

Metro Regional Environmental Management

Assessment of E-Waste Collection & Processing Issues for the Metro Region

Final Report



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and

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I. Introduction

A. PURPOSE OF THE STUDY

This study provides Portland Metro with an initial understanding of the feasibility of expanding collection of electronic waste in the region. Four key questions are addressed:

- 1) How much e-waste exists and is expected to be generated in the near future?
- 2) Can these wastes be collected and handled, given the existing infrastructure? If not, what new services or facilities are needed?
- 3) Can these wastes be processed and reused in an environmentally sound and sustainable manner?
- 4) What next steps should Metro take to manage these wastes?

Importantly, the scope of this study was set by time and budget with the priority being to complete a “rapid assessment” of the e-scrap marketplace to provide order of magnitude planning level answers to these questions. Accordingly, this report presents findings based on available information as well as identifies where additional research is needed to reach more definitive conclusions. The findings that are presented are based on:

- A literature review of both published and unpublished reports and studies
- Interviews with approximately fifteen E-scrap service providers that are either based in the Portland area or have expressed an interest in providing services in the region
- The expertise of core members of the consultant team as well as the client Project Manager.

B. OVERVIEW DESCRIPTION OF THE E-SCRAP SUPPLY CHAIN AND MARKETPLACE

The marketplace for electronic waste is, at this point in time, characterized by rapid change and growth at all points in the supply chain. This supply chain is really just being put together for the first time, as large quantities of obsolete electronic equipment become prevalent in homes and businesses. In response, the public, private and non-profit sectors are scrambling to provide services to collect, handle, and process these materials. In this dynamic time, new businesses are starting up and established operations are moving quickly to invest in capacity and gain market share. At the same time, public sector entities are moving fast to define a regulatory framework for managing electronic scrap in an environmentally safe and sustainable manner. Finally, all sectors are working through local, regional, and national processes to establish stewardship protocols, standards, and funding mechanisms to manage this waste stream effectively and equitably.

Figure 1 provides an overview of this supply chain, which consists of the following elements:

- 1. Generation and Stockpiling.** Many different “economic actors” purchase, use, and then stockpile or discard electronic waste – from manufacturers such as Intel to large and small businesses, households, institutions, and non-profits. This project focuses on how best to meet the needs of **small businesses** and **households**. These users are, in general, less likely than larger entities to organize and pay for services to handle obsolete electronics.

The electronic waste generated or stored by these households and organizations takes many forms. This project focuses on **central processing units (CPUs), monitors, and televisions**. Other discarded electronics include cell phone, microwaves, radios, printers, fax machines and related office equipment. This project attempts to quantify the amount of obsolete computers and monitors generated by households. No attempt was made to estimate quantities from the other sectors, such as large businesses. However, it is perhaps safe to say that electronic waste from households represents a small portion of the total electronic waste stream from all types of generators.

2. **Collection.** There are a wide variety of possible collection alternatives for this e-waste, as shown in the second box on the Figure 1 flow chart. These include collection events, curbside pickup, mail in, or drop-off at some type of a fixed facility. A variety of entities can provide these services including the Electronics Industry, private or non-profit recycling services, and the public sector through the solid waste management and recycling infrastructure. This study examines what is currently happening in the Metro area and then what services might Metro either provide directly or cause to be offered by the other sectors.
3. **Handling & Brokering.** The next link in the supply chain is the handling and brokering services. Here computers, TVs, monitors and other collected electronics are either consolidated and made ready for processing and/or sorted to determine what equipment can be refurbished or reused as whole units and what equipment must be disassembled for commodity processing. Figure 1 depicts these flows and some of the sub-elements within them. This project attempts to understand what capacity currently exists for handling and brokering in the Portland area and then what additional services could readily be imported into the region.
4. **Processing.** After computer equipment is handled and consolidated into materials of like type and quality, it is then processed into either feedstock for new production or refurbished into new equipment. Outputs from demanufacturing activities include scrap commodities such as glass, plastics, and metals – the primary elements from which all electronic hardware is made. This project examines the local and regional processing capacity as well as the national and international markets for both refurbishing and demanufacturing. For export, and to a lesser extent national processing markets, there are significant issues associated with the environmental and health practices of current service providers in this part of the supply chain. These issues are discussed in this report with recommendations provided on how Metro could proceed.
5. **Production.** The final step in this supply chain is to turn the processed commodities or refurbished whole electronics back into new products for sale and consumption by end users. There are many different players and industries involved in this production process and clearly the recycling fraction is miniscule compared with the production of product using virgin materials. This project examines, but does not focus on, the production link in the supply chain. It is important to note that some portion of recovered electronic scrap is likely used as feedstock for energy recovery facilities.

The graphic depiction of the supply chain is intended to be useful to decision makers in understanding the totality and complexity of the markets that must be 1.) in place, and 2.) economically healthy for recycling of electronics waste to truly be considered a success. As noted above, this project is intended to provide an initial understanding of some of the dynamics of this marketplace with a focus on: 1.) meeting the needs of small businesses and households; 2.) determining viable collection and handling methods for the Metro region; and 3.) assessing the adequacy and environmental soundness of processing and production capacity and markets. Figure 2 highlights these areas of project focus.

Figure 1: E-Scrap Flowchart

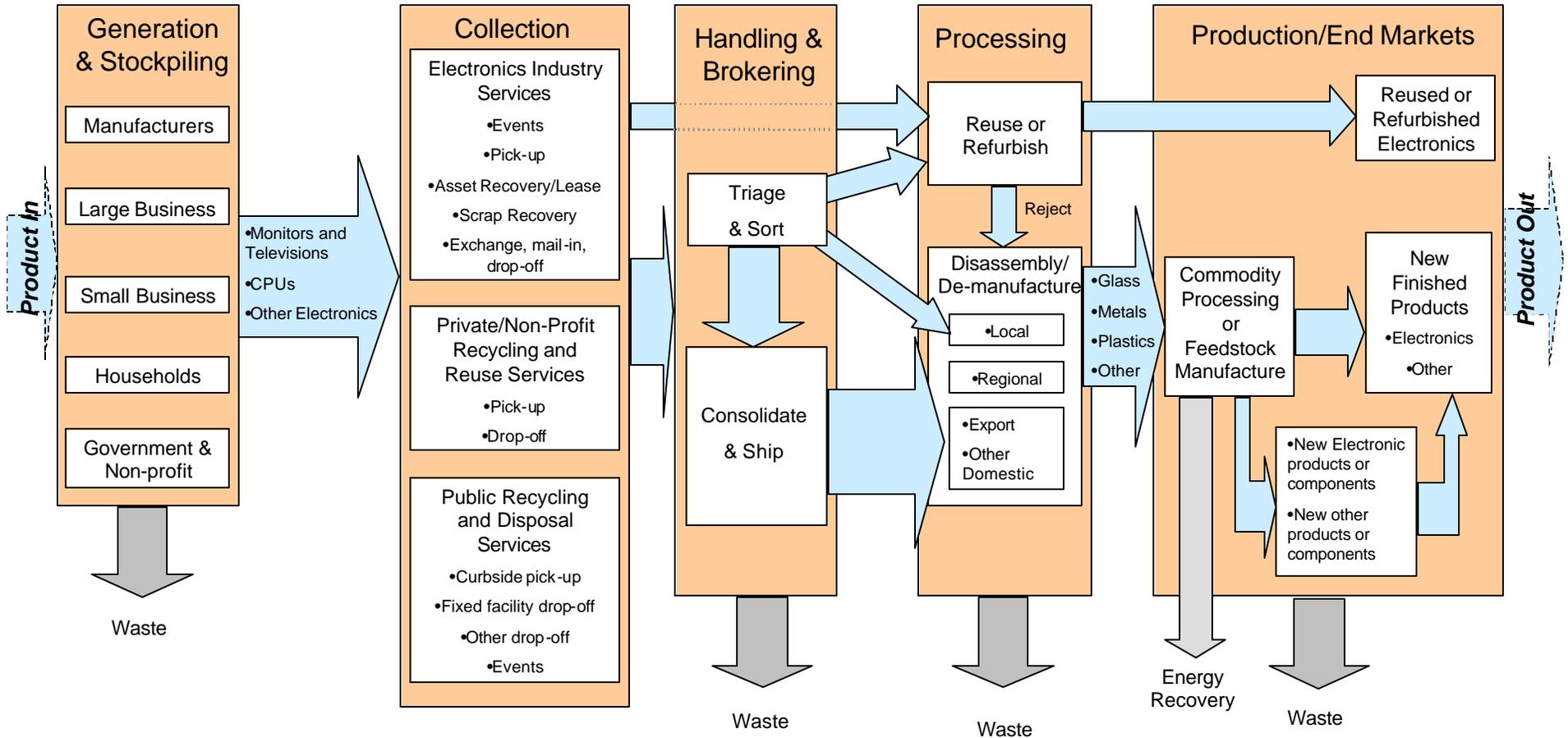
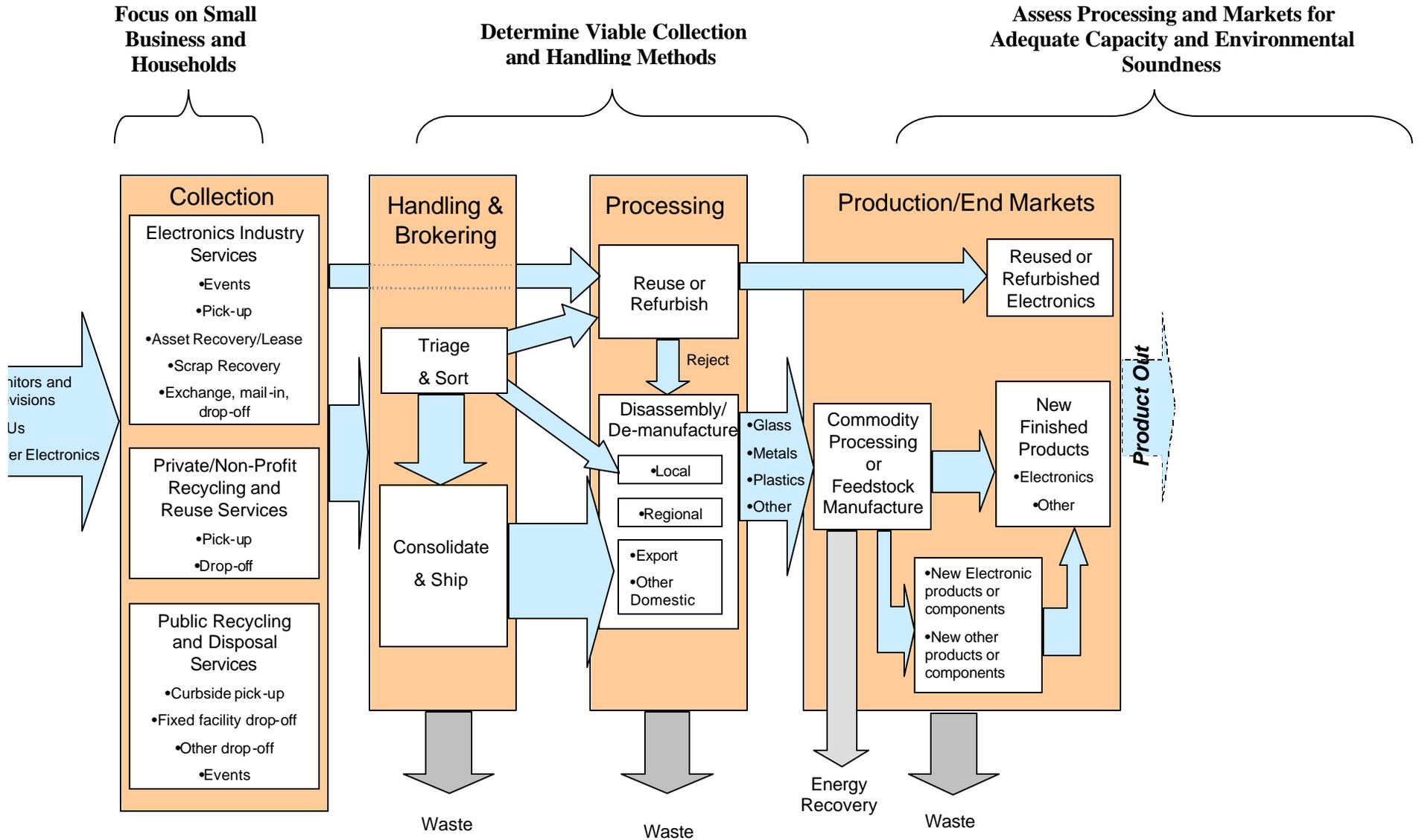


Figure 2: E-Scrap Flowchart – Project Focus



C. ENVIRONMENT AND SUSTAINABILITY

The fundamental purpose of any electronic waste collection system is to 1) recover material for reuse or recycling and 2) mitigate or reduce the adverse environmental consequences of that material at the end of its useful life. Currently, with minimal recycling collection programs available to small businesses and households in the Metro region, obsolete equipment is given away, thrown away, or stored at home and in the back office to be dealt with sometime in the future.

As Metro prepares to make decisions about what recovery systems and collection programs to put in place for this emerging waste stream, many significant environmental and sustainability issues need to be addressed. It is, in fact, not at all easy to keep electronics out of the waste stream and ensure that the environmental and social benefits of such diversion are greater than the costs associated with handling, transporting, processing and either refurbishing or remanufacturing those obsolete electronics into new competitively priced and performing products. The key challenges facing Metro (and indeed any responsible entity recovering electronic wastes) are:

- **How to adhere effectively to the waste hierarchy ensuring the highest and best use for the different forms and types of recovered electronic waste.** Obsolete electronic equipment comes in all vintages and conditions. For working, newer model monitors and CPUs it is relatively easy to send that equipment to the reuse/refurbish marketplace. However, for older, less valuable equipment such as monitors, Metro will need to decide whether to incur the cost and environmental impact of transportation to ensure glass-to-glass recycling or whether to permit the use of this glass in lead smelters. Similarly, for plastics and some of the lower value mixed electronics, decisions will need to be made as to whether energy recovery is an acceptable end-of-life management alternative or whether all materials must be remanufactured into new products.
- **Under what conditions and even whether to allow for export of electronic waste collected from the Metro region.** Currently, as will be discussed later in this report, many electronics destined for export are handled and disposed of improperly, causing harm to workers and the environment. How Metro defines an acceptable export market, and then is able to document and verify that performance, will have important environmental and policy ramifications.
- **How to ensure and verify environmentally sound processing and end-of-life management of all electronic waste.** Current problems with certain export markets offer a vivid real-life example of bad practices. However, any handler or processor of electronic waste (even in the Metro region) could be engaged in practices that are harmful to human health and/or the environment. In the absence of national and even international standards and enforcement mechanisms, Metro must grapple with what policies and accountability practices, including protocols and certification to put in place. Also, and perhaps more fundamentally, Metro must decide whether to adopt a set of standards for handling and processing electronic wastes to be applied to programs initiated, funded, or otherwise supported by the Metro regional government.
- **Whether to allow the use of prison labor to process collected material.** This practice is common among some e-scrap recyclers. Metro must consider the pros and cons of contracting with service providers who use lower cost prison labor versus private or non-profit firms that do not. This decision has both social and marketplace implications: many private and non-profit entities are unlikely to survive in this industry if the use of prison labor becomes widespread.
- **What environmental and social justice standards to apply to the handling and processing of electronic waste.** This issue has many facets, including the impact of facilities on neighborhoods, the pay scale of workers processing wastes, and the health and safety standards

under which those workers and facilities operate. Again, Metro must decide whether to adopt standards here and what accountability mechanisms are to be put in place.

This report highlights and explains these issues in more detail, but is not intended to resolve them or provide Metro with definitive recommendations. However, given Metro's track record with other waste streams it is clear that the same type of due diligence, standard-setting and contractor oversight that is the hallmark of Metro's HHW program can assure that a standard of social and environmental sustainability can be achieved through the recovery of e-scrap.

