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PLASTICS RECYCLING ACTION PLAN FOR MASSACHUSETTS – PART II*

GRETCHEN BREWER
Somerville, Massachusetts

ABSTRACT

This study assesses the feasibility of, and designs a plan for, including recovery of household plastic discards in the statewide multi-material recycling program of the Commonwealth of Massachusetts. Part I of the study, presented in *J. Environmental Systems 18*:3, pp. 213-264, 1988-89, discusses the types and amounts of plastic materials found in the waste stream, methods for collecting them, technologies for recycling them, and markets for the recycled products. Part II, appearing herein, concludes that plastics recycling should be pursued and describes an action plan for integrating the plastics component into the Commonwealth's recycling program. Part II also contains technical appendices.

THE ACTION PLAN

Making plastics recycling work in the Commonwealth requires the successful integration of plastics collection into the statewide recycling program, while simultaneously developing the technologies and markets that will transform that material into economically viable new products. Though less developed than methods for recycling newspaper, glass or aluminum, the plastics recovery cycle is identical: collect the material, process it for remanufacture, create a new product and sell it.

The roadmap for this process given here recommends which plastic discards will be collected; sets recovery goals; suggests sizing and sorting criteria for material recovery facilities (MRFs); predicts the needed industrial recycling

* This research was conducted in cooperation with the state of Rhode Island. The background data in this document are for Massachusetts only; the action plans were developed to match each state's needs. Readers interested in the companion Rhode Island study should contact the Rhode Island Department of Environmental Management, 9 Hayes Street, Providence, Rhode Island 02908 (401) 277-3434.

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capacity, and recommends specific technologies that can help create a strong and sustained market.

Material Targets: Rigid Packaging, Film

Regional recycling programs should initially target the entire rigid packaging fraction of waste plastics–milk jugs, shampoo bottles, detergent and fabric softener containers, yogurt cups, etc.–while keeping open the possibility of adding collection of plastic films (grocery sacks, etc.) when capacity and experience allow. One pilot for rigid containers only and one for film and rigid containers will be launched at the earliest feasible dates.

This strategy maximizes waste diversion levels and savings on trash disposal costs, while optimizing market access and earning potential. It depends on existing, proven technologies that can separate the various plastic resins into four marketable categories: *polyolefins*, made up of the plastics used for most household containers; *high-density polyethylene*, the plastic of dairy jugs, which can be processed into "regrind" and sold; *PET*, the familiar plastic of two-liter soda bottles, also marketable as regrind, and *mixed plastics*, which can include all of the above along with other household plastics including bags and wraps. This broad-based approach offers the best and most reliable economic foundation for plastics recycling.

This approach differs from existing U.S. plastics programs, which in general have targeted only soda bottles made of PET (polyethylene terephthalate) and/or dairy bottles made of high-density polyethylene (HDPE). That limited approach yields plastic recovery levels of up to 11 percent of the estimated 80 pounds of household plastics discarded by each Massachusetts resident yearly. By expanding collections to all rigid containers, and supporting the program with adequate design, publicity and capital investment, that recovery rate can be doubled or tripled.

The rigid container stream includes all plastic bottles, tubs, jars, baskets, boxes, trays, plates, carry-out containers and lids. The only household plastic excluded due to a current lack of recycling technologies is foamed polystyrene ("Styrofoam").

Publicity: Plastic Recycling is Simple

As with any large-scale recycling program, the citizens of the state are the most important participants. The program must therefore be as user-friendly as possible, and publicity must stress that households can recycle plastics as easily as any other material.

There will be no requirements for elaborate sorting of plastics either from each other or from other containers made of glass or metal. Straightforward instructions delivered through a variety of media will emphasize that labels, lids and any metal rings need not be removed. Products will be identified by

their form or contents, not by their technical resin types. Residents will be asked to set out plastic milk, water and juice jugs, detergent and shampoo bottles, prescription and vitamin jars, coffee can lids, clear carry-out containers, film cans, cosmetic containers, salad oil bottles, soft drink bottles, windshield washer fluid jugs, and anti-freeze containers.

A series of flyers, media announcements, and school educational programs can add new examples to the list as needed, and when plastic films are added to the program, residents will be asked to set out their grocery sacks, bread bags, dry cleaning bags, etc.

