B. 2020 materials only. Also note that, for household hazardous waste (HHW), Table 6.25 presents the estimated per-ton cost of separate HHW collection and disposal programs, even though most HHW ends up in landfills at present.

The full costs shown in Table 6.25 form the basis for the illustrative fee calculations in Chapter 7. These are, again, estimates based on the best available (but clearly incomplete) information as of late 1990. They are intended to illustrate a method which could be applied, with better data, in developing actual fee levels; the values here should be viewed as preliminary estimates, not as final values ready to be enacted into law.

CHAPTER 7 - ALTERNATIVE FEE SYSTEMS

In this chapter we examine issues involved in the definition of a fee system, drawing on the calculations presented in Chapters 3 through 6. We identify four major options for a fee system, based on the distinction between fees levied at the point of first sale vs. point of final sale, and on the presence vs. absence of separate recycling incentives (beyond the incentive already incorporated in the disposal cost calculation). These alternatives are shown in the 2 x 2 matrix in Table 7.1.

TABLE 7.1: FOUR ALTERNATIVE FEE SYSTEMS

	Separate recycling incentives included?	
	A. No	B. Yes
Point where fee is levied/ Basis for fee calculation		
1. Point of first sale (producer, distributor, or importer)/ Per pound of each material	1A	1B
2. Point of final sale (retail)/ Per dollar, or based on manufacturers' lists	2A	2B

Goals of the Fee System

The rationale for the disposal fee rests on a fundamental principle of economic theory: those who use resources should pay their full costs. In an economically efficient system, the people who are responsible for monetary or environmental costs are the ones who pay for them.

This principle of efficiency is routinely violated when it comes to solid waste management costs. Even though consumers ultimately pay the disposal costs at present, that payment is not directly linked to the decision to buy waste-generating products. Inevitably, most consumers miss the connection between their purchase decisions and the resulting waste management cost increases; those cost increases are experienced over a period of months or years, and (if publicly funded) may be mixed in with other municipal or county tax burdens.

A disposal fee could remedy this problem by including the costs of waste management into the purchase price of all goods sold in the state. Such a fee system has two very desirable features. The first is that it allows firms and consumers to choose their level of consumption (and resulting pollution) based on their needs and budget constraints. They can choose any type and any quantity of goods, with the accompanying conventional disposal and environmental cost responsibilities automatically included in the price. As a result, the fee system encourages consumers, and thus producers as well, to switch to less polluting products.

A second, practical advantage is that the state receives the fee revenues, which can be used to fund waste management initiatives and/or to mitigate environmental damages resulting from waste management activities.

Exclusions

By law, beverage containers subject to deposit under A.B. 2020 are excluded from the fee. Other exclusions will include yard waste (because it is not sold), sewage sludge, industrial and agricultural wastes (categories which may be reported together with municipal solid waste, but also are not products which are sold), and food waste (because it is hard to envision calculation of the fee, or effective operation of price incentives in this area). These exclusions account for a substantial minority of the reported state waste stream:

Total reported waste stream	50.0 million tons
Exemptions	
A.B. 2020 materials	1.0
Yard waste	7.9
Food waste	3.8
Sewage sludge	1.0 - 1.7
Industrial, agricultural wastes	0 - 4.9
Waste stream subject to fee	30.7 - 36.3 million tons

Front-end vs. Back-end Fees

The fees considered in this report are "front end" fees, collected in advance of disposal. Alternatively, some communities, including Seattle, Washington, have adopted "back-end" fees collected when the product is discarded or reaches the disposal facility. In Seattle's variable can rate, households pay in advance for the number of garbage cans they expect to fill; only that number will be collected. Variations on this theme involve prepayment for special bags or tags that must be used for all garbage set out for collection. Recycling collection is generally exempt from fees. There are scattered, positive reports about the experience with back-end fees, but little systematic analysis.

The clarity and comprehensiveness of a back-end fee are attractive features. The fee is easy to explain; it automatically applies to all goods; it rewards all forms of source reduction and recycling. Nonetheless, back-end fees in general have drawbacks that render them inappropriate for use as the California disposal fee.

The comprehensiveness of the back-end approach is a weakness as well as a strength. The same fee necessarily applies to all materials: a bag full of plastic, a bag full of paper, and a bag full of used batteries all have the same volume, and pay the same back-end fee. Thus it is impossible, in the context of a back-end fee system, to incorporate information about the relative costs or environmental effects of disposal of different materials.

Another possible drawback to back-end fees is the risk of illegal dumping or burning. Finally, while conceptually straightforward, back-end fees require complex administrative systems. Every municipality, county, and private waste hauler would have to participate in administering these systems. The administrative complexities of back-end systems are certainly different from those of the front-end systems proposed in this report, but it is not clear which system is simpler.

Characteristics of Fee Systems

There are two major points at which an advance disposal fee can be levied: at the point of first sale in California (either manufacturer, importer or distributor of out-of-state goods), or at the point of final (usually retail) sale.

An important feature of a fee at the point of first sale is its relative administrative simplicity. For most products, the producers or distributors are fewer in number and larger in size than the retail sales outlets. The alternative, a fee at the point of final sale, involves fee collection from numerous, mainly small, retailers and distributors.

A point of first sale fee is likely to be included in wholesale prices, and therefore somewhat hidden from consumers. On the other hand, a point of first sale fee is highly visible to producers and distributors, and provides a clear incentive for producers to change toward waste-minimizing products. The relative visibility of a point of final sale fee is exactly opposite. However, fees levied at either point may be shifted forward or backward, to consumers or producers; economic theory provides no clear guidance on the expected incidence.

The units in which the fee is assessed should correspond to the units of cost causation in the waste management system. Most waste management costs are based on physical units such as weight or volume. Since volume measurements pose great practical difficulties, the fee should if possible be based on the weight of specific materials in each product. A value-based, sales-tax-like disposal fee system is a "second-best" alternative, to be used only if required for administrative simplicity.

A tricky problem is posed by the question of recycling incentives. Should the fee distinguish, for example, between newspapers made from recycled vs. virgin newsprint? Although they are made differently, in ways that have important environmental impacts, both recycled and virgin newspapers have the same disposal impacts.

A fee based purely on disposal costs rewards source reduction: printing fewer pages in the Sunday paper is the one sure route to a lower fee. In contrast, a fee with exemptions or incentives for use of recycled materials allows lower fees even for enormous Sunday papers, if printed on recycled paper. The conflict is unavoidable: **the same fee system cannot contain the maximum possible incentives for both source reduction and recycling.**

Fee Levels

In theory, the fee should be based on calculated (conventional and environmental) waste management costs for each material. Policy considerations, addressed in Chapter 8, may dictate a lower level, perhaps at a fixed percentage of full cost. Our analysis assumes 100% of the full cost level.

Drawing on the calculations in Chapters 3 through 6, we have estimated fees on a wide range of consumer products, and calculated fees as a percentage of retail prices. Given our time constraints, we examined a small and somewhat arbitrary sample of consumer products, and used late 1990 Boston-area prices. For small products, we bought and weighed one of each; for larger products, we used published prices and weights.

This survey is intended to provide illustrative examples of our methodology and "ballpark" estimates of fee levels, not to establish definitive values. Further refinement of the data is needed before actual fee levels are set.

Table 7.3 provides summary results, and Table 7.7 provides detailed data, from our survey and illustrative fee calculations. The fee on newspapers appears high, at over 7% of the price; however, due to payments from advertisers, price is only a fraction of production cost for newspapers. For selected categories, including appliances, office supplies, and consumer disposables, the fee ranges up to 2-3% of price; on most goods it is 1% or less.

Economic Impacts of the Disposal Fee

In terms of effects on consumers, the fee is virtually certain to be "regressive", taking a larger percentage of income from lower-income households and communities. Estimated disposal fees per household at varying income levels (on residential consumption only, using our survey data as described above) are shown in Table 7.5. In compensation for the regressivity of the fee, it would be possible to target use of some fee revenues to lower-income areas. If set at the full cost of disposal the average fee level derived from our survey would be $141 per household per year. (A large part of these costs are now being paid by waste generators through existing garbage disposal fees.)

Effects on industry can be tentatively estimated, using our survey data and input/output tables to yield fees as a percentage of material inputs, for major industry groups. The results are shown in Table 7.6; the incompleteness of our survey, and of available industrial data, limit the extent of this table. In a number of industries, our estimated fees are 9% to 12% of the cost of material inputs; in other industries the percentage is much lower.

How much change in consumer or producer behavior will result from fees of this magnitude? The greatest changes in consumer behavior are to be expected on items with high fees (especially products containing hazardous waste, which will have the highest fees), luxuries and discretionary purchases (where price elasticity is greatest), and cases where there are well-publicized alternatives which have lower fees due to lower impacts. Economic research on consumer responses to price changes (technically, "price elasticities") is often inconclusive; our review of this literature, in Section 7.6.1 and the Appendix to Chapter 7, leads us to expect relatively small changes in sales, perhaps on the order of 0.5%, in most goods. Larger changes in consumer spending might occur in household disposables (napkins, trash bags, etc.), newspapers, and office supplies.

If possible, even less is known about the precise magnitude of producer responses to materials prices. Making heroic extrapolation from limited information, we estimate that various industries may reduce raw materials usage by 1 to 12 percent, depending on the industry and the material. If exemptions for recycled content are included, then greater shifts to secondary material, but less overall source reduction, would occur.

CHAPTER 8 - RECOMMENDED DESIGN FOR A DISPOSAL FEE SYSTEM

Recommendation

We recommend the adoption of a fee system levied at the point of first sale in California, with no modification of the fee *structure* to create additional incentives for recycling. Fee levels should be proportional to the full monetary and environmental costs of solid waste management, calculated according to the methodology presented in Chapter 6.

Based on the data available in late 1990, our estimate of the fee revenues at 100% of full cost is shown in Table 8.1 included in the text and also reproduced here. The fee totals roughly $4.3 billion on the 35 million tons of non-hazardous waste subject to the fee (an average of $123 per ton), and almost $0.9 billion on the 445,000 tons of household hazardous waste (an average of $1943 per ton). Of the $4.3 billion fee on non-hazardous waste, $3.5 billion ($100 per ton) is conventional waste management costs, and $0.8 billion ($23 per ton) is our valuation of the environmental costs of waste management.

Public policy considerations may dictate that the fee be set at a level below 100% of full cost; we are not making a recommendation as to the exact percentage.

We recommend that the fee be based on (proportional to) the full cost of waste management, without exemptions for secondary content or other recycling-oriented provisions. The purposes of the fee, as explained in Chapter 1 and in Section 7.1, are first to create a market incentive for source reduction, and second to create a source of revenues to fund waste management and related environmental mitigation. Neither of these purposes is served by adding incentives, i.e. fee reductions, for materials based on recycling rates or recycled content.

The priority we give to incentives for source reduction does not mean that we are uninterested in recycling. We address the use of fee revenues to promote recycling in the Section 8.3.

Administrative costs

There is no clear theory of the administrative costs of a tax or fee system. A number of "rules of thumb" can be identified, and used to produce preliminary cost estimates consistent with the costs of other similar taxes or fees. Based on data provided by the Board of Equalization, we estimate the administrative costs (including first-year start-up costs) are $38 million to $48 million. At the full cost level, this amounts to $0.74 to $0.94 per $100 of revenue. This may be compared to the costs of four other major taxes, as shown in Table 8.4, which ranged from $0.80 to $3.27 per $100 of revenue.

Table 8.1 Prospective Fee Revenues at 100% of Full Disposal Costs

(This Table examines the fee revenue which would be generated by a disposal cost fee at 100% of full disposal costs;
"net waste stream" excludes A.B.2020 materials, yard waste, food waste, and "organic non-compostables" (largely sludge)

Materials	Conventional Cost $/ton	Environmental Cost $/ton	Full Cost $/ton	Net Waste Stream	Full Fee Revenues	Conventional Costs Fee Revenues	Environmental Costs Fee Revenues
PAPER							
Newspaper	$63.33	$18.91	$82.24	3212845	$264,221,000	$203,453,000	$60,767,000
OCC	$95.66	$22.49	$118.16	4095150	$483,876,000	$391,759,000	$92,117,000
Mixed Paper	$99.28	$24.72	$124.00	3720684	$461,375,000	$369,393,000	$91,981,000
High Grade	$61.89	$19.23	$81.12	657891	$53,368,000	$40,714,000	$12,654,000
Other Paper	$106.02	$24.02	$130.04	5857029	$761,643,000	$620,983,000	$140,660,000
PLASTICS							
HDPE	$245.55	$43.11	$288.66	350124	$101,067,000	$85,974,000	$15,093,000
PET	$246.15	$43.20	$289.34	88880	$25,716,000	$21,877,000	$3,839,000
Film	$141.71	$38.41	$180.11	1203130	$216,701,000	$170,490,000	$46,210,000
Other	$275.40	$44.29	$319.69	1775855	$567,728,000	$489,078,000	$78,650,000
GLASS							
Recyclable	$28.60	$10.57	$39.17	1969164	$77,128,000	$56,314,000	$20,813,000
Non-recyclable	$29.18	$10.66	$39.83	500177	$19,924,000	$14,592,000	$5,331,000
METALS							
Aluminum	$94.63	$54.08	$148.70	100038	$14,876,000	$9,466,000	$5,409,000
Other Metals	$89.74	$35.59	$125.33	2909875	$364,680,000	$261,132,000	$103,548,000
OTHER ORGANICS							
Wood Waste	$91.07	$8.22	$99.29	2026397	$201,199,000	$184,541,000	$16,658,000
Tires/rubber	$129.77	$36.33	$166.09	802535	$133,295,000	$104,141,000	$29,153,000
Textiles	$165.23	$27.73	$192.96	1077859	$207,982,000	$178,090,000	$29,892,000
OTHER WASTE							
Other Waste	$62.09	$8.10	$70.19	4420039	$310,225,000	$274,442,000	$35,783,000
Subtotal				34767672	$4,265,004,000	$3,476,439,000	$788,558,000
HHW	Separate Cost of Collection $/ton		$1,943.00	445203	$865,029,313		
TOTAL				35212875	$5,130,033,313		

Priorities for use of fee revenues

The disposal fee is a cost-based waste management fee, not a general revenue tax. As such, it should be used to fund directly related waste management activities. The cost of the activities to be funded will determine the amounts to be collected. These amounts will then determine the fee levels on specific products. The priorities for use of revenues include state-level initiatives, especially in promoting markets for recycled materials, and rebates to cities and counties to fund local waste management needs.

In order to meet the requirements of A.B. 939, we recommend that the bulk of the money cities and counties receive from the disposal fee be spent on source reduction, recycling and composting, and household hazardous waste collection programs. For cities and counties to meet the 25 percent source reduction and recycling/composting goals by 1995 and the 50 percent goal by 2000 it is essential that they start developing these programs as soon as possible.

With such programs in place, the question of justification of the fee system and its substantial revenues may be easier to address. Compelling environmental concerns, expressed in A.B. 939, motivate the creation of this seemingly costly new fee. However, the funds are to be used in part for high-priority state waste management activities -- and in large part returned directly to the communities which bear the burdens of solid waste management.

Implementing a disposal fee

To implement a disposal fee as recommended here, it is necessary to identify the point of first sale in the lifecycle of each product. The fee should be levied at the first point where the product has acquired the characteristics which govern its disposal cost and environmental impacts: i.e., after chemical transformation of the major materials is complete. Household hazardous wastes merit separate treatment, in view of their unique environmental hazards and high fee levels; they should pay the fee at the point at which the final (hazardous) product is manufactured.

Products manufactured out-of-state and sold within California would pay the fee at their point of entry into California.

To simplify calculation, we recommend establishment of average fee levels for each relevant Census Bureau Product Code, based on weights and materials used in those categories. This is not quite as precise as separate determination for each individual product, but it is far easier to administer. The greatest practical difficulties will occur in determining the composition of multi-material products manufactured outside California.

To ensure that all products pay the fee once and only once, a paper trail or tax stamps will be necessary.

Exemptions to the fee include raw materials, products included in A.B. 2020, materials and products sold out-of-state but manufactured within state, and retail establishments with low total sales or low sales of products covered by this fee. Small retail establishments which buy only a fraction of their products from out-of-state distributors, for instance, may be liable for so little fee revenue that it is not cost-effective to collect from them.

Updates

The fee system should be updated periodically to reflect changes in pollutant regulations and waste management data. Updates might occur every two years, in coordination with reporting of other solid waste data. In the updates, changes in the following categories should be considered:

- waste composition and generation data
- disposal paths of the various materials in the waste stream
- conventional waste management costs
- pollutant emissions data from waste management facilities
- new regulations requiring control technologies for relevant pollutants
- matching of pollutant emissions costs with their sources in the waste stream.

CHAPTER 9 - INPUTS TO MODEL LEGISLATION

The disposal fee system outlined in this report requires a substantial amount of detailed information be included in the model legislation for the fee system. The most critical parts of the legislation include a clear definition of the terms utilized in the legislation; an outline of the development of the individual product fees; an identification of those products and feepayers exempted from the fees; a clear description of the administration of the fee system; and a description of the penalties for nonpayment of the required fees.

Chapter 9 briefly addresses these issues, drawing on the analysis of earlier chapters of the report.

CHAPTER 1 - WHY A DISPOSAL FEE?

1.1 INTRODUCTION TO THE PROBLEM

California throws out a mountain of trash: currently 50 million tons annually, and growing larger every year. Yet as the quantities of solid waste increase, the landfills that receive most of this waste are fast filling up. Owing to urbanization, rising land values, and heightened environmental concerns, it has become increasingly difficult to site new landfills.

The collision between rising waste volumes and diminishing landfill space is all too easy to foresee. Unless something new can be done, many areas of the state will run out of disposal capacity over the next few years -- resulting in skyrocketing costs for long-distance waste transport and disposal.

Bold new initiatives are required to handle California's waste stream in the coming era of landfill scarcity. In 1989 the legislature passed a landmark bill, Assembly Bill 939, which completely revised the state's procedures for the management of solid waste. This study presents one of the initiatives called for in A.B. 939, a proposal for a disposal cost fee on goods sold in California.[1] The disposal cost fee can play a crucial part in addressing the solid waste crisis -- but it is only one part of an integrated policy framework. It should not be viewed in isolation from other existing and planned waste management programs.

A.B. 939 presents a hierarchy of preferred solid waste management options: the top priority is to maximize the reduction of waste materials; second is to recycle and compost as much as possible; third is to maximize the reuse of waste materials; only then should the remainder be processed in transformation facilities, such as waste-to-energy plants; finally, as a last resort, the remainder should be landfilled. The goal of the disposal cost fee, and of other solid waste management programs, is to increase the reliance on reduction, reuse, and recycling, and to decrease the amount of waste handled in landfills or transformation facilities.

California has set ambitious goals of 25% reduction and recycling of wastes by 1995, and 50% by 2000. To achieve such goals, A.B. 939 outlines many programs for the promotion of waste reduction and increased recycling, as well as the requirement for comprehensive county and city solid waste management plans and diligent environmental monitoring programs.

Most solid waste management options are **targeted** at specific materials, and are **programmatic** in nature. There are specified methods for handling tires, beverage containers, household hazardous wastes, and other materials. Many communities have or are planning yard waste composting programs. Recycling centers and collection programs accept specific materials at specific times or places.

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[1] More precisely, A.B. 939 included Section 40600 of the Public Resources Code, which mandates a study and recommendation of a fee based on the cost of disposal and potential for environmental degradation of all goods sold in California and normally disposed of in landfills or transformation facilities, with the exception of beverage containers subject to redemption.

In contrast, the disposal cost fee is a **general** fee system that is applied to many materials, and is **market-oriented** in nature. A fee is charged on each good before it is used, based on its eventual cost of disposal. Under such a system, broad classes of materials are covered without setting up individual targeted programs.

The disposal cost fee need not replace targeted, programmatic options for source reduction and recycling of specific materials; rather, it is complementary to them. It is likewise complementary to California's landfill surcharge: this fee, which applies to all landfilled waste, is earmarked for use in landfill remediation. The disposal cost fee also affects the waste stream in general, but has a broader range of waste management objectives.

The disposal cost fee is part of the solution to the waste management problem in two different ways. First, it provides a market incentive for source reduction. The fee sends a price signal to consumers and producers, automatically telling them the cost of disposal of each good on the market. Goods that have higher disposal costs will receive larger price increases. The "invisible hand" of the marketplace could thus steer consumers toward source reduction: when the fee is included, it is cheaper to buy goods that cause less waste.

Second, the fee generates substantial revenues, based on the real costs of solid waste disposal. Currently billions of dollars are being paid for solid waste services, but those costs are dispersed and hidden in the budgets of households, businesses, and municipalities throughout California. By collecting a significant fraction of those costs in advance, the disposal cost fee makes it possible for the state to finance new programmatic initiatives in source reduction, recycling, and composting. Such initiatives will reduce the costs now paid for garbage collection and disposal and, at the same time, help to protect California's environment.

In short, a disposal cost fee is both a broad market-based incentive for source reduction and recycling, and a source of funding for targeted programmatic initiatives in waste management. The fee is not proposed as a sole solution to the state's waste problems, and cannot work if adopted alone. Rather, it is an essential part of an integrated program that, in the 1990's and beyond, can make a significant dent in California's mountain of trash.

1.2 BASIS FOR A DISPOSAL FEE

Solid waste management is not free. It imposes a variety of costs, including both the direct monetary costs of collection and disposal and the indirect health and environmental effects of disposal activities. We all pay these costs, and the amount we pay is headed upward.

These costs are involuntary and, for the individual, uncontrollable. None of us can refuse to pay for waste disposal, whether we pay directly or through our local government. Nor can we escape the indirect costs of water supplies polluted by landfill leachate, or air polluted by landfill gases, incinerators, and garbage trucks.

Economic theory and common sense agree that it is only fair to ensure that the "polluter pays." Those responsible for solid waste management costs, namely the consumers and producers who generate solid waste by their consumption choices, should pay the costs their activities impose on society. Moreover, if consumers must pay the cost of disposal when they buy waste-generating commodities, they will have an incentive to change their consumption patterns. This change will in turn affect the nature of the goods produced and the materials used in them. Ultimately, this will lead to the use of goods that have a lower disposal cost, including environmental impacts.

To provide this incentive, it is important to base the fee system on the different costs of waste management for different products. Moreover, the legislative mandate for the disposal cost fee study calls for identification of the potential for environmental degradation associated with individual goods and materials. For this reason, a large part of this study, Chapters 3 through 6, focuses on description of the California waste stream, and on estimation of the costs of current and planned waste management options.

The generality of the fee is itself a source of fairness and impartiality, in at least two distinct ways. First, because it addresses virtually all materials sold in California, it does not single out any one product as "the" problem. It is not solely a newspaper fee, or a packaging fee, or a plastics fee; it applies to all these, and to many more products, in proportion to their waste disposal costs.

Second, it is a disposal cost fee, not a recycling fee. It is based on the full cost of waste management, including the cost of recycling for those items that are recycled. In many cases recycling is a low-cost option, especially when environmental costs are considered; however, if exotic materials are being recycled at very high cost, then the fee should reflect these high costs. In such cases source reduction may be important to reduce the volume of material being recycled or landfilled.

The long-term goal is not simply to promote recycling, though recycling is usually desirable. The goal is to minimize the total monetary and environmental costs of the state's waste management system.

Those total waste management costs, estimated for individual materials, provide a basis for the fee system as developed in Chapters 7, 8, and 9. As our review of existing and proposed legislation (Chapter 2) explains, there are no exact models for the disposal cost fee. Although the concept is undergoing preliminary discussion in a number of other states, California is breaking new ground. The challenge is to translate the detailed cost analysis into a workable, understandable fee schedule.

Since the fee is based on the costs of waste disposal, and the state hopes to achieve a major transformation of disposal methods, it seems appropriate to use the substantial fee revenues to finance new, preferred disposal options. This will lower future costs to households, businesses and municipalities, which currently bear the burden of waste disposal costs.

We discuss the spending priorities only briefly, in Chapter 8. Even within the realm of new waste management options, there are many priorities competing for funding. However, it is our intent, and the intent of A.B. 939, that this be a fee system with revenues reserved for related services in the field of waste management. It is not a tax proposed or designed for general-purpose revenue collection.

At several points in the study we comment on inadequacies in the available data. For example, we could not obtain waste composition data or recycling rates from a number of counties. Instead, we extrapolated from those counties which provided data, yielding the best available statewide estimates.

There are two conclusions we draw from the data problems. First, the methodology proposed here should be evaluated separately from the data. In many instances, particularly in Chapters 7 and 8, the data are used only for illustrative purposes, and need not be the final word on actual fee levels. If necessary, the same methodology could be applied with revised figures.

Second, the periodic updates to the fee system, proposed in Chapter 8, allow the flexibility to incorporate new information as it becomes available. Such changes will reflect not only better research in future years, but also the expected changes in waste stream composition, source reduction, and recycling rates. Over time, as California moves to meet its ambitious goals in waste management, the costs of waste disposal -- and the level of the disposal cost fee -- will naturally decline.

1.3 STRUCTURE OF THE DOCUMENT

Chapter 2 summarizes pre-disposal fees that other states have passed or proposed, such as bottle bills. Although several states have considered or introduced bills that would tax a wider set of products, most bills target specific materials whose disposal is difficult or expensive, leaving little experience that can be applied to California's broad approach. This chapter also analyzes how the size of a pre-disposal fee can influence its effectiveness in spurring consumers and business to produce less waste.

Chapter 3 describes the comprehensive study we conducted of the composition of the state's waste and statewide recycling rates and disposal costs. We gathered data from each county about commercial and residential waste generation and composition, source reduction, disposal facilities, and recycling and hazardous waste programs. This information provides the basis for later calculations in which we allocate overall disposal costs to specific materials. The chapter also discusses shortcomings of the data.

Chapter 4 provides an inventory of the recycling and disposal facilities in California and the amount and types of waste they accept. According to the available data, of the 50 million tons of garbage Californians throw away each year, about 87% is landfilled, 11% is recycled, and 2% is incinerated. The state has 334 active landfills, and 21 more are being planned, but the closing of many sites will cut the state's current capacity in half.

Chapter 5 describes the environmental impacts of solid waste collection programs and facilities, including garbage trucks and recycling trucks, landfills, incinerators, and recycling facilities. We looked at the major forms of pollution each of these programs or facilities releases, using available data about air, water, noise, odor, and litter emissions and allocating a proportion to each material handled in that program. The result is a set of emission vectors describing the pollution produced per ton of each material handled in each waste management facility or collection program.

Chapter 6 describes how we quantified the costs of environmental degradation and combined them with conventional solid waste management costs. In the calculations, we accommodate future changes as recycling programs divert more and more materials from the waste stream, landfills close, and consumers and producers reduce their waste. The result of this chapter is a set per-pound costs for each major material type in the waste stream. Those costs provide the basis for the fees discussed in later chapters.

Chapter 7 looks at the goals of an ideal disposal fee, the materials that would be exempt, and the range of alternative systems. There are a number of possible approaches to a disposal cost fee: It could be collected at the final sale (usually the retail level), or when a product is first sold in the state (usually by the producer, distributor, or importer). It can also be based on a number of different units, such as the volume of a good or its weight. Finally, the fee can be designed with or without incentives to encourage recycling. We discuss the advantages and disadvantages of each approach.

This chapter also presents illustrative, simplified calculations of fee levels and explains how they were derived, and considers potential effects of the fee on consumers and industry.

Chapter 8 presents our recommendation for the fee system, estimates administrative costs of the system, suggests priorities for the use of the funds, and examines the practical problems of implementation and periodic updating of the fee system.

Chapter 9 summarizes issues raised in this report that should be addressed in legislation establishing a fee system.

CHAPTER 2 - RELEVANT EXISTING AND PROPOSED LEGISLATION ON SOLID WASTE DISPOSAL FEES

2.1 INTRODUCTION

There is an enormous variety of laws relating to disposal charges, both in existence and under consideration, throughout the United States. The purpose of this section of the report is not primarily to provide a complete cataloguing of all such legislation, which has been done in different fashions by several other organizations,[1] but to provide an analytical survey which shows in summary form the major characteristics of legislation. Our survey compares characteristics including the types of wastes regulated, the mechanism used (tax or fee, deposit/refund system, etc.), the unit in which the fee is calibrated (such as weight, volume, price, or per item), the amount of the fee, how the funds generated are to be used, at what point in the economic system the fee is collected, what exemptions are given, and what is the administering agency. Our goal is to provide a base of information which is so structured as to provide guidance in legislative design for California.

Table 2.1, at the end of this chapter, outlines the characteristics which we believe to be relevant. All legislation discussed below is shown in schematic form in the table, which is divided into sections by type of waste being regulated. For each piece of legislation, a brief description (usually a code word) is given for each of the major characteristics. See Section 2.4 for a full explanation of the table.

2.2 ANALYSIS BY TYPE OF WASTE

2.2.1 Special Wastes

Of the existing legislation (termed "passed" in Table 2.1), many of the bills deal with a variety of particular, or "special," wastes, which are thought to cause specific problems for the solid waste system, either in terms of the dollar cost of disposal or because of environmental damage.

Batteries

Three states have passed laws dealing with motor vehicle batteries. In Connecticut and Washington State a fee of $5 per battery was imposed, with Maine having a smaller $1 levy.[2,3,4] The larger fees are rebated if an old battery is returned when the new one is purchased, while in Maine the funds are designated to be used for recycling programs. In each case the fee is imposed at the retail level. Connecticut and Washington administer the law through the state agencies responsible for environmental affairs, while Maine utilizes the state waste management agency. Washington has a provision for suspending the fee if the cost for the wholesaler or distributor to transport an old battery to the smelter is greater than the price that the latter is willing to pay for the battery.

Tires

Thirteen states have considered legislation regulating disposal of tires via an advance disposal fee; at least ten of the bills have been passed into law. In California, AB 1843 (Code Chapter 5, Article 5, Section 66799.140), passed in September 1989, sets a 25 cent per tire disposal fee collected at the retail level on both new and used tires.[5] In various states, the fees ranged from 25 cents to $2 per tire, with five states setting the fee at $1, while in Louisiana the legislation did not specify an amount.[6] The fee is set on a per item basis in all cases except North Carolina, where it is one percent of the sales price.[7]

Limited information was available on use of the funds generated for the government, in two cases funds are to be used for recycling, in one for general waste disposal purposes, and in North Carolina there is a revenue sharing formula with localities. In all cases the fee is collected at the retail level. Utah has exemptions for recycled content and bicycle tires,[8] while Virginia exempts bicycles and farm vehicles.[9] In most cases the law is administered by the state tax commissioner or revenue agency.

Hazardous Wastes

Only one state, Rhode Island, has passed legislation putting specific fees on several categories of hazardous waste - tires, motor vehicle oil, antifreeze, and organic solvents. Besides tires, there is a 5 cent fee per quart on motor oil, 10 cents per gallon on antifreeze, and 0.25 cents ($0.0025) per gallon on organic solvents.[10] Connecticut's law, effective October 1, 1990, bans the use of several toxic metals - lead, cadmium, mercury, and hexavalent chromium - in packaging. There are exemptions if the metals are added to comply with health or safety requirements of federal law, or if there is "no feasible alternative," which the law defines as meaning "no substitute".[11]

Diapers

Wisconsin passed a provision creating a subsidy program (called "grant/loan" in Table 2.1) to "fund diaper services and businesses that produce products from post-consumer waste materials."[12] In addition, Wisconsin has pending legislation to put an excise tax on sales of disposable diapers.[13] Illinois and New Hampshire also have pending fees on disposable diapers, both on a per item basis, the former a minimal amount of one cent per diaper, with the latter being ten cents.[14,15]

"Whitegoods" and "Browngoods"

Maine has an existing law which places an advance disposal fee of $5 on new major appliances (clothes dryers and washers, dishwashers, refrigerators, etc.), new major furniture, new bathtubs, and new mattresses. The legislation went into effect on July 1, 1990. Funds collected will be used for administrative costs of state agencies related to solid waste, and for local recycling programs.[16] A pending bill, LD 2354, would replace the existing flat fee with a one percent ad valorem tax on white goods, "brown goods" (furniture), electronics, and business equipment.[17]

2.2.2 Beverage Containers

Deposit/Refund Legislation

The other largest category of existing legislation includes so-called "bottle bills" or deposit/refund laws. These exist in at least ten states (California, Connecticut, Delaware, Iowa, Massachusetts, Maine, Michigan, New York, Oregon, and Vermont), and are fairly uniform in character.[18] In general, the deposit ranges from two to five cents, with a few states having provisions for fees as high as 20 cents, and usually applies only to carbonated beverages, meaning soda and beer. In every case where a refund is offered, the deposit is on a per item basis. Usually there is a provision for paying a handling fee to the distributor, generally ranging from one to three cents per item. Funds which remain from unclaimed deposits, less handling fees, generally revert to the State government. In one case (Iowa) the funds are reserved for alcohol treatment programs. A variety of exemptions exist, such as in Delaware where containers over 64 ounces are excluded, and aluminum is at present exempt. In Maine, milk, dairy products, and juice containers were originally exempt, but the law was amended so that by the end of 1990 it covered distilled spirits, wine bottles, juice, and bottled water.[19]

Litter Cost Taxes

Besides the deposit/refund bills, several states impose beverage container taxes, which are generally viewed as litter cost fees. In most cases the amounts of the tax are too small to possibly have an effect on business or consumer behavior, and so should be viewed solely as revenue-generating mechanisms. Rhode Island has a four cent per case tax; and Virginia has a fee which is a maximum of 0.06 cents ($0.0006) per dollar of sales.[20] Tennessee has more substantial fees of six percent of receipts on soda sales, and 50 cents per beer barrel. These latter types of taxes are generally imposed at the distributor or wholesale level.

In a number of other cases, the taxes are on a broader class of goods than solely beverage containers, and thus are discussed under "Multiple Materials" legislation below.

2.2.3 Packaging

Florida has passed a broad-based advance disposal fee on containers made from glass, plastic, aluminum, plastic-coated paper, "or other metals." Although passed in 1988, it does not go into effect until 1992, conditional on whether 50 percent recycling for the particular material has been achieved by that time. If not, a one cent fee per container would be imposed, rising to two cents in 1995. The fees on containers are relatively small, although conceivably large enough to affect behavior on low-cost products.[21]

No other broad packaging fees have been passed to date. In California, Senate Bill 2091/Assembly Bill 4193 was pending as of last report.[22] It would place a fee on distributors of packaging materials equal to the cost of recycling. Beverage containers which are already covered by the deposit system would be exempt. In Illinois, House Bill 3980 would place a tax of five cents per item on food containers made of materials which do not have a 50 percent recycling rate statewide. The rate would go to ten cents in 1997. The containers could be returned to a recycling center for a refund, making the Illinois program in effect an extension of the bottle bills to a wider variety of containers.[23] In New Jersey, Assembly Bill 2218 would place a three cent tax on rigid containers with a capacity of six ounces or more.[24] Both the Illinois and New Jersey bills would collect the fee at the retail level, while the California legislation would implement the tax at the distributor level.

2.2.4 Newsprint

Florida currently has a ten cent per ton fee on the disposal of newsprint. In addition, if 50 percent of the newsprint used in the state is not made from recycled fiber by October 1992, the fee will be increased to 50 cents per ton. The newsprint fee at present is so small relative to either the cost of purchasing or disposing of the materials that it is meaningful only for revenue-generating purposes.[25]

2.2.5 Multiple Materials

Existing laws relating to broader classes of materials which end up in the solid waste stream are mainly of two types. Several laws, including AB 939 in California, place substantial fees either on landfills or on all disposal facilities. Several other cases are broad-based advance disposal taxes, but they are generally in the nature of a "litter tax," with the goal of revenue generation, and the rates are so low as to only raise small amounts of money and not to be relevant for changing behavior.

Fees at Disposal Facilities

In the first category, Utah Senate Bill 255 places fees on commercial nonhazardous solid waste disposal facilities and incinerators. If the facility was operating prior to January 1, 1990, the fee is $192,000 per year. If opened after that time, it is $2.50 per ton for commercial waste and $0.50 per ton for municipal waste. Revenues collected go into the State's General Fund.[26] Texas has a law, in effect since 1983, which places a tax on all landfilled waste, of 50 cents per ton, 17 cents per compacted cubic yard, or 10 cents per uncompacted cubic yard. At least 50 percent of funds collected are designated to be used for permitting and enforcement purposes.[27] West Virginia has a tax, passed in 1988, on all solid waste disposed in the state. The rate is $1.20 per ton for local waste, $2.20 per ton for "outside" waste. It is paid at the disposal facility.[28] In California, Assembly Bill 939, passed in September 1989 (Code Chapter 7), sets an annual fee on landfills, based on weight or volume of waste disposed, currently not to exceed $1/ton, or approximately $40 million annually. Earlier, AB 2448 (September 1987) imposed another landfill surcharge to be set so that the total collected in the State equals $20 million annually.[29]

Variable Can Rates

Another category of fees are imposed directly on residents at the point of collection of solid waste. In many jurisdictions there is a flat fee for trash collection, whether done municipally or through private contractors. Such fees do not reflect the volume of waste discarded, nor of course its environmental characteristics. A smaller number of localities have imposed variable fees based on the volume or weight of trash put out. Seattle is notable in this category, having implemented such a "variable can rate", in which the City provides standardized sizes of containers. Residents pay for the number and size of containers to be collected, and the City will only collect waste placed in these standard containers. Illinois has pending House Bill 3370, which would require that certain fees for collection of trash under municipal control be based either on the volume or weight of material. Cities over one million population - meaning Chicago - are exempted in the bill.[30]

Litter Taxes

Low-rate litter control taxes have been enacted in Nebraska, New Jersey, Ohio, Virginia, and Washington. Unlike any of the other types of legislation described above, some of these laws are imposed at several levels of the economy. Nebraska's law, directed at manufacturers, wholesalers, and retailers, is written as $150 per $1 million in gross sales above $350,000. When converted, this means a rate of only 0.015 cents ($0.00015) per dollar - 0.015 percent of sales.[31] New Jersey's legislation also covers the three levels of firms, and is in the same range of magnitudes, $225 per million dollars of sales for retail, $300 per million for wholesale and manufacturing. The first $250,000 is exempt for retailers. Of the funds collected, 80 percent goes to grants for municipalities, 10 percent to counties, and 10 percent for other purposes.[32]

Ohio places an increase of $5,000 in the franchise tax on firms which make or sell "litter generating products," which may or may not be significant depending on the size of the firm. The funds are used for grants for litter abatement and recycling.[33] The "Virginia Litter Tax Act" imposes a minimal tax of $10 on all business firms, and a similarly small tax of $25 for firms which sell groceries, beverages, and beer. The tax is imposed on manufacturers, wholesalers, distributors, and retailers.[34] Washington's "Model Litter Control & Recycling Act" taxes all these same types of businesses at a rate of $0.00015 per dollar, or 0.015 percent of sales. 40 percent of the funds are dedicated to litter control, 20 percent to education, 20 percent to recycling, and 20 percent to administration.[35]

2.2.6 Environmental Criteria

There is a small sampling of laws existing or under consideration which specify environmental criteria in attempting to differentiate how solid waste will be regulated. Rhode Island House 9163, passed in 1988, exempts biodegradables and returnables from the state sales tax.[36] While this does not generate revenues, it does clearly provide a price preference for types of packages which are seen as imposing lower financial and environmental costs in the solid waste system.

Illinois House Bill 3634, which was pending as of June 1990, would, in addition to taxing disposable diapers, also place an advance disposal fee of one cent on other "single-use products."[37] In Vermont, Senate 326, Section 7, which was introduced in January of 1990, would increase the state sales tax from four to eight cents per item on disposable and single use products. "Single use" is used to mean food and beverage related items, while "disposable" means items such as batteries which are part of another product.[38]

2.3 ANALYSIS BY CHARACTERISTICS OF LEGISLATION

2.3.1 Mechanism

Within existing legislation, or even those bills currently under consideration in almost all states, there is very little in the way of broad-based tax or fee systems where the fee is imposed prior to disposal of solid waste. Florida's law, which does not go into effect until 1992, comes the closest to what is being considered for California. And even in Florida's case, the range of materials is limited to packaging (not including uncoated paper), and a relatively minor fee on newsprint.[39]

Those tax/fee provisions already in effect are primarily directed at specific wastes, including tires and batteries. Several states have taxes on beverage containers and/or multiple types of packaging materials. But in almost all cases (excluding the deposit/refund systems for "bottle bills") the rates are so low that the taxes could not be expected to have significant impact on producer or consumer behavior.

"Bottle Bills" are by far the most important category of existing laws which bear some relationship to a broader tax. Although limited to a small fraction of the waste stream, their success in causing beverage containers to be recycled rather than put into the trash (or disposed as litter) has been substantial.[40] Of course, it is the availability of the refund to the final consumer, rather than the deposit by itself (which is the same as a tax/fee) that has resulted in the behavioral change. The refund system does have, however, substantial costs of administration and handling, which would clearly be expanded for a system which applied to more materials.

2.3.2 Fee Unit

The tax/fee and deposit laws in existence are overwhelmingly imposed on a per item basis. For those materials where a refund is provided it is clear that this greatly simplifies the administration of the system, since it is only necessary to return the item itself, without having to document what price was paid. This consideration applies both to the beverage container deposit laws and also to the motor vehicle battery laws. It is not clear why the motor vehicle tire taxes are usually set on a per item basis, since in general no refund is offered. In those cases where the legislation specified the basis of the fee, only one out of ten was on a percentage of price basis (North Carolina).

Hazardous wastes are in almost all cases regulated by bans and restrictions. Rhode Island has the only law which places a tax on several categories of environmentally destructive materials, and it does so on a per volume basis. At present no taxes on diapers have been passed, but those under consideration in Illinois and New Hampshire would be on a per item basis. Maine's tax on white and brown goods is currently per item, although legislation has been introduced to change to one percent of the sales price.

The one tax on packaging which has been passed to date, in Florida, is on a per item basis, as are the pending bills in Illinois and New Jersey. Similarly, the taxes based on environmental criteria, which are pending in Illinois and Vermont, are also per unit.

Only the "litter taxes", which are usually imposed on the total receipts of manufacturers, distributors, wholesalers, and retailers, rather than as charges to the ultimate consumers which are collected by business firms, are normally related to the price of the product. In Virginia, Nebraska, New Jersey, and Washington State, the rates are extremely low. In Tennessee, at 6 percent of soda receipts and 50 cents per beer barrel equivalent, the fee is more meaningful.

2.3.3 Amount of Fee

The amount of the tax or fee charged is relevant primarily for two reasons:
(1) It influences the degree to which the behavior of business firms and ultimate consumers is changed. The extent of influence will depend on:

- the size of the fee, in relation to the price of the product and its importance to purchasers.
- whether or not the basis on which the fee is charged allows its amount to vary depending on shifts in producer and consumer behavior (for example, a per item charge provides no incentive to reduce the weight or volume of material contained in the product).
- the availability of technology which can reduce the amount of waste material due to the influence of the tax.
- the availability of substitutes which can be used due to a shift in relative costs as a result of the tax (such as from one packaging material which has higher disposal costs to a lower-cost material).
- exemptions provided for recycled and/or reusable materials.
- the provision of a deposit/refund system which gives consumers a financial incentive to recycle and/or reuse the product.
- where the goal is to cause shifts from use of non-recyclables to recyclables, and a refund is not offered, the availability of convenient and efficient recycling systems.

(2) It will determine the amount of governmental revenue which will be generated by the tax. To the degree that the goal of the legislation is to generate funds which can be used to mitigate the economic and environmental externalities caused by solid waste, rather than to prevent the occurrence of those externalities in the first place, then the tax should be set so as to provide sufficient funds for the government to implement mitigation measures.

Deposit/refund systems exist primarily for motor vehicle batteries and beverage containers. For batteries, in the two states where deposit/refunds of $5 per unit are in effect (Connecticut and Washington), it seems reasonable to assume that this value is high enough to induce return of the batteries rather than disposal, especially if the return can be done conveniently at the point where a new unit is purchased. Maine's $1 fee is smaller in relation to the value of the product, and so should have a smaller impact on consumer behavior. In addition, the $1 fee level may not fully cover the mitigation cost for disposal of an automotive battery in a landfill or by other means.

For beverage containers, where the most empirical evidence exists, the deposit/refund does not appear to cause much of a reduction in the use of containers, or in a shift to reusable bottles and cans, but does cause very high rates of return of the containers to obtain the redemption value (see the various studies cited above).

For the other "special waste" categories besides batteries, existing and proposed laws are primarily non-refundable taxes. For tires, the fees of 25 cents to $2 may be too small, being less than 5 percent of the purchase price, to substantially affect purchasing behavior, but large enough to generate substantial revenues, at least at the upper end of the range. Rhode Island's fees on motor oil, antifreeze, and organic solvents would also appear to be useful for revenue generation only. For disposable diapers, Illinois' pending tax of one cent is quite small, but New Hampshire's proposed 10 cent fee is certainly in a range which could affect the decision between disposables and reusables. Maine's tax on "white" and "brown" goods is quite small in proportion to the prices of the products involved.

As discussed earlier, the "litter taxes" for both beverages and broader classes of materials are usually far too low to affect consumers, except as a source of funds for litter prevention and cleanup activities. Tennessee's fee of six percent on soda and 50 cents per beer barrel equivalent is the major current exception.

Fees imposed at landfills and other disposal facilities often reflect only a modest increase in total disposal costs per ton, and are again sources of revenue rather than effective incentives for behavioral change.

Of most relevance to California are the several fees on packaging and either "single use" or "disposable" items (these latter types being listed in Table 2.1 under "Environmental Criteria"). Florida's is the only one which has passed to date, and at an initial rate of one cent per item is fairly small, although possibly significant for the most low-cost item, small-portion items. Illinois' and New Jersey' proposed fees of five cents and three cents, respectively, on packaging, could have more impact on producers and consumers. A bill has also been introduced in Illinois for a one cent fee on single-use items, and one is pending in Vermont to impose a four cent tax on disposables and single use items.

2.3.4 Use of Funds (Revenues) Generated

Our data base is less complete on this characteristic. For the deposit/refund systems dealing with both beverage containers and batteries, funds received go primarily to the refunds, with money remaining paying administrative costs of the business firms involved and the governmental agencies. Anything remaining may go to the state's general fund (Massachusetts, New York), to fund recycling programs (Maine's battery law), or in one case for alcoholism treatment programs (Iowa).

Where information was available on tire fees, in most cases funds are designated for waste disposal costs or recycling programs, with North Carolina distributing the money to localities on the basis of population. The pending diaper fees, and Maine's existing tax on white and brown goods, all reserve the money for recycling or source reduction programs.

The litter taxes designate revenues in almost all cases to litter prevention and cleanup. The fees at landfills and other disposal facilities are generally reserved for landfill-closure costs and other solid waste disposal costs, including recycling initiatives. We do not have information on how funds are to be used from most of the proposed taxes on packaging, single use, and disposable products.

Florida's advance disposal fee is to be redeemable at designated centers. The Department of Revenue is allowed to retain up to three percent of total funds for administration of the law, with the rest going into a "Container Recycling Trust Fund." At the centers, refunds can be obtained "in addition to payment for the market value of the product from which the container is made" (this provision appears rather unclear). Anything remaining in the Trust Fund is designated to support container recycling programs, allocated in the following percentages: 60% capital assistance grants; 15% litter control; 10% promotion and education; 8% technical assistance; 5% research and development; and 2% administration. The law appears to contain a contradiction in that it also specifies that remaining funds are to be transferred to the "Solid Waste Management Trust Fund for the purposes specified therein."[41]

2.3.5 Collection Point

All of the fees on batteries, tires, hazardous wastes, white and brown goods, packaging, single use, and disposable products are or are proposed to be collected at the retail level. The New Hampshire and Wisconsin proposed taxes on disposable diapers specify imposition at the "first sale" within the state. Beverage container deposits are usually collected by the distributor or wholesaler. In the "Multiple Materials" category, fees at the point of landfill or other disposal are collected at that level. The "litter taxes" are generally imposed simultaneously, charging the fee to manufacturers, distributors, wholesalers, and retailers, which would appear to increase the actual rate by three or four times.

2.4 EXPLANATION OF TABLE 2.1

2.4.1 Waste Categories

Table 2.1, on the following pages, shows in outline form the information which has been discussed above. The legislation is divided into sections by the type of material being regulated. Some of these categories are self-evident: batteries; tires; hazardous wastes; diapers; and beverage containers. "Whitegoods" refers to appliances, such as refrigerators and washers. "Packaging" refers to the wrappings in which food, beverages, toiletries, cleaning products, and other items are sold, but then are disposed either before or after the product itself is utilized. "Multiple Materials" is a categorization for laws which cover broader classes of items which end up in the solid waste stream. "Environmental Criteria" refer to specifications concerning the expected environmental and economic costs of disposal, or whether or not the item can be or is likely to be recycled.

2.4.2 Legislative Characteristics

Eight characteristics, plus an additional "note," are described for each piece of legislation (not all information is provided for all items). The **Status** of a bill is given as either passed or pending (the dates on which existing legislation was passed and/or became effective is available in our data base, but was omitted here for clarity of presentation). The **Mechanism** should generally be evident. **Fee Unit** refers to whether a tax or fee is placed according to weight, volume, price (which includes taxes based on revenues), or per item. The **Amount** is generally per whatever unit is given in the Fee Unit column. **Funds Use** provides some information on how governmental revenues are to be used, where that was known. **Collection Point** refers to the point within the economic system where a tax or fee is collected. **Exemption** refers to exemptions stated in the bill for particular sub-categories of products or materials. **Agency** is the governmental organization responsible for administering the bill. The **Notes** column provides some additional information, within the limits of the space available.

TABLE 2.1: SURVEY OF SOLID WASTE TAX/FEE LEGISLATION

State	Bill Number	Status	Mechanism	Fee Unit	Amount	Funds Use	Collection Point	Exemption	Agency	Notes
BATTERIES										
CT	90-248	Passed	Deposit	Item	$5.00	Admini-strative	Retail		DEP	No fee if old battery returned
ME	Title36/Sec4832	Passed	Tax/fee	Item	$1.00	Recycling	Retail		WMA	Lead acid batteries
WA	70.95.610	Passed	Tax/fee	Item	$5.00	Rebate	Retail	Market	Dept of Ecology	No fee if old battery returned
TIRES										
CA	AB1843	Passed	Tax/fee	Item	$0.25		Retail			
IL	PA 86-452	Passed	Tax/fee	Item	$0.50					When vehicle title is transferred
LA	ACT 185	Passed	Tax/fee	Not set						
ME	Title36/Sec4832	Passed	Tax/fee	Item	$1.00	Recycling	Retail		WMA	
NC	SB111/S130A-309	Passed	Tax/fee	Price	1 %	Revenue Sharing	Retail		Secretary of Revenue	
OK	HB 1533	Passed	Tax/fee	Item	$1.00		Retail			
OR	HB 2022	Passed	Tax/fee	Item	$0.50		Retail			
UT	SB 5		Tax/fee	Item	$1.00 to $2.00	Recycling	Retail	Recycle content	Tax Commission	$1.00 - $2.00 based on rim diameter
VA	Sec58.1-640	Passed	Tax/fee	Item	$0.50	Waste Disposal	Retail	Bicycles	Tax Commission	
WA	ESHB 1671		Tax/fee	Item	$1.00		Retail			
WI		Passed	Tax/fee	Item	$2.00		Retail			$2 fee on new vehicles
HAZARDOUS WASTES										
CT	90-215	Passed	Ban							Bans hazardous metal from packaging
RI	HB5504	Passed	Tax/fee	Volume	.0025-.10		Retail			Oil, antifreeze, organic solvents

State	Bill Number	Status	Mechanism	Fee Unit	Amount	Funds Use	Collection Point	Exemption	Agency	Notes
DIAPERS										
NH	HB1368-FN	?	Tax/fee	Item	$0.10	Source Reduction	First sale		Dept of Rev Administration	Funds to encourage reusable diapers
WI	SB300	Passed	Grant/loan							
WI	SB300	Pending	Tax/fee				First sale		Dept of Revenue	Tax paid by purchase of stamps
WHITEGOODS										
ME	Title36/Sec4832	Passed	Tax/fee	Item	$5.00	Recycling	Retail		WMA	White & "brown" goods
ME	LD2354/Sec4832	Pending	Tax/fee	Price	1 %		Retail			Appliances, electronics, business equipment
BEVERAGES										
CA	AB2020	Passed	Deposit	Item	$0.02		Distributor			
CT		Passed	Deposit	Item	$0.05		Distributor		DEP	$0.01 beer,$0.02 soda handling fee
DE		Passed	Deposit	Item	$0.05		Distributor	>64 ounces	DNR	Aluminum exempt until 1992
IA		Passed	Deposit	Item	$0.05	Alcohol Treatment	Distributor		DNR	Minimum $0.01 handling fee
MA		Passed	Deposit	Item	$0.05	General Fund			Solid Waste Division	$0.02 handling fee
ME	Title32/Sec1861	Passed	Deposit	Item	$0.03-$0.15	Admini-strative	Retail	Milk, Dairy	Agriculture Dept	
MI		Passed	Deposit	Item	$0.05-$0.10	General Fund			DNR	Handling fee is a %
NY		Passed	Deposit	Item	$0.05				DEC	$0.015 handling fee
OR		Passed	Deposit	Item	$0.02-$0.20		Distributor			$0.02 on certain reusable
RI		Passed	Tax/fee	Case	$0.04	Litter	Wholesale		DEM	
TN		Passed	Tax/fee	Price	6% soda receipts	Litter			DOT, Dept Conservation	
TN		Passed	Tax/fee	Item	$0.50/beer barrel equivalent	Litter			DOT, Dept Conservation	

State	Bill Number	Status	Mechanism	Fee Unit	Amount	Funds Use	Collection Point	Exemption	Agency	Notes
VA	Sec 58.1	Passed	Tax/fee	Price	max 0.06%		Wholesale		Dept Taxation	
VT		Passed	Deposit	Item	$0.05				DNR	$0.03 handling fee

PACKAGING

State	Bill Number	Status	Mechanism	Fee Unit	Amount	Funds Use	Collection Point	Exemption	Agency	Notes
CT	90-309	Passed								Prohibits bans on polystyrene packaging
CT	90-215	Passed	Ban/req							Bans toxic metals from packaging
FL	CH88-130/Sec72	Passed	Tax/fee	Item	$0.01			Recyclable		Glass, plastic, aluminum, coated paper, metals
IL	HB3980	Pending	Tax/fee	Item	$0.05		Retail			On containers w/out 50% recycling rate
NC	SB111/S130A-309	Passed	Ban/req							Bans several container types
NJ	A2218	Pending	Tax/fee	Item	$0.03		Retail	?		Rigid containers > 6 ounces

MULTIPLE MATERIALS

State	Bill Number	Status	Mechanism	Fee Unit	Amount	Funds Use	Collection Point	Exemption	Agency	Notes
IL	HB3370	Pending	Can rate	Weight/ volume			Waste Collection	City size		Requires variable can rates
CA	AB939	Passed	Tax/fee	Weight/ volume	-----	Landfills-env prot	Landfill	Firm size		Set to raise $20 million total
NB		Passed	Tax/fee	Price	0.015%	Several	Several		DEC	Sunsets 10/30/92
NC	SB111/CH784	Passed	Tax/fee				Waste Processing			Fees on waste processing facilities
NJ		Passed	Tax/fee	Price	0.0225%	Litter	Several	Firm size	DOE,DEP	Expires end of 1991
OH		Passed	Tax/fee	Firm	$5000.00	Litter	Several		DNR	Sunsets 7/1/93
TX		Passed	Tax/fee	Volume/ weight	$0.50/ton	Waste Disposal	Landfill		Dept Health	
UT	SB255	Passed	Tax/fee	Weight	$0.50-$2.50/ ton	General Fund	Waste Disposal			$0.50 municipal, $2.50 other
VA	58.1-1706	Passed	Tax/fee	Firm	$10.00- $25.00		Several			Manufacturer, Wholesaler, Distributor, Retail

State	Bill Number	Status	Mechanism	Fee Unit	Amount	Funds Use	Collection Point	Exemption	Agency	Notes
WA		Passed	Tax/fee	Price	0.015%	Litter	Several			
WV		Passed	Tax/fee	Weight	$1.20-$2.20/ton		Waste Disposal		DNR	$1.20 local, $2.20 other waste

ENVIRONMENTAL CRITERIA

RI	HB9163	Passed	Tax exempt				Retail	Biodegrade/Returnable		Exempts biodegradable and returnable from tax
IL	HB3634	Pending	Tax/fee	Item	$0.01	Recycling	Retail			Single use items
VT	SB326/Sec7	Pending	Tax/fee	Item	$0.04					Disposable items
VT	SB326/Sec7	Pending	Tax/fee	Item	$0.04					Single use items

2.5 ENDNOTES

1. See the following:

   State Action on Packaging and Source Reduction: A Compendium of Legislative Options, Solid Waste Alternatives Project, Environmental Action Foundation, June 1990.

   Jim Glenn, "The State of Garbage in America," *BioCycle*, April 1990.

   Constance Thomas, "State Legislative and Regulatory Initiatives in Solid Waste Management," Intergovernmental Health Policy Project, George Washington University, in cooperation with The Center for Environmental Management, Tufts University, December, 1989.

   "State Index -- Selected Solid Waste Bills," American Paper Institute, April 27, 1990.

   "Summary of State Environmental Laws and Alternative Litter Control & Recycling Programs Affecting the Soft Drink Industry," National Soft Drink Association, January 1990.

2. Public Act No. 90-248, "An Act Concerning Lead Acid and Nickel Cadmium Batteries," provided by Connecticut State Library, Legislative Reference Section.

3. Washington State Code 70.95.610-670 concerning disposal of vehicle batteries, provided by Washington State Department of Ecology.

4. "Maine Solid Waste Laws 1990," Office of Planning, Maine Waste Management Agency, Section 4831-4834, "Solid Waste Advance Disposal Fee," pages 18-19.

5. California Assembly Bill 1843, pages 14-15.

6. See, for example, Thomas, December 1989, summary chart.

7. "An Act to Improve the Management of Solid Waste," Chapter 784, Senate Bill 111, General Assembly of North Carolina, 1989 Session, Ratified Bill, Section 130A-309.54-309.56, page 27.

8. Utah Senate Bill No.5, "Recycling of Waste Tires," 1990 General Session, obtained from the Utah Bureau of Solid and Hazardous Waste.

9. "Virginia Tire Tax," Virginia Code, Chapter 6.1, Section 58.1-640 to 644.

10. Jim Glenn, "The State of Garbage in America," *BioCycle*, April 1990, page 39.

11. Public Act 90-215, "An Act Concerning Reduction of Toxics in Packaging," provided by Connecticut State Library. Also "Summary of 1990 Public Acts, Connecticut General Assembly," Office of Legislative Research, page 41.

12. Solid Waste Alternatives Project, Environmental Action Foundation (EAF), *State Action on Packaging and Source Reduction*, June 1990, page 3.

13. *Ibid.*

14. HB 1368-FN, State of New Hampshire, "An Act to impose a disposable diaper fee," provided by the Department of Environmental Services.

15. EAF, *op. cit.*

16. "Fact Sheet: Advance Disposal Fee, Information For Retailers," Maine Waste Management Agency.

17. "Fiscal Note" on LD 2354 from Maine Waste Management Agency.

18. See:

    "Part 367, Returnable Beverage Containers, Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York, Pursuant to Article 27, Title 10, Environmental Conservation Law," effective July 1, 1983, New York State Department of Environmental Conservation; and "Amendments, Part 367, Returnable Beverage Containers," effective October 21, 1983.

    "Beverage Containers Deposit," Iowa State Code, Chapter 455C.

    "Fact Sheet: Maine's Bottle Bill," Maine Waste Management Agency, September 1990, and Maine Solid Waste Laws, Title 32, Sections 1862-1867, pages 11-15.

    "Oregon's Bottle Bill: The 1982 report," Oregon Dept. of Environmental Quality, Hazardous and Solid Waste Division.

19. "Fact Sheet: Maine's Bottle Bill, Maine Waste Management Agency, September 1990.

20. Virginia State Code, Chapter 17, Article 1, "Soft Drink Excise Tax," pages 179-180, and Article 2, "Litter Tax," pages 180-181.

21. Florida Code, Chapter 88-130, Sections 71-78, pages 80-88.

22. EAF, *op. cit.*

23. *Ibid.*

24. *Ibid.*

25. Florida State Code, Section 71, "Waste newsprint disposal fees," pages 80-81; and Environmental Action Foundation, June 1990.

26. Enrolled Copy Senate Bill No. 255, "Waste Management Amendments 1990 General Session," obtained from the Utah Bureau of Solid and Hazardous Waste.

27. National Soft Drink Association, *op. cit.*, January 1990.

28. *Ibid.*

29. California Assembly Bill 939, pages 68-69.

30. EAF, *op. cit.*, June 1990.

31. National Soft Drink Association, *op. cit.*

32. *Ibid.*

33. *Ibid.*

34. Virginia State Code, Section 58.1.

35. National Soft Drink Association, *op. cit.*

36. EAF, *op. cit.*

37. *Ibid.*

38. *Ibid.*

39. Connecticut State Code Chapter 88-130, page 81.

40. Many studies of the impacts of bottle bills have been performed. See, for example:

    Moreland Act Commission on the Returnable Container Act: Report, performed for the State of New York, March 15, 1990.

    "Effects of Michigan's Bottle Bill on Michigan's Resources;" "Effects of Michigan's Bottle Bill on Municipal Solid Waste;" and "The Bottle Bill," all May, 1990, by the Michigan Department of Natural Resources.

    William Gehr, "Effect of the Vermont Beverage Container Deposit System and Recommendations by the Committee," Agency of Natural Resources.

    "Oregon's Bottle Bill: The 1982 Report," *op. cit.*

41. Florida State Statutes Chapter 88-130, pages 82-83.

CHAPTER 3 - CALIFORNIA WASTE STREAM ANALYSIS

In order to develop a disposal cost fee system for California, it is imperative to have a full understanding of the state's waste stream and current and future waste management strategies. The purpose of this chapter is to compile and analyze available California waste stream data, in order to develop a data set which will be used in developing and analyzing a disposal fee system. In the following chapters this data will be employed in estimating pollutant loadings in different waste management facilities, estimating the conventional and environmental costs of disposal, and evaluating the prospective revenues from the disposal fee system.

3.1 DATA REQUIREMENTS

Characterization of the California waste stream requires a number of types of data:

- composition of the residential and commercial waste streams
- quantities of waste generated by the residential and commercial sectors
- total annual waste generation for California
- information on current handling of household hazardous wastes
- levels of recycling for all materials in the waste stream
- current disposal paths for each material in the waste stream
- description of existing and planned disposal facilities in California

In general, California statewide data was not readily available, necessitating the development of the data from more disaggregated sources. We collected data on a county level (for counties without data, we made estimates based on other similar counties) and aggregated the county data to arrive at statewide totals.

A large part of the data we were seeking with respect to waste composition, recycling and waste generation was under development in California in late 1990 and was not available for our use. This data is being developed by cities and counties as part of their A.B. 939 Source Reduction and Recycling Element (SRRE), which must be submitted by July 1, 1991.

Data was drawn from many sources: County Solid Waste Management Plans, data prepared for SRREs, California Integrated Waste Management Board documents, Department of Conservation documents, Board of Equalization data on collection of landfill surcharges, and Tellus studies, among others. In order to ensure that we had identified all existing county and city data, we contacted each county and asked for the latest available data or reports. In the end we obtained usable composition data for 23 counties, and for the city (but not county) of Los Angeles. In most cases the data came from SRRE's or from County Solid Waste Management Plans (CoSWMPs).

3.2 DEFINING THE WASTE STREAM

Analyzing both the residential and commercial waste streams required the adoption of standard material definitions. Materials analysis was disaggregated to a greater level of detail in the waste stream analysis tables (Tables 3.1 and 3.2) than was the case for later tables. More specifically, in later tables white goods and ferrous metals were combined with the "other metals" category. Thus there are only two metals categories in tables beyond 3.2: aluminum, and other metals. Similarly, bulky items were combined with inert solids, and the category was renamed "other waste."

Standard definitions for each of the materials analyzed are presented below.

PAPER CATEGORIES

Old Corrugated Containers (OCC) - a container consisting of a corrugated medium sandwiched between two layers of kraft linerboard. Kraft paper is usually made from wood pulp and possesses a basis weight range of 18-200 pounds. Corrugated mediums are made from wood pulps, straw, or reclaimed paper stock.

Mixed Paper - an unsegregated mixture of a variety of different paper categories (i.e.,OCC, colored paper, newspapers, high grade).

Newspaper - low quality paper used for manufacturing newsprint.

High Grade Paper - high quality white paper which possess presentation qualities, usually generated in offices.

Other Paper - low grade paper or paper containing products/packaging not included in the above categories. This categories includes paper contained in composite packages such as milk cartons and aseptic packages.

PLASTIC CATEGORIES

High Density Polyethylene (HDPE) - a rigid plastic material usually opaque or clear in color. HDPE is often used in milk containers, cleaning solutions, oil bottles, etc. Such containers usually carry the triangular recycling symbol with a "2" inside the symbol.

Polyethylene Terephthalate (PET) - a flexible plastic materials often used in soda bottles. PET containers are characterized by a small dot or nipple at the base as opposed to a seam. Such containers usually carry the recycling triangle with a "1" inside the symbol.

Films - any of a variety of plastic materials which are flexible and thin (10 mil or less). Films are often used for plastic grocery bags, food wraps, and agricultural covering.

Other Plastics - all plastics except HDPE, PET, and films.

GLASS CATEGORIES

Recyclable Glass - includes flint, amber, green, mixed, and refillable glass beverage containers.

Non-recyclable Glass - glass that usually cannot be processed at a recycling facility, including pyrex, plate, light bulbs, and automobile glass.

METAL CATEGORIES

Aluminum Cans - Any container which is composed of 99% or more aluminum.

Ferrous Metals - iron or steel materials which posses an iron content sufficient for magnetic separation.

Non-ferrous Metals - metal scraps which do not adhere to a magnet, including aluminum, copper, brass, bronze, lead, and zinc.

White Goods - large enamel coated appliances such as washing machines, clothes dryers, stoves, refrigerators, etc.

Other Metals - for the purposes of this report, in tables beyond 3.2, other metals include a combination of ferrous, non-ferrous, and white goods.

YARD WASTE CATEGORY

Yard Waste - usually organic waste resulting from the maintenance or alteration of landscapes including but not limited to grass clippings, leaves, tree trimmings, prunings, brush, and weeds.

OTHER ORGANIC CATEGORIES

Organic Compostables - non-petroleum based wastes containing naturally produced organic compounds. Such wastes are biologically decomposable by microbial and fungal processes into water, carbon dioxide, and other simpler organic compounds. A major constituent of this category is food wastes.

Organic Non-compostables - for tables up to 3.2, this category is defined as wastes that do not readily decompose through biological action; disposable diapers are one example. Beyond Table 3.2, sewage sludge is also included within this category.

Textiles - fabric materials, including clothing, rugs, and upholstery made from natural fibers (i.e., cotton, wool, silk).

Tires/Rubber - materials consisting of an amorphous polymer of isoprene derived from natural latex, ceratin tropical plants, and petroleum.

Wood Waste - waste materials consisting of wood pieces or particles.

OTHER WASTE

Bulky Items - large discarded items including furniture, and other large composite products. This category was aggregated with the other wastes category after Table 3.2.

Miscellaneous Inorganics - any of a variety of mixed inorganic materials includes such things as non-bulk ceramics and other clay products. Many waste composition analyses do not distinguish this category from inert solids. For the purposes of this report, this category was aggregated with the other special waste category after Table 3.2.

Inert Solids - often fine, non-hazardous waste materials including but not limited to soil, concrete, gypsum, etc. This category was aggregated with the "other waste" category after Table 3.2.

Household Hazardous Waste - a variety of consumer products which because of their quantity, concentration or physical chemical or infectious characteristics, may pose a hazard to human health or the environment.

OTHER SPECIAL WASTE CATEGORY

Other Special Waste - often classified as a slurry of which the solid constituents are insoluble in water. These wastes contain inorganic solids and are thus hazardous. For the purposes of this report, inert solid were aggregated with this category after Table 3.2.

3.3 THE RESIDENTIAL WASTE STREAM

Based on the data we obtained from 23 counties plus the city of Los Angeles, we estimate that the California residential waste stream consists of

35% paper
6% plastics
7% glass
7% metals
19% yard waste
17% other organic
1% special waste
8% other waste

These figures are derived from Table 3.1, which presents the detailed composition data for the 24 jurisdictions.

The category "other waste" includes such waste components as bulky items, miscellaneous inorganics, inert solids, and household hazardous waste. Household hazardous waste makes up approximately 1% of the residential waste stream and is discussed further in Section 3.9. Diapers may represent as much as 2.7-3.0% of the waste stream, but are not reported consistently by all jurisdictions.

3.4 THE COMMERCIAL WASTE STREAM

It is important to evaluate the commercial waste stream, as the types and quantities of waste generated by businesses will in general differ from that of households. Based on our analysis of the county data, we estimate that the California commercial waste stream consists of

35% paper
8% plastics
6% glass
6% metals
11% yard waste
21% other organic
1% special waste
12% other waste

The "other waste" category contains the same materials as in the residential waste stream analysis. See Table 3.2 for the county by county development of the commercial waste stream composition.

