PLASTICS RECYCLING COST OPTIMIZATION PROJECT

New York State
Department of Economic Development
Office of Recycling Market Development

April, 1998
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April 6, 1998

Mr. James Gilbert  
Market Development Specialist  
New York State Department of Economic Development  
Office of Recycling Market Development  
400 Andrews Street, Suite 710  
Rochester, NY 14604

Subject: Plastics Recycling Cost Optimization Project Report

Dear Jim:

We are pleased to submit the final report of the Plastics Recycling Cost Optimization Project. Thank you for your thoughtful comments during the course of the project and preparation of the final report.

The results of the project validated several strategies to reduce plastics recycling system costs, improve recycled plastics quality, and increase recycled plastics use in products. Field testing the strategies under real world conditions make the project results particularly applicable to other recycling entities. We hope the results of the project are shared with a wide audience.

Please feel free to call me at your convenience if you have any additional questions.

Sincerely,

R. W. BECK, INC.

Jonathan Burgiel  
Director, Environmental Services

cc: The United States Environmental Protection Agency  
The American Plastics Council  
The Procter & Gamble Company
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COMMUNITIES/COLLECTORS

CITY OF NIAGARA FALLS
CITY OF SCHENECTADY
COLUMBIA COUNTY
MODERN CORP./TOWN OF LEWISTON

HANDLERS

COLUMBIA COUNTY & RESOURCE RECOVERY SYSTEMS INC.
MODERN CORP.
SCHENECTADY COUNTY SOLID WASTE MANAGEMENT DISTRICT
WESTERN FINGER LAKES SOLID WASTE MANAGEMENT AUTHORITY
XEROX

RECLAIMERS

CLEARVUE POLYMERS INC.
OUT-SOURCE ENTERPRISES/XEROX
PURE TECH PLASTICS, INC.
WTE RECYCLING CORP. (OMITTED AT THE COMPANY’S REQUEST)

END PRODUCT MANUFACTURERS

BO-MER MANUFACTURING
CLEARPLASS CONTAINERS
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<td>EVALUATION OF STRATEGIES</td>
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</table>
How do we get plastics recycling off welfare? That is the question the Procter & Gamble Company, Quantum Chemical Company, and the American Plastics Council began asking in the early 1990's. Unlike other secondary materials processing industries that had been recycling for decades, such as the paper and metals industries, the post-consumer plastics recycling industry was a relative newcomer — approximately five years old. And the economics of plastics recycling when compared to other recycling industries wasn’t proving to be very favorable.

In response, the American Plastics Council formed the Cost Optimization Committee with representatives from the plastics manufacturing and plastics recycling collection, handling, and reclamation industries. The Committee analyzed potential strategies to improve the economics of plastics recycling. The analysis looked at the total impact of each strategy on the plastics recycling industry as an economic system. This holistic approach was particularly important because the post-consumer plastics recycling industry is a system where actions or processes undertaken (or not undertaken) by upstream entities can significantly affect the quality or full system cost of the recycled plastic or end product. As a result of the Committee's research, 16 Tactics For Cost Optimization was published.

The work done by the Committee caught the attention of the EPA and the New York State Department of Economic Development’s Office of Recycling Market Development. They committed to field test and implement several of the cost optimization strategies, and other recycled plastics improvement strategies, to see if the recommended strategies could actually reduce costs, create jobs, and lead to the development of sustainable recycling markets.

To meet these objectives, the Department; with funds from the American Plastics Council, the Procter & Gamble Company, and the EPA’s Jobs Through Recycling program, commissioned the consulting engineering firm of R. W. Beck, Inc. to lead a team of experts in conducting this Plastics Recycling Cost Optimization Project.

Costs incurred at one stage were projected to result in much greater savings at other stages, for an overall system cost reduction.

1EPA: U. S. Environmental Protection Agency.

2Department: New York State Department of Economic Development.
A total of 18 firms and communities in New York State participated in the Project\(^1\), representing all elements of the plastics recycling chain. Eleven improvement strategies were pilot tested, yielding the following results:

- A community was able to make collection and processing of plastic bottles more cost-efficient through implementation of a public education and awareness campaign. Although recycling education costs outweighed the operational efficiency gains for recovered plastics, specific program improvements included:
  - Householder recycling program participation levels increased;
  - Recyclables quality levels were improved; and
  - Recycling collection became more efficient as collected quantities increased.

- A facility that sorts and bales plastic bottles installed a perforator/flattener that allowed heavier bales to be produced. By improving bale weights, truck payloads were maximized and transportation economics improved. Although the perforator/flattener could not be used effectively for all types of plastic bottles, the equipment allowed the facility to save 1¢ per pound of plastics processed through the unit.

