# END –OF –LIFE CONSUMER ELECTRONIC AND ELECTRICAL PRODUCTS IN THE ALAMEDA COUNTY AND CITY OF SAN FRANCISCO MUNICIPAL WASTE STREAMS: AN INVESTIGATION OF MODELS FOR COMMUNITY ECONOMIC DEVELOPMENT

A study conducted by Materials for the Future Foundation and Steve Holroyd and Associates, sponsored by the Alameda County Waste Management Authority and Recycling Board and the San Francisco City Recycling Program.

**May 1999**

**ACKNOWLEDGMENTS**

Materials for the Future Foundation (MFF) would like to thank the Alameda County Waste Management Authority and Recycling Board and the City and County of San Francisco Recycling Program for their support of this project.

MFF gratefully acknowledges all the organizations who gave freely of their time for this project: Americorps*VISTA volunteers Leana Schelvan, Mar Kaw Shu Wa and Dawn Beaudry, East Bay Conservation Corps, CURA, City of Hayward, Computer Resource Center, Berkeley Neighborhood Computers, Goodwill of San Francisco, United Datatech, Metech, HMR, Steve Holroyd, Byron Hoffman of Waste Management of Alameda County, Paul Braund, David Jones, US EPA Region IX.

# Table of Contents

## Introduction

Materials for the Future Foundation (MFF) worked with the counties of San Francisco and Alameda to document the quantity and recyclability of electronic and electrical products in the residential waste stream[1]. The mission of MFF is to integrate the environmental goals of resource conservation through waste prevention, reuse and recycling with the economic goals of job creation and enterprise development.

MFF's work focuses on low-income communities, communities of color and areas of high worker displacement, especially in the San Francisco Bay Area. Therefore, the primary goal of the year-long Electronic Collection and Recycling Pilot Project was to explore the potential for local communities to benefit from the collection, processing, reuse and recycling of electronic materials recovered from municipal collection programs.

Electronic products represent a new era in materials recovery and recycling. Electronics differ from traditional products made from fairly uniform types of wood, metal, paper, glass or textiles that have been recycled for many years. Electronic products are a complex composite of plastics, metals, integrated circuit boards, leaded glass, adhesives, paints and fire retardants. Local communities lack the technology and the facilities to recycle these materials, some of which are characterized as hazardous to human health and the environment.

Advancements in materials science are making new complex synthetic materials for electronic appliances as well as furniture, toys and even building construction materials. At a time when cities are mandated by a 1989 California law (AB 939) to divert 50 percent of the materials sent to landfills by the year 2000, many new consumer products comprised of a variety of synthetic materials are in fact becoming more difficult to recycle.

European countries are addressing their landfill crisis and resource conservation concerns by enacting laws that require original equipment manufacturers (OEMs) to take back products at the end of the products' life cycle. The logic behind the take back is that all non-recyclable products will become the responsibility of the OEM rather than the sole responsibility of municipalities. The European take-back laws have motivated many OEMs to implement design for the environment programs that look at the entire life cycle of the products. However, US OEMs are not in favor of European style take-back laws being implemented in the US. The electronics industry has suggested that the existing municipal waste collection and recycling systems should be utilized to recover and recycle products. The Electronic Collection and Recycling Pilot Project is an effort

[1] For the purpose of brevity, EOL electronic and electrical products are often referred to in this document as electronics. The EOL electronic and electrical products collected during this pilot program included everything that plugged-in or ran on batteries.

to begin to explore what type of electronic products end up in the municipal waste stream and how these products can be recycled.

MFF worked with the cities of San Francisco, Hayward and Oakland to determine if the electronic products in the residential collection programs could be diverted from the landfill. In Oakland and San Francisco, MFF conducted two-week pilot collection projects through the residential bulky materials collection programs (residents are given the opportunity to place large appliances, furniture, yard waste and other materials on the curb for collection by the city waste hauler). MFF worked with the City of Hayward to facilitate the collection of electronic products during that city's Recyclables Drop Off program (RDO). The RDO provides Hayward residents with a special day to drop off their recyclable materials at a city-owned lot. MFF also conducted a waste assessment of reusable products donated to the Goodwill Industries in San Francisco to document what electronic products the Goodwill was not able to sell and subsequently threw away.

Commercial electronic recyclers that accept computers and other high-end office equipment have laid the foundation for a burgeoning Northern California recycling industry. However, the commercial elecronic recyclers shun consumer electronics that are rich in plastics and contain small integrated circuit boards with very few precious metals or valuable microprocessors.

The Electronics Collection and Recycling Pilot Project explored the possibility of recycling larger quantities of consumer electronic products through the involvement of community-based nonprofit organizations (CBOs). CBOs have traditionally played a leading role in Northern California recycling efforts by providing advocacy, volunteers and performing labor-intensive recycling processes that are not cost effective for commercial recyclers.

MFF collaborated with three community-based nonprofit organizations to process the materials collected from the municipalities. Each CBO represented a different organizational model. The Computer Resource Center is a volunteer organization that repairs, redistributes and recycles surplus computers donated by corporations. CURA, a long term drug and alcohol treatment program recycles bulky waste materials from the City of Fremont. The East Bay Conservation Corps, a youth employment training program, recycles California redemption value beverage containers.

San Francisco Bay Area commercial recycling companies such as United Datatech, Metech and MBA Polymers also provided valuable assistance in recycling and evaluating the electronic products collected from the municipal programs.

MFF hopes the information from this study will be of value to the electronics industries, community-based organizations and San Francisco Bay Area governments that are searching for alternative methods to divert materials from the landfills, protect the environment and support local economies.

## Summary of Findings

### A. Background

The Materials for the Future Foundation's (MFF) Residential Electronic Collection and Recycling Pilot Project documented the quantities and types of end-of-life (EOL) consumer electronic and electrical products found in the residential waste streams of the cities of San Francisco, Oakland and Hayward. MFF also conducted waste assessments at the Goodwill Industries in San Francisco and collected EOL products from San Francisco's Public Disposal and Recycling Area in order to investigate how consumer electronic products could be recycled to contribute to the local economy and reduce waste deposited in the municipal landfill.

The Electronics Collection and Recycling Pilot Project investigated the possibility of recycling larger quantities of consumer electronic products through the involvement of community-based nonprofit organizations (CBO). MFF worked with three Bay Area CBOs to determine the feasibility of the nonprofits collecting and processing the EOL consumer electronic and electrical materials from existing municipal collection programs. Each CBO represented a different organizational model as well as a different social service mission.

The Pilot Project recorded the types and weights of products and conducted an analysis of the plastic from the most frequently collected products. The utilization of different residential collection models allowed MFF to evaluate how each city's contractual arrangement with waste haulers, organized labor and city recycling resources affect large scale collection of EOL electronic and electrical products. The development of efficient and effective recycling collection systems can take years to establish. The EOL Electronics Collection and Recycling Pilot project only scratched the surface in its effort to explore the possibilities of implementing an EOL electronic and electrical recovery system.

### B. Collection Models

Ten-day pilot collection programs were conducted through residential bulky materials collection programs in the cities of Oakland and San Francisco. The bulky materials collection programs provide residents with the opportunity to place large appliances, furniture, yard waste and other materials on the curbside for collection by the city waste hauler.

EOL electronic and electrical products were also recovered for a ten day period from San Francisco's Public Disposal and Recycling Drop-off Area (PDRA) located at the city transfer station. The PDRA provides the public with the opportunity to recycle wood, metal, yard trimmings and dispose of waste materials for a fee.

The Hayward Recyclable Drop-Off (RDO) event invited Hayward residents to drop off white goods, yard trimmings, mattresses and wood waste at a vacant lot owned by the City Department of Public Works. The Drop-Off Event is held several times a year and is staffed by city workers. The EOL electronic and electrical products

were also included in the list of items accepted during the one day Drop-Off event. The EOL electronic and electrical products were disassembled to determine the value of the constituent metals.

In order to characterize the volume and types of electronic and electrical products collected by charities that accept donated consumer products, the Pilot Project also audited the electronic and electrical products processed through Goodwill Industries in San Francisco. For three consecutive days, MFF weighed and documented the electronic products that entered the Goodwill facility and also weighed and documented the electronic and electrical products designated for recycling or the landfill in order to get a better understanding of how those products are currently sorted for resale, recycling or disposal.

The Pilot Project's primary goals at all five sites were to record the type and weight of EOL electronic and electrical products in the waste stream and to determine if CBOs could work with city recycling programs to recover the EOL products in a cost effective manner. However, the emphasis on data collection increased the overall labor hours and limited the amount of time the CBOs were able to spend disassembling the products and recovering metal, integrated circuit boards, or microchips for recycling or reuse. Therefore the real cost benefits of disassembly and materials recovery could not be thoroughly assessed. MFF also determined that the CBOs' expertise in recycling beverage containers, paper and scrap metal did not provide adequate knowledge for recycling EOL electronic and electrical products. The CBOs' lack of knowledge of electronic and electrical product repair and component parts hindered the CBOs' ability to assess the value of the EOL products' constituent materials and to efficiently disassemble the EOL products.

However, even if the EOL products collected from the Oakland Bulky Waste Project were disassembled and the constituent materials thoroughly recovered, the cost of collection and processing would still be prohibitive due to the cost of labor. The diversity of the type of EOL electronic and electrical products collected also made the products inefficient to disassemble and generated small quantities of highly diverse constituent materials. Resell markets are not available for small quantities of plastic mixed in random compositions of dissimilar resin types.

Unfortunately, televisions, which composed the largest volume of the EOL electronic and electrical waste stream, are also very complex to recycle. More than half of the products placed on the Oakland curbside were televisions and monitors. Televisions and monitors proved to be time consuming to disassemble and the constituent materials are of low value. Although an analysis of the televisions' housing showed that almost 86 percent of the plastic content was resellable high impact polystyrene (HIPS), televisions also contain leaded glass that is characterized as hazardous waste. Resell markets could be identified for the HIPS resins and the televisions' constituent metals, however, the televisions' leaded glass has extremely limited resell markets and would present a disposal problem.

The San Francisco and Hayward models are more promising due to reduced labor cost of the CBOs and effective use of existing collection vehicles and personnel. The results of these programs suggest that residential collection of EOL electronic products can be more cost effective when critical resources such as a subsidized labor force and an appropriate collection infrastructure are already in place.

The Pilot Project model of collecting everything that plugged in or ran on batteries was also an inefficient system of collection. Residential collection of EOL products should target items with high resell and recycling value and/or similar material types. Bay Area residential collection of EOL products should also be combined with broader EOL electronics regional collection strategies in order to achieve the economies of scale required to make recycling cost effective. Other collection strategies that could be combined with residential bulky waste collection programs include product recovery at retail stores, charitable organizations, commercial recycling programs and residential collections by appointment.

**C. Oakland Bulky Waste Pick-Up**

Oakland residents are provided an annual Bulky Waste Pick-up Day in which Waste Management of Alameda County (WMAC), the franchised hauler for the city, collects white goods, brown goods (electronic and electrical appliances), tires, household furniture and yard trimmings. The white goods and tires collected in the bulky waste program are recycled. The remaining materials are landfilled.

Approximately 3,690 Oakland households received notification that they had been selected for the special Electronic Collection and Recycling Pilot Project. The East Bay Conservation Corps (EBCC), a nonprofit community-based organization that provides employment training to at-risk youth, documented the quantities and types of materials collected from the Bulky Waste Pick-up Programs for a two week period. WMAC provided an extra flat bed truck and driver to collect the EOL electronics from the curbside and to transport the materials to EBCC.

The collection model used in the Oakland Bulky Waste Pick-up program appears to be the least cost effective model. The $4,300 for a separate WMAC driver and truck, as well as the standard $8,975 East Bay Conservation Corps (EBCC) fee for service for two week period resulted in a $1,970 per ton recycling rate. The EBCC contract included three corpsmembers and one supervisor for two 40 hour work weeks.

The positive response of the Oakland residents to the flier announcing the pilot project demonstrates that Oakland residents are willing to participate in a residential collection of EOL electronic and electrical products. Approximately 12.7 tons of EOL products were set out for collection. The EOL electronics and electrical products comprised 2.2 percent of the total materials collected during the Bulky Waste Collection. However, the overwhelming volume of televisions set out for recycling by residents significantly drove up the recycling cost per ton. EBCC's

warehouse became so overwhelmed by the volume of televisions, the Pilot Project stopped the collection of televisions for two days in order to allow EBCC to catch up.

The cathode ray tube (CRT) glass in televisions and computer monitors may be classified as hazardous waste under the Environmental Protection Agency's Resource Conservation Recovery Act provisions (RCRA, 42 USC 6924) because the glass contains lead. There are few CRT recycling options available in California. The CRT recycling options available to the Pilot Project included recycling the intact televisions and monitors at ECS (located in San Jose) at a cost of 25 cents per pound or selling the units for 2 cents per pound for export to China. The CRTs were recycled at ECS because MFF could not confirm that the Chinese vendor would recycle the CRTs in an environmentally responsible manner. The Pilot Project paid $500 per ton for CRT recycling. The average cost per ton for recycling paper, beverage containers and other materials in Alameda County residential collection prgorams is $100 to $150 per ton.