II. Current Local Reuse and Recycling Stream: Overview & Needs Assessment

This section of the report presents: 1) estimates of the amount of selected types of obsolete electronic waste that is expected to be generated and/or stockpiled in the Portland Metro region in the near future; 2) a summary of collection and handling services now provided in or available to the region; 3) an overview of processing and end markets for material recovered from the region; and 4) a review of the environmental soundness and sustainability of those services and markets.

A. ELECTRONIC WASTE GENERATION AND STOCKPILING

There is very little available, published data on how much of what type of electronic waste is currently being either generated or stockpiled in the Portland Metro region by small businesses and households.¹ Even less is known about the demand for collection services by these generators and their expectations or desires for what types of services might be provided by the public, private, and/or non-profit sectors. Reports such as DEQ's electronic reports estimate the quantity of electronic equipment in the municipal waste stream. According to this report, electronics are a small but growing fraction of the waste stream. Electronics are, however, such a small fraction of the waste stream at this point that they are difficult to measure with a level or degree of accuracy.

Nonetheless, it is possible to develop some order-of-magnitude planning level estimates, based on experience elsewhere and the data and assumptions published in other studies and reports. These estimates are presented below as ranges, given the uncertainty associated with the underlying data and projections.²

Table 1: Estimated Number of Computers, Monitors and Televisions owned by Households in the Portland Metro Region, for 2000, 2002, 2005, and 2010

Households	Year 2000	Year 2002	Year 2005	Year 2010
Households	569,461	591,408	624,573	674,418
Computers				
Baseline: assume 1.05 per HH	597,934	620,979	655,802	708,139
Faster HH growth (up 2%-5%-10%)		633,398	688,592	778,953
Jump in 1 computer HH (10%)	660,575	686,034	724,505	782,325
Jump in multiple computer HH (1.21/HH)	689,048	715,604	755,734	816,046
Skew top end (+ 0.5 or 1.09/HH)	620,712	644,635	680,785	735,116
Obsolete units accumulated (baseline only)	62,451	285,122	619,127	1,229,679
Monitors				
Baseline: assume 0.928 per HH	528,460	548,827	579,604	625,860
Faster HH growth (up 2%-5%-10%)		559,804	608,584	688,446
Jump in 1 computer HH (10%)	563,766	585,494	618,328	667,674
Jump in multiple computer HH (1.09/HH)	620,712	644,635	680,785	735,116
Skew top end (+ 0.5 or 0.97/HH)	552,377	573,666	605,836	654,186
Obsolete units accumulated (baseline only)	157,741	333,894	598,124	1,081,127
Televisions				
Baseline: assume 2.5 per HH	1,423,653	1,478,521	1,561,433	1,686,045
Faster HH growth (up 2%-5%-10%)		1,508,091	1,639,505	1,854,650
Skew top end (+ 0.5 or 2.62/HH)	1,491,988	1,549,490	1,636,382	1,766,976
Obsolete units accumulated (baseline only)	145,782	552,540	1,162,677	2,277,986

¹ Oregon DEQ Reports: Product Profile: CRTs—Computer Monitors; Televisions; Computers – CPUs, March 2001.

Table 2: Estimated Number of Obsolete Computers, Monitors and Televisions owned by Households in the Portland Metro Region, for 2000, 2002, 2005, and 2010

Households	2000	2002	2005	2010
Obsolete/Stored CPU's	62,451	285,122	619,127	1,229,679
Obsolete/Stored Monitors	157,741	333,894	598,124	1,081,127
Obsolete/Stored TV's	145,782	552,540	1,162,677	2,277,986

The estimates presented in Table 1 project that the number of computers, monitors and televisions owned by households will increase substantially over time. These increases are a function of 1.) population growth, and 2.) varying assumptions about the number of units per household, with different assumptions for different types of households. More detail on these assumptions and calculations is provided in Appendix 1.

Table 2 takes the baseline projections in Table 1 and applies a set of assumptions to develop order of magnitude estimates of the number of obsolete computers, monitors, and televisions owned by Metro area households in the future. As can be seen, these quantities soar between 2005 and 2010, as more and more electronic equipment is assumed to be replaced and become obsolete. The key assumptions underlying these projections are:

1. CPU obsolescence:

- ✓ One quarter of the households with 2 computers have an obsolete unit.
- ✓ One third of households with 3 or more computers have an obsolete unit.

2. CPU replacement:

- ✓ Every 3-5 years, 98% of the installed base of CPU's will be replaced:
 - 95% of those units will be stockpiled or stored for recycling
 - 5% will be disposed or given away for recycling

3. Monitor Obsolescence: every monitor is replaced every 4-6 years³

4. Television obsolescence: televisions have a lifespan of 5-7 years.⁴

These assumptions apply to the estimates for the number of obsolete units expected for the years 2002 to 2010. For the year 2000, estimates of obsolete units were derived using results of studies conducted in California and Massachusetts applied to the number of households in the Portland Metro area. These studies provide data on the electronic equipment owned by households and the number of units stockpiled

² Please see Appendix 1 for documentation of these estimates and projections.

³ California published survey indicate that 19.4% of households stockpile monitors, with 13.9% stockpiling one; 2.9% stockpiling two, and 2.8% stockpiling three or more monitors.

⁴ California research reveals that 18.5% of households stockpile televisions, 13% have one, 3.9% have two and 1.6% have three or more.

by those households. More detail on these studies is provided in Appendix 1. The estimates for the year 2000 may be conservative, in that no attempt was made to “backcast” and account for computers purchased in the 80’s or early 90’s. The analysis assumes an accelerating rate of replacement of old units, particularly between the years 2000 and 2002.

ESTIMATED POTENTIAL DEMAND FOR COLLECTION SERVICES FOR ELECTRONIC WASTE IN THE PORTLAND METRO REGION

It is difficult to predict the potential demand for e-scrap collection services beyond the estimates presented above of the number of units that are expected to be stockpiled as they become obsolete. There are no survey data available for the Metro population providing self-reported interest in such services. King County Washington has conducted such a survey, which is not yet published. Preliminary results reveal that respondents are most likely to donate their used equipment to charity or give it away to friends, rather than recycle or dispose of that equipment.⁵ Experience from collection events reveal that, with effective advertising, between .7% and 1% of a population served will bring old equipment to an event. This figure, however, cannot be interpreted as “potential demand”, rather a typical response rate to a well-advertised collection event.

As more and more households begin stockpiling obsolete computer equipment, demand for collection services will likely grow, the capacity of charities to absorb this equipment will be filled, and more units may be placed in the garbage. More research will be required to better understand potential demand for collection services and evolving consumer behavior regarding obsolete equipment.

B. COLLECTION, HANDLING & PROCESSING SERVICE PROVIDERS

A wide variety of firms and organizations currently provide or are potentially interested in providing collection, handling, and brokering services for electronic waste generated by Metro area households and/or small businesses. These entities can be categorized into four main types:

- **Small businesses (less than 10 employees) that typically refurbish and resell computers**, but are not engaged in collection or disassembly.
- **Non-profit organizations** involved in collecting, refurbishing and reselling whole units as well as disassembly. Portland Metro is fortunate to have some of the leading non-profits based in the region delivering these services with the goals of training unskilled workers in computer recovery and making low cost or free computer equipment available to low-income students, households, as well as to other non-profits.
- **Regional e-waste recycling businesses** engaged primarily in handling and processing of e-scrap.
- **National recycling companies** that provide different types of services, including collection, handling, and shipment to processors. Also included in this category are processors based outside the region who are interested in sourcing from Portland Metro and both solid and hazardous waste recycling firms with national/international facilities who are diversifying into the electronics recycling marketplace.

Appendix 2 provides a current list of these organizations, based on information provided by Metro and supplemented by the consultant team. The consultant interviewed a subset of these organizations as part

⁵ King County Solid Waste Division: unpublished household survey, 2002.

of this project. Appendix 3 presents a summary report on these interviews. Table 3 presents information on the location, core activities and types and quantities of materials collected, handled, and/or processed by the entities interviewed. The results of these interviews were used in part to develop the findings presented later in this report.

Table 3: Summary information on firms interviewed

Business	Location	Core Handling Activities	Materials and Quantities
Computer Drive Connection	Regionally Based Cornelius, OR	<ul style="list-style-type: none"> • Consolidate • Sort • Disassemble 	All electronics From OR and WA : 48,000 electronic units per year, plus 36,000-60,000 monitors per year.
Earth Protection Services	Nationally Based Atlanta Philadelphia Phoenix Texas S. California Local Office Lake Oswego	<ul style="list-style-type: none"> • Collect • Donate functional units to StRUT. • Consolidate • Sell to recycler 	All electronics and fluorescent light tubes Business is primarily lighting (99%). Electronics recycling is about 1% of their business. 12 tons per year from Portland facility which consolidates materials from OR, WA, MT ,ID, AK, ND, SD
Free Geek	Portland Based	<ul style="list-style-type: none"> • Sort • Disassemble • Refurbish • Resell 	All computer parts and monitors. 48,000 units per year from Portland area
GenTech	Portland Based	<ul style="list-style-type: none"> • Sort • Consolidate • Disassemble • Refurbish • Resell 	Accepts all computer parts and monitors. 480 tons per year mainly from WA. Not currently taking material from Oregon.
HMR	Internationally Based Sacramento Los Angeles San Francisco Philippines Australia	<ul style="list-style-type: none"> • Sort • Resale to overseas and domestic markets • Disassemble 	All electronics except microwaves, smoke detectors and ‘white goods’ 3,600 tons of electronics tons per year from CA. Small fraction from OR. New facility: 200-250 tons of CRTs from May 2002 only (CA)
NxtCycle	Nationally Based Phoenix Utah	<ul style="list-style-type: none"> • Collect • Disassemble • Refurbish • Resale (very few) 	Computers, small appliances, TV’s, copiers, fax machines, (everything except large appliances such as washers, dryers, etc.) 120,000 units per year nationwide

Business	Location	Core Handling Activities	Materials and Quantities
Quantum Resource Recovery	Regionally Based Beaverton	<ul style="list-style-type: none"> • Sort • Disassemble • Recycle scrap 	All electronics except CRTs and TVs. 5,400 tons per year materials from Oregon . Of this approximately 2,400 tons are non-disassembled units.
Recycle America	Nationally Based Phoenix	<ul style="list-style-type: none"> • Collect • Sort • Resale (few) • Process/disassemble 	Everything except 'white goods' 20,000-30,000 tons per year nationwide. None from OR or WA in recent years
StRUT	Portland Based	<ul style="list-style-type: none"> • Sort • Disassemble • Refurbish • Reuse in schools 	All electronics <i>except</i> Apple components, and monitors smaller than 15 inches. Approx. 1,000 tons in 2001 from Portland area
Total Reclaim	Regionally Based Seattle	<ul style="list-style-type: none"> • Collect • Sort • Disassemble and recycle scrap to domestic and foreign recycling businesses 	All electronics and appliances Receive from EPA Region 10 states plus Montana. Currently receiving many units from Portland 50,000 monitors per year. 15,000 TVs per year
Western Tech	Regionally Based Vancouver, WA	<ul style="list-style-type: none"> • Resale • Broker 	Computers only at this time From Portland area, 720 tons per year
Ram Turbo Systems	Portland Based	<ul style="list-style-type: none"> • Refurbish (only Pentium 2000 or newer) • Resale • Broker 	A few computers per month from the Portland Area
Simply Marvelous Recycling	Portland Based	No longer recycling electronics	
SJ Nudelman & Son	Portland Based	No longer accepting electronics	
Appliance Recycling – Jaco Environmental	Portland Based	Not currently accepting electronics; only appliances at this time	

C. E-WASTE COLLECTION

CURRENT ACTIVITIES

Electronic waste collection programs accessible to households and small businesses are currently limited to a handful of events and pickup services provided by non-profits, governments, and the private sector. These activities include:

- **Drop-off** – Several regional recyclers, both non-profit and for-profit, collect computers at their facilities. Homeowners, businesses or schools can deliver individual units or truckloads of materials.
- **Pick-up** – Some recycling vendors collect and transport materials from schools, businesses or other sources, and deliver the units back to their facilities. There is usually a minimum load size (or quantity) requirement and customers are usually charged for pick up.
- **Special Collection Events** – Both regional and national recycling businesses have been involved in special collection events in recent years, in the Portland area. These events are sponsored or arranged by municipalities, retailers, and the electronics industry.

To date, these collection efforts have served only a small fraction of the Portland Metro population. The consultant team's best estimate is that approximately 9,000 tons of electronics were collected in 2001 with perhaps 1,000 to 3,000 tons from the residential and small business sectors⁶. The primary drivers for the activities have been:

- The demand by StRUT, Free Geek and the smaller private operators for computer equipment to supply the refurbish market,
- Government and private sector, pilot initiatives, designed to meet perceived consumer needs and test the feasibility of alternative forms of collection.
- Ancillary collections associated with services provided to the electronics manufacturing sector and large businesses.

CAPACITY & EXPANSION POTENTIAL

There is significant potential for expanding collection given: 1) the quantities of obsolete equipment currently being stockpiled and 2) the regional, national, and international capacity for handling and processing this equipment once it has been collected (see sections D & E below). However, research for this project suggests that it is highly unlikely that these collection activities will expand without more extensive government or industry involvement. This is because the broader market for electronic waste is driven by the interest in keeping this material out of landfills and incinerators rather than by end user demand for used equipment and/or recycled component parts and commodities. Prices for these units and materials are low and declining, relative to collection, handling, and processing costs, which are

⁶ This figure includes substantial quantities collected from businesses and institutions. For more detail on these estimates, please see Appendix 2

increasing. Accordingly, firms rely on revenues from front-end collection, handling, and processing fees, (not just end market prices) to make a profit.⁷

In the Metro region, some small operators have stopped collecting computers as the market for refurbished equipment and components has declined, making this business unprofitable. In contrast, the larger recyclers and non-profits are interested in expanding their programs and, therefore, obtaining more material from collection programs. They are looking to the public sector to provide these collection services, either directly or through partnerships with private/non-profit entities.

ENVIRONMENTAL AND SUSTAINABILITY CONSIDERATIONS

As with any material that is recovered for recycling, reuse, or disposal, electronic waste must be collected in an environmentally responsible manner and in way that protects worker health and safety. In general, such concerns related to collection (as opposed to processing) are minimal. However, there is some concern among service providers that monitors once aggregated at a collection site or facility could be considered hazardous waste and regulated as such. Also, safety concerns associated with the weight and bulk of monitors and CPUs must be addressed to ensure compliance with OSHA regulations as well as the health of personnel at the collection site.

D. HANDLING & BROKERING

CURRENT ACTIVITIES

In the Metro region, handling and brokering activities today are limited by the small supply of material being collected. Nonetheless there is a strong, vibrant infrastructure in place to handle computers and monitors for the reuse/refurbish market. In fact, the Portland area benefits from the model programs that have been developed by StRUT and Free Geek to collect, handle, refurbish, and then resell used computers with the goal of educating workers and providing low-cost computer equipment to schools, community groups, and low-income residents. These non-profits, supported in part by industry and government, have been extremely successful in growing their operations and are interested in expanding both regionally and nationally.

In addition to StRUT and Free Geek, a number of local businesses are handling, sorting and brokering used electronics. These include:

- **GenTech** –Resells about 20% of units they receive, mainly to overseas markets.
- **Quantum Resource Recovery**- Approximately half of the units collected (those that are functional) are sold to overseas markets.
- **Western Tech** – Collects and ships functional units to Eastern Europe and Middle East.
- **Computer Drive Connection** – Sorts and sells functional units to other brokers.

⁷ In the case of non-profits, costs are covered by the sale of products, grants, and up-front fees.

While current handling and brokering activities are limited, there appears to be no shortage of firms interested in providing these services in the Metro region. Other firms that have expressed an interest in expanding operations in the Portland region include Total Reclaim, Recycle America, HMR and Earth Protection Services.

CAPACITY AND EXPANSION POTENTIAL

There appear to be no constraints on capacity to handle increased quantities of electronic waste collected from the Portland area, particularly for material that would enter the national and international disassembly and de-manufacturing system. However, there may be constraints on the market for refurbished computers and, therefore, limitations to the handling systems that accept whole units. Also, there are limited markets for, and high costs associated with, handling obsolete monitors that affect the handling system for all electronic waste.