Recovery Goal: 45 Percent of Rigid Plastics

By integrating plastic collections into the state's multi-material curbside collection programs, a 45 percent recovery of rigid plastics can be attained. To reach that level will require that 75 percent of households served by multi-material collection programs participate, and that each of those households recycles 60 percent of the rigid plastic containers coming into the home. Assuming a 1990 plastics content in Massachusetts solid waste of 492 million pounds, of which roughly 40 percent is rigid plastic, a single recycling region would recover 7.4 million pounds (3,700 tons) of material in 1990 and 8.8 million pounds (4,400 tons) in 2000 if plastics consumption continues to grow as expected.

Because no programs of this magnitude exist in the United States, the 45 percent recovery rate cannot be compared to actual experience. The calculations used to arrive at the target rate, however, are firmly grounded in the experience of other curbside collection programs that attain 80 percent or better participation and up to 90 percent capture of targeted materials. Also, the assumptions of plastics volume in the waste stream were purposely weighted towards the conservative side. The rapid growth of citizen acceptance of recycling nationwide also supports the possibility that the 45 percent target may in fact be low.

Collection: How Best to Haul 'Balloons'?

Transporting uncompacted plastics bottles has been likened to carrying a load of balloons: there is much volume but little resale value in terms of material weight. This characteristic of household plastics underlies every aspect of the collection and sorting process; it will demand both ingenuity in equipment design and an ability of program directors to make operational adjustments as programs mature.

The Massachusetts Regional Recycling Program calls for distribution of one 1.5 cubic foot recycling container to each participating household in the service area. Assuming the 45 percent recovery rate, about three-quarters of a pound of plastic per week will be set out in the box, and it will take up from one-quarter

of the space. While that may prove adequate, the experience of other multi-material curbside programs is that some households store materials for two to four weeks before setting out their boxes, and that households that consume a lot of plastics tend to overflow their boxes. Thus, other set-out container configurations such as the larger rolling cart used in Germany's "green bin" system should be evaluated in collection pilots. Another promising approach is to have households put plastics in a separate plastic bag that is then clipped to the recycling box to keep it from blowing away.

Collection vehicles must confront the same problems by having a large capacity and, if possible, a built-in compaction process for plastics. The regional plan calls for one collection vehicle per 25,000 households, with an expected daily payload of eight tons per day, or one and a half truckloads. When roughly three-quarters of a pound of plastic per household is added to the mix, the truck must haul an additional 1,042 pounds per day, or 27 cubic yards of uncompacted material. Given the planned use of vehicles in the 28- to 34-cubic yard range, that means each truck on plastic collection routes would handle one full additional load per day.

A number of ways to respond to the problem are possible–extended shifts, additional trucks, off-loading plastics en-route, using packer trucks that compress the material. But the most cost-effective and therefore recommended approach is to fit an existing high-capacity curbside vehicle with a mechanism that densifies the plastics, flattening but not shredding, as they are loaded at the curb. This change would require that instead of two-compartment trucks (one for paper, the other for co-mingled containers), as currently planned, three-bin vehicles will be needed, with operators doing truck-side sorting of plastics into the third compartment.

MRFs: Include Plastics Capability

With collection logistics solved and 45 percent recovery of rigid plastics, a regional material recovery facility (MRF) will need the space and equipment to handle 7.1 million pounds or 187,000 cubic yards of plastics per year, or roughly 719 cubic yards per day assuming a one-shift operation.

Each MRF will have to be individually tailored for plastics processing depending on the technologies used and the expected overall capacity of the facility. Key design criteria will depend on the plant's through-put rate, processing techniques, indoor and outdoor storage space, shipping turnover, and number of shifts per day. Certain other specifications, though varying from plant to plant, will relate strictly to the plastic fraction:

- *Front-end separation* may be desirable to cull soft-drink bottles and/or dairy jugs to allow their sale as distinct plastic resins;
- *Segregation of plastic* from other containers will be needed in programs where a two-compartment truck delivers co-mingled containers;

- *Visual spot checks* of glass and metal streams will be needed to maintain quality control in programs with delivery by three-compartment trucks; otherwise, stray plastic containers could cause contamination problems.
- *Shredders and/or balers* will be required to reduce the volume of plastics before shipping to markets. The shredders may be fitted with air classification systems to provide a preliminary sort of film from rigid plastics;
- *Production space* may be desirable for an on-site plastics molding system (an "ET/1"; see Part I) that can produce plastic lumber and other products from mixed plastics.