Illegal curbside scavenging and rain damage to the EOL products also limited EBCC's opportunity to generate revenue from repair, reuse and resale. Fig 1 shows the cost of the Oakland Pilot Project. It should be noted that Fig. 1 does not include the televisions that were not collected, which MFF estimates to be approximately 9,847 pounds. Also, more than 5,900 pounds of materials were sent to the landfill. There was no charge for disposal of those materials.

| | | |
|---|---|---|
| Revenue | | |
| Scrap Metals | $ 21.00 | |
| | | $21.00 |
| Cost | | |
| WMAC Collection | $4,300.00 | |
| EBCC Labor | $8,975.00 | |
| Advertising | $ 365.00 | |
| CRT recycling | $1,750.00 | |
| | | <$15,390.00> |
| Total Cost | | <$15,369.00> |

**Fig. 1**
**Cost of collecting and processing 15,623 pounds of electronic products from 3,692 Oakland households. The above figure does not include the cost of recycling the 9,847 pounds of televisions that the pilot project was not able to collect.**

EBCC's commitment to accurately recording the types and weight of materials limited the amount of time EBCC was able to spend recovering constituent materials. However, if EBCC had been able to disassemble the products and recover the integrated circuit boards, and if EBCC sold the televisions to a Chinese vendor at a rate of 2 cent per pound, the pilot project cost could have been reduced to $1,574.62 per ton (see figure 2).

| | | |
|---|---|---|
| Revenue | | |
| IC board recovery | $1,000.00 | |
| Scrap metals | $ 21.00 | |
| Export CRTs | $ 336.94 | |
| | | $1,357.94 |
| Cost | | |
| Collection | $4,300.00 | |
| EBCC Labor | $8,975.00 | |
| Advertising | $ 365.00 | |
| | | <$13,640.00> |
| Total Cost | | <$12,282.06> |

**Fig. 2**
**The collection and transportation cost shown in Fig. 2 also includes revenue from exporting CRTs to China and an estimated $1000 revenue for IC board recycling. The $1000 estimate was derived by comparing the types of products collected from the San Francisco collection (which earned $1,000 in revenue from the IC boards) with those products collected from the Oakland project.**

According to the Alameda County Waste Management Authority staff, a new municipal recycling program typically experiences a 40 percent reduction in recycling and processing cost over a 1-5 year period, as more efficient systems are created.

A 40 percent improvement in the efficiency could reduce EOL electronic and electrical recycling and processing cost to approximately $762 per ton. However, the cost of recycling EOL electronic and electrical products would remain almost 5-7 times the cost of recycling standard materials (paper, beverage containers, and yard trimmings) collected in municipal residential programs.

**D. San Francisco Super Recycling Day Collection and Public Disposal and Recycling Drop-off Area Collection**

The San Francisco Electronic Collection and Recycling Pilot Project collected materials from the San Francisco Residential Super Recycling Program as well as the Public Disposal and Recycling Drop-off Area (PDRA).

Two community-based nonprofit organizations participated in the Pilot Project. The Computer Resource Center (CRC) initially agreed to collect and disassemble the materials from the Public Disposal and Recycling Drop-off Area. Carnales Unidos Reformando Adictos (CURA), a 24-hour residential drug and alcohol treatment program, agreed to collect and disassemble the EOL products from the San Francisco Super Recycling Day.

The goal of the PDRA Pilot Project was to record the quantity and type of electronic products dropped off at the transfer station for disposal. All electronic products that plugged in or operated on batteries were set aside in a separate bin at the PDRA. CRC expressed strong interest in disassembling the products at the PDRA in order to reduce the cost of renting a vehicle and transporting the materials to their overcrowded 4,000 square foot warehouse in Marin County. CRC 's staff was clearly the most technically savvy of the three participating nonprofits. CRC felt that they could assess the value of the EOL component materials more efficiently at the PDRA location and save time by disassembling some of the EOL products at the PDRA site.

However, CRC was not able to process materials at the PDRA due to concerns of non-union laborers working at the PDRA site. CRC made arrangements with operators of the transfer station to collect the PDRA materials for a ten day period and transport all of the collected materials to its location in Marin County, approximately 25 miles north of San Francisco. All non-recyclable materials were to be transported back to the PDRA location for disposal. At the time of the Pilot Project, CRC received no public or private funding support. CRC supports its computer repair and redistribution activities through the sale of scrap and computer components and a 3.5 inch disk recycling business. The City of San

Francisco Recycling Program (the Pilot Project's sponsor) was only able to pay CRC $1,000 consulting fee for their participation.

The PDRA Pilot Project was delayed for two months due to heavy rains. During those intervening months, CRC experienced a significant increase in its computer donations. When the PDRA Pilot collection began May 11, 1998 the CRC determined that the computers were its priority so it did not have the warehouse space or the volunteer staff to transport and process the low value EOL products collected at the PDRA.

The CRC's decision to focus on computer repair and recycling rather than the PDRA materials is indicative of the low value of most EOL consumer electronic products compared to computers. CRC's inability to collect and store the PDRA materials also demonstrated the ongoing challenge of Bay Area nonprofit computer recyclers to acquire adequate and affordable warehouse space. CURA subsequently agreed to process the materials from the PDRA. Approximately 2,800 pounds of EOL electronic products from the PDRA were combined with the 11,800 pounds of electronic and electrical products from the San Francisco Super Recycling Day collection.

CURA agreed to process the materials from the San Francisco Super Recycling Day residential collection and the PDRA strictly on speculation of securing future contracts with San Francisco. CURA's ability to include clients enrolled in the drug and alcohol treatment in special work projects as paid or unpaid labor provided a flexible labor rate for the San Francisco residential collection program.

Although the City of San Francisco has a restrictive agreement with Sunset Scavengers (the franchised waste hauler) that prevented CURA from using their own trucks and drivers for collection, Sunset Scavenger used the company's existing metal collection trucks and drivers to collect the EOL products.

Response to the San Francisco Super Recycling Day Electronics Collection was limited. MFF and the San Francisco Recycling Program (SFRP) decided not to inform the 13,392 San Francisco households participating in the electronic recycling Pilot Project. The flier announcing the Super Recycling Day indicates that only materials listed are accepted for recycling. Electronic products did not appear on the list of acceptable items. This resulted in the EOL electronics comprising 1.2 percent of the total bulky waste stream. Approximately 14,600 pounds of EOL electronics were recovered from the combined collection programs.

| | | |
|---|---|---|
| Revenue | | |
| Scrap metal | $14.89 | |
| IC boards | $1007.55 | |
| | | $1022.44 |

| Cost | | |
|---|---|---|
| Transportation | $39.00 | |
| CRT recycling | $1,177.25 | |
| CURA | $6,732.00 | |
| Sunset Scavenger | $2,680.00 | |
| | | <$10,628.25> |
| Total | | < $9,605.81> |

Fig. 3

Fig. 3 shows the cost of the San Francisco Super Recycling Day and the PDRA pilot projects if CURA charged $8.50 per hour for labor and Sunset Scavenger charged an estimated $134 per hour for its truck and driver for an average of two hours per day for 10 days. Although the $1,628 cost per ton is lower than the Oakland Bulky Waste Pilot Project, a long term collection and processing would most likely not be econmically sustainable for CURA.

A long term collection effort would require CURA to compete with Sunset Scavenger's metal collection program, which typically collects metal rich electronic and electrical products that contain IC boards.

**E. Hayward Recycling Drop-Off Event**

Despite several economic advantages, such as reduced transportation cost, the Hayward Recycling Drop-Off (RDO) Pilot Project cost approximately $2,000 per ton. The Hayward RDO collection model benefits include CURA's subsidized labor force, as well as the reduced collection and transportation cost associated with a drop-off program. However, CURA was paid a flat rate of $9,950 to participate in the Hayward Pilot Project. Organizers also allowed the City of Hayward and CURA to be more selective about the type of materials accepted for recycling. The one day event also included contingency plans for rain which would have protected the EOL products from water damage. Fig. 4 shows the total cost of the Hayward RDO. The $20 transportation cost reflects the fact that CURA owns their own truck and does not have to pay the labor cost for their drivers. A total of 9,791 pounds of EOL consumer electronic products were dropped off by 221 participants. The $42.38 advertising cost is the additional space purchased in the newspaper to list the electronic products that would be accepted during the Hayward RDO project.

| | | |
|---|---|---|
| Revenue | | |
| Scrap metal | | |
| | $71.38 | |
| | | $71.38 |
| Cost | | |
| Processing/Labor | $9950.00 | |
| Disposal | $ 152.55 | |
| Television disposal | $ 69.00 | |
| Transportation | $ 20.00 | |
| Advertising | $ 42.38 | |
| | | <$10,233.93> |
| Total Cost | | <$10,162.55> |

**Fig. 4**

Fig. 5 is an estimate of the Hayward RDO showing a labor rate of $8.50 an hour and $1000 revenue earned from IC boards. Fig. 5 is only an estimate of potential earnings from IC boards. The estimated amount was derived by comparing the types of products collected in the San Francisco and Hayward Projects. The estimate shown in Fig. 5 is not based on a laboratory analysis or assay process used by smelters to determine the value of recoverable precious metal contained in a load of IC boards.

| | | |
|---|---|---|
| Revenue | | |
| IC board recovery | $1,000.00 | |
| | | $1,000.00 |
| Cost | | |
| Labor/processing | $4,488.00 | |
| Disposal | $152.00 | |
| Advertising | $42.38 | |
| Transportation | $20.00 | |
| | | <4,702.38> |
| Total Cost | | <$3,702.38> |

**Fig. 5**

**The actual cost of labor and revenue generated from IC boards could have potentially reduced the cost from approximately $2,000 per ton to $757.00 per ton.**

**F. Goodwill Industries EOL Electronic and Electrical Waste Assessment**

MFF weighed and documented EOL electronic and electrical products processed by Goodwill, separating those products designated for the landfill or recycling. The assessment provided a general understanding of the types of products received by Goodwill, how the products are sorted and handled, and which products are thrown away and which products are recycled. The assessment found that newer, lighter weight products were more frequently sent to the landfill than similar

older model products that were constructed with more metal and less plastic. As newer electronic and electrical products become lighter weight, Goodwill and other similar organizations will be forced to landfill larger quantities of plastic-rich EOL electronic and electrical products.

Goodwill is primarily an employment training and retail operation. Recycling is performed in order to save money on the cost of landfilling unsold products. Goodwill has little incentive to use its facility and labor force to divert larger quantities of electronic and electrical products unless the organization can use electronic recycling as a means to provide successful employment training programs or reduce landfill expenses.

**G. Conclusion**

The pilot goals to record the type of EOL products in the municipal waste stream took precedence over processing the materials. Therefore, the goal to record the materials ,and given the lack of disassembly skills of the CBOs, the real cost benefit of disassembly and materials recovery could not be thoroughly assessed. However, the cost of WMAC collection and EBCC processing (in the Oakland model) are standard labor rates for the respective agencies. Even if more efficient materials recovery methods were applied, it is unlikely the revenue generated through the sale of constituent materials would cover the cost of labor and collection. Many of the products collected by WMAC were rain-soaked and contaminated with mud and insects. The water damage and contamination limited the prospects for EBCC to generate revenue through repair or resale.

The San Francisco and Hayward models which integrated electronic collection into an existing collection program, proved to be more economically feasible. The flexible labor rate of CURA and the incorporation of an existing Sunset Scavenger driver and vehicle for the Pilot Project collection contributed to the reduced cost of the San Francisco model. The ability of the Hayward RDO to reduce collection and transportation costs is also promising.

The Pilot Project showed that the success of a residential collection program will be based on a city's ability to integrate EOL electronic and electrical product collection into an existing collection program without incurring an additional cost. In order to partner with CBOs, the municipality must identify a CBO that has a subsidized labor force and the technical skill and internal capacity to effectively process the materials.

However, even with these conditions the residential collection mode should not be considered as a primary conduit for EOL electronic and electrical product recovery. The value of the electronic products are too low to merit any special provisions that will incur a cost. Weather damage and illegal scavenging also lowers the value of EOL products placed on the residential curbside. Even with a large scale residential collection program and improved product disassembly, the cost for municipalities to collect and process EOL electronics would be

approximately $762 per ton, which is almost five times the cost of recycling bottles, cans and paper from the curbside.

Residential collection programs should also target products that have a higher recycling value, or products with similar plastics or other constituent materials in order to collect the economies of scales required for effective recycling. The San Francisco Bay Area has a variety of collection conduits that should also be explored. These existing conduits for collecting EOL electronic and electrical products include non-profit retailers such as Goodwill, public disposal areas, commercial retail stores and a variety of materials drop-off programs. The residential collection should be combined with a broader collection strategy in order to achieve the economy of scale required to make recycling EOL electronic and electrical products cost effective.