The commercial waste stream estimates are not simply based on reported waste generation data, since counties often do not disaggregate their data into residential and commercial waste streams. As a result, it was necessary to develop a separate estimate of the California commercial waste stream in order to identify waste generated by the residential versus commercial sector. To do this we researched economic activity in California and waste generation factors for different economic sectors.

For the level of economic activity, we used data from the U.S. Department of Commerce, Bureau of the Census, County Business Patterns and Geographic Area Series, and the Department of Education. To identify waste generation factors for the various sectors we consulted a variety of previous studies; many of the waste generation factors were based on work done by Tellus for New York City. When waste generation factors were not available for each sector, waste generation factors of other similar sectors were used. For example, for the administrative and auxiliary sector we assumed that the annual waste generation rate was 0.4 tons per employee, based on estimates for office work in general.

We estimate the California commercial waste stream at 22,530,600 tons annually. The largest contributors to the commercial waste stream are:

general merchandise stores	8%
general retail	6%
eating and drinking places	13%
food stores	18%
manufacturers	13%

See Table 3.4 for a detailed overview of the commercial waste stream derivation.

3.5 RECYCLING IN CALIFORNIA

We estimate the total recycling rate for California to be 10.97%, inclusive of all California Beverage Container Recycling and Litter Reduction Act (A.B. 2020) materials. Recycling rates for individual materials are shown in Table 3.6.

In estimating the state's total recycling level, we did not include data from counties which reported a total recycling rate but failed to support it with specific material recycling rate breakdowns. Such counties tended to report higher overall recycling rates than the counties which specified their rates by material. See Table 3.5 for an overview of current recycling within each county.

Approximately 5.5 million tons of materials are recycled annually, making up the 10.97% recycling level. Table 3.6 identifies the actual quantities of each material recycled, as well as the recycling rate for each material. Those materials which have the highest recycling rates are paper, metal, organic non-compostables, and other wastes.

We derived these recycling tonnages from the previous tables, using statewide projections of reported recycling rates from those counties with detailed information. There are several reasons why our figures may differ from industry reports (which generally show higher recycling), including possible errors in our data or in the industry data, high recycling levels in counties which did not report to us, or inclusion of industrial process scrap and/or out-of-state recycled materials in the industry figures.

For instance, our estimate of glass recycling for 1990 is 275,000 tons, whereas glass manufacturers have reported a figure of approximately 475,000 tons.[1] We have not attempted to analyze such discrepancies further; they may be more easily resolved once the mandatory SRRE's and Waste Generation Elements are submitted to the CIWMB.

The 13.73% recycling rate which we list for the "other waste" categories is an aggregate figure encompassing several disparate subcategories. Household hazardous waste recycling, one important subcategory, is approximately 0.75% In this report, however, the actual cost of household hazardous waste collection and disposal is estimated to be the cost of the separate collection programs. Therefore, the aggregate "other waste" recycling rate of 13.73% does not enter our calculation of the cost of managing household hazardous wastes.

3.6 SUMMARY OF THE CALIFORNIA WASTE STREAM

We estimate the total annual waste generation for California at 50,017,700 tons, based primarily on estimates extracted from County Solid Waste Management Plans. Where more current data was available, we used it in our analysis. Where no data was available, we assumed a per capita waste generation factor of 7 pounds/day (below the state average).[2]

Recent estimates of the quantity of solid waste generated in California range from 40 million to more than 41 million tons, based on the receipts of landfill surcharges as mandated by A.B. 2448, and A.B.939[3]. However, these figures include only waste loadings at landfills. They do not include waste which is recycled, composted, or incinerated. But even for landfill volume alone, we believe that 44 million tons is a better estimate. In light of the imprecision in measurement of quantities received at landfills, such discrepancies are not surprising.

Those counties which generate the most waste (with their percentages of the state waste stream) are:

Alameda	4%
Los Angeles	34%
Orange	12%
Riverside	4%
San Bernardino	5%
San Diego	7%
Santa Clara	4%

It is not surprising that a large portion of the California waste stream is generated in the southern counties, since these are also the largest centers of population and economic activity. Table 3.7 presents the contribution of each county to the overall waste stream.

Tables 3.7 and 3.8 summarize the California waste stream and analyze the composition of the waste entering different facility types. The resulting 1990 total waste stream by material was projected to be:

17.5 million tons paper (35%)
3.5 million tons plastics (7%)
3.3 million tons glass (7%)
3.2 million tons metals (6%)
17.3 million tons organic (34%)
5.3 million tons other waste (11%)

This waste stream represents both residential and commercial/industrial waste. By subtracting the estimated commercial/industrial waste stream from the total waste stream generated, we estimate the residential waste stream to be approximately 27,487,100 tons annually.

To determine the amounts of each material being diverted to waste-to-energy facilities in California we examined the waste streams of the three operating waste-to-energy facilities in California and then took a weighted average based on the capacity of each facility. Table 3.8 shows that 933,000 tons of waste (1.9% of the state total) would be directed to waste-to-energy facilities each year if all facilities operated at full capacity. These numbers may be taken as an upper bound, since in reality the facilities likely operate below year-round full capacity; lacking precise information on capacity utilization, we have used the full capacity figures.

In all, we estimate that roughly 87% of the state's waste stream is landfilled, 11% is recycled, and 2% is burned in waste-to-energy facilities. Using our 50 million ton estimate for the total waste stream, and subtracting roughly 5 million tons of recycling and 1 million tons of incineration, we are left with 44 million tons being landfilled.

The disposal fee being developed in this study is mandated to exclude the materials covered by the California Beverage Container Recycling and Litter Reduction Act (A.B.2020). In order to correctly reflect the state's non-A.B. 2020 waste stream we developed Table 3.9. That table identifies the total non-A.B.2020 waste stream as 49 million tons, and shows disposal paths for that waste stream, exclusive of the 1 million tons of A.B. 2020 materials.

The A.B. 2020 waste stream consists of 1 million tons of materials with 640,000 tons of A.B. 2020 materials landfilled, 353,000 tons of A.B. 2020 materials recycled and 11,000 tons of A.B. 2020 tons incinerated. The disposal path of all A.B. 2020 materials combined is 64% landfilled, 35% recycled, and 1% incinerated. These materials do not enter our cost calculations in subsequent chapters.

3.7 HOUSEHOLD HAZARDOUS WASTES

In 1989, nineteen counties and twenty-one cities in California conducted some sort of household hazardous waste (HHW) collection program. Data was available for the following counties: Marin, Monterey, Nevada, Plumas, Sacramento, San Benito, San Bernardino, San Diego, San Francisco, San Mateo, Santa Barbara, Santa Cruz, Ventura, and Yolo. City data was available for the following cities: Benicia, Beverly Hills, Burbank, Cupertino/Los Altos/Mountain View, Gilroy/Morgan Hill, Hayward, Healdsburg, Inglewood, Los Angeles, Modesto, Newark/Fremont/U, Palo Alto, Petaluma, Portola, Salinas, San Jose, Santa Monica, Santa Rosa, Scotts Valley, Sonoma, Sunnyvale, and Vallejo.

By volume, paint, household and lead acid batteries, and used oil made up an average of 69% of the HHW collected by counties, and 79% of the HHW collected by cities in 1989. Of the HHW collected by counties, we estimated that batteries comprised an average of 3%, latex paint comprised 15%, solvent paint comprised 27%, and used oil comprised 24%. These numbers are derived in Table 3.10. The remaining 31%, called "other waste", included a variety of materials such as acids, aerosols, antifreeze, automotive materials, asbestos, caustics, cosmetics, drain cleaners, fertilizers, furniture polish, gasoline, herbicides, household cleaners, medication and drugs, paint thinner, pesticides, photography chemicals, solvents, and wood preservatives.

Of the HHW collected by cities, we estimated that batteries comprised an average of 4%, latex paint comprised 32%, solvent paint comprised 23%, and used oil comprised 20%. These numbers are derived in Table 3.11. The composition of the remaining 21% for cities is similar to that of the counties.

For counties, we calculated that an average of 2.52% of the population participated in collection efforts and collected 135,958 gallons of HHW; 2,892 "55-gallon" drums of HHW, and 3859 batteries. For cities, we calculated that an average of 3.86% of the population participated in collection efforts and collected 68,343 gallons of HHW; 8,611 "55-gallon" drums of HHW; and 3,466 batteries.

In order to come up with a total number of gallons of HHW collected by counties and cites, we assume that a car battery is equivalent to 1 gallon of waste (the assumption used in San Francisco's HHW Collection Facility, Second Year 1989 Annual Report).

In the summary table, we calculated that 714,986 gallons of HHW were collected in California in 1989. Of the total gallons collected, batteries contributed 4%, latex paint 26%, solvent paint 24%, used oil 22%, and other waste 24%.

In Table 3.12, we project the total amount of HHW generated in California. In order to calculate this total, we first assumed that the capture rate of the base case was 100%. This means that the program collected 100% of the participants' HHW. Then we scaled up the amount of HHW in the base case, the amount collected from 2.52% of the population, by multiplying by [100% population participation/actual population participation %]. This product projects the amount of HHW which would be collected with a 100% participation rate and 100% capture rate. Since we cannot be certain that program collected 100% of the participants' HHW, we utilized different capture rates, namely, 75%, 50%, and 25% as other cases. For cases 2,3, and 4, the above mentioned product is then divided by different capture rate percentages. The projected total amount of HHW derived will increase as one uses lower capture rates. These calculations assume a linear relationship between population participation and amount being collected. That is, as the participation rate increases, the amount being collected increases proportionally.

The types of materials which were recycled or reused included used oil, lead-acid batteries, latex paint, oil-based paint, antifreeze, mercury, fertilizers, and solvents. An average of 57% of the HHW collected by counties was recycled. An average of 37% of the HHW collected by cities was recycled. It is not clear to what extent each waste is recycled. We will assume that latex paint, used oil, and batteries are recycled at 100%, an estimate based on individual survey entries. The remaining percentage of HHW which was recycled was distributed proportionately over the two categories solvent paint and other waste.

Table 3.1 Residential Waste Composition by County

COUNTIES	Calaveras	Contra Costa	Fresno	Humboldt [3]	Lassen [11]	LosAngeles[12]	Marin	Merced	Monterey
PAPER	42	51.3	42.6	37.6	17.5	33.8	36	48.5	31.5
Corrugated		11.7	5.9		6.0	2.6	9.0	9.5	5.7
Mixed paper		30.6	26.8		1.0		16.0	30.5	15.6
Newspaper		9.0	9.9		10.0	5.7	8.0	8.5	6.9
High grade					0.5		3.0		
Other paper [5][13]						25.5			3.3
PLASTICS		6.2	6.0	5.2		4.2	6.0	5.9	6.0
HDPE									1.1
PET									0.2
Film		2.6							1.2
Other		3.6							3.5
GLASS	3.3	14.6	6.6	10.9	7.0	6.4	8.0	5.9	4.9
Recyclable							6.0		4.7
Non-recyclable							2.0		0.2
METALS	6.2	6.5	7.1	11.1	6.0	3.5	6.3	7.7	9.0
Aluminum cans		1.2		2.2	1.0	0.5	0.3		0.5
Ferrous		5.3	5.4	8.8	5.0	3.0		5.8	7.6
Other metals [10]			1.7					1.9	0.3
White goods									0.6
YARD WASTE	8.3	13.7	17.1	10.6		35.6	17.0	12.9	19.7
OTHER ORGANICS	21.3	7.7	19.4	19.5		13.2	15.2	18.1	19.2
Org compostables/Food	8.6	2.9	16.0	10.6		8.8	11.0	15.2	7.7
Org non-compostables		3.2					1.0	2.9	3.0 [1]
Textiles			3.4			1.6			3.5
Tires/Rubber	12.7	0.8		8.8		0.6	0.2		1.1
Wood waste		0.8				2.2	3.0		3.9
OTHER WASTE	21.5		1.2	5.1		3.2	12.0	0.9	6.4
Bulky items						0.0			
Misc. inorganics			1.2			0.0			1.3
Inert solids	21.5			5.1		3.2		0.9	4.4
HHW						0.0			0.7
SPECIAL WASTE CATEGORY									
Other special waste									
TOTALS	102.6	100.0	100.0	100.0		99.9	100.5	99.9	96.7

Table 3.1 Residential Waste Composition by County

COUNTIES	Nevada	Orange	Placer	Plumas	Riverside	Sacramento	San Bernardino	San Francisco	San Joaquin
PAPER	33	28	35.6	32.6	48	24.6	38.5	46.7	47
Corrugated	9.0			8.0		4.0			10.0
Mixed paper	15.0	20.0		0.7		6.0			
Newspaper	8.0	8.0		6.8		8.0			4.0
High grade	1.0			1.3		0.4			
Other paper [5][13]				15.8		6.2			33.0
PLASTICS	6.0	5.0	7.3	10.2	4.0	4.9	8.5	8.6	10.0
HDPE				0.3		0.3			
PET				1.1		0.1			
Film				4.0		2.1			
Other				4.8		2.4			10.0
GLASS	6.0	7.0	8.4	4.2	4.0	4.2	7.0	7.8	8.0
Recyclable				4.0		3.7			
Non-recyclable				0.2		0.5			
METALS	8.0	5.0	8.9	6.2	5.0	4.3	6.0	6.2	10.0
Aluminum cans				0.5		0.3			1.0
Ferrous	3.0	1.0		4.2	5.0	2.5	4.5		8.5
Other metals [10]	1.0	4.0		1.4		1.3	1.5		0.5
White goods	4.0			0.1		0.2			
YARD WASTE	17.0	30.0	20.1	17.2	24.0	40.9	18.0	3.5	15.0
OTHER ORGANICS	7.0	17.0	17.8	20.3	13.0	14.3	15.5	21.2	10.0
Org compostables/Food		6.0	8.9	9.6	8.0	6.7			
Org non-compostables			2.0	6.1		2.7 [2]			6.0
Textiles						3.3			
Tires/Rubber	1.0	6.0	2.8	0.9		0.3			
Wood waste	6.0	5.0	4.1	3.7	5.0	1.3			4.0
OTHER WASTE	23.0	8.0	1.9	6.9	2.0	6.2	6.5	6.0	
Bulky items									
Misc. inorganics									
Inert solids	21.0	8.0		4.9	2.0	6.2			
HHW	2.0			2.0					
SPECIAL WASTE CATEGORY				2.3		0.4			
Other special waste				2.3		0.4			
TOTALS	100.0	100.0	100.0	99.9	100.0	99.8	100.0	100.0	100.0

Table 3.1 Residential Waste Composition by County

COUNTIES	Santa Barbara	Santa Cruz	Shasta	Sonoma	Ventura	Yolo	AVERAGE	Adjusted AVERAGES
PAPER	9.35	31	30.23	40.6	32.1	34.9	35.5 [4]	35
Corrugated	3.3	5.5	9.3		3.8		7.4 [4]	8
Mixed paper		7.4	2.0		7.4		5.4 [6]	6
Newspaper	5.7	8.4	9.9		8.5		8.0 [4]	9
High grade	0.4	0.4			0.4		0.9 [4]	1
Other paper [5][13]		9.3	8.9		12.0		10.8 [6]	12
PLASTICS	3.4	5.4	6.5	4.6	6.5	5.9	6.2 [4]	6
HDPE		0.3	1.6		0.7		0.7 [4]	1
PET		0.1	0.2		0.2		0.3 [4]	0
Film	1.4	2.3	2.4		1.3		2.2 [4]	2
Other	2.0	2.7	2.4		4.3		3.3 [7]	3
GLASS	5.1	4.5	10.9	10.9	4.9	8.1	7.0 [4]	7
Recyclable		3.9	9.8		3.6		5.1 [4]	6
Non-recyclable		0.6	1.1		1.3		0.8 [4]	1
METALS	3.8	6.7	4.4	9.0	4.4	9.0	6.7 [4]	7
Aluminum cans	0.4	0.4	0.2		0.7		0.7 [4]	1
Ferrous		3.7	2.8		2.0	7.9	4.8 [4]	4
Other metals [10]	3.4	1.9	0.5		0.3	1.1	1.0 [8]	1
White goods		0.7			1.7		1.2 [4]	1
YARD WASTE	41.8	25.1	13.8	10.4	23.7	12.9	19.5 [4]	19
OTHER ORGANICS	18.1	17.9	27.7	13.4	25.3	17.5	16.9 [4]	17
Org compostables/Food	4.2	7.2	22.2	10.7	20.4	9.7	10.2 [4]	8
Org non-compostables		4.8	4.8		2.6	3.4	2.9 [9]	2
Textiles	3.6			1.7			2.8 [4]	2
Tires/Rubber	1.1				0.2	2.1	2.8 [4]	2
Wood waste	9.3	5.9	0.8	1.0	2.0	2.3	3.5 [4]	3
OTHER WASTE	18.4	8.4	7.4	11.1	5.6	1.4	7.8 [4]	8
Bulky items						—		
Misc. inorganics				11.1				
Inert solids	18.0	8.4	7.1		4.8	1.4	7.8 [4]	7
HHW	0.4		0.2		0.8		0.9 [4]	1
SPECIAL WASTE CATEGORY		0.5					1.1 [4]	1
Other special waste		0.5					1.1 [4]	1
TOTALS	100.0	99.0	100.8	100.0	102.4	89.7	104.1 100.7	100

Table 3.1 Residential Waste Composition by County

Notes:

[1] 3% of which is disposable diapers
[2] 2.7% of which is disposable diapers
[3] The Humboldt %s are derived using 68255 tons MSW generated for 1987.
[4] Average from all counties with an entry for this category.
[5] Other paper includes non-recyclable paper.
[6] Averages from Plumas, Sacramento, Santa Cruz, and Ventura.
[7] Average from Monterey, Plumas, Sacramento, Santa Cruz, Shasta, and Ventura.
[8] Average from Monterey, Plumas, Sacramento, Santa Cruz, and Ventura.
[9] Average from Monterey and Sacramento
[10] Other metals includes non-ferrous
[11] % only available for materials which are recycled
(12) City data was used for Los Angeles in the absence of countywide data.
(13) L.A. city data indicates that mixed and high grade paper were included in the "other paper" category

Sources:

Data was extracted from County Solid Waste Management Plans and current data being compiled by Counties in order to meet the AB939 requirements.

Table 3.2 Commercial Waste Composition by County

COUNTIES	Fresno		Orange [3]		Placer [4]		Plumas		Sacramento		Santa Barbara		Santa Cruz	
PAPER		55.7		42		35.6		33.5		41.8		14.75		22.0
Corrugated	14.9						8.3		11.6		8.2		8.4	
Mixed paper	34.9						0.7		8.8				5.3	
Newspaper	5.9		2				7.1		6.2		4.8		1.7	
High grade							2		2.7		1.75		2.3	
Other paper [5]							15.4		12.5				4.3	
PLASTICS		7.1		7		7.3		11.3		6.7		5.48		8.4
HDPE							0.7		0.2				0.1	
PET							0.3		0.1					
Film							4.5		3.3		2		1.9	
Other							5.8		3.1		3.48		6.4	
GLASS		5.3		7		8.4		7.4		4.3		6.1		1.5
Recyclable							4.8		3.8				1.4	
Non-recyclable							2.6		0.5				0.1	
METALS		9.2		2		8.9		8.3		4.5		5.25		5.3
Aluminum cans			1				0.6		0.4				0.2	
Ferrous	6.9		1				5.8		2				2.3	
White goods													1.2	
Other metals [12]	2.3						1.9		2.1		5.25		1.6	
YARD WASTE		3.4		5		20.1		7.2		8		25.79		16.4
OTHER ORGANICS		18.8		20		17.8		22.6		24.4		17.7		22.9
Org compostables/Food	16.3				8.9		13.1		14		6.12		3.1	
Org non-compostables			8						0.9 [2]					
Textiles	2.5				2		3		5.1		1.1		3.9	
Tires/Rubber					2.8		0.8		0.8		0.5			
Wood waste			12		4.1		5.7		3.6		9.98		15.9	
OTHER WASTE		0.5		13		1.9		7.9		9.8		24.95		23.1
Bulky items									1.5					
Misc. inorganics	0.5		9				1.2						23.1	
Inert solids			4				5		8.3					
HHW							1.7				0.76			
SPECIAL WASTE CATEGORY								1.9		0.4				0.3
Other special waste							1.9		0.4				0.3	
TOTALS		100		96		100		100		99.9		100		99.9

Table 3.2 Commercial Waste Compositio

COUNTIES	Shasta		Ventura		AVERAGE		Adjusted AVERAGE	
PAPER		35.0		32.9		34.8 [6]		34.8
Corrugated	13.5		16.0		11.6 [6]		11.1	
Mixed paper	8.7		9.9		6.1 [7]		5.9	
Newspaper	4.2		5.6		4.7 [6]		4.5	
High grade	0.4		1.4		1.8 [6]		1.7	
Other paper [5]	8.1				12.0 [7]		11.6	
PLASTICS		7.31		9.3		7.8 [6]		7.8
HDPE	2.0		0.6		0.7 [6]		0.7	
PET	0.2		0.1		0.2 [6]		0.2	
Film	2.0		3.9		2.9 [6]		2.8	
Other	3.2		4.6		4.2 [6]		4.0	
GLASS		8.8		3.7		5.8 [6]		5.8
Recyclable	8.5		2.8		4.3 [6]		4.8	
Non-recyclable	0.3		0.8		0.9 [6]		1.0	
METALS		6.41		5.4		6.1 [6]		6.1
Aluminum cans	0.5		0.7		0.6 [6]		0.5	
Ferrous	5.7		1.5		3.6 [6]		3.2	
White goods					1.2 [6]		1.1	
Other metals [12]	0.2		3.1		1.6 [9]		1.4	
YARD WASTE		7.6		7.1		11.2 [6]		11.2
OTHER ORGANICS		15.5		31.4		21.2 [6]		21.2
Org compostables/Food			7.4		9.8 [6]		7.4	
Org non-compostables	14.4 [1]		12.2		6.6 [10]		5.0	
Textiles			2.2		2.8 [6]		2.1	
Tires/Rubber			1.9		1.4 [6]		1.0	
Wood waste	1.1		7.6		7.5 [6]		5.7	
OTHER WASTE		18.7		9.9		12.2 [6]		12.2
Bulky items					1.5 [6]		1.5	
Misc. inorganics	18.7		6.4		5.5 [11]		5.6	
Inert solids			3.0		4.0 [11]		4.0	
HHW			0.6		1.0 [6]		1.0	
SPECIAL WASTE CATEGORY		0.8		0.1		0.7 [6]		0.7
Other special waste	0.8		0.1		0.7			
TOTALS		100.0		99.7		100		100

Notes:

[1] 0.8% of which is disposable diapers
[2] 0.9% of whlich is disposable diapers
[3] %'s include industrial wastestream
[4] %'s are the same as residential compostion
[5] Other paper includes non-recyclable paper
[6] Average from all counties with an entry for this category.
[7] Average from Plumas, Sacramento, and Shasta.
[8] Average from Plumas, Sacramento, Shasta, and Ventura.
[9] Value taken from Santa Cruz data.
[10] Average from Ventura and Sacramento.
[11] Average from Orange, Plumas, and Ventura.
[12] Other metals includes other aluminum and non-ferrous

Sources:

Data was extracted from County Solid Waste Management Plans and current data being compiled by Counties in order to meet the AB939 requirements.

TABLE 3.3 Projected Total Waste Generation 1990

COUNTY	TONS 1990
Alameda	1916000
Alpine	29072
Amador	43800
Butte*	233899
Calaveras*	46229
Colusa	17264
Contra Costa	972580
Del Norte	18105
El Dorado	122312
Fresno	767964
Glenn	22500
Humboldt	93052
Imperial	510635
Inyo	13517
Kern	1429379
Kings	87118
Lake	44737
Lassen*	35131
Los Angeles	16755984
Madera	62900
Marin	288653
Mariposa	13000
Mendocino	58765
Merced	150862
Modoc	7010
Mono*	12647
Monterey	469685
Napa	159263
Nevada	75220
Orange	6228485
Placer	228847
Plumas	39199
Riverside	2001922
Sacramento	1343334
San Benito	33904
San Bernardino	2642447
San Diego	3638295
San Francisco	984000
San Joaquin	546580
S. L. Obispo	277148
San Mateo	1144822
Santa Barbara	707124
Santa Clara	1866430
Santa Cruz	316444
Shasta*	196271
Sierra*	4471
Siskiyou	52059
Solano	313700
Sonoma	599797
Stanislaus*	480346
Tehema	47370
Trinity	10057
Tulare	327456
Tuolumne*	63844
Ventura	1107588
Yolo	219654
Yuba-Sutter	138836
TOTALS	50,017,713 TONS

* Based on a 7lb/person/day waste generation factor.

Sources:

Data was extracted from County Solid Waste Management Plans and current data being compiled by Counties in order to meet the A.B. 939 requirements.

Table 3.4 California Commercial Waste Stream Analysis

SIC #	Commercial/Industrial Category	Waste Generation Factor	Activity Unit	Annual Activity Level	Waste Generated (tons)
	General Retail:				
53	General Merchandise Stores	0.082	Sales($,000)	21,449,870	1,758,889
56	Apparel & Accesory Stores	0.082	Sales($,000)	9,597,700	787,011
57	Furniture & Home Furnishings	0.082	Sales($,000)	10,446,777	856,636
59 (1)	Miscellaneous Retail	0.082	Sales($,000)	15,758,838	1,292,225
52	Building Materials and Garden Supplies	0.082	Sales($,000)	9,058,773	742,819
	Miscellaneous Services:				
76	Miscellaneous Repair Services	0.060	Sales($,000)	2,622,732	157,364
72	Personal Services	0.060	Sales($,000)	3,816,075	228,965
58	Eating & Drinking Places:	0.150	Sales($,000)	19,989,156	2,998,373
	Food & Drug Stores:				
54	Food Stores	0.120	Sales($,000)	34,494,918	4,139,390
591	Drug Stores	0.120	Sales($,000)	7,319,546	878,346
	Automotive Dealer & Service Stations:				
55	Automotive Dealer & Service Stations:	0.010	Sales($,000)	49,635,860	496,359
75	Auto Repair, Services and Parking	0.085	Sales($,000)	7,715,490	655,817
70	Hotel/Motel	3.800	Employees	157,307 (2)	597,767
	Warehouse:				
50-51	Wholesale Trade	0.800	Employees	683,164	546,531

(1) This excludes SIC # 591.

(2) This generation datum was drawn from a DSM Environmental Service Inc., "Analysis of Solid Waste Generation in the Addison Waste Management District."

SIC #	Commercial/Industrial Category	Waste Generation Factor	Activity Unit	Annual Activity Level	Waste Generated (tons)
	Health Services:				
80	Health Services	0.940	Employees	737,703	693,441
806	Hospital	3.720	Beds	87,189	324,343
	Office:				
60-67	F.I.R.E.	0.400	Employees	804,909	321,964
73	Business Services	0.400	Employees	725,656	290,262
81	Legal Services	0.400	Employees	111,962	44,785
89	Miscellaneous Services	0.400	Employees	215,195	86,078
86	Membership Organizations	0.400	Employees	168,775	67,510
83	Social Services	0.400	Employees	147,893	59,157
	Education & Schools	0.070	Students	6,277,334	439,413
40-49	Transportation, Communication & Utilities	1.000	Employees	608,642	608,697
20-39	Manufacturing:	1.400	Employees	2,099,639	2,939,495
	Administrative and Auxillary	0.400	Employees	307,024	122,810
	State Government	0.400	Employees	990436	396,174
Total Waste Generated					**22,530,620**

Sources:

U.S. Department of Commerce, Bureau of the Census,
County Business Patterns, 1987, California (CBP-87-06), Table 1a.

U.S. Department of Education, Office of Educational Research and Improvement,
NCES 89-643, National Center for Education Statistics, "Digest of Education Statistics 1989,"
Table 6, Table 37, Table 163.

U.S. Department of Commerce, Bureau of the Census, Geographic Area Series,
California, "1987 Census of Service Industries," Table 1.a.

TABLE 3.5 **RECYCLING IN CALIFORNIA BY COUNTY**

COUNTY	YEAR	TOTAL GENERATED	TOTAL GEN OF COUNTIES with % SPECIFIED	TOTAL DIVERTED OF COUNTIES with % SPECIFIED	% DIVERTED FOR COUNTIES with % SPECIFIED	PAPER tons	%	News tons	%
Alameda	1990	1916000							
Alpine	1990	29072							
Amador	1990	43800	43800	6482	14.80%	628	1.43%	24	0.05%
Butte	n/a	n/a	no recycling programs						
Calaveras	n/a	n/a	no recycling programs						
Colusa	1990	17264							
Contra Costa	1990	972580							
Del Norte	1988	17000	17000	3543	20.84%	1642	9.66%	419	2.46%
El Dorado	1988	108040	108040	2542	2.34%	2111	1.95%	177	0.16%
Fresno	1990	767964	767964	142743	18.59%	23273	3.03%	20946	2.73%
Glenn	1990	22500							
Humboldt	1990	93052	93052	21533	23.16%	4187	4.50%	1210	1.30%
Imperial	1990	510635							
Inyo	1988	13069							
Kern	1987	1303028							
Kings	1990	87118							
Lake	1990	44737							
Lassen	n/a	n/a							
Los Angeles	1990	16755984							
Madera	1990	62900	62900	8806	14.00%	4403	7.00%	2404	3.82%
Marin	1990	288653							
Mariposa	1990	13000							
Mendocino	1990	58765							
Merced	1990	150862	150862	4456	2.95%	347	0.23%		
Modoc	1990	7010							
Mono	n/a	n/a	no recycling programs						
Monterey	1988	457707	457707	39191	8.56%	7781	1.70%	2235	0.49%
Napa	1987	150818	150818	29402	19.40%	4187	2.78%	2187	1.45%
Nevada	1990	75220	incomplete data						
Orange	1989	6112350	6112350	690060	11.29%	355020	5.81%	112200	1.84%
Placer	1988	207967	incomplete data						
Plumas	1984	35400							
Riverside	1987	1610000	incomplete data						
Sacramento	1988	1263766	1263766	221123	17.50%	110700	8.76%	44772	3.54%
San Benito	1988	30811	incomplete data						
San Bernardino	1988	2321012	incomplete data						
San Diego	1985	3031000	3031000	64427	2.13%	22027	0.73%	12148	0.40%
San Francisco	1986	984000	984000	183000	18.60%	149000	15.14%	32000	3.25%
San Joaquin	1986	494723							
San Luis Obispo	1986	238999	incomplete data						
San Mateo	1987-88	1113428	incomplete data						
Santa Barbara	1990	707124	707124	127035	17.97%	13733	1.94%	10173	1.44%
Santa Clara	1988	1811672	incomplete data						
Santa Cruz	1988	300024	300024	19081	6.36%	15131	5.04%	6734	2.24%
Shasta	n/a	n/a							
Sierra	n/a	n/a	no recycling program						
Siskiyou	1988	49744	49744	3362	6.76%	575	1.16%		
Solano	1987/88	282916	282916	48949	17.30%	11883	4.20%	2221	0.79%
Sonoma	1988	561000	561000	51783	9.23%	24997	4.46%	10869	1.94%
Stanislaus	n/a	n/a	recycling scheduled to begin 11/90						
Tehema	1990	47370							
Trinity	1984	9228							
Tulare	1990	327456							
Tuolumne	n/a	n/a							
Ventura	1988	1054218	1054218	125113	11.87%	43132	4.09%	17436	1.65%
Yolo	1989	212843	212843	19604	9.21%	4098	1.93%		
Yuba-Sutter	1990	138836	138836	3014	2.17%	2603	1.87%	953	0.69%
TOTALS		46912665	16549964	1815250		801458		279108	
					10.97%		4.84%		1.69%

Recycling rate (per material as a percentage of the total waste stream)

TABLE 3.5

COUNTY	OCC tons	OCC %	Mixed tons	Mixed %	High Grade tons	High Grade %	PLASTICS tons	PLASTICS %	HDPE tons	HDPE %	PET tons	PET %	other tons	other %	GLASS tons	GLASS %
Alameda																
Alpine																
Amador	275	0.63%	330	0.75%											517	1.18%
Butte																
Calaveras																
Colusa																
Contra Costa																
Del Norte	1223	7.19%													469	2.76%
El Dorado	678	0.63%	1256	1.16%											159	0.15%
Fresno					2327	0.30%									9309	1.21%
Glenn																
Humboldt	2512	2.70%	465	0.50%											1023	1.10%
Imperial																
Inyo																
Kern																
Kings																
Lake																
Lassen																
Los Angeles																
Madera	1999	3.18%													1887	3.00%
Marin																
Mariposa																
Mendocino																
Merced	339	0.22%			8	0.01%										
Modoc																
Mono																
Monterey	5546	1.21%													9849	2.15%
Napa	2000	1.33%													747	0.50%
Nevada																
Orange	180000	2.94%	62820	1.03%			1500	0.02%	300	0.00%	960	0.02%	240	0.00%	34500	0.56%
Placer																
Plumas																
Riverside																
Sacramento	44916	3.55%	2204	0.17%	18808	1.49%									4668	0.37%
San Benito																
San Bernardino																
San Diego	1739	0.06%			8140	0.27%									3043	0.10%
San Francisco	31000	3.15%	58000	5.89%	28000	2.85%									5000	0.51%
San Joaquin																
San Luis Obispo																
San Mateo																
Santa Barbara	3058	0.43%			502	0.07%	80	0.01%					80	0.01%	5094	0.72%
Santa Clara																
Santa Cruz	7675	2.56%	121	0.04%	601	0.20%	49	0.02%			25	0.01%	24	0.01%	3175	1.06%
Shasta																
Sierra																
Siskiyou	325	0.65%	250	0.50%											250	0.50%
Solano	8971	3.17%	691	0.24%											3740	1.32%
Sonoma	13115	2.34%	694	0.12%	319	0.06%									3388	0.60%
Stanislaus																
Tehema																
Trinity																
Tulare																
Tuolumne																
Ventura	17006	1.61%	8690	0.82%											2184	0.21%
Yolo	1139	0.54%	2959	1.39%											2061	0.97%
Yuba-Sutter	1650	1.19%													260	0.19%
TOTALS	325165		138480		58704		1629		300		985		344		91323	
Recycling rate (per material as a percentage of the total waste stream)		1.96%		0.84%		0.35%		0.01%		0.00%		0.01%		0.00%		0.55%

TABLE 3.5

COUNTY	METALS tons	%	Aluminum Cans tons	%	Other Metals tons	%	ORGANICS tons	%	Yard Waste tons	%	Wood Waste tons	%	Food Waste tons	%	Tires/ Rubber tons	%
Alameda																
Alpine																
Amador	337	0.77%	42	0.10%	295	0.67%										
Butte																
Calaveras																
Colusa																
Contra Costa																
Del Norte	1113	6.55%	113	0.66%	1000	5.88%										
El Dorado	254	0.24%	126	0.12%	128	0.12%										
Fresno	72924	9.50%	4655	0.61%	68269	8.89%	13964	1.82%								
Glenn																
Humboldt	8415	9.04%	651	0.70%	7764	8.34%	6328	6.80%					6328	6.80%		
Imperial																
Inyo																
Kern																
Kings																
Lake																
Lassen																
Los Angeles																
Madera	2516	4.00%	2516	4.00%												
Marin																
Mariposa																
Mendocino																
Merced	297	0.20%	1	0.00%	295	0.20%	3748	2.48%			3241	2.15%			506	0.34%
Modoc																
Mono																
Monterey	3392	0.74%	3392	0.74%												
Napa	12150	8.17%			12150	8.06%										
Nevada																
Orange	177060	2.90%	9000	0.15%	168060	2.75%	121080	1.98%							15600	0.26%
Placer																
Plumas																
Riverside																
Sacramento	3883	0.31%	3103	0.25%	780	0.06%	96184	7.61%	70000	5.54%			26184	2.07%		
San Benito																
San Bernardino																
San Diego	39357	1.30%	8599	0.28%	30758	1.01%										
San Francisco	7000	0.71%	1000	0.10%	6000	0.61%										
San Joaquin																
San Luis Obispo	571		571	0.25%												
San Mateo																
Santa Barbara	13202	1.87%			13202	1.87%										
Santa Clara																
Santa Cruz	726	0.24%	726	0.24%												
Shasta																
Sierra																
Siskiyou	2537	5.10%	125	0.25%	2412	4.85%										
Solano	9293	3.28%	5891	2.08%	3402	1.20%	23659	8.36%			3659	1.29%				
Sonoma	18066	3.22%	1046	0.19%	17020	3.03%										
Stanislaus																
Tehema																
Trinity																
Tulare																
Tuolumne																
Ventura	35730	3.39%	2184	0.21%	33546	3.18%	2067	0.20%	1667	0.16%						
Yolo	1159	0.54%	542	0.25%	617	0.29%	2060	0.97%	1000	0.47%					60	0.03%
Yuba-Sutter	151	0.11%	151	0.11%												
TOTALS	410133		44434		365698		269090		72667		6900		32512		16166	
		2.48%		0.27%		2.21%		1.63%		0.44%		0.04%		0.20%		0.10%

Recycling rate (per material as a percentage of the total waste stream)

TABLE 3.5

COUNTY	Textile tons	%	Sludge tons	%	Special Waste tons	%
Alameda						
Alpine						
Amador					5000	11.42%
Butte						
Calaveras						
Colusa						
Contra Costa						
Del Norte					319	1.88%
El Dorado						
Fresno	13964	1.82%			23273	3.03%
Glenn						
Humboldt					1600	1.72%
Imperial						
Inyo						
Kern						
Kings						
Lake						
Lassen						
Los Angeles						
Madera						
Marin						
Mariposa						
Mendocino						
Merced					65	0.04%
Modoc						
Mono						
Monterey					18168	3.97%
Napa					12000	7.96%
Nevada						
Orange			105480	1.73%	900	0.01%
Placer						
Plumas						
Riverside						
Sacramento					5688	0.45%
San Benito						
San Bernardino						
San Diego						
San Francisco					22000	2.24%
San Joaquin						
San Luis Obispo						
San Mateo						
Santa Barbara					94930	13.42%
Santa Clara						
Santa Cruz						
Shasta						
Sierra						
Siskiyou						
Solano			20000	7.07%	374	0.13%
Sonoma					5332	0.95%
Stanislaus						
Tehema						
Trinity						
Tulare						
Tuolumne						
Ventura			400	0.04%	42000	3.98%
Yolo	1000	0.47%			10226	4.80%
Yuba-Sutter						
TOTALS	14964		125880		241874	
		0.09%		0.76%		1.46%
Recycling rate	(per material as a percentage of the total waste strea					

Sources: County Solid Waste Management Plans

Table 3.6 Recycling by Material

Material	Waste Stream	Tons Recycled	Recycling Rate By Material
Paper:			
OCC	4095150	982723	24.00%
Mixed Paper	3720684	418518	11.25%
Newspaper	3212845	843526	26.25%
High Grade	657891	177418	26.97%
Other	5857029	0	0.00%
Plastics:			
HDPE	350124	907	0.26%
PET	127523	2977	2.33%
Film	1203130	0	0.00%
Other	1775855	1040	0.06%
Glass:			
Recyclable	2753226	275997	10.02%
Non-recyclable	500177	0	0.00%
Metals:			
Aluminum	277576	134290	48.38%
Other metals	2910940	1105223	37.97%
Yard Waste	7855925	219616	2.80%
Organics:			
Food Waste	3783772	98259	2.60%
Organic Non-Compostables	1703760	380438	22.33%
Textile	1077859	45225	4.20%
Tires	802535	48858	6.09%
Wood Waste	2026397	20854	1.03%
Other Waste:			
HHW	445203	61112	13.73%
Other Waste(inert solids)	4420039	606733	13.73%
Other Special Waste(other inorganics)	460072	63154	13.73%
TOTAL	50017713	5486867	10.97%

TABLE 3.7 SUMMARY OF THE CALIFORNIA WASTE STREAM

Material	Residential Waste Composition		Residential Total Waste Generated	
Paper:		35.30%		9702944
OCC	5.80%		1594251	
Mixed Paper	8.70%		2391377	
Newspaper	8.00%		2198967	
High Grade	1.00%		274871	
Other	11.80%		3243477	
Plastics:		6.10%		1676713
HDPE	0.70%		192410	
PET	0.30%		82461	
Film	2.00%		549742	
Other	3.10%		852100	
Glass:		7.00%		1924096
Recyclable	6.00%		1649226	
Non-recyclable	1.00%		274871	
Metals:		6.60%		1814148
Aluminum	0.60%		164923	
Other metals	6.00%		1649226	
Organics:		36.20%		9950328
Food Waste	7.70%		2116506	
Wood Waste	2.70%		742152	
Textile	2.20%		604716	
Tires	2.10%		577229	
Organic Non-Compostables	2.10%		577229	
Yard Waste	19.40%		5332496	
Other Waste:		8.80%		2418864
HHW	0.80%		219897	
Other Waste(inert solids)	6.90%		1896609	
Other Special Waste(other inorganics)	1.10%		302358	
TOTAL	100.00%			27,487,093

TABLE 3.7 SUMMARY OF THE CALIFORNIA WASTE STREAM

Material	Commercial Waste Composition		Commercial Total Waste Generated		Total Waste Stream
Paper:		34.80%		7840656	
OCC	11.10%		2500899		4095150
Mixed Paper	5.90%		1329307		3720684
Newspaper	4.50%		1013878		3212845
High Grade	1.70%		383021		657891
Other	11.60%		2613552		5857029
Plastics:		7.90%		1779919	
HDPE	0.70%		157714		350124
PET	0.20%		45061		127523
Film	2.90%		653388		1203130
Other	4.10%		923755		1775855
Glass:		5.90%		1329307	
Recyclable	4.90%		1104000		2753226
Non-recyclable	1.00%		225306		500177
Metals:		6.10%		1374368	
Aluminum	0.50%		112653		277576
Other metals	5.60%		1261715		2910940
Organics:		32.40%		7299921	
Food Waste	7.40%		1667266		3783772
Wood Waste	5.70%		1284245		2026397
Textile	2.10%		473143		1077859
Tires	1.00%		225306		802535
Organic Non-Compostables	5.00%		1126531		1703760
Yard Waste	11.20%		2523429		7855925
Other Waste:		12.20%		2748736	
HHW	1.00%		225306		445203
Other Waste(inert solids)	11.20%		2523429		4420039
Other Special Waste(other inorganics)	0.70%		157714		460072
TOTAL	100.00%			22372905	50017713

TABLE 3.7 SUMMARY OF THE CALIFORNIA WASTE STREAM

Material	Recycling As % of Waste Stream	Tons Recycled	
Paper:	4.84%		2422187 *
OCC	1.96%	982723	
Mixed Paper	0.84%	418518	
Newspaper	1.69%	843526	
High Grade	0.35%	177418	
Other			
Plastics:	0.01%		4923 *
HDPE	0.00%	907	
PET	0.01%	2977	
Film			
Other	0.00%	1040	
Glass:	0.55%	275997	275997
Recyclable			
Non-recyclable			
Metals:	2.48%		1239513
Aluminum	0.27%	134290	
Other metals	2.21%	1105223	
Organics:	1.63%		813250
Food Waste	0.20%	98259	
Wood Waste	0.04%	20854	
Textile	0.09%	45225	
Tires	0.10%	48858	
Organic Non-Compostables	0.76%	380438	
Yard Waste	0.44%	219616	
Other Waste:	1.46%	730999	
HHW			
Other Waste(inert solids)			
Other Special Waste(*other inorganics*)			
TOTAL	10.97%		5,486,869

* Totals in Paper and Plastics do not add due to rounding.

Sources: Previous Tables: 3.1, 3.2, 3.3, 3.4, and 3.5

Table 3.8 Facility Waste Composition Data

Material	Tons Landfilled	% of total waste in landfills	Tons Recycled	% of total waste recycled	Tons WTE	% of total waste WTE
Paper:						
OCC	3062590	7.02%	982723	17.91%	49837	5.34%
Mixed Paper	3177278	7.29%	418518	7.63%	124888	13.39%
Newspaper	2309671	5.30%	843526	15.37%	59648	6.40%
High Grade	478086	1.10%	177418	3.23%	2387	0.26%
Other	5840319	13.40%	0	0.00%	16710	1.79%
Plastics:						
HDPE	343647	0.79%	907	0.02%	5570	0.60%
PET	123611	0.28%	2977	0.05%	934	0.10%
Film	1168550	2.68%	0		34580	3.71%
Other	1749200	4.01%	1040	0.02%	25616	2.75%
Glass:						
Recyclable	2432749	5.58%	275997	5.03%	44479	4.77%
Non-recyclable	492097	1.13%	0		8081	0.87%
Metals:						
Aluminum	141140	0.32%	134290	2.45%	2146	0.23%
Other metals	1759822	4.04%	1105223	20.14%	45895	4.92%
Yard Waste	7396483	16.97%	219616	4.00%	239827	25.71%
Organics:						
Food Waste	3612849	8.29%	98259	1.79%	72664	7.79%
Organic Non-Compostables	1277639	2.93%	380438	6.93%	45683	4.90%
Textile	1005274	2.31%	45225	0.82%	27360	2.93%
Tires	750494	1.72%	48858	0.89%	3183	0.34%
Wood Waste	1963779	4.50%	20854	0.38%	41763	4.48%
Other Waste:						
HHW	381703	0.88%	61112	1.11%	2387	0.26%
Other Waste(inert solids)	3813306	8.75%	606733	11.06%	0	0.00%
Other Special Waste(other inorganics)	317889	0.73%	63154	1.15%	79030	8.47%
TOTAL	43598176	100.00%	5486867	100.00%	932669.8	100.00%

Source: Previous Tables.

Table 3.9 Disposal Paths of Non-A.B. 2020 Waste Stream

Material	Tons Landfilled	A.B. 2020 Tons Landfilled	Total Tons Recycled	A.B. 2020 Tons Recycled
Paper:				
OCC	3062590		982723	
Mixed Paper	3177278		418518	
Newspaper	2309671		843526	
High Grade	478086		177418	
Other	5840319		0	
Plastics:				
HDPE	343647		907	
PET	123611	35668	2977	2705
Film	1168550		0	
Other	1749200		1040	
Glass:				
Recyclable	2432749	537989	275997	236237
Non-recyclable	492097		0	
Metals:				
Aluminum	141140	62354	134290	114236
Other metals	1759822	1018	1105223	20
Yard Waste	7396483		219616	
Organics:				
Food Waste	3612849		98259	
Organic Non-Compostables	1277639		380438	
Textile	1005274		45225	
Tires	750494		48858	
Wood Waste	1963779		20854	
Other Waste:				
HHW	381703		61112	
Other Waste(inert solids)	3813306		606733	
Other Special Waste(other inorganics)	317889		63154	
TOTAL	43598176	637029	5486867	353198

Table 3.9 Disposal Paths of Non-A.B. 2020 Waste Stream

Material	Tons WTE	A.B.2020 Tons WTE	Waste Generation Net of A.B. 2020	Paths of Disposal % Landfilled	% recycled	% WTE
Paper:						
OCC	49837		4095150	74.79%	24.00%	1.22%
Mixed Paper	124888		3720684	85.39%	11.25%	3.36%
Newspaper	59648		3212845	71.89%	26.25%	1.86%
High Grade	2387		657891	72.67%	26.97%	0.36%
Other	16710		5857029	99.71%	0.00%	0.29%
Plastics:						
HDPE	5570		350124	98.15%	0.26%	1.59%
PET	934	270	88880	98.95%	0.31%	0.75%
Film	34580		1203130			
Other	25616		1775855			
Glass:						
Recyclable	44479	9836	1969164	96.22%	2.02%	1.76%
Non-recyclable	8081		500177			
Metals:						
Aluminum	2146	948	100038	78.76%	20.05%	1.20%
Other metals	45895	27	2909875	60.44%	37.98%	1.58%
Yard Waste	239827		7855925	94.15%	2.80%	3.05%
Organics:						
Food Waste	72664		3783772	95.48%	2.60%	1.92%
Organic Non-Compostables	45683		1703760	74.99%	22.33%	2.68%
Textile	27360		1077859	93.27%	4.20%	2.54%
Tires	3183		802535	93.52%	6.09%	0.40%
Wood Waste	41763		2026397	96.91%	1.03%	2.06%
Other Waste:						
HHW	2387		445203	85.74%	13.73%	0.54%
Other Waste(inert solids)	0		4420039	86.27%	13.73%	0.00%
Other Special Waste(other inorganics)	79030		460072	69.10%	13.73%	17.18%
TOTAL	932670	11081	49016405	87.65%	10.47%	1.88%

Source: Previous Tables, and California Department of Conservation,
"Biannual Report of Redemption & Recycling Rates,"January 1, 1990- June 30, 1990.

Table 3.10
Household Hazardous Waste Collection by County: 1989

COUNTY		% Batteries [1]	% Latex Paint	% Solvent Paint	% Used Oil	% Other Waste	Total HHW	55-Gal Drums Collected (2)	Disposal cost per Drum ($)	Gallons Collected (3)	Disposal Cost per Gallon ($)	Batteries Collected	Total Disposal Cost ($)	% of HHW Recycled	Population Participation
Amador															
Marin		3%	27%	25%	8%	37%	100%	705	389	0		230	272367	30.00%	3.00%
Monterey									288	1435		339	2300	61.00%	0.02%
Nevada [4]	periodic	3%	19%	20%	0%	58%	100%	110	317	0		0	38340	32.00%	5.00%
Nevada	permanent							0		7021	1.05	377		100.00%	5.00%
Plumas								0		1050		254			
Sacramento		6%	13%	19%	34%	28%	100%	152	300	3280		388	61800	64.00%	0.40%
San Benito								80	140	375		58			2.00%
San Bernardino								109		28835		1071	120000	88.00%	
San Diego	permanent							0	600	11187			201210	73.00%	0.04%
San Diego	periodic							0	600	42787			390450	73.00%	0.50%
San Francisco		1%	5%	37%	30%	27%	100%	0		35740	4.19	495	150000	70.00%	0.06%
San Mateo								199	200	6320		130		28.00%	0.30%
Santa Barbara								639	332	0			278501		12.00%
Santa Cruz								240		168		175	131000	38.00%	2.00%
Ventura								268	489	0		157	130000	50.00%	0.01%
Yolo								129	272	0		187	40434	50.00%	5.00%
SUM								2829		135958		3859	1814402		
AVERAGE [4]		3%	15%	27%	24%	31%	100%		357.00		2.62		181200	57.46%	2.52%

Notes:

(1) Percentages of the total collected HHW.

(2) The 55-Gallon drums are usually hold the "other waste."

(3) Number of gallons usually include latex paint, solvent paint, and used oil.

[4] Averages for % batteries, % latex paint, % solvent paint, %used oil, and %other waste do not include Nevada County.
When calculating averages, only counties with collection for each waste category are included.

Sources:

1) California Integrated Waste Management Board, "Household Hazardous Waste Survey for California Cities and Counties," 1989.

2) California Integrated Waste Management Board, "A Report to the California State Legislature on Household Hazardous Waste," 1988.

Table 3.11
Household Hazardous Waste Collection by City: 1989

CITY		% Batteries (1)	% Latex Paint	% Solvent Paint	% Used Oil	% Other Waste	Total HHW	55-Gal Drums Collected (2)	Disposal cost per Drum ($)	Gallons Collected (3)	Disposal Cost per Gallon ($)	Batteries Collected	Total Disposal Cost ($)	% of HHW Recycled	Population Participation
Benicia		0%	22%	0%	78%	0%	100%					51		100.00%	1.00%
Beverly Hills								28		0	0	0		0.00%	2.00%
Burbank								209	320	4872	6.5	59	127815		0.80%
Cupertino/L. Altos/Mt. View		5%	25%	10%	25%	35%	100%	488	300	0	0	88	98340	10.00%	1.00%
Gilroy/Morgan Hill								24	227	0	0	16		50.00%	0.00%
Hayward		1%	60%	20%	1%	18%	100%	134	225	1200		50	51000	20.00%	2.50%
Healdsburg		0%	0%	40%	40%	20%	100%	20	125	0	0		12500		15.00%
Inglewood		0%	12%	15%	55%	18%	100%	22		144		0			2.00%
Los Angeles	periodic	1%	20%	42%	20%	17%	100%	4862	350	0	0	1091	1014145	41.00%	1.70%
Los Angeles	pickup	10%	24%	19%	35%	12%	100%	313	280	0	0	800		59.00%	4.20%
Modesto		0%	0%	0%	100%	0%	100%	0	0	6500	0	0		100.00%	30.00%
Newark/Fremont/U								259		13655		0	260000		1.00%
Palo Alto								786	210	3872	0	0		10.00%	3.00%
Petaluma		0%	0%	35%	40%	25%	100%	92	125	0	0		45000		
Portola								0	0	100		50	37500	25.00%	
Salinas								159	534			0	85000	1.00%	0.05%
San Jose									380	38000		900	335000	50.00%	1.50%
Santa Monica								180	300	0	0	48	80000	30.00%	4.00%
Santa Rosa								257	125	0	0	0	32990		1.00%
Scotts Valley								86	241	0	0	28	22222	24.00%	2.00%
Solano/Vallejo		0%	14%	9%	17%	60%	100%	124	484	0		0	80000	31.00%	1.90%
Sonoma								43	125	0			19500		1.00%
Sunnyvale		0%	9%	4%	0%	87%	100%	447	258		13	285	104410	10.00%	1.50%
SUM								8611.00		68343.00		3466	2385222.00		
AVERAGE (4)		4%	32%	23%	20%	21%	100%	453.21	271.12		9.75		149076.38	37.40%	3.86%

Notes:

(1) Percentages of the total collected HHW.

(2) The 55-Gallon drums are usually hold the "other waste."

(3) Number of gallons usually include latex paint, solvent paint, and used oil.

(4) Averages for % batteries, % latex paint, % solvent paint, %used oil, and %other waste are from Cup/L.Altos/Mt V; Hayward, and Los Angeles (periodic and pickup).

When calculating averages, only counties with collection for each waste category are included.

Sources:

1) California Integrated Waste Management Board, "Household Hazardous Waste Survey for California Cities and Counties," 1989.

2) California Integrated Waste Management Board, "*A Report to the California State Legislature on Household Hazardous Waste*," 1988.

Table 3.12 Projections of Household Hazardous Waste in the California Waste Stream

	County base case	County case 1	County case 2	County case 3	County case 4	City base case	City case1	City case 2	City case 3	City case 4
% pop participation (average)	2.52%	100%	100%	100%	100%	4%	100%	100%	100%	100%
% capture rate		100%	75%	50%	25%		100%	75%	50%	25%
Gallons of HHW collected [1]	135958					68343				
"55-gal" drums HHW collected [1]	2829					8611				
Number of batteries collected [1]	3859					3468				
Projected Total gallons of HHW		5387523	7183384	10775047	21550093		1771692	2362255	3543383	7086766
Projected Total "55-gal" drums HHW		112103	149471	224206	448412		223227	297637	446455	892910
Projected Total number of batteries		152918	203891	305836	611673		89851	119801	179702	359404

Notes:
[1] These values are the sums taken from Table 3.10 for counties and Table 3.11 for cities.

Summary Table for HHW (Counties plus Cities)

Total amount of HHW collected in Counties and Cities = # of gallons + 0.80* (# of "55-gal" * 55) + # of batteries

*We are assuming that about 20% of what is contained in the 55-gal drums is absorbants and/or containers and that one battery is equivalent to 1 gallon of HHW.

Total amount of collected HHW in Counties = 284293 gallons
Total amount of collected HHW in Cities = 450693 gallons

Waste	% Counties	Total Gallons collected by Counties	% Cities	Total Gallons collected by Cities	TOTAL GALLONS collected	% of TOTAL GALLONS
Batteries	3%	9162	4%	19154	28317	4%
Latex Paint	15%	39644	32%	145348	184992	26%
Solvent Paint	27%	71359	23%	102533	173892	24%
Used Oil	24%	63430	20%	91265	154696	22%
Other waste	31%	80697	21%	92392	173090	24%
TOTAL	100%	284293	100%	450693	714986	100%

ENDNOTES:

1. Owens-Brockway, personal interview with John Holzmer, January 7, 1991.

2. This waste generation figure was provided by the California Integrated Waste Management Board in 1988 for use in the Report, "Integrated Solid Waste Management: Putting A Lid On Garbage Overload," Assembly Office of Research and Assembly Committee on Natural Resources, April 1988.

3. California State Board of Equalization, personal interview Bob Frank, November 19, 1990.

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CHAPTER 4 - DISPOSAL PATHS OF MATERIALS

Our evaluation of the disposal paths (percentages recycled, burned, and buried) for each waste stream component required an inventory of the current waste disposal and recycling facilities utilized in California, combined with a determination of the amount and types of waste being accepted by each facility. The quantity of each material entering landfills or waste-to-energy facilities in California was developed in Chapter 3. This chapter will focus on the facilities themselves, drawing on the results obtained in Chapter 3.

4.1 LANDFILLS AND WASTE-TO-ENERGY FACILITIES

There are more than 330 active landfills in California, accepting more than 44,000,000 tons of waste each year.[1] The current daily capacity of California landfills is about 179,000 tons per day, with current waste received averaging 120,500 tons per day. See Table 4.1 for a complete listing of daily landfill capacities within each county and estimated daily capacity over time. With many landfills closing in the next decade, by the year 2000 California will have less than 50% of its current landfill capacity and will need to explore new methods of both diverting and disposing of wastes.

At this time there are only three active waste-to-energy facilities operating in California with a combined daily tonnage capacity of 2560 tons/day. Two of these facilities are located in Los Angeles County and the third facility is located in Stanislaus County. (For a more detailed description of the three facilities, see Chapter 5). In addition to the three operating facilities, there are two more facilities which are currently inactive and one facility which is in the planning stage. See Table 4.2.

Much of California's waste passes through a transfer station on route to its final destination. The daily capacity of California transfer stations and the number of transfer stations within each county are listed in Table 4.3.

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[1] Our estimate of the amount of waste entering landfills is about 6% higher than the estimate of the Board of Equalization, which is based on the collection of landfill surcharge revenues. This is not surprising in view of the imprecision in measurement of incoming tonnage at many landfills. Our landfill estimate, derived in Chapter 3, is the total waste stream minus the amounts being recycled or incinerated; it is not based on reports from landfills.

TABLE 4.1 California Population and Daily Tonnage Landfill Capacity by County

	Official State Estimates Population 7/1/89	Landfill Daily Tonnage Capacity Closure Year <= 1995	Landfill Daily Tonnage Capacity Closure Year 1996<=2000	Landfill Daily Tonnage Capacity Closure Year >=2001	Total Daily Tonnage Landfill Capacity
Alameda	1,261,500	850		7607	8457
Alpine	1,200				
Amador	30,000			1540	1540
Butte	178,800			501	501
Calaveras	33,600	80		225	305
Colusa	15,900		50	1	51
Contra Costa	790,000	2990	22		3012
Del Norte	21,100	40			40
El Dorado	128,900	113			113
Fresno	635,000	720	175	640	1535
Glenn	24,000			221	221
Humboldt	118,700	7	650	32	689
Imperial	117,600		188	503	691
Inyo	18,300		15	104	119
Kern	537,500	2380	414	546	3340
Kings	99,300	300		57	357
Lake	53,100			100	100
Lassen	27,500	31		113	144
Los Angeles	8,710,400	32815	11741	21070	65626
Madera	86,100	400			400
Marin	234,100			1121	1121
Mariposa	15,200			33	33
Mendocino	77,900	19	46	570	635
Merced	175,200	914		1	915
Modoc	9,500		2	13	15
Mono	9,900			31	31
Monterey	353,400	1		1288	1289
Napa	108,900	423		176	599
Nevada	80,900			284	284
Orange	2,301,200	8164		9333	17497
Placer	162,900			871	871
Plumas	20,300	95	5	10	110
Riverside	1,062,700		2449	8613	11062
Sacramento	1,007,300	945	60	2822	3827
San Benito	36,200			55	55
San Bernardino	1,378,800	6603	502	949	8054
San Diego	2,459,500	2840	3498	3857	10195
San Francisco	727,400				
San Joaquin	464,900	1930		2820	4750
San Luis Obispo	216,600		713	135	848
San Mateo	637,200	200	2	2500	2702
Santa Barbara	350,400	100		1839	1939
Santa Clara	1,454,700	2672		7952	10624
Santa Cruz	232,900	310	250	260	820
Shasta	146,600			345	345
Sierra	3,500		5		5
Siskiyou	44,500	9	88	75	172
Solano	330,200	54	59	2601	2714
Sonoma	378,200	2369	3	403	2775
Stanislaus	358,100	1100		1419	2519

	Official State Estimates Population 7/1/89	Landfill Daily Tonnage Capacity Closure Year <= 1995	Landfill Daily Tonnage Capacity Closure Year 1996<=2000	Landfill Daily Tonnage Capacity Closure Year >=2001	Total Daily Tonnage Landfill Capacity
Sutter/Yuba	121,300	30	337	55	422
Tehama	47,900			222	222
Trinity	14,200			27	27
Tulare	303,900	135	825	359	1319
Tuolumne	48,100	4			4
Ventura	664,000			2280	2280
Yolo	136,200		63	772	835
Total	29,095,890	69,643	22,162	87,351	179,156
Percent of Daily Tonnage		38.87%	12.37%	48.76%	100.00%

Counties with Planned Landfills:
(Calaveras, Colusa, Contra Costa, Humboldt, Imperial, Kern, Los Angeles, Riverside, San Bernardino, San Diego, San Joaquin, Sonoma, Tulare, Ventura)

Sources:

California State and County Population Estimates - REPORT 89 E-2,
Department of Finance, Demographic Research Unit, Sacramento, California, January 1990.

Solid Waste Information System (SWIS), California Integrated Waste Mangement Board, Report Generated October,1990.

TABLE 4.2 California Waste-to-Energy Facilities

County	Status	Operational Tons/day
Lassen	inactive	0
Los Angeles	active	380
Los Angeles	active	1380
Los Angeles	closed	0
San Diego	planned	0
Stanislaus	active	800
Total Available Capacity		2560

Source: CIWMB Solid Waste Information System (SWIS), October 1990.

TABLE 4.3

Daily Tonnage Transfer Station Capacity by County

	Official State Estimates Population 7/1/89	Number Active Transfer Stations	Transfer Stations Tons/Day	Number Planned Transfer Stations
Alameda	1,261,500	3	3,023	
Alpine	1,200			
Amador	30,000	1	34	
Butte	178,800	3	126	
Calaveras	33,600	5	304	1
Colusa	15,900	1	44	
Contra Costa	790,000	1	2,500	1
Del Norte	21,100	2	28	
El Dorado	128,900	1	423	
Fresno	635,000	3	422	
Glenn	24,000			
Humboldt	118,700	15	268	
Imperial	117,600			
Inyo	18,300	4	8	
Kern	537,500	11	216	8
Kings	99,300	1	21	
Lake	53,100	1	40	
Lassen	27,500	4	5	1
Los Angeles	8,710,400	43	13,479	5
Madera	86,100	2	48	
Marin	234,100	1	260	
Mariposa	15,200	5	12	
Mendocino	77,900	4	28	1
Merced	175,200	1	11	
Modoc	9,500	7	7	
Mono	9,900	1	2	
Monterey	353,400	7	558	
Napa	108,900			
Nevada	80,900	4	34	
Orange	2,301,200	6	6,276	1
Placer	162,900	5	216	
Plumas	20,300	6	93	
Riverside	1,062,700	5	137	4
Sacramento	1,007,300	3	509	
San Benito	36,200			

	Official State Estimates Population 7/1/89	Number Active Transfer Stations	Transfer Stations Tons/Day	Number Planned Transfer Stations
San Bernardino	1,378,800	2	204	3
San Diego	2,459,500	13	728	
San Francisco	727,400	1	2,000	
San Joaquin	464,900	6	3,835	2
San Luis Obispo	216,600			
San Mateo	637,200	6	2,548	
Santa Barbara	350,400	1	455	
Santa Clara	1,454,700	2	458	3
Santa Cruz	232,900	1	300	
Shasta	146,600	11	54	1
Sierra	3,500	4	9	
Siskiyou	44,500			
Solano	330,200			
Sonoma	378,200	6	496	
Stanislaus	358,100	4	951	
Sutter/Yuba	121,300			2
Tehama	47,900	4	95	
Trinity	14,200	9	56	
Tulare	303,900	5	41	1
Tuolumne	48,100	2	59	
Ventura	664,000	3	157	
Yolo	136,200	2	38	
Total	29,095,890	238	41,616	34

Sources:

***California State and County Population Estimates* - REPORT 89 E-2,**
Department of Finance, Demographic Research Unit, Sacramento, California, January 1990.

Solid Waste Information System (SWIS), California Integrated Waste Mangement Board, Report Generated October, 1990.

4.2 DISPOSAL PATHS FOR EACH MATERIAL

Materials in the California waste stream are managed in one of three ways: they get recycled, incinerated, or landfilled. A complete listing of the path of each material in the waste stream was developed in Chapter 3 and is summarized here.

TABLE 4.4 DISPOSAL PATHS OF EACH WASTE STREAM MATERIAL

Materials	% Recycled	% Landfilled	% Incinerated
Paper:			
Newspaper	26.25%	71.89%	1.86%
OCC	24.00%	74.79%	1.22%
Mixed Paper	11.25%	85.39%	3.36%
High Grade	26.97%	72.67%	0.36%
Other	0.00%	99.71%	0.29%
Plastics:			
HDPE	0.26%	98.15%	1.59%
PET	0.31%	98.95%	0.75%
Glass	2.02%	96.22%	1.76%
Metals:			
Aluminum	20.05%	78.76%	1.20%
Ferrous	37.98%	60.44%	1.58%
Organics:			
Yard Waste	2.80%	94.15%	3.05%
Wood Waste	1.03%	96.91%	2.06%
Food Waste	2.60%	95.48%	1.92%
Tires	6.09%	93.52%	0.40%
Textiles	4.20%	93.27%	2.54%
Non-Compost	22.33%	74.99%	2.68%
Other Wastes:	13.73%	86.27%	0.09%

Table 4.4 presents the percent of each material being recycled, landfilled, or directed to a waste-to-energy facility. It is interesting to observe that papers and metals are being recycled at rates reaching 20-40%.

4.3 RANKING OF MATERIALS

Data already presented in previous tables can be used to examine the share of each material in the total waste stream entering landfills and waste-to-energy facilities. These ratios will be used in Chapter 5 when the pollutant loadings are attributed to the materials entering waste disposal facilities.

TABLE 4.5 RANKING OF MATERIALS IN LANDFILLS AND WASTE-TO-ENERGY FACILITIES

Material	% of total waste in landfills	% of total waste recycled	% of total waste WTE
Paper:			
OCC	7.02%	17.91%	5.34%
Mixed Paper	7.29%	7.63%	13.39%
Newspaper	5.30%	15.37%	6.40%
High Grade	1.10%	3.23%	0.26%
Other	13.40%	0.00%	1.79%
Plastics:			
HDPE	0.79%	0.02%	0.60%
PET	0.28%	0.05%	0.10%
Film	2.68%	0.00%	3.71%
Other	4.01%	0.02%	2.75%
Glass:			
Recyclable	5.58%	5.03%	4.77%
Non-recyclable	1.13%	0.00%	0.87%
Metals:			
Aluminum	0.32%	2.45%	0.23%
Other metals	4.04%	20.14%	4.92%
Yard Waste	16.97%	4.00%	25.71%
Organics:			
Food Waste	8.29%	1.79%	7.79%
Organic Non-Compostables	2.93%	6.93%	4.90%
Textile	2.31%	0.82%	2.93%
Tires	1.72%	0.89%	0.34%
Wood Waste	4.50%	0.38%	4.48%
Other Waste:			
HHW	0.88%	1.11%	0.26%
Other Waste(inert solids)	8.75%	11.06%	0.00%
Other Special Waste(other inorganics)	0.73%	1.15%	8.47%
TOTAL	100.00%	100.00%	100.00%

Source: Table 3.8

Ranking the waste types in order of their contribution to the total amount of waste entering landfills, we obtain the following:

1. Organics	37%
2. Paper	34%
3. Other Wastes	10%
4. Plastics	8%
5. Glass	7%
6. Metals	4%

Ranking the waste types in order of their contribution to the total amount directed to waste-to-energy facilities, we obtain the same order, though with different quantities:

1. Organics	46%
2. Paper	27%
3. Other Wastes	9%
4. Plastics	7%
5. Glass	6%
6. Metals	5%

The fact that the rankings are identical for both disposal options is not surprising given the general composition of the waste stream.

CHAPTER 5 - METHODOLOGY FOR IDENTIFYING GOODS and MATERIALS with POTENTIAL for ENVIRONMENTAL DEGRADATION

This section assesses the environmental impacts of disposing of municipal solid waste (MSW) in California. "Environmental impacts" are defined in this report as including air and water emissions from MSW management facilities and from solid waste and recycling collection. Four facilities are included under the term "MSW management facility":

1. MSW landfill;
2. MSW incinerator;
3. Mixed waste composting; and
4. Materials recovery (recycling).

Air emissions and water effluent are quantified for the four types of facilities and for solid waste and recycling collection. Environmental impacts are quantified for each material disposed of at each facility type. The method of allocating environmental impacts for each facility type to each material is discussed below. In general, environmental impacts for each material will be based on total pollutant loadings from the facility type and the amount of each material disposed of or recycled. Thus, each material will have per ton pollutant factors for each facility type. Pollutants included for each material will depend on the material and the type of facility.

