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Profile and Prospects for Plastics Recycling Industry in Oakland

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University of California at Berkeley
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PROFILE AND PROSPECTS FOR PLASTICS RECYCLING INDUSTRY IN OAKLAND

EXECUTIVE SUMMARY

This paper is the first of a two part profile on Oakland recycling industries for the University-Oakland Metropolitan Forum. This part focuses on Plastics Recycling, an emerging industry with opportunities available as early as this summer. The second part, forthcoming, is on the scrap metal industry.

The general strategy for both papers is to describe the basic workings of the industry, to list the general site requirements and labor needs of the industry, and then to consider Oakland's prospects for maximizing the benefits of the industry. My premise is that additional benefits accrue from developing new economic activity related to industry inputs (backward linkages) and industry outputs (forward linkages).

Plastics recycling within the manufacturing plant has always been technically feasible. The key to recycling plastic products (such as soda bottles) after use is cleanliness and careful sorting. The pelletized product of the recycling process, known as regrind or resin, can be melted in with batches of virgin resin to make non-food or non-medical related plastic products.

Only plastic scrap from clean commercial-industrial sources is economically viable to recycle at this time. Because of this, the plastics recycling industry in the Bay Area is small (8 to 12 firms). Although two important plastics brokers are located in Oakland, the metropolitan area is not the hub of the industry as it is, for example, with scrap metals.

Resin from reprocessed plastic is ultimately an inexpensive commodity, which nevertheless embodies a significant amount of labor. Its low price is dictated by the price of the virgin resins and "off-specification" resins with which it competes. Because of these low prices, the industry tends toward mechanization to minimize labor costs.

Plastics recycling, however, has the interest and support of a wide range of interests, including the Plastics Industry. Members of the industry express optimism about the recycling's prospects, especially with regard to new end users and new technologies emerging from current research and development efforts. The major event looming in this industry's future is

the time when post-consumer plastics handled by community recyclers becomes commercially viable.

The Oakland Metropolitan Area can maximize the economic benefits of this local resource industry by attracting local end users and processors for the Bay Area's plastic scrap. This would facilitate further developing the sources of the scrap to include household plastics. That there is a need and an opportunity to fill these market niches is clear. How well-suited Oakland (or the Bay Area) is to fill these niches is still uncertain.

What is clearer is that several immediate opportunities present themselves for Oakland to look further into the plastics recycling industry. First, this summer (1989) the San Francisco Recycling Program is actively investigating the potential for bringing a recycled plastics end user/ manufacturer to the Bay Area. Second, RPX Resins, a plastics broker and exporter, is looking for a Bay Area community to participate in a pilot household plastic recycling program. Finally, interest by the Oakland Metropolitan Forum (and more recently by members of the Oakland City Council) in recycling and solid waste issues provides a framework for further investigation of the local recycling industry.

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I. OVERVIEW

Why Plastics Recycling Is of Interest to Oakland

Plastics recycling is among the least developed of the recycling industries. The industry is currently limited by certain institutional barriers (e.g. consumer education) and technical barriers (e.g. mechanical sorting, end uses). As these barriers are overcome, however, plastics recycling could increase dramatically.

Although the types of plastics that are usually recycled are limited, there is a major distinction in the industry between plastics separated from commercial-industrial waste and those derived from households (so-called "post-consumer" plastics). Between 8 and 12 Bay Area and Oakland firms buy plastic scrap from local commercial sources. However no reliable buyers of post-consumer plastic currently exist in the Bay Area. This lack of demand for post-consumer plastics is generally true nationally. Furthermore, the plastics recycling industry on the West Coast is generally less well developed than in the East and Midwest.

The following summarizes the major trends driving the plastics recycling industry. A national shortage of landfill space has triggered a spate of legislative efforts by various jurisdictions to ban plastics. This in turn has increased the Plastics

Industry's apparent interest in plastic recycling. Although currently plastics recycling is currently profitable only for plastic scrap gathered from commercial-industrial waste, new technologies or industrial relations may make post-consumer plastics a viable industry in the near future. Reprocessed plastic "resin" is currently much more limited in end use applications than are virgin resins. Further the low price of virgin resins, and the availability of "off-specification" resins consistently limit profitability of the plastics recycling industry.

The Oakland Metropolitan Area can maximize the economic benefits of this local resource industry by attracting local end users and processors for the Bay Area's plastic scrap. This would facilitate further developing the sources of the scrap to include household plastics. That there is a need and an opportunity to fill these market niches is clear. How well-suited Oakland (or the Bay Area) is to fill these niches is still uncertain.