## Model: Oakland Bulky Waste Pick-up Collection

### 1. 0 Introduction

Oakland residents are provided an annual Bulky Waste Pick-up Day in which Waste Management of Alameda County (the franchised hauler for the City) collects whites goods, brown goods, tires, household furniture and yard trimmings. The Bulky Waste Pick-up Program collects from approximately 300 Oakland households per day. The Bulky Waste Pick-up Program is designed to correspond with Oakland residents' garbage collection days. Residents are allowed to place 3 cubic yards of materials on the curbside for the Bulky Waste Pick-up collection. Two trucks are used to collect tires and white goods for recycling. A garbage truck with a rear loading garbage truck is used to collect and dispose of non-recyclable bulky waste items.

In 1997, the Oakland Bulky Waste Pick-up Collection Program collected approximately 5,700 tons of materials from 80,000 Oakland households.

The East Bay Conservation Corps (EBCC), a community-based nonprofit organization that provides employment training and educational services to at-risk youth, documented the electronics products collected from the Oakland Bulky Waste Pick-up Program May 11-22, 1998.

EBCC is one of the few Oakland-based CBOs with access to a labor force, a warehouse, forklifts and trucks. The EBCC staff expressed strong interest in using computers and electronics recycling as a means to explore revenue generating activities for EBCC and as a tool to introduce Corpsmembers to basic computer and electronic hardware.

### 1.1 Distinct aspects of the Oakland Bulky Waste Collection Pilot Project compared to the San Francisco Pilot Project and the Hayward Residential Recyclables Drop-Off Event

- The EBCC's fee for service contract was inflexible. The wages for Corpsmembers and supervisors were set and strict time tables were established.
- The EBCC provided an opportunity to explore the potential of providing at-risk urban youth with hands-on exposure to electronic appliances and computer hardware.
- Oakland residents were notified that their neighborhood had been selected to participate in a special electronics collection and recycling pilot project.
- Waste Management of Alameda County dedicated an extra truck and driver to collecting electronic products from the curbside during the Pilot Project.
- Alameda County Waste Management Authority and Recycling Board provided funding support for processing the materials collected during the Oakland Electronic Collection and Recycling Pilot Program.

## 1.2 About the City of Oakland

(1990 Census)

| | | |
|---|---|---|
| City of Oakland population | | 372,242 |
| Number of housing units in the city | | 154,737 |
| Average gross rent | $669 | |
| Average age of resident | | 34.7 |
| Average person per household | | 2.53 |
| Average household income | | $37,099 |
| Average number of rooms per household | | 4.44 |

## 1. 3 Electronic Collection and Recycling Project Goals

- Determine type and the volume of electronic products collected during Oakland Bulky Waste Pick-up Program.
- Determine whether a youth employment training organization could generate revenue through the disassembly of EOL electronic and electrical products recovered from the Oakland Bulky Waste Pick-up Program.
- Determine whether Oakland residents will participate in a curbside electronics recycling program.

## 1. 4 Electronic Recycling and Collection Methodology

### 1. 4a Fliers/Advertisement

MFF worked with the City of Oakland Recycling/Solid Waste Program staff to select residential neighborhoods to participate in the Electronic Collection and Recycling Pilot Project (see Appendix 2).

Fliers announcing the Bulky Waste Pick-up are sent to Oakland neighborhoods approximately 3 weeks prior to the Bulky Waste Pick-up Collection (see Appendix 3). A special insert that notified residents of the electronic collection pilot project was folded inside the standard 8 1/2 X 14 flier (see Appendix 4).

### 1. 4b Selection of Oakland Residential Routes

The Bulky Waste Program collection routes are generally designed by Waste Management of Alameda County, Inc. (WMAC) to collect in a hilly area (higher elevation) two days a week and in the flatlands (lower elevation) the remaining three days. The area covered in the flatlands is much larger than the hilly area, however, the streets in the hilly areas are typically narrower and require more time for the WMAC drivers to negotiate the trucks.

By alternating Bulky Waste Pick-up Collection between the hilly neighborhoods and the flatlands, WMAC is able to balance the work load of its drivers. However, several days during the ten-day Electronic Collection and Recycling Pilot Project, the total volume of materials in some neighborhoods was so heavy the drivers could not complete the route in one day (see Appendix 5) and collection carried over into the next day.

**1. 4c Waste Management of Alameda County Inc. Collection Procedures**

WMAC added an extra flatbed truck and driver to accommodate the Electronic Collection and Recycling Pilot Project. The additional driver and the flatbed truck cost a total of $4,300 for the 10-day pilot project. The Pilot Project truck driver drove ahead of the compactor truck, which collected the non-recyclable bulky waste.

The EBCC Corpsmembers were not allowed to ride on the WMAC trucks due to labor and liability issues. WMAC was concerned about using non-union workers to collect residential waste materials, even on a temporary basis.

MFF staff rode with the Pilot Project driver for five of the ten days of the Pilot Project collection in order to observe the response to the Electronics Collection and Recycling Pilot Project and to determine level of recovery of the electronic products from the piles of bulky waste materials.

The electronic products were placed in Gaylords (large cardboard boxes sitting on a pallet) aboard the flat bed truck. The electronic products were then transported to EBCC, which generally required 15-25 minutes of travel time depending on the location of the Bulky Waste Collection and traffic on the freeway.

**1.5 Residential Response to the Electronic Collection and Recycling Pilot Project.**

Through informal interviews with Oakland residents and observations of the volume of electronic products set on the curbside, MFF determined that most residents read the insert announcing the collection program.

Many residents who happened to be in their front yards casually pointed out electronic products that were buried beneath other debris. When asked by MFF staff if they had read the flier, most residents confirmed that they had read the flier. However, from MFF observations, the residents clearly did not take the time to separate the materials (see Appendix 6). MFF and the WMAC driver had to dig through the piles of bulky waste materials in order to recover the electronic products. However, the instructions to separate EOL electronics was probably not strongly emphasized in the flier. It is also possible that sorted piles were inadvertently commingled by scavengers. The inconsistent shapes and sizes of the bulky waste materials and household electronic appliances might have also made the electronic products difficult for residents to stack neatly.

Some Oakland residents may not have participated in the Electronic Collection and Recycling Pilot Project out of fear that scavengers would take the products before WMAC drivers arrived. During the Pilot Project, an elderly women came out of her house to inform the WMAC driver that she had placed a microwave oven in a black garbage bag to camouflage it from the scavengers and to protect the microwave oven from the rain (see Appendix 7). She also went into her home and returned with a VCR to contribute to the Pilot Project collection.

## 1. 6 About the East Bay Conservation Corps

The East Bay Conservation Corps promotes youth development through community service and environmental stewardship. Last year the EBCC engaged more than 2,500 children and young adults in academic programs and employment training that includes recycling and environmental restoration.

The East Bay Conservation Corps (EBCC) was founded in 1983 and was one of the first in an emerging national movement of urban community service organizations for youth and young adults. The EBCC is a private 501(c)(3) nonprofit agency that serves East Bay residents and communities within Alameda and Contra Costa Counties. Agency sponsors include public works departments, city and regional parks, churches, public housing developments, schools and community-based agencies. The program receives a broad base of support and funding from public/private partnerships with land management agencies, marinas, community service organizations, federal, state and local government agencies, private foundations and corporations. The agency's 1996/1997 fiscal year budget was $7,486,287, which includes,
$2, 752,380 in fee-for-service contract revenue. The EBCC employs over 90 full-time professional staff with operations based out of the agency's main office located at 1021 Third Street, Oakland.

The 2,500 youth and young adults who participate in the EBCC's programs annually represent the socio-economic, racial and cultural diversity of the East Bay area. The EBCC program is unique in its capacity to address a high level of both participant and community needs. The agency's programs include Charter School and Project YES (Youth Engaged in Service), the largest AmericaCorps/National Service Program ("domestic Peace Corps") in California.

The current program and service components of EBCC Corpsmember Program include the following:

### 1. 6a Field Operations

Corpsmembers work 32 hours per week on various environmental and community improvement projects. Crews composed of four to eight Corpsmembers managed by trained site supervisors work to improve natural resources, promote community services, increase public access, assist with disaster relief efforts and beautify neighborhoods and recreational lands in Alameda and Contra Costa counties.

### 1. 6b EBCC Recycling Program

Through a grant from the California Department of Conservation (DOC), Division of Recycling, EBCC provides recycling pick-up and drop-off services for East Bay nonprofit agencies, small businesses and residents. The purpose of the EBCC recycling program is to promote recycling of California Redemption Value (CRV) beverage containers as well as other recyclable materials. Over 100 Corpsmembers annually participate in one of the EBCC's Recycling Programs.

**1. 6c EBCC Internship**
The EBCC coordinates over 20 paid internships designed to expose advanced Corpsmembers to a variety of work environments and careers and to provide them with hands-on job training.

**1. 6d EBCC Comprehensive Education & Corpsmember Development Programs**
The EBCC operates a charter school. This program includes academic skills training, career education, life skills training, and case management support.

**1. 7 EBCC Electronic Collection and Pilot Project Recycling Procedures**

**1. 7a EBCC Off-Loading Procedures for Electronics Pilot Project**
When the WMAC truck arrived at the EBCC Third Street location, the EBCC team supervisor used the forklift to unload the flatbed truck. The electronic products were taken to the warehouse or put in a special storage container. The EBCC Corpsmembers labeled each product, recorded the manufacturer, product type, product weight and then plugged the product in to determine if the product worked.

**1. 7b EBCC Product Disassembly and Data Collection**
Approximately 40 square feet of the EBCC warehouse was dedicated to disassembling the electronic products. Although the EBCC supervisor had observed electronics on the curbside in Oakland neighborhoods in preparation for the Pilot Project, he was unprepared for the amount of materials collected in the Pilot Project collection.

Storing the large volume of collected materials posed the greatest challenge to EBCC. According to the EBCC supervisor, televisions required 20 minutes to one hour for Corpsmembers to safely disassemble. Television chassis were also connected to the housing in a manner that was time consuming to disassemble, according to the supervisor. Television component parts that the supervisor had determined would be valuable to recover, such as circuit boards and other metals, were also encased or affixed in a hard to remove manner. Disassembly was also slowed by the fact that different brands of televisions used different types of screws and required different types of tools.

Televisions quickly backlogged the EBCC warehouse May 11-12 as EBCC Corpsmembers attempted to dismantle the televisions in order to recover the metal. Due to the backlog of materials in the EBCC warehouse, televisions were recorded at the curbside May 13 -15 and not collected. However, collection of televisions resumed May 18-22, and the Pilot Project paid for the televisions and monitors to be recycled by ECS in San Jose California.

MFF decided not to export the televisions and monitors to overseas markets. MFF was unable to confirm that Chinese vendors dismantled the CRTs in a fashion

that protects the health and safety of Chinese workers and that all hazardous materials are disposed of properly.

A total of 58 portable televisions, 63 console televisions and 8 console stereos were left on the curbside. An average weight of 34 pounds was assigned to each portable television and an average weight of 125 pounds was assigned to console televisions and stereos. MFF estimates a total of 9,847 pounds of televisions were left on the Oakland curbside. However, for the purpose of consistency, the televisions that were recorded on the curbside are not included in the attached data set (see Appendix 8).

Wood stereo speakers were also difficult to collect in the Bulky Waste Program. The stereo speakers, manufactured from pressed wood, were frequently rain soaked, covered with mud, infested with roaches and placed at the bottom of the pile of bulky waste materials. The stereo speakers were also heavy, contain few constituent materials of value and took up a considerable amount of space in the Gaylord boxes. The WMAC driver and the EBCC Corpsmembers clearly preferred not to handle the speakers and, unfortunately, the speakers were arbitrarily left on the curb and not accurately recorded.

**1. 7c EBCC Storage of Electronic Products**

The Pilot Project competed with other EBCC recycling activities for warehouse space. The electronic products were stored in Gaylord cardboard boxes on the floor. Because the Gaylord boxes were filled with electronic products of dissimilar shapes and sizes, the Gaylords could not easily be stacked on racks. The Pilot Project also competed with other recycling activities for the use of the forklift. The inability to stack the electronic products, the need for the forklift and the infestation of the appliances with roaches and other insects significantly impacted other recycling operations in the warehouse.

Off-loading the products from the WMAC flatbed truck into a roll-off required more time than EBCC supervisors anticipated. Each time the WMAC truck arrived, the EBCC Corpsmembers and a supervisors dedicated up to one hour to unloading the truck and making room for all the materials in the warehouse and storage container.

**1.7d Plastics**

MBA Polymers instructed EBCC and the other nonprofits on the types of plastics that MBA was interested in collecting for the study. However, time constraints limited the level of disassembly and most of the products sent to MBA Polymers by EBCC were not disassembled well enough for MBA Polymers to analyze ( See Appendix 1).