MRF Incentives: Priming the Pump

The Regional Recycling Program has been promoted to Massachusetts communities largely on the basis of savings in disposal costs: while conventional disposal tipping fees will continue to cost $50 per ton or more, tipping at the state's first MRF will be free. Incentives to attract private-sector operators to this MRF include a contractual fee for running the facility plus earned revenues for recovered material sold to markets. This fee structure needs to be reevaluated for post-consumer plastics, whose processing costs might cancel out earned revenues, depending on which markets are accessed. To alleviate risk for MRF operators, it is recommended that they be allowed to charge a nominal, flat-rate tip fee for all recyclables. This will eliminate disincentives for maximum recovery of plastics and other materials that may be added later, e.g. mixed paper.

Recycling tip fees should be fixed by contractual arrangement at a rate significantly lower than prevailing disposal tip fees. This places recycling on a par with other disposal methods from a cost-management standpoint, while retaining its competitive edge over the less-desirable landfilling and energy recovery options.

Technologies: Pursue All Types

To recycle plastics on a large scale will require that whole new markets be opened for products made from recycled material, while currently active markets are expanded. In turn, large and steady material supplies will fuel demand for post-consumer plastics and help stabilize market prices. The Massachusetts strategy is to tap into existing plastic markets while vigorously pursuing development of two newer and complementary recycling technologies: a *polyolefin separation system* to produce a pellet feedstock for molders, and a *mixed-plastic molding system* that creates end products including plastic lumber.

The Commonwealth will use its full economic development resources (see Appendices) and/or the financial resources provided by the 1987 Solid Waste Act to assist in the siting of at least one industrial-scale plant of each type by 1990. With both plants on-line, the state is guaranteed to have production capacity for both rigid plastics, which are the preferred feedstock for polyolefin

Table 1. Growth of Plastic Volume Through 2000

Year	*MRFs On Line*	*Rigid Only (Million Pounds)*	*Rigid/Film (Million Pounds)*
1990	2	14.8	21.9
1995	7	56.7	85.1
2000	12	105.6	158.4

systems, and for plastic films, which are one essential ingredient of mixed-plastic molding recipes. The systems further complement each other because mixed-plastic machines can accept heavier plastic resins, barrier packages, and other plastics that are separated out in the production of polyolefin pellets. Both systems are compatible with existing domestic and export markets for regrind made of separated PET soda bottles or HDPE dairy bottles; both can operate efficiently even if those materials are culled from the mix.

Thorough research and development of domestic and export markets for all four end-products–pellets, mixed-plastic products, PET regrind, and HDPE regrind–should coincide with implementation of plastic collections and start-up of the two new production facilities. Preliminary research indicated sufficient demand to support the first facilities, and they in turn will generate end-products needed to penetrate and expand markets for additional products. Markets, material supply and end uses must be developed simultaneously, each bolstering the chances of the others' success.

Year 2000: A Full-Scale Industry

If projected recovery rates are met and the plastic collections are spread into all twelve recycling regions, the nation's first full-scale plastic recycling industry is likely to develop here. Plastic volume would increase by a factor of seven or more between 1990, when the pilots begin, and 2000, when the program is statewide.

These quantities could supply a mix of up to six pellet-making plants, ten mixed-plastic systems, and/or domestic and export regrind markets. Clearly, aggressive market and product development will be required to accomplish this growth, which shows volumes doubling every thirty months. Though government leadership will be essential, such growth will also depend on strong and inspired involvment of the plastics industry (see Table 1).

IMPLEMENTATION

Government-Industry Teamwork

This study revealed a number of promising technologies, markets and collection approaches to be examined and refined through further research and

pilot projects. The Commonwealth is prepared to co-sponsor appropriate projects, and has committed funding for collection of plastics to ensure a steady flow of raw material. Thus it aims to minimize risks and foster teamwork with industry in the transition to large-scale plastics recycling. In turn, were industry to match the Commonwealth's commitment with its own formidable talents and resources, most barriers to plastics recycling would easily fall away.