II. INTRODUCTION TO PLASTICS RECYCLING INDUSTRY

Plastics comprise 6 to 8 percent by weight and 20 to 30% by volume of the waste stream. Plastics is also the fastest growing component of the waste stream. In 1973, 14.5 million tons of plastics were produced. 4.5 million tons entered the waste stream that year. By 1984, about 23 million tons were produced and 9 million tons discarded - a doubling of waste tonnage in 11

years. By the year 2000, plastics production could reach 38 million tons.(1)

Overall the U.S. Recycling rate for plastics is only 1%. Current technology would permit a recycling rate of 25%. (2) A variety of factors explain the difficulty in increasing the portion being recycled. Collection and sorting of plastics is made difficult by the variety of plastics in use (46 common types according to one source).(1) Segregating plastic types is necessary to do business with brokers and end users of recycled plastic. The industry has strict specifications for purely sorted and decontaminated plastic scrap. The biggest barrier to further recycling, however, is economics. Recycled plastics must compete in a market against low priced "virgin resins" and even lower priced "off-specification" virgin resins (used for the low-quality end of plastic products).

Types of Plastics Recycled. From a purely technical standpoint, virtually all plastics are recyclable. An estimated 85% of in-house trimmings from plastics manufacturing, for example, gets remelted into the next batch of resin. This being said, the subject of this report is those plastics which reach household and commercial consumers.

The largest single use of plastic resins in the U.S. is for packaging, representing 28% of total plastic resin production.

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(1) Stauffer, "Energy Savings From Recycling," National Appropriate Technology Assistance Service

(2) Resource Conservation Consultants, Plastics Recycling Opportunities For San Francisco, February 1987

(Packaging is followed by construction, 22%, and consumer durables, 9%) Containers plastics are the major focus of the plastics recycling industry. Because of its short-term usefulness, packaging has the highest total presence of plastics in the waste stream. The City of San Francisco, for example, estimated it had 8200 tons of container plastics in its 1986 waste stream.

The Plastic container market is dominated by just a half dozen plastic types. Of these, the most commonly recycled are rigid jug containers made of high density polyethylene (HDPE) and 1 and 2 liter soft drink bottles made of PET.

Also recycled extensively is plastic sheeting or "film" from commercial sources. Film is primarily made of low density polyethylene (LDPE). San Francisco estimated it disposed of 2800 tons of LDPE film in 1986.(1)

PLASTIC CONTAINER MARKET -- 1985

Source	Marketshare	Uses
High Density Polyethylene (HDPE)	53%	Rigid jugs: milk, detergent
Polystyrene	16	Styrafoam: cups, cartons
Polyethylene terephthalatate (PET)	13	Soft drink bottles: ltr.
Polypropylene	6	medicine bottles, vitmns.
Polyvinyl chloride (PVC)	5	
Low Density Polyethylene (LDPE)	4	butter tubs, not incl. film
Other resins	3%	
	100%	

Source: Society of the Plastics Industry, cited by Resource Conservation Consultants

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(1) RCC

II. STRUCTURE OF THE INDUSTRY

Because plastics manufacturing has a very low tolerance for impurities, the plastics recycling process is aimed at assembling commercial quantities of entirely one plastic type. The basic steps of the recycling process are:

- Collection and Presorting
- Consolidating quantities
- Cleaning and Processing into "regrind"
- Reuse by Plastics Industry

The types of firms performing these functions in the plastics recycling industry are: Sources; Brokers & Processors; and End Users. **Firms located in Oakland and the Bay, by and large, are plastics brokers.**

Recycling of the various plastics takes on one of two industrial structures. These are depicted below. The major distinction between the two structures is whether the plastic is processed domestically or abroad.

(Conventional economic development theory explains the greater advantages of the domestic processing industry structure to Oakland. With plastic scrap, as with any resource, the maximum benefit to a region's economy is derived from performing the value-adding functions of processing and manufacturing locally, rather than exporting the raw resource.)

Two segments of the local plastics recycling industry currently appear to be commercially viable. These are high density polyethylene (HDPE) collected from commercial-industrial sources and processed domestically, and low density polyethylene (LDPE)

DOMESTIC PROCESSING INDUSTRY STRUCTURE

Role	Function	Type of Company
1) Sources	Collection, Presort	Commercial accounts Resource Recovery Community Recyclers
2) Brokers	Consolidate quantities	Plastics Brokers
3) Processors	Clean, Granulate, Pelletize	Brokers/Processors Subcontractor Processors
4) End Users	Purchase and Reuse	Plastics Industry

(domestic, foreign?)