**1. 7e Equipment and Tools**

The tools used by EBCC for disassembly included screwdrivers, hammers, pliers, wire cutters, cordless drills with screwdriver bit attachments and

overhead lights.

**1. 7f EBCC Personnel**

The EBCC contract called for four Corpsmembers and one supervisor to work two 40 hour weeks. Two Corpsmembers were recruited off the grade (restoration field work) to work on the project. Two Corpsmembers came off the DOC recycling crew to assist. A supervisor and manager both worked half time with corpsmembers on the Pilot Project. The total contract agreement was for $8,975 for 320 labor hours.

**1.7g EBCC Corpsmember Skill Level**

The ages of the Corpsmembers ranged from 18 to 24. All of the Corpsmembers were in the process of earning a high school diploma.

## 1.8 Oakland Cost Analysis

### 1.8a Overview

The Electronics Collection and Recycling model used in the Oakland Bulky Waste Pick-up Program appears to be the least cost-effective model. The $4,300 for a special Waste Management of Alameda County (WMAC) driver and truck, as well as the standard $8,975 East Bay Conservation Corps (EBCC) fee for service resulted in a $1,973 per ton recycling rate. The average cost per ton for standard curbside recycling in Alameda County is $100 to $150.

The positive response from Oakland residents to the flier inserted into the Bulky Waste Recycling mailing demonstrates that they are willing to participate in a residential electronic recycling program. However, the overwhelming volume of televisions set out for recycling significantly drove up the recycling cost. Illegal curbside scavenging and rain damage reduced revenue from repair, reuse and resale.

Fig. 6 shows the cost of the Pilot Project. It should be noted that Fig 6 does not include the estimated 9,847 pounds of televisions that were not collected. More than 5,900 pounds of materials that were sent to the landfill.

**This figure shows the cost of collecting 15,623 pounds of electronic products from 3,692 Oakland residents.**

| | | |
|---|---|---|
| Revenue | | |
| scrap metals | $ 21.00 | |
| | | $21.00 |
| Cost | | |
| WMAC Collection / transportation | $4,300.00 | |
| EBCC Labor | $8,975.00 | |
| Advertising | $365.00 | |
| Television / monitor recycling | $1,750.00 | |
| | | <$15,390.00> |
| Total Cost | | <$15,369.00> |

**Fig 6**

### 1. 8b Cost of Labor

The Pilot Project's goal was to record the types and weights of electronic products in the residential waste stream. The EBCC's effort to meet the Pilot Project goals limited the amount of time EBCC was able to spend disassembling the products and recovering metal, integrated circuit boards, or microchips for recycling or reuse.

However, if EBCC had been able to disassemble the electronic products and recover component parts for recycling / reuse, it is unlikely that the value of the IC boards,

chips or metals would have covered EBCC's cost of labor. The $8,975 fee is a standard fee for EBCC contracts which includes three crew members and one supervisor for 320 hours. Every work project requires a supervisor and it is difficult for EBCC to justify the supervisor's time and salary on a work project with fewer than three Corpsmembers.

The televisions also significantly increased labor cost. More than half of the products placed on the Oakland curbside were televisions and monitors. Televisions and monitors are time consuming to disassemble and the constituent materials are of low recycling value. Televisions and monitors also contain leaded glass that is characterized as hazardous waste. The EBCC could not disassemble the televisions in a cost effective manner, nor could they repair the televisions because of rain damage. Most of the televisions newer than 1985 were aggressively scavenged for parts prior to the WMAC pick up. The console televisions were too heavy for one WMAC driver to lift by himself and the portable televisions were frequently buried beneath other materials. If the use of a flat bed truck and separate driver were continued, an additional WMAC driver would have to be added to the Bulky Waste Pick-up route in order to assist the driver of the flat bed truck to lift the console televisions set out for recycling.

**1.8c Integrated Circuit (IC) Board Processing**

Due to the time restraints, EBCC was unable to recover the integrated circuit (IC) boards. The IC boards earned $1,008 in the San Francisco Pilot Project Pilot. Fig 7 compares the type and weight of the most frequently collected products from the San Francisco Project with similar products collected during the Oakland Bulky Waste project. It can safely be assumed that if the Oakland products had been disassembled and the IC boards sent to a smelter for precious metal recovery, the revenue generated from the Oakland products would have equaled the revenue earned in the San Francisco Pilot Project. Fig. 8 includes the estimated earnings from IC boards as well as an estimation of the revenue that could have been generated if the CRTs were exported to China for 2 cent a pound.

| City | Total lbs. tele-visions | Total lbs. computers | Total lbs. micro-wave ovens | Total lbs. stereos | Total lbs. VCRs | Total lbs. monitors | Total lbs. of products shown |
|---|---|---|---|---|---|---|---|
| Oakland | 6,658 | 911 | 2,023 | 1,291 | 345 | 273 | 11,501 |
| S.F. | 4,386 | 848 | 840 | 70 | 131 | 1,008 | 7,283 |

**Fig 7**

**The above figure compares the total weight of products collected in the Oakland Bulky Waste Program with the weight of frequently collected items in the San Francisco Super Recycling Day program. All of these items contain IC boards. The IC boards earned the San Francisco project approximately $1,008.**

| | | |
|---|---|---|
| Revenue | | |
| IC board recovery | $1,000.00 | |
| Scrap metals | $ 21.00 | |
| Export CRTs | $ 336.94 | |
| | | $1,357.94 |
| Cost | | |
| Collection | $4,300.00 | |
| EBCC Labor | $8,975.00 | |
| Advertising | $ 365.00 | |
| | | <$13,640.00> |
| Total Cost | | <$12,282.06> |

**Fig. 8**
**The collection and transportation cost shown in Fig. 2 also includes revenue from exporting CRTs to China and an estimated $1000 revenue for IC board recycling. The $1000 estimate was derived by comparing the types of products collected from the San Francisco collection (which earned $1,000 in revenue from the IC boards) with those products collected from the Oakland project.**

### 1. 8d Cathode Ray Tube (CRT) Processing

There are few CRT recycling options available in California. The CRT recycling options available to the Pilot Project included recycling the intact televisions and monitors at ECS located in San Jose at a cost of 25 cents per pound or selling the units for 2 cents per pound for export to China.

If all the televisions and monitors set out on the curbside were collected and sent overseas, the monitors and televisions would earn approximately $337 in revenue. The cost to recycle the same number of units at ECS would be approximately $4,211. Fig 9 compares the CRT recycling and disposal cost.

| City | Total TV/monitors set-out on the curbside for recycling | Revenue generated from export to China | Cost of recycling CRT at ECS | Cost to landfill CRTs in Alameda County |
|---|---|---|---|---|
| Oakland | 16,847 lbs. | $336.94 | $4211.75 | $589.64 |

**Fig 9**

The revenue generated from the IC boards and the televisions and monitors would not cover the cost of WMAC or EBCC labor. The electronics collection and recycling program would cost approximately $967 per ton for recycling. It should be noted that inserting a flier in the Bulky Waste mailer is a Pilot Project cost. If

the electronics were an on going program, the information about the program would be included in the Bulky Waste pick-up mailer.

According to the Alameda County Waste Management Authority staff, a new municipal recycling programs typically experience a 40 percent reduction in recycling and processing costs over a 1-5 year period, as more efficient systems are created.

A 40 percent improvement in the efficiency in recycling could reduce EOL electronic and electrical recycling and processing cost to $537- $762, depending on whether the CRTs are exported to China or processed by ECS. However, the cost of recycling EOL electronic and electrical products would remain almost 5-7 times the cost of recycling standard materials (paper, beverage containers, and yard trimmings) collected in municipal residential programs.

## Model: San Francisco Electronics Collection and Recycling Pilot Project

### 2. 0 Introduction

The San Francisco Electronic Collection and Recycling Pilot Project collected materials from the San Francisco Residential Super Recycling Program as well as the Public Disposal and Recycling Drop-off Area (PDRA).

Two CBOs , CURA and the Computer Resource Center (CRC).
CRC is located in Marin County, approximately 25 miles north of San Francisco. The mission of CRC is to repair, recycle and redistribute computers discarded by corporations and individuals. The CRC has four full time employees and has placed approximately 4,000 computers with schools and charitable organizations.

Carnales Unidos Reformando Adictos (CURA) processed the electronic materials from the San Francisco Super Recycling Day. CURA is a long term drug and alcohol treatment facility located in Fremont, approximately 60 miles from San Francisco.

The CRC and CURA represent two very different types of CBO with different organizational management style, social missions and client base. The CRC works with a volunteer labor force including computer hobbyists, individuals referred from the local homeless shelter, as well as individuals fulfilling their community service obligations for traffic violations. CRC sustains its operations through revenue generated from recycling, limited resell of parts and a disk recycling business.

CURA caters to ex-drug offenders referred from the criminal court system. CURA is primarily funded through public health and human service contracts. However, the organization has traditionally generated additional funds through small enterprises and work contracts.

### 2.1 Distinct aspects of the San Francisco Pilot Project compared to the Oakland Bulky Waste Pick-up and Hayward Recyclables Drop-off Pilot Projects :

- A nonprofit recycler with adequate warehouse space, labor force and storage space willing to participate in the Electronics Collection and Recycling Pilot Project did not exist within San Francisco city limits.
- The San Francisco Recycling Program was able to provide limited funds to a nonprofit or a commercial recycler to process the materials collected from the Pilot Project.
- The commercial electronic recyclers, HMR and Login Mein, based in San Francisco, indicated that the electronic products generated from the residential waste stream would be of such low value that they would certainly export the materials overseas for processing.

- San Francisco residents were not notified that their neighborhood had been selected to participate in the Electronics Collection and Recycling Pilot Project.

**2.2 About the City of San Francisco**

(1990 Census Data)

| | |
|---|---|
| San Francisco population | 723,059 |
| Number of housing units | 328,471 |
| Average household property value | $316,073 |
| Average gross rent | $884 |
| Average age of residents | 38.5 years |
| Average persons in household | 2.29 |
| Average household income | $45,663 |
| Average number of rooms | 4.10 |

**2.3 San Francisco Electronic Collection and Recycling Program Goals**

- Determine the quantity of electronics products that are in the San Francisco residential waste stream.
- Determine whether the electronic products generated from the residential waste stream could be processed in a cost effective manner.
- Determine if opportunities exist for nonprofit recyclers to collect and recycle electronic material.

**2.4 San Francisco Electronic Collection and Recycling Methodology**

**2.4a Public Disposal and Recycling Program Overview**

The Public Disposal and Recycling Area (PDRA), located in the southeast section of San Francisco, is open to the public seven days a week to recycle and/or dispose of bulky waste items for a fee. Metals, wood and yard trimmings can be recycled at the PDRA. All non-recyclable items are disposed of in a pit and later transferred to the landfill. Metal-rich electronics and electrical equipment are placed in the metals bin for recycling.

Between May 11 and 22, 1998 all electronic and electrical products that plugged in or operated on batteries were collected separately at the PDRA site. The goal of the PDRA collection was to record the quantity and type of electronic products dropped off at the transfer station. The Pilot Project also intended to compare the quantity of electronic products dropped off at the PDRA with the quantity of materials collected during the Super Recycling Days.

In order to determine the types of materials that would be collected during the two-week PDRA pilot project, the transfer station manager made arrangements for the PDRA workers to set aside all electronics products that plugged in or operated on batteries for a one-day period. CRC as well as HMR, a commercial electronic recycler located in San Francisco, visually inspected the materials. The HMR manager concluded that his organization could not accept the material unless it was sorted and dismantled. HMR also required large enough quantity of materials

to fill an overseas shipping container. However, shipping the products overseas was not consistent with the Pilot Project goal to recycle the material locally.

CRC took the materials from the PDRA to their facility in Marin to determine what could be salvaged and what could be recycled. CRC was able to repair four 486 PC computers, a 17-inch color monitor and several televisions.

CRC expressed strong concern about the health hazards from food waste on some of the kitchen appliances; however, CRC agreed to accept electronic products from the PDRA for a two-week period. CRC worked with Sunset Scavenger's staff to build several special containers that could be easily transported by CRC to Marin County.

The PDRA collection was slated to occur in February, however, the torrential rains soaked the electronic products. The PDRA collection of electronics was postponed until May.

During the period between February and May 1998, CRC's computer donations increased dramatically as a result of several ads published in *Microtimes*, a Bay Area computer trade magazine. Negative publicity about a Southern California nonprofit computer reuse agency caused several large corporate donors to redirect their surplus computers from the Southern California nonprofit to CRC.

When the PDRA collection began on May 11, 1998, CRC could not fit the materials in its warehouse. Nor was CRC willing to neglect the large volume of high-end computers donated by corporations by using its skilled volunteer labor pool to dismantle PDRA materials which consisted mainly of damaged televisions, monitors, household appliances and low value items.