- A facility that reclams plastic bottles added equipment to detect and separate out certain contaminants, allowing it to purchase and reclaim more material, including plastics bottles that previously were recycled outside of New York State. As a result of the material increases, two local jobs were produced and reclamation costs decreased by 1¢ per pound because of improved economies of scale.

- A manufacturer of plastic bottles was able to produce bottles with 25 percent recycled plastic at a cost savings of nearly 3¢ per pound over virgin bottles. The recycled content plastic bottles had some defects from impurities in the recycled plastics. If the recycler invests in process improvements to improve the purity of the recycled plastics, the manufacturer still would be able to produce plastic bottles with recycled content comparable to bottles manufactured with virgin plastic with no cost disadvantage.

- A manufacturer of recycling bins was able to save 5¢ per
pound compared to virgin plastics by reclaiming plastic bottles, creating special recycled plastic blends from those reclaimed plastic bottles, and using those blends in its manufacturing operations.

- A manufacturer of transparent packages was able to save 5.5¢ per pound by using recycled plastic instead of the virgin plastic it was using.

Not all proposed improvement strategies were implemented, or proved successful. This Project, which was designed to field test theoretical cost saving strategies under real world conditions in New York State, revealed several important barriers:

- Benefits must be forecasted to substantially outweigh costs before private or public entities expressed willingness to modify practices (in other words, small gains may not be worth the pains).

- Strategies that have theoretical application may not be perceived as practical under the specific market and economic conditions faced by the plastics recycling industry;

- Competing priorities must be acknowledged, and may delay implementation of cost saving strategies; and

- The benefits from capital-intensive improvements may be impeded by lack of (or insufficient) access to capital.

To lower overall system costs and maximize the sustainability of New York’s recycling infrastructure, the valuable lessons from this Project need to be transferred to other entities in the State’s recycling chain. While many of the improvement strategies apply only to entities recycling plastics, several are broad enough to also benefit the general recycling community, including entities recycling other materials. New York should consider promoting widespread implementation of successful project strategies:

- Through workshops, an internet web page, and other means;

- By facilitating access to low cost capital (essential for this industry, which operates on low margins); and

- By providing specialized technical assistance to support strategy implementation.
In conclusion, there are a variety of cost optimization and improvement strategies, although all are not applicable to all situations. Choosing appropriate strategies and modifying them to individual circumstances reduces costs, improves recycled plastics quality, and results in the use of more recycled plastics in products.
Section 1

Introduction

Section 261 of Article 14 of New York State's Economic Development Law authorizes the New York State Department of Economic Development to identify special needs and problems facing secondary materials processing industries within New York State and to assist businesses within the industries to succeed. The Department\(^1\) does this through its Office of Recycling Market Development. The mission and objectives of ORMD\(^2\) are to:

- Facilitate the development of sustainable markets for New York recyclables;
- Promote economic activity so that jobs are created and retained in New York; and
- Encourage productivity through waste reduction and the beneficial use of secondary materials.

In reviewing the various secondary materials processing industries in the State\(^3\), ORMD concluded that the post-consumer\(^4\) plastics recycling industry needed special attention. Unlike other secondary materials processing industries that have been recycling for decades, such as the paper and metals industries, the post-consumer plastics recycling industry is a relative newcomer.

Plastic soft drink bottles were only first introduced in 1977, and then only soft drink bottles were recovered through deposit-return systems for reclamation. Recycling of most other types of post-consumer plastics did not begin to occur until the late 1980s, as municipal governments began to implement curbside recycling collection programs. Because of the youth of this new and developing industry, and concerns over the cost-effectiveness of plastics recycling, ORMD identified the need for technology transfer and technical assistance to New York companies and communities recycling plastics.

ORMD commissioned the consulting engineering firm of R. W. Beck, Inc. to lead a Project Team\(^5\) of experts to conduct a Plastics Recycling Cost Optimization Project to:

- Establish a more cost-effective post-consumer plastic reclamation infrastructure in the State; and
- Expand the base of manufacturers capable of using PCR\(^6\) as a feedstock supplement or substitute.

---

\(^1\) **Department**: New York State Department of Economic Development.

\(^2\) **ORMD**: Office of Recycling Market Development.

\(^3\) **State**: New York State.

\(^4\) **Post-consumer**: packaging or products that have entered the stream of commerce and served their intended useful purpose.

\(^5\) **The Project Team** was composed of:
- R. W. Beck, Inc.
- Bottom Line Consulting, Inc.
- Mr. Tom Tomaszek, special consultant.

\(^6\) **PCR**: post-consumer recycled plastic resin.
The Project\(^1\) was a public-private partnership, cooperatively funded by the Department, the American Plastics Council, the United States Environmental Protection Agency, and the Procter & Gamble Company.