OVERSEAS PROCESSING INDUSTRY STRUCTURE

Role	Function	Type of Company
1) Sources (domestic)	Collection, Presort	Commercial accounts Resource Recovery Community Recyclers
2) Brokers (domestic)	Consolidate quantities	Plastics Brokers
3) Exporters	Ship	Brokers
4) Processors (overseas)	Clean, Granulate, Pelletize	Brokers/Processors Processors
5) End Users	Purchase and Reuse	Plastics Industry

(overseas) (foreign)

film from commercial-industrial sources which is usually exported for processing.

What follows are descriptions of how the local plastics recycling industry handles the major plastic types: HDPE, PET, and LDPE, as well as post-consumer plastics. Each plastic type is described in terms of its sources, brokers, processors and end users.

Domestic Processors - High Density Polyethylene (HDPE).

HDPE containers, especially milk jugs and bottled water containers, are the most commonly recycled plastics. HDPE is also the plastic type most likely to be processed and reused in the domestic market. In particular, HDPE is the only plastic processed in any significant quantities in the Bay Area.

In general, a local commercial account can sell its plastic scrap to a broker if it is: primarily one type of plastic (preferably presorted); of acceptable quality (clean and dry); and in adequate quantities. The most common plastic collected presorted from commercial accounts is rigid HDPE containers.

Sources. The sources for HDPE in the Bay Area are primarily commercial-industrial firms with either presorted or mixed plastic separated from their waste. Bottled water companies with empty five gallon containers are a prime example or a presorting source. These containers are consistently HDPE, are clean, and are available in large quantities in centralized locations.

Brokers. There are at least four buyers of commercial-industrial HDPE plastic scrap in the Bay Area. Two of the largest are U.S Recycling in Oakland and Bay Polymers in Fremont.

Processors. HDPE is the most likely plastic to be processed domestically. Processing includes some sorting, cleaning, granulating, purifying, and pelletizing the plastic for resale. The pellet-form product of this process is called "regrind" or "resin". (This is obviously a significant value-added step in plastics recycling.) At least one Bay Area broker does its processing in the Bay Area. Another subcontracts locally for sorting and then ships to Los Angeles for processing.

End User. HDPE "regrind" may be mixed with virgin resins in standard plastics manufacturing. Because of quality control assurances required by the U.S. Food and Drug Administration (FDA), recycled plastic resins are used only in nonfood, nonmedical products. Despite this limitation, there exists good final demand for quality HDPE regrind.

Having said this, however, it is much more difficult to determine who local brokers/processors actually sell to. Plastic recycling is a very competitive industry. Even more so, for example, than with scrap metals, a broker's markets are considered proprietary. ("Our markets are our business.") Another reason for this reluctance may be that plastics manufacturers fear a low-quality-product stigma if it were advertised that they use plastic regrind. This issue has been apparent even when government has tried procurement practices with preference for recycled material.

In general, however, HDPE resin is known to have the best domestic end markets of all plastic scrap, One broker/processor

reported that they sold their resins to plastics manufacturers primarily in Northern California. The export demand for HDPE regrind unclear. Given the absence of FDA limits on end uses overseas, however, export markets are possible.

Domestic Processors - Polyethylene terephthalate (PET).
PET is the plastic for which the steadiest supply is guaranteed. Based largely on its inclusion in various state's Bottle Bills, and estimated 20% of PET containers are recycled. PET is thus an interesting study of the proposition that the key need of the industry is simply a reliable supply of plastic scrap, which then begets end markets and commercial viability. This aspect of the PET case is discussed in the last section of this paper.

Sources. The major source of PET is through the buyback of plastic soda bottles in Bottle Bill states (Oregon, Michigan, New Jersey, etc.). In California PET is collected at buyback centers and, on a limited basis, by community recycling programs (drop off and curbside).

Brokers. Because there exists a legislative incentive to collect PET, this plastic is unique in the scrap plastic industry. How PET is consolidated by brokers is unclear at this time. Two year old literature identified at least two Oakland Metro buyers of PET, but such information changes rapidly in the plastic recycling industry. Several people in the industry identified Plastic Recycling Corporation of California (PRCC) in the Los Angeles area as the state's major PET broker. I have so far been unable to make contact with this firm.

Processors. PET processing is similar to HDPE processing - through a series of procedures which include granulation, air classification, washing and rinsing, float-sink separation (in a density-controlled tank of liquid, PET sinks while other plastics float), and electrostatic separation. The result is high purity PET.

Whether brokers who buy PET also process it locally in not known at this time. Nationwide, several broker/processors have appeared in the literature (e.g. Saint Jude's Polymer in Pennsylvania). In addition, Dow Chemical (a major plastics producer) is reported to be starting a joint venture with Domtar, Inc. of Canada to build a pilot PET processing plant in Canada.