Research and pilot projects recommended for immediate attention are as follows:

Create public–private research consortium – Recognizing the need to create a mechanism for teamwork among government, industry and academia, the Massachusetts Division of Solid Waste Management conceived and organized a public-private consortium called the Plastics Recycling Applied Research Institute, Inc. PRARI's mission is to foster coordinated, pragmatic research and development to optimize waste plastic collections, processing, recycling technologies, products and markets.

PRARI's co-founders are New England Container Recovery, Inc. (CRInc.), of North Billerica and the University of Lowell's Plastics Engineering Department in Lowell. The first PRARI project is a pilot ET/1 mixed-plastic molding plant capitalized by New England CRInc., with research support provided by Lowell University under a Massachusetts Centers of Excellence Corporation grant. Officially opened in May 1988, the project focuses on optimizing ET/1 processes, products and markets, and provides the first post-consumer plastic recycling capacity in the Commonwealth.

PRARI supporters also include the states of Massachusetts and Rhode Island, the Vinyl Institute, Coca Cola U.S.A. and Citizens Energy Corporation. Additional assistance is expected from other Northeastern states, universities and private firms. PRARI will serve as a research body, funding conduit, and think tank of recycling, business and polymer experts, and will be specially suited to conducting research and development projects like those recommended below.

Design and implement pilot collections – The history of recycling programs throughout the nation shows that the most important first step in any program is to *begin*: to get people recycling. This is especially important for the plastics program as it will provide day-to-day proof that plastics recycling is possible. Two collection pilots will be launched at the earliest possible date, preferably by working with existing community-sponsored curbsides which can easily add the plastics component to their programs. The best strategy will be to strength programs in areas scheduled to be included in the first regions by providing early delivery of state-purchased vehicles and set-out containers, publicity, and program design/evaluation assistance.

One pilot will target all rigid plastic containers; the other will target all rigid plastics and films. Various configurations of collection vehicles, on-truck densification methods, set-out containers and publicity will be evaluated to

resolve questions about collection efficiency and costs, equipment capacity, participation and recovery rates. This will provide concrete information on which to base plastic recycling expansion plans.

Build two production plants – True long-term development of the industry cannot begin until finished products made from Massachusetts post-consumer plastics are being tested by the marketplace. The Commonwealth will mobilize economic development assistance and solid-waste bond funds to assist private sector installation of two industrial-scale recycling plants in Massachusetts. This includes one polyolefin separation plant and one full-capacity ET/1 system with multiple machines. Steps will be taken to help in-state reprocessors expand, and to attract out-of-state reprocessors to locate plants in the Commonwealth.

Develop markets for new products – The Commonwealth will conduct in-depth market research and development projects for polyolefin pellets, mixed-plastic profile items, and regrind. These projects will explore domestic and export demand, identify and cultivate likely end-users, evaluate economics and market size, conduct market tests, and design comprehensive short- and long-term market strategies.

For polyolefin pellets, major companies using non-food-contact products and packaging will be approached and asked to consider using this alternative feedstock. The public relations value of the switch will be stressed.

For mixed-plastic profile items, market development will focus first on docks, piers, boardwalks, park benches and horse stalls already identified as promising sectors in New England. Additional research will focus on boating and ski industry uses, grave vaults, playground structures, bus shelters, and fence posts and rails. As well, *in situ* performance tests of items like park benches will be staged in highly visible locations like state parks and piers, in cooperation with New England state governments.

Evaluate MRF technologies – In-depth evaluations will be conducted on at least four European MRFs or sorting plant technologies with proven plastics processing capabilities. Most such systems are either not available or not yet on line in the U.S. The Division of Solid Waste Management should broaden its knowledge of MRF technologies and plastic sorting systems in order to specify and/or better assess proposed private-sector MRF systems.

Improve separation technologies – The state will sponsor research and development to optimize polyolefin separation technologies in two key areas. One is to improve the molding properties of the resulting polyolefin pellet (95% polyethylene and 5% polypropylene). The second is to devise ways to further segregate distinct resins from the process residue of PVC, PET, PS and other plastics. This will increase recovery by this technology and strenthen end-product marketability.