The Department asked that the Project utilize existing research, development, and demonstration efforts when considering plastics recycling optimization strategies to ensure that the Project advanced recovery efforts in the State without duplicating previous research. The Project therefore drew heavily from the work of others and the Project Team members’ previous experience.

The Department’s ultimate goal is the successful field testing and implementation of several of the cost optimization and quality improvement strategies that were identified as part of the Project. In that respect, the Project was not just a study, but an exercise in actually implementing cost optimization strategies in the field.
The methodology used by the Project Team to achieve the Department’s stated goals consisted of two main phases. Phase 1 focused on identifying strategies to improve material quality and reduce the production cost of post-consumer plastics. Phase 1 also included identifying New York companies that could potentially implement those strategies successfully. Phase 2 involved implementing those quality and cost optimization strategies. This section provides an overview of the steps the Project Team undertook during the two phases. A more detailed explanation of the Project methodology can be found in Appendix A.

**PHASE 1 - IDENTIFY POTENTIAL PROJECT PARTICIPANTS AND IMPROVEMENT STRATEGIES**

Figure 2-1 provides a simplified illustration of the principal flow of plastics recyclables through the post-consumer plastics recycling chain.

![Simplified Post-Consumer Plastics Recycling Flowchart](image)

Note: for simplicity, the generators of recyclables (homes and businesses) and brokers or exporters that direct the flow of recovered plastics are not shown.

Representatives from each part of the recycling chain were selected as participants in the Project, using the following steps:

- Potential Project participants were evaluated using a set of specific selection criteria;
- Select potential Project participants were invited to group meetings to discuss the Project goals and improvement strategies; and
- Project participants were selected.

The criteria used to select Project participants can be found in Appendix A. Regional meeting materials can be found in Appendix B. Table 2-1 lists the selected Project participants alphabetically by type.

1Collector: a business or community that physically collects post-consumer plastics either through curbside collection, drop-off, or buy-back programs.

2Handler: a facility (such as a materials recovery facility) that sorts and densifies post-consumer plastics for shipment to reclaimers.

3Reclaimer: a business that sorts, granulates, washes, and/or pelletizes incoming baled or flaked PCR.

4End user or end product manufacturer: a business that manufactures an end product out of post-consumer and/or virgin plastic resin.
Table 2-1
Project Participants

| Collector/Community          | Handler                                | Reclaimer                            | End Product Manufacturer          |
|------------------------------|----------------------------------------|                                     |                                  |
| City of Schenectady          | Columbia County & Resource Recovery    | Clearvue Polymers Inc.              | Bo-Mer Manufacturing              |
|                             | Systems Inc.                           |                                      |                                  |
| Columbia County              | Modern Corp.                           | Outsource/Xerox Corp.               | Clearplass Containers Inc.        |
| Modern Corp./Town of Lewiston| Schenectady County                     | Pure Tech Plastics Inc.             | Confidential Corp.                |
| Modern Corp./City of Niagara Falls | Western Finger Lakes Solid Waste Management Authority | wTe Recycling Corp.              | Innovative Plastics Corp.        |
|                             | Xerox Corp.                            |                                      | McKechnie Plastic Packaging       |

One of the companies asked that its identity not be disclosed. It is referred to as “Confidential Corporation” in this report.

As Figure 2-2 shows, those Project participants were generally geographically grouped in different regions of the State.

Figure 2-2
Project Participant Locations
Section 2

Concurrent with the Project participant selection process, the Project Team assembled a portfolio of cost optimization and quality improvement strategies for testing and implementation in Phase 2. Those strategies are discussed in Section 3 of this report.

PHASE 2 - IMPLEMENTATION OF QUALITY AND COST OPTIMIZATION STRATEGIES

Phase 2 of the Project focused on implementing the quality and cost improvement strategies identified during Phase 1. Three steps were used in implementing the strategies:

**Step 1** — The Project Team visited the sites of the Project participants.

**Step 2** — Based on the results of the site visits, implementation plans were developed for each Project participant for feasible strategies.

**Step 3** — Project participants field-tested the strategies, with technical assistance from the Project Team.

The individualized attention provided to Project participants ensured that: (1) appropriate improvement strategies were selected for each entity; (2) an appropriate plan, including necessary analyses, had been completed; and (3) the Project participants had the technical capability to implement their plans (either internally, or through technical assistance from the Project Team).

Implementation plans for each Project participant can be found in Appendix C.

Each individual Project participant chose which, if any, improvement strategies it would implement. Ultimately, this meant that only improvement strategies that were appropriate for and chosen by the individual Project participants were evaluated in this Project.

The implementation plans included discussions of capital and operating costs, revenue projections, a return-on-investment analysis, conceptual facility modifications, and potential funding sources.