Although household hazardous wastes are often collected and disposed of (or recycled) separately from the MSW stream, the majority of them still find their way into incinerators and landfills. Therefore, in assessing environmental impacts of incinerators and landfills, household hazardous wastes are included as being disposed of within these facilities. Materials considered as "household hazardous waste" include: motor oil; paints and paint thinners; batteries, household and automotive; pesticides/herbicides/rodenticides; household cleaners and polishes; auto anti-freeze and auto degreasers; cosmetics; medications and drugs; photography chemicals; solvents; and wood preservatives.[1]

5.1 LANDFILLS

Allocating environmental impacts to specific materials/products in landfills is difficult because numerous factors contribute to landfill leachate and gas generation. Data which link environmental impacts directly to specific materials are extremely limited. Therefore, the environmental impacts of each material is derived from total landfill pollutant loadings and percentage of material disposed in California landfills (from Chapters 3 and 4). If it is known that a material does not contribute to leachate or gas generation, then no environmental impacts are attributed to it. In estimating pollutant factors for landfill leachate and gas emissions it is important to note that there is a delay between deposition and the generation of leachate and gas.

One caveat to the data used to estimate landfill leachate and gas emissions is that average data are used instead of median data. To use median data would exclude many pollutants that are toxic and are sometimes emitted at levels dangerous to public health. For example, in the case of landfill gases, seven of the ten trace constituents of landfill gas are undetected at median levels. But the exclusion of these seven trace constituents would mean that the two pollutants that contribute most to the toxicity of landfill gases, benzene and vinyl chloride, would be excluded from the study. Therefore, to reflect the fact that landfills emit different toxins, average emissions are used instead of median emissions.

5.1.1 Landfill Leachate Generation

The purpose of this section is to develop leachate pollution factors for each material disposed of in a MSW landfill. To do this, it is necessary to determine the amount of leachate generated, the composition of that leachate, and the materials contributing to that leachate in California landfills. In this report two generic landfills are examined: 1) a landfill with no liner (old landfill); and 2) a landfill controlled with liners and leachate collection systems (new landfill). Assessing leachate generation, leachate composition, and materials contributing to leachate in California landfills, however, is difficult without field work. Therefore, in this section leachate generation, composition, and contributors are estimated using the best available data.

The development of leachate pollution factors for each material disposed of in a MSW landfill was a four step process:

1. identify the amount of leachate (in gallons) generated in California landfills;
2. identify the concentration of pollutant (ppm or mg/l) in leachate;
3. convert pollutant concentration to pollutant factors (lbs pollutant/ton MSW); and
4. allocate pounds of pollutant to materials based on percent of material in a ton of landfilled California MSW (Chapters 3 and 4) and how much that material contributes to that pollutant.

First, quantifying leachate generation requires knowledge of the geology, hydrogeology, precipitation, climate, field capacity (water-holding capacity of landfill materials), cover permeability, landfill slope, and cover material of a landfill. To estimate the quantity of leachate generated by a generic California landfill the water balance model developed by the U.S. EPA for landfills was used: "HELP" (the "Hydrologic Evaluation of Landfill Performance" model).[2]

Using HELP and making the assumptions outlined in Tables 5.1 and 5.2, annual uncontrolled leachate (landfill without a liner) generation for a generic California landfill was 33.26 gallons per ton of waste over the lifetime of the landfill (see Table 5.3). Landfill lifetime includes 25 active years and 30 post-closure years. In developing leachate generation data it was assumed that 67.6% of all waste is generated in southern California and the remaining 32.4% is generated in northern California.[3] Controlled leachate (landfill with a liner) generation for the generic landfill in California is 2.95 gallons per ton of waste (see Table 5.4). These leachate generation rates are estimates based on calculations using the HELP Model. No specific data were found on California leachate generation rates.

The different leachate generation levels between northern and southern California landfills are due to the different cap and liner assumptions made for southern and northern landfills. We assume that southern California landfills meet state requirements, while northern California landfills, due to higher precipitation levels, are built with caps and liners well in excess of state requirements. Variations in leachate generation between the two regions are due to landfill area and depth, annual precipitation, and types of liner and cap used. For example, in Tables 5.3 and 5.4, annual leachate escaping from lined landfills is larger for southern California than for northern California. This is because the northern California landfill was assumed to have a three foot clay liner with a synthetic membrane as compared to the southern California landfill which was assumed to have a one foot clay liner without a membrane. Thus the southern California landfill has significantly more leachate escaping through the liner -- 4.33 gallons/ton -- as opposed to the northern California landfill, 0.08 gallons/ton (see Table 5.4). Once capped, both landfills were able to collect all leachate generated.

As shown in Tables 5.3 and 5.4, leachate generation is affected by two principal factors: design (type of cap and liner) and precipitation. What this illustrates is that the amount of leachate produced per ton of waste is dependent upon factors other than the waste. In other words, if it does not rain or if all water is kept out of a landfill, a landfill will not produce any leachate.

Second, to identify pollutant concentrations in leachate it is necessary to have test data on landfill leachate. We talked with Greg Jacobs (CIWMB, Division of Corrective Actions), Charlene Herbst (Water Resources Board), and Frank Bowerman (Director and Chief Engineer, Department of Public Works, Orange County) in an attempt to locate specific data on California leachate composition, but found no usable leachate composition data for California landfills. In the absence of California data, national data on leachate composition is used as a proxy. Listed in Tables 5.5 and 5.6 are leachate composition concentrations for inorganic pollutants (see Table 5.5) and organic pollutants (see Table 5.6).

In the third step the pollutant concentrations were multiplied by the gallons of leachate per ton of waste (see Tables 5.3 and 5.4) to arrive at total per ton pollutant loadings for old -- non-liner (uncontrolled, see Table 5.7) -- landfills and for new -- liner and leachate collection system (controlled, see Table 5.8) -- landfills. In the fourth step these pollutants were allocated to specific materials depending on composition analysis ("ultimate analysis"), reactivity of the material in a landfill, and percentage of the material in the waste stream.

All heavy metals -- with the exception of cadmium, lead, mercury,* nickel, and zinc -- were allocated to specific materials based on the ultimate analysis done for eight metals in Table 5.9 and/or percentage of the material landfilled. Cadmium, lead, mercury, nickel, and zinc were allocated to specific materials after large fractions of their total contribution to landfill leachate was allocated to household hazardous wastes. Household hazardous wastes accounted for 52% of all cadmium,[4] 13% of all lead,[5] 93% of all mercury,[6] 20% of all nickel,[7] and 45% of all zinc.[8] Therefore, for example, 52 percent of all cadmium is apportioned to household hazardous wastes and the remaining 48 percent is allocated across all other materials containing cadmium (see Table 5.9). The household hazardous waste which accounts for the high use of these metals, with the exception of lead, is batteries. Lead-acid batteries account for 64.6% of all lead use, but 80% of all lead-acid batteries are recycled.[9]

Organic pollutants were allocated to specific materials based on their reactivity in a landfill, contribution to the specific pollutant, and/or percentage of the material in the waste stream. Glass, metals, miscellaneous inorganics, and inert solids do not contribute to organic pollutants from landfills. All pesticides -- 2,4-D; 4,4-DDT; endosulfane sulfate; and lindane -- and 1,1-dichloroethane (used only as a solvent) were allocated to household hazardous wastes. Yard waste may also be a

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*Mercury was not identified as a constituent of leachate from landfills meeting RCRA requirements.

small contributor to pesticides in landfill leachate, but in this report we assumed that household hazardous wastes were responsible for all pesticides found landfill leachate. All other organics, with the exception of phenol, were allocated to paper, plastics, tires/rubber, miscellaneous organics (non-compostable organics), and household hazardous wastes based on their percentage in the waste stream. Phenols were the only organic chemicals attributed to organic wastes.

In Table 5.10, heavy metals and organic pollutants from a landfill without a liner and leachate collection system were allocated to specific materials based on their percentage in a ton of California waste. In Table 5.11, heavy metals and organic pollutants from a landfill without a liner and leachate collection system were allocated to specific materials per ton of that material. In Table 5.12, heavy metals and organic pollutants from a landfill with a liner and leachate collection system were allocated to specific materials based on their percentage in a ton of California waste. In Table 5.13, heavy metals and organic pollutants from a landfill with a liner and leachate collection system were allocated to specific materials per ton of that material.

5.1.2 Leachate from Landfills with Incinerator Ash

California generates relatively small amounts of incinerator ash, and at least some of it is landfilled with MSW. The landfilling of incinerator ash with MSW alters the constituents of landfill leachate. The concentrations of inorganic and organic pollutants in codisposal (ash and MSW) leachate are listed in Tables 5.14 and 5.15. The principal difference in pollutants between codisposal landfills and MSW landfills is that codisposal landfills have low levels of dioxins and dibenzofurans, neither of which are found in leachate from MSW landfills. Because incinerator ash accounts for such a small proportion of total material landfilled in California, the environmental impacts of incinerator ash on landfill leachate are not assessed in this study.

5.1.3 Landfill Gas Generation

Landfill gas is produced primarily by the anaerobic decomposition of organic materials. Factors which affect landfill gas generation include: landfill temperature; aeration; moisture content; pH; and waste composition.[10] Because numerous factors affect landfill gas generation -- similar to leachate generation -- it is difficult to allocate specific pollutants in landfill gas to specific materials. This is further complicated by the fact that some gases are a byproduct of reactions which occur in the landfills. Therefore, in order to apportion landfill gases to specific materials, it is necessary, in some cases, to make simplifying assumptions.

To allocate landfill gas emissions to specific materials/products requires the following four steps:

1. identify constituents of landfill gas and their concentration levels;
2. determine the amount of gas produced at a generic California landfill (cubic feet gas/ton refuse);
3. convert pollutant concentration to pollutant factors (lbs pollutant/ton MSW); and
4. allocate pounds of pollutant to materials based on percent of material in a ton of landfilled California MSW (Chapters 3 and 4), and how much that material contributes to that pollutant.

The principal gases emitted from landfills are methane* and carbon dioxide. Other gases emitted from landfills include nitrogen, oxygen, hydrogen, sulfides, and trace constituents (see Table 5.16). Specific gas composition data for California landfills have been compiled by the California Air Resources Board as part of the solid waste air quality assessment testing program (SWAT). The gases analyzed in this landfill testing program are methane, oxygen, nitrogen, carbon dioxide, and ten trace constituents: benzene; carbon tetrachloride; chloroform; 1,2-dichloroethane (ethylene dichloride); ethylene dibromide; methylene chloride; perchloroethylene; 1,1,1-trichloroethane; trichloroethylene; and vinyl chloride. Because landfill gas can contain more than 70 different organic compounds,[11] all of which are found only in trace amounts in a few landfills, the analysis is limited to the ten trace landfill gas constituents identified in the SWAT program.

Since data have only been published on methane and trace constituent concentrations for California landfills,[12] in this report U.S. EPA data (Table 5.16) for all landfill gases, except trace constituents, is used. The disaggregation of trace constituents will be based on data from *The Landfill Testing Program* report (see Table 5.17).

To determine landfill gas pollutant factors, the pollutant fraction is multiplied by the median landfill gas emission rate. The median landfill gas emission rate is based on cubic feet of landfill gas emitted per pound of refuse per year. A range of gas emission capture rates from California landfills is shown in Table 5.18, with the median being 0.078 cubic feet/lb/yr.

Gas collection systems however are not 100% efficient. Estimates of the efficiency of gas collection systems range from a low of 40% to a high of 90%.[13] We used the California Air Resources Board's estimate of 60%.[14] Therefore, assuming that the median gas generation rate of 0.078 cubic feet/lb/yr has a 60% collection efficiency rate, total gas generation equals 0.13 cubic feet gas per pound refuse. Assuming that 23.8 cubic feet of gas weighs a pound[15] and one pound of refuse produces 0.13 cubic feet of gas, a ton of waste will produce 10.9 pounds of landfill gases (see Table 5.19). This estimate of landfill gas generation rates, however, is considerably lower than theoretical estimates of potential gas generation, which range from 1.5 to 4.3 cubic feet gas per ton.[16] Since no data from California verify these higher landfill gas generation rates, the more conservative rate of 0.13 cubic feet gas per pound of refuse is used for uncontrolled landfills. Landfill gas emissions from a landfill collecting the gas and generating energy from a gas turbine is 5.39 pounds gas per ton of waste from the landfill and 0.014 pounds gas per ton of waste from the gas turbine (see Table 5.20).

Having identified the constituents of landfill gas and the amount of gas produced per ton of waste, the next step is to allocate these gases to specific materials in the landfill. Landfill gases are produced by the decomposition of organic materials: paper, yard waste, wood waste, food waste, textiles, plastics, and tires/rubber. These materials decompose at different rates: food waste, yard waste, and paper decompose the quickest; followed by wood and textiles; with plastics and rubber decomposing the slowest.[17] The ability of these materials to decompose is indicated in Table 5.21 (column "volatile solids biodegraded") which lists the percentage of volatile solids

*Methane emissions from landfills can "migrate" to nearby locations, causing risks of explosion or asphyxiation, in addition to the health hazards and global warming effects examined in this study.

biodegraded. Only 2% of plastics and rubber volatile solids are biodegraded whereas 50% of all food waste volatile solids are biodegraded.

Methane and carbon dioxide are the primary gases produced during anaerobic decomposition. The principal contributor to methane and carbon dioxide generation is carbon. Table 5.21 lists the carbon content of organic materials as documented by three different sources. In this study data from New York City are used since it covers all materials. New York City data are also used as a reference for heavy metal content in specific materials. Table 5.22 lists the distribution of degradable carbon for each material based on their percentage in California waste. This percentage is then multiplied by the pounds of methane produced per ton of waste to produce the pollutant coefficients listed in Table 5.23 (uncontrolled landfill) and Table 5.25 (controlled landfill). Pollutants per ton of material are listed in Tables 5.24 (uncontrolled landfill) and Table 5.25 (controlled landfill).

The pollutant coefficients for carbon monoxide (CO), carbon dioxide (CO_2), and methane were apportioned according to the percentage of carbon in a material (Table 5.22). The pollutant coefficients for sulfides were apportioned according to the percentage of sulfur in a material (Table 5.22).

Apportioning trace constituents to specific materials, however, is more difficult. The principal confounding factor is knowing exactly what went into the landfill. For example, the Waste Management Board *Landfill Gas Characterization* study concluded that there are "several possible explanations for the presence of trace compounds detected in municipal landfill gas":[18]

1. industrial hazardous wastes placed in MSW landfills prior to strict controls are volatilized;
2. chemicals contained in household hazardous wastes are volatilized;
3. gases are formed during biological and chemical decomposition of industrial or household hazardous wastes; and
4. gases are formed during biological and chemical decomposition of non-hazardous MSW.

Given currently available data, the first three explanations seem the most plausible for the majority of trace compounds generated by landfills. Trace compounds generated in post-RCRA landfills would most likely be explained by the second and third statements. For example, the Batelle report, *Study of Vinyl Chloride Formation at Landfill Sites in California*, identified the decomposition of chlorinated organic solvents by methanogenic bacteria as the principal cause of vinyl chloride in California landfills.[19] The off-gassing of vinyl chloride from plastic polymers was identified as responsible for "less than 5% and probably less than 1% of the total VC [vinyl chloride] measured."[20]

Although no data are available which identify the sources of the trace compounds examined in this study, it seems likely that they are produced primarily from products which contain hazardous wastes. As shown in Table 5.27, all of the organic compounds found in landfill gas are also found in household hazardous wastes such as home cleaners, pesticides, car products, paints, paint thinners, and paint strippers. Because these products are the primary repository of the trace compounds found in landfill gas, it is assumed that they are also the primary sources of trace compounds.

5.2 MSW INCINERATORS

In this section, the environmental emissions associated with solid waste incineration, air emissions and solid waste, are presented. The emissions associated with solid waste incinerators are summarized in Table 5.28.

5.2.1 Description of Existing Solid Waste Incinerators

Currently, three solid waste incinerators are operating in California. The Commerce Refuse to Energy Facility, located in Commerce, consists of one mass-burn waterwall furnace with a design capacity of 380 tons per day. Emission controls for this facility include a spray dryer, fabric filter, and Thermal $DeNO_x$.[21] The Southeast Resource Recovery Facility in Long Beach consists of three mass-burn waterwall furnaces, each with a design capacity of 460 tons per day, or a total of 1,380 tons per day. The emission controls also include a Thermal $DeNO_x$, spray dryer and fabric filter.[22] The third incinerator, the Stanislaus Waste-to-Energy Facility, is located in Stanislaus County. This facility consists of two mass-burn waterwall furnaces, each with a 400 ton per day capacity, or 800 ton per day total design capacity. The emissions are controlled using the same pollution control devices as the previous two facilities.[23] Thus, all three operating facilities use the same design, mass-burn waterwall furnaces, and employ similar pollution control devices. The characteristics of these facilities are summarized in Table 5.29.

5.2.2 Air Emissions Associated with Solid Waste Incineration

As with the combustion of any material, the combustion of solid waste generates air emissions. The quantity of a pollutant released into the air per unit of solid waste incinerated depends on the efficiency of the pollution control device (and on combustion efficiency). Since all three of California's incinerators employ similar pollution control devices, one set of emission factors that correspond to the level of control provided by these devices was developed.

To develop representative air emission factors for California incinerators, Tellus collected emission test data that are available for the three facilities. These data are presented in Table 5.30. Emission factors for the array of pollutants associated with solid waste incineration are available for both Stanislaus and Commerce. The data for SERRF are more limited.

Two sets of emission factors are presented for the Commerce facility. Commerce usually burns solid waste fuel that consists of 95% commercial waste and 5% residential waste. The emissions resulting from the test burn of this fuel are reported under the column entitled "commercial." In addition, another test burn was conducted using a mixed fuel that consisted of 60% commercial and 40% residential waste; this mix is typical of the municipal solid waste composition that enters other California incinerators. The emissions resulting from this test burn are reported under the column entitled "mixed." The emissions from both test burns are similar.[24]

The emission factors from all three facilities are averaged to derive a representative emission factor for each pollutant. Since the emissions from both tests performed at Commerce are similar, both test results are included in this average (i.e., it is not necessary to derive separate emission factors associated with burning commercial versus mixed commercial/residential waste). The average emission factors are presented in the last column of Table 5.30.

5.2.3 Ash Associated with Solid Waste Incineration

Incineration of MSW achieves a 90% volume reduction of the waste that must be landfilled. However, two types of solid waste are generated by solid waste incinerators: bottom ash, which is the residue formed from the combustion of MSW; and fly ash, which is the particulates formed in the furnace and carried with the flue gases that then enter and are collected in the air pollution control devices. By weight, the resulting ash is 25-35% of the incoming waste. Thus, for example, a 1,000 ton per day incinerator will generate 250 to 350 tons per day of ash. Approximately 90% of this ash is bottom ash and 10% is fly ash.

Bottom ash and fly ash differ markedly in their compositions. Bottom ash is a largely inert, incombustible residue. It mainly consists of large particles of broken glass, metals, ceramics and any other heavy incombustible residues which are not removed by the incinerator flue gas. The metals in the bottom ash are usually visible and recoverable. The remaining incombustible portion is granular in nature and usually has lower metal concentrations than those found in fly ash.

Fly ash, on the other hand, consists of lighter particulates formed in the furnace and carried with the flue gases that then enter and are collected in the air pollution control devices. The particle size of the fly ash is much finer than that of the bottom ash. Metal concentrations in the fly ash are generally higher than those of the bottom ash. This can be attributed to the fly ash's relatively small particle size and hence proportionately larger surface area.

While on a weight basis bottom ash exceeds fly ash, it is the fly ash that contains most of the environmental contaminants of concern. In the air pollution control device, volatile contaminants including heavy metals, dioxins, dibenzofurans, and other organics condense on these particulates. As the efficiency of air pollution control devices increases, the amount of these contaminants captured in the pollution control device also rises, thereby increasing the amount of contaminants in the fly ash.

The Commerce incinerator is the only facility that ash data could be obtained from and these data are limited. Comprehensive test results for the Commerce facility were not available in the timeframe of this study[25]. Consequently, other sources of data were reviewed. A study prepared for the U.S. EPA characterizing municipal waste incinerator ash was used instead.[26] This report summarizes the range of concentrations of various pollutants found in bottom and fly ash. To determine the representative pollutant content of incinerator ash, the midpoint of the concentration range for each pollutant was used. These concentrations were then converted to pounds of a pollutant per ton of MSW incinerated assuming that the total ash generated was 25% by weight of the entering waste. These data are shown in Table 5.31.

5.2.4 Apportioning Air Emissions and Pollutant Content of Incinerator Ash to Waste Components

The next step is to apportion pollutant emissions to waste stream components. The methodology employed is described in this section.

There are three methods by which pollutants are generated from solid waste incinerators: 1) they are present in the fuel and are released during combustion; 2) they are formed from various precursors in the fuel; or 3) they are formed as products of combustion. Pollutants in the first category include metals, sulfur oxides (formed from sulfur in the fuel), and NO_x (formed from nitrogen in the fuel). Pollutants in the second category include volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs). The third category includes CO, particulates, and nitrogen oxides -- pollutants which are associated with all combustion processes. (While nitrogen in the fuel does give rise to NO_x emissions, combustion processes also emit NO_x due to the presence of nitrogen in air.)

The theoretical method of apportioning these emissions to waste stream components is simple. For emissions that result from the pollutant's presence in the fuel, the emissions are apportioned according to the relative amount of the pollutant in each waste stream component. Emissions that arise from precursors in the fuel are attributed to components containing those precursors. For the last category of pollutants, emissions are related to the amount of solid waste incinerated (and to furnace characteristics such as temperature). Therefore, those emissions are evenly apportioned across waste stream components.

Unfortunately, this theoretical method is not easily applied since much is still unknown about the chemical reactions and product yields of complex reactions in municipal waste incinerators. In addition, the waste stream component sources of all these emissions are not always known.

Table 5.9 provides an ultimate analysis of various waste stream components. Emissions of the metals documented in this table - arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver -- are apportioned according to the weighted average (i.e., the amount of metal that each component contributes to the total amount of metal) of these metals in the waste stream components (see Table 5.32 and 5.33). Batteries contribute several metals to the solid waste stream. Batteries account for 13% of lead, 52% of cadmium, 93% of mercury, 20% of nickel, and 45% of zinc.[27,28] The percentages of these metals are attributed to household hazardous waste and the remaining percentages for each metal are apportioned according to the ultimate analysis. As no information could be found about waste stream sources of antimony, nickel, tin, and vanadium, emissions of these metals are distributed evenly to each waste stream component. Batteries are responsible for 45% of the zinc in the waste stream. Therefore 45% of the zinc emissions is attributed to household hazardous waste; the remaining 55% is attributed to the rest of the waste stream components. Metals are responsible for 30% of the copper in the waste stream and miscellaneous inorganics are responsible for another 40%. Thus, 30% of the copper emissions is attributed to the metals category, 40% to miscellaneous inorganics, and 30% to the remaining waste stream components.

Criteria air emissions include CO, NO_x, particulates, sulfur oxides (SO_2), and VOCs. Carbon monoxide and particulate emissions are related to the amount of waste incinerated; therefore these emissions are apportioned evenly across waste stream components. Nitrogen oxide emissions are associated both with nitrogen present in the fuel and also with the amount of waste incinerated. A literature search does not elucidate which of these two pathways are predominant. Half of the emissions is assumed to arise from nitrogen in the fuel and therefore, 50% of the emissions is attributed to waste stream components containing nitrogen according to the weighted average of nitrogen in the waste stream components. The remaining 50% of the emissions is attributed evenly to each waste stream component. Sulfur oxide emissions are attributed to waste stream components containing sulfur according to the weighted average sulfur content. Emissions of VOCs arise from the combustible portion of the waste stream. These emissions are evenly apportioned to those categories.

Hydrogen chloride and hydrogen fluoride are associated with the presence of chlorine and fluorine in waste stream components. Hydrogen chloride emissions are allocated based upon the content of chlorine in each waste stream component. Sources of fluorine in waste include plastic, teflon coated metals, and floor and wall panel facings.[29] Hydrogen fluoride emissions are therefore apportioned to plastics, metals, bulky items, and textiles.

Polycyclic aromatic hydrocarbons (PAHs) and PCDDs/PCDFs are generated from precursors in the waste stream. Precursors for PAH formation include paper, plastics, organics, and household hazardous waste. Emissions of PAHs are apportioned evenly among these components. The chemistry behind PCDD/PCDF formation is somewhat more complex. Precursors are formed from aromatic organics and chlorine sources. Emissions are apportioned evenly among waste components that yield aromatic organic compounds and chlorine during combustion, such components include paper, plastics, yard waste, wood waste, rubber, textiles, miscellaneous inorganics (which contain chlorine), and household hazardous waste. The emissions associated with plastics were evenly apportioned between the film plastic and other plastic categories as these are the two categories of plastics that contain chlorine.

The amount of pollutant contributed by each solid waste component is then combined with incinerator waste composition data to determine the total amount of each pollutant associated with the incineration of one ton of solid waste. These data are shown in Table 5.34. These emission data are not necessarily the same total emissions as shown in Tables 5.30 and 5.31 due to the fact that Table 5.34 is based upon an average waste composition.

5.3 MIXED WASTE COMPOSTING

The environmental impacts of a mixed waste composting facility will depend on the type of facility (indoor or outdoor; windrow or enclosed) and the waste composition (amount of organic matter in the waste, and the inclusion or exclusion of sewage sludge). The principal water effluent from mixed waste compost would be from windrow leachate, water that percolated through the compost piles. If the composting occurs indoors (either enclosed or windrows in a building), there will be less water effluent than with outdoor windrows. The principal air emissions from a composting facility are bacteria and fungi from the compost pile, odor emissions from aerobic decomposition, and air emissions from the machinery.

In this analysis, mixed MSW composting operations are examined because these systems process the most comprehensive assortment of materials targeted by the proposed disposal fee.

MSW can be composted either completely in windrows, entirely in an enclosed system, or with a combination of enclosed composting followed by curing in windrows. Enclosed systems are examined for the purpose of this report because such systems allow for better environmental and general process control. Of the 12 facilities in or near construction phase throughout the U.S., there is a trend toward more enclosed systems.

Virtually all enclosed systems that receive a mixed MSW waste stream involve some level of front-end recovery of recyclables. Ferrous metals are magnetically removed and more advanced systems remove some plastics and glass. The remaining materials are mixed, typically macerated, and placed in an enclosed system to accelerate the composting process. The duration of residence time within enclosed systems varies from 3 to 28 days. After the organic matter has decomposed within the enclosed system, outdoor windrowing and curing are typically employed prior to transporting the compost off-site.

The materials likely to be composted may be classified under four A.B. 939 categories: paper, yard wastes, other organics, and other wastes. These categories are consistent with those used in the regulations pursuant to A.B. 939. The materials are disaggregated in more detail in Table 5.35.

An average of 225 pounds of carbon dioxide (CO_2) is emitted per ton of mixed MSW compost (this estimate excludes manure and crop residue emissions).[30,31] Carbon dioxide has been identified as the principle greenhouse gas responsible for more than 50% (and perhaps as much as 70%) of global warming potential.[32] Table 5.36 below shows the estimated pounds of CO_2 emitted per ton of mixed MSW.

Air emissions may also include ammonia, hydrogen sulfide (H_2S) and NO_x[33] and volatile organic carbons (VOCs).[34] The quantities produced are a function of mix ratios and type of scrubbing system used for odor control.

Leachate emissions from enclosed systems are minimal and any leachate is usually collected in a reservoir and used to moisturize the compost. Leachate contains nutrients, heavy metals, and pathogens.[35,36] A compost facility in Clayton, Georgia with a capacity of 3 tons/day (dry weight) produces 5 to 10 gallons/day of leachate.[37]

Paper contains small quantities of nutrients and will release the least nutrients, e.g. nitrate and phosphate, into leachate. Disposable diapers, food, and grass clippings are rich in nutrients and have the greatest impact on leachate. In general heavy metals of concern in mixed MSW include: arsenic; barium; cadmium; chromium; copper; lead; mercury; nickel; silver; selenium; and zinc.[38] The distribution of heavy metals present in mixed MSW materials at the compost site are probably similar to those presented in Table 5.9. Yard waste, agricultural residues, manure and food are low in heavy metals. Printed papers will produce some heavy metals (usually cadmium or chromium) leachates, originating in the ink.

Odors originate from feedstock storage, the tipping floor, and feeding devices. Odors are easiest to control in in-vessel plants where negative pressure can be maintained in the plant and the outgoing air can be filtered.[39] Nutrient rich materials, such as food, manure, grass, and disposable diapers will generate the most odors.

5.4 MATERIALS RECOVERY

The impacts of materials recovery facilities arise primarily from the air emissions of mechanical machinery and particulates from processing operations, such as glass crushers. Most of the emissions are minimal and local in nature, representing more of an in-facility issue than external environmental problem.

One source of data was found for recycling facility air emissions. In a report by the Center for the Biology of Natural Systems (CBNS), *Development and Pilot Test of an Intensive Municipal Solid Waste Recycling System for the Town of East Hampton*, results are presented from a two-day sampling of a materials recovery facility in Groton, Connecticut. This facility accepts mixed glass, aluminum, and tin containers, which are separated and processed through a combination of manual or automatic systems.

The data from this report are not necessarily representative of all recycling facilities and will not be used for producing environmental impacts in this report. In addition, the CBNS study is an analysis of ambient conditions because measurements are from the exhaust fan in the building. Converting ambient measurements to environmental emissions is not a straightforward process and further reduces the suitability of the data to this project.

Pollutants levels measured in the Groton, Connecticut facility are listed below in Tables 5.37 and 5.38. The tables present data collected both during active sorting (Table 5.38) and when no sorting occurred (Table 5.37). While emissions differed for organics and microorganisms during sorting, no change in the particulate emissions and heavy metals was found. Consequently, particulates and heavy metals are only listed in Table 5.37, which reports emissions when no sorting occurred.

Emissions within a recycling facility can emanate from a number of sources: vehicle emissions from collection vehicles; the unloading of materials on the tipping floor; emissions from front-end loaders; particulates from glass crushers and other sorting and processing equipment; and emissions from automated sorting and processing machinery. Some of these emissions result from sorting activities, though many occur from other activities, such as the dumping of materials. Therefore, particulates or heavy metals in the air may result from these other activities even though they appear to result from sorting.

Seven materials were responsible for the majority of organics detected: silicone oil (a lubricant); isobutane (use in liquid petroleum gas fuel); trichlorofluoromethane (a refrigerant); 1,1,1-trichloroethane (a cleaning solvent); acetone (an industrial solvent); toluene (an industrial solvent and component of gasoline); ethyl benzene (a component of gasoline); and xylene (a solvent and component of gasoline). Several organic compounds increased in concentration during active sorting. Of these materials, only isobutane showed a clear increase during both sampling days. A number of other materials showed increased concentrations only during the first day of sampling, when 65% of sampling was performed. These include trichloroethane, trichloroethylene, benzene, tetrachloroethylene, and possibly hexane and toluene. The average concentration of VOCs measured is about 3,256 ug/m^3.

CBNS speculates that the source of isobutane may be a front-end loader. They also speculate that the source of many of the compounds found during the first day (particularly the trichloroethane, trichloroethylene, tetrachloroethylene and benzene) may have been contaminated containers brought in with the recyclables.

Microorganism concentrations increased dramatically during sorting: increasing from 242 colonies per ton without sorting to 7,159 colonies per ton with sorting. Most of these bacteria do not present a significant health threat to humans, and no primary pathogens were found. The likely source of the bacteria is bacterial growth in residues from food containers.

5.5 SOLID WASTE AND RECYCLABLE COLLECTION

All impacts for the collection of garbage and recyclables are considered in this section, with the exception of water effluents, which are not generated by trucks. The principal data source for transportation air emission factors is the U.S. EPA report, *Compilation of Air Pollutant Emission Factors II: Mobile Sources*. Additional information was obtained from the California Air Resources Board, including *Identification of Volatile Organic Compound Species Profiles*, and *Technical Guidance Document to the Criteria and Guidelines Regulations for AB-2588*. Air emissions factors were found for HC, CO, NO_x total VOCs, benzene, ethyl benzene, toluene, and xylenes.

Emission factors in the U.S. EPA *Compilation* report are based upon pounds of pollutants emitted per ton-mile. These factors are available for HC, CO, NO_x and total VOCs; they are converted to a volume-measure (i.e., pollutants per cubic yard-mile) that is based upon standard recycling and garbage truck capacity. The volume-based measure is more appropriate for assessing collection impacts because materials fill up trucks by volume, not by weight.

Emissions factors for benzene, ethyl benzene, toluene and xylenes are based on the percentage composition of all individual VOCs emitted from diesel exhaust.

Air impacts are estimated for each material, based upon in-truck volumes (different for recycling and garbage trucks because of compaction) and assumed truck collection miles. The truck mileage is based upon estimates for distance travelled from collection routes to California facilities, and time spent on-route. Some adjustment to emission factors is required because these factors assume normal transport of goods at high average speeds, whereas waste collection involves large amounts of idle time spent collecting materials, combined with higher average speed during transport to the waste facility.

Per ton emission levels from recycling and garbage collection vehicles are presented in Table 5.39. From these figures, emissions per ton for each material are determined. These results are presented in Table 5.40 for recycling and in Table 5.41 for garbage. Data on HC, CO, NO_x total VOCs, benzene, ethyl benzene, toluene, and xylenes are shown in these tables. The emission factors have been converted to emission levels per ton based upon the following assumptions:

3.0 pounds waste generated per person per day;
2.6 people per household;
15% of material recycled by weight;
a recycling collection rate of 80 households per hour; and
a garbage collection rate of 60 households per hour.

These assumptions are generic and do not necessarily reflect actual conditions in California. As data specific to California are developed, these generic assumptions will be revised to adjust the per ton emission levels.

Emissions from garbage and recycling trucks are assumed to be identical. However, in reality, emissions are higher from garbage trucks due compaction cycles and slightly larger engine requirements. For both trucks, emission factors for "heavy duty diesel vehicles" are used from the *Compilation of Air Pollutant Emission Factors*. These emission factors assume operating conditions of standard trucks transporting goods, not of waste collection vehicles with frequent stops, starts, and compaction cycles. To account for this, emission factors for idle time and adjustments for slower traveling speed are made to the standard emission factors.

TABLE 5.1 NORTHERN CALIFORNIA LANDFILL ASSUMPTIONS and LEACHATE GENERATION

TPD	1,000
Acres	182.9
Square Feet	7,967,124
Depth (feet)	80
Cap	
1. 12" loam	
2. 36" clay	
3. 24" coarse sand	
Liner	
1. 60" clay w/synthetic membrane	
Years Open	25
Post-Closure Period (yrs)	30
Cells, number	5
time period cells are open (yrs)	5
Cell Size (sq ft)	1,593,425
Cell Depth, average	40
Active Landfill Leachate Generation	
no liner (gallons)	8,340,032
liner (gallons)	22,240
Closed Landfill Leachate Generation	
no liner (gallons)	4,817,502
liner (gallons)	0
Total Waste Landfilled over 25 yrs (tons)	7,280,000
Percent of CA's Waste	32.40%
Annual Precipitation for Bay Area (inches/yr)	26.44

Sources: U.S. EPA, "HELP Model," 1984; and Tellus Institute.

TABLE 5.2 SOUTHERN CALIFORNIA LANDFILL ASSUMPTIONS and LEACHATE GENERATION

TPD	1,000
Acres	115.4
Square Feet	5,026,824
Depth (feet)	130
Cap	
1. 12" loam	
2. 12" clay	
3. 24" coarse sand	
Liner	
1. 24" clay	
Years Open	25
Post-Closure Period (yrs)	30
Cells, number	5
time period cells are open (yrs)	5
Cell Size (sq ft)	1,005,365
Cell Depth, average (ft)	65
Active Landfill Leachate Generation	
no liner (gallons)	1,642,209
liner (gallons)	1,259,888
Closed Landfill Leachate Generation	
no liner (gallons)	3,120,019
liner (gallons)	0
Total Waste Landfilled over 25 yrs (tons)	7,280,000
Percent of CA's Waste	67.60%
Annual Precipitation for Los Angeles Area (inches/yr)	13.52

Sources: U.S. EPA, "HELP Model," 1984; and Tellus Institute.

TABLE 5.3 CALIFORNIA LANDFILL LEACHATE GENERATION, UNCONTROLLED

Northern California Landfill Status	Annual Leachate Generation (gallons)	Annual Leachate Escaping from Lined Landfill (gallons)	Leachate from Capped Part of Active Landfill (25 yrs) (gallons)	Leachate from Open Cells (gallons)	Leachate from Capped Landfill (gallons)	Average Annual Leachate Generation (gallons)	Uncontrolled Leachate Generation (gallons/ton)	Weighted Average by Region (gallons/ton)
Active Landfill	8,340,032	22,240	48,175,018	208,500,797				
Capped Landfill	4,817,502	0			144,525,055			
Total Over Landfill Life (25 yrs active, 30 years closed)						7,294,561	55.11	17.86
Southern California Landfill Status								
Active Landfill	1,642,209	1,259,888	31,200,193	41,055,228				
Capped Landfill	3,120,019	0			93,600,579			
Total Over Landfill Life (25 yrs active, 30 years closed)						3,015,564	22.78	15.40
Total								33.26

Sources: U.S. EPA, "HELP Model," 1984; and Tables 5.1 and 5.2.

TABLE 5.4 CALIFORNIA LANDFILL LEACHATE GENERATION, CONTROLLED

Northern California Landfill Status	Annual Leachate Generation (gallons)	Annual Leachate Escaping from Lined Landfill (gallons)	Total Leachate Escaping from Lined Landfill (gallons)	Controlled Leachate Generation (gallons/ton)	Weighted Average by Region (gallons/ton)
Active Landfill	8,340,032	22,240			
Capped Landfill	4,817,502	0			
Total Over Landfill Life (25 yrs active, 30 years closed)			555,988	0.08	0.025
Southern California Landfill Status					
Active Landfill	1,642,209	1,259,888			
Capped Landfill	3,120,019	0			
Total Over Landfill Life (25 yrs active, 30 years closed)			31,497,206	4.33	2.925
Total					2.95

Sources: U.S. EPA, "HELP Model," 1984; and Tables 5.1 and 5.2.

TABLE 5.5 MSW LEACHATE CONSTITUENTS – INORGANIC POLLUTANTS – FROM LANDFILLS MEETING RCRA REQUIREMENTS

Inorganic Pollutant	Average Concentration (ppm)	Average Concentration (lbs/gal)	Median Concentration (ppm)	Maximum Concentration (ppm)
Aluminum	2.04E+00	1.70E-05	2.00E+00	5.80E+00
Antimony	n/d	n/d	n/d	n/d
Arsenic	1.10E-02	9.18E-08	9.00E-03	2.30E-02
Barium	7.31E-01	6.10E-06	4.80E-01	1.70E+00
Beryllium	n/d	n/d	n/d	n/d
Cadmium	2.20E-03	1.84E-08	2.00E-03	7.00E-03
Chromium (total)	8.30E-03	6.93E-08	6.25E-03	3.90E-02
Cobalt	n/d	n/d	n/d	n/d
Copper	n/d	n/d	n/d	n/d
Iron	8.01E+01	6.69E-04	1.94E+01	2.68E+02
Lead	1.70E-02	1.42E-07	3.00E-03	6.10E-02
Manganese	3.06E+00	2.56E-05	1.21E+02	4.24E+02
Magnesium	2.00E+02	1.67E-03	1.51E+00	8.87E+00
Mercury	n/d	n/d	n/d	n/d
Nickel	6.79E-02	5.67E-07	6.50E-02	1.60E-01
Selenium	8.60E-04	7.18E-09	n/d	6.00E-03
Silver	n/d	n/d	n/d	n/d
Thallium	n/d	n/d	n/d	n/d
Tin	n/d	n/d	n/d	n/d
Vanadium	1.60E-02	1.34E-07	1.70E-02	2.40E-02
Zinc	7.29E-01	6.08E-06	3.15E-01	2.59E+00

Source: U.S. EPA, "Characterization of Leachates from Municipal Waste Disposal Sites and Co-Disposal Sites," 1987, pp. 4-8 - 4-10.

TABLE 5.6 MSW LEACHATE CONSTITUENTS – ORGANIC POLLUTANTS – FROM LANDFILLS MEETING RCRA REQUIREMENTS

Organic Pollutant	Average Concentration (ppm)	Average Concentration (lbs/gal)	Median Concentration (ppm)	Maximum Concentration (ppm)
Acetone	1.97E+00	1.64E-05	1.13E+00	4.60E+00
2-Butanone [1]	3.56E+00	2.97E-05	9.70E-01	1.20E+01
p-Cresol [2]	1.33E+00	1.11E-05	2.65E-02	5.10E+00
2,4-D	1.49E-02	1.25E-07	n/d	1.20E-01
4,4-DDT	7.36E-05	6.14E-10	5.30E-05	1.60E-04
1,1-Dichloroethane	2.90E-04	2.42E-09	n/d	4.00E-03
t-1,2-Dichloroethene	2.43E-03	2.03E-08	n/d	1.60E-02
Diethyl phthalate	2.29E-03	1.91E-08	n/d	3.20E-02
Endrin	n/d	n/d	n/d	n/d
Endosulfan sulfate	2.00E-05	1.67E-10	n/d	2.80E-01
Ethyl benzene	n/d	n/d	n/d	n/d
bis(2-Ethylhexyl)phthalate	2.60E-03	2.17E-08	n/d	1.90E-02
2-Hexanone [3]	1.69E-01	1.41E-06	2.55E-02	6.90E-01
Lindane	2.90E-06	2.42E-11	n/d	2.30E-05
4-Methyl-2-pentanone [4]	7.36E-02	6.14E-07	n/d	5.70E-01
Methylene chloride	1.12E-01	9.35E-07	9.70E-01	3.60E-01
Phenol	5.12E-01	4.27E-06	2.05E-02	2.10E+00
1,1,3-Trichloropropane	1.64E-02	1.37E-07	n/d	2.30E-01
Toluene	3.06E-01	2.55E-06	n/d	1.10E+00
Xylenes, total	n/d	n/d	n/d	n/d

[1] = also known as methyl ethyl ketone
[2] = also known as 4-methyl phenol
[3] = also known as methyl butyl ketone
[4] = also known as methyl isobutyl ketone

Source: U.S. EPA, "Characterization of Leachates from Municipal Waste Disposal Sites and Co-Disposal Sites," 1987, pp. 4-14 - 4-15.

TABLE 5.7 POUNDS OF POLLUTANTS PER TON GENERIC WASTE FROM LANDFILLS WITHOUT LINERS

INORGANIC POLLUTANTS	TOTAL (lbs pollutant/ton waste/landfill life)
Aluminum	5.67E-04
Antimony	n/d
Arsenic	3.05E-06
Barium	2.03E-04
Beryllium	n/d
Cadmium	6.11E-07
Chromium (total)	2.30E-06
Copper	n/d
Iron	2.22E-02
Lead	4.72E-06
Manganese	8.50E-04
Mercury	n/d
Nickel	1.88E-05
Selenium	2.39E-07
Tin	n/d
Vanadium	4.44E-06
Zinc	2.02E-04
ORGANIC POLLUTANTS	
Acetone	5.46E-04
2-Butanone	9.88E-04
p-Cresol	3.68E-04
2,4-D	4.14E-06
4,4-DDT	2.04E-08
1,1-Dichloroethane	8.05E-08
trans-1,2-Dichloroethylene	6.74E-07
Diethyl phthalate	6.35E-07
Endrin	n/d
Endosulfane sulfate	5.55E-09
Ethyl benzene	n/d
bis(2-Ethylhexyl)phthalate	7.22E-07
2-Hexanone	4.69E-05
Lindane	8.05E-10
4-Methyl-2-pentanone	2.04E-05
Methylene chloride	3.11E-05
Phenol	1.42E-04
Toluene	8.49E-05
1,2,3-Trichloropropane	4.55E-06
Xylenes	n/d

Sources: Tables 5.3, 5.5, and 5.6

TABLE 5.8 POUNDS OF POLLUTANTS PER TON GENERIC WASTE FROM LINED LANDFILL

INORGANIC POLLUTANTS	TOTAL (lbs pollutant/ton waste/landfill life)
Aluminum	5.03E-05
Antimony	n/d
Arsenic	2.71E-07
Barium	1.80E-05
Beryllium	n/d
Cadmium	5.41E-08
Chromium (total)	2.04E-07
Copper	n/d
Iron	1.97E-03
Lead	4.18E-07
Manganese	7.54E-05
Mercury	n/d
Nickel	1.67E-06
Selenium	2.12E-08
Tin	n/d
Vanadium	3.94E-07
Zinc	1.79E-05
ORGANIC POLLUTANTS	
Acetone	4.84E-05
2-Butanone	8.76E-05
p-Cresol	3.27E-05
2,4-D	3.67E-07
4,4-DDT	1.81E-09
1,1-Dichloroethane	7.14E-09
trans-1,2-Dichloroethylene	5.98E-08
Diethyl phthalate	5.64E-08
Endrin	n/d
Endosulfane sulfate	4.92E-10
Ethyl benzene	n/d
bis(2-Ethylhexyl)phthalate	6.40E-08
2-Hexanone	4.16E-06
Lindane	7.14E-11
4-Methyl-2-pentanone	1.81E-06
Methylene chloride	2.76E-06
Phenol	1.26E-05
Toluene	7.53E-06
1,2,3-Trichloropropane	4.04E-07
Xylenes	n/d

Sources: Tables 5.4 - 5.6.

TABLE 5.9 ULTIMATE ANALYSIS FOR RESIDENTIAL/COMMERCIAL (55/45) MSW

Parameter	Unit	Paper	Plastics	Organics [1]	Wood	Textiles	Rubber	Ceramics	Glass	Metal	Inorganics	Sludge
Arsenic	ppm	12.04	4.00	42.00	2.65	4.66	3.30	64.10	4.03	26.02	2.41	0.10
Barium	ppm	23.27	26.96	65.55	24.14	87.67	16.17	145.23	100.22	27.35	109.90	720.00
Cadmium	ppm	2.80	6.42	4.40	0.55	2.46	2.12	3.29	0.98	0.86	0.89	20.59
Chromium	ppm	13.77	12.13	54.22	5.29	303.94	356.17	9.93	91.33	572.00	28.74	319.29
Lead	ppm	36.48	37.52	298.07	41.90	28.56	286.43	559.24	333.11	1221.74	243.92	536.43
Mercury	ppm	0.60	0.54	1.15	0.68	2.24	0.53	0.08	0.23	0.43	1.05	4.10
Selenium	ppm	5.34	1.73	2.01	1.44	3.20	23.24	1.25	1.31	3.05	5.28	
Silver	ppm	0.71	0.72	0.64	0.80	1.12	0.60	0.75	0.53	1.12	0.87	
Carbon	%	35.00	49.63	19.40	42.12	38.33	43.08	4.39	1.40		9.66	
Hydrogen	%	7.08	7.99	8.13	6.25	6.78	4.83	1.69	0.95		2.57	
Nitrogen	%	0.57	0.36	0.51	0.29	1.59	0.86	0.52	0.28		0.97	5.90
Oxygen	%	50.26	41.31	60.82	49.85	47.62	15.89	0.00	0.00		18.18	
Sulfur	%	0.12	0.12	0.27	0.06	0.15	0.60	0.08	0.08		1.18	
Chlorine	%	0.29	1.05	0.19	0.22	0.38	3.19	0.09	0.43		1.30	

[1] Brush, grass, food waste, and miscellaneous organic wastes.

Source: SCS Engineers, "NYC Solid Waste 'Ultimate Analysis,'" 1990.

TABLE 5.10 POLLUTANTS FROM UNLINED LANDFILL (lbs/ton California MSW)

	PAPER	PLASTICS	GLASS	METALS	yard waste	wood waste	food waste	tires/ rubber
INORGANIC POLLUTANTS								
Arsenic	7.39E-07	5.59E-08	4.86E-08	2.04E-07	1.28E-06	2.15E-08	6.27E-07	1.02E-08
Barium	3.27E-05	8.62E-06	2.77E-05	4.91E-06	4.58E-05	4.48E-06	2.24E-05	1.15E-06
Cadmium	9.73E-08	5.08E-08	6.73E-09	3.83E-09	7.59E-08	2.53E-09	3.71E-08	3.71E-09
Chromium (total)	1.62E-07	3.25E-08	2.11E-07	8.61E-07	3.17E-07	8.22E-09	1.55E-07	2.12E-07
Lead	2.57E-07	6.01E-08	4.61E-07	1.10E-06	1.04E-06	3.89E-08	5.10E-07	1.02E-07
Manganese	2.90E-04	6.60E-05	5.70E-05	3.71E-05	1.44E-04	3.83E-05	7.04E-05	1.46E-05
Nickel	5.14E-06	1.17E-06	1.01E-06	6.57E-07	2.56E-06	6.79E-07	1.25E-06	2.59E-07
Selenium	8.14E-08	1.85E-08	1.60E-08	1.04E-08	4.05E-08	1.07E-08	1.98E-08	4.11E-09
Vanadium	1.51E-06	3.45E-07	2.98E-07	1.94E-07	7.53E-07	2.00E-07	3.68E-07	7.64E-08
Zinc	3.79E-05	8.64E-06	7.46E-06	4.85E-06	1.89E-05	5.01E-06	9.22E-06	1.92E-06
ORGANIC POLLUTANTS								
Acetone	3.91E-04	8.90E-05						1.97E-05
2-Butanone	7.08E-04	1.61E-04						3.57E-05
p-Cresol	2.64E-04	6.01E-05						1.33E-05
2,4-D								
4,4-DDT								
1,1-Dichloroethane								
trans-1,2-Dichloroethylene	4.83E-07	1.10E-07						2.44E-08
Diethyl phthalate	4.55E-07	1.04E-07						2.30E-08
Endosulfane sulfate								
bis(2-Ethylhexyl)phthalate	5.17E-07	1.18E-07						2.61E-08
2-Hexanone	3.36E-05	7.65E-06						1.70E-06
Lindane								
4-Methyl-2-pentanone	1.46E-05	3.33E-06						7.39E-07
Methylene chloride	2.23E-05	5.07E-06						1.12E-06
Phenol	6.65E-05	1.51E-05			3.31E-05		1.62E-05	3.36E-06
Toluene	6.09E-05	1.39E-05						3.07E-06
1,2,3-Trichloropropane	3.26E-06	7.43E-07						1.65E-07

Sources: Tables 5.7 and 5.9.

TABLE 5.10 POLLUTANTS FROM UNLINED LANDFILL (lbs/ton California MSW) (cont.)

	textiles	misc org	other waste solids	hhw	TOTAL
INORGANIC POLLUTANTS					
Arsenic	1.93E-08		4.49E-08		3.05E-06
Barium	8.32E-06		4.68E-05		2.03E-04
Cadmium	5.77E-09		9.38E-09	3.17E-07	6.11E-07
Chromium (total)	2.42E-07		1.03E-07		2.30E-06
Lead	1.36E-08		5.21E-07	6.13E-07	4.72E-06
Manganese	1.96E-05	2.49E-05	7.89E-05	9.07E-06	8.50E-04
Nickel	3.48E-07	4.42E-07	1.40E-06	3.77E-06	1.87E-05
Selenium	5.50E-09	7.00E-09	2.22E-08	2.55E-09	2.39E-07
Vanadium	1.02E-07	1.30E-07	4.12E-07	4.74E-08	4.44E-06
Zinc	2.57E-06	3.26E-06	1.03E-05	9.10E-05	2.01E-04
ORGANIC POLLUTANTS					
Acetone		3.36E-05		1.22E-05	5.46E-04
2-Butanone		6.08E-05		2.22E-05	9.88E-04
p-Cresol		2.27E-05		8.26E-06	3.68E-04
2,4-D				4.14E-06	4.14E-06
4,4-DDT				2.04E-08	2.04E-08
1,1-Dichloroethane				8.05E-08	8.05E-08
trans-1,2-Dichloroethylene		4.15E-08		1.51E-08	6.74E-07
Diethyl phthalate		3.91E-08		1.43E-08	6.35E-07
Endosulfane sulfate				5.55E-09	5.55E-09
bis(2-Ethylhexyl)phthalate		4.44E-08		1.62E-08	7.22E-07
2-Hexanone		2.89E-06		1.05E-06	4.69E-05
Lindane				8.05E-10	8.05E-10
4-Methyl-2-pentanone		1.26E-06		4.58E-07	2.04E-05
Methylene chloride		1.91E-06		6.97E-07	3.11E-05
Phenol		5.71E-06		2.08E-06	1.42E-04
Toluene		5.23E-06		1.90E-06	8.49E-05
1,2,3-Trichloropropane		2.80E-07		1.02E-07	4.55E-06

Sources: Tables 5.7 and 5.9.

TABLE 5.11 POLLUTANTS FROM UNLINED LANDFILL (lbs/ton material)

	PAPER	PLASTICS	GLASS	METALS	yard waste	wood waste	food waste	tires/ rubber
INORGANIC POLLUTANTS								
Arsenic	2.17E-06	7.20E-07	7.25E-07	4.68E-06	7.56E-06	4.76E-07	7.56E-06	5.94E-07
Barium	9.58E-05	1.11E-04	4.13E-04	1.13E-04	2.70E-04	9.94E-05	2.70E-04	6.66E-05
Cadmium	2.85E-07	6.54E-07	1.00E-07	8.78E-08	4.48E-07	5.61E-08	4.48E-07	2.16E-07
Chromium (total)	4.75E-07	4.18E-07	3.15E-06	1.97E-05	1.87E-06	1.82E-07	1.87E-06	1.23E-05
Lead	7.53E-07	7.74E-07	6.87E-06	2.52E-05	6.15E-06	8.64E-07	6.15E-06	5.91E-06
Manganese	8.50E-04	8.50E-04	8.50E-04	8.50E-04	8.50E-04	8.50E-04	8.50E-04	8.50E-04
Nickel	1.51E-05	1.51E-05	1.51E-05	1.51E-05	1.51E-05	1.51E-05	1.51E-05	1.51E-05
Selenium	2.39E-07	2.39E-07	2.39E-07	2.39E-07	2.39E-07	2.39E-07	2.39E-07	2.39E-07
Vanadium	4.44E-06	4.44E-06	4.44E-06	4.44E-06	4.44E-06	4.44E-06	4.44E-06	4.44E-06
Zinc	1.11E-04	1.11E-04	1.11E-04	1.11E-04	1.11E-04	1.11E-04	1.11E-04	1.11E-04
ORGANIC POLLUTANTS								
Acetone	1.15E-03	1.15E-03						1.15E-03
2-Butanone	2.08E-03	2.08E-03						2.08E-03
p-Cresol	7.74E-04	7.74E-04						7.74E-04
2,4-D								
4,4-DDT								
1,1-Dichloroethane								
trans-1,2-Dichloroethylene	1.42E-06	1.42E-06						1.42E-06
Diethyl phthalate	1.34E-06	1.34E-06						1.34E-06
Endosulfane sulfate								
bis(2-Ethylhexyl)phthalate	1.52E-06	1.52E-06						1.52E-06
2-Hexanone	9.86E-05	9.86E-05						9.86E-05
Lindane								
4-Methyl-2-pentanone	4.29E-05	4.29E-05						4.29E-05
Methylene chloride	6.53E-05	6.53E-05						6.53E-05
Phenol	1.95E-04	1.95E-04			1.95E-04		1.95E-04	1.95E-04
Toluene	1.78E-04	1.78E-04						1.78E-04
1,2,3-Trichloropropane	9.56E-06	9.56E-06						9.56E-06

Sources: Tables 3.1 - 3.7 and 5.10.

TABLE 5.11 POLLUTANTS FROM UNLINED LANDFILL (lbs/ton material) (cont.)

	textiles	misc org	other waste	hhw
INORGANIC POLLUTANTS				
Arsenic	8.39E-07		4.84E-07	
Barium	3.61E-04		5.05E-04	
Cadmium	2.50E-07		1.01E-07	2.97E-05
Chromium (total)	1.05E-05		1.11E-06	
Lead	5.89E-07		5.61E-06	5.75E-05
Manganese	8.50E-04	8.50E-04	8.50E-04	8.50E-04
Nickel	1.51E-05	1.51E-05	1.51E-05	3.53E-04
Selenium	2.39E-07	2.39E-07	2.39E-07	2.39E-07
Vanadium	4.44E-06	4.44E-06	4.44E-06	4.44E-06
Zinc	1.11E-04	1.11E-04	1.11E-04	8.53E-03
ORGANIC POLLUTANTS				
Acetone		1.15E-03		1.15E-03
2-Butanone		2.08E-03		2.08E-03
p-Cresol		7.74E-04		7.74E-04
2,4-D				3.88E-04
4,4-DDT				1.91E-06
1,1-Dichloroethane				7.54E-06
trans-1,2-Dichloroethylene		1.42E-06		1.42E-06
Diethyl phthalate		1.34E-06		1.34E-06
Endosulfane sulfate				5.20E-07
bis(2-Ethylhexyl)phthalate		1.52E-06		1.52E-06
2-Hexanone		9.86E-05		9.86E-05
Lindane				7.54E-08
4-Methyl-2-pentanone		4.29E-05		4.29E-05
Methylene chloride		6.53E-05		6.53E-05
Phenol		1.95E-04		1.95E-04
Toluene		1.78E-04		1.78E-04
1,2,3-Trichloropropane		9.56E-06		9.56E-06

Sources: Tables 3.1 - 3.7 and 5.10.

TABLE 5.12 POLLUTANTS FROM LINED LANDFILL (lbs/ton California MSW)

	PAPER	PLASTICS	GLASS	METALS	yard waste	wood waste	food waste	tires/ rubber
INORGANIC POLLUTANTS								
Arsenic	6.55E-08	4.96E-09	4.31E-09	1.81E-08	1.14E-07	1.90E-09	5.56E-08	9.07E-10
Barium	2.90E-06	7.65E-07	2.46E-06	4.35E-07	4.06E-06	3.97E-07	1.98E-06	1.02E-07
Cadmium	8.63E-09	4.51E-09	5.97E-10	3.39E-10	6.74E-09	2.24E-10	3.29E-09	3.29E-10
Chromium (total)	1.44E-08	2.88E-09	1.88E-08	7.63E-08	2.81E-08	7.29E-10	1.37E-08	1.88E-08
Lead	2.28E-08	5.33E-09	4.09E-08	9.75E-08	9.25E-08	3.45E-09	4.52E-08	9.02E-09
Manganese	2.57E-05	5.85E-06	5.06E-06	3.29E-06	1.28E-05	3.40E-06	6.25E-06	1.30E-06
Nickel	4.56E-07	1.04E-07	8.97E-08	5.83E-08	2.27E-07	6.02E-08	1.11E-07	2.30E-08
Selenium	7.22E-09	1.64E-09	1.42E-09	9.23E-10	3.59E-09	9.53E-10	1.75E-09	3.64E-10
Vanadium	1.34E-07	3.06E-08	2.64E-08	1.72E-08	6.68E-08	1.77E-08	3.26E-08	6.78E-09
Zinc	3.37E-06	7.66E-07	6.62E-07	4.30E-07	1.67E-06	4.44E-07	8.18E-07	1.70E-07
ORGANIC POLLUTANTS								
Acetone	3.47E-05	7.90E-06						1.75E-06
2-Butanone	6.28E-05	1.43E-05						3.17E-06
p-Cresol	2.34E-05	5.33E-06						1.18E-06
2,4-D								
4,4-DDT								
1,1-Dichloroethane								
trans-1,2-Dichloroethylene	4.29E-08	9.76E-09						2.16E-09
Diethyl phthalate	4.04E-08	9.20E-09						2.04E-09
Endosulfane sulfate								
bis(2-Ethylhexyl)phthalate	4.59E-08	1.04E-08						2.31E-09
2-Hexanone	2.98E-06	6.79E-07						1.50E-07
Lindane								
4-Methyl-2-pentanone	1.30E-06	2.96E-07						6.55E-08
Methylene chloride	1.98E-06	4.50E-07						9.97E-08
Phenol	5.90E-06	1.34E-06			2.93E-06		1.43E-06	2.98E-07
Toluene	5.40E-06	1.23E-06						2.72E-07
1,2,3-Trichloropropane	2.89E-07	6.59E-08						1.46E-08

Sources: Tables 5.8 and 5.9.

TABLE 5.12 POLLUTANTS FROM LINED LANDFILL (lbs/ton California MSW) (cont.)

	textiles	misc org	other waste	hhw	TOTAL
INORGANIC POLLUTANTS					
Arsenic	1.72E-09		3.99E-09		2.71E-07
Barium	7.38E-07		4.15E-06		1.80E-05
Cadmium	5.12E-10		8.32E-10	2.82E-08	5.41E-08
Chromium (total)	2.14E-08		9.10E-09		2.04E-07
Lead	1.20E-09		4.62E-08	5.44E-08	4.18E-07
Manganese	1.74E-06	2.21E-06	7.00E-06	8.05E-07	7.54E-05
Nickel	3.08E-08	3.92E-08	1.24E-07	3.34E-07	1.66E-06
Selenium	4.88E-10	6.20E-10	1.96E-09	2.26E-10	2.12E-08
Vanadium	9.08E-09	1.15E-08	3.66E-08	4.20E-09	3.94E-07
Zinc	2.28E-07	2.89E-07	9.16E-07	8.07E-06	1.78E-05
ORGANIC POLLUTANTS					
Acetone		2.98E-06		1.09E-06	4.84E-05
2-Butanone		5.40E-06		1.97E-06	8.76E-05
p-Cresol		2.01E-06		7.33E-07	3.27E-05
2,4-D				3.67E-07	3.67E-07
4,4-DDT				1.81E-09	1.81E-09
1,1-Dichloroethane				7.14E-09	7.14E-09
trans-1,2-Dichloroethylene		3.68E-09		1.34E-09	5.98E-08
Diethyl phthalate		3.47E-09		1.26E-09	5.64E-08
Endosulfane sulfate				4.92E-10	4.92E-10
bis(2-Ethylhexyl)phthalate		3.94E-09		1.44E-09	6.40E-08
2-Hexanone		2.56E-07		9.33E-08	4.16E-06
Lindane				7.14E-11	7.14E-11
4-Methyl-2-pentanone		1.12E-07		4.06E-08	1.81E-06
Methylene chloride		1.70E-07		6.18E-08	2.76E-06
Phenol		5.07E-07		1.85E-07	1.26E-05
Toluene		4.64E-07		1.69E-07	7.53E-06
1,2,3-Trichloropropane		2.49E-08		9.05E-09	4.04E-07

Sources: Tables 5.8 and 5.9.

TABLE 5.13 POLLUTANTS FROM LINED LANDFILL (lbs/ton material)

	PAPER	PLASTICS	GLASS	METALS	yard waste	wood waste	food waste	tires/ rubber
INORGANIC POLLUTANTS								
Arsenic	1.92E-07	6.39E-08	6.43E-08	4.15E-07	6.71E-07	4.23E-08	6.71E-07	5.27E-08
Barium	8.50E-06	9.85E-06	3.66E-05	9.99E-06	2.39E-05	8.82E-06	2.39E-05	5.90E-06
Cadmium	2.53E-08	5.80E-08	8.89E-09	7.79E-09	3.97E-08	4.97E-09	3.97E-08	1.91E-08
Chromium (total)	4.22E-08	3.71E-08	2.80E-07	1.75E-06	1.66E-07	1.62E-08	1.66E-07	1.09E-06
Lead	6.67E-08	6.87E-08	6.09E-07	2.24E-06	5.45E-07	7.67E-08	5.45E-07	5.24E-07
Manganese	7.54E-05	7.54E-05	7.54E-05	7.54E-05	7.54E-05	7.54E-05	7.54E-05	7.54E-05
Nickel	1.34E-06	1.34E-06	1.34E-06	1.34E-06	1.34E-06	1.34E-06	1.34E-06	1.34E-06
Selenium	2.12E-08	2.12E-08	2.12E-08	2.12E-08	2.12E-08	2.12E-08	2.12E-08	2.12E-08
Vanadium	3.94E-07	3.94E-07	3.94E-07	3.94E-07	3.94E-07	3.94E-07	3.94E-07	3.94E-07
Zinc	9.87E-06	9.87E-06	9.87E-06	9.87E-06	9.87E-06	9.87E-06	9.87E-06	9.87E-06
ORGANIC POLLUTANTS								
Acetone	1.02E-04	1.02E-04						1.02E-04
2-Butanone	1.84E-04	1.84E-04						1.84E-04
p-Cresol	6.87E-05	6.87E-05						6.87E-05
2,4-D								
4,4-DDT								
1,1-Dichloroethane								
trans-1,2-Dichloroethylene	1.26E-07	1.26E-07						1.26E-07
Diethyl phthalate	1.18E-07	1.18E-07						1.18E-07
Endosulfane sulfate								
bis(2-Ethylhexyl)phthalate	1.34E-07	1.34E-07						1.34E-07
2-Hexanone	8.74E-06	8.74E-06						8.74E-06
Lindane								
4-Methyl-2-pentanone	3.81E-06	3.81E-06						3.81E-06
Methylene chloride	5.79E-06	5.79E-06						5.79E-06
Phenol	1.73E-05	1.73E-05			1.73E-05		1.73E-05	1.73E-05
Toluene	1.58E-05	1.58E-05						1.58E-05
1,2,3-Trichloropropane	8.48E-07	8.48E-07						8.48E-07

Sources: Tables 3.1 - 3.7 and 5.12.

TABLE 5.13 POLLUTANTS FROM LINED LANDFILL (lbs/ton material) (cont.)

	textiles	misc org	other waste	hhw
INORGANIC POLLUTANTS				
Arsenic	7.44E-08		4.29E-08	
Barium	3.20E-05		4.48E-05	
Cadmium	2.22E-08		8.96E-09	2.64E-06
Chromium (total)	9.30E-07		9.81E-08	
Lead	5.23E-08		4.98E-07	5.10E-06
Manganese	7.54E-05	7.54E-05	7.54E-05	7.54E-05
Nickel	1.34E-06	1.34E-06	1.34E-06	3.13E-05
Selenium	2.12E-08	2.12E-08	2.12E-08	2.12E-08
Vanadium	3.94E-07	3.94E-07	3.94E-07	3.94E-07
Zinc	9.87E-06	9.87E-06	9.87E-06	7.56E-04
ORGANIC POLLUTANTS				
Acetone		1.02E-04		1.02E-04
2-Butanone		1.84E-04		1.84E-04
p-Cresol		6.87E-05		6.87E-05
2,4-D				3.44E-05
4,4-DDT				1.70E-07
1,1-Dichloroethane				6.69E-07
trans-1,2-Dichloroethylene		1.26E-07		1.26E-07
Diethyl phthalate		1.18E-07		1.18E-07
Endosulfane sulfate				4.61E-08
bis(2-Ethylhexyl)phthalate		1.34E-07		1.34E-07
2-Hexanone		8.74E-06		8.74E-06
Lindane				6.69E-09
4-Methyl-2-pentanone		3.81E-06		3.81E-06
Methylene chloride		5.79E-06		5.79E-06
Phenol		1.73E-05		1.73E-05
Toluene		1.58E-05		1.58E-05
1,2,3-Trichloropropane		8.48E-07		8.48E-07

Sources: Tables 3.1 - 3.7 and 5.12.

TABLE 5.14 CODISPOSAL (ASH AND MSW) LEACHATE CONSTITUENTS – INORGANIC POLLUTANTS – FROM LANDFILLS MEETING RCRA REQUIREMENTS

Inorganic Pollutant	Average Concentration (ppm)	Median Concentration (ppm)	Maximum Concentration (ppm)
Aluminum	n/d	n/d	n/d
Antimony	8.30E-03	5.00E-03	2.00E-03
Arsenic	2.73E-02	2.80E-02	4.60E-02
Barium	6.03E-01	6.15E-01	8.90E-01
Beryllium	n/d	n/d	n/d
Cadmium	4.00E-03	3.00E-03	1.10E-02
Chromium (total)	7.70E-03	4.91E+02	1.30E-02
Cobalt	n/d	n/d	n/d
Copper	9.50E-02	9.00E-02	2.00E-01
Iron	7.10E+01	9.31E+01	1.04E+02
Lead	2.00E-02	2.00E-02	2.70E-02
Manganese	1.55E+02	6.34E+00	1.13E+01
Magnesium	6.31E+00	1.54E+02	1.99E+02
Mercury	n/d	n/d	n/d
Nickel	1.62E-01	1.85E-01	2.40E-01
Selenium	n/d	n/d	n/d
Silver	n/d	n/d	n/d
Thallium	n/d	n/d	n/d
Tin	n/d	n/d	n/d
Vanadium	1.67E-02	1.60E-02	2.90E-02
Zinc	6.65E-01	6.80E-01	1.21E+00

Source: U.S. EPA, "Characterization of Leachates from Municipal Waste Disposal Sites and Co-Disposal Sites," 1987, p. 4-11.