- With StRUT and Free Geek well established in the Portland area, **the local reuse/refurbish market is maturing and capacity for growth is uncertain**. Prices for used computers are low and falling, reflecting both the low cost of new computers and the large supply of refurbished units. The outlets for computers from the two non-profits – primarily local education programs – are likely to be relatively fixed, suggesting that rapid expansion and, therefore, the ability to handle and refurbish additional units may be restricted. On the other hand, some of those surveyed reported that the overseas markets for refurbished computers is “unlimited”, meaning that the potential for expansion is high but with no clear understanding of how those units would be managed at end-of-life. In either case, the relative value of refurbished computers is likely to decline over time, meaning that the non-profits must either rely on a front-end fee for handling and/or more grant support for their activities.
- The other primary limitation of this reuse/refurbish market is that **televisions are not accepted**; only computers and monitors.
- **For the disassembly market, capacity is virtually unlimited for regional and national firms to handle e-waste collected from the Metro area**, consolidating that material and then shipping it to processing facilities located outside of the region. Firms contacted for the survey are interested in expanding their operations in the Northwest, provided that there is a reliable supply of electronic equipment and that regulatory barriers are overcome. Obsolete equipment handled by these firms is then shipped to processing facilities located nationally or overseas.

ENVIRONMENTAL AND SUSTAINABILITY CONSIDERATIONS

Service providers involved in handling electronic waste must adhere to all federal, state, and local laws for environmental protection and worker safety. Performance in relation to these laws can be monitored, given that the handling takes place locally. Key environmental and sustainability issues at the handling stage of the supply chain are:

- **Application of the hazardous waste regulations** : service providers are unclear when and how hazardous waste regulations apply to the handling (as opposed to processing or end manufacturing) of electronic wastes. Companies interviewed reported that this uncertainty has limited their involvement in the region. The adoption of an interim CRT rule by the Oregon DEQ may allow a regulatory system that encourages recycling. This rule allows CRTs that are destined for recycling to be excluded from hazardous waste regulations. This rule may allow for

the collection of more material at less cost with improved environmental performance. The rule will be reviewed in the coming months to see if it is achieving these purposes.⁸

- **Accountability for downstream processing and markets**: Handlers and brokers ship electronic waste to global markets for processing. Accordingly these companies are often the main point of contact with the processors and production facilities whose environmental practices may be in question. The handlers are not required at this time to know what happens with those wastes or to certify that those materials are processed in an environmentally responsible manner. However discussions are occurring at the national level about establishing some type of accountability protocols for handlers.

E. PROCESSING

CURRENT ACTIVITIES

Most of the recycling businesses interviewed process electronic materials into scrap⁹. While there is a small market for refurbished or used computers, the majority of units collected for processing are disassembled for scrap. Because of fluctuating markets for scrap materials, businesses may select markets for scrap that are outside of the Portland region, or send material to overseas scrap markets. Metro Metals, located in Portland, is one of the largest Portland-area markets for scrap materials from e-waste recycling. One of the largest processors of CRTs in the Northwest is Total Reclaim, located in Seattle. However, many of the processors interviewed do not sell monitors or other materials to Total Reclaim. High costs associated with transporting and reluctance of the public to pay for recycling monitors, has limited the flow of Portland CRT's and other electronic waste materials to Total Reclaim for processing.

Current local and regional processing activities identified through the survey consist of the following:

- **StRUT and Free Geek** – These non-profit organizations rely on volunteers and students to disassemble non-functional materials for scrap metals, plastics and other components. All materials go to local and regional markets.
- **Quantum Resource Recovery** – Disassembles and sells scrap to local and overseas markets.
- **Computer Drive Connection** – Disassembles with all materials processed domestically through Metro Metals and High Tech Now.
- **High Tech Now** – Disassembles and sells scrap. Closed recently due to fire, but plans to reopen in next few months.
- **GenTech** – Disassembles; all materials are processed in Texas.

⁸ This report does not address regulatory issues in detail. In addition to the rules promulgated by the Oregon Department of Environmental Quality, draft US EPA rules need to be considered to gain a more comprehensive understanding of the regulations that are and will be affecting the handling, processing, and disposal of electronic wastes.

⁹ "Scrap" consists of components and materials resulting from the disassembly of electronics, including metals, plastics, glass, wood and other materials.

In addition to the regional processors interviewed, four national firms were interviewed that do not have a local processing facility. Recycle America, Earth Protection Services, HMR, and NxtCycle report disassembling a total of 20,000 to 30,000 tons per year at facilities located throughout the world.

CAPACITY & EXPANSION POTENTIAL

There is potential for the existing regional firms to expand their processing capacity and new firms to construct facilities in the region provided that: 1) there is adequate supply; 2) companies receive certainty about the regulatory framework under which they will be operating; and 3) specific material and market bottlenecks are overcome.

- **Capacity for disassembly and de-manufacturing in this region is limited**
- **Total Reclaim, GenTech, StRUT, Free Geek Computer Drive Connection and Quantum Resource Recovery are interested in expanding their processing capacity.** These facilities report that the primary factor limiting their operations is the difficulty in finding viable markets for either whole monitors or, in the case of Total Reclaim, the leaded glass that is recovered from those monitors. These operators need either an environmentally sound export market or a US-based lead smelter that can process these materials.
- **The national firms interviewed provide assurances that they do have adequate capacity outside the region to process Metro's electronic waste.** They have not committed to locating processing capacity in this region. However, they indicate a strong interest in expanding their Northwest operations in response to the perception that Northwest communities will be leaders in implementing collection programs. However, these national firms are reluctant to establish facilities in the Northwest until future material volume can be predicted.
- As discussed above, **the capacity for expansion of the refurbishing market is ultimately constrained by the size of the reuse market and prices for refurbished units.** The two non-profits interviewed are highly interested in expanding their operations and report being constrained by volunteer labor, access to capital and viable options for handling monitors.
- The impact of the recent fire at High Tech Now on regional processing capacity has not been determined. It is likely that materials they handled and processed will be shipped to Total Reclaim or to facilities elsewhere in the western United States.

ENVIRONMENT AND SUSTAINABILITY CONSIDERATIONS

E-waste contains a variety of hazardous and toxic elements including lead in glass monitors, heavy metals in CPUs, and brominated fire retardants in plastic casings. Consequently, processing of electronic waste can be hazardous to both workers and the environment in the absence of adequate facilities, safeguards, or standards. The recent film by the Basel Action Network graphically documented the abuses that may be prevalent at "processing" centers located in Asia. The film documented that many obsolete electronics recovered for recycling are, in fact, not recycled but dismantled and dangerously discarded in waterways, in the streets of remote villages, and/or the countryside.

The key environmental, health, and safety concerns associated with processing e-waste are as follows:

- **Worker safety.** As with many recycling facilities, e-scrap processing facilities can have a variety of worker safety issues, including air-quality concerns over dust from CRT's and the size-reduction of plastics.

- **Improper disposal abroad.** As illustrated in the aforementioned report, there is a problem with the dumping of e-waste abroad.
- **Capture of heavy metals in CRT's.** The lead contained in CRT's is an ongoing environmental concern. Assuring that the methods of processing and recycling CRT's are able to contain and capture this lead is a critical factor in evaluating CRT recovery systems.
- **Plastic additives and impact on recycling process/persistence.** There has been a great deal of concern in Europe over the persistence of certain additives that are contained in e-scrap plastics, mostly brominated fire retardants (BFR). However, there are a number of classes and types of BFR's and not all appear to have the same performance, and therefore environmental concerns. The performance and impact of BFR on recycling is still unclear. At least one OEM reports preferring BFR-containing post-consumer plastics for recycling.¹⁰

F. PRODUCTION – END MARKETS

This section of the report provides a brief summary description and assessment of end markets for the different types and components of the electronic waste stream (the production end of the supply chain). While such an assessment was not an explicit element of the scope of work of this study, this overview provides an understanding of the ultimate disposition of the primary electronic wastes likely to be recovered from Portland area businesses and households.

Whole Units

- **Central Processing Units (CPUs):** There remains a relatively strong demand for working or repairable late model computers for the refurbish market. This demand in the Metro region is presently being met and serviced by FreeGeek and StRUT. In addition, this demand allows for the reuse of individual components – drives, video cards, memory – from older computers that may not, as a whole unit, be acceptable for a reuse opportunity.
- There is a severely limited demand for older models. The biggest reuse opportunity that exists for this equipment is to be cannibalized for valuable parts and components.
- **Monitors :** There is a demand for working or repairable late model monitors. While specifications may vary, usually it is for SVGA, 15" or bigger. There is a limited demand for small screens and no demand for monochrome monitors.
- **Television sets:** Demand for refurbished TVs is minimal. There may be some possibility for Metro to access the capacity to disassemble TVs now being established by Total Reclaim as part of a project being undertaken for King County and the City of Seattle. Handling and processing costs are, however, likely to be high.

COMPONENT PARTS AND COMMODITY MATERIALS

- **CPU components :** Computers can be de-manufactured or shredded to recover the component parts. If the equipment is shredded, a series of magnets and other methods are used to separate the metal from non-metallic components and then further classify the metal components. De-

¹⁰ Source: Consultant team interview.

manufacturing recovers a broad stream of materials including: chips, power supplies, wiring, metals (precious, ferrous and non-ferrous) and plastics. Commodity prices for the component parts of a CPU have declined over times and this material is not as valuable as it once was. However, this material is still readily marketable in the global marketplace. Currently, domestic markets for much of this material are limited.

- **Monitor glass:** The market for glass-to-glass recycling (turning a cathode ray tube screen (CRT) back into a CRT) is both limited and growing. The market is limited because there are only two firms currently processing glass in this manner in the country, and these firms can charge anywhere from \$.12 - \$.40/lb to take scrap monitor glass, not including transportation costs. It is growing because one of the firms (affiliated with Panasonic) recently announced a technical breakthrough that allows them to utilize a higher percentage of post-consumer content in making new tubes.¹¹ Glass-to-glass recycling is the preferred method of dealing with old monitors as this reprocessing represents the highest and best use of the glass, with no down-cycling and the lead stays in the glass. There are no technical constraints on utilizing recycled glass to make new glass. The economics can also be viable with enough of a front-end fee.
- The other domestic market for glass from monitors is smelting. Here the glass is used as a fluxing agent in primary or secondary smelters. It provides a source of lead and helps reduce in-stack pollutants with the glass from recycled monitors as a substitute for calcium carbonate. Any primary or secondary lead smelter can take such glass. However, there are only a few in the US. One major end user of this glass, Doe Run, based in Missouri, is rumored to be in financial difficulty. This development creates a degree of instability in the marketplace that, combined with the lower value and decreased environmental performance, means that this is not the preferred market for this material. However, it remains a potential secondary market for monitor glass.
- **Plastics:** Markets for plastics from disassembled computers, monitors, TVs and other electronics are extremely limited. This material is, in fact, considered by many to be the most problematic component of the electronic waste stream. Challenges to recycling include the presence of fire retardants, the incompatibility of and difficulty in separating different types of plastics resins used in electronic products, and the presence of contaminants such as hot-glues and water insoluble or non-removable fasteners. The limited processing infrastructure for this material, expensive processing lines and a limited demand for a narrow spectrum of the potentially recoverable resins combine to make recycling this material extremely challenging. Some processing of this material is taking place overseas. The rest ends up being disposed or as a feedstock in waste to energy facilities.
- **Metals:** Scrap metals recovered from electronic waste processed in the Northwest typically are processed into commodity metals by local firms including Metro Metals, Pacific Iron and Metals, and Schnitzer Steel and Hallmark Refining Company, as well as other smaller metals recycling businesses.

EXPORT MARKETS

- Export markets currently accept all types of electronic waste from whole units, to components, and processed commodity glass, metals, and plastics.

¹¹ For more information, please see the Panasonic press release, found in Appendix 6.

- The reuse and refurbish market is truly international in scope, with end markets on all major continents. One firm interviewed considered this market unlimited, with strong demand in particular, in the Middle East and Eastern Europe.
- With the publication of “Exporting Harm: The High-Tech Trashing of Asia” by the Basel Action Network and the Silicon Valley Toxics Coalition the issue of exporting e-scrap has been raised to a national level. This report documents the hazards of irresponsible dumping of e-scrap by recyclers and brokers. However, it is incomplete to view the export market for e-scrap only from the perspective presented in the report. The export marketplace is highly variable – consisting of a spectrum of practices including those described in the report, legitimate mission-driven organizations that repair and refurbish e-scrap, and state-of-the-art recycling facilities. The challenge in utilizing the export market for e-scrap lies in identifying and documenting exactly what happens with those materials.
- It is also important to note that Basel Action Network report documents the hazards of exporting whole electronic units. It does not address the practice of exporting component or commodity parts from electronics. In fact, much of the material that is capable of being recovered from e-scrap, notably the copper and many of the computer chips, have large and vibrant export markets, in contrast to limited domestic demand.
- Capacity is a difficult term to define in the export market. While there is a directory of “North American Electronics Recycling Industry”, no such directory exists for the global market. It was beyond the scope of this project to determine the size of the export market for electronics relative to domestic markets. However, it is common practice for electronics recyclers to impose a per-pound fee or surcharge if a client insists on utilizing only domestic markets. This surcharge ranges from \$0.10 - \$0.25 a pound.
- Consequently, the export market for electronic waste is, at this point, problematic. One firm interviewed (HMR) reported operating their own facilities overseas, allowing for internal control and monitoring of facility operations. However, much – perhaps most – of the export market is completely unregulated. Abuse may be rampant and specifications and standards may be needed to ensure socially and environmentally responsible processing and production.

III. Gap Assessment: Key Findings

This section of the report presents the consultant team's findings on the ability of the electronic waste infrastructure and marketplace to absorb new materials collected from households and small businesses in the Metro region, with a particular emphasis on identifying bottlenecks. The analysis distinguishes between the local infrastructure, over which Metro can exert some control, and the regional and national infrastructure, where Metro has much less influence. The assessment also addresses regulatory and environmental issues associated with handling and processing of electronic wastes.

Figure 3 graphically summarizes these issues in terms of a snapshot assessment of capacity and service availability at different points in the supply chain. Elements of the supply chain highlighted in red are areas where the consultant team concluded that gaps exist. Supply chain elements depicted in green are places where capacity and/or services are considered readily available. Finally elements depicted in blue are activities where some services or capacity are in place, but limitations and constraints exist as well.

ORDER OF MAGNITUDE ESTIMATES OF COLLECTION SERVICE SUPPLY AND DEMAND GAP

The consultant team estimates that in the year 2000 there were approximately 366,000 units or approximately 5,670¹² tons of obsolete electronic equipment (monitors, TVs and other electronic equipment) stockpiled by Metro area households¹³. Research suggests that perhaps 1,000 –3,000 tons of material were collected last year from the residential sector, leaving a gap of about 2,670 to 4,670 tons. As Table 2 indicates, the supply of obsolete equipment is expected to grow significantly while the quantity of waste collected is unlikely to increase substantially, without government or industry involvement. Thus the likely "demand" for effective management of electronic waste is likely to grow. If not met, much of this material will either end up in the landfill or will be stockpiled at homes for years to come.

CURRENT AND PROJECTED GAPS IN COLLECTION SERVICE, WITHOUT METRO ACTION

As was discussed in Section IIC, collection services are now limited to: ancillary activities associated with large business recovery programs, pick-up and drop-off services associated with the refurbish operations of StRUT and Free Geek, experimental private industry collection events, and a few small-scale government sponsored programs. The consultant team concluded that these services are unlikely to expand significantly, without involvement of government or the electronics industry.