End Users. Although at a national level end users exist for PET, no significant end market appears be operating on the West Coast (California Bottle Bill or not). Virtually anyone connected with the scrap plastic industry can tell you that Wellman, Inc. in South Carolina buys PET to reform as fiberfill (for furniture, coats, etc.) That California PET has been known to be shipped to South Carolina, however, tells of the difficulty of locating other end users.

The export market in the Pacific Rim has been particularly unstable for PET in years past. Current status is uncertain.

Brokers with Off-shore Processors -
Low Density Polyethylene (LDPE) Film and Mixed Bales.

Although LDPE film is a distinct type of plastic, in the Bay Area it is collected and brokered primarily as a component of mixed

bales of plastic. These bales are then exported unsorted to the Pacific Rim, where sorting and processing are accomplished using lower priced labor.

Sources. The major sources for LDPE, as for HDPE, are commercial-industrial firms with large enough and clean enough plastic waste generation to merit servicing. In some cases the broker may provide the firm with their own baler; the firm separates the plastic, bales it, and the broker picks it up (the hauler often being a subcontractor). Sometimes the broker provides a drop box from which the hauler separates and recycles the cardboard, paper, etc. and delivers the plastic to the broker.

In addition to commercial accounts, beginning June 1989, Alameda County's Resource Recovery facility will produce between 12 and 14 tons per day of LDPE/ Mixed plastics from county commercial-industrial waste. Having invested $10 million to upgrade the former Bay Recycling plant in South Oakland, the County recycling facility will be one of the largest most modern plants in the West.

Because it is exported, clean and dry scrap are the key requirements for this plastic scrap. After three weeks in a shipping container enroute to the Pacific Rim any residual garbage in the bales of plastic is clearly evident. Upon arrival, if government port inspectors see (or smell) an unsanitary plastics shipment, they will seize and landfill the load, and then fine the plastics broker for importing garbage!

Because of this criteria, resource recovery plastics would not normally be considered saleable scrap. The County recycling facility, is acceptable only because it processes waste solely from commercial-industrial firms. After proper staff training, the plastic will be baled on site, valued at a fixed price, and exported directly overseas.

Brokers. One firm appears to be the dominant broker of LDPE/ Mixed Bale plastic in the Bay Area: RPX Resins Inc. of Scots Valley in Santa Cruz County. RPX picks up from companies generating various types of plastic, bale this mix of plastic together ("comingling"), and export it to be sorted in Asia. RPX is able to handle large quantities of plastic scrap since they are less discerning at the collection end.

Processors. Sorting and processing is performed entirely in Asia. RPX has invested in processing plants in several locations in China.

End Users. No domestic end markets of LDPE / mixed plastics consumers are now known. An additional incentive to processing in Asia is that End Markets in do not have the same US FDA restrictions on uses of recycled resin.

Sources Without Markets - Community Recyclers/ Post-consumer

Because of sorting and cleanliness issues, community recyclers have no strong markets for collected plastics. As a more general point, once a plastic has entered the municipal waste stream it is considered unusable as plastic scrap. This points to the need

for post-consumer plastic to be sorted by the consumer before the material enters the waste stream.

Sources. Community Recyclers, curbside and dropoff, do not produce a great deal of plastic scrap. Arguably, this is because little demand exists for post-consumer plastic. The various barriers to expanding this resource are discussed below under "Industry Needs and Opportunities."

RPX has looked into buying post-consumer plastic from both the Marin Recycling Center and the Berkeley Transfer/Recycling facility. In both cases the plastic did not meet current specifications for clean dry scrap.

Brokers. One Oakland plastic broker did claim to buy from community recyclers on a limited basis. Another broker explicitly avoids these non-industrial sources. RPX does not currently deal much with household post-consumer plastic, although they expect to be in this market by 1990. They expect to be able to collect 100 tons of post-consumer plastic per day in California alone.

Processors/ End Users. The only plastic recycled regularly from this source is PET.

IV. SITE REQUIREMENTS AND LABOR NEEDS

The necessary prologue to this discussion of site requirements and labor needs is that it is difficult to directly learn from people in the industry about their operations. The scrap plastic industry is a very competitive one. As with the identification of end markets above, much of this information about necessary

site and labor needs is considered proprietary. ("So are you interested in going into this business?") This fact affects the completeness of the following section. Inferences from interviews are identified as such.