The individualized approach was very important for the success of this Project.
The Project Team assembled a list of cost optimization and quality improvement strategies for this Project based on their potential to improve the economics of post-consumer plastics recycling. While some strategies are very specific to plastics, others are general enough to be of value to the general recycling community, including entities recycling other materials. In response to ORMD’s interest in building on existing research and demonstration efforts, the Project Team assembled its list of improvement strategies from:

- 16 Tactics For Cost Optimization, a document created by the American Plastics Council’s Cost Optimization Committee;
- The Project Team’s previous experience.

APC\(^1\) formed the Cost Optimization Committee with representatives from the plastics manufacturing and plastics recycling collection, handling, and reclamation industries. The Committee analyzed potential strategies to improve the economics of plastics recycling, and published the results of its research in a document titled 16 Tactics For Cost Optimization. The Cost Optimization Committee’s analysis looked at the total impact of each strategy on the post-consumer plastics recycling industry as an economic system. This holistic approach was particularly important because the plastics recycling industry is a system where actions or processes undertaken (or not undertaken) by upstream entities can significantly affect the quality or full system cost of PCR and end products produced. Several of the 16 tactics require cooperation among plastics recycling chain entities for successful implementation.

The Project Team’s previous experience was the second source for cost optimization and quality improvement strategies. Strategies from the Project Team focused on reducing costs by automating handling and reclamation processes, and increasing revenues by improving PCR quality and performance.

Table 3-1 lists the cost optimization and quality improvement strategies assembled by the Project Team, including the strategy source and the economic impact (cost or benefit) on each entity and the plastics recycling chain as a whole. In general, the strategies are listed in order from most applicable

\(^1\)APC: American Plastics Council.
Plastics Recycling Cost Optimization Project

New York State Department Of Economic Development

to communities, to most applicable to end product manufacturers.

Table 3-1
Improvement Strategies and System Cost Impacts

<table>
<thead>
<tr>
<th>Improvement Strategy</th>
<th>Community</th>
<th>Collector</th>
<th>Handler</th>
<th>Reclaimer</th>
<th>End Product Manufacturer</th>
<th>Net System Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term bottle supply contracts¹</td>
<td>-0.5</td>
<td>-0.5</td>
<td></td>
<td></td>
<td></td>
<td>-1.0</td>
</tr>
<tr>
<td>Increase householder participation in recycling²</td>
<td></td>
<td></td>
<td></td>
<td>-1.4</td>
<td></td>
<td>-1.4</td>
</tr>
<tr>
<td>Householders step on bottles¹</td>
<td>-4.0</td>
<td>+0.5</td>
<td></td>
<td></td>
<td></td>
<td>-3.5</td>
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<tr>
<td>Householders remove caps¹</td>
<td></td>
<td></td>
<td>-1.0</td>
<td>-0.1</td>
<td></td>
<td>-1.1</td>
</tr>
<tr>
<td>Collectors tag and leave unacceptable items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share materials revenues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long-term sales contracts¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Automate the handling of collected plastics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto-sort plastic bottles by resin¹</td>
<td>-2.0</td>
<td>-1.0</td>
<td></td>
<td></td>
<td></td>
<td>-3.0</td>
</tr>
<tr>
<td>Improve bottle design for recyclability²</td>
<td>-0.7</td>
<td>-0.8</td>
<td></td>
<td></td>
<td></td>
<td>-1.5</td>
</tr>
<tr>
<td>Bulk ship unwashed, sorted flake from handler to reclaimer¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-2.5</td>
</tr>
<tr>
<td>Automate the handling of recovered plastics and PCR at reclaimers</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>PCR/virgin melt blended pellet¹</td>
<td></td>
<td></td>
<td></td>
<td>+2.0</td>
<td>-5.0</td>
<td>-3.0</td>
</tr>
<tr>
<td>Bulk receipt/handling of PCR flake or pellet¹</td>
<td>0.6</td>
<td>-4.0</td>
<td></td>
<td></td>
<td></td>
<td>-3.4</td>
</tr>
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<td>State-of-the-art reclaim</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct use of flake PCR in wheel machines¹</td>
<td></td>
<td></td>
<td></td>
<td>-3.5</td>
<td></td>
<td>2.2</td>
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<tr>
<td>Integrate reclamation with manufacturing²</td>
<td></td>
<td></td>
<td></td>
<td>-1.0</td>
<td></td>
<td>-1.0</td>
</tr>
<tr>
<td>Long-term PCR contracts (converters and reclaimers)¹</td>
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<td></td>
<td></td>
<td>-0.7</td>
<td></td>
<td>-0.8</td>
</tr>
</tbody>
</table>

¹One of the American Plastics Council's 16 tactics.
²Non-quantified cost savings.
³Could be a cost or cost savings depending on fleet utilization.