TABLE 5.15 CODISPOSAL (ASH AND MSW) LEACHATE CONSTITUENTS -- ORGANIC POLLUTANTS -- FROM LANDFILLS MEETING RCRA REQUIREMENTS

Organic Pollutant	Average Concentration (ppm)	Median Concentration (ppm)	Maximum Concentration (ppm)
Acetone	5.12E-01	4.59E-01	8.10E-01
2-Butanone (methyl ethyl ketone)	9.58E-01	9.15E-01	2.20E+00
p-Cresol(4-methyl phenol)	8.85E-01	n/d	5.10E+00
2,4-D	4.83E-02	n/d	1.60E-01
4,4-DDT	1.03E-04	1.10E-04	1.30E-04
1,1-Dichloroethane	n/d	n/d	n/d
t-1,2-Dichloroethene	n/d	n/d	n/d
Diethyl phthalate	n/d	n/d	n/d
Endrin	4.17E-05	n/d	2.50E-04
Ethyl benzene	2.50E-03	n/d	1.50E-02
bis(2-Ethylhexyl)phthalate	2.83E-02	n/d	1.70E-01
2-Hexanone (methyl butyl ketone)	8.97E-02	n/d	4.50E-01
Lindane	n/d	n/d	n/d
4-Methyl-2-pentanone (methyl isobutyl ketone)	1.30E-02	n/d	8.00E-02
Methylene chloride	1.38E-01	5.75E-02	2.90E-01
Phenol	3.94E-01	8.35E-02	2.10E+00
1,1,3-Trichloropropane	n/d	n/d	n/d
Toluene	8.00E-02	5.30E-02	1.20E-01
Xylenes, total	4.83E-02	n/d	2.90E-01

Dioxins and Dibenzofurans		(ppt)	(ppt)
2,3,7,8-TCDD		n/d	n/d
Total TCDD		n/d	n/d
Total PCDD		n/d	n/d
Total HxCDD		0.0885	0.13
Total OCDD		0.445	0.77
2,3,7,8-TCDF		7.605	15
Total TCDF		n/d	n/d
Total PCDF		n/d	n/d
Total HxCDF		0.0315	0.035
Total HpCDF		0.038	0.041
Total OCDF		0.0385	0.085

Source: U.S. EPA, "Characterization of Leachates from Municipal Waste Disposal Sites and Co-Disposal Sites," 1987, p. 4-20 -- 4-21.

TABLE 5.16 TYPICAL CONSTITUENTS FOUND IN LANDFILL GAS

Component	R.K. Ham, et al (%) (dry volume basis) [1]	U.S. EPA (%) (dry volume basis) [2]	Weighted Average of U.S. EPA Data (%) (dry volume basis)
Methane	45-60	48.73	48.49%
Carbon dioxide	40-60	37.63	37.45%
Nitrogen	2.0-5.0	12.73	12.66%
Oxygen	0.1-1.0	0.89	0.88%
Sulfides, Disulfides Mercaptans, etc.	0-1.0	0.17	0.17%
Hydrogen	0-0.2	0.08	0.08%
Carbon monoxide	0-0.2	0.03	0.03%
Trace Constituents	0.01-0.6	0.24	0.24%
TOTAL		100.48 [3]	100.00%

[1] Ham, et al, "Recovery, Processing, and Utilization of Gas from Sanitary Landfills," 1979.

[2] U.S. EPA, "Report to Congress: Solid Waste Disposal in the U.S.," 1988, p. 4-31; average of four studies.

[3] Average of four studies, therefore the total does not add up to 100.0 %.

BLE 5.17 TRACE CONSTITUENTS ANALYZED IN THE CALIFORNIA MSW LANDFILL GAS TESTING PROGRAM

Chemical	Concentration (PPM, average)	Percent
nzene	2.500	19.14%
rbon Tetrachloride	.011	0.08%
loroform	.360	2.76%
:-Dichloroethane [1]	.600	4.59%
ıylene dibromide	.004	0.03%
thylene chloride	4.800	36.74%
chloroethylene	1.100	8.42%
,1-Trichloroethane	.650	4.98%
:hloroethylene	.840	6.43%
yl chloride	2.200	16.84%
TAL	13.065	100.00%

1,2-Dichloroethane is also known as ethylene dichloride.

ırce: California Air Resources Board, "The Landfill Testing Program," 1990, p. 15.

TABLE 5.18 CALIFORNIA LANDFILL GAS EMISSION RATES

Landfill	Project Type	Location (California)	Refuse in Place (MM tons)	Gas Emission Rate (cu. ft/lb/yr)
Bradley	field testing	Sun Valley	8.3	0.080
Scholl Canyon	field testing	Los Angeles	4.7	0.046
Ascon	gas recovery	Los Angeles	3.0	0.070
Azuza-Western	gas recovery	Los Angeles	4.5	0.041
Mountain View	gas recovery	Mountain View	1.2	0.077
Sheldon-Arlets	gas recovery	Los Angeles	5.8	0.120
Hewitt	gas control	Sun Valley	5.0	0.092
Penrose	gas control	Sun Valley	5.0	0.079
Median				0.078

Source: Argonne National Laboratory, "Gas Enhancement," 1983, p. 244.

TABLE 5.19 LANDFILL GAS BREAKDOWN FOR UNCONTROLLED LANDFILLS (lbs/ton refuse)

Gas	Uncontrolled Landfill (lbs/ton waste)
Methane	5.298
Carbon dioxide	4.091
Nitrogen	1.384
Oxygen	.096
Sulfides	.018
Hydrogen	.009
Carbon monoxide	.003
Trace constituents	.026
TOTAL	10.924

Trace Constituents	Pounds/ Ton Waste
Benzene	5.05E-03
Carbon Tetrachloride	2.22E-05
Chloroform	7.27E-04
1,2-Dichloroethane	1.21E-03
Ethylene dibromide	8.07E-06
Methylene chloride	9.69E-03
Perchloroethylene	2.22E-03
1,1,1-Trichloroethane	1.31E-03
Trichloroethylene	1.70E-03
Vinyl chloride	4.44E-03
Total	0.026

Sources: Tables 5.16 and 5.17.

TABLE 5.20 LANDFILL GAS BREAKDOWN FOR CONTROLLED LANDFILL (lbs/ton refuse)

Pollutant	Landfill with Gas Collection and Turbine (lbs/ton waste)
Methane	2.61E+00
Carbon dioxide	2.02E+00
Nitrogen	6.82E-01
Oxygen	4.76E-02
Sulfides	8.91E-03
Hydrogen	4.22E-03
Carbon monoxide	1.41E-03
Trace constituents	1.30E-02
TOTAL	5.39E+00

Trace Constituents	Pounds/ Ton Waste
Benzene	2.49E-03
Carbon Tetrachloride	1.09E-05
Chloroform	3.58E-04
1,2-Dichloroethane	5.97E-04
Ethylene dibromide	3.98E-06
Methylene chloride	4.78E-03
Perchloroethylene	1.09E-03
1,1,1-Trichloroethane	6.47E-04
Trichloroethylene	8.36E-04
Vinyl chloride	2.19E-03
Total	1.30E-02

POLLUTANTS FROM GENERATING ENERGY FROM GAS TURBINES

Pollutants	Emissions from Gas Turbine (lbs/ton waste)
VOCs	5.46E-04
NOx	5.46E-03
CO	7.80E-03

Sources: CARB, "Suggested Control Measure," p. 31, and Tables 5.16 and 5.17.

TABLE 5.21 CARBON CONTENT AND PERCENT VOLATILE SOLIDS BIODEGRADED

Product/Material	Carbon Content Source: B&C [1] (%)	Carbon Content Source: NYC [2] (%)	Carbon Content Source: T,T, & E [3] (%)	Volatile Solids Biodegraded [4] (%)
Food Waste	15.00	19.40 [5]	48.00	50
Yard Waste	17.00		47.80	35
Paper/Paperboard	40.00	35.00	43.75	20
Textiles	40.00	32.04	55.00	5
Wood	30.00 [6]	29.48 [6]	34.65 [6]	5
Plastics		49.63		2
Rubber		43.08		2

[1] = Bingemer and Crutzen, "The Production of Methane from Solid Wastes," 1987.
[2] = SCS Engineers, "NYC Solid Waste 'Ultimate Analysis,'" 1990.
[3] = Tchobanoglous, Theisen, and Eliassen, "Solid Wastes," 1977.
[4] = Emcon, "Methane Generation and Recovery from Landfills," 1980.
[5] = Includes brush, food, and grass wastes.
[6] = Excludes lignin content.

TABLE 5.22 CONTRIBUTORS TO LANDFILL GAS BASED ON ULTIMATE ANALYSIS and MSW CONTENT

	Paper	Plastics	Organics [1]	Wood	Textiles	Rubber
Element	Weighted Average Based on MSW Content	Weighted Average Based on MSW Content	Weighted Average Based on MSW Content	Weighted Average Based on MSW Content	Weighted Average Based on MSW Content	Weighted Average Based on MSW Content
Carbon	52.19%	1.69%	42.76%	2.07%	0.97%	0.32%
Hydrogen	36.07%	0.93%	61.24%	1.05%	0.58%	0.12%
Nitrogen	41.74%	0.60%	54.67%	0.70%	1.97%	0.32%
Oxygen	34.99%	0.66%	62.59%	1.15%	0.56%	0.06%
Sulfur	22.13%	0.54%	75.88%	0.38%	0.49%	0.58%
Chlorine	46.57%	3.90%	44.69%	1.18%	1.05%	2.61%

[1] Includes both yard and food waste.

Sources: SCS Engineering, "New York City Solid Waste 'Ultimate Analysis,'" 1990; and Tables 3.1 - 3.7.

TABLE 5.23 UNCONTROLLED LANDFILL GAS GENERATION (lbs pollutants/ton waste)

CRITERIA AIR POLLUTANTS	PAPER	PLASTICS	yard waste	wood waste	food waste	tires/ rubber	textiles	hhw	TOTAL
CO	1.49E-03	4.81E-05	8.20E-04	5.92E-05	4.00E-04	9.25E-06	2.76E-05		2.85E-03
ORGANIC POLLUTANTS									
Acetone									
Benzene								5.05E-03	5.05E-03
Carbon tetrachloride								2.22E-05	2.22E-05
Chloroform								7.27E-04	7.27E-04
1,2-Dichloroethane								1.21E-03	1.21E-03
Ethylene dibromide								8.07E-06	8.07E-06
Methylene chloride								9.69E-03	9.69E-03
Perchloroethylene								2.22E-03	2.22E-03
1,1,1-Trichloroethane								1.31E-03	1.31E-03
Trichloroethylene								1.70E-03	1.70E-03
Vinyl chloride		4.44E-05						4.40E-03	4.40E-03
MISCELLANEOUS									
Carbon dioxide	2.14E+00	6.89E-02	1.18E+00	8.48E-02	5.74E-01	1.33E-02	3.95E-02		4.09E+00
Methane	2.76E+00	8.93E-02	1.52E+00	1.10E-01	7.43E-01	1.72E-02	5.12E-02		5.30E+00
Sulfides	4.00E-03	9.70E-05	9.22E-03	6.86E-05	4.50E-03	1.06E-04	8.84E-05		1.81E-02

Sources: Tables 5.19 and 5.22.

TABLE 5.24 UNCONTROLLED LANDFILL GAS GENERATION (lbs pollutants/ton material)

CRITERIA AIR POLLUTANTS	PAPER	PLASTICS	yard waste	wood waste	food waste	tires/ rubber	textiles	hhw
CO	4.37E-03	6.19E-04	4.83E-03	1.31E-03	4.83E-03	5.38E-04	1.20E-03	
ORGANIC POLLUTANTS								
Benzene								4.73E-01
Carbon tetrachloride								2.08E-03
Chloroform								6.81E-02
1,2-Dichloroethane								1.13E-01
Ethylene dibromide								7.56E-04
Methylene chloride								9.07E-01
Perchloroethylene								2.08E-01
1,1,1-Trichloroethane								1.23E-01
Trichloroethylene								1.59E-01
Vinyl chloride		5.72E-04						3.62E-01
MISCELLANEOUS								
Carbon dioxide	6.26E+00	8.88E-01	6.93E+00	1.88E+00	6.93E+00	7.71E-01	1.71E+00	
Methane	8.11E+00	1.15E+00	8.97E+00	2.44E+00	8.97E+00	9.98E-01	2.22E+00	
Sulfides	1.17E-02	1.25E-03	5.43E-02	1.52E-03	5.43E-02	6.13E-03	3.83E-03	

Sources: Tables 3.1 - 3.7 and 5.23.

TABLE 5.25 CONTROLLED LANDFILL GAS GENERATION (lbs pollutants/ton waste)

CRITERIA AIR POLLUTANTS	PAPER	PLASTICS	yard waste	wood waste	food waste	tires/ rubber	textiles	hhw	TOTAL
CO	4.25E-03	8.24E-04	2.15E-03	4.94E-04	1.05E-03	1.82E-04	2.51E-04		9.21E-03
NOx	2.46E-03	5.61E-04	1.22E-03	3.25E-04	5.98E-04	1.24E-04	1.66E-04		
VOCs	2.46E-04	5.61E-05	1.22E-04	3.25E-05	5.98E-05	1.24E-05	1.66E-05		
ORGANIC POLLUTANTS									
Acetone									
Benzene								2.49E-03	2.49E-03
Carbon tetrachloride								1.09E-05	1.09E-05
Chloroform								3.58E-04	3.58E-04
1,2-Dichloroethane								5.97E-04	5.97E-04
Ethylene dibromide								3.98E-06	3.98E-06
Methylene chloride								4.78E-03	4.78E-03
Perchloroethylene								1.09E-03	1.09E-03
1,1,1-Trichloroethane								6.47E-04	6.47E-04
Trichloroethylene								8.36E-04	8.36E-04
Vinyl chloride		2.19E-05						2.17E-03	2.17E-03
MISCELLANEOUS									
Carbon dioxide	1.05E+00	3.40E-02	5.79E-01	4.18E-02	2.83E-01	6.54E-03	1.95E-02		2.02E+00
Methane	1.36E+00	4.40E-02	7.50E-01	5.42E-02	3.66E-01	8.47E-03	2.52E-02		2.61E+00
Sulfides	1.97E-03	4.78E-05	4.54E-03	3.38E-05	2.22E-03	5.20E-05	4.36E-05		8.91E-03

Sources: Tables 5.20 and 5.22.

TABLE 5.26 CONTROLLED LANDFILL GAS GENERATION (lbs pollutants/ton material)

CRITERIA AIR POLLUTANTS	PAPER	PLASTICS	yard waste	wood waste	food waste	tires/ rubber	textiles	hhw
CO	1.25E-02	1.06E-02	1.27E-02	1.10E-02	1.27E-02	1.03E-02	1.09E-02	
NOx	7.22E-03	7.22E-03	7.22E-03	7.22E-03	7.22E-03	7.22E-03	7.22E-03	
VOCs	7.22E-04	7.22E-04	7.22E-04	7.22E-04	7.22E-04	7.22E-04	7.22E-04	
ORGANIC POLLUTANTS								
Benzene								2.33E-01
Carbon tetrachloride								1.03E-03
Chloroform								3.36E-02
1,2-Dichloroethane								5.59E-02
Ethylene dibromide								3.73E-04
Methylene chloride								4.47E-01
Perchloroethylene								1.03E-01
1,1,1-Trichloroethane								6.06E-02
Trichloroethylene								7.83E-02
Vinyl chloride		2.82E-04						2.05E-01
MISCELLANEOUS								
Carbon dioxide	3.09E+00	4.38E-01	3.42E+00	9.29E-01	3.42E+00	3.80E-01	8.45E-01	
Methane	4.00E+00	5.67E-01	4.42E+00	1.20E+00	4.42E+00	4.92E-01	1.09E+00	
Sulfides	5.78E-03	6.16E-04	2.68E-02	7.51E-04	2.68E-02	3.02E-03	1.89E-03	

Sources: Tables 3.1 - 3.7 and 5.25.

TABLE 5.27 HEAVY METALS AND ORGANICS IN HOUSEHOLD HAZARDOUS WASTES

	HOME CLEANERS						
HEAVY METALS	Toilet, Drain, & Septic	Oven	All Purpose	Disin-fectants	De-greasers	Wood Cleaner/ Metal Polish	Chimney, Deck, & Patio
Cadmium							
Lead							
Mercury							
Selenium							
ORGANICS							
Acetone							
Benzene							
Benzol							
Butanone							
Carbon Tetrachloride							
Chloroform							
Cresol							
2,4-D							
DDT							
1,1-Dichloroethane							
Endosulfan							
Endrin							
Lindane							
Methyl butyl ketone							
Methyl ethyl ketone							
Methyl isobutyl ketone							
Methylene chloride	*	*			*		
Perchlorethylene					*		
Phenol							
Toluene							
1,1,1-Trichloroethane	*	*			*	*	
Trichloroethylene	*						
Xylene							

x = "A Survey of House old Hazardous Waste & Related Collection Programs", EPA, October 1986
* = "Planning Guideline for Local Hazardous Waste Plans", Washington Department of Ecology, July 1987
+ = Noted on both lists

TABLE 5.27 HEAVY METALS AND ORGANICS IN HOUSEHOLD HAZARDOUS WASTES (continued)

	AUTOS, BOATS, AND EQUIPMENT MAINTENANCE										LAWN/GARDEN PRODUCTS		
HEAVY METALS	Car Batteries	Lubricating Fluids	Gas	Oil/Fuel Additives	Radiator Fluid Additives	Starter Fluids	Flushes	Carburetor Fuel/ Injection Cleaners	Grease/ Rust Solvents	Waxes/ Polishes	Herbicides	Pesticides	Fungicides Wood Preserv.
Cadmium													
Lead	*	+	*										
Mercury													
Selenium													
ORGANICS													
Acetone								X					
Benzene			*										
Benzol													
Butanone								X					
Carbon Tetrachloride													
Chloroform													
Cresol									X				
2,4-D											X	X	
DDT												X	
1,1-Dichloroethane													
Endosulfan												X	
Endrin												X	
Lindane												X	
Methyl butyl ketone													
Methyl ethyl ketone													
Methyl isobutyl ketone								X					
Methylene chloride													
Perchlorethylene													
Phenol													
Toluene			*					X					
1,1,1-Trichloroethane													
Trichloroethylene										*			X
Xylene			*	X				X					

x = 'A Survey of House
* = 'Planning Guideline
+ = Noted on both lists

TABLE 5.27 HEAVY METALS AND ORGANICS IN HOUSEHOLD HAZARDOUS WASTES (continued)

	HOME MAINTENANCE PRODUCTS						HOBBY/RECREACTION				MISCELLANEOUS	
HEAVY METALS	Solvent/ Thinners	Paint Removers & Strippers	Paint	Stains, Var- nishes	Adhe- sives	Roof Coatings/ Sealants	Chemicals (e.g., pool photo)	Glues, Cements	Inks & Dyes	Glazes	Bat- teries	Electronic Items (e.g., solder, switches)
Cadmium											*	
Lead						*					X	X
Mercury											+	X
Selenium							X					
ORGANICS												
Acetone	X	+	*		X		*	*				
Benzene		*	*				*					
Benzol								*				
Butanone	X				X							
Carbon Tetrachloride			*				*					
Chloroform			*									
Cresol	*		*									
2,4-D												
DDT												
1,1-Dichloroethane					X							
Endosulfan												
Endrin												
Lindane												
Methyl butyl ketone			*									
Methyl ethyl ketone	X				+							
Methyl isobutyl ketone	+		*									
Methylene chloride		*	*									
Perchlorethylene		*	*									
Phenol			*			*						
Toluene	+	+	+		+							
1,1,1-Trichloroethane		*										
Trichloroethylene			*									
Xylene	*	*	+		X	*						

x = "A Survey of House

* = "Planning Guideline

+ = Noted on both lists

TABLE 5.28 - POLLUTANTS ASSOCIATED WITH MSW INCINERATORS

Air emissions	Solid waste (ash)
Criteria Air Pollutants	*Metals*
Particulates	Antimony
SO_2	Arsenic
NO_x	Barium
CO	Cadmium
VOCs	Chromium
Lead	Copper
	Lead
Acid Gases	Mercury
Hydrogen fluoride	Nickel
Hydrogen chloride	Selenium
	Tin
Metals	Vanadium
Antimony	Zinc
Arsenic	
Beryllium	*Organic Compounds*
Cadmium	Polycyclic aromatic hydrocarbons
Chromium	Polychlorinated dibenzo-p-dioxins
Copper	Polychlorinated dibenzofurans
Manganese	
Mercury	
Nickel	
Selenium	
Tin	
Vanadium	
Zinc	
Organic Compounds	
Polycyclic aromatic hydrocarbons	
Polychlorinated dibenzo-p-dioxins	
Polychlorinated dibenzofurans	

TABLE 5.29 DESCRIPTION OF EXISTING SOLID WASTE INCINERATORS

Location	Size (tons/day)	Pollution Controls
Commerce	380	Spray dryer Fabric filter Thermal $DeNO_x$
Long Beach	1,380	Spray dryer Fabric filter Thermal $DeNO_x$
Stanislaus	800	Spray dryer Fabric filter Thermal $DeNO_x$

Source: U.S. EPA, Office of Air Quality Planning and Standards, 1989. *Municipal Waste Combustors - Background Information for Proposed Standards: Post-Combustion Technology Performance*, EPA-450/3-89-27c, August.

TABLE 5.30 AIR EMISSION FACTORS FOR CALIFORNIA SOLID WASTE INCINERATORS

	Emission Factors (lbs/ton MSW)				
	Stanislaus [1]	Commerce [2]		SERRF [3]	Average
CRITERIA AIR POLLUTANTS		(mixed)	(commercial)		
CO	1.68E-01	3.47E-01	2.59E-01	1.36E+00	5.33E-01
NOx	1.74E+00	2.30E+00	2.26E+00	1.23E+00	1.88E+00
Particulates	1.20E-01	1.17E-01	1.60E-01		1.32E-01
SO2	1.20E-01	5.56E-02	1.05E-01	1.77E-01	1.15E-01
VOCs	6.00E-03	6.88E-02	5.31E-02	4.64E-02	4.36E-02
INORGANIC POLLUTANTS					
Antimony	2.86E-05	3.16E-06	3.16E-06		1.16E-05
Arsenic	9.52E-06	9.47E-07	3.16E-07		3.60E-06
Beryllium	7.14E-08	9.47E-07	9.47E-07		6.55E-07
Cadmium	1.52E-05	2.02E-05	3.79E-06		1.31E-05
Chromium (total)	1.90E-05	2.40E-05	2.53E-06		1.52E-05
Copper	6.29E-05	2.75E-04	2.87E-04		2.08E-04
Lead	2.55E-04	2.02E-05	3.35E-05	2.25E-04	1.33E-04
Manganese	1.08E-02	1.01E-05	1.45E-05		3.60E-03
Mercury	4.22E-03	4.23E-04	7.77E-04	1.62E-03	1.76E-03
Nickel	4.00E-05	6.32E-05	1.58E-06		3.49E-05
Selenium	2.86E-06	1.39E-05	1.29E-05		9.90E-06
Tin	3.23E-04	9.47E-06	1.26E-05		1.15E-04
Vanadium	2.86E-06	3.16E-07	1.26E-06		1.48E-06
Zinc	7.71E-04	3.92E-04	3.60E-04		5.08E-04
ORGANIC POLLUTANTS					
PAHs (total)	5.05E-04	2.26E-06	6.63E-06		1.71E-04
PCDD/PCDF (total)	2.24E-09	1.24E-09	2.25E-09		1.91E-09
MISCELLANEOUS					
Hydrogen chloride	3.48E-02	1.14E-01	8.91E-02	3.25E-01	1.41E-01
Hydrogen fluoride		8.21E-04	5.81E-04	6.78E-04	6.93E-04

Note: PCDD/PCDF expressed as toxic equivalents based upon California method.

[1] Galson Technical Services, 1990. "Source Emission Testing of the Municipal Solid Waste Incinerators at the Stanislaus Waste Energy Company Facility ," Galson Project #S9-079, March.

[2] McDannel, M.D., Green, L.A., and Bell, A.C., 1988. "Results of Air Emission Tests During the Waste-to-Energy Demonstration Program at the Commerce Refuse-to-Energy Facility," prepared by Energy Systems Assoc., Dec.

[3] Compliance Test Results for SERRF Unit No. 1 with Air Quality Permit Limits, no date.

TABLE 5.31 POLLUTANT CONTENT OF INCINERATOR ASH

INORGANIC POLLUTANTS	Fly ash	Bottom ash	Total
	(lb pollutant/ton MSW)		
Antimony	2.25E-02		2.25E-02
Arsenic	1.91E-02	5.83E-03	2.50E-02
Barium	2.27E-01	4.61E-01	6.88E-01
Cadmium	5.53E-02	1.06E-02	6.59E-02
Chromium (total)	4.80E-02	1.20E-01	1.68E-01
Copper	6.45E-02	2.43E+00	2.49E+00
Lead	6.70E-01	1.15E+00	1.82E+00
Mercury	8.98E-04	4.28E-04	1.33E-03
Nickel	4.94E-02	5.29E-02	1.02E-01
Selenium	4.02E-04	5.63E-04	9.65E-04
Tin	3.20E-01	1.89E-01	5.09E-01
Vanadium	4.70E-03	2.39E-02	2.86E-02
Zinc	3.87E+00	2.84E+00	6.71E+00
ORGANIC POLLUTANTS			
PAHs (total)	8.81E-04	8.21E-04	1.70E-03
PCDD/PCDF (total)	3.52E-04	3.94E-05	3.91E-04

Source: NUS Corp., 1987. "Charcterization of MWC Ashes and Leachates from MSW Landfills, Monofills, and Co-Disposal Sites. Vol. 1.," prepared for U.S. EPA, EPA/530/SW-87/028a, Oct.

TABLE 5.32 INCINERATOR AIR EMISSIONS ASSOCIATED WITH WASTE STREAM COMPONENTS (lb pollutant/ton component)

CRITERIA AIR POLLUTANTS	PAPER	PLASTICS	film	other	GLASS	METALS	ORGANICS	yard waste
CO	8.88E-02	8.88E-02			8.88E-02	8.88E-02	8.88E-02	
NOx	2.47E-01	2.14E-01			2.01E-01	1.57E-01	6.70E-01	
Particulates	2.20E-02	2.20E-02			2.20E-02	2.20E-02	2.20E-02	
SOx	4.98E-03	5.30E-03			3.64E-03		4.67E-02	
VOCs	1.09E-02	1.09E-02					7.26E-03	
INORGANIC POLLUTANTS								
Antimony	1.94E-06	1.94E-06			1.94E-06	1.94E-06	1.94E-06	
Arsenic	2.62E-07	8.71E-08			8.76E-08	5.66E-07	1.15E-06	
Beryllium	1.09E-07	1.09E-07			1.09E-07	1.09E-07	1.09E-07	
Cadmium	7.10E-07	1.63E-06			2.50E-07	2.19E-07	2.41E-06	
Chromium (total)	1.45E-07	1.27E-07			9.58E-07	6.00E-06	7.55E-06	
Copper	9.37E-06	9.37E-06			9.37E-06	6.25E-05	9.37E-06	
Lead	1.37E-06	1.41E-06			1.25E-05	4.59E-05	2.46E-05	
Manganese	5.99E-04	5.99E-04			5.99E-04	5.99E-04	5.99E-04	
Mercury	9.78E-06	8.85E-06			3.83E-06	7.05E-06	7.51E-05	
Nickel	4.65E-06	4.65E-06			4.65E-06	4.65E-06	4.65E-06	
Selenium	1.10E-06	3.57E-07			2.71E-07	6.31E-07	6.18E-06	
Tin	1.92E-05	1.92E-05			1.92E-05	1.92E-05	1.92E-05	
Vanadium	2.46E-07	2.46E-07			2.46E-07	2.46E-07	2.46E-07	
Zinc	4.65E-05	4.65E-05			4.65E-05	4.65E-05	4.65E-05	
ORGANIC POLLUTANTS								
PAHs (total)	3.42E-05	3.42E-05					6.85E-05	3.42E-05
PCDD/PCDF (total)	2.39E-10	2.39E-10	1.19E-10	1.19E-10			9.55E-10	2.39E-10
MISCELLANEOUS								
Hydrogen chloride	5.65E-03	2.08E-02			8.39E-03		7.84E-02	
Hydrogen fluoride		1.73E-04				1.73E-04	1.73E-04	

Sources: Based upon data from Tables 4.5, 5.9, and 5.30.

TABLE 5.32 CONTINUED

CRITERIA AIR POLLUTANTS	wood waste	tires/ rubber	textiles	OTHER WASTE	misc. inorganics	inert solids	hhw	SPECIAL WASTE
CO				8.88E-02				
NOx	4.58E-02	1.36E-01	2.52E-01	3.93E-01	2.36E-01			
Particulates				2.20E-02				
SOx	2.59E-03	2.60E-02	6.51E-03	5.40E-02	5.40E-02			
VOCs				7.26E-03				
INORGANIC POLLUTANTS								
Antimony				1.94E-06				
Arsenic	5.76E-08	7.18E-08	1.01E-07	1.45E-06	1.45E-06			
Beryllium				1.09E-07				
Cadmium	1.40E-07	5.37E-07	6.23E-07	7.86E-06	1.06E-06		6.80E-06	
Chromium (total)	5.55E-08	3.74E-06	3.19E-06	4.06E-07	4.06E-07			
Copper				9.90E-05	8.96E-05			
Lead	1.57E-06	1.08E-05	1.07E-06	4.75E-05	3.02E-05		1.73E-05	
Manganese				5.99E-04				
Mercury	1.11E-05	8.68E-06	3.66E-05	1.66E-03	1.86E-05		1.64E-03	
Nickel				1.16E-05			6.98E-06	
Selenium	2.98E-07	4.81E-06	6.62E-07	1.35E-06	1.35E-06			
Tin				1.92E-05				
Vanadium				2.46E-07				
Zinc				2.75E-04			2.28E-04	
ORGANIC POLLUTANTS								
PAHs (total)	3.42E-05			3.42E-05			3.42E-05	
PCDD/PCDF (total)	2.39E-10	2.39E-10	2.39E-10	4.78E-10	2.39E-10		2.39E-10	
MISCELLANEOUS								
Hydrogen chloride	4.34E-03	6.28E-02	7.56E-03	2.75E-02	2.75E-02			
Hydrogen fluoride			1.73E-04	1.73E-04		1.73E-04		

Sources: Based upon data from Tables 4.5, 5.9, and 5.30.

TABLE 5.32 CONTINUED

CRITERIA AIR POLLUTANTS	TOTAL
CO	5.33E-01
NOx	1.88E+00
Particulates	1.32E-01
SOx	1.15E-01
VOCs	3.63E-02
INORGANIC POLLUTANTS	
Antimony	1.16E-05
Arsenic	3.60E-06
Beryllium	6.55E-07
Cadmium	1.31E-05
Chromium (total)	1.52E-05
Copper	1.99E-04
Lead	1.33E-04
Manganese	3.60E-03
Mercury	1.76E-03
Nickel	3.49E-05
Selenium	9.90E-06
Tin	1.15E-04
Vanadium	1.48E-06
Zinc	5.08E-04
ORGANIC POLLUTANTS	
PAHs (total)	1.71E-04
PCDD/PCDF (total)	1.91E-09
MISCELLANEOUS	
Hydrogen chloride	1.41E-01
Hydrogen fluoride	6.93E-04

Sources: Based upon data from Tables 4.5, 5.9, and 5.30.

TABLE 5.33 INCINERATOR ASH POLLUTANTS ASSOCIATED WITH WASTE STREAM COMPONENTS (lb pollutant/ton component)

INORGANIC POLLUTANTS	PAPER	PLASTICS	film	other	GLASS	METALS	ORGANICS	yard waste
Antimony	3.75E-03	3.75E-03			3.75E-03	3.75E-03	3.75E-03	
Arsenic	1.82E-03	6.04E-04			6.08E-04	3.93E-03	7.95E-03	
Barium	2.56E-02	2.96E-02			1.10E-01	3.00E-02	2.12E-01	
Cadmium	3.58E-03	8.21E-03			1.26E-03	1.10E-03	1.22E-02	
Chromium (total)	1.60E-03	1.41E-03			1.06E-02	6.64E-02	8.35E-02	
Copper	1.12E-01	1.12E-01			1.12E-01	7.47E-01	1.12E-01	
Lead	1.87E-02	1.92E-02			1.71E-01	6.27E-01	3.36E-01	
Mercury	7.36E-06	6.66E-06			2.88E-06	5.31E-06	5.66E-05	
Nickel	1.36E-02	1.36E-02			1.36E-02	1.36E-02	1.36E-02	
Selenium	1.08E-04	3.48E-05			2.64E-05	6.15E-05	6.03E-04	
Tin	8.48E-02	8.48E-02			8.48E-02	8.48E-02	8.48E-02	
Vanadium	4.76E-03	4.76E-03			4.76E-03	4.76E-03	4.76E-03	
Zinc	6.15E-01	6.15E-01			6.15E-01	6.15E-01	6.15E-01	
ORGANIC POLLUTANTS								
PAHs (total)	3.41E-04	3.41E-04					6.81E-04	3.41E-04
PCDD/PCDF (total)	4.89E-05	4.89E-05	2.45E-05	2.45E-05			1.96E-04	4.89E-05

Sources: Based upon data from Tables 4.5, 5.9 abd 5.31.

TABLE 5.33 CONTINUED

INORGANIC POLLUTANTS	wood waste	tires/ rubber	textiles	OTHER WASTE	misc. inorganics	hhw	SPECIAL WASTE	TOTAL
Antimony				3.75E-03				2.25E-02
Arsenic	4.00E-04	4.99E-04	7.04E-04	1.00E-02	1.00E-02			2.50E-02
Barium	2.65E-02	1.77E-02	9.63E-02	2.80E-01	2.80E-01			6.88E-01
Cadmium	7.03E-04	2.71E-03	3.14E-03	3.96E-02	5.33E-03	3.43E-02		6.59E-02
Chromium (total)	6.13E-04	4.13E-02	3.53E-02	4.49E-03	4.49E-03			1.68E-01
Copper				1.18E+00	1.07E+00			2.38E+00
Lead	2.15E-02	1.47E-01	1.46E-02	6.48E-01	4.12E-01	2.37E-01		1.82E+00
Mercury	8.39E-06	6.53E-06	2.75E-05	1.25E-03	1.40E-05	1.23E-03		1.33E-03
Nickel				3.41E-02		2.05E-02		1.02E-01
Selenium	2.90E-05	4.69E-04	6.45E-05	1.32E-04	1.32E-04			9.65E-04
Tin				8.48E-02				5.09E-01
Vanadium				4.76E-03				2.86E-02
Zinc				3.63E+00		3.02E+00		6.71E+00
ORGANIC POLLUTANTS								
PAHs (total)	3.41E-04			3.41E-04		3.41E-04		1.70E-03
PCDD/PCDF (total)	4.89E-05	4.89E-05	4.89E-05	9.78E-05	4.89E-05	4.89E-05		3.91E-04

Sources: Based upon data from
Tables 4.5, 5.9 abd 5.31.

TABLE 5.34 TOTAL POLLUTION ASSOCIATED WITH INCINERATORS (lb pollutant/ton MSW)

CRITERIA AIR POLLUTANTS	AIR	ASH	TOTAL
CO	3.51E-02		3.51E-02
NOx	9.29E-02		9.29E-02
Particulates	8.70E-03		8.70E-03
SOx	1.92E-03		1.92E-03
VOCs	3.74E-03		3.74E-03
INORGANIC POLLUTANTS			
Antimony	7.65E-07	1.48E-03	1.48E-03
Arsenic	8.19E-08	5.69E-04	5.69E-04
Barium		1.47E-02	1.47E-02
Beryllium	4.31E-08	4.31E-08	8.62E-08
Cadmium	3.22E-07	1.62E-03	1.62E-03
Chromium (total)	9.78E-08	1.08E-03	1.08E-03
Copper	3.70E-06	4.42E-02	4.42E-02
Lead	1.12E-06	1.53E-02	1.53E-02
Manganese	2.37E-04	2.37E-04	4.73E-04
Mercury	3.49E-06	2.63E-06	6.12E-06
Nickel	1.84E-06	5.38E-03	5.39E-03
Selenium	3.40E-07	3.31E-05	3.34E-05
Tin	7.57E-06	3.35E-02	3.35E-02
Vanadium	9.73E-08	1.88E-03	1.88E-03
Zinc	1.84E-05	2.43E-01	2.43E-01
ORGANIC POLLUTANTS			
PAHs (total)	1.18E-05	1.17E-04	1.29E-04
PCDD/PCDF (total)	8.87E-11	1.82E-05	1.82E-05
MISCELLANEOUS			
Hydrogen chloride	3.45E-03		3.45E-03
Hydrogen fluoride	1.24E-05		1.24E-05

Sources: Based upon data from Tables 4.5, 5.32, and 5.33.

TABLE 5.35 MATERIALS LIKELY TO BE COMPOSTED BY A MSW COMPOSTING FACILITY

- **PAPER**
  - brown paper bags
  - mixed paper
  - other paper
  - disposable diapers
- **OTHER ORGANICS**
  - food waste
  - wood waste
  - crop residues
  - manure
- **YARD WASTE**
  - leaves, grass, prunings
- **OTHER WASTES**
  - inert solids

TABLE 5.36 ESTIMATED CARBON DIOXIDE EMISSIONS FROM MSW COMPOST FACILITIES (lbs CO_2/ton material composted)[1]

	Paper	Food	Yard	Total
CO_2	120	37	68	225

[1]Estimates are based on ultimate analysis and MSW content as presented in Table 5.4.

Table 5.37 Recycling Facility Environmental Impacts - Inactive (No Sorting)

	Emission Concentration (ug/CM)	Emission Rate (lb/hr)	Emissions per Ton (lb)
Particulates (1)	3,000,000	0.064	0.0128
Heavy Metals (1)			
Cadmium	0.4	8.53E-09	1.71E-09
Chromium	1.4	2.99E-08	5.97E-09
Lead	2.3	4.91E-08	9.81E-09
Nickel	4.95	1.06E-07	2.11E-08
Arsenic	n/d		
Mercury	0.23	4.91E-09	9.81E-10
Organics (2)			
Acetone	125	2.67E-06	5.33E-07
Benzene	5	1.07E-07	2.13E-08
Carbon disulfide	5	1.07E-07	2.13E-08
Carene	16	3.41E-07	6.83E-08
Chloroform	2	4.27E-08	8.53E-09
Cyclohexane	5	1.07E-07	2.13E-08
Diethyl Ether	5	1.07E-07	2.13E-08
Ethyl Acetate	10	2.13E-07	4.27E-08
Ethyl Benzene	29	6.19E-07	1.24E-07
Hexane	4	8.53E-08	1.71E-08
Isobutane	116	2.47E-06	4.95E-07
Methyl chloride	39	8.32E-07	1.66E-07
Mehtyl Cyclohexane	2	4.27E-08	8.53E-09
Methylpentane	3	6.40E-08	1.28E-08
Silicone Oil	252	5.38E-06	1.08E-06
Pentane	5	1.07E-07	2.13E-08
Tetrachloroethylene	17	3.63E-07	7.25E-08
1,1,1-trichloroethane	44	9.39E-07	1.88E-07
Trichloroflouromethane	143	3.05E-06	6.10E-07
Toluene	88	1.88E-06	3.75E-07
Xylenes	707	1.51E-05	3.02E-06
	Bacterial Colonies/CM	Colonies/HR	Colonies/ton
Air Microorganisms			
Inactivity	125	1,209	242

(1) Active sorting appears to have no noticable impact on emission levels.
(2) For most pollutants, represents underestimate since detectors were oversaturated.

Source: Center for the Biology of Natural Systems. "Development and Pilot Test of an Intensive Municipal Solid Waste Recycling System for the Town of East Hampton: Volume I", prepared for the New York State Energy Research and Development Authority. February 1990.

Table 5.38 Recycling Facility Environmental Impacts - Active Sorting

	Emission Concentration (ug/CM)	Emission Rate (lb/hr)	Emissions per Ton (lb)
Organics (2)			
Acetone	137	2.92E-06	5.85E-07
Benzene	7	1.49E-07	2.99E-08
Carbon disulfide	5	1.07E-07	2.13E-08
Carene	2	4.27E-08	8.53E-09
Chloroform	2	4.27E-08	8.53E-09
Cyclohexane	5	1.07E-07	2.13E-08
Diethyl Ether	5	1.07E-07	2.13E-08
Ethyl Acetate	22	4.69E-07	9.39E-08
Ethyl Benzene	14	2.99E-07	5.97E-08
Hexane	7	1.49E-07	2.99E-08
Isobutane	1500	3.20E-05	6.40E-06
Methyl chloride	47	1.00E-06	2.01E-07
Mehtyl Cyclohexane	3	6.40E-08	1.28E-08
Methylpentane	3	6.40E-08	1.28E-08
Silicone Oil	467	9.96E-06	1.99E-06
Pentane	31	6.61E-07	1.32E-07
Tetrachloroethylene	12	2.56E-07	5.12E-08
1,1,1-trichloroethane	103	2.20E-06	4.39E-07
Trichloroflouromethane	142	3.03E-06	6.06E-07
Toluene	98	2.09E-06	4.18E-07
Xylenes	91	1.94E-06	3.88E-07
	Bacterial Colonies/CM	Colonies/HR	Colonies/ton
Air Microorganisms	3700	35,797	7,159

(2) For most pollutants, represents underestimate since detectors were oversaturated.

Emissions of particulates and heavy metals same as Table 5.15

Source: Center for the Biology of Natural Systems. "Development and Pilot Test of an Intensive Municipal Solid Waste Recycling System for the Town of East Hampton: Volume I", prepared for the New York State Energy Research and Development Authority. February 1990.

Table 5.39 - Recycling and Garbage Collection Air Emissions

	Recycling Collection		Garbage Collection	
	Emission Factor (g/hour)	Emissions per Ton (lb)	Emission Factor (g/hour)	Emissions per Ton (lb)
CO	102.12	0.68736	102.12	0.16173
NOx	144.49	0.97253	144.49	0.22883
SOx	20.64	0.13893	20.64	0.03269
VOCs	34.71	0.23360	34.71	0.05496
ORGANIC POLLUTANTS				
Benzene		0.00418		0.00098
Ethyl benzene		0.00014		0.00003
Toluene		0.00420		0.00099
Xylenes		0.00150		0.00035
Collection Rate (tons/hr)		0.32760		1.39230

Assumes 3.0 lb/person/day, 2.6 people/household, 15% recycled, 80 households/hour for recycling and 60 hh/hr for garbage

Source: U.S. EPA, "Compilation of Air Pollutant Emission Factors, Volume II: Mobile Sources", fourth edition, September 1985.

TABLE 5.40 EMISSIONS FROM RECYCLING COLLECTION BY WASTE TYPE (LBS/TON OF MATERIAL)

CRITERIA AIR POLLUTANTS	news	occ	mixed paper	hi grad	other paper	hdpe	pet	film	other plastic	recyc glass
CO	0.3655	2.1929	1.0965	0.8224	1.6447	4.6992	5.4824	6.5788	4.6992	0.2741
NOx	0.5171	3.1028	1.5514	1.1635	2.3271	6.6488	7.7569	9.3083	6.6488	0.3878
SOx	0.0739	0.4433	0.2216	0.1662	0.3324	0.9498	1.1081	1.3298	0.9498	0.0554
VOCs	0.1242	0.7453	0.3726	0.2795	0.5590	1.5970	1.8632	2.2358	1.5970	0.0932
ORGANIC POLLUTANTS										
Benzene	0.0022	0.0133	0.0067	0.0050	0.0100	0.0286	0.0334	0.0400	0.0286	0.0017
Ethyl benzene	0.0001	0.0004	0.0002	0.0002	0.0003	0.0010	0.0011	0.0013	0.0010	0.0001
Toluene	0.0022	0.0134	0.0067	0.0050	0.0101	0.0287	0.0335	0.0402	0.0287	0.0017
Xylenes	0.0008	0.0048	0.0024	0.0018	0.0036	0.0102	0.0119	0.0143	0.0102	0.0006

TABLE 5.40 EMISSIONS FROM RECYCLING COLLECTION BY WASTE TYPE (LBS/TON OF MATERIAL) (cont)

CRITERIA AIR POLLUTANTS	non-rec glass	alum cans	ferrous	non-ferrous	white good	yard waste	wood waste	food waste	tires/ rubber	textiles
CO	0.2741	2.7412	0.8224	1.0965	0.4699	0.8224	0.6579	0.4699	0.4699	1.3158
NOx	0.3878	3.8785	1.1635	1.5514	0.6649	1.1635	0.9308	0.6649	0.6649	1.8617
SOx	0.0554	0.5541	0.1662	0.2216	0.0950	0.1662	0.1330	0.0950	0.0950	0.2660
VOCs	0.0932	0.9316	0.2795	0.3726	0.1597	0.2795	0.2236	0.1597	0.1597	0.4472
ORGANIC POLLUTANTS										
Benzene	0.0017	0.0167	0.0050	0.0067	0.0029	0.0050	0.0040	0.0029	0.0029	0.0080
Ethyl benzene	0.0001	0.0006	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0003
Toluene	0.0017	0.0168	0.0050	0.0067	0.0029	0.0050	0.0040	0.0029	0.0029	0.0080
Xylenes	0.0006	0.0060	0.0018	0.0024	0.0010	0.0018	0.0014	0.0010	0.0010	0.0029

TABLE 5.40 EMISSIONS FROM RECYCLING COLLECTION BY WASTE TYPE (LBS/TON OF MATERIAL) (cont)

CRITERIA AIR POLLUTANTS	misc org	misc. inorganics	inert solids	hhw	SPECIAL WASTE
CO	0.9398	0.6579	0.3289	0.6579	0.6579
NOx	1.3298	0.9308	0.4654	0.9308	0.9308
SOx	0.1900	0.1330	0.0665	0.1330	0.1330
VOCs	0.3194	0.2236	0.1118	0.2236	0.2236
ORGANIC POLLUTANTS					
Benzene	0.0057	0.0040	0.0020	0.0040	0.0040
Ethyl benzene	0.0002	0.0001	0.0001	0.0001	0.0001
Toluene	0.0057	0.0040	0.0020	0.0040	0.0040
Xylenes	0.0020	0.0014	0.0007	0.0014	0.0014

TABLE 5.41 EMISSIONS FROM GARBAGE COLLECTION BY WASTE TYPE (LBS/TON OF MATERIAL)

CRITERIA AIR POLLUTANTS	news	occ	mixed paper	hi grade	other paper	hdpe	pet	film	other plastic
CO	0.15847	0.27651	0.23176	0.21517	0.25111	0.58531	0.59693	0.34026	0.65193
NOx	0.22422	0.39123	0.32791	0.30445	0.35529	0.82815	0.84459	0.48143	0.92241
SOx	0.03203	0.05589	0.04684	0.04349	0.05076	0.11831	0.12066	0.06878	0.13177
VOCs	0.05386	0.09397	0.07876	0.07313	0.08534	0.19892	0.20287	0.11564	0.22156
ORGANIC POLLUTANTS									
Benzene	0.00096	0.00168	0.00141	0.00131	0.00153	0.00356	0.00363	0.00207	0.00397
Ethyl benzene	0.00003	0.00006	0.00005	0.00004	0.00005	0.00012	0.00012	0.00007	0.00013
Toluene	0.00097	0.00169	0.00142	0.00132	0.00154	0.00358	0.00365	0.00208	0.00399
Xylenes	0.00034	0.00060	0.00050	0.00047	0.00055	0.00127	0.00130	0.00074	0.00142

TABLE 5.41 EMISSIONS FROM GARBAGE COLLECTION BY WASTE TYPE (LBS/TON OF MATERIAL) (cont)

CRITERIA AIR POLLUTANTS	recyc glass	non-rec glass	alum cans	ferrous	non-ferrous	white good	yard waste	wood waste	food waste
CO	0.06398	0.06398	0.69527	0.27430	0.30184	0.21537	0.13218	0.20047	0.09397
NOx	0.09052	0.09052	0.98373	0.38811	0.42706	0.30472	0.18702	0.28364	0.13296
SOx	0.01293	0.01293	0.14053	0.05544	0.06101	0.04353	0.02672	0.04052	0.01899
VOCs	0.02174	0.02174	0.23629	0.09322	0.10258	0.07319	0.04492	0.06813	0.03194
ORGANIC POLLUTANTS									
Benzene	0.00039	0.00039	0.00423	0.00167	0.00184	0.00131	0.00080	0.00122	0.00057
Ethyl benzene	0.00001	0.00001	0.00014	0.00006	0.00006	0.00004	0.00003	0.00004	0.00002
Toluene	0.00039	0.00039	0.00425	0.00168	0.00185	0.00132	0.00081	0.00123	0.00057
Xylenes	0.00014	0.00014	0.00151	0.00060	0.00066	0.00047	0.00029	0.00044	0.00020

TABLE 5.41 EMISSIONS FROM GARBAGE COLLECTION BY WASTE TYPE (LBS/TON OF MATERIAL) (cont)

CRITERIA AIR POLLUTANTS	tires/ rubber	textiles	misc org	misc. inorganics	inert solids	hhw	special waste
CO	0.26640	0.37884	0.18794	0.17183	0.07290	0.17183	0.17183
NOx	0.37693	0.53602	0.26591	0.24312	0.10314	0.24312	0.24312
SOx	0.05385	0.07657	0.03799	0.03473	0.01473	0.03473	0.03473
VOCs	0.09054	0.12875	0.06387	0.05840	0.02477	0.05840	0.05840
ORGANIC POLLUTANTS							
Benzene	0.00162	0.00230	0.00114	0.00105	0.00044	0.00105	0.00105
Ethyl benzene	0.00005	0.00008	0.00004	0.00004	0.00001	0.00004	0.00004
Toluene	0.00163	0.00232	0.00115	0.00105	0.00045	0.00105	0.00105
Xylenes	0.00058	0.00082	0.00041	0.00037	0.00016	0.00037	0.00037

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CHAPTER 6 - ASSESSING THE FULL COST OF WASTE MANAGEMENT

6.1 INTRODUCTION

6.1.1 The Scope of the Analysis

In this chapter, we develop a method for quantifying the full marginal cost of waste management in California. We describe the types of cost that constitute the full waste management cost, and argue for explicit monetization and inclusion of all external costs associated with waste management -- i.e. its environmental/public health impacts. Explicit dollar values are thus assigned to the various externalities -- the pollutants quantified in the preceding chapter -- associated with the components of the waste stream. In subsequent sections, we discuss methods and issues of valuing these costs and present our choice of methodology.

Two broad categories of cost arise with the disposal of waste: first, the *conventional* costs of waste management, and second, the environmental damage or *external* costs associated with waste management. Both types of cost are actually borne by people: some costs are borne by each member of society, other costs only by some; some costs will be borne in the near term, other costs over the longer term.

The conventional waste management cost is the monetary cost of collection, transport, processing, and disposal. For collection and transport, this is the purchase and maintenance of trucks as well as the collection workers' wages and the fuel consumed to operate the trucks. For processing and disposal, this is the cost of constructing, operating, and closing different waste disposal facilities.

Environmental damages (and their costs) can occur at each stage of waste management. For the collection and transport stages, the most important environmental costs are caused by the pollutant emissions to the air from fuel combustion by collection and transport vehicles. For the disposal stage, the largest environmental costs will differ according to the disposal method. When waste is landfilled, environmental costs are incurred through the leaching of pollutants into surface and ground water, as well as from releases of pollutants to the air from decomposition of materials. When waste is incinerated, costs are incurred through air emissions from combustion and leaching of toxic materials contained in the incinerator ash (which is usually landfilled). The magnitudes and mix of pollutants entering the air and water will be different for each facility type.*

Some of the environmental cost is already monetized and experienced as such by people, albeit not internalized in the disposal cost of materials or experienced in the price of commodities containing these materials. For example, treatment of health effects of pollution will embody some environmental costs. Large parts of the environmental cost will not, however, be monetized. Untreated health impacts are among these. Beyond these are reductions of the stock and quality of natural resources available for human consumption, for present and future generations. This includes, for example, groundwater contamination through leachate and soil degradation through deposition of air emissions.

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* E.g., decomposition of carbonaceous materials in landfill gives rise to a different mix of carbon dioxide and methane emissions than does the combustion of those materials.

Of course, very important, but hard to quantify, is the loss of the ideal value which many people place on the natural environment, e.g. the preservation of ecosystems, habitats, species. The fact that these environmental costs are not monetized at present does not mean that they never will be.

6.1.2 The Case for the Monetization of Externalities

It may well be argued that a large component of the environmental damages cannot or ought not be valued in monetary terms. Many people feel that the human race has a responsibility for creation, and that this has an intrinsic value that lies outside the sphere of money. At the same time, many also believe that there is no objective way by which such intrinsic values -- e.g. a human life, a pristine habitat -- can be quantified.

However, the treatment of the environment is, in our open society, a matter of public policy. On the basis of both scientific results and public discourse, society broadly and local communities may express their willingness to pay to avoid or, alternatively, accept certain levels of environmental degradation. Environmental regulations set limits that affect the costs of production, distribution and consumption of goods. Decisions affecting the treatment of environments and risks to human health -- within the constraints of environmental protection -- are made on a daily basis. These policies and choices imply specific valuations of natural and human resources. Assigning dollar values to environmental impacts makes these existing valuations explicit.

Systems have been suggested that appear to avoid the monetization of environmental damages, for example scoring and ranking systems that assign points to resource alternatives for their impact on the environment. However, these evaluation systems still do contain implicit monetary valuations. The choice of one resource alternative over another implies a monetary valuation of the environmental impacts. If the option with the higher monetary cost is chosen, then this implies that the difference in environmental impacts between the two policies is valued higher than the difference in monetary cost.[1]

Suppose, for example, that the two resource alternatives are compared using a scoring system to account for their environmental impacts. Assume that on the basis of conventional economic costs one is preferable (i.e., cheaper) but that with the environmental scoring system the other is preferable. Thus the score differential is worth at least the cost differential and thereby overcomes it. By extension, to a potential continuum of costs and scores for different options, the scoring system could, indeed must, be translatable into monetary terms if stable comparisons are made. At their best, scoring systems will logically and consistently embody the monetary values that the relevant community holds. But they would tend to obscure rather than clearly illuminate these values and their relationship to conventional costs.

Systems for choosing between alternative resources or plans with different environmental attributes, as well as systems of environmental targets or constraints, imply or can be expressed in monetary terms. For example, the decision to construct a reservoir that provides water at a lower monetary cost than conservation measures but which destroys a unique ecosystem implies that preservation of this ecosystem is worth less (in dollar terms) than the savings in the cost of water provision. Another example is a ban on the use of polystyrene for the purpose of fast food packaging. This ban implies the judgement that the externality caused by polystyrene in this use is to be valued higher (i.e. more negatively) than the cost imposed on the businesses that have to turn to the next "best" (from their point of view) option for fast food packaging.

6.2 METHODOLOGY FOR COST ASSESSMENT

6.2.1 Marginal Cost Analysis

In order to give the correct signal to the production and consumption decisions that affect the magnitude and character of waste generation, the disposal fee should reflect the true marginal cost of waste management. Why marginal costs? Our goal is to assess the waste management costs that should be incorporated into the cost of goods sold in California. For this purpose, the marginal costs rather than average costs are appropriate. The fee system is intended to express the true costs *caused by* new waste generated by goods produced and consumed. The changes in waste disposal costs that may result from these activities are changes at the margin: the next increment in landfill capacity utilization, the construction and use of new disposal facilities, etc., Correspondingly, the fee system is intended to reflect these marginal costs and, through its influence on production and consumption decisions, change these marginal waste management costs which would otherwise occur.

Current costs of waste management have already been incurred, and thus are not affected by new waste generation or avoided by a fee influencing waste generation. Thus the appropriate costs are marginal costs, rather than current average costs. This distinction is of critical importance when assessing the importance of existing landfill costs (among other issues). Almost all solid waste in California is currently disposed of in landfills that were permitted before the current (1984) regulations took effect. Thus the actual costs of waste disposal today would very heavily reflect the costs of existing landfill operation, to the degree that capacity remains available for new waste. Even for existing systems, however, the costs per ton of added waste may not be the same as the cost per ton of previously landfilled waste (for example, since the construction costs are already incurred).

6.2.2 Variation in Marginal Costs by Location and Time

At present, 87 percent of the waste generated in California is landfilled, 11 percent is recycled, and 2 percent is incinerated. This mix of disposal facilities is the basis for our calculation of the conventional waste management cost at present. It is also necessary to distinguish between the use of existing and new landfills. Within the next decade, roughly half of landfill capacity in the state as a whole will be exhausted; and all of today's capacity may be exhausted in 20 years.[2]

Waste management is organized on a county basis, and many counties will run out of landfill capacity within the next few years. Only some of these can ship their waste to other counties that still have abundant landfill space. There are, moreover, both political and economic limitations to inter-county waste transfer: for example, hauling the waste over long distances may be prohibitively expensive, and some communities might balk at accepting others' waste. The counties that run out of landfill space and cannot ship their waste into neighboring counties will have to construct new facilities, at a higher cost.

There are thus two types of counties: those which still have access to existing landfill space and those which have to develop new disposal capacity, whether landfill, incineration or recycling. For the purposes of this report, we have assumed that the latter utilize new landfills, with the higher costs associated with requirements for liners, leachate collection systems, and capping layers. The particular controls differ between Southern and Northern California, as discussed further in Section 6.3.2. Those counties which have access to existing landfill space will have lower conventional costs of disposal, but higher environmental costs, due to greater quantities of leachate being emitted per ton of solid waste.

The marginal costs of collecting and disposing of solid waste will also vary over time, regardless of location, as, for example, the rate of recycling increases and the cost per ton of using a landfill changes. If we were to project the full costs of disposal for a number of years into the future, it would be necessary to estimate these changes. However, there are several problems with doing so. First, future costs are highly uncertain, and realistic projections would involve extensive analysis which is beyond the scope of this report. Second, our initial efforts to model such costs yielded anomalous results, which conflicted with the goal of reflecting the current full cost to society of waste disposal. For example, based on current recycling technologies and secondary materials markets, it is very expensive to recycle plastics. If we were to assume growing future rates of recycling plastics, but no changes in technologies and markets, this would result in an extremely high and rising average cost for disposing of plastics. Such results are not reflective of the actual disposal system in California. In this specific instance, we assume that new recycling technology and/or higher materials prices will be required to stimulate plastics recycling.

Thus, we have chosen to use current marginal costs for disposal, and the current mix of disposal methods. We recommend that changes in these two factors be reflected in the periodic updates of the disposal fee system which are expected to be incorporated into the legislation.

6.2.3 Individual Material Cost

For the sake of simplicity, we have so far assumed that there is one single number for the waste management cost per ton of waste in a given facility. However, individual materials give rise to different costs. This is obvious for the environmental cost: the emissions to which a product gives rise when being processed in a waste disposal facility depend on its chemical make-up. Materials containing chlorine can contribute to the formation of chlorinated dioxins and materials containing heavy metals are the source for the emissions of heavy metals. In conventional waste management, too, individual materials affect waste management cost in different ways, depending on their density, their scrap value, and their BTU content. We thus have to compute the conventional and environmental cost of waste management on a material-specific basis. An important function of the disposal cost fee is to charge individual materials according to their differential effects on waste management cost.

Conventional waste management costs are attributed directly to individual materials, as is described in section 6.3. below. For environmental cost, we value individual emissions with a dollar value per pound of pollutant. Section 6.4 of this report offers a general description of the methodology which we employ to do this. We then add up these individual emission costs to arrive at one dollar figure which is the environmental cost per ton of each material type in a given facility.

The cost categories we employ, and the basis for cost calculations in each category, are summarized in Table 6.1 and explained in detail in the remainder of this chapter.

TABLE 6.1 - SUMMARY OF DISPOSAL COST COMPONENTS

Activity	Conventional Costs	Environmental Costs
Recycling collection	Transport costs *based on uncompacted volume*	Truck emissions *based on volume*
Garbage collection	Transport costs *based on compacted volume*	Truck emissions *based on volume*
Recycling facility	Costs minus revenue *based on tonnage, and types of material*	None reported
Incinerator	Costs minus revenue *based on tonnage, and types of material*	Air emissions *based on material type (ash disposal impacts omitted)*
Landfill (old and new separately)	Capital, operating, and closure/post-closure costs *based on in-fill volume*	Leachate and gas emissions *based on material type*

These costs are combined into four program totals: (i) recycling costs include recycling collection and facility costs; (ii) incineration includes garbage collection and incinerator costs; and both (iii) old and (iv) new landfills include garbage collection and the appropriate landfill costs. For each material in the waste stream, we thus obtain four pairs of numbers. Each pair contains a conventional cost figure and an environmental cost figure. For each disposal option, we add up the two figures in the pair to arrive at the full cost of waste management for a given material in that disposal option.

6.3 ANALYSIS OF CONVENTIONAL SOLID WASTE COSTS

6.3.1 Collection

Collection of garbage and recyclables accounts for a significant portion of conventional solid waste system costs. Vehicles that collect materials fill up by volume; consequently the collection cost of particular material types is dependent upon the volume of that material. To estimate collection costs, the average per ton costs of collecting mixed garbage and recyclable material is determined. Assuming constant collection costs per cubic yard, collection costs per ton are inversely proportional to a material's density.

The resulting per ton collection costs for each material type are presented in Table 6.3 for garbage collection and Table 6.4 for recycling collection. Material densities are also presented to illustrate the direct relationship between density and cost. Materials with low densities, such as plastic and aluminum, require a lot of space in the collection truck and therefore have high costs per ton. Materials with high densities, such as glass and food waste, have low collection costs per ton. Values for the loose density of recyclable materials are listed. For garbage collection, the compacted density is calculated based upon existing data on loose density and in-landfill density.

Under California Assembly Bill 939, beverage containers which are subject to the deposit/redemption provisions of A.B. 2020 are expected to be exempt from the disposal fee. Based upon redemption percentages from the California Department of Conservation, we have removed from the recycling and disposal streams the appropriate percentages of each material, including glass, aluminum, PET, and tin cans. In each case, this reduces the percentage of each material which is recycled separately from the deposit/redemption system.

Garbage

The cost of garbage collection was estimated for both residential and commercial service, which differ with collection frequency and container size. Cost estimates are based upon County Solid Waste Management Plans (CoSWMPs) that often list prices charged by private haulers in the county. Garbage collection in California is almost exclusively performed by the private sector, which is often granted franchise of an entire region or portions of a community.

Residential customers are usually charged a fixed monthly fee for weekly garbage collection. This cost includes both the cost of collection and disposal of waste. Table 6.5 lists the average monthly fees for weekly collection in a number of counties. Monthly fees are converted into per ton fees, assuming that the average household generates 70 pounds of garbage per week (2.5 people per household, 4 pounds of waste per person per day). Average per ton landfill costs are subtracted from the total collection cost to arrive at the collection and transportation cost. For many counties, a state-wide average disposal cost is used because county specific data is unavailable. To calculate costs per material, a mixed waste density of 572 pounds per cubic yard used; this figure is based on the densities of each material and the residential composition.

Commercial customers are charged by the size of collection container used and the frequency of collection. Container sizes vary from 90-gallon cans to five-cubic yard roll-off containers. Collection ranges from one to five times a week. The cost per cubic yard decreases as container size and collection frequency increase, therefore a weighted average of these costs was developed. Table 6.6 presents the average charge to customers per cubic yard and converts these values into costs per ton. Total collection and transportation costs are derived by subtracting the average cost of disposal from the average weekly charge to customers.

For both residential and commercial collection, the collection costs include both on-route costs of collection and any long-distance hauling costs if waste is initially sent to a transfer station. Transfer station costs include the cost of operating the transfer facility and long-distance hauling to a landfill. No effort was made to determine what proportion of the collection costs are associated with transfer stations.

Recycling Costs

Little data on recycling collection costs was available from California municipalities. The recycling collection costs we developed are based upon the costs of garbage collection and the relationship between garbage and recycling collection costs in other regions. Table 6.4 presents recycling collection costs per material. Costs are approximately 50% greater than garbage collection costs per ton of material collected. However, it is assumed that 15% of recyclables are self-hauled and therefore have no conventional costs.

For residential collection, weekly curbside collection of materials is assumed, although in existing programs collection may be bi-weekly or monthly. Also assumed is that 15% of the materials are delivered to drop-off facilities, which have no collection costs. Recyclables are collected in standard recycling vehicles which do not compact materials, so as-disposed (in-can) densities are used for calculating individual material costs.

Commercial recyclables may be recovered from loads which have been completely source separated, partially separated (high graded) or mixed. Because of the range of conditions recyclables are collected, we have assumed materials are collected either source separated or commingled without any compaction. There are two exceptions: corrugated cardboard is given a density of 225 lb/cy because the majority of it is collected compacted, and white paper has a density of 400 lb/cy because the majority is collected source separated and stacked which increases its density.

6.3.2 Disposal

The two types of garbage disposal currently used in California are landfills and incinerators. In this section the costs of landfilling and incineration are considered. Costs of existing and state-of-the-art landfills are estimated, along with the current costs of incineration. Costs for new landfills will differ greatly from older landfills that have little to no environmental controls.

Landfills

Our estimates of existing landfill costs are based on California landfill data. A Tellus Institute study, *A Cost Analysis of Municipal Waste Landfilling in California*, looked at 27 landfills of various sizes and analyzed their existing and post-closure costs. For existing landfills, a reference facility of 1,000 tons per day was used, which has a mean cost of $13.10 per ton. This cost includes operating and maintenance expenses, payment on capital outlays and closure and post closure costs. Of the $13.10 cost, $11.80 is for capital and operating expenses and $1.30 is for closure and post-closure activities. The fee for closure and post-closure will ensure there are adequate funds for these activities once the landfill stops accepting waste. Post-closure costs are spread across the entire landfill life.

In determining future landfill costs, the costs are calculated for 1,000 TPD landfills in northern and southern California employing state-of-the-art environmental controls.
Because of low precipitation rates, the southern landfill meets the minimum regulatory requirements for liner and cap material. Three feet of clay is used in the liner, while one foot of clay, with two other soil layers, is used in the cap. The northern landfill uses greater controls because of higher

precipitation rates. Five feet of clay and a synthetic membrane is used in the liner, while three feet of clay is used in the cap.

Costs are greatly affected by site characteristics and particularly site geometry. Costs are reduced when landfill depth is large because many capital and operating costs are proportional to acreage. The southern landfill is assumed to be deeper than the northern one because of the prevalence of mountain canyons that provide natural holes for filling with waste. The southern landfill has an average depth of 130 feet while the northern is 80 feet deep on average. This results in an active fill area of 115 acres in the southern site and 183 in the northern site. A full list of the site characteristic assumptions used in developing these landfills is summarized in Table 6.7.

Detailed costs of these landfills are presented in Table 6.8. This table outlines capital, operating, closure and post-closure costs. Closure and post-closure costs represent the net present value costs that will be incurred many years in the future. These costs are based upon national and regional landfill costs because limited data was available on construction of new landfills in California.

Landfills, like garbage collection vehicles, fill up by volume, not by weight.. Association of landfill costs with individual materials is achieved by adjusting the average per ton costs by the ratio of the average landfill density to the landfill density of each individual material. These densities are presented in Table 6.9 along with the per ton costs of landfilling each material.

Incineration

California currently has only three operating garbage incinerators with a total capacity of 2,560 tons per day. Incineration costs are based on the current costs of these facilities plus an estimated cost for the planned San Marcos facility. This is the only municipal solid waste incinerator being planned in the state, with the exception of a few private ventures which are in very preliminary stages. The tipping fees at these facilities are presented in Table 6.10, with the weighted average tipping fee of all the facilities.

The net facility cost is a combination of capital and operating costs, residue disposal costs, and revenue from the sale of electricity. Capital and operating costs are proportional to the weight of the material type. Revenues are based upon the BTU value of the material and residue costs are based upon the ash content of the material. For each material type, the incineration cost is calculated based on the BTU value and ash content of the material. These values are listed in Table 6.11 along with the per ton material costs of incineration for each material.

Revenues are calculated based upon the following formula:

revenue/ton = BTU/lb * 2,000 lb/ton * electric price ($/kwh) / heat rate (BTU/kwh)

The conversion from waste to energy is dependent upon the heat rate that measures the efficiency of the conversion of BTUs to kwh. Revenues are then calculated based upon the price of electricity ($/kwh). The following values are used in the study:

heat rate 14,000 BTU/kwh

electricity price $0.06/kwh.

Residue costs are calculated by multiplying the percent ash composition by the per ton cost of ash disposal, which is assumed to be $15 per ton.

In calculating the costs per material, there is an intermediate step where the average per ton capital and operating cost is calculated using BTU values and ash content for mixed MSW. For mixed waste, we assume an ash content of 25% and a BTU content of 4,750 per pound. Using these values, the capital and operating portion of costs is calculated to be $91.56 per ton, while residue disposal is calculated at $3.75, and revenues at $40.71 per ton of mixed solid waste.

Recycling Processing Costs

Once recyclables have been collected, they must be processed before they can be sold. Processing may involve separation of the material from other recyclables or mixed waste, contaminant removal, and volume reduction of the material, i.e., glass crushing, tire shredding, or paper baling. The variety of processing methods used for a single material type may be enormous and makes generalizations about the costs of processing and revenues difficult to arrive at. We modelled several methods of recyclable processing and assumed that a mix of these processes is used.

For residential recycling, four facility types are used: a materials recovery facility (MRF), a recycling depot, a multiple separation facility, and a drop-off facility. Both the MRF and the depot accept commingled recyclables. The MRF is larger and has automated sorting, while the depot is smaller and relies primarily on manual sorting. The multiple separation facility accepts materials that are already separated. Residents bring recyclables directly to the drop-off facility.

Separate cost structures (capital costs, operating costs, and revenues) for each facility are presented in Tables 6.12 through 6.14. These costs are based upon regional and national costs of recycling facilities. For drop-off centers, capital and operating costs are assumed to total $3 per cubic yard of material received.