Sources. Commercial viability of the current plastics recycling industry appears to depend on adequate sources of plastic scrap which meet industry specifications described earlier (i.e. that the scrap is clean, separated from the waste stream and in adequate quantities to justify hauling costs. The significance of the site location of the Oakland plastic recycling industry is based first of all on its proximity to commercial-industrial plastic scrap. Hence Oakland's central place in the I-80-I-880 industrial corridor is an asset for the plastics recycling industry. One broker described the Oakland Metro as "a good market" for source materials.

Oakland is also well located for future expansion of the plastics recycling industry via the addition of post-consumer plastic. Community Recyclers represent a potentially valuable source of plastic scrap if several barriers can be overcome (discussed in the next section). Oakland's strong transportation links give it access to the 50 community recyclers in the Bay Area. These include well established curbside programs in Palo Alto, Marin County, and new programs San Francisco and to a lesser extent in Berkeley and Oakland.

(Site requirements for community recyclers meanwhile, are to be near population centers. If drop off centers, these need be very

convenient to residents and businesses. If a curbside program, the site requirements are presumably inexpensive land, centrally located with good transportation access.)

Brokers. Firms had a general reluctance to discuss their number of employees. Labor requirements will vary in size according to firm functions and structure. The major labor component of brokering, for example, appears to be in sales and front office workers, hauling (sometimes subcontracted), and some presorting. Without counting hauling or presorting a broker seems to be able to service the Bay Area with 5 to 7 core employees, plus clerical. One broker's general comment on labor requirements was that plastics recycling industry "needs good higher-end management people."

From a location standpoint, once again, most plastic scrap is currently collected from commercial-industrial sources. Hence, Oakland appears advantaged by its proximity to Bay Area industries. The operating radius for plastics recyclers appears generally smaller than for scrap metals - quite likely due to the lower value of the commodity. For example there seemed some hesitancy to serve commercial accounts in San Jose. On the other hand, once baled and shipped, RPX was at one time accepting mixed bales of plastic from Seattle, Denver, and even New Jersey.

Oakland Metro's other major advantage is of course, access to the Port. This is key for brokers who export directly to overseas processing.

Processors. Processors appear to have standard industrial siting concerns: labor, land, and power (electricity). In general the scrap plastic industry, like scrap metals, requires good labor skills - better skills, for example, than paper recycling. On the other hand, because of the low value of the final product and the labor content of handling and processing, there is a great deal of pressure to minimize labor costs. Hence high labor costs in the Bay Area are of particular concern to processors. One Bay Area processor interviewed, for example, said he needs to compete with electronics assembly jobs paying $8-9 per hour.

Mixed bales of plastics, which require a significant labor input, are a case in point. Brokers either subcontract these bales out for sorting and then ship them to Los Angeles for lower wage processing, or they export the unsorted bale directly to the Pacific Rim.

Reliable low cost electric power is required for processors because of the extent to which processing is mechanized. One offshore processor described having to build an electric generating plant in a Pacific Rim country in order to guarantee adequate power supply.

Locations near scrap sources or end users does not appear to be a strong site determinant for recycled plastics processing. This trend may be due to plastics light weight and, especially after granulating, its ease of transport.

Despite the dearth of processors for most scrap plastics on the West Coast, a preliminary assessment shows the Oakland Metro

(much less the Bay Area) does not appear to be an ideal location for plastics processing. On broker/processor offered the opinion that the Bay Area's land costs, building costs, and labor costs are too high for a large scale scrap plastics processing plant. Rather, he would locate a new processing plant in the Central Valley where labor, land and power are all less expensive.

The attractiveness of the Bay Area currently is its commercial-industrial sources, and its proximity to the Port. It is even possible that proximity through the Port to the Pacific Rim hurts West Coast processing plant prospects.

Finally, it is unclear how powerful an effect would result from a strong local end market for recycled plastic resin. The presence of end users of recycled plastic resin would have an unknown, possibly potent effect on the attractiveness of local processing.

End Users. Developing end markets and products for recycled plastic resins is still in its product innovation phase. Even for those plastics whose resins are in some demand (primarily HDPE), the basis for confidence in the future of plastic scrap recycling industry rests on faith in additional end markets being generated. In the words of one broker "The technology [for using recycled resins] needs to catch up [with the potential supply]." According to a major recycled plastics end user in the Midwest, the major location requirements for an end market plant are the standard labor land and power criteria seen earlier. The company's Midwest plant is served by both rail and truck routes, indicating the impcrtance of transportation connections as well.

To the location requirements listed above one could add the standard business criteria of adequate supply of raw materials, and adequate demand for final products. One story circulating in the industry, for example, is that a processor/ end user expressed interest in a Bay Area location (which would provide a strong market for local scrap plastic) if the area could guarantee adequate supply of materials and guarantee a demand for its end product. Such a guarantee would obviously require some type of interfirm agreement or public-private cooperative agreements.