AVAILABLE SERVICES IF COLLECTION PROGRAMS ARE INITIATED BY METRO

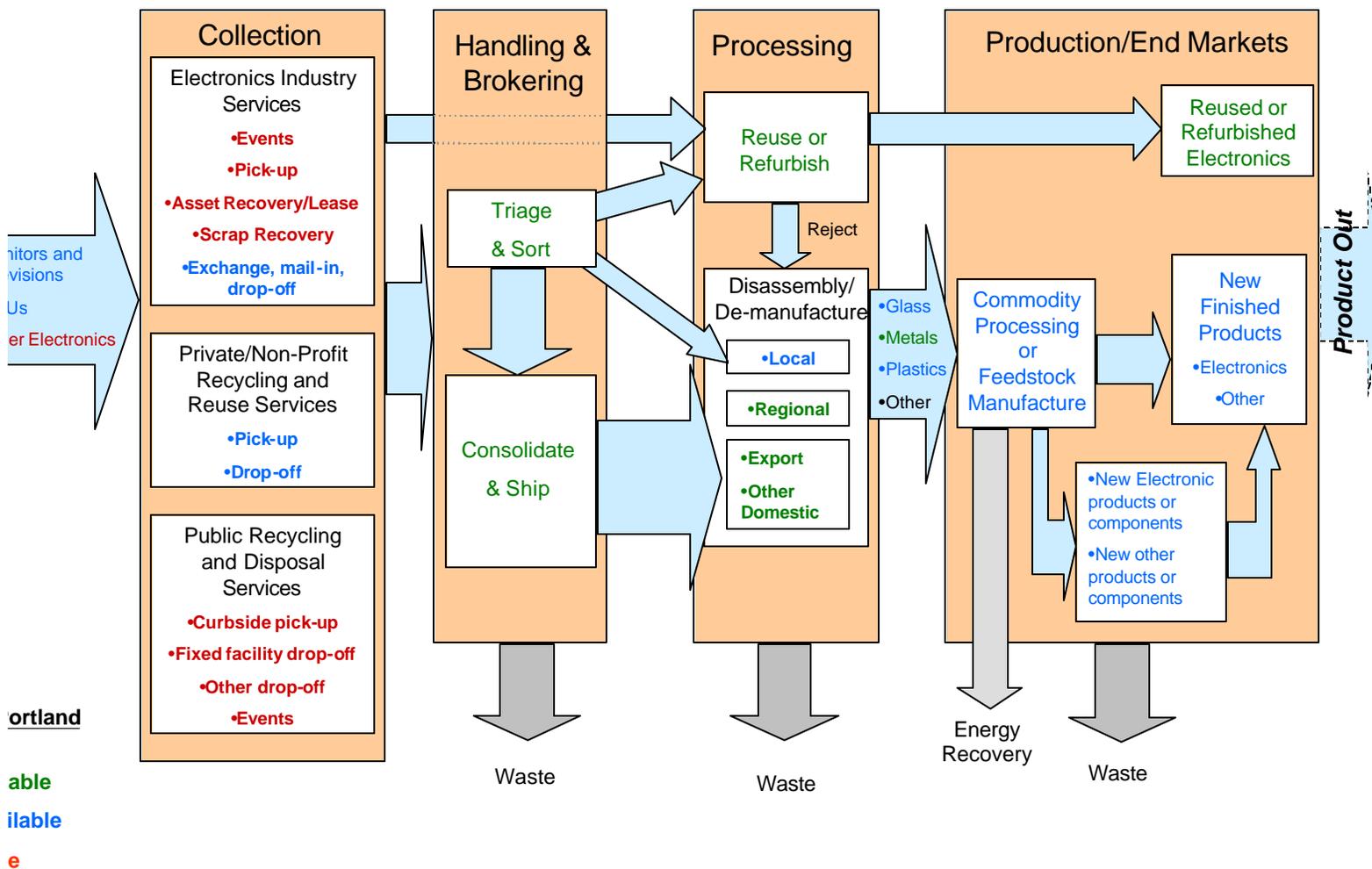
If Metro were to implement expanded collection of electronic waste, the consultant team concluded that several critical services *are* available, with no constraints or limitations:

¹² This number is calculated using the following assumption: the average weight per unit of monitors, CPUs and TVs is approximately 31 pounds. The number provided here is a rough estimate of the tonnage stockpiled. Actual values will vary depending on the number of monitors, CRTs and TVs within each household.

¹³ Given resource limitations, no gap estimates were developed for the small business sector.

- There are a number of firms with proven experience who can provide event collection and material handling services on request. Several of these firms are local; others are national but with some kind of local or regional presence.
- These and other firms can also provide handling services: consolidation, sorting, and shipping of collected equipment to national or international processing facilities.

Figure 3: E-Scrap Flowchart – Capacity and Service Availability



PROJECTED GAPS AND BOTTLENECKS WITH EXPANDED COLLECTION INITIATED BY METRO

There are several gaps and bottlenecks that would or could emerge if collection programs are initiated:

- If all of the collected electronics were delivered to the existing local reuse/refurbish market, these operators would likely be overextended, and without assistance, unable to process or market all the materials collected. Local end markets for refurbished computers could be saturated. Disassembly markets would still need to be located for monitors and televisions.
- Regional processing facilities also could have difficulty processing all the collected material, depending, of course, on the quantity and type of equipment received.
- There could be limitations on environmentally sound processing and markets for monitors and televisions. Also, much of the plastics could end up as feedstock in waste to energy facilities. Given the challenges associated with marketing some materials, service providers may charge a premium when environmental standards (such as “no exports”) are included as part of a bid process.

LIMITATIONS AND CONSTRAINTS ASSOCIATED WITH CHANGING REGULATIONS

The market research conducted for this study suggests that uncertainty associated with hazardous waste rules and how electronic wastes are or will be regulated has deterred some operators from expanding facilities and services in the region. Several service providers expressed concern that they are unsure what rules will apply when, and whether and if regulations will change over time. They do not want to invest in facilities and operations under one set of regulations only to have them revised in the future. The bottom line: service providers want clarity and certainty regarding how the hazardous waste rules apply to electronic waste from households and small businesses and to material that must be disposed as a by-product of a recycling operation.

POTENTIAL IMPACT OF THE NEPSI PROCESS ON METRO INITIATED COLLECTION PROGRAMS

Over time, the National Electronic Product Stewardship Initiative (NEPSI) process is expected to lead to a financing mechanism to pay for the cost of electronic scrap recovery. This process will also delineate roles and responsibilities of industry and the public sector in environmentally sound management of this new waste stream. Over the next 12-18 months, the impact of NEPSI on local collection programs is likely to be indirect. For example, there may be increased coordination with industry to organize collection events and share data on the results of those events. The NEPSI process is expected to result in a set of protocols and frameworks for municipalities to follow in managing electronic waste. Metro may wish to consider these as it moves forward with its approach.¹⁴

¹⁴ This report does not address or explain the NEPSI process in detail. Scott Klag of Metro is participating in this effort and can provide additional information as needed by Metro management. Information on NEPSI and the Western Electronic Product Stewardship Institute (WEPSI) can be <http://www.recyclingadvocates.org/wepsi/>

POTENTIAL FOR INCREASED FLOWS TO BE HANDLED IN ENVIRONMENTALLY RESPONSIBLE MANNER; INCREMENTAL COST ASSOCIATED WITH SUCH PRACTICES

The potential is high for e-waste to be handled and processed in an environmentally responsible manner, given that there are facilities located nationally and internationally that can and do meet emerging WEPSI and NEPSI standards. However, this potential must be qualified by the fact that there are many unknowns about the actual capacity of the market to process in an environmentally acceptable way all different types of electronic wastes, especially plastics and monitor glass. It is also important to consider the potential impact of many communities across the country all beginning to collect electronic waste in the same general time frame and all setting a high environmental standards (such as no export of e-waste). Under this scenario, **the environmentally preferred supply chain could become overloaded, with bottlenecks emerging for selected materials.**

The incremental costs associated with environmentally sound processing are also hard to pin down. Currently, many service providers offer a “domestic only” option (which does not necessarily mean environmentally sound). The price differential for this option typically ranges from \$.15 - \$.25/lb, often doubling or almost doubling the price.

Additional research is needed here to more completely address these questions. Such research could be both extensive and expensive, with a great deal of uncertainty associated with the findings, given the rapidly changing marketplace. While Metro may be able to look to others that are addressing this issue, it will, at some point, need to decide what standards to apply and whether to develop its own or rely on other third party standards.

Recommendations are provided in Section V on how best to address and overcome this uncertainty.

IV. Collection Options

This section of the report provides an overview and rapid assessment of the potentially feasible options to collect electronic waste from households and small businesses. The overview is intended to provide Metro decision makers with an understanding of the potential participation, costs, and recovery levels associated with the different options and the advantages and disadvantages of each option. The data and findings presented in this section are based on a review of published and unpublished reports on both private and public sector collection activities that have been undertaken to date.

A. SUMMARY OF OPTIONS

The consulting team developed, in cooperation with Metro staff, a list of collection options to analyze and consider. This list is as follows:

1. **Retail-based collection.** These options included special event collection, drop-off facilities (on-site or in-store) and a one-for-one exchange at the time of purchase.
2. **Original Equipment Manufacturer (OEM) sponsored collection.** These options included mail-back programs and lease options.
3. **Electronics Re-Use Recycling Service Providers.** Drop-off locations were considered.
4. **Recycling and Disposal Services (public and private).** Options considered include e-scrap collection events, multi-material collection events that include e-scrap, staffed and un-staffed drop-off locations and curbside collection.

The consulting team analyzed each of these options consisting of the following factors:

- **Cost.** Where possible the consulting team identified what real cost figures existed. However, there are several problems with comparing cost information including use of cost ranges instead of actual dollars and not knowing what expenses are included in reported costs. As a result, the consulting team focused the cost analysis on real world recycling costs from existing service providers.
- **Participation.** This figure is usually reported as either the number of participants/tons collected by a program or as a percentage of population served, usually by county.
- **Advantages.** These were drawn from existing reports and program summaries but also discussion with Metro staff.
- **Disadvantages.** See above.
- **Regulatory Issues.**

B. ASSESSMENT OF OPTIONS

PUBLIC ORGANIZED COLLECTION EVENTS

Collection events are a very common method to collect e-scrap. They are often an “e-scrap only” event but can also be conducted in conjunction with bulky waste, HHW or other waste collection events. These

events can and are organized by a variety of organizations including state and local government, retailers, and non-profit agencies. The advantages and disadvantages of collection events are listed in the table below.

Table 4 Advantages and disadvantages of collection events.

Advantages	Disadvantages
Reduces overhead and fixed costs;	Can be overwhelmed and cause long-delays for citizens;
Can increase economies of scale;	Could cause challenges and bottlenecks if implemented in conjunction with other event services (e.g. HHW collection)
Tends to be held in easily accessible locations;	Require citizens to be aware of the event and store material until the event;
Offers citizens a chance to dispose or recycle of all their electronics at once,	Do not offer a continual opportunity for recycling; and
Is a familiar waste collection option for citizens;	The success of an event (as defined by amount of material collected) is contingent upon ongoing and effective advertising.
Can be held at a variety of locations to increase accessibility for populations being served; and,	Can be overwhelmed and cause long delays for citizens;
Can easily be scaled up or down depending upon anticipated participation.	Could cause challenges and bottlenecks if implemented in conjunction with other event services (e.g. HHW collection)

Events are usually easily permissible under existing regulatory frameworks, especially when organized by government. However, local regulations regarding traffic, signage and other considerations need to be considered also.

DROP-OFF COLLECTION AT FIXED FACILITIES

Drop-off collection at fixed facilities is also a very common method of collecting electronics. Typically, fixed facilities are ongoing recycling operations, such as transfer stations or HHW stations – some building that already provides a waste-related function. But that need not be the case and the facilities could include retail locations and non-profit agencies. The advantages and disadvantages of collecting at fixed facilities are listed in Table 5.

Table 5. The advantages and disadvantages of collecting at fixed facilities.

Advantages	Disadvantages
Provide the public with a near continual opportunity to recycle e-scrap and reduce the need to store the material;	Adds fixed costs to the program;
Aggregate the material centrally;	Electronics collection may compete with or crowd out other existing functions and space;
Provide a new service at an existing facility; and,	The facilities are not always centrally located;
“Small business drop-off” days can be provided with little regulatory difficulty.	Require storing substantial material on-site until collection, and transportation to a processing center, and
	Can entail use of “milk run” pick-up of small loads

The regulatory considerations for drop-off programs are dictated by where the material is dropped off. If the facility is an existing waste facility, most likely they are now or can be easily permitted to serve as a collection and aggregation facility. However, if the facility being utilized is not currently a waste facility

there may be concerns over the collection, aggregation and storage of e-scrap – particularly if the facility is a for-profit, non-waste related facility.

CURBSIDE COLLECTION

Curbside collection of e-scrap, particularly including it as part of existing bulky waste collection systems, is becoming more common. While few, if any, curbside programs allow residents to put e-scrap out with their cans, bottles and paper, the collection of e-scrap at the curb is becoming more common. While these programs appear to be growing, published data is still relatively limited. However, the following advantages and disadvantages seem clear. The advantages and disadvantages are listed in Table 6:

Table 6. The advantages and disadvantages of curbside collection.

Advantages	Disadvantages
Curbside is an accepted, familiar method to collect material;	Service is expensive on a per unit and per ton basis;
Offers regular, reliable opportunity to all consumers;	Discrete storage space/facility is required at the MRF;
Can provide regular, predictable supply of material to support local programs;	High-volume participation could overwhelm the system;
Limited effort is needed for consumer to participate; and,	
Can build upon existing bulky waste curbside programs.	

There do not appear to be any regulatory concerns regarding curbside collection of e-scrap. However, as with the concerns regarding facilities for drop-off facilities, there may be regulatory considerations for the materials aggregation and storage facility.

MAIL BACK PROGRAMS

Several OEM’s offer mail-back programs for e-scrap. Uniformly, they require the consumer to take extensive action to prepare and mail the material. The OEM then contracts with a service provider to recycle the material. The consulting team could find no publicly available data on the performance of these programs but offer the following advantages and disadvantages based on their expertise and knowledge. Advantages and disadvantages of a mail-back program are provided in Table 7.

Table 7. Advantages and disadvantages for mail-back program.

Advantages	Disadvantages
Available year round;	Requires substantial consumer awareness and initiative to participate;
Usually brand-blind;	Tend to be expensive;
Will accept broad range of equipment; and,	Not well-publicized;
OEM-sponsorship can increase consumer acceptance.	No programs for TV’s.

RETAIL BASED EXCHANGE

Also considered was a retail-based one-for-one exchange at the time of purchase. Last Spring, Staples, an office-products store, offered an exchange program. There is no publicly available data on this program but the consulting team again brought its experience and knowledge to bear to develop a list of advantages and disadvantages. Advantages and disadvantages of retail-based exchange are listed in Table 8.

Table 8. Advantages and disadvantages of retail-based exchange.

Advantages	Disadvantages
Direct connection between the point of product distribution to the consumer and recycling;	Does not address issue of backlogged/stored material effectively;
Limits consumers need to store material;	Requires substantial consumer planning;
Convenient retail locations;	Impulse purchasing limits participation;
	E-tailer participation not clear;
	No existing programs.

The regulatory framework surrounding this program is still unclear. If this was a permanent collection option, it may put retail locations under certain hazardous waste collection and storage regulations, especially if they accept e-scrap from businesses.

LEASING

Finally, the consulting team considered the use of leased equipment that is returned to the OEM upon the expiration of the lease. Many OEM's currently offer such a program, for both individual and institutional customers. Acceptance at the individual consumer level is not clear though many institutions use a lease-system. Advantages of this system are:

Advantages	Disadvantages
Provides ready system and financial incentive for consumer to return product;	Seeming consumer preference to purchase than lease;
Recycling/return of machine is directly linked to acquisition;	Lack of lease options at bricks-and-mortar retail stores;
Direct OEM role in return of equipment;	Only applicable to computers, not TV's.
	Requires fundamental change in consumer buying habits to institutionalize.

There are no regulatory concerns regarding a lease option on computers or other electronic items.