Non-quantified additional cost or revenue increase.

Non-quantified cost savings.
Section 3

Improve Strategies

<table>
<thead>
<tr>
<th>Improvement Strategy</th>
<th>Community</th>
<th>Collector</th>
<th>Handler</th>
<th>Reclaimer</th>
<th>End Product Manufacturer</th>
<th>Net System Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto-sort plastic bottles by color(^1)</td>
<td></td>
<td></td>
<td>-4.5</td>
<td>-2.0</td>
<td>-6.5</td>
<td></td>
</tr>
<tr>
<td>Long-term PCR sales (converters and customers)(^1,3)</td>
<td></td>
<td></td>
<td></td>
<td>-0.8</td>
<td>-1.5</td>
<td></td>
</tr>
<tr>
<td>PCR/virgin dry pellet blend(^2)</td>
<td></td>
<td></td>
<td></td>
<td>-4.7</td>
<td>-4.7</td>
<td></td>
</tr>
<tr>
<td>Manufacture high value-added products with PCR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selective blending and compounding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^3\)Package filler cost savings of 0.7 cents per pound not shown.

Appendix D includes a reproduction of APC’s summary document on the 16 tactics, which includes discussions on individual and system-wide cost savings for each. Other related best management practice document information can also be found in Appendix D. Descriptions of each improvement strategy listed in Table 3-1 follow.

**APC’S 16 TACTICS FOR COST OPTIMIZATION**

Listed below are descriptions of APC’s 16 Tactics For Cost Optimization:

- **Long-Term Bottle Supply Contracts** — In this tactic, the collector would sign long-term contracts with communities for collection of specified bottles.

- **Increase Householder Participation In Recycling** — By increasing householder participation the quantity and quality of the material collected can increase.

- **Householders Step On Bottles** — Residents can be instructed to step on bottles prior to collection. This action will result in a 25 percent reduction in the volume of plastic bottles, which should reduce vehicle payload costs by nearly 20 percent. Municipalities may incur some new educational costs.

- **Householders Remove Caps** — In this tactic residents are instructed to remove caps from bottles prior to collection. Municipalities will incur some new educational costs.
- **Long-Term Sales Contracts** — Two types of long-term sales contracts were considered as tactics. The collector may sign a long-term contract with the handler to take its collected bottles at a pre-agreed pricing structure or arrangement. The handler may sign the same type of agreement to sell its baled or ground bottles.

- **Auto-Sort Plastic Bottles By Resin** — Automated sorting of plastics results in reduced labor costs and improved quality. Most systems would probably be used only to separate two high-volume resins or two incompatible resins.

- **Improve Bottle Design For Recyclability** — A number of specific design changes can be implemented by the bottle manufacturer to reduce PCR production costs, including:
  - Use water-soluble glues that release readily;
  - Use caps that are the same color as the bottle, unpigmented, or made from the same resin as the bottle;
  - Design “peel seals” that peel off completely with no residue; and
  - Make multilayer bottles of recycling-compatible resins.

- **Bulk Ship Unwashed, Sorted Flake From Handler To Reclaimer** — In this tactic, the handler sorts and granulates bottles, producing PCR flake. Shipments of flake are transported by hopper truck or rail car to the reclaimer. The tactic is based on the assumption that the handler can achieve consistent quality, the handler and reclaimer have bulk handling systems and that flaking does not increase transportation costs.

- **PCR/Virgin Melt Blended Pellet** — Using a PCR/virgin blend in bottles forestalls the need for new multilayer equipment. This tactic avoids future costs, it does not reduce the current system cost of recycling.

- **Bulk Receipt/Handling Of PCR Flake Or Pellet** — Bulk shipment of PCR flake or pellet (in hopper trucks or rail cars instead of gaylords or sacks) from the reclaimer to the converter reduces handling, packaging and shipping costs.

- **Direct Use Of Flake PCR In Wheel Machines** — Using clean flake PCR instead of pellet PCR eliminates additional processing. This requires adding a commercially available automatic screen changer. Clean PCR flake can also be used
in thick-walled applications not requiring melt filtration such as drainage pipe, tote bins, and trash cans.

- **Integrate Reclamation With End-Product Manufacturing** — Vertical integration is a natural outcome of a maturing recycled material industry. Integration can take two forms: converters could start reclaiming plastics, or reclaimers could start converting PCR to end products. This tactic can reduce transaction, transportation and other logistical costs.

- **Long-Term PCR Contracts For Converters And Reclaimers** — In this tactic, the converter would sign a long-term supply contract with the reclaimer for PCR.