The costs of these three facility types are weighted, based on the assumption that capacity is divided as follows:

MRF	30%
Depot	30%
Multiple Separated	25%
Drop-off	15%

Table 6.15 shows the costs per ton of each of the residential recyclable materials. For those materials where costs are not presented, the costs of commercial recycling are used.

Commercial recycling processing costs are very difficult to generalize for many of the materials presented. Costs vary depending upon the form of collection (source separation, partial separation, or mixed), quantity of the recyclables, and type of separation and processing technology used. Most commercial recyclables are recovered in one of several ways:

• Separation of materials from mixed recyclables or waste. These facilities usually target mixed waste from specific types of generators, primarily office and commercial generators, and construction and demolition waste. Loads from these generators may be source separated, partially separated or completely mixed; dump and sort facilities (often combined with transfer stations) take mixed or high grade commercial loads and remove valuable recyclables; construction and demolition debris facilities separate and process different grades of aggregate materials, ferrous and wood; and mixed recyclables from restaurants, bars, and other generators may be sent to a recycling facility, similar to residential recyclables.

• Source separated recyclables. Certain generators may produce enough of a particular material to justify separate collection: corrugated cardboard from large retail stores and grocery stores is often compacted separately and collected; white office paper is often collected separately from offices; and manufacturers and other industry may have separate collection for materials, such as ferrous, which they generate in large quantities.

Because of the variability of processing costs and lack of availability in collecting data on commercial recycling facilities (most are privately owned), we have relied upon a variety of sources in estimating costs, including material revenues, operating costs from facilities in other regions of the country, tip fees for California and regional commercial recycling facilities and costs of processing residential recyclables. A summary of these costs is presented in Table 6.16. This table presents high and low revenue values and the average revenue we used in this analysis. The revenue range represents differences in material quality (contamination level, amount of processing and mixture with other materials) and the size of the load being sold.

6.4 ENVIRONMENTAL COST OF MATERIALS IN THE WASTE MANAGEMENT SYSTEM

This section is organized as follows: subsection 6.4.1 discusses our choice of methodology and describes how it should ideally be applied. It also explains some of the problems which arise when this methodology is applied to the environmental costs of waste management. Subsection 6.4.2 presents our valuation of individual pollutants and shows how we have arrived at these values. Subsection 6.4.3 determines the environmental cost of each material in each waste management facility type.

6.4.1 Methodology

Three methods are currently employed to value environmental costs. The first approach attempts to estimate the physical damage associated with the degradation of the environment. This implies tracing the physical environmental impacts and valuing the physical damage. The second approach, favored by academic economists, concentrates on consumer preferences and efforts to elicit them. The third approach uses pollution abatement and remediation costs to indicate the value that society places on environmental damage. This last approach is adopted for this study. A detailed discussion of each method and the reasons for selecting pollution abatement and remediation costs are presented in Appendix I to this chapter.

Our control cost approach is based on the notion that the marginal cost per unit of pollution abatement rises with the amount of pollution abated. The value that society places on residual emissions is a point on this marginal cost function. The highest amount that is required, or actually observed to be spent on the abatement of a specific pollutant, can be taken as a lower bound of the value that society places on removing this pollutant from the environment.[3] This value, which is associated with removal of the pollutant, is the cost that is ascribed to the presence of that pollutant.

When society or a community, through its regulations and policies, establishes pollution limits -- either through ambient concentrations, air basin aggregates, facility-specific emission caps, technology specifications, or outright bans on certain materials or facilities -- it is establishing its monetary value for the avoided pollution at the margin. Of course this is an evolving process of revealing the values and their monetary expression, which depends upon science, public discourse, and policy. Thus, the values may change over time.

The task then is to identify regulations and policies that address the pollutants present in waste management, and to determine the costs of complying with these regulations. The pollutants that are typical for waste management include a host of hazardous substances, EPA's criteria air pollutants and greenhouse gases. Each pollutant group and their valuation is discussed below.

Hazardous Substances

The emission of hazardous substances, such as heavy metals and various organics, may be the overriding environmental concern of waste management. Public discussion focuses on the health hazards caused by incinerator emissions and the contamination of groundwater from landfill leachate. The regulations and control policies which address all of these hazardous substances at once are, not surprisingly, the ones pertaining to waste management facilities -- namely mandated incinerator air pollution devices, suggested control measures for landfills, and mandated containment practices for leachate.

We want to use these controls for the evaluation of environmental cost. They qualify for this purpose if they actually reflect the highest price which society is willing to pay for the control of pollution. To determine whether they fulfill this requirement, two questions must be answered.

First, are the controls for waste management facilities indeed the policies with the highest compliance cost? We cannot answer this question because we did not have the time and the resources to explore and evaluate the entire body of regulations in place in California. There seem to be few regulations which address these hazardous substances individually.[4] The ones which do address these pollutants are hard to operationalize. If we have not identified the most "expensive" regulations, then we have underestimated the value which society places on the emission of pollutants. However, of the three control measures which we investigated -- incinerator air pollution control devices, leachate remediation, and landfill gas control -- we singled out the control measure that implies the highest price for pollution abatement.

Second, when one control device or control measure deals with a group of very different pollutants, the question of how to attribute the joint cost of pollution abatement to individual pollutants becomes an important issue.[5] One potential solution is to find different regulations for different pollutants, and to attribute the cost of a control device to only that pollutant that the device was intended to abate. However, as argued above, this proved to be difficult for the many pollutants which are present in waste management. Moreover, it is possible that the device was intended to control the full mix of pollutants, perhaps with some particular emphases.

We have therefore decided to combine the control cost approach with a **hazard ranking system**, a system which ranks pollutants according to the relative damage they cause. Specifically, this ranking system establishes equivalences between individual pollutants, such that the environmental impacts caused by any pollutant are expressed in proportion to the impacts of any other. In other words, the system establishes relative numerical values to reflect the relative toxicity of various pollutants.[6] This system allows us to allocate the joint pollution abatement cost to individual pollutants.

Construction of such a hazard ranking system is an extremely complex undertaking. There is no unique catalogue of criteria to be employed. No such system can take account of all environmental impacts of all pollutants. Ultimately, the relative impact of various pollutants depends upon many variables such as their transport, the exposure of sensitive populations, and the exposure-response relationships of those populations. Such analysis is beyond the scope of this study. Nonetheless, applying such a hazard ranking system is an improvement over the simple averaging of control costs over pollutants with very different potentials for causing environmental damage.

The hazard ranking system which we employ is based on human health effects only, leaving out other environmental impacts. Moreover, it disregards locational and transport relationships. What this implies for pollutant evaluation is that the price for individual pollutants is the same in each environmental medium. Heavy metals, for example, can be found in leachate as well as in incinerator emissions. While it is possible that these pollutants cause different environmental damage in different media, the valuation method abstracts from this and assigns a dollar value for each pollutant, irrespective of the medium into which it is released. The hazard ranking system is summarized in Table 6.17, and described in detail in Appendix II to this chapter.

EPA's Criteria Air Pollutants

Apart from the hazardous substances, there are other groups of pollutants in waste management. One class is the EPA criteria air pollutants, which are subject to the National Ambient Air Quality Standards. These are particulates, sulfur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs)[7], and oxides of nitrogen (NO_x). They impair human health, are ozone precursors, and precursors of acid precipitation.

The California Energy Commission, which is planning to internalize the external cost of energy production, has already adopted dollar values for these pollutants.[8] These values are based on averages of some costs of compliance with certain regulations for the South Coast Air Quality Management District. Thus, they do not actually represent the marginal cost of pollution control, but because the Commission adopted them, they can be taken to reflect a value that regulators in California place on emissions of these pollutants.

Greenhouse Gases

Another group of pollutants are the greenhouse gases. These are carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), nitrous oxide (N_2O), oxides of nitrogen (NO_x), and chlorofluorocarbons (CFCs). The most important greenhouse gas is CO_2. While other gases have a higher warming potential per unit, CO_2 dominates the other gases because of its high share among the pool of greenhouse gases which are emitted and which are already present in the atmosphere.

No regulation exists to date that addresses greenhouse gases. However, the ongoing debate about the greenhouse effect and the apparent willingness of nations to subject themselves to protocols does reflect a concern about the issue of global climate change. Some nations have already gone further and have adopted taxes that target the production of greenhouse gases. For example, beginning in 1991, Sweden will tax CO_2 emissions at $40 per ton.[9] There is ample evidence that societies do not attribute a value of zero to the emission of greenhouse gases, implying that greenhouse gases should be included in the valuation of environmental impacts.

In the absence of regulations, one measure that could be used to value greenhouse gases is reforestation, as a means to offset CO_2 production. Trees are a "carbon sink"; they absorb CO_2 and produce oxygen. One could calculate the cost of planting the number of trees required to absorb a certain amount of CO2 and thus obtain a value for the gas. There are no unique values for the cost of reforestation. Much depends on where the trees will be planted. Reforestation in a less developed country with a low wage level will cost less than reforestation in the United States. The costs also depend on the terrain that the trees are planted in, and other circumstances. Clearly, reforestation costs can only be interpreted as a placeholder for a more substantive valuation of CO_2. We will use the value adopted by the California Energy Commission.

Other greenhouse gases can be valued on the basis of the estimate for CO_2. These gases have different impacts in the atmosphere; specifically, they differ in their potentials to produce global warming. While the equivalences of the global warming potentials are not exactly known, there are some estimates as to how these gases relate to each other. The global warming potential of methane, for example, has been estimated to be ten times that of CO_2.[10] The environmental impacts of the greenhouse gases other than CO_2 are calculated as the product of the value for CO_2 and the global warming potential equivalent of the specific gas.

6.4.2 Deriving Prices For Pollutants

The "price" for each pollutant, a dollar amount per pound of residual pollutant emission, is a valuation of the damage that this pound of specific pollutant imposes on society. These prices are applied to actual emissions of materials in the waste management facilities.

Identifying the Relevant Control Cost

The controls which we reviewed include landfill gas treatment, incineration air pollution devices, and leachate remediation for specific landfill sites.[11] For each device, we applied the hazard ranking system to the "bundle" of pollutants that are generated by one ton of waste in a typical facility. We then compared the resulting prices for pollutants. In accordance with the control cost approach, we singled out the highest valuations of residual emissions. However, since we only evaluated a subset of controls, we may have failed to identify the regulations which are the most costly to comply with. This biases our cost estimates downwards.

We found that the control measure with the highest compliance cost was containment of leachate from landfills. We took these costs from the Tellus Institute landfill cost study performed for the California Waste Management Board. In that study, a sample of 27 landfill sites was analyzed to produce estimates for site specific environmental remediation costs. The containment measures analyzed were in compliance with prevailing rules and regulations.[12] In some cases, the remediation measures that were proposed went further than the legislation requires.[13]

We applied these remediation cost estimates to the leachate generated by a portion of the tonnage in place in each landfill. Assuming constant leachate generation per year, per ton of waste, for a particular type of landfill and location, the remediation expenses were attributed to the flow of leachate produced by a specific quantity of waste. Specifically, the remediation cost was divided by the tonnage that would be landfilled over an assumed landfill lifetime of forty years. This is a conservative estimate of the amount of leachate that the control measures would seek to remediate. The highest remediation cost per ton of waste was taken to approximate the **marginal cost** of pollution abatement.[14]

Conclusive research on the relationships between landfill containment measures, rainfall, and the pollutants contained in leachate is not available. Using the best information sources that we have located, we have assumed that the concentration of pollutants per gallon of landfill leachate is always the same, but that the volume of leachate falls as the control technology improves, and that this volume is directly proportional to the amount of rainfall in an area. Because northern California has higher rainfall than in southern California, we have assumed that landfills in the north have more advanced remediation techniques - specifically, a synthetic membrane and five feet of clay liner. Landfills in the south are assumed to meet minimum requirements, which include two feet of clay liner. The result is that landfills with more advanced controls, even when they experience higher rainfall levels, produced much less leachate (and pollutants) than those with lower remediation levels.

Dividing the remediation or containment cost by a specific tonnage of waste, for which a typical flow of leachate was simulated, yields a dollar amount that is the cost of abating a specific "bundle" of pollutants, i.e., a group of pollutants in specific amounts. The hazard ranking system allows this dollar amount to be attributed to specific pollutants by weighing them according to their human health impacts.

The Prices for Individual Pollutants

The amount of remediation cost per ton of waste, arrived at in the fashion explained above, is $46.64. We take this amount to be the expense which society is willing to incur for the abatement of a specific combination of pollutants, which are contained in the leachate that is emitted by one ton of waste. This dollar amount is attributed to the different leachate constituents according to their weighted shares in the leachate (the weights being provided by the hazard ranking system).

The price vector thus obtained does not yet include a price for each pollutant we are interested in, since not all these of pollutants occur in leachate. For the pollutants which are absent from leachate, we formed a price by combining the hazard equivalents of the new pollutant with the hazard equivalent and the price of a leachate pollutant. In other words, we formed prices for the additional pollutants by scaling up known prices, the scaling factor being provided by the hazard ranking system. For criteria air pollutants and greenhouse gases, we used the numbers adopted by the California Energy Commission. The price for methane was obtained as explained above, i.e. by applying the price of carbon dioxide to the global warming potential of methane, measured in CO_2 equivalents. The harm caused by methane, however, is not restricted to its contribution to climatic change. High methane concentrations also carry the risk of explosion. For the time being, we did not take this effect into account.[15]

This complete price vector yielded most of the numbers shown in the tables for the environmental costs of materials. However, it produced one spurious result: Landfill gas emissions initially appeared very expensive, with one ton of waste producing gas emissions in the thousands of dollars. This figure was completely dominated by the share of hydrogen sulfide in the cost, caused by the high price which was assigned to hydrogen sulfide. This high price, in turn, was due to the very high value which the hazard ranking system assigned to hydrogen sulfide, which is a very toxic substance. However, it also disperses quickly into the atmosphere, and is not harmful at low concentrations. The hazard ranking system assigns toxic equivalents on the basis of doses which animals are exposed to. These doses are assumed to be of a certain concentration, which is far higher than that for the hydrogen sulfide gas which escapes the landfill. Thus, we felt that the price for hydrogen sulfide implied by the hazard ranking system is inappropriate. We dealt with this problem by assigning a different price to hydrogen sulfide -- pending further study, we arbitrarily chose the environmental cost per ton of sulfur dioxide as a temporary proxy.

The pollutant price vector which we finally employed is presented in Table 6.18.

6.4.3 Environmental Costs of Materials in Waste Management Facilities

The prices derived in the previous section were applied to the physical emissions of materials in waste management facilities. Specifically, we multiplied the individual pollutant emissions by these prices. Then, for each material, the costs pertaining to specific pollutant emission were summed, to yield the dollar amount of environmental cost which each material causes in each facility.

Interpreting the Results for Environmental Costs

Two aspects of these numbers warrant discussion: The scale of the numbers, i.e. their absolute size, and their variation, i.e. the way they differ across materials and facilities.

The scale. The one single number which drives the absolute size of the environmental cost is the leachate abatement cost per ton of waste. Were this number to increase tenfold, all individual cost items would increase tenfold. The reason for this is that a) the pollutant prices are directly derived from this number, and b) individual material costs are obtained by multiplying the physical emissions times the pollutant prices.

Thus, this number should be closely scrutinized. We recognize that the method by which we obtained this number is not a perfect application of the control cost approach, given that it is uncertain how much leachate is contained by the control measure, what the absolute pollutant concentrations in the leachate are, and how much waste actually produced the leachate.

However, despite these uncertainties we believe we have produced a credible estimate for the amount of pollution that is abated by a specific expenditure. We feel that the estimate is very conservative: the leachate remediation expense was assigned to a very long period -- a whole forty-year site lifetime of leachate flow. Leachate abatement would still be appropriate if there were a flow of leachate only for one or a few years, producing unit costs far higher than our estimates.

The variation. The true merit of our exercise is revealed by the pattern of waste management costs across facilities. Independent of the absolute size of the environmental costs, it is striking to see the relative amounts by which they differ. Consider, for example, the cost of landfilling in a state-of-the-art site versus the cost of incinerating garbage. For all materials, the environmental cost of incineration is greater than the cost of landfilling, and in many cases can be up to eight times greater. This is a function of the absolute amounts emitted per ton of waste as well as of the different pollutant combinations emitted by the two facilities.

We briefly discuss some of our results for specific facilities below.

Environmental Cost of Materials in Facilities

For each waste management option, the environmental cost has several components: one collection component and one or more disposal components. For landfills, the disposal components are emissions from leachate, from gas, and from the treatment of leachate. For incineration, the disposal components are air emissions and pollution from landfilling incinerator ash.

Landfill Disposal. We analyzed two landfill types: "Existing" and "New". The "new" landfill is assumed to be lined and to have a gas collection system in place. The existing landfill is assumed to be unlined and without a gas collection system.

We present tables for the leachate emissions from unlined and lined landfills (Tables 6.19 and 6.20). For the typical unlined landfill, it was assumed that there is some drainage system in place which captures 60 percent of total leachate generation. Since leachate emission numbers for the lined landfill were obtained by scaling down the emissions for the unlined landfill, the scaling factor being the control efficiency, all individual costs appearing in the table for the lined landfill are proportional to the costs in the table for the unlined landfill. Leachate costs for the unlined landfill are about ten times those for the lined landfill. For landfill gas, the situation is more complex; controls differentially capture certain pollutants, so the controlled and uncontrolled landfill gas costs are not strictly proportional.

The per-ton costs for paper and plastic are very similar. About 40 to 45 percent of their cost stems from 2-butanone, with p-cresol and acetone contributing another 25 to 30 percent. The major cost difference arises from arsenic, which is 20% of paper costs and three times higher than in plastics. Glass is cheaper per ton, its cost being about half that of paper and plastic. It contributes the same amounts of heavy metal, but none of the organic pollutants. The default assumption that glass is equally reactive as other waste stream categories, i.e. that it releases substances equally easily as for example paper, may have biased upwards the cost estimate for glass. Textiles, inorganics and inert solids display a similar picture. The contributors to the environmental cost of household hazardous waste are (apart from 2-butanone) cadmium, lead, nickel, zinc, and 2,4-D .

Gas emissions for the existing landfill (without a gas collection system) are presented in Table 6.21.

Incineration. We have not included the environmental cost of the disposal of incinerator ash. This constitutes a serious downward bias in the environmental cost number.

Paper and plastic are again practically identical. Glass has a slightly greater advantage over paper and plastic, compared to the landfill case. Mercury is the largest contributor of all pollutants to environmental costs. Textiles' expensive costs ($ 74) are in large part due to mercury emissions ($ 56) which are $28 per ton higher than any other material aside from household hazardous waste. The highest costs arise from household hazardous wastes, whose costs are almost solely associated with mercury emissions ($ 2,522 of $ 2,574). See Table 6.22 for the results.

Garbage collection. Garbage collection is a cost component which is common to all disposal options (except for recycling, whose collection costs are higher). The environmental costs of garbage collection are mainly the fuel emissions of collection and transport trucks. Thus, individual materials will contribute according to the way they fill up garbage trucks, which is a function of material density. That is, all materials have the same environmental cost per cubic yard. The same characteristic drives the conventional cost of garbage collection. Thus, for the case of garbage collection, the environmental cost patterns of materials are similar to their conventional cost patterns. Not surprisingly, plastics and aluminum cans have the highest cost per ton, since they have the lowest density. The results are presented in Table 6.23.

Recycling. For want of data, we have not included emissions from recycling facilities. Thus, the environmental cost of recycling has been calculated as solely the emissions arising from recycling collection. As argued above, the environmental costs of collection parallel the conventional cost of collection. We have not included an extra table for recycling collection.

The environmental costs for the individual materials are summarized in Table 6.24.

6.5 FULL COST OF MATERIALS IN THE WASTE MANAGEMENT SYSTEM

The full cost of a material in the waste management system is the sum of the conventional and the environmental cost. The individual material costs were formed as weighted averages of the costs in these facilities, with the weights being the shares of the material disposed in different facilities. The full costs are presented in Table 6.25. As noted on the table, household hazardous waste (HHW) is treated differently; it is assigned the cost of separate HHW collection and disposal systems, even though most HHW ends up in landfills at present.

6.6 TABLES

TABLE 6.2 YEARS OF REMAINING PERMITTED LANDFILL CAPACITY (as of July 1, 1991)

County	years of remaining capacity	% of California waste generation	cumulative %
Contra Costa	0.00	2.40	2.40
San Mateo	0.00	1.70	4.10
Tuolumne	0.00	1.10	5.20
Madera	0.00	0.20	5.40
Calaveras	0.00	0.05	5.45
Del Norte	0.00	0.03	5.48
San Benito	1.10	0.05	5.53
Ventura	1.20	1.90	7.43
Sonoma	1.20	1.00	8.43
San Bernadino	1.60	4.10	12.53
Lassen	2.30	0.05	12.58
Kings	2.60	2.40	14.98
Kern	4.90	1.90	16.88
Sierra	5.10	0.01	16.89
Orange	5.50	9.70	26.59
Colusa	5.50	0.05	26.64
Nevada	5.60	0.12	26.76
Plumas	5.90	0.03	26.79
Marin	7.00	0.59	27.38
Napa	7.90	0.49	27.87
El Dorado	8.00	0.11	27.98
San Diego	8.20	8.40	36.38
Humboldt	8.50	0.19	36.57
Glenn	8.70	0.05	36.62
Fresno	9.20	1.50	38.12
Sutter-Yuba	9.80	0.27	38.39
Merced	9.90	0.39	38.78
Santa Barbara	10.50	1.10	39.88
San Luis Obispo	11.20	0.57	40.45
Yolo	11.70	0.78	41.23
Siskiyou	12.50	0.07	41.30
Santa Cruz	13.80	0.48	41.78
Imperial	14.40	0.27	42.05
Stanislaus	14.50	0.99	43.04
Trinity	14.60	0.02	43.06

Source: CIWMB, Local Planning Division, 1989:
Memo: "Years of Remaining Landfill Capacity by County, as of July 1, 1991"

Table 6.3 Garbage collection costs per material

	Residential			Commercial	
	In-Truck Density (lbs/CY)	Comp (%)	Collection Cost ($/ton)	Comp (%)	Collection Cost ($/ton)
Paper:					
OCC	334.62	5.80%	89.48	11.10%	106.06
Mixed Paper	399.23	8.70%	75.00	5.90%	88.89
Newspaper	583.85	8.00%	51.28	4.50%	60.78
High Grade	430.00	1.00%	69.63	1.70%	82.53
Other	368.46	11.80%	81.26	11.60%	96.32
Plastics:					
HDPE	158.08	0.70%	189.41	0.70%	224.50
PET	155.00	0.30%	193.17	0.20%	228.96
Film	271.92	2.00%	110.11	2.90%	130.51
Other	141.92	3.10%	210.97	4.10%	250.05
Glass:					
Recyclable	1,446.15	6.00%	20.70	4.90%	24.54
Non-recyclable	1,446.15	1.00%	20.70	1.00%	24.54
Metals:					
Aluminum	133.08	0.60%	225.00	0.50%	266.68
Other metals	347.11	6.00%	86.26	5.60%	102.24
Yard Waste	700.00	19.40%	42.77	11.20%	50.70
Organics:					
Food Waste	984.62	7.70%	30.41	7.40%	36.04
Organic Non-Compostables	492.31	2.10%	60.82	5.00%	72.09
Textile	244.23	2.20%	122.60	2.10%	145.31
Tires	347.31	2.10%	86.21	1.00%	102.18
Wood Waste	461.54	2.70%	64.87	5.70%	76.89
Other Waste:					
HHW	538.46	0.80%	55.61	1.00%	65.91
Other Waste(inert solids)	682.28	6.90%	43.88	11.20%	52.01
Other Special Waste(other ino	538.46	1.10%	55.61	0.70%	65.91

Table 6.4 Recycling collection costs per material

	Density (lbs/CY)	Residential Collection Cost ($/ton)	Commercial Collection Cost ($/ton)
PAPER			
Corrugated/Kraft	75	214.57	56.35
Mixed paper	150	107.28	84.52
Newspaper	450	35.76	28.17
High Grade	200	80.46	31.70
Other Paper	100	160.93	126.78
PLASTICS			
HDPE	35	459.79	362.23
PET	30	536.42	422.60
Film	25	643.71	507.12
Other	35	459.79	362.23
GLASS			
Recyclable	600	26.82	21.13
Non-recyclable	600	26.82	21.13
METALS			
Aluminum Cans	60	268.21	211.30
Ferrous/Tin/Bi-metal	200	80.46	63.39
Other metals	150	107.28	84.52
White Goods	350	45.98	36.22
YARD WASTE	200		
OTHER ORGANICS			
Food Waste/Compostables	350	45.98	36.22
Misc. Organics	175	91.96	72.45
Textiles/Leather	125	128.74	101.42
Tires/Rubber	350	45.98	36.22
Wood waste	250	64.37	50.71
OTHER WASTE			
Bulky Items	300	53.64	42.26
Other In-Organics	250	64.37	50.71
Inert Solids	250	64.37	50.71
HHW	150	107.28	84.52
Special Waste	150	107.28	84.52

TABLE 6.5 PROJECTED RESIDENTIAL COLLECTION FEES IN SELECTED AREAS, 1990

County	Average Monthly Charge to Customer (1) ($)	Average Monthly Charge to Customer ($/Ton)	Average Cost of Disposal (2) ($/Ton)	Collection $ Transport Cost ($/Ton)
Del Norte	14.47	95.42	11.55	83.87
El Dorado	8.11	53.49	8.64	44.84
Monterey	8.84	58.29	11.55	46.74
Orange County	6.32	41.69	11.55	30.14
Placer City	9.19	60.62	0.69	59.93
San Francisco	9.55	62.97	20.15	42.82
Santa Clara	10.62	70.03	21.01	49.02
Santa Cruz	10.19	67.18	11.55	55.63
Yolo	8.65	57.05	15.65	41.40
Average	9.55	62.97	12.48	50.49

(1) Costs per household based on CoSWMP reports and assume 70 pounds of waste generated per household. All costs adjusted to 1990 levels assuming a 6% inflation rate.
(2) When data was available, county disposal and collection rates were applied based on CoSWMP reports. The statewide average ($11.55 per ton) was used when local data was unavailable.

TABLE 6.6 PROJECTED COMMERCIAL COLLECTION FEES IN SELECTED AREAS, 1990

County	Average Weekly Charge to Customer (1) ($)	Average Weekly Charge to Customer ($/Ton)	Average Cost of Disposal (2) ($/Ton)	Collection & Transport Cost ($/Ton)
Del Norte	30.8	64	11.55	52.58
El Dorado	27.0	56	8.64	47.73
Monterey	18.3	38	11.55	26.70
Orange	54.1	113	11.55	101.20
Placer	36.8	77	0.69	75.96
Santa Clara	35.1	73	21.01	52.11
Yolo	30.1	63	15.65	47.19
Average	33.17	69.16	11.52	57.64

TABLE 6.7 NORTHERN CALIFORNIA LANDFILL ASSUMPTIONS and LEACHATE GENERATION

TPD	1,000
Acres	182.9
Square Feet	7,967,124
Depth (feet)	80
Cap	
1. 12" loam	
2. 36" clay	
3. 24" coarse sand	
Liner	
1. 60" clay w/synthetic membrane	
Years Open	25
Post-Closure Period (yrs)	30
Cells, number	5
time period cells are open (yrs)	5
Cell Size (sq ft)	1,593,425
Cell Depth, average	40
Active Landfill Leachate Generation	
no liner (gallons)	8,340,032
liner (gallons)	22,240
Closed Landfill Leachate Generation	
no liner (gallons)	4,817,502
liner (gallons)	0
Total Waste Landfilled over 25 yrs (tons)	7,280,000
Percent of CA's Waste	32.40%
Annual Precipitation for Bay Area (inches/yr)	26.44

Sources: U.S. EPA, "HELP Model," 1984; and Tellus Institute.

TABLE 6.7 SOUTHERN CALIFORNIA LANDFILL ASSUMPTIONS and LEACHATE GENERATION (con't)

TPD	1,000
Acres	115.4
Square Feet	5,026,824
Depth (feet)	130
Cap	
1. 12" loam	
2. 12" clay	
3. 24" coarse sand	
Liner	
1. 24" clay	
Years Open	25
Post-Closure Period (yrs)	30
Cells, number	5
time period cells are open (yrs)	5
Cell Size (sq ft)	1,005,365
Cell Depth, average (ft)	65
Active Landfill Leachate Generation	
no liner (gallons)	1,642,209
liner (gallons)	1,259,888
Closed Landfill Leachate Generation	
no liner (gallons)	3,120,019
liner (gallons)	0
Total Waste Landfilled over 25 yrs (tons)	7,280,000
Percent of CA's Waste	67.60%
Annual Precipitation for Los Angeles Area (inches/yr)	13.52

Sources: U.S. EPA, "HELP Model," 1984; and Tellus Institute.

Table 6.8 Generic California Landfill Costs

REPORT FOR LANDFILL Southern CA

TOTAL DELIVERED WEIGHT	7,280,000 TONS
TOTAL DELIVERED VOLUME	14,560,000 CUBIC YARDS
TOTAL ACRES	155.77
ACRES FILLED	115.39
VOLUME IN LANDFILL	18,720,000 CUBIC YARDS
LIFETIME REMAINING	26 YEARS
TOTAL CAPITAL COSTS --- FOR Southern CA	
SITE ASSESSMENT	934,600
LICENSE	54,500
LANDCOST	934,623
SITE PREPARATION	467,311
EXCAVATION	3,230,794
SURFACE WATER CONTROL	498,466
SCALE HOUSE-ADMIN BUILDING	750,000
LINER COSTS	3,350,795
LEACHATE CONTROL	1,731,121
GAS COLLECTION/VENTING	2,423,096
MONITORING WELLS	415,388
OTHER CAPITAL COSTS	10,904

ENGINEERING	251,627
CONTINGENCY	222,024

TOTAL CAPITAL COSTS	15,275,248
TOTAL CLOSURE COSTS --- FOR Southern CA	
LANDSCAPING	545,197
SURFACE WATER CONTROL	623,082
FINAL CAP	1,675,398
OTHER CLOSURE COSTS	1,557,704

TOTAL CLOSURE COSTS	4,401,381
ANNUAL POST-CLOSURE COSTS (IN CLOSURE YEAR $) --- FOR Southern CA	
WATER MONITORING	46,154
GAS MONITORING	923
OTHER MONITORING	115,386
MAINTENANCE	31,154
OTHER POST-CLOSURE COSTS	3,894
LEACHATE TREATMENT - AVERAGE	2,299,075

TOTAL ANNUAL POST-CLOSURE COSTS	2,496,586
AVERAGE REVENUE POST-CLOSURE GAS	2,989
TOTAL FIXED COSTS	22,173,214
NET COSTS	22,170,226

Table 6.8 Generic California Landfill Costs (cont.)

SOUTHERN CALIFORNIA

YEARLY DELIVERED VOLUME: CUBIC YARDS	560,000
YEARLY COVER: CUBIC YARDS	160,000
CAPITAL COSTS BY REPORT YEAR	
SITE ASSESSMENT	102,020
LICENSE	5,949
LANDCOST	102,023
SITE PREPARATION	51,011
EXCAVATION	352,670
SURFACE WATER CONTROL	54,412
SCALE HOUSE-ADMIN BUILDING	81,869
LINER COSTS	365,770
LEACHATE CONTROL	188,968
GAS COLLECTION/VENTING	264,503
MONITORING WELLS	45,343
OTHER CAPITAL COSTS	1,190
ENGINEERING	27,467
CONTINGENCY	24,236
TOTAL CAPITAL COSTS	1,667,431
CAPITAL COST PER TON	5.96
CLOSURE COSTS BY REPORTYEAR	1995
LANDSCAPING	4,993
SURFACE WATER CONTROL	5,707
FINAL CAP	15,345
OTHER CLOSURE COSTS	14,267
TOTAL CLOSURE COSTS	40,312
CLOSURE COST PER TON	0.14
POST-CLOSURE COSTS BY REPORTYEAR	1995
WATER MONITORING	3,985
GAS MONITORING	80
OTHER MONITORING	9,963
MAINTENANCE	2,690
LEACHATE TREATMENT	211,078
OTHER POST-CLOSURE COSTS	336
TOTAL POST-CLOSURE COSTS	17,053
REVENUE FROM POST-CLOSURE GAS	284
POST CLOSURE COST PER TON	0.06
OPERATING AND MAINTENANCE COSTS	1995
HUNDREDS OF TONS PER DAY	10
VOLUME REMAINING IN LANDFILL CY's	18,160,000
TOTAL YEARLY SALARIES	750,000
MAINTENANCE	420,000
YEARLY EQUIPMENT COSTS	560,000
YEARLY COVER	560,000
UTILITIES	56,000
INSURANCE	56,000
LEACHATE TREATMENT	2,554
MONITORING	1,287
OTHER	666
TOTAL	2,506,506
REVENUES FROM GAS	0
NET OPERATING AND MAINTENANCE COST PER T	8.95
COST PER TON	15.11

Table 6.8 Generic California Landfill Costs (cont.)

REPORT FOR LANDFILL Northern CA

TOTAL DELIVERED WEIGHT	7,280,000	TONS
TOTAL DELIVERED VOLUME	14,560,000	CUBIC YARDS
TOTAL ACRES	245.95	
ACRES FILLED	182.19	
VOLUME IN LANDFILL	18,720,000	CUBIC YARDS
LIFETIME REMAINING	26	YEARS

TOTAL CAPITAL COSTS --- FOR Northern CA

SITE ASSESSMENT	934,600
LICENSE	54,500
LANDCOST	1,890,700
SITE PREPARATION	945,400
EXCAVATION	9,764,600
SURFACE WATER CONTROL	1,008,400
SCALE HOUSE-ADMIN BUILDING	750,000
LINER COSTS	24,403,200
LEACHATE CONTROL	3,123,100
GAS COLLECTION/VENTING	4,411,700
MONITORING WELLS	1,134,400
OTHER CAPITAL COSTS	22,100
ENGINEERING	823,526
CONTINGENCY	726,641
TOTAL CAPITAL COSTS	49,992,868

TOTAL CLOSURE COSTS --- FOR Northern CA

LANDSCAPING	1,102,933
SURFACE WATER CONTROL	1,260,495
FINAL CAP	9,151,191
OTHER CLOSURE COSTS	3,151,237
TOTAL CLOSURE COSTS	14,665,856

ANNUAL POST-CLOSURE COSTS (IN CLOSURE YEAR $) --- FOR Northern CA

WATER MONITORING	126,050
GAS MONITORING	2,521
OTHER MONITORING	210,082
MAINTENANCE	63,025
OTHER POST-CLOSURE COSTS	7,878
LEACHATE TREATMENT - AVERAGE	3,426,922
TOTAL ANNUAL POST-CLOSURE COSTS	3,836,477
AVERAGE REVENUE POST-CLOSURE GAS	2,989
TOTAL FIXED COSTS	68,495,200
NET COSTS	68,492,208

Table 6.8 Generic California Landfill Costs (cont.)

NORTHERN CALIFORNIA

YEARLY DELIVERED VOLUME: CUBIC YARDS	560,000
YEARLY COVER: CUBIC YARDS	160,000
CAPITAL COSTS BY REPORT YEAR	
SITE ASSESSMENT	102,020
LICENSE	5,949
LANDCOST	206,387
SITE PREPARATION	103,199
EXCAVATION	1,065,894
SURFACE WATER CONTROL	110,076
SCALE HOUSE-ADMIN BUILDING	81,869
LINER COSTS	2,663,830
LEACHATE CONTROL	340,915
GAS COLLECTION/VENTING	481,577
MONITORING WELLS	123,830
OTHER CAPITAL COSTS	2,412
ENGINEERING	89,895
CONTINGENCY	79,319
TOTAL CAPITAL COSTS	5,457,174
CAPITAL COST PER TON	19.49
CLOSURE COSTS BY REPORTYEAR	1995
LANDSCAPING	10,102
SURFACE WATER CONTROL	11,545
FINAL CAP	83,816
OTHER CLOSURE COSTS	28,862
TOTAL CLOSURE COSTS	134,325
CLOSURE COST PER TON	0.48
POST-CLOSURE COSTS BY REPORTYEAR	1995
WATER MONITORING	10,883
GAS MONITORING	218
OTHER MONITORING	18,139
MAINTENANCE	5,442
LEACHATE TREATMENT	314,625
OTHER POST-CLOSURE COSTS	680
TOTAL POST-CLOSURE COSTS	35,362
REVENUE FROM POST-CLOSURE GAS	284
POST CLOSURE COST PER TON	0.13
OPERATING AND MAINTENANCE COSTS	1995
HUNDREDS OF TONS PER DAY	25
VOLUME REMAINING IN LANDFILL CY's	18,160,000
TOTAL YEARLY SALARIES	750,000
MAINTENANCE	420,000
YEARLY EQUIPMENT COSTS	560,000
YEARLY COVER	560,000
UTILITIES	56,000
INSURANCE	56,000
LEACHATE TREATMENT	9,475
MONITORING	2,698
OTHER	1,051
TOTAL	2,415,224
REVENUES FROM GAS	0
NET OPERATING AND MAINTENANCE COST PER T	8.63
COST PER TON	28.73

Table 6.9 Landfill Costs by material type

	In-Fill Density (lb/CY)	Existing Landfill Cost ($/ton)	New North Landfill Cost ($/ton)	New South Landfill Cost ($/ton)
Paper:				
OCC	750	17.42	34.48	18.13
Mixed Paper	798	16.37	32.40	17.04
Newspaper	798	16.37	32.40	17.04
High Grade	798	16.37	32.40	17.04
Other	798	16.37	32.40	17.04
Plastics:				
HDPE	355	36.81	72.84	38.31
PET	355	36.81	72.84	38.31
Film	667	19.59	38.77	20.39
Other	313	41.75	82.61	43.45
Glass:				
Recyclable	2,800	4.67	9.23	4.86
Non-recyclable	2,800	4.67	9.23	4.86
Metals:				
Aluminum	250	52.27	103.43	54.40
Other metals	557	23.46	46.42	24.41
Yard Waste	1,500	8.71	17.24	9.07
Organics:				
Food Waste	2,000	6.53	12.93	6.80
Organic Non-Compostables	1,000	13.07	25.86	13.60
Textile	435	30.04	59.44	31.26
Tires	343	38.10	75.38	39.65
Wood Waste	800	16.33	32.32	17.00
Other Waste:				
HHW	800	16.33	32.32	17.00
Other Waste(inert solids)	811	16.12	31.89	16.77
Other Special Waste(other in	950	13.75	27.22	14.31
Average Cost per Ton		13.07	28.73	15.11

Table 6.10 California Incinerator Costs

	Capacity (tons/day)	Cost per Ton (1) ($/ton)	Tipping Fee ($/ton)
Existing (2)			
Commerce	380	86.00	16.00
SERFF	1380	49.09	16.00
Stanislaus	800	56.28	20.00
Total	2560		
Planned			
San Marcos	1600	51.63	20.00
Total	4160		
Average (weighted)		54.82	

(1) Includes Debt Service
(2) Does not include Lassen facility, which is currently shutdown and not anticipated to reopen in near future

Source: "1989 Resource Recovery Yearbook", Government Advisory Associates. October 1990.

Table 6.11 Incinerator Costs by Material

	BTU Value	% Ash Content	Cost ($/ton)
Paper:			
OCC	7800	4.00	25.53
Mixed Paper	6800	10.00	35.00
Newspaper	7800	1.50	25.15
High Grade	7000	6.00	32.69
Other	6200	8.00	39.84
Plastics:			
HDPE	11650	10.00	-6.57
PET	6100	10.00	41.00
Film	11600	10.00	-6.14
Other	16000	10.00	-43.86
Glass:			
Recyclable	100	99.00	105.78
Non-recyclable	100	99.00	105.78
Metals:			
Aluminum	100	99.00	105.78
Other metals	100	99.00	105.78
Yard Waste	2000	4.00	75.24
Organics:			
Food Waste	1000	6.00	84.11
Organic Non-Compostables	13800	6.50	-25.53
Textile	6700	4.00	34.96
Tires	7000	6.00	32.69
Wood Waste	4000	10.00	59.00
Other Waste:			
HHW	2000	35.00	79.89
Other Waste(Inert solids)	1100	74.25	93.49
Other Special Waste(other ino	4000	25.00	61.25

Heat Rate (BTU/kwh) =	14000	
Electric Revenue ($/kwh) =	0.06	
Residue Disposal Cost($/ton) =	15	
Calculation of Average Production Cost =		91.79
Average BTU value =	4750	
Average Residue Content =	25	

Table 6.12 Materials Recovery Facility - Capital and Operating Costs

MRF Capital Costs

Cost Item	
Design, Engineering, etc.	700,000
Building and Site	2,900,000
Mobile Equipment	250,000
Separation Equipment	
Magnetic Separators	40,000
Air Knife/Separator	35,000
Glass Sort Conveyor	150,000
Paper Conveyor	75,000
Conveyors	100,000
Processing Equipment	
Glass Crushers	150,000
Ferrous Flattener/Shredder	70,000
Aluminum Blower	35,000
Horizontal Baler (paper)	250,000
Perforator/Baler (Plastic)	70,000
Conveyors	200,000
Total	5,025,000

Operating Costs

Utilities	80,000
Insurance	35,000
Maintenance	100,000
Supplies	85,000
Residue Disposal	285,870
$/ton	50
% residue	9.77%
Equipment Replacement (%)	5%
Cost	71,250

Labor	Number	Salary/ Employ	Total
Management	2.00	35,000	70,000
Plastics	4.00	23,000	92,000
Glass	4.50	23,000	103,500
Aluminum	1.50	23,000	34,500
Newspaper	2.50	23,000	57,500
Corrugated	1.50	23,000	34,500
Ferrous	1.50	23,000	34,500
Other	7.50	25,000	187,500
Total	25.00	24,560 (average)	614,000

Apportionment of "Building and Site" Costs	% of total building
Plastic	10.00%
Glass	15.00%
Aluminum	6.00%
Ferrous	8.00%
Newspaper	30.00%
Corrugated	5.00%

Apportionment of "Conveyor" Costs	% of total conveyors
Plastic	26%
Glass	31%
Aluminum	18%
Ferrous	8%
General (remainder)	17%

Apportionment of Paper Conveyor Costs	
Newspaper	80%
Corrugated	20%

Apportionment of Residue Costs	% of Specific Mater	% of all Material
Plastic	14%	0.75%
Glass	9%	2.00%
Aluminum	7%	0.16%
Newpaper	10%	5.51%
Corrugated	10%	0.76%
Ferrous	8%	0.60%
General		
Total		

Apportionment of Supplies Costs	
Plastic	10%
Newspaper	20%
Corrugated	5%
General	65%

Table 6.12 Material Recycling Facility - Financial and Throughput Assumptions

Financing Assumptions	
Interest	8.50%
Equipment Lifetime	7
Facility Lifetime	20

		Revenue ($/ton)	Density (lb/CY)	Annual Volume (CY)
Days Operating per Year	260			
Daily Capacity (TPD)	225			
Daily Throughput				
Plastic	12	125	35	178,286
Glass	50	55	650	40,000
Aluminum	5	1,000	60	43,333
Newspaper	124	15	550	117,236
Corrugated	17	40	150	58,933
Ferrous	17	45	150	58,933
Total	225			496,722

Cost Analysis	
Total Operating Cost ($)	1,271,120
Annual Capital Cost ($)	658,817
Total Annual Cost ($)	1,929,937
cost per ton	33
Annual Revenue ($)	2,972,398
Net Annual Cost ($)	-1,042,461
cost per ton	-18

Table 6.13 Recycling Depot - Capital and Operating Costs

MRF Capital Costs	
Cost Item	
Design, Engineering, etc.	200,000
Building and Site	1,800,000
Mobile Equipment	150,000
Separation Equipment	
Magnetic Separators	40,000
Air Knife/Separator	0
Glass Sort Conveyor	100,000
Paper Conveyor	25,000
Conveyors	50,000
Processing Equipment	
Glass Crushers	90,000
Ferrous Flattener/Shredder	40,000
Aluminum Blower	25,000
Horizontal Baler (paper)	250,000
Perforator/Baler (Plastic)	70,000
Conveyors	150,000
Total	2,990,000

Operating Costs	
Utilities	70,000
Insurance	35,000
Maintenance	90,000
Supplies	65,000
Residue Disposal	142,935
$/ton	50
% residue	10%
Equipment Replacement	49,500
% of Equip Cost	5%

Labor	Number	Salary/ Employ	Total
Management	2.00	35,000	70,000
Plastics	3.50	23,000	80,500
Glass	4.50	23,000	103,500
Aluminum	1.50	23,000	34,500
Newspaper	2.50	23,000	57,500
Corrugated	1.50	23,000	34,500
Ferrous	1.50	23,000	34,500
Other	7.00	25,000	175,000
Total	24.00	24,583 (average)	590,000

Apportionment of 'Building and Site' Costs	% of total building
Plastic	12.50%
Glass	12.50%
Aluminum	8.00%
Ferrous	8.00%
Newspaper	30.00%
Corrugated	5.00%

Apportionment of 'Conveyors' Costs	% of total conveyors
Plastic	26%
Glass	31%
Aluminum	18%
Ferrous	8%
General	17%

Apportionment of Paper Conveyor Costs	
Newspaper	80%
Corrugated	20%

Apportionment of Residue Costs	% of Specific Material	% of all Material
Plastic	14%	0.75%
Glass	9%	2.00%
Aluminum	7%	0.16%
Newpaper	10%	5.51%
Corrugated	10%	0.76%
Ferrous	8%	0.60%
Total		

Apportionment of Supplies Costs	
Plastic	10%
Newspaper	20%
Corrugated	5%
General	65%

Table 6.13 Recycling Depot - Financial and Throughput Assumptions

Financing Assumption					
Interest	8.50%				
Equipment Lifetime	7				
Facility Lifetime	20				
Days Operating per Year		260			Annual
Daily Capacity (TPD)		112.50	Revenue	Density	Volume
Daily Throughput			($/ton)	(lb/CY)	(CY)
Plastic		6.00	120	35	89,143
Glass		25.00	50	650	20,000
Aluminum		2.50	1,000	60	21,667
Newspaper		62.00	10	550	58,618
Corrugated		8.50	35	150	29,467
Ferrous		8.50	40	150	29,467
Total		112.50			248,361
Cost Analysis					
Total Operating Costs ($)		1,042,435			
Annual Capital Cost ($)		404,757			
Total Annual Cost ($)		1,447,192			
cost per ton		49			
Annual Revenue ($)		1,489,150			
Net Annual Cost ($)		-41,958			
cost per ton		-1			

Table 6.14 Multiple Separation Facility - Financial and Throughput Assumptions

Financing Assumption	
Interest	8.50%
Equipment Lifetime	7
Facility Lifetime	20

		Revenue ($/ton)	Density (lb/CY)	Annual Volume (CY)
Days Operating per Year	260			
Daily Capacity (TPD)	112.50			
Daily Throughput				
Plastic	5.00	120	35	74,286
Glass	20.00	50	650	16,000
Aluminum	2.00	1,000	60	17,333
Newspaper	49.40	10	550	46,705
Corrugated	6.80	35	150	23,573
Ferrous	6.80	40	150	23,573
Total	90.00			201,471

Cost Analysis	
Total Operating Costs ($)	854,315
Annual Capital Cost ($)	306,809
Total Annual Cost ($)	1,161,124
cost per ton	50
Annual Revenue ($)	1,197,040
Net Annual Cost ($)	-35,916
cost per ton	-2

Table 6.14 Multiple Separated Facility - Capital and Operating Costs

Cost Item	
Design, Engineering, etc.	
Building and Site	200,000
Mobile Equipment	1,400,000
Separation Equipment	150,000
Magnetic Separators	
Air Knife/Separator	20,000
Glass Sort Conveyor	0
Paper Conveyor	75,000
Conveyors	0
Processing Equipment	50,000
Glass Crushers	
Ferrous Flattener/Shredder	75,000
Aluminum Blower	25,000
Horizontal Baler (paper)	20,000
Perforator/Baler (Plastic)	200,000
Conveyors	30,000
	60,000
Total	
	2,305,000

Operating Costs	
Utilities	55,000
Insurance	25,000
Maintenance	75,000
Supplies	50,000
Residue Disposal	143,065
$/ton	50
% residue	10%
Equipment Replacement	35,250
% of Equip Cost	5%

Labor	Number	Salary/ Employ	Total
Management	2.00	35,000	70,000
Plastics	3.00	23,000	69,000
Glass	4.00	23,000	92,000
Aluminum	1.00	23,000	23,000
Newspaper	2.00	23,000	46,000
Corrugated	1.00	23,000	23,000
Ferrous	1.00	23,000	23,000
Other	5.00	25,000	125,000
Total	19.00	24,789 (average)	471,000

Apportionment of 'Building and Site' Costs	% of total building
Plastic	13.50%
Glass	11.00%
Aluminum	6.50%
Ferrous	6.50%
Newspaper	30.00%
Corrugated	5.00%

Apportionment of 'Conveyor' Costs	% of total conveyors
Plastic	26%
Glass	31%
Aluminum	18%
Ferrous	8%
General	17%

Apportionment of 'Paper Conveyor' Costs	
Newspaper	80%
Corrugated	20%

Apportioment of Residue Costs	% of Specific Material	% of all Material
Plastic	14%	0.78%
Glass	9%	2.00%
Aluminum	7%	0.16%
Newpaper	10%	5.49%
Corrugated	10%	0.76%
Ferrous	8%	0.60%
Total		

Apportionment of Supplies Costs	
Plastic	10%
Newspaper	20%
Corrugated	5%
General	65%

Table 6.15 Residential Recycling Processing Costs

	Processing costs per ton (incl. revenues)				
	MRF	Depot	Multiple Separated	Dropoff	Averaged Cost
Plastic	-6.84	46.12	40.84	71.43	32.71
Glass	-12.23	6.37	9.73	-30.77	-3.94
Aluminum	-822.48	-824.92	-853.11	-850.00	-835.00
Newspaper	6.77	17.74	19.54	10.00	13.74
Corrugated	-1.28	20.64	17.41	15.00	12.41
Ferrous	-1.21	22.29	12.62	10.00	10.98
% of Total Recyclables	30%	30%	25%	15%	

Table 6.16 Commercial Recyclables Processing Costs

	Source Separated & Mixed			
	Revenues			Net
	High ($/ton)	Low ($/ton)	Average ($/ton)	Cost ($/ton)
Paper:				
OCC	80.00	20.00	45.00	-30.00
Mixed Paper	0.00	20.00	5.00	10.00
Newspaper	25.00	-10.00	5.00	10.00
High Grade	180.00	60.00	80.00	-60.00
Other				
Plastics:				
HDPE	200.00	60.00	125.00	30.00
PET	160.00	20.00	105.00	35.00
Film	150.00	0.00	75.00	50.00
Other	100.00	0.00	65.00	50.00
Glass:				
Recyclable	70.00	30.00	40.00	-20.00
Non-recyclable				
Metals:				
Aluminum	1,600.00	800.00	1,000.00	-935.00
Other metals	140.00	0.00	35.00	-20.00
Yard Waste				
Organics:				
Food Waste				
Non-Compostables				
Textile				50.00
Tires				50.00
Wood Waste	48.00	0.00	20.00	20.00
Other Waste:				
HHW				250.00
Other Waste	12.00	0.00	4.00	10.00
Other Special Waste				
TOTAL				

* includes collection

Table 6.17 Hazard Ranking System

	Carcinogens Perchloroethylene Equivalents	Noncarcinogens Xylene Equivalents	Combined Ranking [1]
INORGANIC POLLUTANTS			
Antimony		5,000	5,000
Arsenic	15,152		19,697
Barium		40	40
Beryllium	2,545		3,309
Cadmium	1,848		2,403
Chromium (total)	12,424		16,152
Copper		40	40
Lead		1,429	1,429
Manganese		10	10
Mercury		6,667	6,667
Nickel	255		331
Selenium		667	667
Tin		3	3
Vanadium		286	286
Zinc		10	10
ORGANIC POLLUTANTS			
Acetone		20	20
Benzene	9		11
2-Butanone (methyl ethyl ketone)		40	40
Carbon tetrachloride	39		51
Chloroform	25		32
p-Cresol		40	40
2,4-D		200	200
4,4-DDT	103		134
1,1-Dichloroethane		20	20
1,2-Dichloroethane	28		36
trans-1,2-Dichloroethylene		100	100
Diethyl phthalate		3	3
Endrin		6,667	6,667
Endosulfane sulfate		40,000	40,000
Ethyl benzene		20	20
Ethylene dibromide	230		299
bis(2-Ethylhexyl)phthalate	4		6
2-Hexanone (methyl butyl ketone)			
Lindane	394		512
4-Methyl-2-pentanone (methyl isobutyl ketone)		40	40
Methylene chloride	4		6
PAHs (total)	3,485		4,530
PCDD/PCDF (total)	45,454,545		59,090,909
Perchloroethylene	1		1
Phenol		3	3
Toluene		7	7
1,1,1-Trichloroethane		22	22
Trichloroethylene	5		7
1,2,3-Trichloropropane		333	333

Table 6.17 Hazard Ranking System (continued)

	Carcinogens Perchloroethylene Equivalents	Noncarcinogens Xylene Equivalents	Combined Ranking [1]
ORGANIC POLLUTANTS (contd.)			
Vinyl chloride	89		116
Xylenes		1	1
MISCELLANEOUS			
Aldehydes		14	14
Carbon dioxide			
Hydrogen chloride			
Hydrogen fluoride			
Methane			
Sulfides			

Notes:

[1] The Combined Ranking assumes that 1 *Perchloroethylene* Equivalent = 1.3 * Xylene Equivalent.

Aluminum, magnesium, and iron have been dropped from list
No information is available for 2-Hexanone.
Assume hydrogen chloride, hydrogen fluoride, and sulfides are the same ranking as SO2.

Table 6.18 Pollutant Prices

POLLUTANTS	Pollutant Price
CRITERIA AIR POLLUTANTS	
CO	$0.42
NOx	$3.63
Particulates	$5.85
SOx	$5.87
VOCs	$2.50
INORGANIC POLLUTANTS	
Antimony	$1,156,844.59
Arsenic	$4,557,266.55
Barium	$9,254.76
Beryllium	$765,620.78
Cadmium	$555,986.52
Chromium (total)	$3,736,958.57
Copper	$9,254.76
Lead	$330,626.18
Manganese	$2,313.69
Mercury	$1,542,536.57
Nickel	$76,562.08
Selenium	$154,323.07
Tin	$694.11
Vanadium	$66,171.51
Zinc	$2,313.69
ORGANIC POLLUTANTS	
Acetone	$4,627.38
Benzene	$2,643.21
2-Butanone (methyl ethyl ketone)	$9,254.76
Carbon tetrachloride	$11,848.89
Chloroform	$7,382.77
p-Cresol	$9,254.76
2,4-D	$46,273.78
4,4-DDT	$30,989.41
1,1-Dichloroethane	$4,627.38
1,2-Dichloroethane	$8,294.23
trans-1,2-Dichloroethylene	$23,136.89
Diethyl phthalate	$694.11
Endrin	$1,542,536.57
Endosulfane sulfate	$9,254,756.69

Table 6.18 Pollutant Prices (continued)

POLLUTANTS	Pollutant Price
ORGANIC POLLUTANTS (contd.)	
Ethyl benzene	$4,627.38
Ethylene dibromide	$69,270.45
bis(2-Ethylhexyl)phthalate	$1,276.03
2-Hexanone (methyl butyl ketone)	$0.00
Lindane	$118,488.93
4-Methyl-2-pentanone (methyl isobutyl ketone)	$9,254.76
Methylene chloride	$1,276.03
PAHs (total)	$1,048,171.31
PCDD/PCDF (total)	$13,671,799,655.70
Perchloroethylene	$300.78
Phenol	$694.11
Toluene	$1,619.58
1,1,1-Trichloroethane	$5,090.12
Trichloroethylene	$1,549.47
1,1,3-Trichloropropane	$77,045.85
Vinyl chloride	$26,887.87
Xylenes	$231.37
MISCELLANEOUS	
Aldehydes	$3,155.03
Carbon dioxide	$0.00
Hydrogen chloride	$5.87
Hydrogen fluoride	$5.87
Methane	$0.04
Sulfides	$5.87

Notes:

[1] Criteria air pollutant prices are the values adopted by the CEC.

[2] The price of carbon dioxide is actually $0.0035.

[3] The price of sulfides is set equal to the price of SOx.

Table 6.19 UNLINED LANDFILL: Pollutant Emissions $ per Ton of Material

POLLUTANTS	Pollutant Price	PAPER	PLASTICS	GLASS	METALS	YARD	WOOD
		(entries are the physical emission of pollutant * pollutant price)					
INORGANIC POLLUTANTS							
Arsenic	$4,557,266.55	$9.87	$3.28	$3.30	$21.34	$34.46	$2.17
Barium	$9,254.76	$0.89	$1.03	$3.82	$1.04	$2.50	$0.92
Cadmium	$555,986.52	$0.16	$0.36	$0.06	$0.05	$0.25	$0.03
Chromium (total)	$3,736,958.57	$1.78	$1.56	$11.78	$73.76	$6.99	$0.68
Lead	$330,626.18	$0.25	$0.26	$2.27	$8.33	$2.03	$0.29
Manganese	$2,313.69	$1.97	$1.97	$1.97	$1.97	$1.97	$1.97
Nickel	$76,562.08	$1.15	$1.15	$1.15	$1.15	$1.15	$1.15
Selenium	$154,323.07	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04
Vanadium	$66,171.51	$0.29	$0.29	$0.29	$0.29	$0.29	$0.29
Zinc	$2,313.69	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26
ORGANIC POLLUTANTS							
Acetone	$4,627.38	$5.31	$5.31				
2-Butanone (methyl ethyl ketone)	$9,254.76	$19.21	$19.21				
p-Cresol	$9,254.76	$7.16	$7.16				
2,4-D	$46,273.78						
4,4-DDT	$30,989.41						
1,1-Dichloroethane	$4,627.38						
trans-1,2-Dichloroethylene	$23,136.89	$0.03	$0.03				
Diethyl phthalate	$694.11	$0.00	$0.00				
Endosulfane sulfate	$9,254,756.69						
bis(2-Ethylhexyl)phthalate	$1,276.03	$0.00	$0.00				
2-Hexanone							
Lindane	$118,488.93						
4-Methyl-2-pentanone	$9,254.76	$0.40	$0.40				
Methylene chloride	$1,276.03	$0.08	$0.08				
Phenol	$694.11	$0.14	$0.14			$0.14	
Toluene	$1,619.58	$0.29	$0.29				
1,2,3-Trichloropropane	$77,045.85	$0.74	$0.74				
TOTAL		$50.01	$43.56	$24.94	$108.24	$50.07	$7.80

Note: Blank entries imply zero values, $0.00 entries imply positive values which are rounded to zero.

TABLE 6.19 (contd.) UNLINED LANDFILLS: Pollutant Emissions $ per Ton of Material

POLLUTANTS	FOOD	TIRES/ RUBBER	TEXTILES	MISC. ORGANICS	OTHER WASTE	HHW
INORGANIC POLLUTANTS						
Arsenic	$34.46	$2.71	$3.82		$2.21	
Barium	$2.50	$0.62	$3.34		$4.67	
Cadmium	$0.25	$0.12	$0.14		$0.06	$16.53
Chromium (total)	$6.99	$45.93	$39.19		$4.13	
Lead	$2.03	$1.95	$0.19		$1.86	$19.00
Manganese	$1.97	$1.97	$1.97	$1.97	$1.97	$1.97
Nickel	$1.15	$1.15	$1.15	$1.15	$1.15	$27.03
Selenium	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04
Vanadium	$0.29	$0.29	$0.29	$0.29	$0.29	$0.29
Zinc	$0.26	$0.26	$0.26	$0.26	$0.26	$19.73
ORGANIC POLLUTANTS						
Acetone		$5.31		$5.31		$5.31
2-Butanone (methyl ethyl ketone)		$19.21		$19.21		$19.21
p-Cresol		$7.16		$7.16		$7.16
2,4-D						$17.96
4,4-DDT						$0.06
1,1-Dichloroethane						$0.03
trans-1,2-Dichloroethylene		$0.03		$0.03		$0.03
Diethyl phthalate		$0.00		$0.00		$0.00
Endosulfane sulfate						$4.81
bis(2-Ethylhexyl)phthalate		$0.00		$0.00		$0.00
2-Hexanone						
Lindane						$0.01
4-Methyl-2-pentanone		$0.40		$0.40		$0.40
Methylene chloride		$0.08		$0.08		$0.08
Phenol	$0.14	$0.14		$0.14		$0.14
Toluene		$0.29		$0.29		$0.29
1,2,3-Trichloropropane		$0.74		$0.74		$0.74
TOTAL	$50.07	$88.40	$50.40	$37.07	$16.63	$140.82

Table 6.20 LINED LANDFILLS: Pollutant Emissions $ per Ton of Material

POLLUTANTS	Pollutant Price	PAPER	PLASTICS	GLASS	METALS	YARD	WOOD	FOOD
		(entries are the physical emission of pollutant * pollutant price)						
INORGANIC POLLUTANTS								
Arsenic	$4,557,266.55	$0.88	$0.29	$0.29	$1.89	$3.06	$0.19	$3.06
Barium	$9,254.76	$0.08	$0.09	$0.34	$0.09	$0.22	$0.08	$0.22
Cadmium	$555,986.52	$0.01	$0.03	$0.00	$0.00	$0.02	$0.00	$0.02
Chromium (total)	$3,736,958.57	$0.16	$0.14	$1.04	$6.54	$0.62	$0.06	$0.62
Lead	$330,626.18	$0.02	$0.02	$0.20	$0.74	$0.18	$0.03	$0.18
Manganese	$2,313.69	$0.17	$0.17	$0.17	$0.17	$0.17	$0.17	$0.17
Nickel	$76,562.08	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10
Selenium	$154,323.07	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Vanadium	$66,171.51	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03
Zinc	$2,313.69	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
ORGANIC POLLUTANTS								
Acetone	$4,627.38	$0.47	$0.47					
Benzene	$2,643.21							
2-Butanone	$9,254.76	$1.70	$1.70					
p-Cresol	$9,254.76	$0.64	$0.64					
2,4-D	$46,273.78							
4,4-DDT	$30,989.41							
1,1-Dichloroethane	$4,627.38							
trans-1,2-Dichloroethylene	$23,136.89	$0.00	$0.00					
Diethyl phthalate	$694.11	$0.00	$0.00					
Endosulfane sulfate	$9,254,756.69							
bis(2-Ethylhexyl)phthalate	$1,276.03	$0.00	$0.00					
2-Hexanone								
Lindane	$118,488.93							
4-Methyl-2-pentanone	$9,254.76	$0.04	$0.04					
Methylene chloride	$1,276.03	$0.01	$0.01					
Phenol	$694.11	$0.01	$0.01			$0.01		$0.01
Toluene	$1,619.58	$0.03	$0.03					
1,2,3-Trichloropropane	$77,045.85	$0.07	$0.07					
TOTAL		$4.44	$3.86	$2.21	$9.60	$4.44	$0.69	$4.44

Note:
Blank entries imply zero values, $ 0.00 emissions imply positive values rounded to zero.

Table 6.20 (contd.) LINED LANDFILLS: Pollutant Emissions $ per Ton of Material

POLLUTANTS	TIRES/ RUBBER	TEXTILES	MISC. ORGANICS	OTHER WASTE	HHW
INORGANIC POLLUTANTS					
Arsenic	$0.24	$0.34		$0.20	
Barium	$0.05	$0.30		$0.41	
Cadmium	$0.01	$0.01		$0.00	$1.47
Chromium (total)	$4.07	$3.48		$0.37	
Lead	$0.17	$0.02		$0.16	$1.68
Manganese	$0.17	$0.17	$0.17	$0.17	$0.17
Nickel	$0.10	$0.10	$0.10	$0.10	$2.40
Selenium	$0.00	$0.00	$0.00	$0.00	$0.00
Vanadium	$0.03	$0.03	$0.03	$0.03	$0.03
Zinc	$0.02	$0.02	$0.02	$0.02	$1.75
ORGANIC POLLUTANTS					
Acetone	$0.47		$0.47		$0.47
Benzene					
2-Butanone	$1.70		$1.70		$1.70
p-Cresol	$0.64		$0.64		$0.64
2,4-D					$1.59
4,4-DDT					$0.01
1,1-Dichloroethane					$0.00
trans-1,2-Dichloroethylene	$0.00		$0.00		$0.00
Diethyl phthalate	$0.00		$0.00		$0.00
Endosulfane sulfate					$0.43
bis(2-Ethylhexyl)phthalate	$0.00		$0.00		$0.00
2-Hexanone					
Lindane					$0.00
4-Methyl-2-pentanone	$0.04		$0.04		$0.04
Methylene chloride	$0.01		$0.01		$0.01
Phenol	$0.01		$0.01		$0.01
Toluene	$0.03		$0.03		$0.03
1,2,3-Trichloropropane	$0.07		$0.07		$0.07
TOTAL	$7.84	$4.47	$3.29	$1.47	$12.49

Table 6.21 Existing Landfill Uncontrolled Gas Emissions $ per Ton of Material

(entries are the physical emission of pollutant * pollutant price)

POLLUTANTS	Pollutant Price	PAPER	PLASTICS	YARD	WOOD	FOOD	TIRES/ RUBBER	TEXTILES	HHW
CRITERIA AIR POLLUTANTS									
CO	$0.42	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
ORGANIC POLLUTANTS									
Benzene	$2,643.21								$1,249.25
Carbon tetrachloride	$11,848.89								$24.64
Chloroform	$7,382.77								$502.46
1,2-Dichloroethane	$8,294.23								$940.81
Ethylene dibromide	$69,270.45								$52.38
Methylene chloride	$1,276.03								$1,157.92
Perchloroethylene	$300.78								$62.55
1,1,1-Trichloroethane	$5,090.12								$625.48
Trichloroethylene	$1,549.47								$246.06
Vinyl chloride	$26,887.87		$15.37						$9,742.97
MISCELLANEOUS									
Carbon dioxide	$0.00	$0.02	$0.00	$0.02	$0.01	$0.02	$0.00	$0.01	
Methane	$0.04	$0.28	$0.04	$0.31	$0.09	$0.31	$0.03	$0.08	
Sulfides	$5.87	$0.07	$0.01	$0.32	$0.01	$0.32	$0.04	$0.02	
TOTAL		$0.38	$15.42	$0.66	$0.10	$0.66	$0.07	$0.11	$14,604.51

Note:
Blank entries imply zero values; $0.00 entries imply positive values which are rounded to zero.

Table 6.22 INCINERATION: Pollutant Emissions $ per Ton of Material

POLLUTANTS	Pollutant Price	PAPER	PLASTICS	GLASS	METALS	YARD	WOOD	TIRES/ RUBBER
		(entries are the physical emission of pollutant * pollutant price)						
CRITERIA AIR POLLUTANTS								
CO	$0.42	$0.04	$0.04	$0.04	$0.04			
NOx	$3.63	$0.90	$0.78	$0.73	$0.57		$0.17	$0.49
Particulates	$5.85	$0.13	$0.13	$0.13	$0.13			
SOx	$5.87	$0.03	$0.03	$0.02			$0.02	$0.15
VOCs	$2.50	$0.03	$0.03					
INORGANIC POLLUTANTS								
Antimony	$1,156,844.59	$2.24	$2.24	$2.24	$2.24			
Arsenic	$4,557,266.55	$1.19	$0.40	$0.40	$2.58		$0.26	$0.33
Barium	$9,254.76							
Cadmium	$555,986.52	$0.39	$0.91	$0.14	$0.12		$0.08	$0.30
Chromium (total)	$3,736,958.57	$0.54	$0.48	$3.58	$22.43		$0.21	$13.97
Copper	$9,254.76	$0.09	$0.09	$0.09	$0.58			
Lead	$330,626.18	$0.45	$0.47	$4.14	$15.18		$0.52	$3.56
Manganese	$2,313.69	$1.39	$1.39	$1.39	$1.39			
Mercury	$1,542,536.57	$15.09	$13.66	$5.91	$10.87		$17.20	$13.39
Nickel	$76,562.08	$0.36	$0.36	$0.36	$0.36			
Selenium	$154,323.07	$0.17	$0.06	$0.04	$0.10		$0.05	$0.74
Tin	$694.11	$0.01	$0.01	$0.01	$0.01			
Vanadium	$66,171.51	$0.02	$0.02	$0.02	$0.02			
Zinc	$2,313.69	$0.11	$0.11	$0.11	$0.11			
ORGANIC POLLUTANTS								
PAHs (total)	$1,048,171.31	$35.89	$35.89			$35.89	$35.89	
PCDD/PCDF (total)	$13,671,799,655.70	$3.26	$3.26			$3.26	$3.26	$3.26
MISCELLANEOUS								
Hydrogen chloride	$5.87	$0.03	$0.12	$0.05			$0.03	$0.37
Hydrogen fluoride	$5.87		$0.00		$0.00			
TOTAL		$62.45	$60.53	$19.47	$56.80	$39.16	$57.67	$36.56

Note: Blank entries imply zero values; $0.00 entries imply positive values which are rounded to zero.