A likely scenario for the location of end users in the near future is that it will be governed by the dynamics of innovation. Dow Chemical is currently sponsoring some research and development work in the Bay Area for mechanically segregating plastics. (see next section) the results will be pilot/ tested in Ohio, however, to ensure visability within the Plastics/ Chemical Industry. The center of innovation in the scrap plastic industry, in fact, appears to be in New Jersey, with the major chemical companies and Rutger's University's Center for Plastics Recycling Research.

INDUSTRY NEEDS AND LOCAL OPPORTUNITIES FOR OAKLAND

The Strategy of Forward and Backward Linkages.

The purpose of this paper is to gain enough of an understanding of Oakland's plastics recycling industry to assess its prospects and to maximize its benefit to the local economy. A classic strategy for increasing local economic benefit from an industry (especially a resource-based industry) is to develop "forward and

backward linkages." Good examples of forward and backward linkages are those industries related to a local timber industry. Forward linkages are those which could be fed by the timber industry, such as local sawmills (rather than exporting raw/unimproved logs), wood furniture making, or refabricated building components. Backward linkages are activities which could feed into the timber industry, such as tree planting, and chainsaw manufacturing.

Forward linkages in plastics recycling primarily means developing local capacity to process and purify the local scrap plastic, as well as to use this local resource in the manufacture of consumer goods.

Backward linkages in the case of the recycling industry means local economic activity derived from generating sources of scrap. The greatest potential for backward linkages for plastics recycling comes from the mostly untapped business potential associated with post-consumer plastics, e.g. curbside, buyback, or other community recycling programs.

The rest of this section describes the needs of the plastics recycling industry as well as the opportunities for backward and forward linkages in the Oakland Metro economy. Through development of these links the local economy may maximize the benefit derived from this economic activity.

General Prospects.

Industry Forces. The following general points are important for understanding the future prospects of the plastics recycling

industry. Endemic shortages of landfill space has focused some communities' attention on plastics. Several legislative efforts to ban plastic containers (e.g. Berkeley's ban on styrafoam takeout containers) have prompted the interest of the Chemical/ Plastics industry in plastics recycling. The industry is motivated to look good and to protect the viability of their plastic products. The plastics industry, for example, now funds a research/ lobbying group, the Council for Solid Waste Solutions.

Recycling, however, is not the only solution being investigated by the plastics industry. Solid waste incineration and biodegradable plastics strategies compete for the same industry research money, and ultimately, could compete for the same waste stream. Siting of garbage-to-energy plants, however is difficult. In the Bay Area such plants have already failed to gain approval five times. Degradable plastics meanwhile, introduce a host of environmental unknowns which could limit its adoption.

Finally, commercial viability of the plastics recycling industry is governed by economics. Resins from reprocessed plastic is ultimately and inexpensive commodity, which nevertheless embodies a significant amount of labor. Its price is in turn affected by the price of virgin resins and "off-specification" resins, which are a function of the price of petroleum-based feedstocks, and of the efficiency of the oil-to-plastics technology. This relative low price of regrind will limit wage and employment levels.

Backward Linkages - Existing Sources and Brokers.

The existing commercial-industrial sources of plastic scrap appear to be fairly well served by current brokers. One broker/processor expressed doubt that existing Bay Area sources justified much growth in brokers/processors of rigid HDPE containers. Resource recovery, on the other hand, is about to significantly expand Alameda County's LDPE and mixed plastics output.

Backward Linkages - New Sources

Oakland's major expansion opportunity for plastic scrap sources appears to be with post-consumer plastic. For example, this could come about through more aggressively pursuing the PET container resource potential presented by the California Bottle Bill's buyback program.

Perhaps the most exciting opportunity is for a strengthened Oakland industry base to develop the capacity to serve as brokers/processors for community recyclers throughout the entire Bay Area. This prospect is discussed in the following section: Forward Linkages - Local Processors.

Barriers. Several barriers must be overcome in order for Bay Area community recyclers to be able to add to the scrap plastic resource base (whether for Bay Area processing or for any market).

1) Consumer education: the common perception of plastics as non-recyclable tends to reduce public participation, when plastic recycling option is offered by community recyclers. Further,

plastics recycling depends on clean and well sorted scrap. To the extent that households are asked to provide this, participation is further reduced (especially considering the variety of plastic container types). A truism of the industry is that consumer recycling requires convenience above all else.

2) The plastics industry needs to cooperate by labeling plastic containers to aid sorting by the household user. Aware of this, the Society of the Plastics Industry has begun this labeling on a voluntary basis.