CURA agreed to combine the PDRA materials with the materials from the San Francisco curbside collection. Although the PDRA materials were weighed and counted separately, the 2,800 pounds of electronic products were processed with the approximately 11,800 pounds of electronic products collected from the San Francisco Super Recycling Program. EOL electronics comprised 1.2 percent of the total Super Recycling Day bulky waste stream.

**2.4b Description of San Francisco Super Recycling Residential Collection Program**

On Super Recycling Days, San Francisco residents set out white goods, yard trimmings, large appliances and other bulky items for curbside pick-up. Each San Francisco resident may participate in one Super Recycling Day per year. An average of 43 tons of material is collected from 800 residents every eight months. Approximately 15 percent of the material collected is yard waste, 12 percent metal and 9 percent white goods. Almost 64 percent of the material collected is landfilled. However, the actual tonnage collected from the Super Recycling Day program varies according to the season and the neighborhoods.

Three trucks are used to collect metals, organic materials and non-recyclable bulky items. The electronic items collected during the Pilot Program were placed on the metals truck with the white goods.

**2. 4c Super Recycling Day Collection**
**Electronic Collection and Recycling Pilot Project Procedures**
The electronic materials collected during the Super Recycling Day Collection program were placed on the Sunset Scavenger truck designated for metals.
Special wood containers were built for the Pilot Project by the Sunset Scavenger (the contracted waste hauler) staff. These containers were built slightly larger than Gaylord boxes. The boxes were off-loaded at the transfer station by Sunset Scavenger staff and held in a warehouse until enough material was accumulated to fill CURA's box truck.

CURA transported the materials from San Francisco to their facility in Newark, California. The San Francisco Collection and Disposal Ordinance of 1932, which regulates solid waste management, provides that only licensed haulers may transport refuse or charge for the collection of recyclable materials in the City of San Francisco (with the exception of construction and demolition materials). The City and County of San Francisco has a licensing agreement with Sunset Scavenger to provide the city recycling services. Other recycling haulers must either provide collection service at no charge or pay for the residential materials collected in San Francisco. Therefore, CURA could not afford to use their own trucks and staff to collect the electronic materials without violating the city agreement with Sunset Scavenger or potentially violating the 1932 ordinance.

**2.4c Advertising and Selection of Routes**
Eleven by 14 inch brochures promoting Super Recycling Day were mailed to San Francisco households approximately three weeks prior to the Super Recycling Day collection. The brochure also instructed residents on how to separate the materials on the curb so that the materials could easily be picked up by Sunset Scavenger workers (see Appendix 9). Originally, MFF planned to insert a flier announcing the Electronic Collection and Recycling Pilot Project in the brochure mailed to residents.

A special notice was prepared in three languages (English, Spanish and Cantonese) by the City Recycling Program staff. However, the torrential rains and flooding throughout the San Francisco Bay Area caused MFF to postpone the Pilot Project from January to March. MFF decided it was best not to notify the residents of the Electronic Collection and Recycling Pilot Project in case the Pilot Project was further delayed by the bad weather.

The collection date was delayed from March to May due to a family emergency that required the Sunset Scavenger route supervisor to take an extended leave of absence. The Sunset Scavenger management was not confident that the Pilot Project could be fully implemented without the route supervisor on duty. The

neighborhoods that were included in the Pilot Project were pre-selected for the Super Recycling Day collection by the Sunset Scavenger staff (see Appendix 10).

**2.5 About CURA**

CURA is a nonprofit, tax-exempt corporation established to provide 24-hour residential treatment services for individuals addicted to drugs and alcohol. CURA's main therapeutic community (TC) is located in Fremont CA, approximately 60 miles from San Francisco. The CURA program requires a one year minimum commitment from its clients. CURA has the capacity to provide treatment to approximately 60 clients at a time.

Many of the clients are drug offenders who receive a reduced prison sentence under the condition that they enroll in a drug treatment program. CURA's client population also includes people who enter of their own volition and people who are referred from county social service programs.

The annual CURA budget is approximately $1,381,000. Government health and social service contracts constitute approximately $1,126,900 of the budget. More than $219,000 of CURA's revenue is generated through work projects and entrepreneurial pursuits. CURA has contract agreements with Big Tent and Browning Ferris International (BFI). CURA's entrepreneurial activity includes a warehouse, where clothes, furniture, metals and electronic products are collected, repaired, sorted or dismantled for recycling and resale.

**2. 5a CURA Recycling Program**

CURA currently has an agreement with BFI and the City of Fremont to provide recycling services for the Fremont Bulky Waste Collection Program. The City of Fremont bulky waste collection services are provided to Fremont residents by appointment only. The CURA contract with BFI requires CURA workers to collect recyclable materials from Fremont residents before the BFI garbage truck arrives. CURA focuses on collecting metals, reusable appliances and clothing from Fremont residents. The clothing, furniture and other items are used by CURA residents or sold at flea markets.

**2. 5b CURA Work Program**

Most of the cost of providing residential drug and alcohol treatment services are paid for by the public health services or private insurance companies. The residential nature of the drug and alcohol treatment program provides a labor pool for CURA special projects.

During the first three months of the CURA treatment program the residents are re-adjusting to sobriety and are not required to seek employment. However, it is part of the CURA philosophy that everyone in the program should participate in some sort of work activity. Therefore, the CURA drug and alcohol recovery program includes a regimen of paid and unpaid work activities. CURA does not consider the recycling warehouse a job training program. The goal of the recycling

activities are to provide softskills to CURA clients who have spent much of their lives unemployed, incarcerated or working while under the influence of drugs or alcohol. Softskills are qualities that an employer routinely expects from a mature adult: punctuality, teamwork, regular attendance, proper attitude and behavior appropriate to the work place.

CURA clients who participate in the warehouse recycling activities are usually in the early stages of the treatment program and are not paid for their work. Revenue generated from the warehouse is returned to the program and used to expand the treatment services beyond the public funded capacity.

**2. 5c Phases of CURA Recovery Program**:

**1) Candidate phase**

Upon entry no outside communication is allowed for the first 60 days. During the candidate phase, residents work with counselors to develop a treatment plan.

**2) Phase I**

Phone and mail privileges are reinstated, the client may receive visits from their children and the resident may participate in group outings (recreational and drug abuse prevention services).

**3) Phase II**

Full visiting privileges are allowed. Clients are also allowed to participate in outside support systems (AA, NA, outpatient, church) and family counseling.

**4) Phase III**

The client is required to obtain full-time employment. The client must also secure dependable transportation and make permanent living arrangements.

**5) Aftercare**

Aftercare is a voluntary process that runs nine to 12 months. Upon completion of the Aftercare component of the program, the participant may petition for a public graduation ceremony.

**2. 5d Balancing Social Mission with Business Activities**

CURA has designed their recycling program to enhance the drug and alcohol treatment programmatic goals. A large corner of the recycling warehouse is outfitted with couches and throw rugs for group therapy sessions. CURA supervisors frequently stop work activities in order to address issues relating to team building and personal interactions in the workplace. The clients legal and personal obligations are considered a top priority. The number of workers at the warehouse will fluctuate as CURA staff helps clients to meet court dates, doctor appointments, counseling sessions and supervised family visits.

The shutdown is another example of how the CURA treatment program is given priority over other work activities. The shutdown occurs when a CURA client violates the rules of the therapeutic community. All activities, including work projects, are stopped during the shutdown.

Such a shutdown occurred during the San Francisco Pilot Project.

Almost half of the CURA warehouse workers were dismissed from the treatment program after the shutdown. The CURA warehouse workers who were dismissed had become proficient at disassembling products and familiar with the San Francisco Electronic Collection and Recycling Pilot Project goals and procedures.

CURA's commitment to hiring clients and providing employment opportunities within the organization also inadvertently impacted the Pilot Project. At the time of the Electronic Collection and Recycling Pilot Project, both full-time paid warehouse supervisors were graduates of the CURA program. The assistant warehouse supervisor position is considered a transitional position held by individuals who have almost completed their drug and alcohol treatment program. Two different assistant warehouse supervisors kept data during the MFF Pilot projects. This lack of staff continuity lead to inconsistencies in the data collection procedures.

**2.6 CURA Electronic Recycling and Collection Pilot Project Procedures.**

MFF hosted two meetings with recyclers, city representatives and MBA Polymers to review the data collection procedures for the pilot projects. CURA personnel attended each of the meetings.

However, as mentioned before, CURA underwent several personnel changes between the months of March and May that affected the data collection process. The warehouse supervisor (a permanent position), who also attended both data collection meetings, took an extended leave of absence before the San Francisco collection began. The CURA worker who was assigned to collect data for the Hayward Recyclable Drop-Off event collection matriculated to the Aftercare phase of his recovery program and no longer worked in the warehouse during the San Francisco Pilot Project. As a result of the change in CURA staffing, MFF decided that CURA should focus on providing more detailed information about product disassemble rather than keep detailed data regarding product types.

**2. 6a Sorting Systems and Dismantling Procedures**

Once the material arrived at the CURA warehouse, it was unloaded onto the warehouse floor. CURA workers grouped the electronic materials according to product type and then weighed the products in groups rather than weighing the products individually. After the materials were weighed, CURA workers were allowed to select whatever items they pleased from the pile of products. Although the CURA supervising staff recognized that it would probably be more efficient for the CURA workers to select the same product type (for example, each worker select a vacuum cleaner) and disassemble the products simultaneously, the supervisors were concerned about the work becoming too monotonous. The supervisors' commitment is to keeping the clients engaged and occupied with their work.

Once the product was disassembled, its constituent materials were placed in separate containers (aluminum, plastic, circuit boards, ferrous and nonferrous metals).

**2.6b Tools**
Each CURA worker was provided a work bench equipped with electric screw drivers, sledge hammers, wire cutters and manual screw drivers.

**2.6c Plastics**
The plastics were sorted according to the five product types that were most frequently collected in the Oakland Program. Although an effort was made to remove labels, clips and screws, it was almost impossible to remove all contaminants. Hammers proved to be the most effective means of separating plastics from metal components or circuit boards. However, the hammers typically shattered the plastic housing, leaving screws and labels attached to the many broken plastic pieces. The plastic value did not warrant the labor to further remove screws or to peel or scrape off labels.

**2. 6d Circuit Boards**
A representative from Metech International, an electronic asset managment company, visited the warehouse and instructed CURA staff on how to identify chips and select valuable circuit boards for precious metal recovery. The return on sending the circuit boards to Metech were substantially higher than sending the circuit boards to a scrap metal recyclers as breakage. However, only some of the boards from the televisions were included in the 1,038 pounds of boards sent to Metech.

**2.6e Televisions and Monitors**
CURA workers required 15 to 20 minutes to dismantle each television and did not have the expertise to dismantle the CRTs safely. Although copper, circuit boards, and metal were recovered from the televisions, there is no local market for the residual glass, which contains lead. The televisions and monitors were sent to ESC in San Jose for recycling.

**2.7 San Francisco Cost Analysis**

**2. 7a Overview**
CURA's flexible labor rate and Sunset Scavengers pre-existing metal collection program reduced the estimated price of the San Francisco Pilot Project to approximately $1,315 per ton.

CURA did not charge the Pilot Project for labor and agreed to process the materials from the San Francisco residents strictly on speculation of securing future contracts with San Francisco. However, CURA spent a total of 792 labor hours processing the materials. CURA typically charges $8.50 per hour for work contracts.

Sunset Scavenger's truck and driver cost approximately $134 per hour. Sunset Scavenger estimated two hours per day were dedicated to collecting electronics. The pre-existing metals collection program contributed to the lower cost of the

EOL electronics collection. However, a long term collection of electronics from San Francisco Super Recycling Day residential program and the PDRA would also have a negative impact on the Sunset Scavenger's existing residential metal recycling program.

CURA's total labor hours were also affected by a "shutdown" in which CURA dismissed more than half of its workers for violation of the drug and alcohol treatment program rules. The "shutdown" affected the total labor hours spent processing the EOL electronics as the replacement workers had to be trained in the middle of the pilot project. Fig 10 shows the cost of the PDRA and the Super Recycling Day Residential Electronic Collection and Recycling Pilot Projects. The San Francisco residents were not informed that they would be participating in an electronic recycling pilot project. The flier announcing the Super Recycling Day indicates that materials that are not listed are not accepted for recycling. Electronics were not on the list of acceptable items (see appendix 9 ).

| | | |
|---|---|---|
| Revenue | | |
| Scrap metal | $14.89 | |
| IC boards | $1007.55 | |
| | | $1022.44 |
| Cost | | |
| Transportation | $39.00 | |
| CRT recycling | $1,177.25 | |
| CURA | $6,732.00 | |
| Sunset Scavenger | $2,680.00 | |
| | | <$10,628.25> |
| Total | | < $9,605.14> |

**Fig. 10**
**The above shows the cost of collecting and processing 14,600 pounds of from the 13,392 Super Recycling Day households and the PDRA.**

**2. 7b Labor**
CURA's system of disassembling products improved after the completion of the Hayward RDO. CURA established work stations with tools and electrical outlets. Safety features such as eye protection, gloves and coveralls were also added. However, CURA's warehouse operation was still inefficient. CURA did not have a forklift and did not have the expertise to apply ergonomic principals to the disassembly process. CURA spent an estimated 792 hours on the Pilot Project. However, much of the time was spent on Pilot Project task that would not necessarily be required in a normal demanufacturing operation. CURA also dismissed several workers from the drug and alcohol treatment program. The reduction in labor force and the subsequent "shutdown" in which all activity stopped impacted the overall efficiency of the disassembly operation.