Table 6.22 (contd) INCINERATION: Pollutant Emissions $ per Ton of Material

POLLUTANTS	TEXTILES	OTHER WASTE	HHW
CRITERIA AIR POLLUTANTS			
CO			
NOx	$0.92	$0.86	
Particulates			
SOx	$0.04	$0.32	
VOCs			
INORGANIC POLLUTANTS			
Antimony			
Arsenic	$0.46	$6.60	
Barium			
Cadmium	$0.35	$0.59	$3.78
Chromium (total)	$11.92	$1.52	
Copper		$0.83	
Lead	$0.35	$9.98	$5.73
Manganese			
Mercury	$56.40	$28.65	$2,525.25
Nickel			$0.53
Selenium	$0.10	$0.21	
Tin			
Vanadium			
Zinc			$0.53
ORGANIC POLLUTANTS			
PAHs (total)			$35.89
PCDD/PCDF (total)	$3.26	$3.26	$3.26
MISCELLANEOUS			
Hydrogen chloride	$0.04	$0.16	
Hydrogen fluoride	$0.00		
TOTAL	$73.85	$52.96	$2,574.99

Table 6.23 GARBAGE COLLECTION: Pollutant Emissions $ per Ton of Material

POLLUTANTS	Pollutant Price	NEWS	OCC	MIXED PAPER	HIGH GRADE	OTHER PAPER	HDPE	PET
CRITERIA AIR POLLUTANTS								
CO	$0.42	$0.04	$0.06	$0.05	$0.05	$0.06	$0.14	$0.14
NOx	$3.63	$0.45	$0.79	$0.66	$0.62	$0.72	$1.68	$1.71
Particulates	$5.85							
SOx	$5.87	$0.10	$0.18	$0.15	$0.14	$0.17	$0.39	$0.39
VOCs	$2.50	$0.08	$0.14	$0.11	$0.11	$0.12	$0.29	$0.30
INORGANIC POLLUTANTS								
ORGANIC POLLUTANTS								
Benzene	$2,643.21	$1.48	$2.59	$2.17	$2.02	$2.35	$5.48	$5.59
Ethyl benzene	$4,627.38	$0.09	$0.15	$0.13	$0.12	$0.14	$0.32	$0.33
Toluene	$1,619.58	$0.91	$1.60	$1.34	$1.24	$1.45	$3.38	$3.45
Xylenes	$231.37	$0.05	$0.08	$0.07	$0.06	$0.07	$0.17	$0.18
TOTAL		$3.21	$5.60	$4.69	$4.36	$5.08	$11.85	$12.08

Table 6.23 (contd.) GARBAGE COLLECTION: Pollutant Emissions $ per Ton of Material

POLLUTANTS	FILM	OTHER PLASTICS	GLASS	ALUMINUM CANS	YARD	WOOD	FOOD	TIRES/RUB.
CRITERIA AIR POLLUTANTS								
CO	$0.08	$0.15	$0.01	$0.16	$0.03	$0.05	$0.02	$0.06
NOx	$0.97	$1.87	$0.18	$1.99	$0.38	$0.57	$0.27	$0.76
Particulates								
SOx	$0.23	$0.43	$0.04	$0.46	$0.09	$0.13	$0.06	$0.18
VOCs	$0.17	$0.32	$0.03	$0.34	$0.07	$0.10	$0.05	$0.13
INORGANIC POLLUTANTS								
ORGANIC POLLUTANTS								
Benzene	$3.19	$6.11	$0.60	$6.51	$1.24	$1.88	$0.88	$2.50
Ethyl benzene	$0.19	$0.36	$0.04	$0.38	$0.07	$0.11	$0.05	$0.15
Toluene	$1.96	$3.76	$0.37	$4.01	$0.76	$1.16	$0.54	$1.54
Xylenes	$0.10	$0.19	$0.02	$0.20	$0.04	$0.06	$0.03	$0.08
TOTAL	**$6.89**	**$13.20**	**$1.30**	**$14.07**	**$2.68**	**$4.06**	**$1.90**	**$5.39**

Table 6.23 (contd.) GARBAGE COLLECTION: Pollutant Emissions $ per Ton of Material

POLLUTANTS	TEXTILES	MISC. ORGANICS	HHW
CRITERIA AIR POLLUTANTS			
CO	$0.09	$0.04	$0.04
NOx	$1.08	$0.54	$0.49
Particulates			
SOx	$0.25	$0.12	$0.11
VOCs	$0.19	$0.09	$0.09
INORGANIC POLLUTANTS			
ORGANIC POLLUTANTS			
Benzene	$3.55	$1.76	$1.61
Ethyl benzene	$0.21	$0.10	$0.09
Toluene	$2.19	$1.09	$0.99
Xylenes	$0.11	$0.06	$0.05
TOTAL	$7.67	$3.80	$3.48

Table 6.24 Environmental Costs $ per Ton of Material

Materials	RECYCLING Collection Cost	EXISTING LANDFILL [1] Collection Cost	EXISTING LANDFILL [1] Disposal Cost	NEW LANDFILL [1] Collection Cost	NEW LANDFILL [1] Disposal Cost	INCINERATION [2] Collection Cost	INCINERATION [2] Disposal Cost
PAPER							
Newspaper	7.11	3.21	20.38	3.21	4.65	3.21	62.45
OCC	14.23	5.60	20.38	5.60	4.65	5.60	62.45
Mixed Paper	21.34	4.69	20.38	4.69	4.65	4.69	62.45
High Grade	8.01	4.36	20.38	4.36	4.65	4.36	62.45
Other Paper	32.02	5.08	20.38	5.08	4.65	5.08	62.45
PLASTICS							
HDPE	91.47	11.85	32.85	11.85	11.50	11.85	57.27
PET	106.72	12.08	32.85	12.08	11.50	12.08	57.27
Film	128.06	6.89	32.85	6.89	11.50	6.89	58.90
Other	91.47	13.20	32.85	13.20	11.50	13.20	58.90
GLASS							
Recyclable	5.34	1.30	9.97	1.30	2.21	1.30	19.47
Non-recyclable		1.30	9.97	1.30	2.21	1.30	19.47
METALS							
Aluminum Cans	53.36	14.07	43.29	14.07	9.60	14.07	56.80
Other Metals	18.89	5.46	43.29	5.46	9.60	5.46	56.80
OTHER ORGANICS							
Wood Waste	12.81	4.06	3.22	4.06	0.77	4.06	57.67
Tires/rubber	9.15	5.39	35.43	5.39	7.91	5.39	36.56
Textiles	25.61	7.67	20.27	7.67	4.56	7.67	73.85
Misc. organics	18.29	3.80	14.83	3.80	3.29	3.80	39.16
OTHER WASTE							
Other Waste	4.86	2.48	6.65	2.48	1.47	2.48	52.96
HHW	12.81	3.48	14660.84	3.48	7922.40	3.48	2574.99

Notes: [1] Includes leachate and gas emissions.
[2] Does not include emissions from ash disposal.

Table 6.25 Full Waste Management Cost $ per Ton of Material

Materials	Recycling			Existing Landfill		
	Path [1]	Conventional $	Environmental $	Path [1]	Conventional $	Environmental $
PAPER						
Newspaper	26.25%	$38.17	$7.11	64.70%	$70.50	$23.59
OCC	24.00%	$26.35	$14.23	67.31%	$115.74	$25.98
Mixed Paper	11.25%	$94.52	$21.34	76.86%	$97.64	$25.07
High Grade	26.97%	($28.30)	$8.01	65.40%	$93.51	$24.74
Other Paper	0.00%			89.74%	$104.36	$25.46
PLASTICS						
HDPE	0.26%	$392.23	$91.47	88.34%	$242.32	$44.69
PET	0.31%	$457.60	$106.72	89.06%	$241.86	$44.93
Film	0.00%			87.41%	$140.58	$39.73
Other	0.00%			88.65%	$272.77	$46.04
GLASS						
Recyclable	2.02%	$1.13	$5.34	86.60%	$26.90	$11.27
Non-recyclable				88.55%	$27.09	$11.27
METALS						
Aluminum Cans	20.05%	($723.70)	$53.38	70.88%	$293.97	$57.37
Other Metals	37.98%	$38.71	$18.89	54.40%	$116.66	$48.75
OTHER ORGANICS						
Wood Waste	1.03%	$70.71	$12.81	87.22%	$88.83	$7.28
Tires/rubber	6.09%	$86.22	$9.15	84.16%	$128.90	$40.82
Textiles	4.20%	$151.42	$25.61	83.94%	$162.84	$27.94
Misc. organics	22.33%	$63.39	$18.29	67.49%	$81.25	$18.63
OTHER WASTE						
Other Waste	13.73%	$36.21	$4.86	77.65%	$64.63	$9.13
HHW [2]						

Notes:

[1] The path describes the shares of the individual material being disposed in different facilities (based on 1990 data).

[2] The full cost of HHW was derived from CA COSWAMP data, which showed the average disposal cost of a 55-gallon drum to be $357. We assumed that the drums contained 20% absorbants and 44 gallons of HHW. Therefore, the disposal cost of one gallon of waste = $8.11. Assuming that HHW has the density of water, (1 gal = 8.35 lbs), one ton of HHW costs $1,944 to dispose of. This number is shown in the final column; intermediate calculations shown for Other Waste do not apply to HHW.

Table 6. 25 (continued) Full Waste Management Cost $ per Ton of Material

Materials	New Landfill			INCINERATION		
	Path [1]	Conventional $	Environmental $	Path [1]	Conventional $	Environmental $
PAPER						
Newspaper	7.19%	$86.52	$7.86	1.86%	$79.27	$65.66
OCC	7.48%	$132.80	$10.25	1.22%	$123.85	$68.04
Mixed Paper	8.54%	$113.67	$9.34	3.36%	$116.26	$67.14
High Grade	7.27%	$109.54	$9.01	0.36%	$109.82	$66.80
Other Paper	9.97%	$120.39	$9.74	0.29%	$127.83	$67.53
PLASTICS						
HDPE	9.82%	$278.35	$23.35	1.59%	$198.94	$69.11
PET	9.90%	$277.89	$23.58	0.75%	$246.05	$69.35
Film	9.71%	$159.76	$18.39	2.87%	$114.85	$65.79
Other	9.85%	$313.63	$24.69	1.44%	$187.17	$72.09
GLASS						
Recyclable	9.62%	$31.47	$3.51	1.76%	$128.01	$20.76
Non-recyclable	9.84%	$31.66	$3.51	1.62%	$128.20	$20.76
METALS						
Aluminum Cans	7.88%	$345.13	$23.67	1.20%	$347.48	$70.88
Other Metals	6.04%	$139.62	$15.05	1.58%	$198.98	$62.26
OTHER ORGANICS						
Wood Waste	9.69%	$104.81	$4.83	2.06%	$131.49	$61.73
Tires/rubber	9.35%	$166.19	$13.30	0.40%	$123.49	$41.96
Textiles	9.33%	$192.24	$12.22	2.54%	$167.76	$81.52
Misc. organics	7.50%	$94.04	$7.09	2.68%	$42.66	$42.96
OTHER WASTE						
Other Waste	8.63%	$80.40	$3.95		$142.01	$55.44
HHW [2]						

Table 6. 25 (continued) Full Waste Management Cost $ per Ton of Material

Materials	Weighted Conventional Cost $	Weighted Environmental Cost $	Full Weighted Cost $
PAPER			
Newspaper	$63.33	$18.91	$82.24
OCC	$95.66	$22.49	$118.16
Mixed Paper	$99.28	$24.72	$124.00
High Grade	$61.89	$19.23	$81.12
Other Paper	$106.02	$24.02	$130.04
PLASTICS			
HDPE	$245.55	$43.11	$288.66
PET	$246.15	$43.20	$289.34
Film	$141.71	$38.41	$180.11
Other	$275.40	$44.29	$319.69
GLASS			
Recyclable	$28.60	$10.57	$39.17
Non-recyclable	$29.18	$10.66	$39.83
METALS			
Aluminum Cans	94.63	$54.08	$148.70
Other Metals	$89.74	$35.59	$125.33
OTHER ORGANICS			
Wood Waste	$91.07	$8.22	$99.29
Tires/rubber	$129.77	$36.33	$166.09
Textiles	$165.23	$27.73	$192.96
Misc. organics	$77.19	$18.34	$95.53
OTHER WASTE			
Other Waste	$62.09	$8.10	$70.19
HHW [2]			$1,943

6.7 ENDNOTES

1. This argument is made in Bernow et al., Tellus Institute (July 1990), p.17.

2. Based on the estimates by the Waste Board in 1989. We have incorporated the information that Los Angeles county (which contributes close to 40 percent of California's waste stream) has found a new disposal option in an abandoned mine (see also table 6.2.).

3. One could take the next highest cost option for pollution reduction, presumably explicitly or implicitly rejected by society, as a current upper bound.

4. See for example the Toxics Program Commentary, California, p. C5 10.

5. See also the appendix for a discussion of this problem (p.6A - 8).

6. Thus, "ranking" is actually a misnomer, as we aim to set values on a continuum -- rather than ordinal rank -- so that relative effects can be established (A is 2.83 times as toxic to humans as B per pound of each)

7. This category is very similar to the one employed in California rules and regulations (ROGs -- reactive organic gases), but the overlap is not perfect.

8. See California Energy Commission (1990)

9. Swedish Environmental Protection Agency, 1990 Major Review of Strategies ... p.11.

10. Bernow and Marron, Tellus Institute, *Valuation of Environmental Externalities* .... p. 29 f.

11. For landfill gas emissions, the relevant regulation is the Air Resources Board: Suggested Control Measures for Landfill Gas. For the control of emissions from waste-to-energy facilities, this is EPA's study: Municipal Waste Combustors - Background Information for Proposed Guidelines for Existing Facilities, and for leachate remediation, this is Subchapter 15, Title 23, of the California Code of Regulations.

12. California Code of Regulations, Chapter 3 - Water Resources Control Board, Subchapter 15. Landfill Closure Requirements.

13. This was in accordance with the client's intent; thus, we interpret it as a reflection of the preferences of California's regulators.

14. We took actually the second highest remediation per ton of waste number, for the reason that the landfill with the highest remediation dollar amount per ton of waste was very atypical, and the data on which the estimate was based did not seem accurate.

15. Since methane is not a toxic gas nor a carcinogen, one has to identify a regulation addressing this explosive effect. One possibility is to apply the control measures for landfill gas suggested by the Air Resources Board, see note 11.

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CHAPTER 6, APPENDIX I - EVALUATION OF ENVIRONMENTAL DAMAGE

There are essentially three methods by which environmental costs can be valued: the first is the damage cost approach, which attempts to trace the actual physical environmental impacts and to value the physical damage associated with them. The second approach, on which the overwhelmingly largest part of the economics literature focuses, attempts to elicit consumers' preferences, either directly, by presenting them with questionnaires, or indirectly, by observing consumers' behavior in the market. The third is the control or abatement cost approach. Below, we discuss each approach and present our choice of methodology.

It should be noted that the names which we have assigned to these three methods do not enjoy a consistent use in the literature: It seems that in the terminology of academic economics, the "direct valuation approach" refers to methods eliciting consumers' preferences by surveys and questionnaires (in particular: the Contingent Valuation Method), whereas the "indirect valuation approach" refers to the revealed preference approach (in particular, the Hedonic Property Price Method, the Hedonic Wage Method, and the Travel Cost Method). Some papers written in the context of public utility regulation use the term "direct valuation" to refer to the damage cost approach.[1]

The damage cost approach

When we speak about the environmental degradation caused by pollution, we have many specific impacts in mind: The contamination of drinking water with hazardous materials, which poses severe health threats to humans, animals and plants; the pollution of the air, which, apart from impacts on human health, causes damage to forests, crops, and buildings, and so forth. Many of these impacts cause a monetary cost to someone: patients and the public health system have to incur expenditures to treat diseases related to pollution, such as allergies and asthma; farmers are faced with the loss of crops, fishermen with the loss of catch, and so forth.

Of course, the damages caused by pollution far exceed these monetary losses: the general impairment of the quality of life, the physical and mental discomfort to people, the loss of natural environment which is not used commercially - all these do not normally receive a monetary valuation by the market. Many of these impacts are very hard or even impossible to evaluate objectively. What is a human life worth? The sum of its potential earnings? How to value the loss of a species, or of a habitat for rare species?

Even for those impacts which have direct monetary consequences, such as health expenditures and crop loss, it is a very complex endeavor to establish a quantitative causal relationship between the amount of pollutant emitted and the amount of damage caused. There are two approaches by which one could try to establish such a relationship, both of which are problematic: the "bottom-up" and the "top-down" approach. The bottom-up approach focuses on the different paths, spatial and temporal, that an individual pollutant takes from the point of emission to the contact with the medium to which it causes damages, evaluates the damages, and sums up the individual figures thus found. The top-down approach looks at the total emissions and the total damage, economy-wide.

The bottom-up approach

There are five stages that have to be studied in the attempt to trace the impact caused by a pollutant. These are the emission of the pollutant, the dispersal of the quantity emitted, the exposure of the medium to the pollutant, response of the medium (this is the physical damage caused) and valuation of the damage determined in the previous step. Each of these steps has to be quantified. It is probably straightforward to quantify the amount of pollutant emitted. The different paths a pollutant can take are, however, more difficult to determine. They depend on site-specific criteria and weather conditions. Exposure-Response assessments (also called "Dose-Response" studies) come to very different conclusions, because they cannot carry out controlled experiments. Many different factors contribute to the occurrence of particular diseases. It is difficult enough to relate the occurrence of, say, cancer, to the exposure to a specific amount of a pollutant in the laboratory. It is much harder to do so under conditions of an uncontrolled experiment (where other factors are not controlled for). This is not to say that we do not know that certain substances are highly carcinogenic. It is only to say that there is a great degree of uncertainty as to what the exact quantitative relationships are.

An additional source of uncertainty arises from the interaction of different pollutants. In combination, the impacts they cause are often more than the sum of the impacts they would cause in isolation.

These are only some of the difficulties posed by the damage cost approach. There are many more. We refer the interested reader to the literature.[2]

The top-down approach

This approach looks at the damage caused in the entire economy and tries to relate it to total emission (of one pollutant or a group of pollutants). While this provides a great simplification in that site specific factors do not need to be considered, many of the problems described for the bottom-up approach are present in exacerbated form: it is extremely difficult to isolate the influence of individual pollutants.

Because the physical processes which this approach attempts to capture are fraught with so much uncertainty, studies trying to assess and value the physical environmental damage of pollution have yielded very different inconsistent.[3]

Individuals' Preferences Approach, or: Direct and Indirect Monetary Valuation Methods

a) Philosophical Foundations of Welfare Economics

The largest part of the academic economics literature seeks to find values for the commodity "environment" by eliciting people's preferences, whether by asking a sample of the population directly (Direct Valuation Methods), or by observing people's actual behavior from which, it is thought, one can infer values which people put on environmental characteristics (Indirect Valuation Methods, or Revealed Preferences Approach).

To an outsider, this may seem a strange route to take. However, it is based on the central assumption of welfare economics (which provides the basis for valuation of the environment): that each person is the best judge of his or her own interests. Also, it is only the welfare of humans that is relevant. Fauna, flora and the inanimate world have no interests or intrinsic value; their only value lies in the enjoyment or utility they provide to humans. In other words, no end can be prescribed to society; there is no binding overall moral end which members of a society strive for.

For the purpose of analysis, economists have distinguished between different types of value that the environment can hold for individuals: These are use value, option value, and existence value. Use value is based on the utility which people derive from the "consumption" of the environment for recreational purposes, such as boating, fishing and other sportive activities. The option value is the use value in the presence of uncertainty: People may not consume the environment at present, but may want to do so in the future. To have the option for future use preserved is assumed to be valued by the consumers. Finally, the existence value is the value which people assign to the environment for "altruistic" reasons (it is interesting that economics calls this motive altruistic, when it is not directed at other humans); it is the utility which they derive from the knowledge of the existence of the environment.

b) Direct Valuation, or: Contingent Valuation Method (CVM)

The Contingent Valuation Method (CVM) assumes hypothetical (contingent) markets. In essence, it consists of experiments in which people are asked to express their valuation for a specific environmental commodity. These experiments can be designed as bidding games, they can consist of filling in questionnaires, and so forth.[4]

To render this approach valid, i.e. to allow that it actually measures what is claimed it measures, several assumptions have to be made, e.g. pertaining to the aggregability of individual preferences.[5] In addition, it is subject to many sources of bias.[6] There is e.g. the strategic bias: Since environmental quality is a public good (i.e. it exhibits jointness of supply, that means: once it is provided, people cannot be excluded from its consumption), people have an incentive to understate their preference (if they are held to pay), counting on the fact that other people will provide for the supply of the good. This is the free-rider problem. Then there are several sources of bias which stem from the fact that individuals are not perfectly rational. It has been observed that people respond to the starting value that is quoted to them (source for the "starting point bias"). Also, the question is whether the hypothetical markets correspond well enough to real markets.

It is also of crucial importance exactly which change in environmental conditions consumers are asked to evaluate: Two concepts are suggested in the literature: Willingness to Pay (WTP) and Willingness to Accept (WTA). Loosely speaking, the former is the amount of money that a consumer would be willing to spend to secure an environmental benefit, and the latter is the compensation that he would demand to accept an environmental cost. However, both concepts can be applied to one and the same change in environmental conditions. Consider e.g. a policy to clean up 90 % of sulfur oxides emissions: WTP then is the maximum amount of money an individual would give away to have 90 % of SO_x emissions abated, while maintaining his or her utility level; and WTA is the amount of money he or she would have to be given to accept the pollution while maintaining the utility level corresponding to the absence of 90 % of the present pollution. Clearly, the two concepts imply a different distribution of property rights. In the first setting, the pollution with SO_x is the reference case, and it is perceived that cleaning up will yield a benefit to the consumer. In the latter setting, a clean environment is the reference case, and pollution is seen to be a cost to the consumer. It seems that in the first case, the polluter is assumed to have a right to pollute, and in the latter case, the parties bearing the pollution have the right to a clean environment.[7]

It has been asserted that economic theory suggests that these two values do not differ much. However, this result is only true for very specific assumptions (which, so it has been argued, are plausible). Empirical studies assessing the magnitude of WTA versus WTP have consistently produced far greater amounts for WTA than for WTP. The estimates for WTA have often exceeded the ones for WTP by a factor of four.[8]

There has been an ongoing discussion about this apparent discrepancy. It was long known that the difference between the two magnitudes is the greater, the greater the income elasticity of demand is.[9] This makes sense intuitively: The WTP is obviously limited by an income constraint. People may care very much for the environment, but they may not be able to afford to spend much on it if their income is small. However, it is not only the price elasticity of income which influences the difference between WTP and WTA. Recently, the very interesting result has been derived that the difference between WTP and WTA depends also on the uniqueness of the good in question. The more unique an environmental good is, the more will WTA exceed WTP.[10] The large difference between WTA and WTP may then be taken to indicate that the uniqueness of environmental features is actually perceived as such by people. This provides a strong argument for conservation.

In this context, it is very interesting to note that federal regulations, in the assessment of damages in the context the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 1980) actually barred the use of the WTA method.[11] Carson and Navarro state that "... It should be openly acknowledged that there is an important divergence between what Congress wanted to be measured - WTA including existence values - and what the Department of the Interior regulations eventually mandated should be measured - WTP excluding existence values. This divergence occurred because of the admitted difficulty by economists of measuring WTA and existence values, but it is a divergence which leads to an underestimate of damages which is likely to be significant."[12]

c) Indirect Valuation Methods, or Revealed Preference Approach: Hedonic Price Method (HPM) and Travel Cost Method (TCM)

Hedonic price methods: Hedonic property prices. The hedonic price method tries to identify surrogates for the nonexistent market for the environment. Markets which qualify as surrogate markets for the environment are those in which a private good is traded that may bear some relationship to the public environmental good. The notion underlying the concept of hedonic prices is that people derive utility from various attributes of a product. A product has many attributes, some of which can relate to the presence of a public good. A house, e.g., can have different features which individual consumers value differently: it can have a cellar or not, a loft, balconies, a garden, etc. Each of these features commands a price; however, this price is implicit: Individual features of a house are not sold separately. One attribute of the house is the environment in which it is located. In theory, one can construct demand functions that depend on these individual characteristics, and one can derive an implicit price for certain environmental features. That is to say, one can derive the amount of money consumers are willing to spend to obtain one more unit of q, the environmental quality feature (if q is air quality, then "one more unit of q" would refer to "one unit less of pollutant", where the "pollutant" could refer to an index of air pollution). One would expect to observe differentials in housing prices, depending on the quality of the specific environment they are located in.

The derivation of an implicit price for an environmental characteristic from an ideal type demand function is a rather straightforward calculation. To estimate these implicit prices from observable market data, however, requires some strong assumptions and is far from unproblematic: Apart from the usual assumptions about the structure of individual utility functions relating to aggregability, it has to be assumed that people have a wide enough array of choices to make their decision on the basis of all characteristics. This is obviously hardly ever the case. Often, one characteristic overrides all others; proximity to the place of work often takes this role. People mostly have not much choice over where they find work and thus move into an environment that they would not move to otherwise. Another problem is that it is not easy to find a sample with sufficient variation, i.e. enough houses which exhibit different characteristics. The specific environment of houses varies together with other factors, and it is very hard to isolate the influence of one variable when they vary together. And, as stated above, in the absence of a wide array of choices, people are likely to base their decision on other characteristics than only the specific environment.

Hedonic price method: Hedonic wages

The notion of a good embodying many characteristics implies that a job, too, has many characteristics, not only the wage that it pays. One important characteristic is the risk to the health and life of the worker. It is argued that workers will only accept a job with high risk when given a "compensating wage differential". The hedonic wage method consists of relating the size of wage differentials for various jobs to their different risk characteristics. From this relationship, the value which workers ascribe to their lives is inferred. One problem with this method is that it presupposes information about the job characteristics, on the part of the workers and on the part of the researcher. Workers often do not have sufficient information about the risks to health and life which they are exposed to at work. Also, unless a job implies exposure to specific pollutants it is not possible to establish the dislike which workers hold for a specific pollutant. There is also a problem of measurement here. Data on specific pollution at work are not readily available; data usually exist only on the consequences of hazards, such as accidents, morbidity, and mortality. The hedonic wage studies would be of more use, if of any, in damage cost studies, in that they could give an indication of the value which people ascribe to their lives.

The travel cost method

The travel cost method is employed to evaluate the recreational benefits which a specific area holds for consumers. The amount of time and money which people are spending to get to and spent in the area is supposed to indicate the use value which they ascribe to this area.

Apart from various technical problems,[13] the obvious flaw of this approach is that it only targets the value of an area for a very specific narrow use. Surely people value natural resources for more than the amenity. And again, there is no way in which this method would allow us to evaluate the contribution of a single pollutant to environmental degradation.

The control cost approach

This method enjoys increasing popularity in the attempt of utility companies to internalize the environmental cost of energy production.[14] Some states have actually adopted this approach to incorporate environmental cost of electricity production in their energy planning process.[15]

The control cost approach infers the cost that society attributes to pollution from the regulations that it imposes on itself. Complying with standards set for pollutant emission is costly - thus, there must be a perceived benefit to pollution abatement. Two concepts are central to this approach: The marginal cost of pollution abatement, and the marginal benefit of pollution abatement.

The **marginal cost of pollution abatement** is an increasing function of the amount of pollutant being controlled. This does not only imply that to abate more pollution costs more. (The latter would be expressed by a **total** cost function of pollution abatement rising with the amount of pollution being controlled.) Increasing marginal cost also implies that the unit cost of abatement, the cost of abatement per unit of pollutant, rises with more and more pollution being abated. This just reflects economic decision making. To remove the first unit of pollutant, one would choose the cheapest technology available. The most expensive technology would only be employed if the potential of cheaper technologies were exhausted, i.e. if as much pollution as possible were abated with cheaper technologies.

The **marginal benefit of pollutant abatement** is a decreasing function of the amount of pollutant being removed. This does not only mean that the overall benefit is greater, the more pollution is abated, but it also implies that the benefit per unit of pollutant removed is greater, the greater the overall level of pollution is. In other words: The benefit from preventing one more ton of SO_x to enter the atmosphere is smaller, the more SO_x has already been controlled. The negative side of this relationship is that the marginal damage function of pollution is generally increasing, that is, the damage that one unit of pollutant causes is greater, the higher the overall pollution levels. (The capacity of ecosystems to absorb pollution can reach critical points beyond which the damage increases drastically).

These functions may not be strictly monotonic, i.e. they may contain constant portions. It is for example, plausible that the first unit of pollutant (say, the first hundred thousand tons of SO_x) causes as much damage as the tenth, but less than the eleventh. This would imply that the marginal benefit of pollution abatement is approaching constancy after falling initially.

With this constellation of costs and benefits of pollution abatement, the optimal emission standard for a particular pollutant emission is that level of pollutant at which the marginal cost of abatement equals the marginal benefit of abatement. To set such a standard would constitute an efficient allocation of resources to the activity of pollution abatement. To do more would cost society more than the benefits which would result from the implementation of that standard.

The next step of the argument is somewhat of a leap of faith: It is assumed that the way in which regulatory standards are set are a) completely rational, and b) accurately represent society's preferences.

An ideal, rational public decision maker would set the emission standard for the pollutant at the optimal level. Thus, knowing what it costs to remove the last unit of the pollutant to satisfy the regulation, one knows the benefit accruing from removing this unit of pollutant. But the benefit of removing one unit of pollutant is equal to the cost its presence imposes on society (this is approximately true when we are not dealing with large amounts of pollutants).

Another way to depict this is as follows: the emission standard can be expressed as a linear function. The point of intersection of the emission standard with the marginal cost of abatement curve determines the marginal cost of removing that last unit of pollutant to meet the standard. Recall that it is important to get at the marginal cost of compliance: Which is the most expensive pollution control which is administered? This is the price society is willing to pay to have the last unit of pollutant controlled, thus, this is the value that society ascribes to the absence of that unit of pollutant.

Of course there are several problems with this approach. For one, existing legislation and regulations are not perfectly rational, nor do they perfectly reflect society's preferences. What are "society's preferences" anyway? We will deal with these ideological, normative issues later. First we turn to some problems which are more technical in nature.

First, there is no emission standard for each individual pollutant. Some pollutants are not regulated at all, and for others, not standards, but controls are administered.

The latter feature presents the problem of "joint cost of pollution control": Several pollutants causing very different environmental impacts can be captured with one and the same device. How should the cost of that device be allocated to individual pollutants? E.g., a smokestack scrubber may capture some amount of sulfur dioxide as well as some small amount of heavy metals. Does that imply that the cost of the scrubber will be "evenly" divided and ascribed to control costs of SO_x as well as cadmium? No. Recall that it is the marginal cost of control of a specific pollutant which provides the (negative) value of that pollutant to society. If of all the cadmium potentially released into the environment, smokestack scrubbers capture, say, 60 %, but there are other regulations addressing the remaining 40 %, then it is these regulations that are relevant; in effect, it is the regulation removing the "last" unit of cadmium which will provide the value that society places on cadmium removal from the environment. It will be the most stringent regulation, and the costliest to comply with.

In addition, we can only infer a value to that pollutant which the device is intended to capture, i.e. the pollutant to which the regulation is addressed, because it is this pollutant for which the regulation implies a certain value.

Another problem is that there may not exist regulations for all pollutants. A case in point is the emission of greenhouse gases. One could value the costs caused by these emissions through the costs of the measures which would offset the emission of the gases - e.g. afforestation. It seems also legitimate to assume that society holds consistent preferences, and that for some pollutants, regulations addressing different but similar ones can be used: For example, the banning of lead acid batteries from incinerators reveals the regulator's (representing society's) preference that heavy metals should not be emitted. It seems legitimate to assume a regulation banning other heavy metals products of similar toxicity from incinerators.

Rationale for Our Choice to Employ the Control Cost Approach

Clearly, the best method to value external costs is the damage cost approach. It corresponds most closely to what we understand environmental impacts to be. Although there are some damages that hold very different values to different people, there are still considerable costs that can, potentially, be valued objectively because they are costs that affect goods which are traded in the market. The estimates of these costs would establish a lower bound to the dollar value of the externality.

However, to undertake such an estimation is an extremely complex endeavor. Millions of dollars have been spent on studies, and their results are still loaded with much uncertainty. We clearly do not have the resources to engage in this kind of study for disposal fee analysis.

As to the approaches employed by academic economics, we feel too uncomfortable with the kind of assumptions that are required to lend them credibility. In addition, the data limitations and sources of bias have a too great potential to let the researcher miss the subtle relationships posited by theory. It is an approach that rests on highly technical and theoretical notions which, again, are plausible in the realm of economic theory but which may not be legitimate in the real world. Last, not least, they are hard to convey and thus hard to justify to a wider audience.

Thus, we have decided to adopt the Control Cost Approach. Two main considerations have guided our choice:

For one, the Control Cost Approach is the only approach which is feasible to employ and administer with the available resources. Any administrative body would be ill advised to adopt a method for evaluation of externalities which is costly, complex, and fraught with a lot of uncertainty. The control cost approach is being discussed by public utilities as a sensible compromise between what one would want to study and the limitation of resources. Also, Tellus Institute has developed some expertise with this approach. Several studies have been undertaken in house that employ the control cost approach[16]; and the state of Massachusetts has adopted the methodology suggested by Tellus.

The second reason is more normative in nature: We know that regulators are not perfectly rational; nor are they perfect representatives of society's preferences. "Society's preferences" are diverse - individual members of society may hold wildly different values, and very diverse interests are at stake. However, we have to ascribe legitimacy to the political process and assume that it will, with all its imperfections, attain some kind of consensus which is expressed in the regulations which society imposes on itself. Thus, although we may not believe that existing regulation always reflects a fair societal compromise[17], we do, with some qualifications, subscribe to its normative content.

ENDNOTES

1. However, the recent OECD (1989) study which surveys methods of externality evaluation employed by the academic economics profession uses these terms in yet a different way: "Direct valuation techniques" refers to all methods trying to elicit consumers' preferences, be it by contingent valuation or by revealed preferences, and "Indirect Valuation Procedures" refers to what we call the "damage cost approach". (p.7). Then, later in the text, studies focussed on revealed preferences are referred to as "indirect market studies" (p.38).

    The following more technical terms are used with some consistency: Contingent Valuation Method (CVM), Revealed Preferences Approaches: Hedonic Price Method (HDM) (Hedonic Property Prices, Hedonic Wages), and Travel Cost Method (TCM). See in the present document "Assessing the Full Cost of Waste Disposal", II, 2.

2. An informative discussion of the complex issues arising with the damage cost approach can be found in Chernick and Caverhill (1989).

3. For a review of physical damage cost studies see Ottinger et al. (1990), Chapter V.

4. A brief but comprehensive list can be found in A. Myrick Freeman III (1982). The 1979 monograph by the same author is a classic in the field. For a more recent presentation, see Mitchell and Carson (1989).

5. Per-Olov Johansson (1979), p.52; Mitchell and Carson (1989), p.41 f.

6. A brief but informative discussion can be found in OECD, 1989, p. 36 f.

7. For a profound discussion of the history of these concepts, see Mitchell and Carson, p.30 f.

8. See e.g. OECD (1989), p.39 f.

9. A consumer's income elasticity of demand for a good is the relative change in his or her purchase of this good in response to a relative income change; in other words: the percentage change in the amount spent on the good, given a 1 % change in income.

10. (The following is based on discussions in Mitchell and Carson (1989) and Carson and Navarro (1988). We have not yet reviewed the relevant papers but will do so.)

    Randall and Stoll (1980) have found that the difference between WTP and WTA is a function of a parameter which they call the "price flexibility of demand". Hanemann (1989) has identified this parameter as the ratio of an income elasticity divided by a substitution elasticity. If the denominator of this expression becomes small (and goes towards zero), the expression as a whole becomes large (and goes towards infinity). That implies that the more unique an environmental commodity is, (i.e. the less close substitutes it has), the larger will be the difference between WTP and WTA.

11. Carson and Navarro (1988), p.817.

12. *Ibid.*, p. 830.

13. See e.g. OECD (1989), p.43 f.

14. See e.g. Chernick and Caverhill (1989), Tellus Institute (1990).

15. The state of Massachusetts has done so, upon a recommendation by Tellus Institute, Boston May (1989).

16. Bernow, Stephen, and Donald Marron: *The Treatment of Environmental Impacts in Electric Resource Evaluation: A Case Study in Vermont.* Tellus Institute, Boston, MA, January 22, 1990, and Bernow, Stephen et al.: *Incorporating Environmental and Economic Goals into Nevada's Energy Planning Process.* Tellus Institute, Boston, MA, July 30, 1990.

17. Also, by assuming consistency on the part of the regulator, we will paint a "regulation reference case" that is more stringent than the regulations which are at present in case. Also, we may take recourse to planned legislation and regulation, or policies advocated by large parts of the population.

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CHAPTER 6, APPENDIX II - CONSTRUCTING A HAZARD RANKING SYSTEM

As shown in Chapter 5, the various waste management facilities that handle California's waste stream emit a range of pollutants. As different pollutants exert varying degrees of harm to human health and the environment, simply summing pollutants is not an acceptable method to determine the impacts associated with waste management. Summing pollutants implicitly assumes for example, that one pound of sulfur dioxide has the same impact as one pound of benzene, two pollutants that have very different health effects. Therefore, a methodology is required that ranks pollutants according to the relative harm that they cause.

Risk assessment methodologies have been developed in recent years to evaluate the hazard posed by different pollutants. The framework for evaluation includes quantifying the release of each pollutant into an environmental media (i.e., air, water, soil), predicting the fate and transportation of the pollutant within and between media, analyzing the pathways by which humans and other organisms will be exposed to the pollutant, and analyzing the health effect of the pollutant.

As the system described above is complex and beyond the scope of this study, a simplified ranking system was developed instead. This ranking system is based upon human health effects only (as extrapolated from animal testing); environmental impacts are not considered.

The first step in developing the ranking system was to classify the list of pollutants developed in Chapter 5 into carcinogens (cancer causing pollutants) and noncarcinogens (pollutants that cause toxic health effects other than cancer). The health impacts of these two classes are measured differently, thereby requiring a separate ranking in each class. Pollutants were assigned to these two classes based upon the U.S. Environmental Protection Agency's classification system.[1]

Carcinogenic compounds were ranked based upon each pollutant's cancer potency factor (measured as milligrams pollutant/kilogram bodyweight/day).[2] This factor is indicative of the cancer-causing potential of a pollutant. Perchloroethylene has the lowest potency factor of the carcinogenic pollutants associated with waste management; its potency factor was thus used as the baseline of comparison. The potency factors of other carcinogens were then compared to perchloroethylene to derive "perchloroethylene equivalents." These are shown in Table 6.17. Thus, for example, the perchloroethylene equivalent for benzene is 9, meaning that benzene is 9 times more potent in causing cancer than perchloroethylene.

Toxic, noncarcinogenic compounds were ranked based upon each pollutant's reference dose.[3] The reference dose (measured as milligrams pollutant/kilogram bodyweight/day) is an estimate of the daily level of exposure which will not cause harm. Less toxic chemicals have a higher reference dose since a higher dose is required to elicit an effect. The inverse of the reference dose (i.e., 1/reference dose) was used as the ranking factor so that a smaller number would be indicative of lower toxicity. As xylene has the smallest value based upon this scale, it was used as the baseline of comparison. The inverse of the reference dose of all other toxic pollutants were then compared to xylene to derive "xylene equivalents." These are also shown in Table 6.17. Based upon this equivalency, barium is 40 times more toxic than xylene for example.

While the ranking scheme described above allows a long list of pollutants to be compared, the problem remaining is that there are still two disparate groups of pollutants -carcinogenic and toxic pollutants. These two groups do not lend themselves easily to comparison. An exposure to even a small dose still carries a positive, albeit small, cancer risk. Thus, it is difficult to compare the two groups.

One method that can be used to infer a relationship between the two groups of pollutants is to compare the regulated levels of perchloroethylene and xylene. The only regulations for these two chemicals is in the workplace environment. The Occupational Safety and Health Administration (OSHA) sets permissible exposure levels (PELS) that specify the amount of an pollutant to which a worker can be exposed, averaged over the course of an eight hour workday. The PEL represents the concentration of a pollutant that to which daily exposure will not incur an adverse health effect in exposed workers. OSHA has set a PEL of 100 parts of xylene per million parts of air (ppm) and a PEL of 100 ppm for perchloroethylene. However, the National Institute for Occupational Safety and Health (NIOSH), the research arm of OSHA has recommended that the perchloroethylene PEL should be lowered to 50 ppm.[4] This lower PEL is in agreement with the recommended exposure limit set by the American Conference of Governmental Industrial Hygienists, a private institution which recommends exposure levels.[5] Thus, we use this lower exposure level for our basis of comparison.

The exposure limits expressed in ppm can be converted to milligrams of pollutant per cubic meter of air. For xylene, a PEL of 100 ppm corresponds to 433 mg/m^3 and for perchloroethylene, a PEL of 50 ppm corresponds to 338 mg/m^3. This implies that a "safe" dose of xylene is 1.3 times the "safe" dose of perchloroethylene. We have used this factor of 1.3 to weight the perchloroethylene equivalents to reflect the fact that a given dose of a carcinogen is not equivalent to the same dose of a noncarcinogen.

ENDNOTES:

1. U.S. EPA, 1990. *Health Effects Assessment Summary Tables - Third Quarter FY - 1990*, July.

2. *Ibid.*

3. *Ibid.*

4. U.S. Department of Labor, Occupational Safety and Health Administration, "Occupational Health Guidelines for Chemical Hazards."

5. U.S. Department of Health and Human Services, 1986. *Registry of Toxic Effects of Chemical Substances*.

CHAPTER 7 - ALTERNATIVE FEE SYSTEMS

The purpose of this chapter is to propose several alternative disposal fee systems, and to analyze issues that arise in designing these systems. This will provide a basis for our recommendation and discussion of a particular fee system in Chapter 8.

Preview: four alternatives

We have identified two major distinctions among possible fee systems. First, the fee may be levied either at the point of final sale (usually retail) or at the point of first sale in California. This distinction also affects the basis on which the fee is calculated (e.g., per pound or per dollar) due to the need for administrative simplicity in a fee collected at retail. Second, the fee structure may be designed either with or without separate recycling incentives. These distinctions will be discussed in detail below.

Combining these two distinction, we obtain the four fee systems shown in the 2 x 2 matrix in Table 7.1.

TABLE 7.1: FOUR ALTERNATIVE FEE SYSTEMS

	Separate recycling incentives included? A. No	B. Yes
Point where fee is levied/ Basis for fee calculation		
1. Point of first sale (producer, distributor, or importer)/ Per pound of each material	1A	1B
2. Point of final sale (retail)/ Per dollar, or based on manufacturers' lists	2A	2B

System 2A is a point of final sale fee system with no separate recycling incentives; System 1B is a point of first sale system with separate recycling incentives built in; and similarly for 1A and 2B.

Overview of Chapter 7

This chapter includes a number of sections. In Section 7.1 we explain how a disposal fee should operate in theory, under conditions of perfect information and minimal administrative costs. Looking at a theoretical, ideal fee system is helpful because it illuminates the economic justification for designing an actual disposal fee. It also provides a design goal to guide the development of a detailed practical system.

In Section 7.2 we consider two boundary questions that define the scope of the disposal fee system. First, although the fee is intended to be general and inclusive, some important categories of materials must nonetheless be excluded. Second, this report focuses on "front-end" or advance disposal fees, collected before a good is used and discarded; a major alternative, "waste-end" fees collected at the time of disposal, must also be discussed.

Section 7.3 presents and motivates the principal defining characteristics of the four alternative fee systems: the point of first sale/point of final sale distinction; the presence or absence of recycling incentives; and the units of measurement. The choice among the four alternatives involves questions of the precise goals of the fee system, and of the administrative feasibility of differing approaches.

In Section 7.4 we offer tentative estimates of fee levels for a number of goods, based on the waste stream characteristics and waste management costs developed in preceding chapters. These estimates are presented to illustrate the methodology we propose; they do not constitute a complete or final fee schedule for all products sold in California.

In Section 7.5 we discuss the effects of the fee on households and industry; finally in Section 7.6, we examine the changes in behavior that may be induced by the fee.

Additional discussion of the recommended fee system and the use of the fee revenues will be found in Chapter 8. Mechanisms for updating the fee levels are proposed in Chapter 9.

The fee system, no matter how successful it proves to be, is not a complete solid waste policy for California, nor even a complete recycling and source reduction program. It would be a mistake to try to achieve all of the state's goals in this broad area through refinements of a single fee structure. Some policy objectives may be more appropriately addressed through the use of the fee revenues. Other objectives require additional policy initiatives, perhaps adopted in coordination with the fee system.

7.1 GOALS OF AN IDEAL DISPOSAL FEE

Solid waste is the byproduct of the population's consumption of material goods. Management of solid waste imposes significant and growing costs on society, yet those costs are not considered when consumption decisions are made. For example, a consumer can spend the same amount of money on a reusable (conventional) camera, or on several disposable cameras; there is no price signal telling the consumer that the disposable cameras will generate more solid waste, and more waste management costs, when they are discarded.

A fundamental principle of economic theory holds that those who use resources should pay their full costs. Economic efficiency is maximized (consumers' wants are satisfied at the least possible cost) if all products are priced at their full marginal cost. This cost must include any "externalities", or costs imposed on others by the production and consumption of the goods in question. In an economically efficient system, the people who are responsible for monetary or environmental costs are the ones who pay for them.

This principle of efficiency is routinely violated when it comes to solid waste management costs. Continuing with the example of reusable vs. disposable cameras, efficiency would require that camera consumers pay the costs of camera disposal, which are higher for those who choose disposable models. Lacking such price signals, consumers are likely to purchase "too much" of waste-generating products -- that is, more than they would choose to purchase, if they had accurate information about disposal costs.

Even though consumers ultimately pay the disposal costs at present, that payment is not directly linked to the decision to buy waste-generating products. Inevitably, most consumers miss the connection between their purchase decisions and the resulting waste management cost increases; those cost increases are experienced over a period of months or years, and (if publicly funded) may be mixed in with other municipal or county tax burdens.

A disposal fee could remedy this problem by including the costs of waste management into the purchase price of all goods sold in the state. The ideal fee would cause an **average** price increase, since it would be applied to all goods; but more important, it would cause **differential** increases based on differential waste management costs. All cameras would increase in price, since all must be thrown out some day -- but disposable cameras would experience much greater percentage increases than reusable ones. The ideal fee structure would assign each product a fee based on the waste management costs imposed by that product.

It is important to recognize that the fee should be based on overall solid waste management costs, not simply on the costs of or current level of recycling. Items that can be recycled, but at very high cost -- as might be the case for disposable cameras -- would still receive high cost-based fees. Recycling would only lead to lower fees if it leads to lower waste management costs associated with different specific goods. Indeed, goods that can only be recycled at very high cost may be targets for source reduction or product redesign rather than recycling alone; in such cases the fee should ideally encourage these broader changes, rather than subsidizing "gold-plated recycling" schemes.

Likewise, potential recyclability of materials is not an appropriate basis for fees. The social costs of waste management are affected by actual recycling, not by the potential for recycling. If materials are potentially recyclable, but not actually being recycled, they are in fact incurring the full costs of conventional disposal, and should bear the corresponding fee. Knowledge of potential recyclability is important for waste management planning, as it may affect future recycling programs; however, it does not directly affect the costs that are reflected in the disposal fee system.

Solid waste management costs that should be reflected in disposal fees include both conventional costs and environmental costs. The **conventional costs** are the amounts currently being paid for waste management activities, including waste collection, transportation to facilities, and recycling, incineration or landfilling. Some of the conventional costs are public sector expenditures, paid or subsidized out of tax revenues; others are private costs, paid by households or businesses that purchase waste management services.

Conventional costs include the costs of equipment and facility design to contain pollutants in accordance with existing regulations and engineering practices. Nonetheless, each waste management activity causes some pollution or environmental degradation. The type and amount of environmental degradation vary with the materials being handled and with the method of waste management. Currently, no monetary value is assigned to these **environmental costs,** but their effects are felt nevertheless in indirect ways, such as in human health problems or reduced water quality.

The ideal disposal fee would depend on the material being disposed, the quantity being disposed, and the method by which it is disposed. The disposal fee for a good made up of many materials would ideally reflect the environmental damages generated by disposing of each of the component materials. A good containing hazardous wastes would receive a much higher fee, reflecting the high cost of hazardous waste collection and disposal.

An economically efficient disposal fee system has two very desirable features. The first is that it allows firms and consumers to choose their level of consumption (and resulting pollution) based on their needs and budget constraints. They can choose any type and any quantity of goods, with the accompanying conventional disposal and environmental cost responsibilities automatically included in the price. While they pay for all costs caused by their own purchases, they are not charged for costs that they do not cause. In this respect it is a very fair system.

As a result, the fee system encourages consumers, and thus producers as well, to switch to less polluting products. If the fee causes a higher percentage increase in costs for disposable cameras than for reusable cameras, it thereby creates an incentive to switch back to conventional, reusable cameras. This occurs whether or not the consumer is aware of the portion of the cost that is due to the fee: the price tag automatically embodies the message about the relative pattern of disposal costs.

A second, practical advantage is that the state receives the fee revenues, which can be used to fund waste management initiatives and/or to mitigate environmental damages resulting from waste management activities. Many policies required to promote waste reduction and recycling cannot be financed by local communities or private waste management firms. By giving a single agency an income stream based on disposal costs, the fee system facilitates concerted action to address the pressing problems of the waste management system.

Many of the desirable features of a disposal fee system have been identified above. However, the fee system as it would exist under ideal conditions is not achievable in the real world. We do not have perfect information on either conventional or environmental costs of disposal for each material, as was made clear in Chapters 5 and 6. Perhaps more important, the theoretical discussion in this section has ignored the question of administrative feasibility. The ideal system would involve detailed calculation of fee levels on different goods, and would require collection of fee revenues from countless economic actors. In the real world, such a system might be extremely costly to operate, and compromises must be made for the sake of practicality.

In summary, in designing a disposal fee system, there are two important objectives. These are that 1) those responsible for the costs should pay the fee, and 2) the fee should capture the differential pattern of costs. However, in reality the disposal fee system must be designed subject to several constraints. The amount of the fee, the way it is levied, and the point in the production process at which it is imposed, must be designed in the face of imperfect knowledge about the environment, about the time, method, and location of disposal, and within the constraints required for easy and cost-effective administration.

7.2 SCOPE OF THE DISPOSAL COST FEE SYSTEM

In this section we consider two important boundary questions that help define the scope of the disposal fee system: the criteria for materials to be excluded from the fee, and the pros and cons of back-end or "waste-end" systems collecting the fees at the time of disposal.

7.2.1 Exclusions from the Fee System

Following Section 40600 of the Public Resources Code, the disposal cost fee will be developed for all goods sold in California that are normally disposed of in landfills or transformation facilities, except those subject to Division 12.1 ("A.B. 2020 materials", i.e. beverage containers subject to deposits). As explained in Chapter 3, we estimate the California waste stream at 50 million tons in 1990, of which 1 million tons were A.B. 2020 materials.

One category of exemption will be for **goods that are not sold**. In particular, **yard waste**, accounting for 7.9 million tons of waste, will be exempt. This reflects the language of Section 40600, which specifically refers to goods sold in California. It also reflects the realities of yard waste generation, which differ from many other waste-generating activities.

There is no doubt that yard waste is an important part of the California waste stream, and imposes real disposal costs, much like other waste materials. Programs such as yard waste composting can be designed to handle this material. Indeed, yard waste may be one of the materials for which it is easiest to find environmentally attractive alternatives to landfilling. Such alternatives are an important part of waste management policy, but not a part of the disposal fee structure.

The fee system is intended to incorporate costs of disposal into the cost of goods, in order to provide a price signal to purchasers of the goods. There is no way to provide such a price signal for yard waste, since it is not sold: it just grows. Fees on fertilizer, grass seed, or other "yard waste inputs" would have a very tenuous relationship, at best, to the quantity of yard waste requiring disposal.

Other materials that are not sold will also be exempt. For example, **sewage sludge, industrial and agricultural wastes** are not sold (and often are not handled in landfills or transformation facilities). Thus the fee will not apply to such wastes. Sewage sludge accounts for most of the 1.7 million tons of "organic non-compostables" identified in Chapter 3; industrial wastes comprise an unknown portion of the poorly defined "other wastes" and "other special wastes", totalling 4.9 million tons (see, for instance, Table 3.9).

Another category of exemption will occur in cases where the fee would be extremely difficult to calculate and/or to administer. **Food waste**, for example, does impose waste management costs: chicken bones and orange peels must be collected and disposed of. Yet it would be very expensive to assess the quantity of bones, peels, or other organic wastes in each food purchase. Administration of a food waste disposal fee would be messy, both literally and figuratively. Moreover, it seems far-fetched to imagine that a disposal fee system could prompt the development of smaller chicken bones or thinner orange peels. Food waste accounts for 3.8 million tons of waste annually.

An exemption for the inherent organic wastes in food, however need not imply any exemption for food packaging. Manufactured packaging is readily measured, and packaging reduction is among the goals of a fee system.

Summarizing the exemptions identified here, the fee would apply to 30 - 36 million tons of the reported 50 million ton waste stream, as follows:

Total reported waste stream	50.0 million tons
Exemptions	
A.B. 2020 materials	1.0
Yard waste	7.9
Food waste	3.8
Sewage sludge	1.0 - 1.7
Industrial, agricultural wastes	0 - 4.9
Waste stream subject to fee	30.7 - 36.3 million tons

The uncertainty as to quantity depends on the composition of the relatively large reported "other" waste categories.

7.2.2 Front-end vs. Back-end Fees

A different kind of boundary question arises in setting the point in the product lifecycle where the fee is assessed. Broadly speaking, there are two alternatives. "Front-end", or advance disposal fees, are collected before the product is used and discarded, typically at the point of sale or earlier. "Back-end" fees are collected when the waste is discarded, or when it reaches the disposal facility.

In this study we focus on front-end fees. All the alternatives examined in detail, including the recommended fee system, are advance disposal fees. In this section we will briefly examine back-end fees, and explain the reasons why we have not pursued this option.

Back-end fees are volume-based disposal charges, requiring households to pay a varying amount depending on how much trash they discard.[1] One such approach is a "variable can rate", under which households sign up and pay for the number of garbage cans they expect to fill. Another approach is a "bag/tag system", under which households pay in advance for special bags or tags that must be used on all garbage set out for collection. Either system provides a clear incentive for waste reduction. Separate recycling and composting collection can be exempt from fees, providing an incentive for these activities as well.

Seattle, Washington is the largest (and best-studied) U.S. community using a back-end fee system. Since the introduction of a variable can rate in 1981, Seattle has witnessed a significant decline in per capita waste disposal volume. The price elasticity of garbage disposal in Seattle is estimated to be -.14. That is, a 10% increase in per-can charges would cause a 1.4% reduction in disposal volume.[2]

Other scattered indications of success with back-end fees have been reported. A number of smaller communities in the East and Midwest have implemented bag/tag garbage fee systems, often in conjunction with recycling programs. Perkasie, Pennsylvania reported a dramatic drop in landfill volume upon implementation of such a system. However, back-end fees have not been universally popular; cities such as Holyoke, Massachusetts have rejected back-end fees after extensive debate. The experience to date remains fragmentary, and little systematic analysis has been done.

The clarity and comprehensiveness of a back-end fee are attractive features. The fee is easy to explain; it automatically applies to all goods; it rewards all forms of source reduction and recycling. Nonetheless, back-end fees in general have drawbacks that render them inappropriate for use as the California disposal fee.

The comprehensiveness of the back-end approach is a weakness as well as a strength. The same fee necessarily applies to all materials: a bag full of plastic, a bag full of paper, and a bag full of used batteries all have the same volume, and pay the same back-end fee. Thus it is impossible, in the context of a back-end fee system, to incorporate information about the relative costs or environmental effects of disposal of different materials. Since the legislative mandate for this study (Section 40600) explicitly calls for analysis of the relative potential for environmental degradation caused by disposal of specific materials, a back-end fee is inadequate to the task. Use of a back-end fee would implicitly assume that most waste materials impose roughly similar disposal costs and environmental impacts per unit volume -- an assumption that is contradicted by our findings in Chapter 6.

Another possible drawback to back-end fees is the risk of illegal dumping or burning. Illegal disposal is reportedly rare in Seattle, despite the volume-based fees. This has been attributed to the city's strong environmental ethic and to the scarcity of vacant land (implying few opportunities for illegal dumping), among other factors.[3] In other areas, illegal disposal might be a more serious problem.

Finally, while conceptually straightforward, back-end fees require complex administrative systems. Variable can rates involve far more detailed recordkeeping and monitoring than flat rates per household. Bag/tag systems involve extensive distribution of the bags or tags, as well as monitoring of their use. Every municipality, county, and private waste hauler would have to participate in administering these systems. The administrative complexities of back-end systems are certainly different from those of the front-end systems proposed in this report, but it is not clear which system is simpler.

7.3 DEFINITION OF ALTERNATIVE FEE SYSTEMS

In this section we outline the characteristics that define and distinguish the four alternative fee systems listed in Table 7.1. There are three sets of characteristics to be considered: the point at which the fee is levied; the units in which the fee is calculated; and the presence or absence of recycling incentives.

7.3.1 Point of First Sale vs. Point of Final Sale

There are two major points at which an advance disposal fee can be levied: at the point of first sale in California (either manufacturer, importer or distributor of out-of-state goods), or at the point of final (usually retail) sale. These approaches are shown as Options 1 and 2 in Table 7.1. These two choices have opposing advantages and disadvantages.

An important feature of a fee at the point of first sale is its relative administrative simplicity. For most products, the producers or distributors are fewer in number and larger in size than the retail sales outlets.* This means that administrative costs are lower for a point of first sale fee than for a retail fee (see Chapter 8). It also means that there is more flexibility in defining the basis for the fee (see Section 7.3.2).

We employ the unfamiliar term, "point of first sale", rather than calling it a producer fee, in order to emphasize that the fee applies equally to all goods sold in California, whether they are produced in-state or out-of-state. For goods made in California, the first sale is made by the producer. For goods brought in from other states or countries, the first in-state sale is typically made by an importer or distributor. In either case the fee will be calculated and applied in the same manner, based on the material content of the good. Goods made in California and sold outside the state will be exempt.

The alternative, a fee at the point of final sale, involves fee collection from numerous, mainly small, retailers and distributors. Here we refer to "point of final sale" in order to include bulk purchases by business and government, which may not be made through retail establishments. Administrative costs will be higher than for a point of first sale fee, owing to the large number of establishments at which the fee is collected. However, it is possible that the fee could "piggyback" on the existing sales tax collection system, achieving some cost reduction. Since many small establishments are involved, the fee must be extremely simple to calculate and verify. This limits the options for definition of the fee.

In a point of final sale fee, intermediate goods sold to business must be separated from final goods, to avoid double counting. For example, steel sold to an auto plant should not be subject to

* In cases where there are many producers of the same products, such as agriculture, administrative feasibility might argue for the fee being collected from distributors rather than from original producers. But in this specific case, since food waste is exempt, the only fee on food products is the fee on the packaging. This would be levied at the point at which packaging is first sold or applied.

a fee, since the steel is going into automobiles that will bear a fee. On the other hand, cars sold to a steel company should be subject to a fee, since the cars will not be physically incorporated into the steel company's product.

A point of first sale fee is likely to be included in wholesale prices, and therefore somewhat hidden from consumers. This does not affect the purely monetary incentive for source reduction; if the fee is passed on to final consumers, it still penalizes the more waste-intensive products. However, environmentally concerned consumers may want to know the size of the fee, and may use it as a measure of the environmental impact of their purchases. In general, publicity about the fee will likely heighten its impact. Public education about the basis for the fee, perhaps combined with labelling standards, will be important to make a point of first sale fee visible to consumers.

On the other hand, a point of first sale fee is highly visible to producers and distributors, and provides a clear incentive for producers to change toward waste-minimizing products. Such changes by producers, in turn, influence the availability of waste-minimizing options for consumers, allowing reduction in total waste quantities.

The relative visibility of a point of final sale fee is exactly opposite. Since it is collected at the retail level, it could easily be shown separately on price tags and cash register receipts. A point of final sale fee will likely be obvious to consumers, without great educational effort. It will be correspondingly less directly visible to producers and distributors, although these firms will likely notice the fee and analyze its effect on their sales.

The relative visibility of the fee should not be confused with its ultimate impact on production and consumption. A point of first sale fee is clearly more visible to producers, while a point of final sale fee is more visible to consumers. However, this does not necessarily indicate the point at which the financial burden of the fee is felt. Fees imposed on producers can be either absorbed by producers (through cuts in costs or profits, holding prices constant), or shifted forward to consumers through price increases. Similarly, fees imposed on consumers can be either absorbed by consumers, or shifted back to producers (if sales fall so much that producers are forced to cut prices and absorb the fees).

Economic theory offers clear-cut analysis of this incidence problem only under selected, idealized circumstances, such as perfect competition among numerous small producers. In the real world, the question of tax-shifting and ultimate incidence of the financial burden must remain somewhat uncertain. We will examine this question further in Section 7.5.

The point of first sale/point of final sale distinction is one of the most important variations among possible fee systems. It is closely linked to the question of the units in which the fee is assessed, the topic of the next subsection.

7.3.2 Choice of Units

In implementation of the fee, it will be necessary to establish the units in which it will be assessed. In theory, the units should correspond to the units of cost causation in the solid waste management system. Thus, it would be appropriately based upon physical units, i.e. weight or volume. A pure sales tax, based on the value of a purchase, is inappropriate; a $5 wine bottle and a $20 wine bottle take up the same amount of space in a landfill. A value-based, sales-tax-like disposal fee system is a "second-best" alternative from a theoretical standpoint; its only virtue is its administrative simplicity.

Some solid waste disposal costs depend on the volume of a good; others depend on weight and material type. Volume is the key determinant of many conventional costs, including both collection costs (based on the rate at which trucks fill up) and landfill costs. So the theoretically ideal system would base the fee, at least in part, on volume. Environmental costs would stem from the mass of materials of different types. So the theoretically ideal system would base the fee in part on weight.

However, it does not appear practical to assess taxes on a volume basis, due to difficulties of measurement. Calculation of volume is easy only for objects with very simple shapes, such as rectangular boxes and cylinders. Laboratory approaches to volume measurement for more complex shapes, such as immersion of an object in water and measurement of the displacement, are time-consuming for all goods, and difficult to envision for categories such as flexible paper packaging.*

If volume rates are excluded, the remaining realistic alternatives are weight or piece rates, i.e. per-pound or per-unit fees, differentiated by material as needed. Most of the existing or proposed fees identified in Chapter 2 are per-unit fees, typically assessed on some well-defined unit (a fixed amount per tire, per car battery, per diaper, etc.) Such an approach has an appealing simplicity for single-item fees, but raises new administrative complexities in the context of an across-the-board fee.

Weight-based measures, while more complex for single-item fees, will be simpler in the broader context of the disposal fee. The weight of materials to be disposed is the determinant of some costs, such as the monetary costs of recycling or incineration, or the environmental damages caused by particular materials. Weight may also serve as a proxy for volume (within any particular category of goods, weight is likely proportional to volume), indirectly measuring volume-based costs as well as weight-based costs.

In our choice of major options, presented in Table 7.1, we link the units or basis for fee determination to the level at which it is collected. A point of final sale fee system (Option 2), potentially involving fee collection by hundreds of thousands of retail outlets, must be very simple and straightforward. Here, despite its theoretical limitations, a value-based fee may be necessary for practical reasons; it should be differentiated by material type, to capture the differential pattern of disposal costs. One possible alternative for point of final sale fees is to have manufacturers or distributors calculate and provide retailers with weight-based fee schedules. Another alternative is to provide standard schedules of per-unit charges, differentiated by type of product. However, either of these approaches seems administratively cumbersome.

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* Back-end fees, as discussed in Section 7.2.2 above, are based primarily on volume. Measurement of volume is no longer a problem at the time of disposal; it becomes a matter of counting the number of standard bags or cans filled. Volume-based back-end fees, however, reward households that crush their garbage before disposal just as much as households that actually achieve source reduction, a potentially problematical outcome.

A point of first sale fee system (Option 1) provides greater flexibility in definition of the basis for fees. The firms collecting the fee are larger, and fewer in number; they can reasonably be asked to administer a system that might be too complex for retailers. It does not seem unduly onerous to ask manufacturers and distributors to report the weight and major material types used in their products. Since weight-based fees are the most theoretically appropriate (with the possible exception of volume-based fees, which remain unworkable even at the producer level), a point of first sale fee system should involve weight-based fees. Of course, this option, too, should be differentiated by material; that is, the per-pound charge should depend on the type of material.

7.3.3 Fee Structure and Recycling Incentives

A tricky problem is posed by the question of recycling incentives. Should the fee distinguish, for example, between newspapers made from recycled vs. virgin newsprint? Although they are made differently, in ways that have important environmental impacts, both recycled and virgin newspapers have the same disposal impacts. The goal of using the fee to reflect disposal costs could conflict with the goal of using it to stimulate use of recycled newsprint.

The issue here is in part one of source reduction vs. recycling goals. A fee based purely on disposal costs rewards source reduction: printing fewer pages in the Sunday paper is the one sure route to a lower fee. In contrast, a fee with exemptions or incentives for use of recycled materials allows lower fees even for enormous Sunday papers, if printed on recycled paper. The more effective the fee is in encouraging use of recycled paper, the less effective it is in encouraging overall reduction of paper use (and vice versa).

The law mandating this study (Section 40600 of the Public Resource Code, as amended) is ambiguous as to its goals. Onthe one hand, it calls for the fee to be "based on the estimated cost of handling and processing a material for recycling or disposal", suggesting a full-cost fee which would stimulate source reduction. On the other hand it calls for the fee to create "an incentive for the use of disposable materials for recycling over equivalent materials for disposal", a goal which may conflict with the development of a cost-based fee (if, as with some materials, recycling is at least as expensive as disposal).

Both source reduction and recycling goals are important, and could be embodied in different fee systems. Or, of course, a single fee system can be based on a compromise between these goals, perhaps offering only a partial fee reduction for recycled content. But the conflict is unavoidable: **the same fee system cannot contain the maximum possible incentives for both source reduction and recycling.** In designing a fee system, we have to make a choice between providing an incentive for source reduction, or for some combination of the two objectives.

To focus on this basic choice, we have included presence or absence of recycling incentives as one of the key distinctions among fee systems (Options A and B, in Table 7.1). This choice is independent of the point of first sale/point of final sale distinction. Thus one could create point of first sale fees either without separate incentives (fee system 1A), or with incentives such as lowered rates for products made of recycled materials (1B). Likewise, point of final sale fees could exist either without (2A) or with (2B) incentives for secondary content.

This discussion about possible incentives for recycled *content* should not be confused with the automatic incorporation of recycling *rates* into our calculation of disposal costs. (The state's recycling rate is not the same as the recycled content level: for instance, newspapers could be made out of 100% virgin newsprint, then recycled and shipped out of state for reuse.) Our calculated disposal cost for a material such as newspaper is a weighted average of the cost of recycling and the cost of disposal; the weights are based on our analysis of recycling rates. As recycling rates change, the weights in that weighted average will change.

Assuming that recycling costs are lower than traditional disposal costs (which is true for most materials, particularly when environmental costs are included), an increase in recycling rates will automatically mean a reduction in fees. This will happen in the periodic updates of the fee system, to be addressed in Chapter 8; we suggest updates every two years. So, regardless of the current recycled content of California newspapers, their calculated disposal cost depends directly on the actual rate of recycling, and will change as recycling rates change.

In light of this built-in mechanism, it would not make sense to modify the fee structure to give additional, separate incentives based on recycling rates. A separate exemption for a material that reaches a (high) target recycling level amounts to an assumption that recycling is costless -- which is not generally true. Source reduction remains a higher priority than recycling; a cost-based fee should still reflect the (usually low, but still real) costs of recycling each material.

Another possibility, exemptions or fee reductions to provide incentives for use of potentially recyclable materials, was discussed briefly in Section 7.1. Encouraging use of potentially recyclable materials is a desirable goal, and an important part of long-run waste management policy. However, *potential* recyclability does not affect disposal costs until it becomes *actual* recycling. Many materials are in one sense or another potentially recyclable, though sometimes not at an affordable cost; if one starts handing out potential recyclability bonuses, how much potential does a material have to show? Actual recycling, in contrast, is easy to define. A cost-based fee, already based on actual recycling rates and costs, including those associated with planned facilities, should not be modified to reward claims of potential recyclability.

Other options to promote recycling will be addressed in Chapter 8, as we discuss the uses of the revenues from the recommended fee system. The fee itself might be, for example, a weight-based tax on certain materials; it would therefore create a direct incentive for source reduction in those materials. The revenues, however, could be used differently, to support local community recycling programs, sponsor research and demonstration projects on use of recycled materials, or other related purposes.

7.4 FEE LEVELS

7.4.1 Relationships Between Waste Management Costs and Fee Levels

Economic theory, as summarized above, dictates the primary functional relationship between waste management costs and the fee level. The theoretical ideal is to incorporate the full marginal costs (both conventional and environmental) of waste management into the fee charged on each good or material. The calculations in Chapters 3 through 6 provide a quantitative basis for recommendations as to the fee levels. Particularly in the valuation of environmental damages, it is possible that a range of uncertainty will remain for some cost elements. Nonetheless, the principle is clear.

Adding the calculated waste management costs for each material yields the total revenue expected from the fee on a full-cost basis (prior to exemption for secondary content, if any). The state might wish to modify this in order to achieve a different revenue target. As shown in Table 8.1 (see Chapter 8), the full cost-based fee generates roughly $5 billion annually.