Improve ET/1 products – Massachusetts will sponsor research and development both to improve performance properties of, and invent/test broader uses for, ET/1 profile products. Various lines of research, such as bringing E-values closer to those of wood, are described in the Markets chapter. These efforts will also include ASTM testing and approval.

Test on-truck densification systems – Two approaches to reducing problems with excessive volume on collection trucks will be pursued. The first is to evaluate the West German green bin system of rolling carts plus automatic side-loading compactor trucks to assess its appropriateness for areas where side-loaders are already used for trash collection. The second effort involves development of a high speed, high volume on-truck densification mechanism to flatten rigid plastic containers as they are loaded onto various dedicated side-loading and top-loading curbside vehicles. The goal is to achieve maximum compaction of whole containers without slowing down truck-loading. Size reduction by shredding is ruled out, because it eliminates the option to cull certain plastic items (PET bottles, milk jugs) at the MRF.

Develop plastic drop-off depots – The Commonwealth will sponsor a feasibility study and the design of two types of drop-off depot systems for rigid plastics. One should be tailored to partly rural regions like the Lower Pioneer Valley where drop-off satellites using roll-off bins will serve outlying areas. The second should meet the requirement of the Plastic Pollution Control Act to establish depositories at major ports for plastic shipping wastes. Both systems should include densification capabilities.

Perform large-scale separation tests – As follow-up to the small-scale tests conducted in this research phase, the Division of Solid Waste Management will conduct on-site plant audits and full-scale process tests of the three top-ranked separation technologies: Transplastek, AKW and Sorema. This means running samples of at least 2,000 pounds of typical MSW rigid plastic. In turn, the market development effort for polyolefin pellets will utilize these finished materials for large-scale production test-runs by local and overseas custom molders.

Evalute PET recycling technologies – A mid-term research activity is to evaluate via plant audits the PET recycling technologies short-listed in Part I, with an eye toward future negotiations to site a plant in Massachusetts once recovered material volumes warrant.

Engaging Industry in Solutions

The preferred approach by the Commonwealth is to utilize incentives to engage the plastics industry in cooperative solutions. Examples of these incentives follow.

Procurement of recycled-content products – State agencies will move quickly to implement Executive Order 279, which requires purchase of products made of post-consumer plastics. The program will boost market strength of existing products and open up markets for new products, thus helping to assure viability of plastic recycling enterprises in Massachusetts. State Purchasing Agents in charge of piers, parks, roads and waterways can look to plastics recyclers for mixed-plastic lumber for docks, piers, park benches and road dividers; polyethylene products including traffic cones, drainage pipe, tiles and culverts; polyolefin products including waste baskets and recycling set-out containers, and recycled asphalt-plastic compounds for road surfacing. Products used in public areas will be fitted with plaques with a message like this: "Recycled Plastic Product: A better use for Massachusetts waste."

Motivate with public education – A critical role in motivating and sustaining participation in recycling programs is public education, especially with plastics because the education must overcome the perception that plastics are impossible to recycle. The public will be informed first about the environmental problems of plastics, including marine pollution, incineration hazards, and pollution from the production process. It will also be given concrete suggestions on how individuals can reduce that damage through packaging choices, anti-litter efforts and support of local recycling programs. Also, a special training program must be directed at two key groups: private and public waste haulers, who will be involved in the collection of plastics, and MRF operators who must integrate plastics into their operations.

Devise code of packaging standards – A program to encourage proper packaging standards will be devised and implemented using the West German "Blue Angel" program as a model. Just as Underwriters Laboratory gives safety approval to products, this program will certify packaging as "environmentally friendly" if it meets standards such as: ease of recyclability, use of a resin-identification symbol, compatibility of material with *existing* recycling markets, absence of excessive packaging layers, tendency of product to become litter, biodegradability or photodegradability, and use of recycled material in manufacture. The seal of approval could be prominently displayed by those companies that come forward to lead the effort, and though not mandatory, will by its high visibility encourage other companies to come into the program. There is a strong precedent for this type of program in other recycling areas: Coca-Cola now prints "Glass Recycles" on its glass containers and the Kellogg Co. prints "Packaged in Recycled Paperboard" on its cereal boxes.