- **Auto-Sort Plastic Bottles By Color** — This tactic would enable end users to incorporate colored PCR directly into their pigmented products without resorting to a multilayer bottle.

- **Long-Term PCR Sales For Converters And Their Customers** — The bottle converter would establish long-term contracts to supply its customers with bottles containing PCR in this tactic.

- **PCR/Virgin Dry Pellet Blend** — By using a dry pellet blend, the converter can vary the percentage of PCR used in a particular application. It allows companies to use PCR, primarily in bottles, without investing in new multilayer bottle production equipment or using more expensive “melt blend” pellets. This tactic avoids future investment costs; it does not reduce the current system cost of recycling.

### OTHER PROJECT COST OPTIMIZATION STRATEGIES

Other Project cost optimization strategies that were based on the Project Team’s knowledge and previous experience are listed and described below:

- **Collectors Tag And Leave Unacceptable Items** — Rather than collect unacceptable items (either because the material is not included in the program or because the material has not been properly prepared), collectors should leave behind and tag the unacceptable item. This educates the householder, and minimizes future handling costs.

- **Share Materials Revenues** — Sharing materials revenues among the community, collectors, and the handler provides
an incentive for all to maximize quality.

- **Automate The Handling Of Collected Plastics** — Install feed and conveying equipment at materials recovery facilities to reduce personnel costs associated with handling plastic bottles. Install perforator-flatteners to minimize the bunker space required for plastics, promote faster feeding of balers/grinders, and produce higher density bales for reduced transportation costs.

- **Automate The Handling Of Recovered Plastics And PCR At Reclaimers** — Install feed and conveying equipment to reduce personnel costs associated with handling recovered plastics and PCR. Install metal detectors/separators and flake-level automated sorters for quality control.

- **State-Of-The-Art Reclaim** — Reclaiming PET or HPDE in state-of-the-art plants can allow the use of PCR in higher value applications. For example:
  - Concerns over food safety limit the use of PCR in food-contact applications to PCR produced by state-of-the-art reclaim plants. Food-contact applications are some of the highest value applications available.
  - Special processing of PET, called solid stating, can upgrade its properties for use in demanding blow molding or thermoforming operations.

- **Manufacture High Value-Added End Products With PCR** — Manufacturing high value-added end products with PCR provides for market stability and the potential to improve profit margins through additional processing, such as additional sorting (by color) or finishing steps.

- **Selective Blending And Compounding** — Selective blending and compounding can upgrade physical properties, adding value to the PCR. For example:
  - Blending LLDPE into HDPE can improve impact strength.
  - Blending PET and polycarbonate, or glass-filling PET can upgrade its properties for use in durable products.
  - Blending high melt flow index grades of plastics into low melt flow index grades (from recycled plastic bottles) can allow the material to be injection molded.
  - Blending virgin and recycled plastics can reduce batch inconsistency and allow properties to be upgraded.
The goal of the Project was to field test and implement several of the cost optimization and quality improvement strategies to see if the strategies could reduce costs, create jobs, and lead to the development of sustainable recycling markets.

This section presents the strategies implemented by Project participants and discusses the implementation results that were available at the Project conclusion. In addition, information is provided on obstacles to strategy implementation for those participants who elected not to implement recommended strategies.

Table 4-1 lists the improvement strategies and implementing entities. Discussions about the strategies and results are organized in the sections that follow by the categories of implementing entities.

<table>
<thead>
<tr>
<th>Improvement Strategy</th>
<th>Implementing Entity</th>
<th>Community</th>
<th>Collector</th>
<th>Handler</th>
<th>Reclaimer</th>
<th>End Product Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase household participation in recycling</td>
<td>City of Niagara Falls</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>City of Schenectady</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Town of Lewiston</td>
<td></td>
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<tr>
<td></td>
<td>Modern Corporations</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Householders step on bottles</td>
<td>City of Niagara Falls</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>City of Schenectady</td>
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<td></td>
<td>Town of Lewiston</td>
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<tr>
<td></td>
<td>Modern Corporations</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Householders remove caps</td>
<td>City of Niagara Falls</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>City of Schenectady</td>
<td></td>
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<td></td>
<td>Town of Lewiston</td>
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<tr>
<td></td>
<td>Modern Corporations</td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collectors tag and leave unacceptable items</td>
<td>City of Schenectady</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share recovered material revenues</td>
<td>Columbia County Resource Recovery Systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Modern Corporations is included because it is responsible by contract for recycling program education and awareness in the City of Niagara Falls and the Town of Lewiston.