The distance from the CURA warehouse in Newark to the San Francisco transfer station also discouraged CURA from making daily trips to the PDRA. The infrequent trips reduced labor hours and transportation cost. The materials from the PDRA sat in open containers and was subsequently exposed to rain for several days at a time. The few products that were operational, such as two vacuum cleaners, were given to CURA clients.

**2. 7c Integrated Circuit Boards**
More than 1,000 pounds of integrated circuit boards were recovered from the 14,600 pounds of products. CURA earned $1,007.55 in revenue from the IC boards. Fig. 11 shows the weight of products in which IC boards were most frequently recovered.

| City | Total lbs. tele-visions | Total lbs. computer | Total lbs. Microwave Ovens | Total lbs. Stereos | Total lbs. VCRs | Total lbs. Monitors | Total lbs. of electronics |
|---|---|---|---|---|---|---|---|
| S.F. | 4,386 | 848 | 840 | 70 | 131 | 1,008 | 7283 |

**Fig. 11**

**2.7d CRT Recycling**

The CRT recycling options available to the Pilot Project included recycling the intact televisions and monitors at ECS (located in San Jose) at a cost of .25 cent per pound, selling the units for 2 cent per pound for export to China or landfilling the units. Fig. 12 compares the cost of these options.

| City | Weight of TV/monitors collected in Pilots | Export to China | Recycle at ECS | Landfill cost |
|---|---|---|---|---|
| S.F | 5394 lbs | $107.88 | <$1348.50> | <$160.20> |

**Fig .12**

| | | |
|---|---|---|
| <u>Revenue</u> | | |
| Scrap metal | $14.89 | |
| IC boards | $1007.55 | |
| CRT export to Chana | $107.88 | |
| | | $1130.32 |
| <u>Cost</u> | | |
| Transportation | $39.00 | |
| CURA | $6,732.00 | |
| Sunset Scavenger | $2,680.00 | |
| | | <$9,451.00> |
| Total | | < $8320.68> |

**Fig. 13**

**Figure 13 shows the cost of collection and processing if the CRTs were exported to China for 2 cents a pound earnings.**

If the CRTs were exported to China, the total cost for collecting and processing EOL electronics would be approximately $1139 per ton. New municipal recycling programs typically experience a 40 percent reduction in collection and recycling cost over a 1-5 year period, as more efficient systems are created. A 40 percent improvement in the efficiency could reduce EOL electronic and electrical recycling and collection to $621-$733 per ton, depending on whether the CRTs are exported to China.

However, even with a 40 percent improvement in recycling and processing efficiency, the cost of recycling EOL electronics remains almost 5 times more than the $128 the City of San Francisco pays to recycle standard beverage containers, paper, glass products currently collected in municipal curbside programs.

## Model: Hayward Recyclables Drop-Off Event

### 3. 0 Introduction

The Hayward Recyclables Drop-Off (RDO) event invites Hayward residents to drop-off white goods, yard trimmings, mattresses and wood waste at a vacant lot owned by the City Department of Public Works. The Drop-Off Event is held several times a year and staffed by city workers. The Saturday March 28, 1998 RDO accepted household electronic products for recycling.

Carnales Unidos Reformando Adictos (CURA), a nonprofit long-term drug and alcohol treatment program, collected and recycled electronic products from the RDO. CURA, located in Fremont, provides residential drug and alcohol treatment services in Southern Alameda County (See section 2 for description of CURA programs). CURA operates a recycling warehouse in Newark (approximately 5 miles from the Fremont residential treatment facility), which focuses on recycling and reuse of household appliances, furniture and clothing collected from the Fremont Residential Bulky Waste Collection Program.

### 3.1 Distinct aspects of the Hayward RDO compared to the San Francisco and Oakland Pilot Programs .

- The Hayward RDO invited residents to drive to a location and drop off electronic products instead of providing curbside collection
- The Hayward RDO event was advertised in the *Daily Review* newspaper
- Plastics from the Hayward RDO were not included in the MBA Polymers study
- The Hayward RDO event collected materials for one day compared to 10 days of collection in San Francisco and Oakland
- The City of Hayward population is significantly smaller than the population of San Francisco or Oakland

### 3. 2 About the City of Hayward

(1990 Census)

| | |
|---|---|
| City of Hayward population | 111,498 |
| Number of Housing units | 42,216 |
| Average household property value | $197,246 |
| Average gross rent | $737 |
| Average age of resident | 33.9 |
| Average person in household | 2.76 |
| Average household income | $41,019 |
| Average number of rooms | 4.68 |

### 3.3 Hayward Electronic Collection and Recycling Pilot Project Goals

- Determine the quantity of electronic products that could be collected in the Hayward Recyclables Drop-Off Event.
- Determine if opportunities exist for nonprofit recyclers to collect and recycle electronic materials.

### 3.4 Electronics Collection and Recycling Methodology

#### 3. 4a Advertisement

The Recyclables Drop-Off event was advertised through the *Daily News*, public service announcements and public access channels (Appendix 11). The ads instructed Hayward residents to call the Hayward Solid Waste Department in order to register for the event. Interested residents were sent recycling guidelines (Appendix 12). Upon arriving to the RDO event, Hayward residents were advised where to unload their recyclable items.

#### 3.4b Hayward Data Collection Procedures

The RDO location was a vacant lot owned by the City of Hayward. The drop-off stations were laid out in a circular fashion (Appendix 13). Drop-off stations were designated for auto batteries, tires, scrap metal, appliances, wood waste and stuffed furniture. CURA provided one trailer, one debris box and a box truck for the electric products collection. Eight CURA workers staffed the RDO electronic staging area. CURA workers helped Hayward residents unload their electronic products and place the items in the CURA box truck. The electronic items were taken to the CURA warehouse located less than 20 miles from the RDO drop-off location.

### 3.5 Residential Response

A total of 9,791 pounds of EOL consumer electronic products were dropped off by 221 participants, which averaged approximately 44.3 pounds of EOL electronics per participants.

### 3.6 About CURA

See section 2.6

### 3.7 CURA Collection and Recycling Procedures

#### 3.7a CURA Data Collection Process

Although MFF had met with CURA and provided instructions on data collection procedures, the CURA staff felt more comfortable inventorying the electronics in the same way that they inventory other items collected or donated to CURA. Although the CURA data collection process provided basic information about the products collected during the RDO, it did not yield the detailed information that MFF requested.

#### 3.7b CURA Sorting and Disassembly Procedures

At the CURA warehouse, materials were unloaded onto the warehouse floor. CURA workers then grouped the electronic materials according to product types. The CURA staff then weighed the products in groups rather than weighing the products individually. After the products were weighed, CURA workers were allowed to freely select items for disassembly. CURA dedicated eight workers for

six hours a day, for 11 days to disassemble electronic products from the Hayward RDO.

At the time of the Hayward RDO, the CURA warehouse had been in operation for less than nine months. Individual work stations with tools had not been set up, so the workers shared tools and work benches.

The warehouse staff supervisor was a former CURA client who learned to recycle electronics as a scavenger. Many of the warehouse recycling practices were a carry over from the supervisor's scavenging career. For example, the gold from the integrated circuit boards were removed with pliers and sold to a goldsmith and the integrated circuit boards were treated as breakage. This practice substantially lowered the revenue generated from the Hayward RDO Electronic Collection and Recycling Pilot project. The 2883 pounds of commingled breakage (circuit boards), copper bearing , copper wire, scrap ferrous metal and iron cast aluminum earned CURA a total of $49.78. However, the 1038 pounds of integrated circuit boards from the San Francisco residential collection project generated $1007.55 in revenue when sent to Metech International Inc. for recovery of precious metals.

### 3.7c Plastics

The plastics recovered from the Hayward RDO were small quantities of mixed resins mostly from television, vacuum cleaner and computer housing. MBA Polymers expressed interest in accepting the recovered computer housing from the Hayward RDO, if CURA remove the painted labels and metal contaminants. However, MBA Polymers was not interested in paying for such a small quantity of plastics. CURA decided that it would not be cost effective to remove the labels, and as a result all the plastics from the Hayward RDO were commingled with glass and other debris and disposed of in the landfill.

### 3.7d Televisions and Monitors

The televisions and monitors from the Hayward RDO were disassembled and the metals were recovered. The glass and plastics from the televisions were sent to the landfill.

### 3. 8 Hayward Cost Analysis

#### 3. 8a Overview

Despite several economic advantages, the Hayward Recycling Drop-Off (RDO) Pilot Project cost were approximately $2,000 per ton. The Hayward RDO collection model benefits included CURA's subsidized labor force, as well as the reduced collection and transportation cost associated with a drop-off program. The one day event also allowed the City of Hayward and CURA to be more selective about the type of materials accepted and to protect the materials from exposure to the weather and other damaging elements that occur at the curbside. Fig 19 shows the total cost of the Hayward RDO. The $20.00 transportation cost reflects the fact that CURA owns their own truck and does not pay its drivers.

| | | |
|---|---|---|
| Revenue | | |
| Scrap | $71.38 | |
| | | $71.38 |
| Cost | | |
| Collection | $20.00 | |
| Labor | $9950.00 | |
| Disposal | $152.00 | |
| Advertising | $42.38 | |
| Landfill | $221.55 | |
| | | <$10,385.93> |
| Total Cost | | <$10,314.55> |

Fig 19

#### 3. 8b Labor Cost

The $9950 Pilot Project cost could be reduced at least 50 percent if CURA was paid an hourly rate and if CURA were better equipped to disassemble and process the electronic products. For example, CURA recorded a total of 528 labor hours to process the materials from the Hayward RDO. At a rate of $8.50 per hour the actual labor cost was $4,488. Thus, the price per ton could have been reduced to $992 if CURA workers had been paid an hourly rate. The labor cost could have been further reduced if the CURA warehouse was organized for efficient disassembly of household electronic products.

Prior to the Pilot Project, CURA's recycling efforts focused on disassembling white goods such as washing machines, stoves and water heaters in order to recover the constituent metals. The CURA warehouse was not set up with stations, work benches and tools for the small electronic appliances collected from the Hayward RDO. CURA did not have a forklift and depended on manual labor to load and

unload materials. The lack of forklifts, tools or efficient work stations undoubtedly added to the disassembly, loading and sorting labor hours.

The Pilot Project's efforts to collect data also artificially added to the total labor hours recorded by CURA. The Pilot Project required CURA workers to dismantle all the collected items and record the resulting constituent metals. CURA spent an estimated 20 minutes on each of the 55 televisions and 6 monitors in order to recover the metals. The glass and plastic from the televisions were eventually landfilled. The integrated circuit boards, copper and other metals from the televisions were treated as breakage and sold to a local scrap metal recycler at a rate of $20 per ton. CURA workers dedicated approximately 20 hours dismantling televisions and monitors that would not have been dismantled under normal circumstances.

The workers also spent a significant amount of time attempting to thoroughly removing contaminants from the plastic in order to evaluate the types of plastics found in the electronic waste stream and to demonstrate disassembly and sorting procedures that would be applied during the San Francisco and Oakland Pilot Projects. MBA Polymers did not process the Hayward plastics and markets could not be identified for the plastics. CURA subsequently landfilled all of the plastics.

**3. 8c Integrated Circuit (IC) Board Processing.**

The integrated circuit boards collected during the Hayward RDO were treated as breakage at a rate of $20 per ton. If the IC boards were sent to Metech or a similar facility for precious metals recovery, the IC boards could have earned approximately $1 per pound. However, it should be noted that IC boards are not homogenous. The value of a product's IC boards can vary dramatically depending on the product type and the product's age. The value of the metals extracted from IC boards also fluxuate with the markets.

The IC boards recovered from the Hayward RDO generated $71 when combined with other metals and sold as breakage, compared to the $1008 revenue generated from the San Francisco Pilot's IC boards.

Fig 14 compares the most frequently collected products from San Francisco and Hayward that contain IC boards, but do not contain cathode ray tubes (CRT).