3) Education of community recyclers is crucial in order to improve the quality of plastics they offer to brokers. Step #1 is eliminating garbage and other contaminants to make a mixed bale of plastic saleable to mixed plastics brokers. Step #2, to the extent that mixed plastics are segregated , they increase in value and in the likelihood of being processed locally.

4) For curbside recycling programs to start including plastics requires financial support for the education/ outreach to assure adequate quality of collected scrap; some capital investment would be needed to provide some special or modified equipment (e.g. modified trucks); and the curbside program would require an agreement with the current solid waste hauler.

Opportunities. At least one mixed plastics broker has expressed a willingness to participate in the above educational efforts and, thereafter to buy plastic from community recyclers. RPX Resins of Scots Valley, Santa Cruz County, expects to be in the post-consumer plastic market by 1990. With research and

development funding from the plastic container industry, they are currently looking for an interested community in the Bay Area with which to do a pilot program for household (probably curbside) plastics recycling.

Other opportunities for post-consumer plastics are expected to emerge from R & D efforts currently being funded by the plastics industry. In particular WTE, Inc. of Benecia is being funded to devise technology for mechanically sorting a mixed bale of plastic. This technology would allow a local broker to buy from community recyclers with poorly sorted plastics. (The results will be demonstrated in early 1990 and pilot tested in Akron, Ohio later that year.) Another innovation which would expand community recyclers' ability to sell plastic scrap is mixed plastic manufacturing, discussed below.

Yet another opportunity suggested by one community recycler is increasing community recyclers capabilities to sort and regrind their own plastic scrap. This would provide a value-adding opportunity and income stream to that level of the recycling industry with the highest employment levels. This idea assumes of course, that all-important quality levels would be maintained. These community recyclers would thereby be adding value to plastic that might otherwise be exported raw. If high enough quality, on the other hand, the plastic regrind that community recyclers market might be directly competing with product sold by current local broker/processors.

Forward Linkages - Local Processors.

An important obstacle to the expansion of post-consumer plastic sources is that currently there is not a reliable buyer of post-consumer plastic. The West Coast suffers from a general shortage of plastic scrap processors for all types of plastics (with the possible exception of HDPE) This situation is particularly true in the Bay Area.

Amy Perlmutter, Director of the City of San Francisco Recycling Program, describes the problem of buyers for community recyclers' scrap plastic as "supply waiting for demand waiting for supply.' That is , community recyclers are reluctant to gear up for collecting post-consumer plastic until there is a proven reliable demand for the scrap. Potential end markets who could create that demand, meanwhile, are reluctant to invest in a new plant until there exists a reliable supply of scrap.

To begin addressing this issue the San Francisco Recycling Program is committing resources this summer (1989) to establishing the conditions necessary to attract a recycled plastics processor/ end user/ manufacturer to the Bay Area. Ms. Perlmutter (554-6197) expressed active interest in cooperating with the City of Oakland and community recyclers from other East Bay cities to address this regional need. These conditions might eventually include, for example, agreements by community recyclers to guarantee a given supply of scrap, or agreements by local governments to purchase a set amount of the final product.

A reasonable argument could obviously be made for locating a recycled plastic plant in the Oakland Metro. Proximity to plastics brokers and to commercial-industrial accounts is an asset. Rail and truck connections to the Central Valley and to Northern California expands Oakland's potential resource radius. And although three potentially important sources of post-consumer plastics are located on the 101 Corridor (curbside recycling programs in Palo Alto, San Francisco, and Marin County), industrial land for the project is probably more available in the East Bay.

Hence the potential exists for Oakland of some other Bay Area community to step in to serve this already established network of suppliers, and to reap the employment and income benefits of this new industry.

To be sure, however, simply visualizing Oakland as a processing center of post-consumer plastics is not enough to make it happen. It is worth speculating, for example, that demand form overseas for the plastic scrap may drive up the cost of operating in the Bay Area for the end user. Also, as discussed above, the Bay Area's high land and labor costs present important obstacles requiring creative solutions. One approach to the labor training and labor expense problems, for example, is a marriage with youth training programs such as the East Bay Conservation Corps. Based on a reliable demand for the labor, such programs could produce labor with specific enough skills to serve as a foundation for the new industry.

Forward Linkages - End Markets.

Expanding end markets for reprocessed plastic resins was the area most often identified by interviewees to be the key to the future of the plastics recycling industry. Such an expansion would be dependent on technological innovations or on public policy choices that guaranteed demand for certain recycled plastic goods.