C. ORDER OF MAGNITUDE ESTIMATED COST OF COLLECTION OPTIONS

Table 9 below provides initial estimates of the costs of several of these collection options. Assumptions of unit costs and per unit recovery in pounds per event and location were based on the expertise of members of the consultant team. Low and high level cost estimates were developed, providing a range of costs per event from about \$5,000 to as high as \$16,500. Annual costs for a drop site range from a low of \$250,000 to a high of \$1.3 million. The wide range between the high and the low estimates suggests the need for additional research, particularly tracking and analyzing the experiences of recent collection programs to derive estimates for Metro that have a higher level of certainty.

Table 9. Collection System Cost Estimates.

<i>Costs per event</i>	<i>Pounds per event</i>	<i>Low cost per pound</i>	<i>Low cost per event</i>	<i>High cost per pound</i>	<i>High cost per event</i>
CPU's	7,875	\$ (0.05)	\$ (394)	\$ 0.12	\$ 945
Monitors	10,500	\$ 0.10	\$ 1,050	\$ 0.40	\$ 4,200
Televisions	11,813	\$ 0.10	\$ 1,181	\$ 0.45	\$ 5,316
Fixed event costs			\$ 3,000		\$ 6,000
Total event costs			\$ 4,838		\$ 16,461
<i>Costs per Drop-off Site</i>	<i>Pounds per location*</i>	<i>Low cost per pound</i>	<i>Low cost per location</i>	<i>High cost per pound</i>	<i>High cost per location</i>
CPU's	990,000	\$ (0.05)	\$ (49,500)	\$ 0.12	\$ 118,800
Monitors	1,320,000	\$ 0.10	\$ 132,000	\$ 0.40	\$ 528,000
Televisions	1,485,000	\$ 0.10	\$ 148,500	\$ 0.45	\$ 668,250
Fixed drop-off costs			\$ 18,996		\$ 18,996
Total costs per drop-off			\$ 249,996		\$ 1,334,046
*assume 5.5 tons/month					

V. Recommendations

This final section of the report presents recommendations formulated by the consultant team related to how Metro could proceed with managing e-waste in the region. Figure 4, found at the end of this section, graphically presents these recommendations as they apply to the major links in the supply chain.

A. RECOMMENDATIONS FOR ADDITIONAL RESEARCH

This report has revealed several areas where facts and data are incomplete or uncertain. Areas for further research and analysis to be conducted so that Metro staff and management will have a more conclusive understanding of the electronic waste marketplace include:

- **Conduct surveys to better understand the demand for collection services from households.** A logical next step for Metro would be to survey its residents to determine: 1) self-reported quantities of obsolete equipment stockpiled and current handling methods; 2) the level of interest in collection services by residents from different demographic segments and with different quantities and types of stockpiled equipment; and 3) the type of collection services these residents would prefer to see offered by Metro. This direct feedback from Metro's customers would be extremely useful to gauge the level of perceived demand and establish the type of services to be provided by Metro. The King County Solid Waste Division in Washington conducted a similar survey in their service territory, which has been used for program design.
- **Conduct additional analysis to better determine the quantity of electronic equipment stockpiled in the Metro region.** The estimates developed for this report are preliminary and could be further refined to provide more accurate projections of stockpiled wastes from the household sector as well as the business sector.
- **Conducting surveys and analyses to better quantify the amount of electronic waste generated, stockpiled, and currently disposed by Metro businesses.** There is very little published data on this issue that seems verifiable or rigorous in its methods. If Metro is to design a system to recover e-scrap, sourcing material from the business sector can dramatically increase the quantity and quality of recovered material. Accordingly better knowledge of the small business generator will be useful to the effective design of the new program.
- **Conduct more in-depth research into, and ongoing monitoring of, the processing and production segments of the supply chain to further understand the capacity of these markets to handle material in an environmentally sound manner.** The findings and conclusions related to environmentally sound markets are tentative, based on secondary research in this rapidly changing marketplace. With the focus on e-scrap recycling growing, the pressure to collect and process the material will increase accordingly. This pressure may lead to real improvements in the system and, it is hoped, spur an increase in utilizing the scrap generated by the programs. Alternatively, capacity could grow more slowly than demand, if processors are squeezed by unfavorable economics and end markets. Metro will need to understand the underlying drivers for this market and follow the changes, in order to be able to ensure that processing of waste collected from Metro meets established standards.

B. RECOMMENDATIONS FOR ENSURING ENVIRONMENTALLY RESPONSIBLE MANAGEMENT OF ELECTRONIC WASTES

As discussed in the main sections of this report, environmentally sound and sustainable management of electronic waste is possible but not a given, with many variables determining where and how material is processed and then managed at the end-of-life. Metro can have significant influence over what happens to electronic waste collected from its customers, but must establish its policies and standards prior to initiating any collection activities. Also, as a leader in this field, Metro's actions and decisions will influence others and may affect the entire marketplace. **Therefore, the consultant team recommends that Metro formally adopt a set of environmental and sustainability standards for the handling, processing, and end-of-life management of electronic wastes. These standards should be clearly delineated and include a mechanism for accountability, such as third party certification.** Once adopted, the standards can then be included in bid or RFP documents for collection and handling services.

In addition, the consulting team cannot foresee a long-range solution to e-scrap recycling that does not utilize and incorporate responsible overseas markets for material. The challenge to Metro staff is to be able to identify and document those responsible markets and to avoid false dichotomies such as import versus export. Potential initiatives include:

- **Using Metro's position as a visible national leader to help establish a market-direction.** Therefore, establish a framework that is both verifiable and can be documented, but also provides clear guidance to service providers as to what is expected.
- **Be willing to pay for compliance with standards, but don't let standards dictate price.** It will likely cost more to have electronic recycling programs adhere to environmental and sustainability standards. Therefore, Metro will need to be willing to pay a reasonable premium for superior performance. However, Metro should watch out for service providers who charge a huge mark-up for compliance with standards. Such a mark-up would probably indicate that the regular services of this service provider (without the standards) are well below minimum requirements for environmentally sound handling and processing. In short, the standards should be a factor in the price paid for recycling services, but should not be the only, or even most significant, factor driving the price.

C. RECOMMENDATIONS FOR MANAGING E-WASTE COLLECTION

Metro faces a "decision tree" with three main choices related to collection of electronic waste from households and small businesses in the region. Metro can:

- 1) **Do nothing** – waiting for the NEPSI process to resolve itself and letting the private and non-profit sectors provide market-driven collection services. If Metro adopts this course of action, we expect that more and more electronic waste will be disposed and the current service providers will be unable to meet the likely demand for collection.
- 2) **Partner with non-profits and/or the private sector to expand collection currently offered by those service providers.** This course of action would provide residents and businesses with more outlets for their electronic wastes, but would require the development of partnership agreements and funding mechanisms to pay for expanded services.
- 3) **Provide direct collection, using the public sector infrastructure such as curbside, drop-off at fixed facilities, or special collection events.** This approach would provide Metro with the most

direct control over the type, scope, and quality of services delivered, as well as the ability to determine where the collected material is processed.

The consultant team recommends that, if Metro is interested in rapidly and efficiently providing expanded collection services to its residents and small businesses, that the organization initiate direct collection, using a mix of public sector facilities and private or non-profit sector service providers to deliver services. Recommended next steps towards implementing a collection program are as follows:

Consider providing the following services, at a minimum:

- 3-5 collection events per year dispersed throughout the Metro territory
- Collection at selected fixed facilities.
- This level of service represents a start towards a comprehensive collection service for Metro residents and small businesses. With available resources, these services can easily be expanded or contracted, based on actual demand and costs.

Issue a “Faux Bid” preliminary RFP to obtain market estimates of the costs and estimated recovery levels for different types and levels of service. A faux bid RFP will allow Metro to obtain relatively accurate cost and quantity estimates from interested service providers. Through this process, Metro should be able to decide on:

- The types and levels of service to offer
- The frequency of that service
- Current costs associated with environmental standards to govern handling of all materials collected
- Based on responses from interested service providers, Metro should also be able to clearly identify cost centers and make changes to its services to fit within available budgets.

Contract for service with a private or non-profit service provider for collection and handling services for a minimum of three years. Contracting over a multi-year period will give certainty to the service provider, encouraging investment in regional capacity and, potentially, lower bid costs. This approach allows for a sharing of risk between Metro and the service provider. However, it may be complicated to structure a contract that deals with the many contingencies and uncertainties in this rapidly changing marketplace. Nonetheless, the consultant team recommends this multi-year approach as the best way to gain control and minimize collection service costs.

- Seek local partners. Metro is encouraged to solicit sponsorships from Industry as it proceeds with this recommended program, either through in-kind services or direct cash contributions. Manufacturers and electronic retailers could be interested in such a sponsorship arrangement as a way to demonstrate stewardship, gain positive public relations exposure and, potentially, increase share of the market for new equipment.

C. HANDLING & BROKERING

The market for handling and brokering of equipment to be disassembled is strong and viable. In contrast, the local refurbish and reuse market could potentially use some assistance from Metro. Since this market

represents the highest and best use of obsolete equipment that will be processed locally, the **consultant team recommends that Metro consider providing support through grants and access to facilities to non-profit service providers involved in reuse and refurbishing of used electronic equipment.**

D. PROCESSING & PRODUCTION

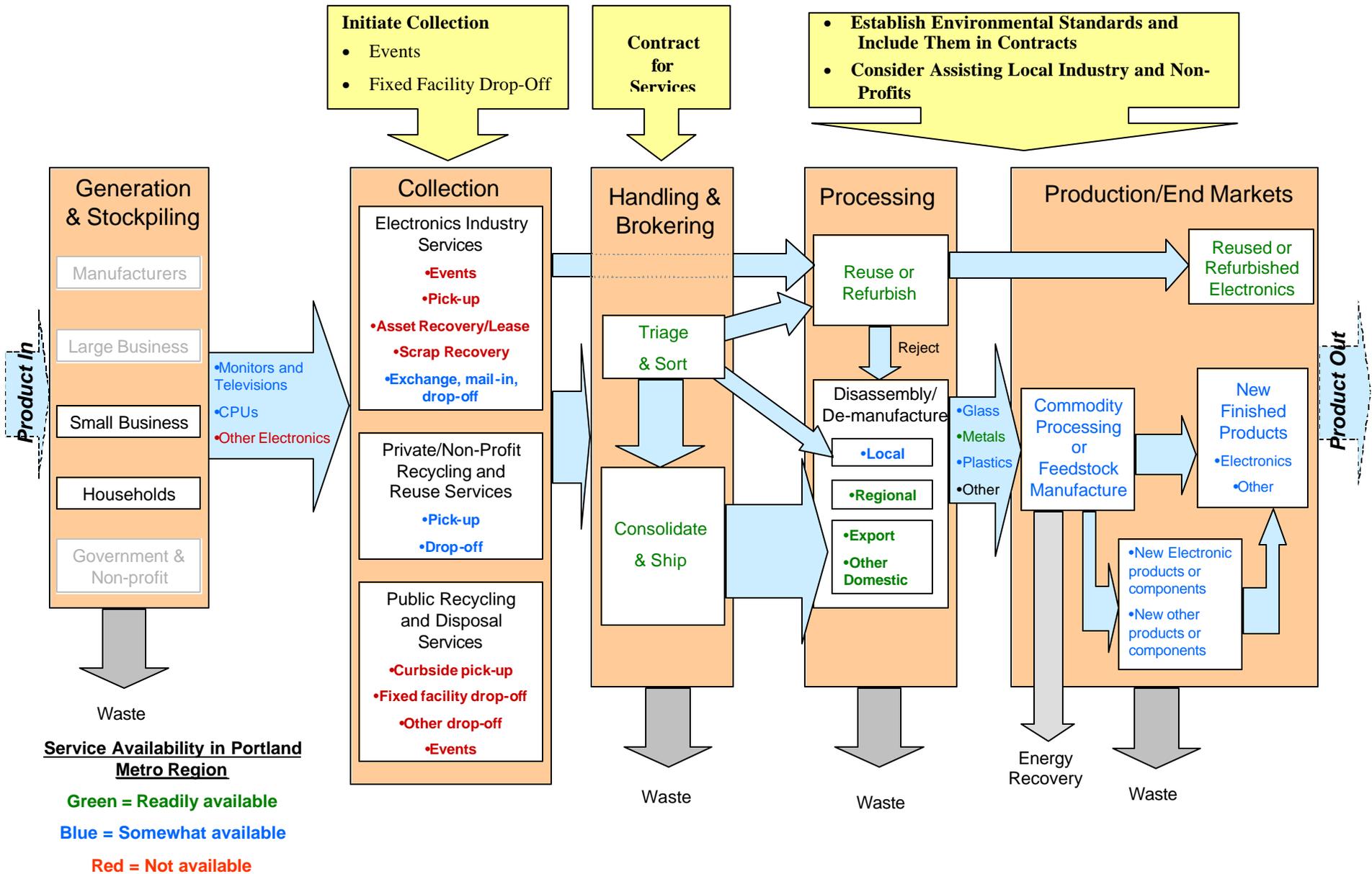
These final recommendations address the processing and production elements of the supply chain. Metro has only indirect control over these markets, through contract arrangements with its collector/handler service provider. Decisions will need to be made about monitor glass and plastics.

Monitor glass: Consider providing a financial incentive for glass-to-glass recycling and allow for glass being used as a feedstock for lead smelting.

Plastics: If Metro is to move forward with e-scrap collection, it may need to consider one of two scenarios:

- **Paying for plastics recycling.** Given the limited quantity of processing and recycling capacity that exists, it is not unreasonable to forecast a situation where plastics are recycled only for a price – similar to the newspaper ONP glut of 1989.
- **Accepting the incineration of the plastics.** The other viable alternative for handling this plastic is waste-to-energy. While this is not the highest and best use and begs a variety of additional questions regarding air pollution, it is an alternative that needs to be considered.

Figure 4: E-Scrap Flowchart – Recommended Metro Services and Initiatives



VI. List of reference materials and citations

“Recycling Used Electronics” Minnesota Office of Environmental Assistance, September, 2001.

“Solid Waste Management Coordinating Board Electronics Recycling Pilot Final Report”, Solid Waste Management Coordinating Board Summer 1998

Best Buy Phase I survey data, e4 partners, inc, Winter 2002.

<http://www.tvturnoff.org/images/facts&figs/factsheets/Facts%20and%20Figures.pdf>

“Electronics Re-Use and Recycling Infrastructure Development in Massachusetts”, Massachusetts Department of Environmental Quality, September 2000.

“Selected E-Waste Diversion in California: A Baseline Study”, CIWMB, December 2001.

Electronic Product Recovery and Recycling Baseline Report, National Safety Council, 1999.

Yahoo! Internet Life, “Most Wired City”, 2001

Northeast Recycling Council Master Survey Database, Summer 2001

VII. Appendices

APPENDIX 1. ESTIMATES OF COMPUTER STOCKPILING AND OBSOLESCENCE

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APPENDIX 1: DOCUMENTATION OF GENERATION AND BACKLOG INFORMATION

Population

Portland Metro's Homepage notes that it serves a population of 1.3 million. The Metro Data Resource Center calculates (after some minor adjustments) that there are 591,408 households in the Portland Metro area in 2002. As many of the figures reported below are based on household estimates, the latter number will be used unless noted otherwise.

Computers Background and Findings

In April 2001 Nielsen Media Research listed Portland as the most "wired" city. This statistic was derived from the fact that 70% of households in Portland, "have access to the Internet from a personal computer at home." The same study noted that Portland's growth of "internet household penetration" was 16.7% that year.

A January 15, 2001 "eMarketer"¹ article that notes that 61.2% of Oregon households own a computer buttresses these assumptions. The same report notes that "urban areas have a higher percentage of PC ownership than do rural areas", suggesting that Portland Metro's overall rate of ownership is going to be higher than the state's overall rate of ownership.

A survey of the general population conducted by the Massachusetts Department of Environmental Protection found that 18% of computer owners own two, 10% own three and 4% own more than three.²

Other related studies found that:

- "Average person who attended an (electronics recycling event) has more than three computers and televisions at home."³
- 1.1 computers at home per survey respondent.⁴
- 1.13 computers at home per survey respondent.⁵

Based on these studies, the authors will assume:

- 70% of households in Portland have a personal computer;
- that a similar rate of ownership holds true throughout the Portland Metro area;
- that the Massachusetts survey numbers on multiple CPU ownership are the most accurate figures publicly available that represent a random sampling of a general population;
- that all households that own "more than three computers" own four.