The most frequently collected types of products in the Hayward, Oakland and San Francisco Pilot Projects were televisions, stereo equipment, vacuum cleaners, computers, microwaves and monitors. These items constituted approximately 75 percent of the total number of items collected.

| City | Computer collected | Micro-wave ovens collected | Stereos collected | VCRs collected | Total Products with IC boards |
|---|---|---|---|---|---|
| S.F. | 54 | 22 | 6 | 8 | 90 |
| Hayward | 83 | 25 | 20 | 12 | 140 |

**Fig . 14**

At least 50 more products containing IC boards were collected during the Hayward RDO than in the San Francisco Pilot Project collection. It can safely be assumed that the Hayward project could have earned at least $1,008, if the Hayward IC boards were sent to smelter for precious metal recovery rather than to a scrap metal vendor.

| City | Total lbs electronics | Number of items with IC boards | Total lbs. metal | Revenue from scrap metal | Revenue from IC boards | Total revenue |
|---|---|---|---|---|---|---|
| S.F. | 14,600 | 90 | 4015 | $14.89 | $1,007.55 | $1022.44 |
| Hayward | 9,791 | 140 | 3432 | $71.38 | N / A | $71.00 |

**Fig . 15**

**The figure above compares the weight of products containing IC boards collected in the San Francisco Pilot Project with the weight of products containing IC boards collected during the Hayward RDO.**

Although the total weight of the San Francisco collection is 14,600 pounds compared to the Hayward RDO 9,791 pounds, the types of products collected from Hayward generally have higher value IC boards. For example, 29 more computers were collected during the Hayward RDO than during the San Francisco Collection. The IC boards from the Hayward project were not weighed separately, so it is difficult to compare the actual weight of IC boards from San Francisco and Hayward.

Fig. 16 is an estimate of the Hayward RDO showing a labor rate of $8.50 an hour and $1000 revenue earned from IC boards. Fig. 16 is only an estimate of potential earnings from IC boards. The estimated amount was derived by comparing the types of products collected in the San Francisco and Hayward Projects. The estimate shown in Fig 16 is not based on a laboratory analysis or assay process used by smelters to determine the value of recoverable precious contained in a load of IC boards.

It should also be noted that CURA recorded small household appliances as a general category of "small appliances," so it is difficult to compare the constituent materials found in such a general category. However, the actual cost of labor and

revenue generated from IC boards could have potentially reduced the cost from $2,037 per ton to $757 per ton.

| | | |
|---|---|---|
| Revenue | | |
| Scrap / IC boards | $1000.00 | |
| | | $1000.00 |
| Cost | | |
| Collection | $20.00 | |
| Labor | $4,488.00 | |
| Disposal | $152.00 | |
| Advertising | $42.38 | |
| | | <$4702.38> |
| Total Cost | | <$3702.38> |

**Fig 16**

**3.8d Cathode Ray Tube (CRT) processing**

Televisions collected during the Hayward RDO were disassembled and the metals recovered. The glass was landfilled. The plastic and wood housings were also landfilled. There are few CRT recycling options available in California that are both cost effective and environmentally responsible. The CRT recycling options available to the Hayward RDO Pilot Project included recycling the whole units at ECS in San Jose at a cost of 25 cents per pound or selling the units to a Chinese vendor at a revenue of 2 cents per pound.

If the units collected from the Hayward RDO were sent overseas, the monitors and televisions would earn approximately $81 in revenue. The cost to recycle the units at ECS would be approximately $1017. Fig 17 compares the CRT processing costs.

| City | Total pounds of weight of TV / monitors collected | Potential Revenue from Export | Potential Cost of Recycle / domestically | Landfill cost |
|---|---|---|---|---|
| Hayward | 4,068 | $81.36 | $1,017.00 | $142.10 |

**Fig . 17**

Thus, if CURA continued to receive public funding to pay the overhead cost of the warehouse and to use workers from the early phases of the drug and alcohol treatment program, who don't receive compensation for work, then the most profitable way to handle the materials would be the following.

1) only accept products with IC boards that can be sent to a refinery
2) landfill the plastics
3) send the televisions and monitors overseas for processing.
4) improve operation efficiency

The priority of the Pilot Project is to find ways to process materials without exporting materials that are characterized as hazardous waste and without landfilling the materials. Clearly long-term strategies will have to be developed in order to address CRT and plastic recycling.

| | | |
|---|---|---|
| Revenue | | |
| CRT export | $81.36 | |
| Scrap / IC boards | $1000.00 | |
| | | $1081.36 |
| Cost | | |
| Collection | $20.00 | |
| Labor | $4,488.00 | |
| Disposal | $152.00 | |
| Advertising | $42.38 | |
| | | <$4702.38> |
| Total Cost | | <$3621.02> |

**Fig 18**

The above figure shows the cost per ton if the CRTs were exported, the IC boards were recovered and CURA paid their workers $8.50 per hour.

If the CRTs were exported to China for 2 cents per pound, the approximate cost of collection and recycling EOL electronics per ton would be $738. However, if the CRTs are recycled at ECS the cost per ton would be $932.

New municipal recycling programs typically experience a 40 percent reduction in collection and recycling cost over a 1-5 year period, as more efficient systems are created. A 40 percent improvement in the efficiency could reduce EOL electronic and electrical recycling and collection to $372-478 per ton, depending on whether the CRTs are exported to China.

However, even with a 40 percent improvement in recycling and processing efficiency, the cost of recycling EOL electronics remains almost 3-4 times more than the $100-$150 the City of Hayward pays to recycle standard beverage containers, paper, glass products currently collected in municipal curbside programs.

## 4.0 Goodwill Industry Electronics Product Waste Assessment

The San Francisco Goodwill is located on Van Ness Street, in the San Francisco downtown area. The Goodwill warehouse serves as a receiving area for goods sold at 26 Goodwill retail stores in the San Francisco Bay Area. Nine Goodwill stores are located in San Francisco, one store is located in Marin County and 17 stores are located in San Mateo County. Approximately 16 Goodwill drivers collect donations seven days a week.

**How the Electronic Products are Processed**
Electronic appliances comprise approximately four percent of the Goodwill retail sales. Ready to wear sales averages 56 percent, kitchen wares 20 percent and furniture 3 percent of the total products sold.

The donations collected from drop-off sites are taken to the San Francisco warehouse facility. The products are sorted into the following categories:

(1) Ready-to-wear
(2) Shoes
(3) Furniture
(4) Electronics

Four workers in the electronics department test the products to determine if they are operational. One part-time employee tests only vacuum cleaners, another part time employee tests computers and two full time workers test all other electronic appliances (Goodwill of San Francisco does not accept white goods).

### 4.1 Repair
Labor cost, space limitations and spare parts shortages prevent Goodwill from repairing most donated products. If an appliance works, it is priced by the Goodwill worker and sent to a store. If the product does not work properly Goodwill workers will make simple repairs.

The resale value of electronic products is too low to justify the cost of extensive repairs. Each employee position in the warehouse facility are paid for by retail sales. In order to repair more products, an appliance repair training program would have to be provided for employees. Goodwill has not identified an obvious job market for people with small appliance repair skills.

A lack of spare parts prevents the workers from performing repairs. Purchasing replacement parts is almost impossible for most older model products. Many of the products such as turntables, vacuum cleaners and microwaves donated to Goodwill were manufactured more than 10 years ago. Although the workers do salvage some frequently used parts (cords and switches), they have neither the time or the space to salvage and stock parts. The electronics department floor

space totals approximately 300 square feet and does not have permanent storage space available. Products are stored on mobile racks adjacent to the four testing stations.

### 4.2 Products that Justify Repair

Revenue generated from the sales of vacuum cleaners and computers justifies the Goodwill dedicating two half-time technicians to repair those products. However, both technicians entered the Goodwill program with their repair credentials. The vacuum cleaner repair person is a former engineer who suffered from a disability. The computer repair technician worked in the computer field for three years before entering the Goodwill program.

The Goodwill vacuum cleaner repair technician cannibalizes parts from vacuum cleaners in order to make repairs. He commented that many of the vacuum cleaner designs make the vacuum cleaners almost impossible to disassemble and repair without special tools. The designs and the inordinate amount of time required to dismantle a vacuum cleaner, and the shortage of space to store spare parts or any products waiting for repair, made it impossible for the worker to repair the products in a time efficient manner.

The worker assigned to test computers uses the same triage process as the worker who repairs vacuum cleaners. The computer repair technician only performs simple repairs that do not require much time. However, it should be noted that several Goodwill Industries located in other cities are test marketing Goodwill retail stores that specialize in computer sales.

### 4.3 Goodwill Industries Training

The mission of the Goodwill training program is to transition workers into the workforce by providing consistent employment in a supportive environment. The Goodwill of San Francisco prides itself on being a retail operation that provides employment training for hard-to-place workers. Recycling is performed in order to save money on the cost of landfilling unsold products. In order to expand the repair or recycling portion of the electronic department, the Goodwill would have to be able to recover the cost of labor and the cost of expanding the San Francisco warehouse in order to provide space for sorting and disassembly. Goodwill would also have to develop an electronic appliance repair and disassembly training curriculum that teaches skills relevant to the job market.

The 14 Goodwill employees participating ing the San Francisco Department of Human Services Temporary Assistance for Needy Families program (TANF) are paid a minimum wage by Goodwill. Goodwill also assumes the responsibility of training the TANF workers to enter the job market. There is not enough information available to determine if TANF workers can acquire marketable skills from recycling electronic products.

### 4.4 As-Is

Products that are not in reasonable selling condition and products that did not sell in the stores are returned to the Van Ness Street warehouse facility and sold in the As-Is sale.

The As-Is sale takes place in a restricted section of the warehouse, and is open from 9:00 a.m. -3:00 p.m., Monday through Friday. Customers begin lining up for the As-Is sale almost an hour before the doors open. According to the Goodwill As-Is manager, most customers are looking for specific types of products that they can resell at specialty stores, thrift stores, flea markets or perennial garage sales. Electronic products are placed on racks along the wall. Electrical outlets are available for customers to test the electronic products to determine if they are operational. However, many As-Is customers purchase electronic products in order to cannibalize the products for spare parts.

The products that do not sell during the As-Is sale are removed at 10:00 a.m. and again at 12:00 p.m. in order to make room for the new inventory to be brought in from the warehouse.

### 4.5 Recycling and Disposal of Unsold Products

Electronic products that do not sell in the As-Is sale are sorted according to the quantity of metal contained in the product. The electronic products that are rich in plastic and do not contain a significant amount of metal are placed in a bin and taken to the landfill. Electronic products that are rich in metal are placed in a recycling bin with other metal products. The decision to recycle or landfill a product is up to the discretion of the Goodwill worker.

The Goodwill yard serves as a parking lot and sorting area. Goodwill does not have adequate space to separate or disassemble products. Electronic appliances are mixed in the recycling bin with other products such as furniture, exercise equipment and kitchenwares. The plastics, glass and wood from the commingled products lower the recycling value of the scrap metal. However, if the electronic products were segregated from the non-electronic products and disassembled, the constituent materials from the electronics would not pay for the cost of labor.

### 4.6 Electronic Assessment Method

For many years the Goodwill Industries has served as a successful model for reuse and recycling of household appliances. In order to get a better understanding of the volume and types of electronic products collected by Goodwill and how those products are currently sorted for resale, recycled or landfilled, MFF weighed and documented electronic products that entered the Goodwill facility for three consecutive days. For three days MFF also weighed and documented the electronic products designated for recycling or the landfill.

Appendix 14 shows products that entered Goodwill. Unfortunately, Goodwill does not have an inventory system that tracks each donation through its system. The Goodwill has a four week rotation cycle. If a product does not sell in four weeks it is sent to As-Is.

According to the Goodwill staff, the donation and sales of products are unpredictable. This unpredictable flow of donated products contributes to the appearance of the total weight of materials exiting the facility being larger than the total weight of materials entering the facility.

However, the assessment does provide a general understanding of the weight and types of products received by Goodwill, how the products are sorted and handled and which products are thrown away and which products are recycled.

Appendix 15 compares how frequently a product was recycled with the frequency with which the same product was sent to the landfill. The products that were deposited in the metals recycling bin are heavier by weight then the same product types that were landfilled. The newer, lighter weight products were more frequently thrown away than similar older model products that were constructed with more metals and less plastics. For example, toasters were frequently recycled because the older model toasters that are donated to Goodwill are comprised of metal. The mean weight of toasters that were thrown away were almost two pounds lighter than the toasters that were recycled. (See Appendix 16).

**4.7 Summary**

The Goodwill is a major conduit for electronic product reuse.
However, the prospect for improving the rate of electronics recycling is limited under the given circumstances:

- As the new electronic products become lighter, Goodwill will be forced to landfill larger quantities of plastic rich electronic products.
- Goodwill has little incentive to divert larger quantities of electronics unless the organization receives the social benefit of using electronic recycling as a means to provide successful employment training programs or the cost benefit of reducing landfill fees.