2 Implemented prior to the Project start.
<table>
<thead>
<tr>
<th>Improvement Strategy</th>
<th>Implementing Entity</th>
<th>Community</th>
<th>Collector</th>
<th>Handler</th>
<th>Reclaimer</th>
<th>End Product Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automate the handling of collected plastics</td>
<td>Modern Corporations Western Finger Lakes Solid Waste Management Authority Xerox Corp./Outsource</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto-sort plastic bottles by resin</td>
<td>Pure Tech Plastics wTe Recycling Corp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automate the reclamation of recovered plastics</td>
<td>Xerox Corp./Outsource</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulk receipt/handling of PCR flake or pellet</td>
<td>Mckechnie Plastic Pack.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>State-of-the-art reclaim</td>
<td>Pure Tech Plastics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Direct use of flake PCR in wheel machines</td>
<td>Clearplass Containers Mckechnie Plastic Pack.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrate reclamation with manufacturing</td>
<td>Clearvue Polymers Confidential Corporation</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Auto-sort plastic bottles by color</td>
<td>Pure Tech Plastics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>PCR/virgin dry pellet blend</td>
<td>Clearplass Containers Mckechnie Plastic Pack.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacture high value-added products with PCR</td>
<td>Clearplass Containers Innovative Plastics Corp. Mckechnie Plastic Pack. Confidential Corporation Xerox Corp./Outsource</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selective blending and compounding</td>
<td>Confidential Corporation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Implemented prior to the Project start.

**COMMUNITIES/COLLECTORS**

The Town of Lewiston, the City of Schenectady, and the City of Niagara Falls implemented education and awareness programs to achieve the following improvement strategies:

- Increase householder participation in recycling;
- Motivate households to remove caps; and
Section 4

The education and awareness program in the City of Niagara Falls was just being implemented as the Project concluded, so results are not included in this report.

Results for the City of Schenectady were obtained; however, some of the data were anomalous, calling into question other data for the program. For that reason Schenectady’s results are not discussed here. A full discussion of the education and awareness program implemented in Schenectady, the methodology used to measure changes, and Schenectady’s data can be found in Appendix E.

Results for the Town of Lewiston follow. As with the City of Schenectady, additional detail about the education program and data collection methodology for Lewiston are included in Appendix E.

Detailed information about strategy implementation for all three communities can be found in Appendix C.

**TOWN OF LEWISTON**

The Town of Lewiston is a small community of 15,500 people located just north of Niagara Falls. Lewiston has approximately 4,000 single family households that receive weekly curbside collection of recyclables, including all plastic bottles. Lewiston had changed its list of targeted plastics from PET and HDPE plastic bottles only to all plastic bottles shortly before the Project began. Although residents had been informed of the program change, Lewiston and its collection contractor, Modern Recycling Corporations, were interested in improving the efficiency of plastics collection and handling by increasing collected plastic bottle quality, tonnage, and density so that downstream costs could be avoided.

A special plastics recycling education and awareness campaign was implemented, including: the distribution of printed material (door hanger brochures as shown in Figure 4-1), a local newspaper advertisement, an Earth Day special event, a recycling challenge by the Town’s Mayor, and local press coverage.

Recycling program statistics were collected before and after the education and awareness campaign. Figure 4-2 documents the results.
Desired plastics: the percentage of plastics collected identified as acceptable by the recycling program.

Bottles without caps: the percentage of plastic bottles without caps or pumps.

Capture rate: the percentage of desired plastics (bottles) placed by recycling participants in their recycling bins as opposed to the garbage.

Participation rate: the percentage of homes that set recyclables out for collection at least once during a four-week monitoring period.

As Figure 4-2 shows, contamination was reduced by approximately 4 percent (measured as an increase in desired plastics from 94 to 98 percent of the total plastics received).

Participants also appeared more willing to remove and dispose of caps and pumps; the percentage of bottles collected without caps rose 11 percent (from 39 to 50 percent). It is important for recycling program participants to remove caps and pumps from plastic bottles. If they don’t, downstream recyclers must do so at an added cost.

Figure 4-2 also shows an increase in the capture rate for plastic bottles from 54 to 58 percent. A higher capture rate means more plastic bottles are diverted from the garbage of participating householders to the recycling bin. This makes collecting recyclables more efficient. Finally, participation in the recycling program increased from 75 percent to 82 percent. Information about changes in the percentages of bottles flattened by participants, while measured, was inconclusive.