Create a package design competition – The state will sponsor a competition to reinforce the code described above and make an impact on the packaging industry's design engineers. The annual competition will solicit entries in a number of categories similar to those of the packaging code, but with an emphasis on using art and design to flaunt a package's engineering.

Encourage New England cooperation – The Commonwealth will continue both to spur technology breakthroughs and build region-wide support for plastics recycling through cooperative efforts with other New England states. This team approach has already greatly enhanced the breadth of research possible, led to creation of PRARI, and will be of the utmost importance as plans are shaped into hard programs.

Pending Legislative Measures

A measure of the importance of plastics recycling is that several of the recommendations outlined here, along with numerous other bills, have already been introduced in the Massachusetts State House and in other state legislatures. Below are three examples of get-tough measures that could become important tools in the months and years ahead:

- *A Packaging Disposal Tax* has been proposed in Massachusetts and about eight other states; it would put a three-cents-per-layer tax on non-food products sold at retail in the state. All packaging materials are targeted, including paper as well as plastic, but certain categories including easily recyclable materials are exempted or given a percentage break. The intent of the bill is to recoup from industry the disposal cost of excessive packaging, and to economically discourage addition of new layers. The resulting fund would be used to finance the rest of the state-wide recycling system, help end-use industries locate in the Commonwealth , and support research and development for recycling of plastics and other materials. Full details of these and other bills are available from the Committee on Natural Resources, State House, Boston, MA 02133.
- *One-resin plastic packaging* would be the only type allowed for sale in Massachusetts if this proposal becomes law. This would facilitate recycling by eliminating multi-layer and multi-component packages including plastic cans, which major soft drink companies have been experimenting with, multi-layer squeeze bottles, PET bottles with HDPE base cups, even milk jugs if the lid is made of a different resin. Recommended additions to this concept would be the elimination of other barriers to recycling including use of non-water-soluble glues for labels and the co-mingling within a single package of different materials (aluminum caps on plastic bottles).
- *A packaging code and a review board* would be a stronger alternative to the voluntary Code of Packaging Standards proposed above. It would mandate the same criteria for packaging, in effect banning environmentally burdensome materials and packaging practices. The Solid Waste Commission created by the Solid Waste Act of 1987 will seriously examine this and other options if industry fails to take meaningful, expeditious steps to address the solid waste problem.

APPENDICES

A: Resin Identification Methods

Listed below are standard criteria used by the plastics industry to identify common resin types.

- *Polyolefins (Polyethylenes and Polypropylene)*
  Visual – majority of containers are opaque or translucent; films are generally translucent or transparent; mat finish
  Tactile – slightly waxy to the touch
  Mechanical – flexible containers do not crack
  Flame test – black smoke, resin drips
  Density – floats on water
  Melt point – HDPE: 275°F; LDPE: 230°F; PP: 380°F.
- *Polystyrene (PS)*
  Visual – few bottles; some containers with wide mouth; smooth and shiny surface
  Mechanical – rigid containers crack when folded
  Flame test – black smoke; filamentous; no drip
  Density – sinks in water
  Melt point – 464°F.
- *Polyvinyl Chloride (PVC)*
  Visual – some transparent bottles have faint blue cast; bottle bottoms show blow-molding mark; bottles have seams; certain more rigid films
  Mechanical – becomes opaque white when folded
  Flame test – black smoke to begin, white after; produces hydrochloric acid and a burnt odor
  Density – sinks in water
  Melt point – 410°F.
- *Polyethylene Terephthalate (PET)*
  Visual – clear, transparent; mainly beverage bottles; no seams; bottle bottom has injection molding nub
  Tactile – tough and highly resilient
  Flame test – bright, crackly, sooty; drips; gas smells sweet, irritating
  Density – sinks in water
  Melt point – 518°F.