## Cathode-Ray Tube recycling

### 5.0 Why are televisions and computer monitors so hard to recycle?

The CRT glass in TV and computer monitors may be classified as hazardous waste under the Environmental Protection Agency's Resource Conservation Recovery Act (RCRA, 42 USC 6924) provisions because it contains lead. The hazardous designation is given because the lead CRT glass often fails the Toxicity Characteristic Leaching Procedure, a test which determines how much lead could leak into the ground from broken CRT glass. Because CRT glass may be considered a hazardous waste, it is very complicated to recycle. Used TVs and monitors in original housings may be transported and handled without being considered a hazardous waste. It is when they are discarded or dismantled that the CRT glass may have to be handled as a hazardous waste.

### 5.1 Who can throw a CRT in the landfill?

The RCRA regulations are confusing; not everyone can just throw their old computers or TV monitors in the trash. Small businesses generating less than 220 pounds per month and households do not have to treat CRTs as hazardous waste. However, businesses generating more than 220 pounds per month of computer or television monitors must treat CRTs as hazardous waste.[2] This means that hospitals, universities, large corporations and other large generators must dispose of their CRTs in an EPA-governed manner, while a family can throw its television out with the trash. MFF estimates that more than 4 tons of televisions and computer monitors are thrown away each week by Oakland residents .

The hazardous waste designation makes CRTs costly to handle. The cost of transporting CRTs from the Bay Area to a recovery facility can be very expensive, and the value recovered from the CRTs is minimal. Recyclers typically do not make money and may even have to pay to recycle their CRTs. Companies accepting discarded CRTs for recycling are required to obtain permits, carry special insurance and comply with regulatory standards.

### 5.2 How can CRTs be recycled?

The most desirable recycling option is to utilize the old CRT glass in manufacturing new CRTs. However, recycled materials may not have the same composition as products that are manufactured today. CRT glass is manufactured with different glass compositions by different companies. These different types of glass cannot be mixed for recycling.[3]

---

[2] Jones, David B., EPA Region 9 CSI Program Director, Letter to Thomas Bartell. May 30, 1997.

[3] Microelectronics and Computer Technology Corporation(MCC). Environmental Consciousness: A Strategic Competitiveness Issue for the Electronics and Computer Industry. March 1993:245.

Several companies have developed processes to separate and clean CRT glass for reuse in new CRTs and to separate other recoverable materials. However, these companies are not located on the West Coast and the cost of transporting the CRTs from the San Francisco Bay Area to a CRT recycling facility in another state is very expensive. The EPA expects to release a revised rule in early 1999 that will allow CRT glass that is being processed for reuse to be handled as a non-hazardous material, which will reduce the cost of recycling.[4]

Most of these recycling alternatives are not economically sustainable. Currently, CRT recycling companies charge their customers to recycle the CRTs. Until the market demand for CRT glass changes and CRT recycling companies are able to pay to accept the CRTs, the process is not economically sustainable.

### 5.3 Options for recycling CRTs in northern California

Businesses have three options for CRT disposal in northern California.

1. They can send the CRTs to Envirocycle, a CRT recycling company with facilities in Ohio, North Carolina and Pennsylvania, or a similar recycling operation. Envirocycle cleans the CRT glass and sends it back to manufacturers to be made into new CRTs. The cost to recycle CRTs at Envirocycle, including transportation from the Bay Area, is approximately $8 per CRT.[5]
2. CRT material can be sent to a shredding operation such as ECS in San Jose. ECS prepares the CRTs and ships them to a primary smelter for the recovery and recycling of lead, copper, glass, plastic and other materials. This option avoids sending CRTs to landfill, however, it is expensive and may not be feasible for smal scale recyclers.
3. CRTs can be sold to overseas markets for approximately two cents per pound. The buyers in countries such as China will try to resurrect and resell as many CRTs as they can. Materials that cannot be reused are recycled and the glass is ground and included in concrete and other cement-like materials.[6] The United States exports over 500 million tons of hazardous waste annually. Tracing the path of some of the exported electronic material to China and other countries in Asia reveals alarming working conditions, improper incineration and unregulated hazardous waste disposal.[7]

### 5.4 How can CRT recycling be made easier and cost effective?

In order to make recycling efficient and cost-effective:

- The CRT must be designed for easy disassembly and sorting.
- The glass used in CRT composition should be consistent, so that recyclers can mix all types of CRT glass.

---

[4]EPA Press Release, June 26, 1998

[5]Holroyd, Steve. Steve Holyrod and Associates, Memo to Sheila Davis. December 15, 1997.

[6]Holroyd, Steve.

[7]Global Dumping Ground. Narr. Bill Moyers. Center for Investigative Reporting and KQED-San Francisco, 1991.

- More CRT recycling facilities are needed in northern California, in order to lower the transportation costs.
- Hazardous waste laws need to be revised so that CRT glass that is being processed for reuse can be handled (but not disposed of) as a non-hazardous material.
- Most importantly, more profitable end markets need to be developed for CRT glass.

### 5.5 What are other states doing about the CRT problem?

The Department of Environmental Protection in Massachusetts is implementing a state sponsored market development program for CRT recycling. The state market development efforts will include a single payer agreement with Global Technology, a CRT recycler. Ninety thousand dollars will be used to support CRT recycling in 21 cities. The grant funds will be credited to the cities for each residential CRT that Global Technology recycles from the city collection programs. Massachusetts is developing a fee-for-service system for the 32 cities who did not receive grant funds to off-set the cost of CRT recycling. An estimated $4-5 disposal fee will be implemented.

Goodwill Industries and other Massachusetts non-profit organizations will serve as collection centers for the CRT recycling programs. All operational CRTs will be resold by Goodwill. Non-operational CRT will be sent to Global Technology for demanufacturing and materials recovery. Global Technology will charge the state approximately $300 per ton for their CRT recycling services, which averages about 15 cent per pound. The CRT glass will be sent to Dubleck for recycling.

The Massachusetts state market development program will also survey 400 television repair companies to determine their interest in receiving monitors and research markets in Mexico and Asia.

North Carolina tried to pass a bill to require retailers to take back used hard-to-dispose items (CRTs are on the list) when the consumer purchases a new version of the item. The act did not pass because of opposition from the North Carolina Retail Merchants Association.[8]

### 5.6 Impact of new technologies on recycling

Alternative monitor technologies, collectively referred to as flat panel displays (FPDs), may make CRTs obsolete in the next five to 10 years. FPDs are expected to consume less energy than CRT monitors and do not use leaded glass. The environmental effects of FPDs are not yet known, although the Design for the Environment Program in the US EPA's Office of Pollution Prevention and Toxics has begun a voluntary, cooperative project with the electronics industry to assess

[8]General Assembly of North Carolina, "Retailers to Accept Goods for Disposal." Senate Bill 846 (Session 1997).

the life-cycle environmental impacts of FPDs and CRTs.[9] However, it is clear already that as FPDs become more affordable and accessible to the general public and people upgrade to the new technology, significant numbers of CRTs will enter the waste stream, multiplying the CRT recycling problem.

Another developing technology that may contribute to the number of television monitors entering the waste stream is digital TV. Digital TV uses a completely different technology than the current analog TV to transmit and display information. While regular TV broadcasting will be around until at least 2006, many households will begin to purchase new digital TV sets or they will upgrade their personal computers to accommodate the new technology in the coming years.[10] This will also add significantly to the number of CRTs entering the waste stream.

[9]MCC Environmental Programs, "Design for the Environment Computer Display Project," http://www.mcc.com/projects/env/dfecd.html.
[10]http://www.lycos.com/news/flash/digitaltv.htm.

## 5.7 Cathode Ray Tube Recycling /Processing Cost Analysis

| City | Weight of TV/monitors collected in Pilots | Export to China | Recycle at ECS | Landfill cost |
|---|---|---|---|---|
| Oakland | 6931 | $138.62 | $1736.00 | $242.20 |
| S.F. | 5395 | $107.88 | $1592.00 | $160.20 |
| Hayward | 4068 | $81.36 | $1017.00 | $142.10 |

**Fig. 19**

The cost to recycle CRTs at Envirocycle (located in Hallstead, Pennsylvania) , including transportation from the Bay Area, is approximately $8 per CRT (approximately 25 cent per pound). Envirocycle cleans the CRT glass and sends it back to manufacturers to be made into new CRTs.

The landfill cost (Fig. 19) is based on a $60.00 per ton rate for San Francisco and a $70.00 per ton rate for materials from Hayward and Oakland. It should be noted that all televisions and monitors collected from the Hayward RDO were disassembled and the metals recovered for recycling. Only the resulting glass and plastics were sent to the landfill. Recovering the metals contributed to the reduced landfill cost in the Oakland model.

CRTs from the Oakland and San Francisco Pilot Projects were sent to ECS, located in San Jose. ECS sends the shredded glass to a Canadian smelter, which recovers the metals. The total CRT recycling cost for Oakland and San Francisco was $2927.25 for 11,709 pounds of intact televisions and monitors. Some of monitors and televisions collected in the Oakland and San Francisco Pilot programs were disassembled and the constituent materials recycled or placed in the landfill with other debris. If all of the televisions and monitors collected were sent to ECS for recycling the cost would have been approximately $3328.

### 5.7a Televisions

MBA Polymers identified televisions housing as a promising material to perform a full scale analysis which included the use of infrared equipment to identify the resin types as well as a wet and dry process to separate the resin types. The television housings appeared to be made from a black, high impact polystyrene (HIPS).

The black plastic was observed to be the most common material used in the housing of portable televisions set out during the Oakland Bulky Waste collection. The black plastic housing was removed from a sample of approximately 30 televisions collected during the Oakland and San Francisco collections and sent to MBA Polymer for analysis. MBA Polymers determined that approximately 86

percent of the sample television housings were (HIPS). MBA Polymers estimated the resell value for the recovered HIPS to be 18-22 cents per pound.

| Resin | %Weight |
|---|---|
| Acrylonitrile-butadiene- styrene<br>High Impact Polystyrene<br>Polyphenylene Oxide | 8<br>86<br>3 |
| Total | 100 |

**Fig. 20**
**HIPS comprised 86 percent of the 270 pounds of sample of television housing analyzed.**

Fig. 20 shows the average weight of constituent materials found in a random sample of 15 disassembled portable televisions recovered from the Oakland Bulky Waste Pick-up Program and the San Francisco Super Recycling Day. The average weight per television in the random sample was 51.8 pounds. The mean weight of the televisions collected from the Oakland curbside was 34 pounds with a standard deviation of 17.2. The average weight of the random sample of televisions that were disassembled is within the higher range of average weight.

| Item | Average Pound of HIPS plastics | Average pounds of metal breakage | Average pounds of glass | Average pound of IC Board | Average , pound of Copper |
|---|---|---|---|---|---|
| Recycling value per pound | .18-.22 | .01 | <.25> | $1.0 | .30 |
| Average weight of material in televisions | 7.6 | 14.0 | 24.6 | 2.9 | 2.5 |

**Fig. 21**
**The average weight of televisions from the random sample was 51 pounds which is higher than the 34 pound mean weight of televisions collected from the Oakland pilot project, but within the 17.2 pound standard of deviation.**

The IC boards from the televisions were not assayed separately. The price per pound assigned to the IC boards in Fig. 21 is the average price per pound for the IC boards recovered from the San Francisco Pilot Project. Fig 22 also shows the value of the materials in the televisions if the glass were sent to ECS at a cost of 25 cent per pound and the IC boards earned $1 per pound.

| | | |
|---|---|---|
| Revenue | | |
| Plastic | $1.36 | |
| Metal | $ .14 | |
| IC boards | $2.90 | |
| Copper | $ .75 | |
| Total | | $5.15 |
| Cost | | |
| Glass | $6.15 | <$6.15> |
| Total Cost | | <$1.00> |

**Fig 22**

The value of metals and plastic and the cost of recycling the leaded glass fluctuate. The price of copper ranges from 30 cents to 60 cents depending on the grade. The cost of recycling glass can range from $300 to $500 and the price of plastic from 18-22 cents. The price of a commodity also depends on the quantity being sold and transportation cost. The estimates in the above table are from the lower-end of the metal and plastic price range using local market. The cost of $1 for each television does not include the cost of collection or the cost of the labor required to disassemble the television.

However, if all 256 portable televisions were collected and disassembled it would have taken approximately 85 EBCC labor hours, at a disassembly rate of 20 minutes per television. Recovery of the 256 televisions would have diverted approximately 4.3 tons of materials and cost approximately $2,639 in recycling and labor cost. The recycling cost per portable television using EBCC labor would be approximately $10.30. The total cost of recycling the 256 televisions intact at ECS would be $2,176.

Using a different CBO that has more flexible labor rates and alternative collection strategies, such as San Francisco or Hayward would reduce the cost significantly. An average weight of 125 pounds was assigned to the 63 console televisions left on the curbside during the Oakland Bulky Waste collection. The console televisions were typically made of wood which would not have contributed to the HIPS plastic feed stock. Because the console televisions were not collected, there is not an estimated time for disassembling the console televisions.

Please call Materials for the Future Foundation for Appendices.
415.561.6530 x14 or x10.