Number of CPU's in Household	Number of Households	Number of CPU's
1	413,985	413,985
2	74,517	74,517
3	41,399	82,798
4	16,559	49,678
Total # of CPU's		620,979

¹ www.emarketer.com

² "Electronics Re-Use and Recycling Infrastructure Development in Massachusetts", September 2000, page H-28.

³ MOEA Report, pg 12

⁴ Solid Waste Management Coordinating Board Electronics Recycling Pilot Final Report, Summer 1998

⁵ Best Buy Phase I survey data.

Monitors Background and Findings

Monitors are an essential part of computer ownership. However, there is little to no data on the percentage ownership of monitors other than to suggest that the percentage of non-CRT based monitors being used in homes is growing – both through the price drop for LCD flat-screens but also because of the growing use of laptops.

Specific data on monitors is derived from “Selected E-Waste Diversion in California: A Baseline Study” published in November 2001. This study found that:

“19.4% of California households stockpile computer monitors: 13.9% said they were stockpiling one monitor; 2.7% were stockpiling two monitors; 2.8% were stockpiling three or more monitors. Accordingly, there are approximately 3.2 million monitors...stockpiled in California households.”

This report only addresses the issue of “stockpiled” monitors and does not address multi-computer households, which may have additional monitors in use but therefore are not considered “stockpiled”. However, the rate of “dual ownership” of monitors seems consistent with the findings above related to dual ownership of computers. Given the direct correlation between computer ownership and monitor ownership, extrapolating the figure from this report seems a reasonable assumption.

It is important to note that these monitors refer to CRT-based monitors. The growth in sales of laptop computers and drop in price of LCD-based monitors, in addition to the relative long-life of a monitor compared to a CPU all play a role in the long-term projected decline in sales of CRT-based monitors. As the laptops and LCD-displays (which have a projected shorter useful life than CRT-based monitors) begin to enter the waste-stream, they represent a recycling and disposal issue that is unique and distinct from that of CRT recycling.

The authors will use the California baseline figures for the Portland Metro area.

However, this report will utilize the California Baseline figures to calculate stockpiled monitors and assume that 93% of the installed base of PC’s in Portland (70% of the Portland metro households) are desktops that utilize a CRT-based monitor.

Number of Monitors in Household	Number of Households	Number of Monitors
1	385,006	385,006
2	82,206	82,206
3	15,986	31,936
4	16,559	49,677
Total # of Monitors		548,825

Televisions Background and Findings

There is substantially more information available on the rate of television ownership. These figures are both national and at a state-level.

The “TV Turnoff Network” notes that 98% of US households have at least one television, 35% have exactly two televisions and 41% have three or more TV sets⁶. Nielson Media Research generated these numbers in 2000.

⁶ <http://www.tvturnoff.org/images/facts&figs/factsheets/Facts%20and%20Figures.pdf>

These figures are supported by the findings in a study by the Massachusetts Department of Environmental Protection (Mass DEP). That study found that 22% of households have one TV, 33% have two, 23% have three, 11% have four, 5% have five and 4% have more than five TV's. This study asked specifically how many televisions were in a household, working or not.

In contrast, The California Baseline Report provides excellent numbers on the rate of stockpiled televisions. It notes that:

“18.5% of California households stockpile televisions: 13% stated that they were storing one television; 3.9% were storing two televisions; and, 1.6% were storing three or more televisions. Consequently, there are approximately 2.9 million televisions...stockpiled in California households.”

Here the issue of “stockpile” versus “have at home” becomes important. The Baseline Report question, as asked, only gets at TV's not in use that are stored, either at home or off-site. This report does appear to get at total number of TV's in a household. Thus, their conclusion of 2.9 million televisions stockpiled in California is accurate to the question asked but seems to seriously underestimate the total number of televisions that will need to be disposed, as it does not account for multiple TV households.

Other studies have found that:

- survey respondents had an average of 2.9 TV's per household⁷;
- 33% have more than 3 TV's;⁸
- 35% of Ramsey County, MN (including the City of St. Paul) residents have two or more TV's;⁹
- 23% of Ramsey County residents have three TV's.¹⁰

All of these findings demonstrate a large population of televisions that will eventually need to be disposed. However, the authors will use a combination TV Turnoff Networks and Mass DEP figures for the purposes of this report. These figures are reasonably recent, represent a rigorous survey methodology, get at the issue of how many TV's are in a household, not how many are stockpiled and tend to support one another. The TV Turnoff figures will be used for households with one or two TV's, Mass DEP numbers will be used for three and up.

Given the lack of clarity on the California study's use of the term “stockpile” and if it refers to only non-working TV's, those figures will not be used in this report, though they do represent an important view into the potential to increase the number below.

Number of TV's in Household	Number of Households	Number of TV's
1	130,110	130,110
2	195,164	390,329
3	136,024	408,072
4	65,055	260,220
5	29,570	147,852
6	23,656	141,938
Total # of TV's		1,478,520

⁷ SWMCB

⁸ Ibid

⁹ Ramsey County Environmental Services Survey of Residents, 1999

¹⁰ Ibid

- Utilizing the vintage study done in the Minnesota report, the television numbers can be furthered analyzed by age. According to the figures from this study, Metro can anticipate:
- 10%, or 147,852 of these televisions are from the 1960's;
- 37%, or 547,052 are from the 1970's;
- 47%, or 694,904 are from the 1980's; and,
- 6%, or 88,711 are from the 1990's.

These are significant for planning purposes because the TV's from the 60's and 70's will most likely contain PCB capacitors, a hazardous waste, as these were phased out of use in the early 1980's. Also, these TV's are far more likely to be "wood console" style TV's and therefore be heavier, more expensive to process and have a higher residual rate from the processing as the wood tends to be unrecoverable.

APPENDIX 2: OREGON'S ELECTRONICS RECYCLING LIST

Computer Drive Connection

923 North Freemont Lane
PO Box 412
Cornelius, Oregon 97113
Contact: Nicki Wood
Phone: 503-992-0180
Fax: 503-992-0179
E-mail: niki7472@aol.com
Electronics recycling company
Services: Materials are sorted for reuse/resale, demanufacture, scrap metal recovery, or shipment to another demanufacturer for recycling.

Earth Protection Services Inc.

6024 SW Jean Rd. Building E
Lake Oswego, Oregon 97035
Contact: Ken Streight
Phone: 503-620-2466
Fax: 503-620-4313
Contact: John Chilcott (Phoenix)
Phone: 602-353-9282; 800-414-0443
Fax: 602-353-9285
E-mail:
Web:
Special wastes recycling company
Services: Electronic materials are packaged and shipped for demanufacture or recycling. EPSI has proposed a program for collection of TVs at \$.15/lb.

Electronics-Recycling

18127 Industrial Road
Surrey BC B3R 3S1 Canada
Contact: Bert Kelm
Phone: 604-582-8087
Fax: 604-589-8211
E-mail: bertkelm@canada.com
web: <http://www.electronics-recycling.com>
Electronics recycling company
Services: Electronic materials are packaged and shipped to a company affiliate in China for total recycling. No reuse or demanufacturing.

FreeGeek

1731 SE 10th Ave.

Portland, Oregon 97214
Contact: Phillip Santo
Phone: 503-234-9725
Fax: 503-232-3524
E-mail: freegeek@spiritone.com
Web: <http://www.freegeek.org/index.html>
Community service & education project
Service: A nonprofit that uses volunteers who earn a computer by providing labor to disassemble, test, assemble, and install open source software on donated computers. Acceptable computers are rebuilt and reused, unacceptable electronics are sent to a recycling company.

Hallmark Refining

1743 Cedardale Road
P.O. Box 1446
Mt. Vernon, WA 98274
Contact
Phone: 800-255-1895
Fax:
E-mail: tim@hallmarkrefining.com
web:
Metals Refining Company
Service: Recovers and recycles CPUs, monitors, and scrap circuit boards.

High Tech Now

2328 NW Reed Street
Portland, Oregon 97210
Contact: Ryan Hall, President
Phone: 503-497-9400
Fax: 503-497-9406
E-mail: info@hightechnow.com
Web: <http://www.hightechnow.com>
Electronics recycling company
Services: Electronic equipment is disassembled and processed scrap is shipped to other companies for recovery. Planning to install a CRT crusher/recycler system
Service: Refurbishes and sells computers that are internet-capable and recycle the

HMR USA, Inc.

435 23rd Street
San Francisco, CA 94107
Contact:

Phone: 415-647-6071
Fax: 415-647-2580
E-mail:
Web: <http://www.hmrusa.com/>
Computer recovery and recycling company
Services: computer remarketing,
demanufacturing, and recycling. Asset
management

MBA Polymers, Inc.,
500 West Ohio Avenue
Richmond, CA 94804
Contact: Michael Biddle, Ph.D.
Phone: 510-231-9031
Fax: 510-231-0302
E-mail: MBAP1MB@aol.com
Web: <http://www.mbapolymers.com>
Plastic Recycling Company
Service: Recycles plastic from durable
goods like electronics, computers,
appliances, automobiles, and
telecommunication equipment. Processes
scrap engineering thermoplastics such as
ABS, HIPS, PC/ABS, PC, PPO, PSF, and
PPS.

Micro Metallic Corporation
1695 Monterey Highway
San Jose, CA 95112
Contact:
Phone: 408-998-4930
Fax: 408-998-5033
E-mail: Skurnacs@micrometallicscorp.com
Web:
Electronics recovery and Recycling
Company
Services:

Quantum Resource Recovery
10750 Denny Road
Beaverton, Oregon 97075
Contact: Michael Wezinger
Phone: 503-646-2427
Fax: 503-469-1997
E-mail: mwezinger@quantumresource.com
Services: Electronic equipment is packaged
and shipped for scrap metal recovery.
Electronic related plastics are recovered.

STRUT
Students Recycling Used Technology
13320 NE Jarrett
Portland, Oregon 97230
Contact: Greg Sampson
Phone: 503-251-3771
Fax:
E-mail: gregs@nwresd.k12.or.us
Web: <http://www.strut.org/recycle/>
School education project
Services accepts all computer electronics for
reuse or recycling. Acceptable computers
are rebuilt by students and reused in schools,
unacceptable electronics are sent to a
recycling company. Tax credits for
donations. Computer demanufacturing

Total Reclaim Inc.
PO Box 24996
Seattle Washington 98124
Contact: Craig Lorch
Phone: 206-343-7443
Fax: 206-343-7445
E-mail: clorch@totalreclaim.com
Web: www.totalreclaim.com
Special wastes recycling company
Electronic equipment is disassembled and
processed scrap is shipped to other
companies for recovery. CRT
crusher/recycler system in operation.

**Waste Management Asset Recovery
Group**
2615 Davis Street
San Leandro, CA 94577
Contact: Kevin McCarthy
Phone: 510-563-4214
Fax:
E-mail:
kmccarthy@wastetmanagement.com
Web:
Electronic asset management company
Service: Provides e-scrap recycling services
statewide for cities and counties through its
asset recovery group.

Gentech

12839 NE Airport Way

Portland, OR 97230

Contact: Leonard Merrit

Phone: 503-891-9787

Website: www.gentechrecycling.com

www.gogentech

Services: Custom build new computers and recycling used computers. Provides collection services to municipalities.

APPENDIX 3A: E-WASTE COLLECTION & PROCESSING ASSESSMENT SUMMARY REPORT FROM INTERVIEWS

This report summarizes the information obtained through phone interviews with fifteen businesses and organizations involved in recycling, refurbishing and resale of electronic products in the Portland Metro region. The businesses interviewed include small 1-2 person operations, regional businesses, non-profit organizations, and national/international businesses with facilities or operations that serve the Northwest. The following table lists the names of the businesses interviewed. Appendix 3B contain details on each business's electronics recycling activities.

Name of Business	
Computer Drive Connection	Ram Turbo Systems
Earth Protection Services	Recycle America
Free Geek	Simply Marvelous Recycling
GenTech	SJ Nudelman & Sons
HMR	StRUT
Jaco Environmental	Total Reclaim
NxtCycle	Western Tech
Quantum Resource Recovery	

Capacity

Small businesses

The four 1-2 person businesses interviewed for this study provide insight into the difficulty that small operations face in handling electronic waste. Most of the smaller operations refurbish and resell computers and do not have the facilities to collect, sort, disassemble and recycle large volumes of materials. The current low market value for many recyclable materials, as well as for used computers, makes it difficult for small businesses to be profitable in handling electronics. Consequently, three of the four business interviewed no longer accept electronic waste. Thus, the contribution (and therefore capacity) of small operations to the overall e-waste recycling stream is presumed to be minimal.

Non-Profit Organizations

The mission of the two community-based non-profit organizations that were interviewed is to use education as a platform for reusing, recycling and disassembling electronic materials. Volunteers and students provide the labor for refurbishing or disassembling computers and electronic products in exchange for training, and free computers and other equipment. These non-profit organizations are exemplary in their commitment to education, in their aim at keeping electronics from the waste stream, and in their use of local industries and businesses in recycling scrap materials. Both organizations encourage other communities to adopt their recycling/educational programs, and are interested in expanding their programs to other regions, locally and nationally. Annually, these two process approximately 1,100 tons per year. Both organizations rely on regional recycling facilities to process materials that they do not use in their rebuild and reuse programs. The capacity for growth is determined by having adequate volunteer labor, securing capital funding sources for space improvements or expansion, and viable options for handling monitors.

Regional Recycling Businesses

For the larger regional businesses involved in recycling e-waste in the Oregon-Washington region, there is a considerable capacity for collecting, sorting, refurbishing and recycling electronic materials. At present, there are four major businesses that handle and/process electronic waste. Combined, these businesses handle approximately 9,000 tons of electronic material per year. A fifth major regional player recently closed due to fire.

All regional businesses interviewed indicated that they have almost unlimited capacity for handling and processing more e-waste materials. The bottleneck for two regional businesses lies in ensuring a market for CRTs, which neither business disassembles or processes. For these businesses to expand their operations, they will need to identify and secure options for handling monitors.

One business located outside the Portland Metropolitan area but still within the Northwest region disassembles and processes nearly all electronic equipment and parts including CRTs, with leaded glass being the only material they do not recycle. For this business, their capacity is unlimited provided there is access to a lead smelter. With few lead and copper smelters remaining in the United States, facilities such as this one will turn to overseas facilities to process leaded glass. Another local handler relies completely on overseas markets for resale of used functional computers. According to the company president, there is an unlimited market for used computers overseas, particularly in the Middle East and Eastern Europe.

National Recycling Companies

Four national companies that recycle electronic materials were interviewed and their combined annual intake of e-waste in the U.S. is approximately 36,000 tons per year¹. The majority of this material is handled by one large company that handles and processes up to 30,000 tons per year. While these companies focus primarily on the disassembly and processing of electronic materials, one company, with operations in the US as well as Philippines and Australia, does market used computers in its retail facilities domestically and abroad. The large national businesses also disassemble units labeled as 'assured-destruct' by clients (customers with proprietary information on computers may ask for destruction rather than rebuild and reuse when recycling computers). All businesses interviewed have plans to expand their operations in the Northwest to some degree, but two mentioned the main issues concerning when and where future expansion may occur: the reliability and of material flow, and the impact of pending regional policy issues surrounding the handling of universal waste.

Where does the e-waste go?

Electronic equipment is either disassembled and recycled for scrap materials (raw materials such as plastics, metals, glass, etc.), or collected, refurbished and resold as functional units domestically and/or overseas. Some of the used computers and electronic equipment is donated to local educational programs in the Portland area. Other larger companies handling functional used computers sell a portion of them domestically and abroad.