As we will discuss in Chapter 8, public policy considerations may require setting the fee at a fraction of this full cost level. However, for the remainder of Chapter 7 we will examine the impacts of the fee if assessed at 100% of the full cost level.

7.4.2 Illustrative Estimates of Fee Levels on Various Categories of Products

In order to forecast the economic impacts of the disposal fee (see section 7.5), it is necessary first to examine how the level of the fee on different materials translates into fee levels on specific categories of products, based on the weight of each material contained in a product. From the viewpoint of the consumer, the concern is not the actual dollar amount of the disposal fee, but the disposal fee in comparison to the price of the product and its alternatives. Given the disposal fee per weight of material, the amount of material in the product, and the price of the product, the disposal fee as a percentage of the product price can be calculated as follows:

$$\text{DF/price of a product} = \frac{\text{(DF per pound of material) * (pounds of material/unit of product)}}{\text{unit product price}}$$

Having such information will aid in the estimation of several important numbers:

1) the relative amounts of disposal costs caused by different products and industries and, assuming that the disposal fee is set according to these costs, the relative impacts of the disposal fee on product prices in those industries.

2) the approximate burden of the disposal fee on households, based on expenditure patterns of households.

3) changes in consumer buying patterns as a result of the disposal fee, calculated by assuming that the response of consumers to price changes can be estimated. In economic terms this response is known as the "price elasticity of demand" for products (see Section 7.6.1 and the Appendix to Chapter 7).

Ideally, the average weights of materials contained in products, and the average prices of these products, would be available in statistically systematic form. Unfortunately, Tellus Institute's prior research has determined that these sets of data are not readily obtainable, either for broadly-defined or narrowly-defined groups of products. For example, suppose we wanted to know the average weight of glass beverage bottles, and the average retail prices of the products (soda, juice, wine, etc.) contained in such bottles. While various sources of information can be used to approximate the necessary figures, it is surprisingly difficult to obtain reliable data. The difficulties are much greater for more complicated categories of products, such as food in paper packaging, household cleansers, or electronic products.

Tellus has, with substantial effort, been developing such a database for packaging materials in connection with our work for the Council of State Governments. However, packaging materials are only a fraction of the total solid waste stream, and it is the latter which is of concern to California. Systematic data on weights of materials in products and prices for categories of products are not available across the entire spectrum of goods in the economy.

7.4.3 Illustrative Sample Survey

Owing to the difficulties in obtaining reliable data, we have performed a sample survey of a variety of products that are important consumer purchases. While intended to be a representative sample, it should be emphasized that the sample has the following limitations:

- It is a relatively small sampling of products, and is neither statistically random nor in proportion to the numbers of products of each specific type (such as computer printers versus stereo receivers) sold in the economy. Broad categories of products are in proportion to overall spending.
- It uses Boston-area prices.
- It covers only **residential** solid waste costs, omitting the major category of commercial waste.
- The list of materials for which full waste management costs have been calculated is not exhaustive of the waste stream. The materials included are those which were easily identifiable in the products sampled.

Our survey is intended to provide illustrative examples, which can be used to make "ballpark" estimates of economic impacts.

In our survey, weight and price information was collected for the following categories of consumer products:

- Beverage containers - juice, milk, and water. Soft drinks and beer were omitted since they are separately covered by AB 2020.
- Food packaging - glass, paper, plastic, and metal packaging. For both beverage containers and food packaging, more than one material is used to package each product. In such cases, we have categorized the package according to the material having the greatest weight. However, weights and disposal costs are calculated separately for each material if more than one is present.
- Alcoholic beverages (excluding beer).
- Fast food restaurant packaging.
- Tobacco products.
- Household disposables - plastic, paper.
- Toiletries - plastic, paper.
- Newspapers.
- Magazines.
- Office supplies.
- Junk mail - in this case, since there is no direct price to the consumer, no disposal cost/price of product ratio can be calculated.
- Clothing

- Consumer durables - several kitchen items and electronic products were sampled.
- Large appliances ("white goods").
- Automobiles.

The methodology used to estimate the amount of the proposed disposal fee in relation to the prices of the products sampled is summarized below.

1) The weight and price of each item was recorded. If a particular product contained packaging of more than one material (such as food packaged in both paper and plastic), the weights were recorded separately.

2) For each product sampled, the full waste management costs per material (calculated in Chapter 6) were multiplied by the weights recorded above, to obtain a full waste management cost for each product. This cost is the actualized fee per product (recall that the fee will be set per ton of material, not per product).

3) The full waste management cost was divided by the price of the product to obtain a ratio that expresses the proposed disposal fee as a percentage of product price.

4) An average was taken of this ratio within a general category of consumer expenditures (beverages, food, appliances, etc.). For beverage containers, food packaging, household disposables, and toiletry items, separate averages were calculated for products packaged in different materials.

For most products, disposal costs are incurred for both the item itself and the materials in which it is packaged. In the case of food and beverages, we have counted only the packaging and have not made any allowance for the liquids and foods which become solid waste. For toiletry items, we have also assumed that the contents are fully utilized, and therefore only the packaging becomes solid waste. In contrast, for certain "household disposables," such as napkins and plastic trash bags, we have counted both the contents and the packaging as solid waste. For newspapers, magazines, and office supplies, we have also assumed that the entire item eventually enters the waste stream. These are all categories of "non-durable" goods -- items which become solid waste in fairly short periods of time.

For durable goods, including kitchen items, electronics, and large appliances, we have weighed and separately calculated disposal costs for both the product itself and the packaging. For clothing and automobiles, we have calculated weights for the items themselves, but have not included any estimate of packaging, which should be relatively insignificant compared to the weights of the items.

TABLE 7.2: CALIFORNIA CONVENTIONAL AND ENVIRONMENTAL COSTS OF SOLID WASTE DISPOSAL (Dollars per Ton of Material Disposed)

CATEGORY	CONVENTIONAL COSTS	ENVIRONMENTAL COSTS	FULL COSTS
aluminum	94.63	54.08	148.71
ferrous metal	89.74	35.59	125.33
white goods	89.74	45.59	135.33
glass	28.60	10.57	39.17
corrugated	95.66	22.49	118.15
newspaper	63.33	18.91	82.24
high grade office paper	61.89	19.23	81.12
other paper	106.02	24.02	130.04
PET	246.15	43.20	289.35
HDPE	245.55	43.11	288.66
polystyrene foam	275.40	44.29	319.69
plastic film	141.71	38.41	180.12
other plastic	275.40	44.29	319.69
textiles	165.23	27.73	192.96
household hazardous waste	—	—	1943.61

In Table 7.3, for comparative purposes, we first show the ratio of the full waste management cost/price for different materials that are used to package similar products. This is done in the cases of non-exempt beverage containers, food packaging, household disposables, and toiletry items. Lower in the table, all materials are combined within the same product category. Beverage containers and food packaging are also combined, so as to permit this category's usage in conjunction with household expenditure data in Section 7.5.

TABLE 7.3: SUMMARY OF DISPOSAL COSTS AS A PERCENTAGE OF CONSUMER-PRODUCT PRICES[4]

PRODUCT CATEGORY	FULL COST/PRICE
SEPARATED BY MATERIAL	
non-exempt glass beverage containers	1.11%
non-exempt plastic beverage containers	1.05%
glass food packaging	0.62%
paper food packaging	0.41%
plastic food packaging	0.44%
metal food packaging	1.17%
plastic household disposables	1.80%
paper household disposables	1.70%
plastic toiletries	0.41%
paper toiletries	0.14%
MATERIALS COMBINED	
non-exempt beverages	1.10%
food packaging	0.64%
food & beverages combined	0.69%
alcoholic beverages	0.43%
household disposables	1.76%
toiletries	0.29%
fast food restaurants	0.18%
tobacco products	0.06%
newspapers	7.53%
magazines	1.15%
office supplies	2.58%
clothing	0.30%
consumer durables	0.95%
appliances	2.83%
automobiles	1.30%

As can be seen in Table 7.3, those industries for which disposal costs are the largest percentage of product prices are newspapers; office supplies; appliances; and household disposables, with over 7 percent for newspapers*, and percentages in the range of 2 to 3 percent for the latter categories. For all other economic sectors, the results are approximately 1 percent or lower. It should be noted that for newspapers and magazines, these percentages are not a fair indication of the impact which a disposal fee would have on prices, due to the role of advertising. Since advertising revenues make up a substantial portion of total income for these sectors, part of the disposal fee could be passed on to advertisers rather than to purchasers of the newspapers and magazines.

For the four sectors shown at the top of Table 7.3 we can examine how disposal costs in relation to product prices vary based on the material used for packaging. It should be recognized that such comparisons do not necessarily show which packaging material is most economical, since different materials are being used for different specific products, based in large part on the particular packaging needs in question.

The full survey information from which these summary averages are derived are provided at the end of this chapter. It should be emphasized again that the data are illustrative only, based on small samples and late 1990 Boston-area prices. The data, while generally representative of consumer purchases, are not exhaustive of those purchasing categories, nor are they strictly proportional to the numbers of items purchased in each category.

7.5 ECONOMIC IMPACTS OF THE DISPOSAL FEE

7.5.1 Impacts on Household Budgets

In considering the effects that the fee has on consumers, it is important to examine the question of income distribution. In technical terms, the fee is virtually certain to be quite "regressive", taking a larger percentage of income from lower-income households and communities. (Recall that $5 and $20 wine bottles will likely have the same fee; that fee is probably a larger percentage of income for those who buy $5 wine.) Partial compensation for this problem could be achieved through targeted use of the revenues from the fee, for instance by special subsidies to recycling or environmental protection in lower-income communities.

Given the dollar value of the disposal fee per dollar of product prices (derived in Section 7.4), we have calculated illustrative average numbers for the disposal fee at 100% of the full cost level, as a percentage of spending for various categories of consumer products. By matching these percentages to Bureau of Labor Statistics (BLS) data on the distribution of household spending for different product categories, we can calculate the amount of the disposal fee for each category of spending. These figures can then be summed to give the total cost of the disposal fee per household, as shown in Table 7.5.

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* Newspapers are atypical, in that advertisers pay a substantial part of the costs, so that prices to consumers are well below production costs. If disposal costs were expressed as a percentage of production costs, newspapers would not appear so far out of line with other goods.

Using BLS data on income and spending by portions of the population in different income brackets, we can then show how the disposal fee affects households of low, moderate, and high incomes. This has been done in Table 7.5 in income "quintiles" - dividing the entire population into five groups containing equal numbers of households.

The data on consumer expenditures by category, and on total income and spending, are for the United States as a whole, modified to account for income differences between the average household in California versus the entire country; the results are shown in Table 7.4. Average personal income in California was approximately 14 percent above the national average as of 1988.

Several detailed adjustments to the sample data and BLS data were required in order to make them comparable. These adjustments are explained in an endnote.[5]

TABLE 7.4: CALIFORNIA INCOME AND SPENDING DATA BY INCOME QUINTILE (adjusted from national data)[6]

	SPENDING CATEGORY	
INCOME QUINTILE	INCOME BEFORE TAXES	TOTAL SPENDING
LOWEST 20%	5,244	11,777
SECOND 20%	13,595	17,840
THIRD 20%	23,819	24,689
FOURTH 20%	37,845	33,668
HIGHEST 20%	74,778	52,851
ALL HOUSEHOLDS*	31,078	28,178

TABLE 7.5: IMPACT OF THE FULL-COST DISPOSAL FEE ON HOUSEHOLD BUDGETS IN CALIFORNIA: BY INCOME QUINTILE (residential disposal costs only)[7]

INCOME QUINTILE	DISPOSAL FEE AS PERCENT OF		TOTAL DISPOSAL FEE
	INCOME BEFORE TAXES	TOTAL SPENDING	
LOWEST 20%	1.05%	0.47%	$55
SECOND 20%	0.63%	0.48%	$86
THIRD 20%	0.51%	0.49%	$121
FOURTH 20%	0.45%	0.51%	$172
HIGHEST 20%	0.36%	0.51%	$271
ALL HOUSEHOLDS*	0.45%	0.50%	$141

Note: "All Households" includes only those households which reported their incomes when surveyed by the U.S. Bureau of Labor Statistics.

It is important to recognize that the figures above are only for solid waste collected at the residential level, since that is all our survey of products weights and prices applied to. Commercial and industrial solid waste is not included. Thus, the above figures on dollar cost per household are what a household could be expected to pay for residential waste disposal costs, through purchases of consumer goods. To the degree that the disposal fee is also imposed on businesses which generate and dispose of solid waste during their own operations, and that the increased costs are passed on to consumers, the total fee burden per household will be substantially greater than is shown in the table above. It is likely that such costs would be passed on in the prices of products.

Another way to see this is to examine the total tax yield based on the table above. With $141 per average household, and a total of 10.3 million households[8], approximately $1.45 billion in tax revenues would be generated from residential non-hazardous wastes. (The higher full-cost-level for revenue reported in Table 8.1 includes commercial waste and household hazardous waste, both of which are excluded from Table 7.5.) In contrast, a more general calculation, based on the total volume of residential, commercial, and industrial solid waste disposed each year in California, would yield an expected tax revenue in the neighborhood of $3 billion.

A table showing the details leading to the summary above is provided at the end of this chapter. In that table, consumer spending for each household income quintile is divided into twenty categories. Each category has applied to it the ratio of disposal costs to product prices (titled "DF as % of cost), yielding the amount of the disposal fee for each quintile by category of consumption spending. Recognizing that these are only illustrative calculations, the table can be used to approximate, for example, the disposal fee cost per household in the third income quintile, for "food at home" or newspapers.

7.5.2 Impacts on Industries in Relation to Product Prices and Cost of Material Inputs

The data in Section 7.4 concerning illustrative changes in product prices by categories of consumer products give an indication of the degree by which commodity prices to households will increase as a consequence of a fee that embodies the full waste management costs of those commodities. We will discuss further in Section 7.6 the extent to which consumer buying patterns can be expected to shift due to changes in relative prices. In general, we can say here that the shifts will be fairly small, due to the fact that the expected price changes are relatively small.

Further questions arise concerning the degree to which the prices of materials purchased by industries will change, as well as the resulting changes in the purchasing decisions of these industries. The first question will be discussed here, and the second addressed in Section 7.6.

Given our sample data on consumer product weights and prices, we could directly calculate the disposal fee as a percentage of raw material costs if we knew the prices of the materials that were used as inputs to these products. Unfortunately, prices of material inputs are very difficult to obtain in a systematic form. The U.S. government provides data series on changes in price levels, but for confidentiality reasons does not publicly reveal actual price levels for product categories. While a variety of prices are available from industry sources and trade publications, they generally do not correspond well to our needs in this study.

As a result, we have employed what is known as "input-output" data, from the *Annual Input-Output Accounts of the U.S. Economy, 1985*, published by the Interindustry Economics Division of the U.S. Department of Commerce. These tables show the inputs from each industry to every other industry, in dollar terms. Using the input-output tables, we were able to extract the inputs of major raw materials to each consumer products sector. Dividing the total value of raw materials by the total value of output for an industry shows material inputs as a percentage of output, which gives a general indication of how important solid waste disposal costs will be to the economics of a particular industry. In Table 7.6 and following this ratio is termed "Material Input/Output."

Using the ratios derived above and the data shown in Section 7.4 on the disposal fee (disposal cost) as a percentage of product prices, we can derive the disposal fee as a percentage of material input costs. This ratio then shows the degree to which the costs of raw materials to an industry will be increased by the disposal fee, which in turn can be used as an indicator of the extent to which the industry can be expected to engage in source reduction as a way of reducing its costs. Note that these ratios could only be calculated for those industries in which we had collected illustrative price and weight data.

The derivation is as follows:

$$\text{DF/material input cost} = \frac{\text{(DF/product price)}}{\text{(material input/output)}}$$

To summarize:

Material Input/Output = in dollar terms, the percentage of the value of an industry's output which is due to raw material inputs.

DF/Product Price = the full waste management cost (conventional disposal cost plus environmental cost) of a consumer product, divided by the price of that product.

DF/Material Input Cost = the full waste management cost, divided by material input costs, for a particular category of products. This can be interpreted as the expected percentage price increase of raw material costs to industries.

Based on the illustrative results in Table 7.6, one can observe that the industry for which the disposal fee as a percent of material input is the highest is the household appliances industry, with 12.19%. Industries with mid-range disposal fee to material input ratios, ranging from 8.83% to 11.80%, are: eating and drinking establishments, the furniture industry, and the motor vehicles and equipment industry. Those industries with the lowest associated disposal fee to material inputs ratios are: tobacco manufacturers (1.84%), drug, cleaning and toiletries industries (3.33%), electronic component and accessories manufacturers (5.93), and food and kindred products manufacturers (7.43%).

A valid ratio of disposal fees to material inputs could not be calculated for the "printing and publishing" industry, because of the role of advertising in providing a large fraction of the total revenues of newspapers and magazines. In the derivation above, it was necessary to assume that the costs of producing products are the same as the prices paid by purchasers. Due to advertising, this is not the case for printing and publishing.

TABLE 7.6: MATERIAL INPUTS TO INDUSTRIES AS A PERCENTAGE OF OUTPUT COSTS, DISPOSAL FEE AS A PERCENTAGE OF MATERIAL INPUT COSTS (all source data in dollars)[9]

SECTOR	MATERIAL INPUTS/ OUTPUT	DISPOSAL FEE/ PRODUCT PRICE (FROM TABLE 7.3)	DISPOSAL FEE/ MATERIAL INPUTS
New construction	14.5%		
Repair, mainten. construct	9.9%		
Food & kindred products	9.3%	0.69%	7.43%
Tobacco manufacturing	3.2%	0.06%	1.84%
Apparel	—	0.30%	—
Misc. fabric & textiles	6.5%		
Household furniture	24.0%	2.83%	11.80%
Printing & publishing	16.0%	4.34%	—
Drugs,clean,toiletries	8.8%	0.29%	3.33%
Footwear, leather products	10.9%		
Household appliances	23.2%	2.83%	12.19%
Electronic compon's & acc's	16.0%	0.95%	5.93%
Motor vehicles & equipment	11.0%	1.30%	11.76%
Wholesale & retail trade	1.2%		
Eating & drinking places	2.1%	0.18%	8.83%

NOTE: For apparel, the I-O tables give major input as "broad and narrow fabrics, yarn and thread mills." Raw material input is not given. For "printing and publishing" a simple average of the newspaper and magazine figures was used.

The full set of data showing detailed material inputs into industries are provided in Table 7.9 at the end of this chapter. Note that these figures show the **direct** material inputs into industries. They do not show **indirect** inputs, and can thus be deceiving. For example, the column titled "personal consumption expenditures", which refers to spending by households, has very small amounts of material inputs. All this means is that households buy very little in the way of such items as "wood containers," "plastics, synthetic materials," and "primary iron and steel." However, the **products** which households purchase contain large amounts of all these materials, the cost of which is presumably passed through from manufacturers to consumers.

Besides personal consumption expenditures and governmental spending, the industries shown in the detailed tables are those which are generally considered "consumer goods" industries. The column titled "Total Material in Consumer Products" is a summation of all materials contained in all these industries. However, the table does not include "producer goods" industries, such as the manufacturers of various types of industrial equipment. It is reasonable to assume that the costs of materials embodied in producer goods are also eventually passed on to final consumers. Finally, in some of the categories there is a combination of consumer and producer spending, such as for "new construction" and "repair and maintenance construction."

7.6 IMPACTS OF THE DISPOSAL FEE ON CONSUMER AND PRODUCER BEHAVIOR

In Section 7.5 we examined the impacts which the disposal fee can be expected to have on households and industries. Those calculations in effect assume that household purchasing patterns for end-user products and business firm purchases of raw materials and intermediate goods are unchanged. In this section we examine possible impacts of the disposal fee on reducing the volume of solid waste generated, both through "source reduction" strictly defined as reductions in the amounts of a material used, and through switches from one material to another.

7.6.1 Consumer Purchasing Behavior

Effects of the fee on consumer behavior depend on the changes in relative prices resulting from the fee, the price-elasticity of demand for the affected products, any explicit incentives incorporated into the fee structure, and the perception or visibility of the fee. Especially on the last issue, a fee imposed at the point of final sale will have greater effects than a fee at the point of first sale. The greatest changes in consumer behavior are to be expected on items with high fees (especially products containing hazardous waste, which will have the highest fees), luxuries and discretionary purchases (where price elasticity is greatest), and cases where there are well-publicized alternatives which have lower fees due to lower impacts.

Changes in consumer purchasing can be estimated based on the product of two factors:

1) the percentage increase in the price of a product, as estimated in Section 7.4 above.

2) the percentage response of consumers to a price increase, known as the "price elasticity of demand."

This second factor is rather difficult to estimate, especially in a situation where it is not only the price of a single product which changes, but the prices of virtually all consumer products. We have conducted an extensive review of the academic economics literature on this subject. That review is contained in the Appendix to Chapter 7. For a variety of reasons, including limitations on the available data and complications in the use of statistical techniques, there are no available figures which are appropriate to use as indicators of consumer response to the proposed California disposal fee. For a full discussion we refer the reader to the Appendix.

When making purchases, consumers must make several decisions relevant to this study. They must:

1) divide expenditures among major categories of consumption, such as food, housing, and medical care;

2) choose among different products within a major category, such as packaged frozen vegetables versus fresh vegetables; and

3) choose between different forms in which the same product can be obtained, such as between two items packaged in plastic, paper, glass, or steel containers.

Each of these sets of decisions requires estimation of a separate set of demand elasticities, and in each case the estimates must account for the prices of all products changing simultaneously. For the first level of decision making, the best available study is one done in 1983 by Blanciforti and Green.[10] The authors found elasticities ranging from -.15 to -.92 for various categories of expenditures, meaning that for a one percent increase in the price of a product category, the demand would fall from 0.15 percent to 0.92 percent, depending on the category. Food, for example, was estimated to have an elasticity of -0.32. However, the figures assume that only the price of *one category* of spending is changing, with all others constant. Since, in the case of the disposal fee, all prices will be rising, we can expect smaller changes in spending for each category. Thus, the relevant demand elasticities would all be well below 1.0, most likely below 0.50, with consumption shifting from solid-waste intensive sectors to those sectors (such as services) where solid waste is a small proportion of total costs. The Appendix to this chapter also reviews several studies, including ones based on consumer behavior in the United Kingdom, and others considering specific products such as tobacco and alcohol, which found results in the same general order of magnitude.

Applying these elasticities to the results in Section 7.4 for disposal costs divided by product prices leads to the conclusion that shifts between major categories of consumer spending are likely to be small. In most cases, the disposal fee would be less than 1 percent of the product price. Multiplied by an elasticity of less than 0.5, such a fee would yield a reduction in purchasing of less than 0.5 percent. The only categories where greater impacts appear possible would seem to be household hazardous wastes; household disposables (such as napkins and trash bags, where both the product itself and the packaging become solid waste); newspapers; and office supplies (such as copy paper). Major household appliances, such as refrigerators, also have a relatively high level of disposal costs compared to their prices.

Estimating impacts on the newspaper and magazine industries involves an additional complication, in that the market price for newspapers and magazines reflects not only the price paid by consumers but also revenues from advertisers. Part of a cost increase can be passed back to the advertisers, thereby moderating the price rise and any consequent reduction in sales.

Reliable data on consumer choices between different products in the same category and between different forms in which the same product can be obtained, listed above as decision types (2) and (3), respectively, are even more difficult to obtain. What exists tends to be marketing research concerning very specific products in comparison to each other, which is not useful in terms of a broadly-based disposal fee.

7.6.2 Producer Use of Materials

As discussed in the Appendix, we have found no studies concerning broad industry responses to price changes in the cost of their material inputs. The most valuable work available is a study, now outdated, done in 1980 by Allen K. Miedema, et al., titled *Modeling the Effects of a Product Disposal Charge*.[11] This study only dealt with packaging materials, not the broader range of solid waste under consideration by California. By varying the prices of all packaging materials at the same time, with exemptions for materials with recycled content, Miedema found an elasticity of demand for the use of virgin materials of between -0.20 and -1.99. At the low end of this range were flexible paper and aluminum packaging, and at the high end were steel and aluminum, with rigid paper, rigid plastic, glass, and flexible plastic clustered in the neighborhood of -1.0.

Making the heroic assumption that Miedema's ten-year-old study still has some degree of validity, and that the results for packaging materials are somewhat generally applicable, this indicates a substantial responsiveness of demand to prices. However, more than half of the response was due to the exemption for recycled content. Without this exemption, the elasticities for rigid materials would range from approximately -0.5 to -1.0.

We can now refer back to Section 7.5.2, in which the disposal fee per dollar of material inputs was estimated. For those sectors in which data was available, the percentage increase in material costs ranged from 2 to 12 percent (leaving aside printing and publishing). The lowest percentage is in tobacco manufacturing, with the highest percentages (all near 12 percent) in household furniture and furnishings, household appliances, and motor vehicles and equipment. Food and kindred products, apparel, electronic components and accessories, and eating and drinking places (which means fast food restaurants in our survey) are all in the range of 6 to 9 percent. Combining these figures with the Miedema results, with no exemptions for recycled products, would yield reductions in materials usage of between 1 and 12 percent, depending on the business sector and material. If reductions in the advance disposal fee, or full exemptions, are offered on the basis of recycled content, then greater shifts from virgin to secondary materials can be expected, but less source reduction would also occur. Unfortunately, making any more definite statements than that above would be unjustified given the existing state of knowledge.

7.6.3 Recycling Habits

Effects on recycling habits depend on any explicit exemptions structured into the fee system, and perhaps on the generally heightened awareness of the importance of recycling that will result from public discussion and debate over the fee. If industry recognizes that increased recycling rates lead to lower fees (in the periodic updates of the fee, to be discussed in Chapter 9), there could be industry initiatives to boost recycling of their own products.

7.6.4 Disposal Habits

Effects on disposal habits, complementary to recycling habits, depend on changes in the mix of recycling versus disposal for specific products, and on heightened awareness of environmental costs of disposal as a basis for the fee. To the degree that the total disposal costs calculated in Chapter 6 lead to substantially different fees, based for example, on rates of incineration vs. landfilling of some goods, this may stimulate interest in changing the future mix of disposal technology in the state.

7.6.5 Sales and Income Tax Revenues

The disposal fee is not expected to change overall consumer spending patterns to a large degree. To the extent that behavior is affected, a reallocation among categories of consumer expenditures, and among specific products and methods of packaging products is the major forecasted result. As a whole, sales of products subject to the California sales tax should not be affected substantially. Unless there is deductibility of the disposal fee from income taxes, the latter should not be affected. Such deductibility would be difficult to implement regardless of which method of implementing the disposal fee is chosen. It would be virtually impossible if the tax is imposed at the point of first sale, since end-user products would embody fees calculated on earlier inputs.

Table 7.7 Disposal Costs Vs. Prices of Products

ITEM	WEIGHT (POUNDS)	PRICE	MATERIAL	ECONOMIC COST/ TON	ENVIRON COST/ TON	TOTAL DISP COST PER POUND	TOTAL DISP COST PER ITEM	DISPOSAL COST/ PRICE
BEVERAGE CONTAINERS								
NON-EXEMPT GLASS BEVER CONT'S								
applejuice w/cap and label	0.381	0.75	glass	28.60	10.57	0.020	0.0075	1.00%
bottle	0.372		glass	28.60	10.57	0.020	0.0073	
cap	0.009		metal	89.74	35.59	0.063	0.0006	
label	0.000		paper				0.0000	
applejuice w/label,no cap	0.369	0.75	glass	28.60	10.57	0.020	0.0072	0.96%
32 oz w/label	0.891	2.00	glass	28.60	10.57	0.020	0.0174	0.87%
bottle	0.881		glass	28.60	10.57	0.020	0.0173	
label	0.009		paper	106.02	24.02	0.065	0.0006	
spr wat 11 oz bottle w/ring	0.456	0.80	glass	28.60	10.57	0.020	0.0089	1.12%
10 Oz water w/label	0.438	0.80	glass	28.60	10.57	0.020	0.0086	1.07%
grapefruit juice w/label	0.341	0.75	glass	28.60	10.57	0.020	0.0067	0.89%
lemonade w/label	0.350	0.75	glass	28.60	10.57	0.020	0.0069	0.91%
64 oz grape juice w/label	1.706	2.50	glass	28.60	10.57	0.020	0.0334	1.34%
cranb/grape 48 oz	1.916	2.00	glass	28.60	10.57	0.020	0.0375	1.88%
bottle	2.525		glass	28.60	10.57	0.020	0.0495	
cap	0.016		metal	89.74	35.59	0.063	0.0010	
AVE-NON-EXEMPT GLASS BEVER CONT								1.11%
GLASS ALCOHOLIC BEVERAGE								
1.5 liter French red table wine	1.628	6.00	glass	28.60	10.57	0.020	0.0319	0.53%
one pint gin bottle	0.763	4.50	glass	28.60	10.57	0.020	0.0149	0.33%
AVE - GLASS ALCOHOL BEVERAGE								0.43%
NON-EXEMPT PLAST BEV CONT'S								
1 gal spr wat w/label-plast	0.153	2.50	HDPE	245.55	43.11	0.144	0.0221	0.88%
bottle	0.147		HDPE	245.55	43.11	0.144	0.0212	
cap(plast and paper)	0.006		HDPE	245.55	43.11	0.144	0.0009	
cider bottle 1/2 gallon	0.109	1.30	HDPE	245.55	43.11	0.144	0.0158	1.21%
apple juice 1/2 gall	0.109	1.50	HDPE	245.55	43.11	0.144	0.0158	1.05%
AVE-NON-EXEMPT PLAST BEVER CONT								1.05%
EXEMPT FROM CALIF ADF LAW								
seltzer 12 oz can pop top	0.038	0.80	alumin	94.63	54.08	0.074	0.0028	0.35%
ginger ale 12 oz can pop top	0.038	0.60	alumin	94.63	54.08	0.074	0.0028	0.46%
10 Oz soda bottle w/ring	0.428	0.60	glass	28.60	10.57	0.020	0.0084	1.40%
16 oz seltzer bottle w/label	0.525	0.90	glass	28.60	10.57	0.020	0.0103	1.14%
fruit punch soda	1.069		glass	28.60	10.57	0.020	0.0209	
bottle	1.066		glass	28.60	10.57	0.020	0.0209	
cap	0.003		metal	89.74	35.59	0.063	0.0002	
2 lit plast w/hdpe base,ring	0.159		plastic	275.40	44.29	0.160	0.0255	
metal cap	0.003		metal	89.74	35.59	0.063	0.0002	
FOOD PACKAGING								
GLASS (OR COMPOS) FOOD PACK								
honey bottle 1 quart-total		2.00	glass			0.000	0.0039	0.19%
bottle	0.750		glass	28.60	10.57	0.020	0.0009	
lid	0.047		metal	89.74	35.59	0.063	0.0029	
pickles 32 fluid ounces		2.39	glass				0.0166	0.70%
bottle	0.750		glass	28.60	10.57	0.020	0.0147	
lid	0.031		metal	89.74	35.59	0.063	0.0020	
peanut butter - 16 ounces		2.39	glass				0.0122	0.51%
jar	0.525		glass	28.60	10.57	0.020	0.0103	
lid	0.031		metal	89.74	35.59	0.063	0.0020	
strawberry jelly		1.79	glass				0.0112	0.63%
jar	0.494		glass	28.60	10.57	0.020	0.0097	
lid	0.025		metal	89.74	35.59	0.063	0.0016	
italian salad dressing-8 fl oz		1.05	glass				0.0111	1.05%
bottle	0.525		glass	28.60	10.57	0.020	0.0103	
lid	0.013		metal	89.74	35.59	0.063	0.0008	
AVE-GLASS (COMPOS) FOOD PACKAG								0.62%

Table 7.7 Disposal Costs Vs. Prices of Products

ITEM	WEIGHT (POUNDS)	PRICE	MATERIAL	ECONOMIC COST/ TON	ENVIRON COST/ TON	TOTAL DISP COST PER POUND	TOTAL DISP COST PER ITEM	DISPOSAL COST/ PRICE
PAPER (OR COMPOS) FOOD PACK								
one qt. skim milk	0.075	0.70	paper	106.02	24.02	0.065	0.0049	0.70%
1 pint ice cream w/lid	0.044	2.30	paper	106.02	24.02	0.065	0.0028	0.12%
cheese crackers 1 lb-total	0.000	2.00	paper				0.0104	0.52%
box	0.125		paper	106.02	24.02	0.065	0.0081	
cellophane bag	0.025		plasfilm	141.71	38.41	0.090	0.0023	
wheat crackers 10.6 oz	0.000	1.75	paper				0.0079	0.45%
box	0.088		paper	106.02	24.02	0.065	0.0057	
plastic bag	0.025		plasfilm	141.71	38.41	0.090	0.0023	
dozen large eggs	0.100	1.09	corrug	95.66	22.49	0.059	0.0059	0.54%
13 oz box cereal	0.000						0.0000	
box	0.131	3.59	paper	106.02	24.02	0.065	0.0085	0.24%
plastic liner	0.025		plasfilm	141.71	38.41	0.090	0.0023	
donuts 16 ounces	0.125	2.49	paper	106.02	24.02	0.065	0.0081	0.33%
AVE-PAPER (COMPOS) FOOD PACKAGE								0.41%
PLASTIC (OR COMPOS) FOOD PACK								
1.5 lb bread-bags	0.063	2.00	plasfilm	141.71	38.41	0.090	0.0056	0.28%
pasta 1 lb	0.016	1.00	plasfilm	141.71	38.41	0.090	0.0014	0.14%
frozen bagels 18.75 oz	0.016	1.25	plasfilm	141.71	38.41	0.090	0.0014	0.11%
potato chip-7 oz(plas/foil comp)	0.031	1.29	plasfilm	141.71	38.41	0.090	0.0028	0.22%
ketchup 28 oz	0.119	1.75	plastic	275.40	44.29	0.160	0.0190	1.08%
yogurt 8 oz - composite	0.000						0.0000	
plastic	0.038	0.75	plastic	275.40	44.29	0.160	0.0060	0.80%
foil lid liner	0.006		metal	89.74	35.59	0.063	0.0004	
AVE - PLASTIC FOOD PACKAG								0.44%
METAL FOOD PACKAG								
soup 10 3/4 oz can	0.106	0.69	metal	89.74	35.59	0.063	0.0067	0.96%
six oz tomato paste	0.075	0.34	metal	89.74	35.59	0.063	0.0047	1.38%
AVE - METAL FOOD PACKAG								1.17%
FAST FOOD RESTAURANT								
salad bar - total		2.85	plastic				0.0045	0.16%
styrofoam tray	0.013		foam	275.40	44.29	0.160	0.0020	
plastic fork	0.013		plastic	275.40	44.29	0.160	0.0020	
napkin-paper	0.008		paper	106.02	24.02	0.065	0.0005	
garlic bread-cardboard tray	0.031	0.99	corrug	95.66	22.49	0.059	0.0018	0.19%
soda-coated paper cup	0.031	0.85	paper	106.02	24.02	0.065	0.0020	0.24%
burger restaurant-total		3.89					0.0057	0.15%
deluxe hamburger	0.016		foam	275.40	44.29	0.160	0.0025	
small french fries	0.003		paper	106.02	24.02	0.065	0.0002	
medium drink	0.022		paper	106.02	24.02	0.065	0.0014	
outerbag	0.016		paper	106.02	24.02	0.065	0.0010	
napkin	0.009		paper	106.02	24.02	0.065	0.0006	
AVE - FAST FOOD								0.18%
TOBACCO PRODUCTS								
cigarettes-1 box(paper & foil)	0.016	1.75	paper	106.02	24.02	0.065	0.0010	0.06%
HOUSEHOLD DISPOSABLES								
PLASTIC HOUSEHOLD DISP'S								
kit waste bags-bags & box	0.000	1.35	plasfilm				0.0460	3.40%
box	0.075		paper	106.02	24.02	0.065	0.0049	
bags	0.456		plasfilm	141.71	38.41	0.090	0.0411	
32 oz dish detergent	0.109	2.00	plastic	275.40	44.29	0.160	0.0175	0.87%
cap	0.019		plastic	275.40	44.29	0.160	0.0030	
64 oz liq laundry det	0.313	3.99	HDPE	245.55	43.11	0.144	0.0451	1.13%
AVE - PLAST (COMPOS) HH DISPOS'S								1.80%

Table 7.7 Disposal Costs Vs. Prices of Products

ITEM	WEIGHT (POUNDS)	PRICE	MATERIAL	ECONOMIC COST/ TON	ENVIRON COST/ TON	TOTAL DISP COST PER POUND	TOTAL DISP COST PER ITEM	DISPOSAL COST/ PRICE
PAPER HOUSEHOLD DISP'S								
paper napkins-total	0.000	1.50	paper				0.0388	2.59%
cellophane bag	0.025		plasfilm	141.71	38.41	0.090	0.0023	
napkins	0.563		paper	106.02	24.02	0.065	0.0366	
powder laun det-4lbs(rec pap)	0.250	1.99	paper	106.02	24.02	0.065	0.0163	0.82%
AVE - PAPER (COMP) HH DISPOS'S								1.70%
TOILETRIES								
PLASTIC TOILETRIES								
11 oz shamp,brown plas,w/lab	0.069	4.00	plastic	275.40	44.29	0.160	0.0110	0.27%
cap	0.031		plastic	275.40	44.29	0.160	0.0050	
band-aids,70 pieces	0.113	2.89	metal	89.74	35.59	0.063	0.0070	0.24%
aspirin (300)	0.044	1.49	plastic	275.40	44.29	0.160	0.0070	0.47%
dental rinse-16 fl oz	0.094	3.59	plastic	275.40	44.29	0.160	0.0150	0.42%
hand lotion-6 fl oz	0.069	1.50	plastic	275.40	44.29	0.160	0.0110	0.73%
shampoo-4 fl oz	0.075	3.59	plastic	275.40	44.29	0.160	0.0120	0.33%
AVE - PLASTIC TOILETRIES								0.41%
PAPER TOILETRIES								
hand soap-13.5 oz	0.025	1.19	paper	106.02	24.02	0.065	0.0016	0.14%
AVE - PAPER TOILETRIES								0.14%
PAPER PRODUCTS, NOV 1990								
NEWSPAPERS								
Boston Globe, 11/1/90	0.909	0.35	news	63.33	18.91	0.041	0.0374	10.68%
Wall Street Journal, 11/7/90	0.613	0.50	news	63.33	18.91	0.041	0.0252	5.04%
Wall Street Journal, 11/8/90	0.650	0.50	news	63.33	18.91	0.041	0.0267	5.35%
Wall Street Journal, 11/13/90	1.078	0.50	news	63.33	18.91	0.041	0.0443	8.87%
New York Times, 11/8/90	0.956	0.40	news	63.33	18.91	0.041	0.0393	9.83%
New York Times, 11/13/90	0.688	0.40	news	63.33	18.91	0.041	0.0283	7.07%
Wall Street Journal, 11/27/90	0.694	0.50	news	63.33	18.91	0.041	0.0285	5.71%
New York Times, 11/27/90	0.750	0.40	news	63.33	18.91	0.041	0.0308	7.71%
AVE - NEWSPAPERS								7.53%
MAGAZINES								
Public Utilities Fortnightly	0.491	3.50	paper	106.02	24.02	0.065	0.0319	0.91%
Nature	0.841	6.95	paper	106.02	24.02	0.065	0.0547	0.79%
E	0.413	3.50	paper	106.02	24.02	0.065	0.0268	0.77%
Business Week	0.597	2.00	paper	106.02	24.02	0.065	0.0388	1.94%
Business Week(spec issue)	0.875	3.95	paper	106.02	24.02	0.065	0.0569	1.44%
Newsweek	0.416	2.50	paper	106.02	24.02	0.065	0.0270	1.08%
Harpers	0.344	2.50	paper	106.02	24.02	0.065	0.0224	0.89%
Money	0.625	2.95	paper	106.02	24.02	0.065	0.0406	1.38%
AVE - MAGAZINES								1.15%
JUNK MAIL								
Ikea catalogue	0.625	---	paper	106.02	24.02	0.065	0.0406	
Bike Nashbar catalog	0.281	---	paper	106.02	24.02	0.065	0.0183	
OFFICE SUPPLIES								
file folders (10)	0.738	1.00	paper	106.02	24.02	0.065	0.0480	4.80%
ream sub 20 recycled copy paper	5.000	3.53	highgrade	61.89	19.23	0.041	0.2028	5.75%
ream 25% cott rag #10 rec env's	5.019	40.36	highgrade	61.89	19.23	0.041	0.2036	0.50%
100 9 X 12 white envelopes	3.450	14.77	highgrade	61.89	19.23	0.041	0.1399	0.95%
ream recycled letterhead	6.000	26.28	highgrade	61.89	19.23	0.041	0.2434	0.93%
AVE - OFFICE SUPPLIES								2.58%

Table 7.7 Disposal Costs Vs. Prices of Products

ITEM	WEIGHT (POUNDS)	PRICE	MATERIAL	ECONOMIC COST/ TON	ENVIRON COST/ TON	TOTAL DISP COST PER POUND	TOTAL DISP COST PER ITEM	DISPOSAL COST/ PRICE
CLOTHING								
men's dress shirt-short sleeve	0.325	16.00	textile	165.23	27.73	0.096	0.0314	0.20%
men's dress shirt-long sleeve	0.469	16.00	textile	165.23	27.73	0.096	0.0452	0.28%
men's dress slacks-wool	0.781	35.00	textile	165.23	27.73	0.096	0.0754	0.22%
men's dress slacks-cotton/poly	0.675	25.00	textile	165.23	27.73	0.096	0.0651	0.26%
men's work pants-cotton/poly	0.925	20.00	textile	165.23	27.73	0.096	0.0892	0.45%
socks- wool blend	0.100	2.50	textile	165.23	27.73	0.096	0.0096	0.39%
AVE - CLOTHING								0.30%
CONSUMER DURABLES								
iron - total	0.000	19.00					0.1781	0.94%
iron	2.500		metal	89.74	35.59	0.063	0.1567	
box	0.363		corrug	95.66	22.49	0.059	0.0214	
answering mach-total	0.000	80.00					0.4078	0.51%
machine	2.400		plastic	275.40	44.29	0.160	0.3836	
foam	0.063		foam	275.40	44.29	0.160	0.0100	
paper box	0.219		paper	106.02	24.02	0.065	0.0142	
AM/FM cass recorder-total	0.000	60.00					0.7894	1.32%
recorder	4.500		plastic	275.40	44.29	0.160	0.7193	
foam	0.125		foam	275.40	44.29	0.160	0.0200	
plastic bag	0.047		plastic	275.40	44.29	0.160	0.0075	
box	0.656		paper	106.02	24.02	0.065	0.0427	
dot-mat computer print-total	0.000	300.00					2.3784	0.79%
printer	14.000		plastic	275.40	44.29	0.160	2.2378	
foam	0.250		foam	275.40	44.29	0.160	0.0400	
flexible foam	0.031		plastic	275.40	44.29	0.160	0.0050	
hard plastic	0.044		plastic	275.40	44.29	0.160	0.0070	
cardboard box	1.500		corrug	95.66	22.49	0.059	0.0886	
toaster oven-total	0.000	40.00					0.5418	1.35%
oven	7.000		metal	89.74	35.59	0.063	0.4387	
foam	0.188		foam	275.40	44.29	0.160	0.0300	
cardboard box	1.125		paper	106.02	24.02	0.065	0.0731	
tape deck-total	0.000	120.00					1.2116	1.01%
deck	7.100		plastic	275.40	44.29	0.160	1.1349	
foam	0.125		foam	275.40	44.29	0.160	0.0200	
plastic bag	0.031		plastic	275.40	44.29	0.160	0.0050	
box	0.875		corrug	95.66	22.49	0.059	0.0517	
casserole set - total	0.000	40.00					0.2826	0.71%
set	10.000		glass	28.60	10.57	0.020	0.1959	
box and packing	1.469		corrug	95.66	22.49	0.059	0.0868	
AVE - CONSUMER DURABLES								0.95%
LARGE APPLIANCES (WHITE GOODS)								
18 cu ft refrig-total		710.00					18.7390	2.64%
refrigerator	255.000		whitegood	89.74	45.59	0.068	17.2546	
box	25.128		corrug	95.66	22.49	0.059	1.4845	
20 cu ft refrig-total		825.00					20.5762	2.49%
refrigerator	280.000		whitegood	89.74	45.59	0.068	18.9462	
box	27.592		corrug	95.66	22.49	0.059	1.6300	
Washer - 18 lb cap-total		440.00					12.7866	2.91%
washer	174.000		whitegood	89.74	45.59	0.068	11.7737	
box	17.146		corrug	95.66	22.49	0.059	1.0129	
Dryer - 18 lb cap-total		290.00					9.5532	3.29%
dryer	130.000		whitegood	89.74	45.59	0.068	8.7965	
box	12.811		corrug	95.66	22.49	0.059	0.7568	
AVE - APPLIANCES								2.83%

Table 7.7 Disposal Costs Vs. Prices of Products

ITEM	WEIGHT (POUNDS)	PRICE	MATERIAL	ECONOMIC COST/ TON	ENVIRON COST/ TON	TOTAL DISP COST PER POUND	TOTAL DISP COST PER ITEM	DISPOSAL COST/ PRICE
HOUSEHOLD HAZARDOUS WASTE								
2 size D alkaline batteries	0.531	2.69	hazard	------	------	0.972	0.5163	19.19%
4 AA alkaline patteries-total	0.000	3.49	hazard				0.2065	5.92%
batteries	0.188		hazard	------	------	0.972	0.1822	
package-paper,plastic	0.025		hazard	------	------	0.972	0.0243	
gallon paint can #1	10.000	18.00	hazard	------	------	0.972	9.7181	53.99%
gallon paint can #2	8.000	11.00	hazard	------	------	0.972	7.7744	70.68%
AVE - HOUSEHOLD HAZARDOUS								37.44%
AUTOMOBILE								
hypothetical-medium size	3000	14000	metal	89.74	35.59	0.063	187.9950	1.34%
hypothetical-subcompact	2000	10000	metal	89.74	35.59	0.063	125.3300	1.25%
AVE - AUTOMOBILES								1.30%

Table 7.8: Household Impacts

HOUSEHOLD SPENDING (IN DOLLARS)

INCOME QUINTILE	INCOME BEFORE TAXES	TOTAL SPENDING	FOOD AT HOME	FOOD AWAY FROM HOME	ALCOHOLIC BEVERAGES	SHELTER	FUEL, UTILITIES PUB.SERV.	HH OPER'S & FURNISH-INGS	HOUSE-KEEPING SUPPLIES	APPAREL & SERVICES	VEHICLE PURCHASES	GAS & MOTOR OIL	ALL OTHER TRANSP	HEALTH CARE
LOWEST 20%	$5,244	$11,777	$1,502	$677	$139	$2,395	$1,226	$515	$213	$623	$698	$423	$643	$835
SECOND 20%	$13,595	$17,840	$2,081	$1,071	$215	$3,138	$1,544	$805	$322	$1,067	$1,383	$729	$1,206	$1,207
THIRD 20%	$23,819	$24,689	$2,344	$1,722	$370	$3,958	$1,814	$1,186	$417	$1,377	$2,048	$1,013	$1,656	$1,303
FOURTH 20%	$37,845	$33,668	$2,776	$2,151	$387	$5,193	$2,113	$1,890	$492	$2,092	$3,070	$1,274	$2,394	$1,377
HIGHEST 20%	$74,778	$52,851	$3,480	$3,530	$613	$8,473	$2,658	$3,580	$651	$3,114	$4,261	$1,572	$3,709	$1,732
ALL HOUSEHOLDS	$31,078	$28,178	$2,437	$1,831	$345	$4,633	$1,872	$1,597	$419	$1,655	$2,293	$1,002	$1,922	$1,291

	FOOD AT HOME	FOOD AWAY FROM HOME	ALCOHOLIC BEVERAGES	SHELTER	FUEL, UTILITIES PUB.SERV.	HH OPER'S & FURNISH-INGS	HOUSE-KEEPING SUPPLIES	APPAREL & SERVICES	VEHICLE PURCHASES	GAS & MOTOR OIL	ALL OTHER TRANSP	HEALTH CARE
DISPOSAL FEE AS % OF COST	0.69%	0.18%	0.43%	0.20%	0.00%	2.83%	1.76%	0.30%	1.30%	0.00%	0.00%	0.20%

DISPOSAL FEE BY QUINTILE AND SPENDING CATEGORY

INCOME QUINTILE	TOTAL DF (DIRECT)	FOOD AT HOME	FOOD AWAY FROM HOME	ALCOHOLIC BEVERAGES	SHELTER	FUEL, UTILITIES PUB.SERV.	HH OPER'S & FURNISH-INGS	HOUSE-KEEPING SUPPLIES	APPAREL & SERVICES	VEHICLE PURCHASES	GAS & MOTOR OIL	ALL OTHER TRANSP	HEALTH CARE
LOWEST 20%	$54.85	$10.39	$1.24	$0.60	$4.79	$0.00	$14.60	$3.74	$1.86	$9.06	$0.00	$0.00	$1.67
SECOND 20%	$86.12	$14.39	$1.96	$0.93	$6.28	$0.00	$22.81	$5.65	$3.18	$17.95	$0.00	$0.00	$2.41
THIRD 20%	$120.79	$16.20	$3.15	$1.60	$7.92	$0.00	$33.61	$7.33	$4.10	$26.59	$0.00	$0.00	$2.61
FOURTH 20%	$171.88	$19.19	$3.93	$1.67	$10.39	$0.00	$53.56	$8.65	$6.23	$39.85	$0.00	$0.00	$2.75
HIGHEST 20%	$270.79	$24.06	$6.45	$2.65	$16.95	$0.00	$101.44	$11.43	$9.27	$55.32	$0.00	$0.00	$3.46
ALL HOUSEHOLDS	$140.61	$16.85	$3.34	$1.49	$9.27	$0.00	$45.24	$7.35	$4.93	$29.76	$0.00	$0.00	$2.58

Table 7.8: Household Impacts

INCOME QUINTILE	HOUSEHOLD SPENDING (IN DOLLARS)								
	PENSIONS, SOC SEC	PERS CARE, EDUC, CONT, MISC.	TOBACCO	FEES, ADMISS	TV, SOUND EQUIP	OTHER EQUIP, SERVICES	NEWS PAPERS	BOOKS, MAGS	PERSONAL TAXES
LOWEST 20%	$148	$1,224	$93	$122	$64	$169	$34	$34	$134
SECOND 20%	$647	$1,669	$93	$139	$217	$213	$47	$47	$603
THIRD 20%	$1,690	$2,357	$93	$265	$395	$529	$75	$75	$1,641
FOURTH 20%	$3,249	$2,877	$93	$515	$620	$884	$110	$110	$3,302
HIGHEST 20%	$6,318	$5,580	$93	$1,044	$850	$1,269	$163	$163	$8,272
ALL HOUSEHOLDS	$2,412	$2,835	$93	$370	$432	$575	$82	$82	$2,792
	0.00%	0.20%	0.06%	0.00%	0.95%	0.50%	7.53%	1.15%	0.00%

DISPOSAL FEE BY QUINTILE AND SPENDING CATEGORY

	PENSIONS, SOC SEC	PERS CARE, EDUC, CONT, MISC.	TOBACCO	FEES, ADMISS	TV, SOUND EQUIP	OTHER EQUIP, SERVICES	NEWS PAPERS	BOOKS, MAGS	PERSONAL TAXES
LOWEST 20%	$0.00	$2.45	$0.05	$0.00	$0.60	$0.85	$2.57	$0.39	$0.00
SECOND 20%	$0.00	$3.34	$0.05	$0.00	$2.06	$1.07	$3.51	$0.54	$0.00
THIRD 20%	$0.00	$4.71	$0.05	$0.00	$3.74	$2.64	$5.67	$0.87	$0.00
FOURTH 20%	$0.00	$5.75	$0.05	$0.00	$5.87	$4.42	$8.31	$1.27	$0.00
HIGHEST 20%	$0.00	$11.16	$0.05	$0.00	$8.04	$6.35	$12.29	$1.88	$0.00
ALL HOUSEHOLDS	$0.00	$5.67	$0.05	$0.00	$4.09	$2.88	$6.17	$0.94	$0.00

Table 7.9: Material Inputs Into Industries (in dollars)

1985 U.S. INPUT-OUTPUT TABLE: INPUTS INTO INDUSTRIES
$ millions at producers prices

INPUT INDUSTRY	OUTPUT INDUSTRY (COMMODITY NUMBER) PERS CONS EXPEND'S 91	FED GOV ENTER-PRISES 78	STATE & LOCAL GOV ENT'S 79	FED GOVT 96/97	STATE, LOCAL GOVT 98/99	TOTAL OUTPUT MATERIAL INDUSTRY	TOTAL MATERIAL IN CONSUM PRODUCTS	NEW CONSTR 11	REPAIR, MAINT. CONSTR 12	FOOD & KINDRED PRODUCTS 14	TOBACCO MANUF. 15	APPAREL 18	MISC FABRIC TEXTILES 19
LUMBER & WOOD PROD'S	$865	$0	$0	$36	$148	$49,711	$27,061	$20,859	$2,899	$35	$0	$0	$21
WOOD CONTAINERS	$0	$0	$0	$8	$0	$557	$106	$0	$0	$52	$3	$0	$0
PAPER PRODUCTS	$11,436	$0	$57	$199	$2,487	$68,955	$27,566	$958	$500	$3,485	$231	$213	$47
PAPER CONT'S,BOXES	$303	$126	$1	$75	$223	$22,334	$11,990	$9	$4	$6,989	$110	$251	$132
PLASTICS,SYNTH MATERIALS	$0	$0	$0	$114	$5	$36,281	$2,896	$0	$0	$66	$0	$1,676	$135
RUBBER,MISC PLASTICS	$10,202	$57	$89	$663	$1,319	$71,020	$26,923	$1,332	$1,068	$3,984	$423	$320	$509
GLASS,GLASS PRODUCTS	$1,135	$3	$3	$29	$667	$13,895	$7,706	$288	$214	$3,951	$0	$0	$0
STONE & CLAY PROD'S	$1,907	$2	$152	$95	$195	$39,597	$28,208	$20,842	$5,742	$87	$2	$9	$3
PRIMARY IRON & STEEL	$8	$2	$0	$246	$55	$61,139	$17,883	$4,855	$1,146	$8	$1	$1	$0
PRIMARY NONFERROUS MET	$54	$11	$1	$642	$43	$48,287	$7,642	$3,725	$1,033	$1	$0	$0	$0
METAL CONTAINERS	$0	$0	$0	$99	$50	$12,098	$9,878	$0	$0	$8,884	$1	$0	$0
TOTAL MATERIAL INPUTS	$25,910	$201	$303	$2,206	$5,192	$423,874	$167,859	$52,868	$12,606	$27,542	$771	$2,470	$847
TOT OUTPUT COLUMN SECTOR	$2,610,576	$45,710	$57,887	$355,176	$465,575		$2,215,017	$364,224	$127,525	$296,099	$24,428	$54,106	$13,037
MATERIAL INPUT/OUTPUT	0.010	0.004	0.005	0.006	0.011		7.6%	14.5%	9.9%	9.3%	3.2%	4.6%	6.5%
DISPOSAL FEE/PRODUCT PRICE										0.69%	0.06%	0.30%	
DISPOSAL FEE/MATERIAL INPUT										7.43%	1.84%	6.52%	

Table 7.9: Material Inputs Into Industries (in dollars)

INPUT INDUSTRY	OUTPUT INDUSTRY (COMMODITY NUMBER) HOUSEHOLD FURNITURE 22	PRINTING PUBLISH 26	DRUGS, CLEANING, & TOILET 29	FOOTWEAR, LEATHER PRODUCTS 34	HOUSEHOLD APPLIANCE 54	ELECTRON COMPONENT & ACCESS 57	MOTOR VEH & EQUIP 59	WHOLE & RETAIL TRADE 69.00	EATING & DRINKING PLACES 74.00
LUMBER & WOOD PROD'S	$1,916	$2	$6	$42	$69	$0	$201	$986	$25
WOOD CONTAINERS	$8	$0	$0	$1	$16	$0	$5	$21	$0
PAPER PRODUCTS	$40	$16,806	$424	$45	$59	$162	$153	$4,024	$419
PAPER CONT'S,BOXES	$167	$270	$1,082	$81	$256	$197	$127	$1,338	$977
PLASTICS,SYNTH MATERIALS	$76	$13	$142	$79	$238	$244	$227	$0	$0
RUBBER,MISC PLASTICS	$980	$791	$2,056	$469	$914	$2,668	$7,745	$1,980	$1,684
GLASS,GLASS PRODUCTS	$91	$0	$584	$0	$105	$554	$1,641	$59	$219
STONE & CLAY PROD'S	$74	$31	$21	$4	$102	$460	$493	$119	$219
PRIMARY IRON & STEEL	$295	$25	$1	$2	$1,128	$385	$10,021	$15	$0
PRIMARY NONFERROUS MET	$106	$36	$4	$0	$577	$1,899	$242	$0	$19
METAL CONTAINERS	$0	$0	$812	$0	$0	$0	$0	$181	$0
TOTAL MATERIAL INPUTS	$3,753	$17,974	$5,132	$723	$3,464	$6,569	$20,855	$8,723	$3,562
TOT OUTPUT COLUMN SECTOR	$15,628	$112,574	$58,203	$6,654	$14,904	$41,132	$188,875	$725,443	$172,185
MATERIAL INPUT/OUTPUT	24.0%	16.0%	8.8%	10.9%	23.2%	16.0%	11.0%	1.2%	2.1%
DISPOSAL FEE/PRODUCT PRICE	2.83%	4.34%	0.29%		2.83%	0.95%	1.30%		0.18%
DISPOSAL FEE/MATERIAL INPUT	11.80%	27.18%	3.33%		12.19%	5.93%	11.76%		8.83%

7.8 ENDNOTES

1. This account is based on Skumatz, Lisa A., Ph.D., and Cabell Breckinridge, *Variable Rates in Solid Waste: Handbook for Solid Waste Officials* (U.S. EPA, June 1990, EPA 910/9-90-012a and 012b).

2. *Ibid.*, Volume II, p. V.16.

3. *Ibid.*, Volume I, p.13.

4. **Combining of different packaging materials into one product category:** In order to combine products whose packaging is made primarily from different materials into overall averages for the beverage, food packaging, household disposables, and toiletry categories, data from the 1987 *Census of Manufacturers* was used, as shown in Table 1 of a 6/27/90 internal Tellus memo by Mark Rossi. This data was used to estimate the relative amounts, in dollars, of glass, plastic, paper, and metal packaging inputs to each of the product categories. Weighted averages for the disposal cost/price ratios were then calculated.

   The Census of Manufacturers data shows, for a list of detailed categories of products which use packaging, inputs of paperboard, glass, steel, aluminum, blow-molded plastic containers, multi-material packaging, metal crowns, and flexible packaging. For the "flexible packaging" category, 50% of the total was allocated to paper and plastic packaging.

   Since soft drinks and malt beverages are exempt from the proposed ADF, "beverages" include only fluid milk, wines/brandy, and distilled liquors. Household disposables include soap/detergents and cleaning/polishing/etc. Toiletries include toiletry preparations" and "pharmaceutical preparations." All other categories are counted under food packaging. For paper, fluid milk is included in food packaging.

   Appliance packaging: the shipping boxes for refrigerators, washers, and dryers were not weighed directly, but extrapolated from data on boxes for household durable goods. Weights per square foot of surface area were calculated for the latter, and the highest values applied to appliances.

5. Where consumer spending categories could be matched to our sample data on product weights and prices, the average figures for DF/product price were used directly. These categories are food at home; food away from home; alcoholic beverages; household operations and furnishings; housekeeping supplies; apparel and services; vehicle purchases; tobacco; television and sound equipment; newspapers, and books and magazines. In several cases the sample data are not precise matches for the BLS spending categories, but were used as rough estimates: "fast food restaurant" disposal costs for "food away from home;" "appliances" for "household operations and furnishings;" "consumer durables" for "television and sound equipment"; "clothing" for "apparel and services," and "magazines" for "books and magazines."

For BLS spending categories where we do not have sample data on product weights and prices, figures were arbitrarily chosen on the basis of the type of industry involved. In most cases, these are sectors where solid waste costs are presumably a small fraction of total costs: health care; pensions and social security; personal care, education, contributions, and miscellaneous spending; fees and admissions to entertainment events; and personal taxes. For shelter; gas and motor oil, and "all other transportation" it would be important for future studies to attempt to determine disposal costs in relationship to price in these sectors.

The BLS data have a category termed "other expenditures" which includes "life insurance, entertainment, personal care, reading, education, tobacco and smoking supplies, cash contributions, and miscellaneous expenditures." This category contains a substantial fraction of household income, and in aggregate cannot be matched to disposal costs. By using other BLS statistical data, and adjusting the data where necessary, we have subdivided this category into spending on tobacco; fees and admissions to entertainment events; television and sound equipment; other entertainment equipment and services; newspapers; books and magazines, and a residual category of personal care, education, contributions, and miscellaneous expenditures. This adjustment has allowed for a better approximation of disposal costs matched to spending.

6. U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States*, Table No. 715. Average Annual Income and Expenditures of All Consumer Units: 1987, page 442-43. U.S. figures were adjusted for California using Table 706, page 437. As of 1988, average "Personal Income" in the U.S. was $16,489, in California $18,753, for a ratio of California to the U.S. of 1.14.

7. *Statistical Abstract of the United States 1990*, Table 715: Average Annual Income and Expenditures of All Consumer Units: 1987, pages 442-43.

"Other expenditures" in Table 715 includes life insurance; entertainment; personal care; reading; education; smoking and tobacco supplies; cash contributions; and miscellaneous expenditures. This total amount was subdivided as follows:

Table 383 provides data on entertainment and reading spending per consumer unit, in eight income categories. We combined the eight categories into income quintiles, for comparability to the data in Table 715.

Table 1320 shows $37.8 billion as total spending on tobacco products in 1988. Lacking data on tobacco spending by quintile, the total was allocated evenly by quintiles, dividing by the total number of households, which is given in Table 55 as 82.83 million in 1989.

Product categories in the sample survey of weights and prices were converted into the categories used by the *Statistical Abstract* as follows:

Sample Survey Category	Statistical Abstract Category
food and beverages	food at home
fast food restaurants	food away from home
alcoholic beverages	alcoholic beverages
appliances	household operations and furnishings
household disposables	housekeeping supplies
clothing	apparel and services
automobiles	vehicle purchases
tobacco	tobacco products
consumer durables	television, sound equipment
newspapers	newspapers
magazines	books, magazines

The sample survey did not provide us with source data for the Statistical Abstract's expenditure categories of gas and motor oil; other transportation; health care; pensions and social security; personal care, etc.; fees and admissions to entertainment; other entertainment equipment and services; and personal taxes. Judgement was used to estimate disposal costs per dollar of product prices in these cases.

8. U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States, 1990*, Table No. 60: Households-States: 1980 to 1988, page 48.

9. Derived from "Annual Input-Output Accounts of the U.S. Economy, 1985," Interindustry Economics Division of the U.S. Dept. of Commerce, *Survey of Current Business*, January 1990, pages 41-56.

10. Laura Blanciforti and Richard Green, "An Almost Ideal Demand System Incorporating Habits: An Analysis of Expenditures on Food and Aggregate Commodity Groups," *The Review of Economics and Statistics*, 1983, Vol. 65, pages 511-515.

11. Allen K. Miedema, Curtis E. Youngblood, and Philip C. Cooley, *Modeling the Effects of a Product Disposal Charge*, Research Triangle Institute, January 1980.

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APPENDIX TO CHAPTER 7 - ECONOMIC RESEARCH ON CONSUMER AND INDUSTRY RESPONSE TO TAXES

CONSUMER BEHAVIOR

The impact on consumer behavior will depend, first, on the degree to which the prices of particular products are changed by the disposal fee, and second, on the degree of consumer response to price changes. The latter will in turn depend on the extent to which the products are necessities versus optional purchases, and the extent to which there are available substitutes for those products whose prices increase.

The price changes for end-user products will reflect in part, the degree to which the total price of the product is dependent on materials which become solid waste. For example, for a newspaper a portion of its price is the cost of the newsprint itself which would be subject to the disposal fee. It seems reasonable to assume that most of the other costs involved in publishing a newspaper, such as all the labor costs in reporting, editing, printing and distributing the paper, do not involve major spending on solid-waste generating expenses. Consumers will be responding not to the percentage increase in newsprint prices, but to the percentage change in the total cost of the newspaper, which will be much smaller. Similar reasoning will hold for a wide variety of other products, such as beverages, packaged food, household cleansers, magazines, etc.

Demand Elasticities

The discussion above regarding the various factors that affect the demand for newsprint, or another good, can be summarized in economic terms by the elasticity of demand for a product, which relates the percentage change in demand to the percentage change in its price (own-price elasticity) or the prices of other products (cross-price elasticities). While in theory these elasticities can be straightforwardly applied to price changes, in practice obtaining estimates for them is rather difficult and the results contain a great deal of uncertainty. Econometric (statistical) methods for deriving estimates of how consumer purchases respond to prices have been developing over recent decades, and somewhat better information is available today than was the case a number of years ago.

However, published estimates are only available for a relatively limited selection of products, usually in either of two forms:

1) academic research, which has produced estimates for rather aggregate classes of products, such as all food, alcoholic beverages, clothing, etc.

2) marketing research focused on very narrowly-defined products, often particular brand names.

While we are able to make use of these estimates, either directly or as general inputs to our own common-sense projections, specific estimates are not available for many of the products with which we are concerned in terms of implementing a disposal fee. Data is available to a greater degree for consumer products than it is for goods which are sold by one business firm to another firm (producer goods).

While Tellus Institute is in the midst of developing its own econometric model to forecast the effects of relative price changes on demands for packaging materials, that work is not yet complete and is beyond the scope of the present study. Such econometric studies are quite complex, both in terms of model development and data collection.

Using the Appropriate Elasticity Measures

There are a variety of different measures of price elasticity of demand which have been estimated in different studies. In order to obtain estimates which are meaningful for California's purposes, it is critical that the appropriate measures be used. Which should be used will in part depend on the design chosen for the disposal fee. In particular, whether or not the fee gives special consideration to recyclable materials or materials with recycled content will have a major impact the relevant elasticities.

To specify how the quantity demanded of a product will respond to a price change, one must be precise as to which prices are changing and which are being held constant. Traditionally, the "own-price elasticity" is defined as the percentage change in quantity when only the price of the product in question changes, with all other prices being held constant. So, for example, the own-price elasticity for beer would assume that the prices of all substitutes for beer, including wine, "spirit" alcoholic beverages, soft drinks, and other beverages, are unchanged. The own-price elasticity for food as a broad category of products would assume that the prices of all foods change proportionally, while those for all other products in the economy are unchanged.

In implementing a disposal fee, California will be changing the prices of a wide variety of products at the same time. The percentage change for a particular product will vary based on the weight of disposable material contained in the product; the amount of the fee per unit of weight (if the fee is set on that basis); and the relationship between these first two factors and the total selling price of the product. In common-sense terms, items which are relatively low in price, which are purchased frequently, and contain large amounts of disposable materials will be most heavily impacted. This will include food; beverages; cleaning supplies; cosmetics and drug-store items; and all forms of disposable reading matter. Items which will be impacted less will be housing costs; utilities; services; and durable goods.

An appropriate elasticity measure would have to be one based on examining the simultaneous variation in all these prices. Apart from the Miedema and Bingham studies on packaging materials conducted in the 1970's, no such estimates are available. Thus, all the existing estimates, which will be summarized below, must be used with a great deal of caution. Estimates of own-price elasticity for narrowly-defined products are of little relevance, since the prices of all or most of the goods which are substitutable for each product will also be changing. Estimates for broad product classes such as food or clothing are closer to being what we need. Since the prices of other broad classes will also be increasing, although probably to a smaller degree on a proportional basis, we would expect the change in quantity demanded of food, for example, to be less than shown by its own-price elasticity.

On the other hand, if the disposal fee is substantial enough to make a significant dent in households' incomes, then the income-elasticity of demand also becomes relevant. This effect, which is measured separately from the price effects, would be expected to increase the reductions in demand due to the disposal fee.

There may be significant differences between the percentage increases in price for competing products, such as food and beverages packaged in different types and amounts of materials, because:

1) the estimates of total disposal costs vary based on the direct monetary and the environmental costs of disposal.

2) specific reductions in fees are legislated for recyclable/recycled products.

If this is the case, then the cross-price elasticities of demand become relevant. Unfortunately, the economics literature generally only presents cross-price elasticities for each product based on the price of one other substitutable product changing. It is much more difficult to obtain estimates when a wide variety of products are changing in price to varying degrees.

Elasticity Estimates for Consumer Goods

Recognizing these limitations inherent in the data, we will review below the available information. The classic study in this field was done in the 1960's, by H.S. Houthakker and Lester D. Taylor. The second edition of their study, *Consumer Demand in the United States: Analyses and Projections*, was published in 1970.[1] The methodology employed was quite complex, using what at the time were the most advanced techniques available. Despite this, the authors acknowledged the limitations inherent in their work. These are discussed their methodological section, running for approximately 60 pages of the book. Houthakker and Taylor used time-series analysis (meaning that changes in demand were related to changes in prices and other variables over time) to conduct their econometrics.