As discussed previously, the most important ground rules for the expansion of reprocessed plastic consumer goods are those established by the Food and Drug Administration. FDA policies amount to a defacto ban on recycled plastics for food and over-the-counter medical product packaging.

Purified recycled plastic resins from commercial-industrial scrap can be blended in small proportions with virgin resins in order to save on feedstock costs. Most often, it is used in the production of lower quality plastic goods. Similarly, reprocessed scrap from post-consumer sources is currently used in low-end plastic products, including "irrigation pipe, toys, pails, fiberfill, floor mats for cars, particle board, and other products that have wide performance tolerances, and where the resin is a high proportion of the cost of production." (1) Plastics Recycling Opportunities for San Francisco, 1987)

The most important new markets for recycled plastics are coming through layering technologies and mixed plastics technologies.

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(1) RCC

One interviewee expects that a layer of reprocessed resins, coated with a virgin resin layer for protection, will be seen in consumer goods like detergent bottles within a year.

Mixed Plastics. European and Japanese technology exists to use a mix of plastics to manufacture building material (lumber, benches, stadium seating), marine products (dock boards, sea walls) animal pens, and truck floorings. In the U.S. these products have trouble competing with their wood and concrete substitutes unless the greater durability of plastic is needed (e.g. in a marine environment). At least one processor/ manufacturer interviewed manufactures a plastic lumber product.

Expanded Supply. The debate continues within the recycling industry about whether expanding supply of plastic scrap (e.g. through more aggressive household plastics recycling) would help increase the number of end users of recycled plastic. The argument is that once a reliable supply of a particular plastic can be guaranteed, that end users will innovate to be able to tap this resources. These innovators then comprise the market demand necessary to make plastic recycling commercially viable.

While not totally discrediting this argument, the experience with PET container recycling implies that the formula is more complicated. Due to deposit laws in several states, a steady supply of post-consumer PET is guaranteed. Finding buyers for the unprocessed scrap, particularly on the West Coast, however, has been very difficult. One reason for this appears to be that, although demand for clean, processed PET regrind has been good,

the low price it fetches has not justified the cost of aggregating and processing the material. (Again, these low prices are determined by the low cost of virgin and off-specification resins with which regrind competes.)

The lesson here seems clear: the formula for expanding demand is more complicated than simply expanding supplies of plastic scrap. In fact, the one viewpoint most often volunteered by the business people interviewed was that massive plastics recycling would not be the solution to the nation's current landfill crisis. These firms fear that such a policy would only flood the recycled plastics market, drive down the price of scrap, and force much of the industry out of business. Rather, they feel, the future expansion of the recycled plastics industry depends on generating new processes, products and markets for recycled plastic resins.

Procurement Policies. Much of the literature on plastics recycling suggests a need for public policy to assist the industry, at least in its early stages. Usually the assistance requested takes the form of procurement policies which give preference to products made of recycled materials. The discussion calls to mind the story mentioned above about a mixed plastics manufacturer seeking a stable market for its goods. Carrying out a procurement policy out to its fullest extent could include the type of guaranteed demand sought by this manufacturer.

CONCLUSION

The intent of this paper has been to gain enough of an understanding of the plastics recycling industry in Oakland and the Bay Area to be able to consider how the Oakland Metro might maximize its benefit from the industry. The paper's major conclusions are as follows:

The Oakland Metropolitan Area can maximize the economic benefits of this local resource industry by attracting local end users and processors for the Bay Area's plastic scrap. This would facilitate further developing the sources of the scrap to include household plastics. That there is a need and an opportunity to fill these market niches is clear. How well-suited Oakland (or the Bay Area) is to fill these niches is still uncertain.

What is clearer is that several immediate opportunities present themselves for Oakland to look further into the plastics recycling industry. First, this summer (1989) the San Francisco Recycling Program is actively investigating the potential for bringing a recycled plastics end user/ manufacturer to the Bay Area. Second, RPX Resins, a plastics broker and exporter, is looking for a Bay Area community to participate in a pilot household plastic recycling program. Finally, interest by the Oakland Metropolitan Forum (and more recently by members of the Oakland City Council) in recycling and solid waste issues provides a framework for further investigation of the local recycling industry.

APPENDIX A

PLASTICS RECYCLING FIRMS IN THE BAY AREA

Bay Polymer	Fremont
Certified Resins	Benecia
First Metals and Chemicals Inc.	San Francisco
Independent Paper Stock	Oakland
Kingman Products	Alameda
King Metal and Plastic Co.	San Francisco
Oakland Plastics Sales	Oakland
U.S. Recycling	Oakland
Wesflex	Richmond

APPENDIX B

SOURCES AND REFERENCES

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