For appliances that are disassembled, several regional businesses are key players in scrap recycling: Metro Metals, Hallmark Refining, Pacific Iron and Metals, and Schnitzer Steel. These businesses play an important role in recycling the metals, plastics, and other materials associated

¹ This value underestimates national volumes handled by the four companies. Two businesses provided data from California and the Northwestern Regions; two provided their nationwide figures.

with electronic waste. Total Reclaim is a prominent recycler of CRTs in the Northwest region, relying on domestic lead smelters for processing leaded glass.

The two businesses interviewed that sell electronic units overseas, only one (HMR) has processing facilities in the countries where they sell used products. The 'closed loop' nature of HMR's business allows the company to provide recycling and processing of e-waste materials in the countries where they do business.

Challenges for recycling/refurbishing electronic waste

Obstacles for recycling e-waste focus mainly on low market value for used computers and scrap materials, and the ease of disposing of rather than recycling electronic waste. Specific challenges include:

- ☛ **Lagging domestic market for used computers.** Prices for new computers have steadily declined in recent years, leaving used computers with little value in the domestic marketplace.
- ☛ **Recent drop in market value for scrap metal.** The drop in market value for copper, silver and gold makes it difficult for small-scale disassembly and scrap businesses to be profitable.
- ☛ **Minimal support is provided from local or state government or manufacturers** in the form of grants, tax breaks or subsidies to help small businesses sustain or expand their recycling operations.
- ☛ **Expense of handling monitors .** The cost for handling monitors has steadily increased in the recent years as fewer lead smelters exist in the US requiring that material is shipped elsewhere for processing.
- ☛ **Customers unwilling to pay for recycling.** Many consumers believe that their old computers and other electronics have intrinsic value, and are not willing to pay for recycling.
- ☛ **Lack of awareness of environmental impact of disposal.** Need for greater involvement by local and state government to inform the public on the environmental impact of disposing electronic waste in the landfill or other waste facilities.
- ☛ **Ease of landfilling.** For recyclable electronic materials that are not designated as hazardous or universal waste, disposal is easy. Few incentives exist to encourage consumers to locate facilities that will accept non-hazardous e-waste materials.

Opportunities for Metro

The main opportunity that businesses identified for Metro is to develop incentives to encourage more recycling and less disposal of e-waste. According to both regional and national recycling businesses, the groundwork for developing a comprehensive recycling program requires that there is a reliable flow of materials to the businesses and organizations that recycle the products. Both regional and national businesses are interested in expanding operations in Portland and the greater northwest region, but nearly all businesses interviewed are watching the regulatory arena for

future restrictions on handling of certain types of e-waste, to see what effect policy changes will have on the volume of material in the electronics waste stream.

Another major opportunity identified by businesses interviewed is for Metro to form a partnership with one or more e-waste processing facilities, to ensure that CRTs and other appliances are handled environmentally sound manner. Several businesses expressed interest in processing For example, METRO could provide grants or partial funding for local businesses that want to expand their electronics recycling facilities, thus enabling them to obtain machinery or facilities to process CRTs.

Other opportunities for Metro include:

- **Work with local recycling businesses** on developing curbside pickup events and special commercial collection events. (*San Jose has curbside pick up of hazardous waste including e-waste 2-3 time per year. Very successful*)
- **Establish collection facilities** at transfer stations, landfills and other convenient drop-off locations in the area.
- **Develop and distribute educational materials** to residents and businesses on the environmental impact of electronic waste disposal, providing information on options for recycling.
- **Partner with electronics industry and recycling businesses in determining where cost of recycling should lie**. The question of who shoulders the cost of recycling is a complex issue. Working together with industry and local and/or national recycling businesses, Metro can learn the most effective way to disperse the cost, whether as a surcharge on new equipment, solid waste handling tax, or other added cost.
- **Work with OEMs and recyclers on third party verification**. This will allow businesses that recycle e-waste to gain credit for environmental practices.
- **Regulate computers** to tracking on their proper disposal.
- **Provide technical assistance** to registered recycling businesses on proper handling of CRTs and other hazardous waste associated with electronics.

APPENDIX 3B: SUMMARY OF 15 SURVEYED BUSINESSES AND ORGANIZATIONS INVOLVED IN E-WASTE RECYCLING

Business	Location	Core Handling Activities	Materials and Quantities	Collection Methods	Collection Capacity	Handling Capacity	Charge to Customer	Markets	Environmental Practices
Computer Drive Connection	Regionally Based Cornelius, OR	<ul style="list-style-type: none"> Consolidate Sort Disassemble 	<p>All electronics</p> <p>From OR and WA: 48,000 electronic units per year, plus 36,000-60,000 monitors per year.</p>	<ul style="list-style-type: none"> Drop off Own a truck and will pick up Will use trucking service for large loads 	No limit. Can take all the materials they can get. Plan to build new facility.	Handling limited by market for monitors. Hoping to buy a unit to process CRT tubes; seeking funding.	\$10 per monitor except schools (\$5)	<p>High Tech Now – monitors</p> <p>Metro Metals – all materials except monitors.</p>	<p>All materials are recycled locally. Nothing is sent overseas.</p> <p>Will sell functional units through local Non-profits.</p> <p>Considering Romania for used functional equipment, but wants to be certain that the monitors won't become a hazardous waste issue there.</p>
Earth Protection Services	<p>Nationally Based Atlanta, Philadelphia, Phoenix, Texas, S. California</p> <p>Local Office Lake Oswego</p>	<ul style="list-style-type: none"> Collect Donate functional units to StRUT Consolidate Sell to recycler 	<p>All electronics and fluorescent light tubes.</p> <p>Business is primarily lighting (99%). Electronics recycling is about 1% of their business.</p> <p>12 tons per year from Portland facility which consolidates materials from OR, WA, MT, ID, AK, ND, SD</p>	<ul style="list-style-type: none"> Collection events Drop-off Pick up with truck Barge, train from other parts of the country 	OR site is a consolidation site. Will ship to Phoenix location from there. No limit in OR.	Plan to expand by building an electronics processing facility in the PNW region, if they can be sure of future volumes.	\$0.35 per pound	<p>Donates all computer units to StRUT.</p> <p>Whatever StRUT does not take, goes to Phoenix facility, then on to: Commodity Management Services (in Phoenix) for recycling.</p>	<p>No materials are shipped overseas.</p> <p>This company processes lighting and would like to become more involved in the processing of electronic waste. Currently all of their computer materials are processed in Phoenix by local business.</p>
Free Geek	Portland Based	<ul style="list-style-type: none"> Sort Disassemble Refurbish Resell 	<p>All computer parts and monitors.</p> <p>48,000 units per year from Portland area</p>	<ul style="list-style-type: none"> Drop-off 	Planning to move to larger space. Trying to increase capacity to meet the demand.	Currently can't meet the demand for computers – many people on waiting list to attend training on computer refurbish and repair.	\$10 per monitor	<p>Total Reclaim – CRTs</p> <p>Metro Metals – scrap metal</p> <p>Calbag – wires</p> <p>Quantum Resource Recovery – metals, plastic, cardboard, printers</p>	<p>Provide free education to volunteer workforce.</p> <p>Everything is reused or recycled locally. They charge for monitors to ensure that they are handled properly and domestically.</p>

Business	Location	Core Handling Activities	Materials and Quantities	Collection Methods	Collection Capacity	Handling Capacity	Charge to Customer	Markets	Environmental Practices
GenTech	Portland Based	<ul style="list-style-type: none"> Sort Consolidate Disassemble Refurbish Resell 	<p>Accepts all computer parts and monitors.</p> <p>480 tons per year mainly from WA. Not currently taking material from Oregon.</p>	<ul style="list-style-type: none"> Collection Events Drop-off 	Has not reached capacity for collection.	Could handle up to 100 tons per month at current facility.	\$5 per monitor	Netel – monitors Odyssey Systems, Texas – also takes monitors, computers	<p>95% of the material they accept is recycled (excluding plastic).</p> <p>Monitors are sold or traded for scrap with NeTel, which takes monitors and other materials to Vietnam. Netel takes photographs of facilities in Vietnam where monitors are taken.</p>
HMR	Inter-nationally Based Sacramento Los Angeles San Francisco Philippines Australia	<ul style="list-style-type: none"> Sort Resale to overseas and domestic markets Disassemble 	<p>All electronics except microwaves, smoke detectors and ‘white goods’</p> <p>3,600 tons of electronics tons per year from CA. Small fraction from OR.</p> <p>New facility: 200-250 tons of CRTs from May 2002 only (CA)</p>	<ul style="list-style-type: none"> Collection events Drop-off Pick up or ship from transfer stations and landfills 	Unlimited. Several facilities nationwide to accommodate . Largest processor of CRTs in CA	Unlimited	\$0.275 per pound for CRTs; \$10 per wood console; \$0.15 per pound other electronics	<p>Closed loop company. All products and materials stay within HMR facilities and operations, unless units are disassembled for scrap. No repairs</p> <p>Scrap materials are sold to domestic markets (for US materials) and oversea markets (from facilities overseas)</p> <p>Leaded glass is crushed and sold to smelter on east coast</p>	<p>This company tries to prolong the functional life of computers by reselling domestically and overseas as operating units, rather than scrapping them outright.</p>
NxtCycle	Nationally Based Phoenix Utah	<ul style="list-style-type: none"> Collect Disassemble Refurbish Resale (very few) 	<p>Computers, small appliances, TV’s, copiers, fax machines, (everything except large appliances such as washers, dryers, etc.)</p> <p>120,000 units of assorted electronics per year nationwide</p>	<ul style="list-style-type: none"> Collection events - works mainly with municipalities offering collection packages 	Unlimited	In the next few years with new California and East Coast facilities, hope to handle over 1 million units per year	Between \$0.15 and \$0.23 per pound	<p>Materials are prepared for local/domestic scrap markets. CRT glass goes to glass processor back east. Working now with a facility overseas that will process CRT glass-to-glass.</p>	<p>All materials are handled and processed domestically. Only a few functional products sent to overseas market.</p> <p>No parts or materials are sent overseas for recycling or processing.</p>

Business	Location	Core Handling Activities	Materials and Quantities	Collection Methods	Collection Capacity	Handling Capacity	Charge to Customer	Markets	Environmental Practices
Quantum Resource Recovery	Regionally Based Beaverton	<ul style="list-style-type: none"> Sort Disassemble Recycle scrap 	<p>All electronics except CRTs and TVs.</p> <p>5,400 tons per year materials from Oregon. Of this approximately 2,400 tons are non-disassembled units.</p>	<ul style="list-style-type: none"> Collection events 	Unlimited	<p>Unlimited so long as they have a market for the monitors.</p> <p>They plan to continue to grow due to fewer competitors locally.</p>	No charge to customers	<p>Domestic markets: lower grade scrap materials</p> <p>Vietnam and China: higher grade scrap materials.</p>	<p>Will not handle hazardous waste, including monitors, CRTs.</p> <p>Equipment that they send to China and Vietnam is refurbished by facilities that they feel are legitimate and reputable.</p>
Recycle America	Nationally Based Phoenix	<ul style="list-style-type: none"> Collect Sort Resale (few) Process/ disassemble 	<p>Everything except 'white goods'</p> <p>20,000-30,000 tons per year nationwide.</p> <p>None from OR or WA in recent years</p>	<ul style="list-style-type: none"> Drop off Collection events Transfer stations and landfills 	Unlimited. Several facilities nationwide.	Unlimited	Varies. Will quote a price to customer when they arrange for transportation or pick up of materials.	<p>Envirocycle – glass</p> <p>Diubak - glass</p> <p>Doe Run Lead smelter – glass</p> <p>Other materials – domestic and overseas markets, depending on product.</p>	Careful handling of CRTs. Working on permitting process for a drop off in the Northwest Region (through Waste Tech).
StRUT	Portland Based	<ul style="list-style-type: none"> Sort Disassemble Refurbish Reuse in schools 	<p>All electronics <i>except</i> Apple components, and monitors smaller than 15 inches.</p> <p>Approx. 1,000 tons in 2001 from Portland area</p>	<ul style="list-style-type: none"> Drop off 	Limited by tax-based funding for processing computers. Could handle more computers if they could support more staff.	<p>Current capacity is limited by labor dollars, since the program is funded through state tax base.</p> <p>Interested in expanding to southern WA. Monitors are the only main obstacle to expanding; ensuring a viable option for their recycling.</p>	\$5 per monitor	<p>High Tech Now – monitors</p> <p>Metro Metals – Plastic, wood, cardboard</p> <p>Hallmark Refining – Circuit boards</p>	<p>StRUT is looking into overseas rebuilding market for monitors, but is waiting for proof of documentation to ensure materials are properly handled.</p> <p>Their philosophy has three elements: keep material out of landfill; provide education; offer teachers free or cheap equipment.</p>

Business	Location	Core Handling Activities	Materials and Quantities	Collection Methods	Collection Capacity	Handling Capacity	Charge to Customer	Markets	Environmental Practices
Total Reclaim	Regionally Based Seattle	<ul style="list-style-type: none"> Collect Sort Disassemble and recycle scrap with to domestic and foreign recycling businesses 	<p>All electronics and appliances</p> <p>Receive from all regions withing EPA Region 10 plus Montana. Currently not getting many units from Portland</p> <p>50,000 monitors per year. 15,000 TVs per year</p>	<ul style="list-style-type: none"> Collection events Drop off 	With current facility, could easily double the number of units.	Can easily process more materials. Could add second shift, and also will be adding additional space soon	\$10 per monitor; \$0.35 per pound for other electronics;	<p>Envirocycle in PA - Glass products, both leaded and unleaded;</p> <p>Pacific Iron and Metal – circuit boards</p> <p>Schnitzer Steel – metals</p> <p>Overseas – high quality plastics</p>	<p>Used to send computers to China, but stopped about two years ago. Suspected that environmentally sound practices may not be in place there.</p> <p>Recycle everything domestically, except for high-quality plastic which is shipped overseas and remanufactured plastic products</p>
Western Tech	Regionally Based Vancouver, WA	<ul style="list-style-type: none"> Resale Broker 	<p>Computers only at this time</p> <p>720 tons per year</p>	<ul style="list-style-type: none"> Buys functional units from consolidators 	Unlimited. Sends overseas as soon as they have enough to fill a container	This broker's impression is that there is an unlimited market for used computers overseas. They can ship as many as they can buy.	Pays by the ton; depends on products and volumes	<p>Romania</p> <p>Pakistan</p> <p>India</p> <p>Middle East</p> <p>Eastern Europe</p>	<p>Started as a third party inspector; main clients are overseas. Wants to ensure proper use and disposal of materials. Has been working with WEPSI on 3rd party verification.</p> <p>This company seeks to keep computers out of the landfills by sending them to countries that will still use older models and keep them functional.</p> <p>Owner has quality control issues; materials are not well sorted when he buys from consolidators.</p>
Ram Turbo Systems	Portland Based	<ul style="list-style-type: none"> Refurbish (only Pentium 2000 or newer) Resale Broker 	A few computers per month from the Portland Area	Drop-off	Only has space and time for a few computers per month	Could expand if he had a subsidy for rental of larger space, or could hire help. This business is one-person volunteer at this time.	None	Romania	Interested in keeping computers out of the landfill by sending functional units to Romania where they can still be used for several years.

Business	Location	Core Handling Activities	Materials and Quantities	Collection Methods	Collection Capacity	Handling Capacity	Charge to Customer	Markets	Environmental Practices
Simply Marvelous Recycling	Portland Based	No longer recycling electronics							
SJ Nudelman & Son	Portland Based	No longer accepting electronics							
Appliance Recycling – Jaco Environmental	Portland Based	Not currently accepting electronics; only appliances at this time							

APPENDIX 4. ESTIMATED QUANTITIES OF E-WASTE COLLECTED AND HANDLED FROM PORTLAND METRO REGION.

The following table summarizes the total annual number of units of electronic waste, and total tonnages reported by the companies interviewed. While some companies report their annual volumes in units of e-waste (e.g. numbers of monitors), most provided data in tons of material handled, specifying only monitors and TVs as distinct from remaining electronic equipment. To compile the table below data provided by handlers in **units** was converted to **tonnage** using conversion factors indicated in the small table below. Likewise, when businesses provided annual **tonnage** data, the number of **units** handled per year was calculated using the conversion factors below. (Conversion values provided by Chris Cloutier).