B: Primary Product Groups

1. *Transportation*
   Motor Vehicles and Parts: including autos, trucks, buses, motorcycles, and bicycles
   All Other: including railroad equipment, travel trailers, campers, golf carts, snowmobiles, aircraft, military vehicles, ships, boats and recreational vehicles.
2. *Packaging*
   Bottles, jars, vials

Food containers: excluding disposable cups
Flexible packaging: including household and institutional refuse bags and film
All other: including tubes, tape, strapping, drums, caps, baskets, trays, boxes, pallets, shipping crates, pails, buckets, shipping cases, blister and bubble containers

3. *Building and Construction*
   Pipe, conduit and fittings: drainage, irrigation, plumbing fixtures, septic tanks
   Building material for all structures: siding, flooring, and insulation materials
   All other: panels, doors, windows, skylights, bathroom units, gratings and railings
4. *Electrical and Electronic*
   Home and industrial appliances: including electrical industrial equipment, wire and cable covers, communications equipment
   Electronic components: including resistors, magnetic tape, records, and batteries
5. *Furniture and Furnishings*
   Rigid and flexible types: including household and office furniture, bedding, carpets, rugs, backing, curtains, blinds, awnings, lamps, picture frames, wall coverings
6. *Consumer and Institutional Products*
   Disposable food serviceware: including disposable cups
   Dinner and kitchenware: including picnicware
   Toys and sporting goods
   Health care and medical products: including laboratory supplies
   Hobby and graphic arts supplies: including photographic equipment and supplies
   All other: including footwear, luggage, buttons, lawn and garden tools, signs and displays, credit cards
7. *Industrial/Machinery*
   All types: including engine and turbine parts, farm and garden machinery, construction and related equipment, machine tools, ordnance and firearms, chemical process equipment
8. *Adhesives/Coatings*
   Adhesives and sealants
   All other: including printing ink, magnet wire enamels, core binders, foundry facings, paper coating and glazing, paints, varnishes, and enamels
9. *Other*
   Sales of resin to resellers, compounders, converters, distributors, etc. Unclassified sales whose end-use markets cannot be ascertained under any of the market categories listed above.

Source: Chem Systems, Inc., 1987 [1].

C: Plastic Collection Programs Surveyed

North America

Bloomsdale, PA
Bronx, NY
Charlotte, NC
Columbia County, WI
Coplay, PA
East Greenwich, RI
Grand Rapids, MI
Islip, NY
Marin County, CA
Naperville, IL
Niagara, Ontario
Ontario, CA
Oregon City, OR
Sunnyvale, CA
Ville La Salle, QC
West Bend, WI

West Germany

Bad Durkheim
Burbach
Dietzenbach
Donnersberg
Enz
Erftkreis
Freiburg
Hannover
Heidelburg
Karlsruke
Kleve
Ortenau
Ravensburg
Rhein-Neckar
Rottweil
Viersen
Witzenhausen
Wolfsburg

Netherlands

Amersfoort
DeBilt
Groningen
Haarlemmermeer
Hertogenbosch
Sanpoort-Zuid
Woerden

D: Profile of Massachusetts Plastics Industry, 1985

Massachusetts ranks in the top ten U.S. states according to the following criteria from the Society for the Plastics Industry:

Category	*Number*	*Rank*
Establishments	959	9
Employees	55,800	9
Payroll	$1.1 billion	9
Wages	$715 million	9
Value of Shipments	$6.0 billion	9
New Capital Expenditures	$250 million	7

E: Sources, Plastic Lumber Market Survey

- *Industry sources:* Plastic Institute of America; Society of the Plastics Industry; Center for Plastics Recycling Research; Plastics Research Foundation.

- *Manufacturers of recycled/mixed plastic products*: Mid-Atlantic Plastic Systems; N.E.W. Plastics; Polymer Products, Inc.; Processed Plastics Co. (subsidiary of Summit Steel).
- *Horse stalls*: American Horse Council; Massachusetts Food and Agriculture Department; Horseman's Yankee Pedlar Magazine; Yankee Horsetrader Magazine; Barn Yard Builders; Morton Buildings; Whitehaven Farms; Northeast Equine Supply.
- *Park benches*: M. E. O'Brien and Sons, Inc.; Commonwealth of Massachusetts Purchasing Agency; Massachusetts Parks Engineering and Construction; Game Time; Quality Industries; National Recreation Parks Association.
- *Boat docks*: International Marina Institute; American Boat and Yacht Council; Waterfront Design Associates; Atlantic Marine; Goodhue Marine; Ed Dougherty (Kingman Marina); National Marine Manufacturers Association; Barnegat Transportation.