Unfortunately, much of their results are not very helpful for our present purposes. In a number of the major categories of consumer expenditures on solid waste-intensive products, the price of the product was **not** found to be a significant predictor of demand. Instead, current income, income from the previous period ("lagged" income), and quantity demanded in the previous period (indicating an effect of habitual purchasing), were often found to be the major variables affecting demand. This was true for "food purchased for off-premise consumption;" alcoholic beverages; "clothing, including luggage;" "semi-durable house furnishings;" and "cleaning and polishing preparations, and miscellaneous household supplies and paper products." In contrast, consumption of "purchased meals," tobacco products; household electricity use; and "newspapers and magazines" were significantly related to price, on an inverse basis, with purchases falling as prices rose.[2] The results are presented in terms of regression equation coefficients, which must be converted to demand elasticities for our purposes.

"Use of different statistical models by succeeding academic researchers resulted in their obtaining widely varying estimates for price elasticities. This caused a shift in focus, to the development of functional forms that were consistent with theoretical notions about demand functions. Deaton and Muellbauer, writing in 1980, developed "An Almost Ideal Demand System" (AIDS), which has been widely utilized by other researchers in the past decade. Deaton and

Muellbauer controlled for the effects of income by using expenditure shares as the dependent variable rather than absolute amounts of spending. By using this methodology other authors have been able to develop econometric results in which the price of a product itself (the "own-price elasticity") is significant. Blanciforti and Richard estimated the following elasticities for the United States, averaged over the time period 1948 to 1978:[3]

Commodity Group	**Own-Price Demand Elasticity**
Aggregate Commodity Groups	
food	-.32
alcohol plus tobacco	-.22
clothing	-.57
housing	-.15
utilities	-.67
transportation	-.34
medical care	-.34
durable goods	-.67
other nondurable goods	-.92
other services	-.21
other miscellaneous goods	-.06
Food Groups	
meats	-.57
fruits and vegetables	-.60
cereal and bakery products	-.55
miscellaneous foods	-1.01

A 1985 article by V.K. Borooah presented consumer spending estimates as related to both own-price and the prices of other products, for United Kingdom data from 1954-1981. The results are presented in terms of elasticities weighted by the product category's share of total expenditure (cost share). Converting to the normal elasticity format yields the following:[4]

Product Category	Own-Price Demand Elasticity
food	-.089
vices	-.60
housing	-.36
fuel	-.0035
clothing	-.76
durables	-.22
household goods	-.47
reading matter	-.039
transport	-.47
communications	-.076
miscellaneous	-.61

Of particular note is the very low elasticity for food in the Borooah U.K. study, both in comparison to other product categories in the same study and in comparison to the elasticities derived by Blanciforti and Green for the U.S. This difference is not surprising because Blanciforti and Green employ a functional specification that incorporates past purchasing behavior. This illustrates how sensitive estimates are the functional form of the regression equation.

Richard Blundell, also using data for the United Kingdom, in this case for the years 1970-84, calculated price and income elasticities for six major spending categories.[5] Unfortunately, Blundell reported the data in separate categories for households with and without children, and with "pensioners" excluded from both groups, increasing the difficulty of comparing his results with those from other studies.

Blundell provided figures for both "uncompensated" and "compensated" price elasticities.[6] The difference between the terms as used in this context is that when the price of one product rises, if that product is a substantial fraction of a household's budget, not only does the cost of that product rise relative to all other items in the household's purchasing, but the real income of the household decreases. An uncompensated elasticity makes no adjustment for this "income" effect, while a compensated elasticity makes a hypothetical addition to the household's budget sufficient to bring the household back to its prior level of economic welfare. Thus, any reduction in purchasing of the good in question will then be a function of only the *relative* price effect, with any income effect eliminated.

The other studies which have been discussed above do not state explicitly whether their results are for compensated or uncompensated elasticities. In the absence of further information, we will assume that they are using uncompensated figures, which is the more traditional method of measurement.

Blundell's results are shown in the table below:

Budget Category	Own-Price Elasticities of Demand	
	Uncompensated Elasticities	Compensated Elasticities
	Households With Children	
food	-0.494	-0.246
alcohol	-1.983	-1.869
fuel	-0.747	-0.718
clothing	-0.852	-0.716
transport	-0.674	-0.475
services	-0.767	-0.587
	Households Without Children	
food	-0.431	-0.235
alcohol	-1.731	-1.596
fuel	-0.733	-0.710
clothing	-0.830	-0.706
transport	-0.728	-0.500
services	-0.813	-0.614

Because they have been the subject of both existing and proposed high-rate excise taxes, "vice" goods such as alcohol and tobacco have been a particular focus of studies. A review of several such studies for tobacco roughly estimated that "consumption has typically declined by around 6% to 7% when prices rose by 10%.[7] This would mean a demand elasticity of 0.6 to 0.7. One study by Michael Grossman, of the National Bureau of Economic Research and City University of New York, yielded an elasticity of approximately 1.0, while another by Frank Chaloupka, of the University of Illinois, estimated an elasticity of 0.66 (in both cases demand elasticities were derived by Tellus from published reports of percentage responses in demand due to excise tax increases).[8] Yet another study, by John A. Bishop and Jang H. Yoo, reported a series of elasticity estimates based on using different statistical techniques. The figures ranged from 0.406 to 0.641, with the authors preferred methodology yielding 0.454.[9]

Estimates of Price Elasticity of Demand for Smoking

Author	Price Elasticity
Michael Grossman	1.0
Frank Chaloupka	0.66
Bishop and Yoo	0.406 to 0.641
survey of several studies	0.6 to 0.7

The authors compared the relative impacts of excise taxes to the "health scare" (the 1964 Surgeon General's report linking cigarette smoking to cancer) and the ban on broadcast advertising, finding that:

"It is also interesting to note that the tax coefficient in equation (7) is substantially larger than the health scare (D_{64}) or advertising ban (D_{71}) coefficients. These values suggest that cigarette excise taxes had more effect on reducing consumption during the period studied (1954-80) than either the health scare or the advertising ban. In fact the small values for the health scare and the advertising ban suggest that these events had little effect in reducing cigarette demand".[10]

Heien and Pompelli examined the demand for alcoholic and other beverages. They used cross-section rather than time-series data, relying on the 1977-78 Household Food Consumption Survey by the U.S. Department of Agriculture.[11] The authors used a two-stage process. In the first stage, "consumers decide how much to spend in total on beverages, both alcoholic and nonalcoholic." Second, "the demand for specific beverages is determined by the prices of these individual beverages and the total expenditure on beverages from the first stage relation." The second stage is done using the Deaton and Muellbauer "Almost Ideal Demand System."[12] Heien and Pompelli present elasticity results for a variety of demographic variables, for own-price, cross-price, expenditures, and income. Because they have the most relevance for our present purposes, below we give the own-price and income elasticities, along with the share of the total beverage budget represented by each item (as of 1977-78). Note that the income elasticities are negative because they are expressed in terms of "budget shares" rather than absolute spending. This means that the percentages of total income spent on each beverage, and beverages in total, declines as income increases.

Elasticity Estimates for Beverages, from Cross-Section Data[13]

Item	Own-Price Elasticity	Income Elasticity	Budget Share
Coffee	-.72	-.19	.185
Tea	-.56	-.04	.043
Soft Drinks	-.70	-.19	.153
Beer	-.84	-.37	.071
Spirits	-.50	-.51	.030
Wine	-.55	-.40	.023
Juice	-.89	-.16	.023
Milk	-.69	-.15	.346

INDUSTRY RESPONSES TO TAXES

It is also necessary to examine the behavior of industry in response to consumer preferences. To continue the example discussed earlier, newspaper publishers will presumably react to an increase in costs based on its size in relation to their total costs of operation. Given that information, the publisher would then examine the available options for substitution - to what degree can other materials be substituted for newsprint, or to what degree can other "inputs" be substituted for the volume or weight of paper in producing a newspaper. We may surmise that there is no substitute for newsprint within a relevant range of prices, except for recycled newsprint. The degree of switching to recycled content would depend on (1) the degree of substitutability between virgin and recycled, on grounds such as ease of use, and (2) relative prices between virgin and recycled, which in turn would in part depend on the degree to which the advance disposal fee is reduced for recycled newsprint.

The publisher also has an option to use less total material, in effect reducing the size (weight) of the newspaper. This could be done by reducing the volume of ads carried, thereby reducing revenues. It could also be done by reducing the amount of news content, thereby reducing the value of the newspaper to purchasers. The publisher must weigh both of these options against whatever loss of sales would take place by increasing the price of the paper in order to account for the higher costs.

Yet another option is to substitute other "inputs" for newsprint itself - for example, a higher quality printing process, or higher quality graphics work, could possibly be used to trade off quality of advertising copy against its volume, so as to retain the same level of advertising revenues while carrying a reduced volume. Of course, such increases in quality would also carry costs.

Elasticity Estimates for Packaging Materials

As with consumer products, the responses of industry to price changes can be summarized in terms of their elasticities of demand for the goods in question. While there are a small sample of studies concerning the responsiveness of demand to prices for consumer goods, even less work has been concerning items bought by producers.

Pioneering studies which attempted to project the impacts of fees on disposable packaging materials were done at the Research Triangle Park in the 1970's. The first, published in 1974 by T.H. Bingham, et al., was titled *An Evaluation of the Effectiveness and Costs of Regulatory and Fiscal Policy Instruments on Product Packaging*. Then in 1980 Allen K. Miedema, et al. published *Modeling the Effects of a Product Disposal Charge*.[14] The data in both studies is quite old by now, and even writing in 1980 Miedema used Bingham's pre-1974 sources for part of his data.

Miedema makes both assumptions and estimates concerning the degree to which materials used in packaging can be substituted for each other, and the degree to which recycled materials can be used in place of virgin materials. Through a series of forecasting techniques, he calculates changes in the amount of material to be disposed, based on (1) absolute reductions in usage of packaging, (2) substitution of one material for another, and (3) substitution of recycled for virgin content. These findings are presented in graphical form, from which we had to approximate the actual numbers.[15]

In the Miedema model, taxes are imposed on all materials simultaneously, with recycled materials exempted. Thus, the model includes the effects of both a rise in the price of a good itself (own-price elasticity) and of substitute goods (cross-price elasticity). Using the highest tax level employed by Miedema, of $40/ton, and 1970 prices for each bulk material, which were inflated to 1974 (derived from the earlier Bingham study),[16] we were able to derive the proportional impacts due to both types of price changes, which we will term "Combined Price Elasticities."

By estimating the demand elasticities for bulk material prices, Miedema's results combine the effects of (1) consumer demand elasticities for end-products and (2) the percentages of end-product prices which the bulk materials constitute. Thus, to the degree that his results are reliable, they are of greater direct relevance in regard to an advance disposal fee than the excise tax studies discussed above. It is thus meaningful that Miedema obtained elasticities ranging from 0.20 to 2.0, indicating substantial responsiveness of demand to prices. However, it is critical to note that for most materials, the majority of the response in the model was **not** due to absolute reductions in amounts of packaging used. Rather, the response was due to *shifting* from virgin to recycled (secondary) materials as a result of the latter being exempt from the tax. For all the materials combined, the $40/ton tax results in approximately a 7 percent reduction in waste disposal, of which 3 percent is due to reduction in waste generation and 4 percent is due to increased recycling (meaning that the waste is generated but not disposed).[17]

"Combined Price Elasticities of Demand" for bulk materials used in packaging, based on 1980 Miedema forecasts, at $40/ton tax rate on all virgin materials

Material	1974 price/ ton	% reduction in weight disposed	combined price elasticity of demand
rigid paper	510	0.105	1.34
rigid plastic	1380	0.025	0.86
glass	295	0.125	0.92
steel	878	0.090	1.98
aluminum	1444	0.055	1.99
flexible paper	238	0.035	0.20
flex plastic	2245	0.015	0.84
flex aluminum	1580	0.005	0.20

For comparison purposes, shown below are the 1974 bulk material prices and the $40 tax rate adjusted to 1988 price levels for each material (based on changes in the Producer Price Index)[18]

Bulk Material Prices and $40 tax rate updated to 1988 price levels

Material	1988 price/ton	1988 tax equivalent to $40 in 1974
rigid paper	1267	99
rigid plastic	2674	78
glass	686	93
steel	1828	83
aluminum	3007	83
flexible paper	591	99
flexible plastic	4350	78
flexible aluminum	3290	83

Non-Perfectly Competitive Conditions

The Miedema and Bingham studies, and in fact all the econometric studies discussed above, assume that all changes in cost will of necessity be passed on to the ultimate consumers, which would be the case under textbook economic assumptions of perfect competition and constant production costs. But, to use our previous example once again, most newspaper publishers in the United States are not facing "perfectly competitive" conditions in the marketplace. Typically, each city has only one or two papers, so that each paper has a substantial degree of monopoly or oligopoly (meaning a few sellers of a product) power, and therefore is not operating at either competitive cost or profit levels. The publisher may very well, therefore, have the ability either to absorb part or all of a cost increase, and/or to reduce other costs without noticeably affecting the quality of the newspaper.

Producers of newsprint also may not be in perfectly competitive market situations, and therefore also may have the ability to absorb part of a cost increase rather than to pass on all of a disposal fee. To do so is likely to be profit-maximizing behavior, with the degree of absorption depending on elasticities of demand from final consumers. The more that purchasers of newspapers, and publishers of newspapers, react to higher newsprint prices by reducing demand, the more the manufacturer will find it profitable to moderate price increases. (Note that economic theory asserts that such absorption cannot take place, except in the short run, in a perfectly competitive market, because firms have no "excess" profits and are producing at minimum feasible cost levels).

The same considerations will of course apply to all other products which are subject to an advance disposal fee. There is clear economic theory for the opposite extreme from perfect competition - a monopoly of one firm in the industry. In this case, the firm recognizes that as it increases output, the market price will fall. The "marginal revenue" from selling one more unit is thus not the price of that unit, but rather that amount minus the reduction in revenue from obtaining a lower price on sales of all other units. Alternatively, the firm recognizes that if it raises prices, it will sell less. Thus, the marginal revenue from a price increase is *not* the increase times the previous sales, but rather the increase times the new, lower quantity of sales, minus the loss in revenue due to a lower sales volume.

For the situation of a disposal fee, economic theory argues that a monopolist will *not* pass along the full amount of the fee to consumers, because doing so will not maximize profits, due to the scenario described in the preceding paragraph. The monopolist will choose to produce at the point where marginal revenue equals marginal cost, which will be at a price higher than before imposition of the fee, but less than the old price plus the full amount of the fee per unit of output. The exact price chosen is a function of the cost curves and demand curve faced by the monopoly firm. As a result, the reduction in quantity sold will be less than predicted by the econometric models which assume the existence of competitive markets.[19]

For more complex market structures, such as oligopoly, there is no clear answer as to what equilibrium price and sales will be from the viewpoint of profit-maximization, because of the interactions among sellers. The most that can be said is that the increase in price and reduction in quantity will be somewhere between that predicted by the competitive and monopoly models.[20]

ENDNOTES

1. H.S. Houthakker and Lester D. Taylor, *Consumer Demand in the United States: Analyses and Projections*, Cambridge, MA: Harvard University Press, second edition, 1970.

2. *Ibid.*, pages 59-123.

3. Laura Blanciforti and Richard Green, "An Almost Ideal Demand System Incorporating Habits: An Analysis of Expenditures on Food and Aggregate Commodity Groups," *The Review of Economics and Statistics*, 1983, Vol. 65, pages 511-515.

4. V.K. Borooah, "Consumers' expenditure estimates using the Rotterdam model: an application to the United Kingdom, 1954-81," *Applied Economics*, 1985, Volume 17, pages 675-688, figures derived from table on page 683.

5. Richard Blundell, "Consumer Behavior: Theory and Empirical Evidence - A Survey," *The Economic Journal*, 98, March 1988, pages 16-65.

6. *Ibid.*, page 35.

7. "Elasticity, It's Wonderful," *Fortune*, February 13, 1989, pages 123-24.

8. "Smoking 101," *Fortune*, February 27, 1989, page 134.

9. John A. Bishop and Jang H. Yoo, "'Health Scare,' Excise Taxes and Advertising Ban in the Cigarette Demand and Supply," *Southern Economic Journal*, Volume 52, October 1985, pages 402-411. Elasticities summarized on page 406.

10. Ibid, page 408.

11. Dale Heien and Greg Pompelli, "The Demand for Alcoholic Beverages: Economic and Demographic Effects," *Southern Economic Journal*, January 1989, pages 759-770.

12. *Ibid.*, page 760.

13. *Ibid.*, page 763.

14. T.H. Bingham et. al., *An Evaluation of the Effectiveness and Costs of Regulatory and Fiscal Policy Instruments on Product Packaging*, Research Triangle Institute Final Report to the Environmental Protection Agency, March, 1974.

    Allen K. Miedema, Curtis E. Youngblood, and Philip C. Cooley, *Modeling the Effects of a Product Disposal Charge*, Research Triangle Institute, January 1980.

15. *Ibid.*, pages 47-52.

16. *Ibid.*, pages D-5 and D-6.

17. *Ibid.*, pages 44-52.

18. *Handbook of Labor Statistics*, August 1989, Table 119, pages 490. Categories used included "rubber and plastic products," "pulp, paper, and allied products," "metals and metal products," and "nonmetallic mineral products."

19. See for example:

James M. Buchanan, "External Diseconomies, Corrective Taxes, and Market Structure," *American Economic Review*, 1969, pages 174-77.

Walter S. Misiolek, "Effluent Taxation in Monopoly Markets," *Journal of Environmental Economics and Management*, March 1980, pages 103-107.

William J. Baumol and Wallace E. Oates, *The Theory of Environmental Policy*, second edition, Cambridge: Cambridge University Press, 1988, pages 79-90.

20. See for example:

James M. Henderson and Richard E. Quandt, *Microeconomic Theory: A Mathematical Approach*, New York: McGraw-Hill, 1980.

F.M. Scherer, *Industrial Market Structure and Economic Performance*, New York: Rand McNally, second edition, 1980.

John F. Due and Ann F. Friedlaender, *Government Finance: Economics of the Public Sector*, Homewood, IL: Richard D. Irwin, 7th edition, 1981.

Dan Levin, "Taxation Within Cournot Oligopoly," *Journal of Public Economics*, 1985, pages 281-290.

Robert Thomas Kudrle, "Excise Tax Incidence in Limit Price Oligopoly," *Public Finance*, no. 3, 1984.

CHAPTER 8 - RECOMMENDED DESIGN FOR A DISPOSAL FEE SYSTEM

This chapter contains five sections. In Section 8.1 we present our recommendation of one of the four fee systems described in Chapter 7, and explain the reasons for that recommendation. The selected fee system is chosen primarily for its feasibility and effectiveness in promoting source reduction, one of the principal goals of this study.

Administrative cost estimates for varying fee systems are presented in Section 8.2, based primarily on information provided by the Board of Equalization.

In Section 8.3 we discuss spending priorities for the funds generated by the disposal cost fee. At the state level these priorities include programs to address environmental impacts of solid waste management, to improve household hazardous waste collection, and to stimulate research and development in the use of secondary materials. However, if the fee is implemented at the full cost-based level, using the methodology proposed in this report, then the bulk of the funds should be returned to counties and cities to offset the cost of solid waste management.

Section 8.4 discusses the recommended methodology for implementing a disposal cost fee at the point of first sale, including how the fee should be differentiated by material content, how the point of first sale should be defined, and the importance of tracking fee payments and exemptions for small feepayers.

Section 8.5 discusses how the fee system can be periodically evaluated for its effectiveness in contributing to successful source reduction and providing revenues to conduct waste management activities. Equally as important is that the fee be updated to reflect changes in regulations, pollutant emissions, waste composition, and waste disposal technologies.

8.1 RECOMMENDATION

We recommend the adoption of a fee system levied at the point of first sale in California, with no modification of the fee *structure* to create additional incentives for recycling. Use of the fee *revenues* to create incentives for recycling is an important part of our recommendation, as described in Section 8.3 below. In the terms introduced in Table 7.1, we are recommending fee system 1A. (The legislation mandating this study is ambiguous as to its recycling vs. source reduction goals, as discussed in Section 7.3.3.)

Fee levels should be proportional to the full monetary and environmental costs of solid waste management, calculated according to the methodology presented in Chapter 6 and updated biannually as proposed in Section 8.5. That methodology produces standard per-pound costs for each material type, based on the percentages of the material being recycled, composted, burned, or buried in California. For each product subject to the fee, the weight and material type must be reported (if substantial amounts of more than one material are involved, they must be reported separately); the standard per-pound costs would then be applied. The illustrative, simplified estimates of fee levels in Section 7.4.2 are based on this type of calculation.

Based on the data available in late 1990, our estimate of the fee revenues at 100% of full cost is shown in Table 8.1. The fee totals roughly $4.3 billion on the 35 million tons of non-hazardous waste subject to the fee (an average of $123 per ton), and almost $0.9 billion on the

445,000 tons of household hazardous waste (an average of $1943 per ton[1]). Of the $4.3 billion fee on non-hazardous waste, $3.5 billion ($100 per ton) is conventional waste management costs, and $0.8 billion ($23 per ton) is our valuation of the environmental costs of waste management.

Public policy considerations may dictate that the fee be set at a level below 100% of full cost; we are not making a recommendation as to the exact percentage. We do, however, recommend that the fee be set according to the methodology presented here, in proportion to the costs shown in Table 8.1, or (as better information becomes available) an updated equivalent of Table 8.1. The extremely high fee level on hazardous waste is the only individual level which may require separate discussion.

We prefer a fee at the point of first sale in part for its administrative simplicity. This point is discussed further in Section 8.2 below. But a more important advantage of point of first sale fees is the possibility of weight-based fee calculation. Producers and distributors may reasonably be asked to report the weights and materials used in their products; many small retailers cannot be expected to report such data. Weight-based fees offer the best practical approximation to the theoretical ideal, in terms of choice of units. The principal alternative, a value-based retail fee, would offer a much poorer approximation of true disposal cost. The goal of the fee is to reflect the differential economic and environmental costs imposed by disposal of different materials; for this purpose, a weight-based fee is essential.

Fee collection at the point of first sale -- typically at the producer or distributor level -- does not imply that the ultimate economic burden of the fee is borne by producers and distributors. In fact, such businesses, like retail establishments, will often try to pass on fees to their customers. The extent to which a fee on any business is passed on to customers depends on changing competitive conditions and other factors in the marketplace, and cannot be predicted with certainty. Thus making a choice between a fee collected from producers and a fee collected from retailers is emphatically **not** the same as making a decision about who could or should pay the ultimate costs.

We recommend that the fee be based on (proportional to) the full cost of waste management, without exemptions for secondary content or other recycling-oriented provisions. The purposes of the fee, as explained in Chapter 1 and in Section 7.1, are first to create a market incentive for source reduction, and second to create a source of revenues to fund waste management and related environmental mitigation. Neither of these purposes is served by adding incentives, i.e. fee reductions, for materials based on recycling rates or recycled content.

Our reluctance to propose recycling incentives is not due to general opposition to inclusion of market incentives in the fee system. Indeed, the importance of the fee system as a whole is that it provides a market incentive for source reduction. Most recent discussions of integrated waste management, like the language of A.B. 939, place source reduction at the top of the hierarchy of preferred waste management options, ahead of recycling. Yet ironically, there are comparatively

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[1] As explained in earlier chapters, the fee on HHW is based on the per-gallon cost of existing HHW collection and disposal programs, even though most HHW is not currently handled by such programs. Our calculation of the environmental cost of landfilling or incinerating HHW produced far higher numbers, due to the high concentrations of hazardous emissions traceable to HHW disposed in these facilities.

Table 8.1 Prospective Fee Revenues at 100% of Full Disposal Costs

(This Table examines the fee revenue which would be generated by a disposal cost fee at 100% of full disposal costs; "net waste stream" excludes A.B.2020 materials, yard waste, food waste, and "organic non-compostables" (largely sludge)

Materials	Conventional Cost $/ton	Environmental Cost $/ton	Full Cost $/ton	Net Waste Stream	Full Fee Revenues	Conventional Costs Fee Revenues	Environmental Costs Fee Revenues
PAPER							
Newspaper	$63.33	$18.91	$82.24	3212845	$264,221,000	$203,453,000	$60,767,000
OCC	$95.66	$22.49	$118.16	4095150	$483,876,000	$391,759,000	$92,117,000
Mixed Paper	$99.28	$24.72	$124.00	3720684	$461,375,000	$369,393,000	$91,981,000
High Grade	$61.89	$19.23	$81.12	657891	$53,368,000	$40,714,000	$12,654,000
Other Paper	$106.02	$24.02	$130.04	5857029	$761,643,000	$620,983,000	$140,660,000
PLASTICS							
HDPE	$245.55	$43.11	$288.66	350124	$101,067,000	$85,974,000	$15,093,000
PET	$246.15	$43.20	$289.34	88880	$25,716,000	$21,877,000	$3,839,000
Film	$141.71	$38.41	$180.11	1203130	$216,701,000	$170,490,000	$46,210,000
Other	$275.40	$44.29	$319.69	1775855	$567,728,000	$489,078,000	$78,650,000
GLASS							
Recyclable	$28.60	$10.57	$39.17	1969164	$77,128,000	$56,314,000	$20,813,000
Non-recyclable	$29.18	$10.66	$39.83	500177	$19,924,000	$14,592,000	$5,331,000
METALS							
Aluminum	$94.63	$54.08	$148.70	100038	$14,876,000	$9,466,000	$5,409,000
Other Metals	$89.74	$35.59	$125.33	2909875	$364,680,000	$261,132,000	$103,548,000
OTHER ORGANICS							
Wood Waste	$91.07	$8.22	$99.29	2026397	$201,199,000	$184,541,000	$16,658,000
Tires/rubber	$129.77	$36.33	$166.09	802535	$133,295,000	$104,141,000	$29,153,000
Textiles	$165.23	$27.73	$192.96	1077859	$207,982,000	$178,090,000	$29,892,000
OTHER WASTE							
Other Waste	$62.09	$8.10	$70.19	4420039	$310,225,000	$274,442,000	$35,783,000
Subtotal				34767672	$4,265,004,000	$3,476,439,000	$788,558,000
HHW	Separate Cost of Collection $/ton		$1,943.00	445203	$865,029,313		
TOTAL				35212875	$5,130,033,313		

few effective programs for source reduction, while there are many programs and proposals for recycling.

The position of source reduction at the top of the hierarchy of solid waste options is a well-founded one. Other options, even recycling and composting, involve substantial costs in transporting and transforming waste materials. Inevitably there are physical losses and environmental impacts from these processes: no program ever achieves 100% recycling, and no recycling truck drives down your street without causing some air pollution. Source reduction, in contrast, avoids waste at the source and thereby eliminates the need for collection and processing.

In short, we favor a cost-based fee without incorporation of *additional* recycling incentives, in order to make the entire fee a more effective incentive for source reduction. Introduction of exemptions and exceptions, or reduction of the fee below the cost-based level, could only serve to weaken the impetus to source reduction. The message is a simple one: if every product bears a fee reflecting its cost of disposal, then it will be cheaper to buy things which cause less waste, and your pocketbook will guide you toward source reduction.

The priority we give to incentives for source reduction does not mean that we are uninterested in recycling. We address the use of fee revenues to promote recycling in the Section 8.3.

8.2 ADMINISTRATIVE AND COMPLIANCE COSTS OF THE FEE SYSTEM

In administrative terms, the fee system resembles a sales or excise tax, with potential added requirements to weigh products and describe their major material contents. Since there is virtually no theory concerning the costs of administration and enforcement of taxes, estimates of these costs for the proposed fee system are based on studies of costs of selected existing tax systems.

8.2.1 Components of Administrative Cost

Budget analysts observe that the administrative costs associated with collection and enforcement of taxes are made up of several components. These include initial start-up investments, such as identifying and registering new taxpayers, training staff, printing new tax forms, acquisition of additional equipment and services. In addition, there are the ongoing costs of updating registration, processing returns, performing audits, and collecting taxes. The costs of these various components may differ, depending on the design of the fee system.

Many factors influence the costs of these components. Analysts note that administrative costs increase as the complexity of the taxing formula increases; they may be affected by how the revenues are distributed, as well. If the revenues are distributed among a number of funds and agencies, administrative costs would be higher than if the revenues go into one pot, because more information must be processed and more transactions are required. Also, administrative costs are typically higher if collection is decentralized, i.e. performed by local agencies rather than a single state agency. On the other hand, the marginal administrative cost decreases as the number of taxpayers increases.

Similarly, the administrative costs are reduced if the tax can be designed to make use of an existing tax-collection infrastructure. This is because adding sections to an existing tax reporting schedule and computer code is less expensive than developing new materials. Finally, some aspects of the administrative process may be influenced by the amount of revenue generated by the tax. Such characteristics as the frequency and cost of tax auditing can be expected to increase with increases in the expected revenues per taxpayer. The frequency of tax collection typically increases with the amount of tax revenue per taxpayer. In California, the sales tax is only collected annually from individuals with a tax liability of up to $75 per month, while it is collected quarterly from individuals with a tax liability of $75 to $250 per month. Although collection costs are lower with an annual collection, the cost efficiency of enforcement may be higher with more frequent collections.

In summary, because of the many variables affecting administrative costs, it is virtually impossible to develop a formula for estimating these costs with any degree of precision without very specific information about the implementation of the proposed fee system. The information that is needed includes detailed definitions of who pays the fee, precise lists of materials that are exempt and materials that are included, estimates of expected revenues generated by the fee, a plan for how the revenues will be distributed, and identification of the various tax collection agencies in California that will be responsible for administering the fee, among other things. In addition, it requires some assessment of the degree of difficulty taxpayers will have in calculating the fees, and auditors will have in monitoring the responses.

8.2.2 Administrative Cost Estimates for the Proposed Fee System

At this stage of the development of the proposed fee system, it is impossible to obtain all of the information that is necessary to prepare a detailed estimate of administrative costs. Therefore, a set of assumptions about the implementation of the fee has been made, on which preliminary cost estimates can be based.

If enacted at the full cost level, the disposal fee could theoretically generate several billion dollars annually. In addition, the State Board of Equalization is assumed to be responsible for collecting the fee. The Board of Equalization collects numerous taxes in California, including the sales and use tax and the hazardous waste fees. For the purposes of this exercise, it is also assumed that the disposal fee will be collected by adding to the ongoing collection activities that are in place for the sales tax. This is the approach used by the Florida Department of Revenue, in their collection of environmental fees. Also, the list of individuals and businesses who would be required to pay the disposal fee in California includes many of the people who are registered to pay the sales tax.

Tables 8.2 and 8.3 show administrative cost estimates for the proposed fee system administered at point of last sale and at point of first sale, respectively. In Table 8.2, where the disposal fee is levied at the point of last sale, like the sales tax, it is assumed that the number of feepayers would include virtually all sales tax registrants. In Table 8.3, where the disposal fee is levied at the point of first sale, the number of feepayers would be a subset of sales tax registrants that could easily be identified by a flag on the file of sales tax registrants. Because information on the likely number of feepayers under the point of first sale system is unavailable, two estimates have been prepared based on different assumptions. The two estimates, referred to as Scenario A and Scenario B in Table 8.3, assume 500,000 and 100,000 feepayers, respectively. However, in all of the cases presented here, in Table 8.2 as well as those in Table 8.3, it is quite possible that some new registration of feepayers would be required. This is because the sales and use tax exempts certain groups which would not be exempt from the disposal fee. Newspapers, shipping containers, and packaging of produce are all exempt from sales tax, but would not be exempt from a disposal fee. In addition, prescription medicines and purchases by the federal government are exempt from sales tax, but may not necessarily be exempt from disposal fees.

The components of the administrative cost for the disposal fee are assumed to be the same as for the sales tax, but the costs of each activity will vary. Estimates are based on administrative costs for the California sales tax, as reported for the Approved 1990-91 Budget. For the purposes of this exercise, it is assumed that they will be scaled either in proportion to the total revenue generated by the fee, or in proportion to the number of feepayers. The full-cost level revenue from the disposal fee could reach 30% of the revenue collected from the state's sales tax. Processing costs were assumed to remain the same as for the sales tax, based on the argument that every return from the sales tax would also have to be processed for the disposal fee. Auditing costs were also assumed to be the same as for the sales tax, because the disposal fee is a new approach (materials and weight based rather than value based) and potentially confusing to taxpayers.

In the case where the disposal fee is levied at point of last sale, the number of permits (feepayers) issued is assumed to be approximately 5% more than the number of permits issued for the sales and use tax. In addition, the administrative cost will include start-up costs, which are estimated as 10% of the other, ongoing costs of administration. If the disposal fee is levied at the point of first sale, Scenario A assumes the number of feepayers is roughly half of the number paying at point of final sale, while Scenario B assumes the number of feepayers is ten percent of those paying at point of final sale. In addition, the administrative costs are scaled to 7.5% of the costs of the sales tax.

The difference between the administrative cost estimates displayed in the following tables is relatively small. This is largely due to the fact that a large portion of the ongoing administrative costs does not vary with the number of feepayers.

TABLE 8.2 ADMINISTRATIVE COST ESTIMATES: FEE AT POINT OF LAST SALE

Number of Permits	1,000,000
Ongoing Administrative Costs:	
Registration	$ 5,500,000
Processing	$20,000,000
Audits	$14,000,000
Collection	$ 4,000,000
Start-up Administrative Costs	$ 4,350,000
Total Administrative Costs	$47,850,000

TABLE 8.3 - ADMINISTRATIVE COST ESTIMATES: FEE AT POINT OF FIRST SALE

	Scenario A	Scenario B
Number of Permits	500,000	100,000
Ongoing Administrative Costs		
Registration	$ 2,800,000	$ 550,000
Processing	$20,000,000	$20,000,000
Audits	$14,000,000	$14,000,000
Collection	$ 2,000,000	$ 400,000
Start-up Administrative Costs	$ 3,900,000	$ 3,500,000
Total Administrative Costs	$47,850,000	$38,450,000

8.2.3 Comparison with Administrative Costs of Existing Taxes

Information about costs and revenues associated with selected existing taxes is used as a benchmark for estimating disposal fee costs. Administrative costs reviewed for four existing taxes are shown in Table 8.4, and compared with costs of the disposal fee of three different levels (using Scenario A in all cases). At 50%-100% of full cost levels, the disposal fee is comparable to existing taxes in its administrative costs. At 10% of full cost levels, the disposal fee is much more expensive than other taxes and fees, measured by administrative cost per $100 revenue.

TABLE 8.4 - 1989 ADMINISTRATIVE COST COMPARISONS

Tax	Cost per ($100 revenue)	Number of Permits	Revenue
FL Sales Tax	$0.60	400,000	n/a
FL Disposal Fees	$3.00	n/a	n/a
CA Sales Tax	$0.80	900,000	$16,939,907,000
CA Hazardous Substance Tax	$3.27	30,000	$ 67,857,000
CA Disposal Fee (100%)	$0.94	500,000	$ 5,130,033,000
CA Disposal Fee (50%)	$1.87	500,000	$ 2,565,016,000
CA Disposal Fee (10%)	$9.36	500,000	$ 513,003,000

The four existing taxes included in Table 8.4 are:

1. **Florida sales tax.** Florida conducts occasional surveys to estimate the administrative costs of tax collection. Its most recent survey estimates administrative costs at $0.60/$100.00 of

all tax revenue. The administrative costs of the sales tax alone would be expected to be somewhat lower, because the number of taxpayers is higher than for most other taxes.

2. **Florida advance disposal fees on newspapers, tires, and batteries.** Revenues from fees levied on these goods have been collected for over a year. Information on representative monthly revenues and (possibly) on the number of taxpayers, is available and can be compared with information about the state sales tax. The disposal fees are collected by the state Department of Revenue. Presently there is no information on the incremental increase in labor required to administer the fees. By law, the state is allowed to extract up to 3% of the revenues from the fees to cover "unavoidable," non-labor costs associated with administration of the fees. However, this has not been necessary to date.

3. **California sales tax.** If the advance disposal fee system is levied at the point of last sale and administered by the State Board of Equalization, then its administrative costs may be calculated as some increment that is added to the cost of administering the sales tax; The cost of specific program elements that are part of the administrative cost of the California Sales and Use Tax as they appear in the Approved 1990-91 budget are listed below:

Ongoing Administrative Costs:	
Registration	$25,093,000
Processing	$38,152,000
Audits	$71,681,000
Collection	$21,061,000
Total	$155,987,000

The approved budget also reports performance measures associated with these costs. In particular, there are 945,000 permits issued and the State portion of the revenue is $15.775 billion.

4. **California tax on disposers of toxic waste.** This is a tax which targets producers and is collected by the Board of Equalization for the Department of Health Services.

8.3 PRIORITIES FOR USE OF FEE REVENUES

The fee will generate substantial revenues. Like other solid waste fee revenues (such as the landfill fees, described in Section 2.2.5), these revenues will go into the Solid Waste Management Fund, to be distributed by the California Integrated Waste Management Board for waste management activities and mitigation of associated environmental degradation. The result will be a noticeable expansion of that fund, raising the question of the fund's spending priorities.

The goal of providing a source reduction or recycling incentive on waste-related behavior across the board requires a fee with relatively large revenues. Yet such revenues, in turn, require a clear statement of spending priorities. These funds cannot be raised frivolously, or simply to satisfy an economic theory; and it is not our intent to recommend this fee as a contribution to the state's general fund.

What are the spending priorities in the state's solid waste management today? If consumers are told that they have paid part or all of the cost of disposal of products in advance, what should they get in return?

One simple answer should be rejected at the outset: even though the fee is based on current waste disposal costs, the funds should **not** just be returned to households and communities to pay for the current system of waste disposal. This would undercut the incentive to reduce waste volumes and costs, and merely move money around without social benefit. The fee is based on current waste disposal costs for a reason -- the current disposal system is unsustainable, and major changes in that system must be brought about within the space of very few years. To accomplish this goal, the fee must discourage current disposal patterns, and encourage others. New spending priorities are clearly required.

The new priorities fall into two categories: activities that must be performed by the state, and activities that are better performed at the local level. At the state level the priority is to promote the use of secondary materials (market development) by businesses within California. On the local level the priorities are to promote source reduction, recycling/composting, and household hazardous waste collection programs.

Efforts to promote secondary material use. To complete the materials cycle of solid waste management, and sustain local recycling efforts, it is important to stimulate the development of markets and technologies using secondary materials. The use of these materials is still in its infancy, and much more could be done.

Raw materials prices fluctuate widely over the course of the business cycle, and community recycling programs may not be able to develop long-term materials marketing relationships without assistance. For example, the recent slump in recycled newspaper prices in many parts of the country has discouraged some local recycling efforts; concerted action at the state level is required to help identify opportunities for selling and using the materials.

If pursued vigorously, use of secondary materials can become an important part of a state economic development strategy. As recycling programs come into wider operation, cities find themselves in possession of "urban forests" of paper and high-grade "deposits" of major industrial materials. Reorientation of industry to use these local materials will create local employment and incomes, and will provide reliable, environmentally sound sources of materials for in-state production.

Rebates to counties and cities. Use of some of the funds by the state is important; the initiatives described above, and others as well, can only be undertaken at the state level. But the bulk of the expenditure for new waste management programs will occur in cities and counties. If the disposal cost fee raises billions, or even hundreds of millions, of dollars annually, it is of utmost importance to return most of the funding to the local level. Local government may either spend the money directly on public programs, or give grants or contracts to support private sector initiatives. In either case, the money should be made available to support the following waste management programs: local source reduction efforts, recycling and composting programs, and household hazardous waste collection programs.

In order to meet the requirements of A.B. 939, we recommend that the bulk of the money cities and counties receive from the disposal fee be spent on source reduction, recycling and composting, and household hazardous waste collection programs. For cities and counties to meet the 25 percent source reduction and recycling/composting goals by 1995 and the 50 percent goal by 2000 it is essential that they start developing these programs as soon as possible. Therefore, the priority for money raised from the disposal fee is the funding of these programs. Especially important, as well as costly, is the removal of household hazardous wastes from transformation facilities and landfills.

Household hazardous waste collection. Just as landfills are the most environmentally damaging waste facilities in California, household hazardous wastes are the most damaging waste materials. Our full cost fee calculation, as summarized in Table 8.1, shows that the cost of handling these wastes approaches a billion dollars -- 17% of total disposal costs, for just over 1% of the total wastes. More thorough removal of household hazardous materials from the general solid waste stream would provide an important environmental benefit throughout the waste management system. Yet most communities cannot fund such efforts on their own. The fee system, to the extent that it collects high fees on hazardous waste, should likewise return those funds to local hazardous waste programs.

In recognition of the environmental risks involved, California and other states have established high standards for separate collection and disposal of household hazardous materials. Yet few local communities have adequate collection programs; current state funding for local programs provides only a small fraction of what is needed. Only an estimated 3% of the population participates in household hazardous waste collection programs at present. Having established high standards for the treatment of household hazardous materials, the state should provide funding for local communities to reach those standards.

With such programs in place, the question of justification of the fee system and its substantial revenues may be easier to address. Compelling environmental concerns, expressed in A.B. 939, motivate the creation of this seemingly costly new fee. However, the funds are to be used in part for high-priority state waste management activities -- and in large part returned directly to the communities which bear the burdens of solid waste management.

8.4 IMPLEMENTING A DISPOSAL FEE

To implement a disposal cost fee it is necessary to determine which materials/products are covered by the fee and who is responsible for paying the fee.
The first part of this section identifies the point of first sale in the lifecycle of a material or product and the second part identifies materials and establishments which would be exempted from the fee.

8.4.1 Point of First Sale

Having determined that the fee should be imposed at the point of first sale it is now necessary to establish where in a product's lifecycle is the "point of first sale." Ideally, this point would be the first sale of any material/product -- subject to the fee -- in California. This ideal is complicated by the fact that the purpose of the fee is to internalize the true costs of solid waste disposal. Therefore, the point of first sale is the point in a product's lifecycle at which the material(s) in that product are similar to how they are deposited at a transformation facility or landfill. If point of first sale is defined as the first sale of any material in California three problems arise:

1) materials not destined for disposal may pay the fee
2) materials destined for disposal may not pay the fee
3) level of material differentiation would diminish

An example of problem 1) is petroleum products: because crude oil is used to manufacture many products which may end up in solid waste (such as plastics, plastic additives, and organic chemicals) it would be difficult to establish an accurate fee for petroleum. An example of problem 2) is newspaper. If the fee is placed on newsprint manufacturers instead of publishers, the price of the fee would not include the environmental impacts of inks contained in newspapers. An example of problem 3) is products made from trees. If the fee is placed on the sale of logs, no distinction -- and no differential fee -- can be made be between newspaper, corrugated containers, mixed paper, high grade paper, other paper, and wood. All these materials would receive the same fee.

Therefore, the point of first sale is the point in a product's lifecycle at which the material(s) in that product are similar to how they are deposited at a transformation facility or landfill. In other words, the point of first sale for materials sent to transformation facilities or landfills in California is the point of final transformation for that material; i.e., the chemical nature of the material does not change although its shape, form, color, or use does. For example, the final transformation for metals is ingot production, for plastics it is the compounded resin(s) -- includes additives; and for corrugated containers it is linerboard and corrugating medium. For newsprint, office paper, glass, wood, leather the final transformation is the point at which these products are manufactured.

The materials covered by the disposal fee, as listed in Table 8.1, are listed below.

PAPER
- newspaper
- corrugated containers
- mixed paper
- high grade paper
- other paper

PLASTICS
- high-density polyethylene
- polyethylene terephthalate
- film
- other

GLASS
- recyclable (bottles and jars)
- non-recyclable (other glass)

METALS
- aluminum
- other

OTHER ORGANICS
- wood waste
- tires/rubber (and leather)
- textiles

OTHER WASTE
- inert solids (ceramics, stone, cement, and asphalt)
- household hazardous wastes

For many of these materials, further physical changes will occur although the chemical properties of the specific materials will remain the same. For example, wood may be painted, varnished, or treated; paper may have ink added to it; linerboard and corrugating medium will be combined with glue; and plastics may be painted or will have labels added. These additional substances are only of concern to transformation facilities and landfills if they contribute hazardous materials to their pollutant emissions. If this is the case, for example, that some paper inks contain cadmium and chromium, then those inks should be classified as household hazardous wastes and should pay the household hazardous waste fee at their point of first sale (as they appear on the material). If these substances are non-toxic they will then fall through the cracks of the fee system because they represent such a small portion of the total waste stream.

One anomaly to the material-based fee system is household hazardous wastes. As explained above, these are the products with by the far the highest fee levels. Products which fall under the classification of household hazardous waste, will pay a fee at the point of first sale of the product instead of the material(s) used in the product. Therefore if oil-based paint is subject to the fee, the fee will be paid at the point of first sale of oil-based paint.

Another anomaly to the material-based fee system are multi-material products which are manufactured out-of-state but are sold within California. Single material products imported into the state, such as newsprint, would pay the fee at their point of first sale in California. But setting the fee for multi-material products imported into California is a more difficult task.

There are two principal methods for placing the fee on multi-material products imported into and sold in state:

1. average fee for general product categories
2. specific fee based on material content of each product

These two methodologies represent trade-offs between ease of implementation and accuracy of accounting for materials used in products. Listed below are some basic characteristics of the fee based on material content of similar products product ("average fee") and the fee based on specific material content of every product ("specific fee"):

Average Fee

- the fee is assessed on products based on the weight of materials in the products;
- "products" are disaggregated according to Product Code (U.S. Bureau of Census) and an average weight and composition for each product category is developed; and
- Board of Equalization or Waste Management Board is responsible for determining average weight and material content of products.

Specific Fee

- the fee is assessed on every product based on material composition of the product;
- each product must be labeled with material content and feepayer must total material content for all products subject to the fee; and
- Board of Equalization is responsible for collecting the fees from feepayers.

We advocate the use of an average fee because it is easier to implement from the standpoint of both the public and private sectors. Although we recognize that gains in ease of implementation are offset by losses in the accuracy of the fee for every product. In the average fee scenario each seven digit U.S. Bureau of Census (U.S. Department of Commerce) product code covered under the disposal fee would have a fee associated with it. This fee would be based on the average weight and material content of the products found in this product code. Because the number of products manufactured and sold in California are vast, it is necessary to define which product codes are included and which are excluded. For example, the U.S. Bureau of the Census list of manufactured and mineral products distinguishes between approximately 6,800 product codes (see Table 8.5). Obviously the developing a product fee for 6,800 products and tracking their payment is a daunting task for even the most efficient public agency.

However, there are far fewer than 6,800 distinct product categories subject to the fee. A large number of the product codes are for raw materials which will undergo further transformation, industrial machinery, and food products (recall that food waste is exempt, and packaging is included in other product categories). In other cases, many similar categories have identical material content, differing only (for our purposes) in weight. We estimate that fees would have to be set for 1,000 or fewer separate categories.

The number of product code listings in each 2-digit industry is shown in Table 8.5.

TABLE 8.5 PRODUCT CODE LISTING BY 2-DIGIT SIC INDUSTRIES

SIC Code	Industry	Number of Product Codes
10	Metal Mining	54
12	Coal Mining	31
13	Oil and Gas Extraction	28
14	Nonmetallic Minerals	57
20	Food and Kindred Products	861
21	Tobacco Products	15
22	Textile Mill Products	252
23	Apparel and Other Textile Products	202
24	Lumber and Wood Products	290
25	Furniture and Fixtures	172
26	Paper and Allied Products	167
27	Printing and Publishing	338
28	Chemicals and Allied Products	444
29	Petroleum and Coal Products	70
30	Rubber and Miscellaneous Products	224
31	Leather and Leather Products	54
32	Stone, Clay, and Glass Products	198
33	Primary Metal Industries	302
34	Fabricated Metal Products	723
35	Industrial Machinery and Equipment	1,221
36	Electronic & Other Electric Equipment	238
37	Transportation Equipment	376
38	Instruments and Related Products	188
39	Miscellaneous Manufacturing Industries	293
	TOTAL PRODUCT CODES	6,798

Source: U.S. Bureau of the Census, *1987 Census of Manufactures and Census of Mineral Industries: Numerical List of Manufactured and Mineral Products* (Washington, D.C.: U.S. Government Printing Office), 1989.

One requirement of the fee would have to be that companies selling their goods in California would be required to provide the material content of their products to the agency requesting it. Manufacturers would have the option of requesting that their material content information remain classified.

For the majority of product categories this would be a relatively straightforward process. Textiles, for example, covers a large range of product categories, yet all textiles would receive the same price with slight variations depending on the average weight for each product category. The most complicated area is multi-material products -- such as appliances, consumer electronics, and cars -- imported into California already assembled. For these products it will be necessary to ascertain from manufacturers the amount of each material in each product category and assign an average fee to this category. For example, if the average car weighs 3,000 pounds and consists of 2,000 pounds of ferrous metal and 1,000 pounds of plastics, the fee would be assessed at the per pound rates developed for these materials and would be paid at the point of first sale in California. In cases such as automobiles, which differ quite substantially in weight, it may be necessary to develop finer categorization, or even to weigh individual models, in establishing the fee.

One shortcoming to using an average fee is that product codes for plastics usually do not distinguish between resin types (i.e., between HDPE and PET). For example, plastics bottles is one product code, 3085000, with no distinction between resin types. Therefore, unless specific data was requested from feepayers at the point of first sale regarding resin type, the three plastic categories -- HDPE, PET, and other -- would have to be lumped together. Specific product codes are available for plastics film and sheet (3081010 -- 3081050 and 308201 -- 3082090).

8.4.2 Amount of Fee and Fee Tracking

The disposal fee is assessed based on pound of material in a product or pound of material manufactured in state. For specific products the fee will be set by the Board of Equalization or the Integrated Waste Management Board based on average material content for that set of products. The fee will be based on the combination of conventional and environmental costs delineated in Chapter 6. It is recognized that the fee may be a fraction of the total economic costs.

To ensure that all materials/products included under the fee have paid and to avoid double-counting of materials/products, once the fee is paid, each material/product will carry along in its lifecycle a receipt of fee payment. One possible accounting method is using disposal fee stamps to indicate that a material or product has paid the disposal fee. These stamps would provide the paper trail for identifying whether or not a material or product has paid the fees required by the disposal fee.

In order to account for the fact that not all products sold in California are manufactured from raw materials produced in state, the fee may be placed either on a material or a product. The fee is designed in this manner to reduce the number of products that actually pay the fee and also to push the fee further upstream so that manufacturers who have the ability to substitute between materials are sent the appropriate price signals. Because of this distinction between materials and products it is necessary to ensure that manufacturers using products from in state pay the same amount as manufacturers using imported materials. Therefore, how point of first sale in state is defined must be clear. For materials manufactured and sold in state, feepayer of point of first sale is clear: if Newsprint Co. sells to newsprint to Publishing Co., Newsprint Co. is responsible for paying the fee for newsprint. However, if Publishing Co. buys their newsprint from Out-of-State Newsprint (based in Portland, Oregon) a new question arises, should Publishing Co. pay the fee based on the purchase of newsprint from Out-of-State Newsprint or on their sale of newsprint to Paper Distributor Co.? We recommend that the fee be placed on Publishing Co.'s purchase of newsprint from Out-of-State Newsprint to help simplify the process and to closely mirror how the fee is paid by manufacturers using materials produced in state. This is also similar to how the use tax is applied in California, where the tax is applied to California consumers who purchase materials from out-of-state.

8.4.3 Exemptions

Exemptions to the fee include raw materials, products included in A.B. 2020, materials and products sold out-of-state but manufactured within state, and retail establishments with low total sales or low sales of products covered by this fee. The rationale for exempting raw materials is because raw materials are not always consistent with the materials deposited at transformation facilities or landfills. The exemption for out-of-state sales is necessary to ensure that California manufacturers are not placed at an unfair competitive disadvantage with manufacturers in other states. Thus manufacturers or distributors at the point of first sale in California would be responsible for reporting the number of products sold out-of-state. Products imported into California would, however, be subject to the fee at their first sale in California.

Under the recommended fee system, there are some individual cases for which the recommended system would be too burdensome to both the payers and to the administrators of the fee to be considered cost-effective. One example of such a case is the very small retail business which purchases some of its goods from out-of-state suppliers. The retailer would be liable for the tax because it would be the first in-state purchaser of the imported products. This could be burdensome to the retailer because the tax may only apply to a small proportion of the retailer's merchandise, yet it would require that the retailer implement a new and somewhat complicated accounting system for that imported merchandise. Furthermore, because the small retail business has a relatively small volume of sales that are subject to the disposal fee in comparison to the sales of many producers or distributors, only a minor amount of tax revenue is generated by the retailer. In such a case, one can argue that it would be more cost-effective to exempt the retailer from the tax liability.

The question that remains is how specific businesses should be exempted from the disposal fee. The basic approach that is recommended is to establish some threshold conditions, and to exempt any establishment from the fee if it can demonstrate that it satisfies the appropriate conditions. One condition could be defined in terms of a threshold level of total sales. For example, establishments are exempt from the fee if their annual sales are under $25,000; in other words, they are exempt if they meet the requirements for paying the State Sales and Use tax on an annual basis. This would eliminate the very small retail businesses from the fee.

In addition, a condition could be defined in terms of level of total disposal fee revenue. For example, establishments are exempt if their annual tax liability is less than a prespecified value. (The amount that is specified would depend on whether the fee is based on full cost or some partial cost). Assuming revenues and participation rates as used to estimate administrative costs in Scenario A (see Section 8.2 above), a threshold level of $600 annual tax liability may be appropriate. Under this condition, any establishment generating less than 10 percent of the average revenue per feepayer would be exempt, and it would relieve establishments that purchase relatively small quantities of disposable goods, regardless of the size of their sales volume, of administrative burdens without significantly compromising the overall tax revenue. Establishments would still have the burden of proving that they qualify for the exemption, and would, perhaps, have to produce receipts which recorded the weight of materials purchased over a year, in order to qualify.

8.5 EVALUATION AND UPDATE OF THE DISPOSAL FEE SYSTEM

The fee system must be periodically evaluated for its effectiveness in contributing to successful source reduction and providing revenues to conduct waste management activities. It is equally as important that the fee system be updated to reflect changes in regulations, pollutant emissions, waste composition, and waste disposal technologies.

8.5.1 Evaluation of the Disposal Fee System

Evaluation of the fee requires a careful examination of source reduction, recycling, emissions reduction in the overall waste management system, and the administrative costs of administering the fee.

Source Reduction

In order to estimate the quantity of waste that has been avoided, one must choose a base year from which to measure the current level of waste reduction. Second, one must inventory waste loadings at landfills, waste-to-energy facilities, composting facilities, and recycling facilities. The difference between the estimated waste generated and the summation of these facility loadings should provide an approximation for total source reduction. Furthermore, if one were to incorporate waste stream composition information for each facility type into the calculation, it would be possible to not only evaluate total waste reduction, but the amount of reduction in each waste category. This category specific information would be useful in evaluating which materials are not responding to the disposal fee incentives and which may require more financial efforts be invested in reduction strategies in order to elicit the desired response.

As a matter of practicality, and to ensure consistency in the evaluation, we recommend that the estimated waste generation for the year 1990 be chosen as the base generation rate, and that the source reduction rate for that year is assumed to be zero. The waste generation for the future years is forecast by evaluating changes in population growth and changes in commercial and industrial activity levels. Then, the waste loadings to each facility is inventoried every year. The difference between the forecasted waste generation and the inventory of facility waste loadings amounts to the total source reduction.

For instance, imagine that the population growth rate for 1991 is 2.5% and assume for simplicity that the economic activity levels for the generation of the commercial waste stream also increase by 2.5%. Then, absent source reduction, a 2.5% increase in waste generation would be expected; the waste stream might be expected to rise from 50 million to 51.25 million tons. If, however, waste loadings at all landfills, waste-to-energy facilities, composting facilities, and recycling facilities total 48 million tons for the year, then we would assume that source reduction achieved in 1991 is 3.25 million tons, or 6.5%.

Revenue Generation

Revenue generation for implementation of solid waste management programs is the second major goal of the disposal cost fee system. The fee system must be evaluated on two points with respect to the fee revenue. First, is the fee system efficient, or is there an unusually high administrative burden per dollar of revenue generated? Secondly, is the revenue being distributed so as to accomplish the solid waste management goals of California? Is it effectively increasing recycling and reduction, mitigating pollution emissions, and reducing the total amount of waste being generated?

Administrative costs of the fee system will be obtainable from the California Board of Equalization, as they will be responsible for administering and collecting the disposal fees from the fee payers, and will therefore be maintaining records on administration expenses and the total revenues received. Based on the Board of Equalization estimates it will be easy to verify the administrative efficiency of the fee. Initial estimates of these costs indicate that the administrative costs should amount to about 2% or less of the total revenue collected, based on the assumed $3 billion revenue total (see Section 8.2).

Over time, the total amount of fees collected should decrease as solid waste management policies are successful in achieving the desired goals. As producers shift to utilizing more environmentally benign inputs and conscientious consumers use more environmentally responsible products, a smaller, less environmentally damaging waste stream will be generated. As a result, one expects the total fees collected to decrease. Thus, the ratio of total administrative costs to fees collected may well increase in the long run -- but as a result of success in lowering waste management costs, on which the fee is based.

Solid waste management program implementation success can best be evaluated by each program's contribution to increased source reduction and recycling, and reduced and/or mitigated pollutant emissions. In the event that a program is not effective in achieving these goals, given the funds distributed to it, this may signal a need for redistribution of the fees among the existing programs, the dissolution of certain programs, or the creation of new solid waste management programs to better achieve these goals. This is not so much a reflection of the success of the fee system itself, as it is a reflection of the effective disbursement of the fee revenues. The inability to achieve these goals does not justify altering the fees placed on materials, as these fees are based on the economic and environmental costs of disposal. The fees on the individual materials should only be altered if these costs change.

8.5.2 Method of Disposal Fee System Update

The fee system should be updated periodically to reflect changes in pollutant regulations and waste management data. A natural review period is every two years, as all the SRRE's and Waste Generation Elements must be reviewed every two years for accuracy. Given the size of the fee revenues, based on the full disposal cost, small changes in waste composition, generation, or facility types, may have significant impacts on the amount of fees collected for each material.

The fee system as developed is based on many different aspects of the waste stream and of solid waste management practices. If any of these aspects or practices change significantly, either individually or in combination with other factors, this would alter the material fee per ton. The data which must be updated to revise the fee system include: waste composition and generation data; disposal path data; pollutant emissions data; conventional cost data; legislative changes in permitted pollutant emissions; and control cost data.

- A change in the amount of waste generated, even assuming an unchanged waste composition, will have an impact on all solid waste management activities. As the quantities of wastes generated increase, the environmental and conventional costs may rise disproportionately to the increase in the waste stream. In this case, it is important to evaluate whether there are significant changes in pollutant loadings occurring which may necessitate the redistribution of the environmental and conventional costs among the individual materials.

- A change in overall waste composition can result in a change in the composition of the waste entering each facility type. This in turn could result in new pollutant loadings at the different facility types. The environmental costs of these pollutant loadings need to accrue to the individual materials in proportion to their contribution to the total waste loading at that facility type. Therefore, updating the fee per material would be necessary.

- A change in the material composition of products (as well as a change in the fee per material) will alter the fee assigned to each product code. And as product designs change frequently, it is necessary that the fee assigned to each product code be updated.

- A change in the disposal paths of the individual materials, would influence the composition and quantity of the waste entering the different facilities. Again, if this caused a change in conventional and/or environmental costs at the facilities, a recalculation of the per material fee would be needed.

- A change in the facility mix, i.e. a sudden increase in mixed municipal solid waste composting as a disposal option, would serve to influence the quantities and composition of waste entering each facility type. As was stated above, such a change would require a recalculation of the fees.

- Hopefully, the pollutant emission factors measured at the various facility types will decrease over time as those materials which cause the most environmental damage upon disposal are slowly phased out of the waste stream or are collected for source separated disposal. Any change in the pollutant loadings at the facilities should result in a reevaluation of fees per material.

- A change in the conventional solid waste management or control costs would affect the total disposal cost per material and would thus result in different fees.

All of these data changes are critical in determining the correct fees to access on each material, and should therefore be evaluated and updated every two years.

8.5.3 Improvement of the Fee System

In the construction of the fee system, there were two areas where more specific information would have been beneficial: waste composition and pollutant legislation information.

If more specific waste composition data was available it would have been possible to more accurately attribute the pollutant emissions to their source. For example, if the breakdown included a separate category for polyvinyl chloride (PVC) it would have been possible to trace chlorine emissions to PVC as opposed to spreading these emission control costs across the entire plastics category. As more specific data becomes available, as it will with the completion of the SRRE's and

Waste Generation Elements, the fee system should be updated to incorporate this improved data set.

The lack of legislation relating to specific pollutant control requirements was also problematic. Should more specific pollutant level legislation be introduced, the impact on control costs must be added to the analysis. If additional controls are required to satisfy this new legislation, then these control costs need to be reflected in the fee system.

As more information becomes available both with respect to the waste stream and pollutant control requirements, it will be possible to adjust this disposal fee system to be more effective.

8.5.4 Summary of Disposal Fee System Updates

In summary, the fee update process requires the collection and evaluation of a substantial amount of data, all of which may change over time:

- waste composition and generation data
- disposal paths of the various materials in the waste stream
- conventional waste management costs
- pollutant emissions data from waste management facilities
- new regulations requiring control technologies for relevant pollutants
- matching of pollutant emissions costs with their sources in the waste stream.

The financial cost of updating the fees as outlined would be minor as compared to the initial costs of developing the fee system, and would serve to make the fee system more effective.

CHAPTER 9 - INPUTS TO MODEL LEGISLATION

The disposal fee system outlined in this report requires a substantial amount of detailed information be included in the model legislation for the fee system. The most critical parts of the legislation include a clear definition of the terms utilized in the legislation; an outline of the development of the individual product fees; an identification of those products and feepayers exempted from the fees; a clear description of the administration of the fee system; and a description of the penalties for nonpayment of the required fees.

9.1 DEFINITION OF TERMS:

9.1.1 Materials in the Waste Stream:

"Municipal Solid Waste Stream" - all residential, commercial, and institutional solid waste generated within the boundaries of any municipality.

PAPER

- **Old Corrugated Containers (OCC)** - a container consisting of a corrugated medium sandwiched between two layers of kraft linerboard. Kraft paper is usually made from wood pulp and possesses a basis weight range of 18-200 pounds. Corrugated mediums are made from wood pulps, straw, or reclaimed paper stock.

- **Mixed Paper** - an unsegregated mixture of a variety of different paper categories (i.e.,OCC, colored paper, newspapers, high grade).

- **Newspaper** - low quality paper used for manufacturing newsprint.

- **High Grade Paper** - high quality white paper which possess presentation qualities, usually generated in offices.

- **Other Paper** - low grade paper or paper containing products/packaging not included in the above categories. This categories includes paper contained in composite packages such as milk cartons and aseptic packages.

PLASTIC CATEGORIES

- **High Density Polyethylene (HDPE)** - a rigid plastic material usually opaque or clear in color. HDPE is often used in milk containers, cleaning solutions, oil bottles, etc. Such containers usually carry the triangular recycling symbol with a "2" inside the symbol.

- **Polyethylene Terephthalate (PET)** - a flexible plastic materials often used in soda bottles. PET containers are characterized by a small dot or nipple at the base as opposed to a seam. Such containers usually carry the recycling triangle with a "1" inside the symbol.

• **Films** - any of a variety of plastic materials which are flexible and thin (10 mil or less). Films are often used for plastic grocery bags, food wraps, and agricultural covering.

• **Other Plastics** - all plastics except HDPE, PET, and films.

GLASS CATEGORIES

• **Recyclable Glass** - includes flint, amber, green, mixed, and refillable glass beverage containers.

• **Non-recyclable Glass** - glass that usually cannot be processed at a recycling facility including: pyrex, plate, light bulbs, and automobile glass.

METAL CATEGORIES

• **Aluminum Cans** - Any container which is composed of no less than 99% or more aluminum.

• **Other Metals** - other metals include a combination of ferrous, non-ferrous, and white goods. Ferrous Metals - iron or steel materials which posses an iron content sufficient for magnetic separation. Nonferrous metals - metal scraps, other than iron and its alloys in steel, which cannot be adhered to with a magnet. Includes aluminum, copper, brass, bronze, lead, and zinc. White Goods - large enamel coated appliances such as washing machines, clothes dryers, stoves, refrigerators, etc.

YARD WASTE CATEGORY

• **Yard Waste** - usually organic waste resulting from the maintenance or alteration of landscapes including but not limited to grass clippings, leaves, tree trimmings, prunings, brush, and weeds.

OTHER ORGANIC CATEGORIES

• **Organic Compostables** - non-petroleum based wastes containing naturally produced organic compounds. Such wastes are biologically decomposable by microbial and fungal processes into water, carbon dioxide, and other simpler organic compounds. A major constituent of this category is food wastes.

• **Organic Non-compostables** - wastes that do not readily decompose through biological action.

• **Textiles** - fabric materials, including clothing, rugs, and upholstery made from natural fibers (i.e., cotton, wool, silk).

• **Tires/Rubber** - materials consisting of an amorphous polymer of February 15, 1991 isoprene derived from natural latex, ceratin tropical plants, and petroleum.

- **Wood Waste** - waste materials consisting of wood pieces or particles.

OTHER WASTE

Bulky Items - large discarded items including furniture, and other large composite products.

Miscellaneous Inorganics - any of a variety of mixed inorganic materials includes such things as non-bulk ceramics and other clay products. Many waste composition analyses do not distinguish this category from inert solids.

Inert Solids - often fine, non-hazardous waste materials including but not limited to soil, concrete, gypsum, etc.

Household Hazardous Waste - a variety of consumer products which because of their quantity, concentration or physical chemical or infectious characteristics, may pose a hazard to human health or the environment.

OTHER SPECIAL WASTE CATEGORY

Other Specials Waste - often classified as a slurry of which the solid constituents are insoluble in water. These wastes contain inorganic solids and are thus hazardous.

9.1.2 Fee Administration Terms:

"System" - The disposal fee system.

"Account" - The disposal fee system account.

"Board" - The California Integrated Solid Waste Management Board.

"Fee" - The fee levied on materials or products at the point of their first sale in California. This fee is based on the full cost of disposal of that material or the combination of materials comprising that product.

"Feepayer" - The party responsible for paying the fee at the point of first sale, this may be the manufacturer, wholesaler, distributor, supplier or retailer of the material or product subject to the fee.

"Fee Rebate" - that portion of the fee revenues which is returned by the Board to individual cities and counties, and which has not been identified for use in implementation of specific A.B.939 programs.

"Point of first sale" - This would be the point of final transformation for each material. The point of first sale is the point in a product's lifecycle at which that material(s) in that product are similar to how they are deposited at a transformation facility or landfill. The point of first sale is the point of final transformation of that material;i.e. the chemical nature of the material does not change although its shape, form, color, or use does. For goods or materials imported into California, the fee will be paid at the point of first sale within California.

"Sale" or "selling" - any sale, transfer, exchange, barter, gift or offer of sale or distribution by a manufacturer, wholesaler, distributor, supplier, or other person or entity in any manner or by any means whatsoever.

"Retailer" - any person or entity, other than a distributor, supplier, or wholesaler, who sells or otherwise dispenses to consumers any material or product.

"Supplier" - the first person or entity who sells any material or product within California to another person or entity.

"Wholesaler" - Any person or entity who sells materials or products to retailers, suppliers, distributors, or other wholesalers for resale purposes.

9.2 SPECIFICATION OF FEE DETERMINATION METHODOLOGY

The average fee is assessed on products based on the weight of materials in the products; "Products" shall be disaggregated according to Product Code (U.S. Bureau of Census) and an average weight and composition for each product category is developed; and the Board of Equalization is responsible for determining average weight and material content of each product.

The fees shall be proportional to the full disposal cost of the materials which comprise the product, calculated according to the methodology presented in Chapter 6 of this report.

9.3 MATERIALS AND PRODUCTS SUBJECT TO THE DISPOSAL FEE

All materials present in the California municipal solid waste stream shall be subject to the fees with the exclusive exception of those materials listed below, as defined above:

* Food waste
* Yard waste
* Sewage sludge
* Those materials subject to Division 12.1, (Section 14500 et seq.) of the California Public Resources Code.

9.4 SPECIFICATION OF FEE TARGET

The specification of the exact amount of fee revenues to be collected shall be set to meet the programmatic needs of the Board.

9.5 FEE SYSTEM UPDATE

The fee system should be evaluated, reviewed, and updated on a biannual basis, the same frequency with which the SRRE's will be reviewed. The evaluation of the fee system should incorporate changes in: the California waste stream, waste generation, new legislation, pollutant emissions, material makeup of different products, and solid waste management program implementation expenses.

9.6 METHOD OF FEE PAYMENT

The method of fee payment should outline in detail the role of the California State Board of Equalization in administering the fee system. The fee payers should be clearly identified in the legislation as well as the specific products which will carry the fees, and the amount of the fee that each product should carry.

Those fee payers who would present an undue administrative burden on the fee system, due to the insignificant amount of fees which they would be required to pay, would need to be exempted from the fee payment for administrative efficiency reasons. The specific quantity of "minimal fee payment" would have to be determined in the legislation.

The frequency of fee payment should be specified in the legislation as determined by the California State Board of Equalization. If certain parties will be responsible for submitting fee payments on a monthly, quarterly, or yearly basis, guidelines for these payment responsibilities should be included in the legislation.

9.7 PENALTIES FOR NON-PAYMENT

Penalties for nonpayment of the fees would need to be determined by the California State Board of Equalization, in accordance with California State Law, for inclusion in the legislation.