Collection and Handling of Ewaste Material									
		Units Per Year*				Tons Per Year			
		Monitors	TVs	All Electronics**	Total Electronics from Portland Area only**	Monitors	TVs	All Electronics**	Total Electronics from Portland Area only**
Collection Vendor	Earth Protection Services			774	774			12	12
	NxtCycle			120,000	N/A			1,860	N/A
	Computer Drive Connection	60,000		60,000	60,000	900		900	900
	HMR	200,000		200,000	N/A	3,000		6,600	N/A
	Quantum Resource Recovery			1,548,387	1,548,387			5,400	5,400
	Recycle America			1,935,484	N/A			30,000	N/A
Handling Vendor	GenTech			30,968	30,968			480	480
	Total Reclaim	50,000	15,000	65,000	N/A	750	338	1,075	N/A
	SRUT			64,516	64,516			1,000	1,000
	Free Geek			48,000	48,000			744	744
Export Only Vendor	Western Tech			46,452	46,452			720	720
Total		310,000	15,000	4,119,581	1,799,097	4,650	338	48,791	9,256

* Facilities provided data on number of units or tonnage of material handled. For those providing number of units, the total tonnage was figures in Assumptions table below. Similarly, the tonnage conversion was used to calculate total number of units based on tonnages provided by business.

** Includes monitors, TVs, central processing units (CPUs), copiers, fax machines, phones, keyboards and other computer peripherals

** When available, businesses provided data on material collected from the Portland metropolitan area only.

Assumptions for Calculating Electronics Tonnage Data		
Item	Average Weight (lb)	Tons
Computer Monitor	30	0.015
TV	45	0.0225
CPUs	17	0.0085
Average	31	0.0155

APPENDIX 5: E-WASTE COLLECTION OPTIONS

Collection Focus	Options	Number of Programs Surveyed	Effectiveness	Participation	Metro Opportunity	Regulatory Issues	Advantages	Disadvantages	Suitability with NEPSI
Retail	Special collection event	Two programs – MN Pilot and Best Buy Phase I. Total of 12 events.	<p>“...single most successful collection strategy during the project both as a percent of total participants and as cost per participant.”¹</p> <p>A retail-based event model is highest rated of 6 programs using 18 program attributes in New Jersey Institute of Technology analysis.</p> <p>77% of participants in Best Buy collection events are “Very Satisfied” with the program.</p>	<p>35% of all participants in Minnesota pilot attended a retail collection event.²</p> <p>1.06 – 1.7% per county participation.³</p> <p>85% of participants in Best Buy events are within 20 miles of the event.</p>	<p>Metro could work with local computer stores to hold/ sponsor recycling events.</p> <p>Metro could work with existing retail programs to subsidize the transportation cost from Portland to selected service provider to reduce the cost of holding an event in Portland.</p>	<p>Depending on state regulation, this can vary from none to some. Issues can include: accepting e-scrap from businesses, storing e-waste on-site, and having to file as a generator of hazardous waste. This does not include a variety of local regulatory issues regarding signage, event licenses and traffic flow.</p>	<p>Tend to be convenient locations. Blind to age, type or manufacturer of equipment. No to low fee. No quantity limits. Can involve small business and institutional generators. These programs are self-contained, offers turnkey recycling program with little local effort or expenditure. No purchase requirements.</p>	<p>Difficult to recruit retailers. Existing programs have limited number of events per year. Not permanent collection. Programs must demonstrate value to retailer to be sustained.</p>	<p>Identified in current “Base Services Document” as one of four roles for retailers.</p>
Retail	Drop-off	One program – San Francisco’s. Over a year of operating experience.	<p>“This program just didn’t work. It was cost prohibitive for everyone (retailers and recyclers) and people didn’t use it.”⁴</p>	<p>“Not that great, maybe 1500 units all year.”⁵</p> <p>No public data available from Verizon cell phone take-back program.</p>	<p>Metro could pursue a drop-off system similar to San Francisco’s. The model has been developed, however participation – either by the retailer or consumers – does not seem to justify it.</p>	<p>Haz waste aggregation issues.</p> <p>Local licensing issues as a transfer station.</p>	<p>Permanent collection location. Tends to be convenient locations. Blind to age, type or manufacturer of equipment.</p>	<p>Tends to be limited range of products.</p> <p>Space constraints at store.</p> <p>Cost prohibitive to do “milk runs” to collect material.</p> <p>Retailer’s pick-off high-value equipment leaving recyclers with low-value material.⁶</p>	<p>In full agreement with current iteration of “Base Services Document.”</p>

¹ Chris Cloutier, e4 partners

² Ibid

³ Ibid

⁴ Ibid

⁵ Ibid

⁶ Ibid

Collection Focus	Options	Number of Programs Surveyed	Effectiveness	Participation	Metro Opportunity	Regulatory Issues	Advantages	Disadvantages	Suitability with NEPSI
Retail	One4One Exchange/ Take Back	One program – Staples.	While there is not published analysis of Staples’ program, anecdotal reports indicate spotty participation, inconsistent acceptance standards and uncertainty over the management of the material collected.	Evidence is anecdotal. Individual reports from around the country note everything from “lines out the door” in California to nobody all day (Austin, MN).	With a strong local OEM presence (Epson) it seems possible that some sort of retail/OEM/Metro partnership would be possible. However, as most of the decisions on this programs, from a retail perspective, are made at a corporate level. Metro would either have to negotiate with a locally owned chain or step outside Portland to negotiate with a national chain.	Haz waste aggregation issues.	Creates distinct link between purchase and disposal for consumer. Strong product stewardship link. Convenient locations. Retail outlets consistently identified as a preferred option for consumers.	Requires significant planning on consumers part to participate. Doesn’t address “backlog issue” only replacements. Limited in product scope. May be limited in brand scope. System does not exist yet. Lack of retailer involvement.	Consistent with “Base Services Document”.
OEM	Mail-back	Several existing programs, but none provided data.	Not known.	Not known.	Publicize opportunity to Metro residents. Negotiate with mail-back organizations to provide subsidize mail-back program to Metro residents. Purchase recycling options for Metro residents.	None known.	Available year round. Some are brand blind.	Requires substantial research and packing on part of consumer. Considered expensive. May not be brand blind.	Consistent with “Base Services Document.”
OEM	Lease Return	Several existing programs but none provided data.	Not known though Gateway has shut their program down.	Not known.	Could encourage lease purchases both institutionally and individually including assuring the Metro’s computers are leased.	None known.	Available year round.	Limited number of lease options. Brand specific. Doesn’t include peripherals. Requires a long-term lease. Eliminates reuse option. Hasn’t appeared to be embraced by consumers.	Consistent with Base Services Document.

Collection Focus	Options	Number of Programs Surveyed	Effectiveness	Participation	Metro Opportunity	Regulatory Issues	Advantages	Disadvantages	Suitability with NEPSI
Electronics Reuse/Recycling Service (for and non-profit)	Permanent, staffed drop-off	Numerous programs through NERC and MN data.	Data is unclear. Individual organizations report strong to constant participation.		Publicize availability of drop-offs. Subsidize development of satellite drop-off locations to increase availability and opportunity to recycle.	Haz waste aggregation issues.	Available year-round.	Not always convenient or easily accessible locations. Requires significant consumer effort to participate.	Consistent with Base Services Document.
Recycling and Disposal Services	Curbside	Over 170 programs surveyed by NERC including 13 curbside programs. 2 programs surveyed by “5 Communities” report.	.14 – 1.98 lbs. per capita material collected. ⁷ “In terms of pounds of material collected per resident, the curbside collection programs appeared to be more efficient than the other collection models....” ⁸	1.72% ⁹	Monitor curbside programs in Hennepin County, MN and Sarasota County, FL to track costs, participation, effectiveness. Develop alternative model that creates a curbside “event” offers designated curbside pick-up on a regular, but not constant basis.	None known.	Simple consumer participation. Available consistently and regularly.	Costs are not known from a broad range of programs. Concerns that “new service” will create a deluge of material.	Consistent with Base Services Document.
Recycling and Disposal Services	Permanent staffed drop-off	Over 170 programs surveyed by NERC, 67 of which include ongoing drop-off.	.013 – 18.34 lbs per capita material collected. ¹⁰		Metro could assure that transfer stations and HHW facilities, as a condition of license, accept e-scrap from the public.	None known.	Available regularly.		Consistent with Base Services Document.

⁷ NERC Master Survey Database

⁸ “Analysis of Five Community Community/Residential Collections”, USEPA, April 1999, pg. 5.

⁹ MOEA

¹⁰ NERC Master Survey Database

Collection Focus	Options	Number of Programs Surveyed	Effectiveness	Participation	Metro Opportunity	Regulatory Issues	Advantages	Disadvantages	Suitability with NEPSI
Recycling and Disposal Services	Permanent, unstaffed drop-off	One program with 5 sites.		“Houston County, the control site, had only 10% of the anticipated participation using Minnesota’s calculation and only 5% of the participation using the CSI estimate.” ¹¹	Metro could develop and fund a series of satellite drop-offs, possibly in conjunction with a local charity to accept e-scrap and other “donatable” items.	None known.	Available regularly.	Contamination. Looting/theft. “Milk runs” to pick up material are expensive. Participation levels and effectiveness not known.	Consistent with Base Services Document.
Recycling and Disposal Services	Multi-material events	MN Pilot included over 20 multi-material events.	“General public was inclined to participate...in events...held in conjunction with HHW programs.” ¹²	The Minnesota project tested 16 of these events but drew no distinct conclusions.		The DEQ’s new CRT rule, the major regulatory issues appear to have been addressed. Other, local issues, regarding signage, tents, licenses, traffic, etc. may still need to be explored.	Allows residents opportunity to bring many items to event. Often already a regular event.	Not a permanent option. Requires significant effort on part of consumer to participate. Consumers may not know that e-scrap is accepted.	Consistent with base service document, but not sufficient.
Recycling and Disposal Services	E-scrap only events	Over 170 programs surveyed by NERC including 69 that use event collection..	.009 – 5.11 lbs per capita material collected. ¹³	124 cars per day ¹⁴ There is widespread anecdotal evidence as to the success of this strategy, if not, at least, its acceptance. One estimate is that 1000 events will be held across the county this year. ¹⁵	These events already appear to be going on in the Portland Metro area. Expanding upon them, publicizing them more or otherwise increasing their scale and scope appears a feasible option.	The DEQ’s new CRT rule, the major regulatory issues appear to have been addressed. Other, local issues, regarding signage, tents, licenses, traffic, etc. may still need to be explored.	A convenient, accessible and accepted method of collecting e-scrap. Tends to attract a high “per car” amount, can handle a wide-range of material. If done regularly, can attract significant, ongoing participation.	Not a permanent option. Requires significant promotion and publicity. Requires significant consumer action and effort to participate. Often has an “end of life” fee.	Consistent with base service document, but not sufficient.

¹¹ Ibid, pg. 30

¹² Ibid, pg 38

¹³ NERC Master Survey Database

¹⁴ NERC Master Survey Database

¹⁵ Resource Recycling, May 2002, pg 26

APPENDIX 6: PRESS RELEASE

FOR RELEASE: June 17, 2002

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PANASONIC, TECHNEGLAS AND ENVIROCYCLE ACHIEVE BREAKTHROUGH IN TELEVISION PICTURE TUBE RECYCLING

Three Companies Demonstrate Feasibility of CRT Recycling and Use of High Ratio of Recycled Glass in New CRTs

Secaucus, NJ (June 17, 2002) – As concern and interest in recycling electronic products rise, Panasonic, Techneglas and Envirocycle are collaborating to provide a model for the recycling of cathode ray tubes (CRTs) in televisions and computer monitors, and to demonstrate the cost-effectiveness of using recycled glass in producing new CRTs. For several years, Panasonic, best known for its consumer electronic products, Techneglas, a leading CRT glass manufacturer and Envirocycle, heralded for its national recycling programs, have worked together to develop processes for recycling of CRTs from discarded televisions and computer monitors. The glass recovered in this effort is then used to produce Panasonic TV tube funnels composed of 10% post-consumer recycled glass—the highest percentage of recycled glass ever used in new television tubes, and the highest proportion that is practical with today’s technology.

This breakthrough offers a model to help governments and manufacturers address environmental concerns about disposal of discarded televisions and computer monitors whose CRTs contain lead and other hazardous materials. Panasonic, Techneglas and Envirocycle have created an unprecedented system for collecting and re-using all the glass in reclaimed CRTs and manufacturing them into new Panasonic television CRTs.

“Quality concerns have long made the industry hesitant of using large amounts of post-consumer glass. Techneglas was willing to take a risk into unknown territory and introduce a large percentage of this glass into its process,” says Steve Wood, Manager of Environmental Affairs of Techneglas. “The three companies have shown for the first time that it is possible to safely recycle and reuse a high percentage of post-consumer TV tube and computer monitor glass to create new CRTs.”

The recycling process begins with collection events sponsored by Panasonic, Envirocycle and others in several states—over forty collection events are planned for the 2002 calendar year. With the discarded televisions reclaimed, Panasonic underwrites Envirocycle costs to safely remove and separate the parts and then Techneglas purchases the glass processed by Envirocycle. From there, Techneglas incorporates the reclaimed CRT glass into major new CRT glass components using a process developed by Techneglas. These components, the large funnel glass of the TV tube, are manufactured into finished CRTs, composed of up to 10% of post-consumer recycled glass, at Panasonic’s Ohio TV picture tube plant.

“Panasonic is committed to conserving society’s resources and reducing any potential threat posed by lead in discarded television tubes,” says David Thompson, Panasonic’s General Manager, Corporate Environmental Department. “For the first time, the television and computer monitor production industry has been given the technology to fully reuse materials which may have a potentially negative

environmental impact. We are hopeful other manufacturers will join in support for this product stewardship model, and invite their collaboration on recycling projects.”

“We have worked for many years to reach this point,” says Greg Voorhees, Vice President of Envirocycle. “Panasonic, Techneglas and Envirocycle have developed a model for the electronics manufacturing industry in the efficient use of resources and environmental protection.”

Panasonic’s commitment to environmental protection is unrivaled in the consumer electronics industry. Panasonic has made great strides in eliminating the use of lead-based solder from printed circuit boards, and recently received the Energy Star Partner of the Year Award for the fourth year in a row by the Environmental Protection Agency and Department of Energy in recognition of Panasonic’s position as a leader in the development and marketing of energy efficient products. More than 415 Panasonic product models bear the Energy Star label and all Panasonic video and DVD products sold in the US meet or exceed Energy Star performance levels.

Panasonic is also working with and acknowledges Sharp and Sony for their joint sponsorship of television and electronic product collection events across the country.

ABOUT PANASONIC

Matsushita Electric Corporation of America (“Panasonic”) is the principal North American subsidiary of Matsushita Electric Industrial Co., Ltd., (NYSE:MC) of Japan, one of the world’s largest producers of innovative electronic and electric products for consumer, business and industrial use. The company is a global leader in the total number of facilities – currently 248 – registered to the ISO14000 environmental standard. For more information on Panasonic products, visit www.panasonic.com. Panasonic brand television picture tubes are manufactured by American Matsushita Electronics Company, a division company of Matsushita Electric Corporation of America, located in Troy, Ohio.

About Techneglas

Techneglas, Inc. is an innovative manufacturer of television glass. It is a wholly-owned subsidiary of Nippon Electric Glass (NEG) of Japan and main supplier to 70% of the NAFTA market for the NEG Group. Techneglas employs over 2,000 in three facilities: Columbus and Perrysburg, OH and Pittston, PA.

ABOUT ENVIROCYCLE

Envirocycle has been involved in the electronic recycling industry for over 15 years, with operations in Hallstead, Pennsylvania and Mt. Pleasant, Pennsylvania. The facility in Hallstead Pennsylvania is the only operation in North America that has the ability to refurbish and resell computer equipment and recycle CRT glass in a closed loop system. In its fifteen year history, Envirocycle has shipped back over 700,000 tons of CRT glass for reuse in the manufacturing of new glassware.

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