F: Potential Financial Incentives

Name/Contact	*Investment Eligibility Criteria*	*Amount*	*Type*
1. *Massachusetts Technology Development Corporation (MTDC)* John Hodgeman (617) 723-4920	Investment in the following businesses – Hi tech – Start up or early expansion stage – viable product/service – unable to secure sufficient capital from conventional sources	$100,000–$500,000	Loan or equity
2. *Massachusetts Community Development Corp. (CDFC)* Milton Benjamin, Jr. (617) 742-0366	*Venture Capital Investment Program* Investment in the following businesses: – Must be in a community development corporation area – provide significant public benefit to CDC area residents – Unable to secure financing from conventional sources – Reasonable likelihood of success	$75,000–$300,000 Up to one-third of total financing	Loan or equity
	Community Development Program Same eligibility criteria as above – include sufficient ongoing CDC control – assist CDC in revitalizing residential, commercial and industrial property	Not more than $250,000; not more than 20% of project costs	Loan or equity
3. *Economic Development Administration (EDA)*	– As a general principal the assistant secretary of commerce has determined that		

Name/Contact	*Investment Eligibility Criteria*	*Amount*	*Type*
William Fitzhenry (617) 565-7236	Massachusetts is not eligible for EDA funds.		
	–The major program with funding availability *Public Works and Development Facilities Assistance* –Must conform with overall approved program from EDA.	50–80% of project cost excluding land acquisition	Grant
4. *Massachusetts Centers of Excellence (MCEC)* Megan Jones (617) 727-7430	Polymer Science Centers of Excellence at University of Lowell and University of Massachusetts–Amherst. –Leverage federal and funds –Information clearinghouse.	Leverage federal funds	Investment
5. *Massachusetts Capital Resource Company (MCRC)* William Torpey (617) 536-3900	Loans to the following businesses –Moody's Bond rating lower than BAA. –Unable to secure financing from conventional sources	$100,000–$5,000,000 fixed rate, long-term, subordinated	Loans
6. *Massachusetts Business Development Corporation (MBDC)* Kenneth Smith (617) 350-8877	Medium to long-term financing for companies that do not qualify for conventional financing	Average 1985 $400,000	Loans or equity
	U.S. Small Business Administration (SBA) Pollution Control Financing Guarantee Program –Net worth less than $6,000,000 –Net profit less than $2,000,000 –In operation 5 years –Profitable 3 out of 5 years	Max $5,000,000 over 30 years	100% guarantee
7. *Massachusetts Certified Development Corporation (MCDC)* Richard Tomeo (617) 565-5562	Administer SBA 503 Program	Maximum $500,000 Maximum guarantee = 90% Average loan $175,000	Guarantee Loan
	Administer SBA 504 Program –Net worth less than $600,000 –Net profit less than $2,000,000 for last 2 years	Lesser of 40% of project cost or $500,000	Mortgage
8. *The Thrift Fund* Paul Rupp (617) 227-0604	Priority is given to job intensive projects in areas of higher than average unemployment	No maximum, average $200,000–$500,000	Loans
9. *Massachusetts Government Land Bank*	Mortgage on Properties/ projects that must –Be blighted, decadent, substandard	$100,000–$3,000,000	Mortgage

Name/Contact	*Investment Eligibility Criteria*	*Amount*	*Type*
Kathleen Hogan (617) 727-8257	–Be financially feasible –Have community support –Leverage additional financing –Be replicable by other organizations		
10. *Executive Office of Community and Development (EOCD)* Karen Blair (617) 727-7001	*Economic Development Set Aside Program (EDSA)* Criteria are: –Creation/retention of low/moderate income jobs –Community needs –Substantial non-EDSA funding –Increased tax revenues –Community population less than 50,000 people –Community must apply	$50,000–$500,000 Max 25% of project cost	Loans or grants

REFERENCE

1. Chem Systems, Inc., *Plastics: AD 2000, Production and Use through the Turn of the Century*, Society of the Plastics Industry, Washington, D.C., 1987.

Direct reprint requests to:

Gretchen Brewer
Earth Circle
23 Harold Street
Somerville, MA 02143