Table 4-2 below summarizes the pertinent costs and cost reductions (savings) as a result of the recycling education and awareness campaign. Costs data are shown two ways. The first column (“Cost (Reduction) Per Incremental Pound”) shows incremental changes in cost divided by additional amounts of plastic bottles collected. The second column (“Cost (Reduction) Difference Between Average Pound Costs”) shows the difference between “before” and “after” average costs.
Table 4-2
Town of Lewiston Cost Optimization Analysis

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost (Reduction) Per Incremental Pound</th>
<th>Cost (Reduction) Difference Between Average Pound Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection</td>
<td>23.1 cents per pound</td>
<td>(3.5) cents per pound²</td>
</tr>
<tr>
<td>Handling</td>
<td>6.4 cents per pound</td>
<td>(0.4) cents per pound²</td>
</tr>
<tr>
<td>Avoided Disposal Tip Fee</td>
<td>(1.6) cents per pound</td>
<td>0.0²</td>
</tr>
<tr>
<td>Material Revenue</td>
<td>(13.9) cents per pound</td>
<td>0.0²</td>
</tr>
<tr>
<td>Cap Removal Savings²</td>
<td>none assumed</td>
<td>none assumed</td>
</tr>
</tbody>
</table>

**Operational Cost Optimization**

| Plastics Education Campaign⁴      | 128.0 cents per pound                  | 17.5 cents per pound                                  |

| **Net Cost Optimization**         | **142.0 cents per pound**              | **13.6 cents per pound**                              |

¹ Efficiency-related impacts from increases in plastic bottles recycled.
² Per pound values are independent of amount, therefore the difference is zero.
³ Reduced contamination levels provide savings for some handlers and reclaimers of a few cents per pound because less sorters are needed to remove contaminants. The primary contaminant is pigmented caps on natural HDPE bottles. Modern’s market however, is not sensitive to caps — therefore, no savings was assumed.
⁴ Education campaign costs ($2,000 or 50 cents per home) included printing costs of the door hangers, the newspaper advertisement cost, and incremental costs for plastics specific programs at the Earth Day event, which was already scheduled. Boy Scouts distributed the door hangers as a community service project, so no distribution costs were included. Education campaign costs were divided by total plastics collected in 6 months. This assumes higher total collection levels from education campaign are effective for 6 months before education must be repeated.

Cost figures will vary by community depending on recycling increases and education campaign costs.

Lewiston diverted over 15 percent more plastic bottles at a net cost of 142.0 cents per additional pound recovered, or 13.6 cents when averaged over all pounds.

Appendix E contains additional detail on the cost calculations shown in Table 4-2. Lewiston was able to recycle over 15 percent more plastic bottles, although as Table 4-2 shows recycling added costs when compared to disposal. Table 4-2 also shows that the targeted plastics recycling education program's unit average costs far outweighed the operational unit average cost reductions that were achieved. It would be improper, however, to conclude that public education programs are unwarranted based on this analysis. Here's why:

- Unit cost improvements are also usually seen in other materials as well — this is known as the spill-over effect. For example, increased householder recycling participation benefits all materials. These cost improvements for other materials have not been included in the above analysis.
- The unit cost results might have been completely different if a less expensive education and awareness campaign had...
been implemented. For example, radio public service announcements are available from the American Plastics Council at no cost. As long as local radio stations air PSAs\(^1\) for free, there would be virtually no out-of-pocket costs.

- Finally, Lewiston’s recycling program participation rate was 75 percent before the education and awareness campaign began. This participation rate is higher than the average recycling program based on data from the American Plastics Council. Other communities with lower participation rates have the potential to post greater improvements, which would improve the results.

**Community/Collector Improvement Strategies Evaluation**

The strategies implemented in Lewiston proved to be effective in recovering more plastic bottles and reducing unit operational costs associated with plastic bottle collection and handling. Educational costs, however, were more expensive than savings that occurred from operational unit cost reductions.

Other studies have shown that recycling education and awareness messages must be periodically repeated in order to maintain gains that are achieved, sometimes as frequently as every 4 to 6 months. Each community must weigh education program costs against the benefits that are achieved, including increased diversion of recyclables from disposal.

**Handlers**

Three handlers — Modern Corporations, the Western Finger Lakes Solid Waste Management Authority, and the Xerox/Outsource partnership — selected implementation of the improvement strategy to automate the handling of collected plastics. Modern Corporations and the Western Finger Lakes Solid Waste Management Authority sought to reduce handling costs for plastic bottles collected through municipal recycling collection programs. The Xerox/Outsource partnership sought to reduce handling costs for scrap copier toner bottles recovered through Xerox’s toner bottle refill program.

Because the Western Finger Lakes Solid Waste Management Authority and the Xerox/Outsource partnership were just beginning implementation as this Project concluded, no results were available. Results obtained for Modern Corporations are

\(^1\) PSAs: public service announcements.
discussed below. Detailed strategy implementation information for all three handlers can be found in Appendix C.

**Modern Corporations**

Modern Corporations sorts plastic bottles by type and bales them for transport to market. Modern Corporations’ baler did not allow for the use of additional bale ties to contain baled plastic bottles. Without additional bale ties, the pressure exerted on the existing ties by full-size high-density bales of plastic bottles was causing the ties to snap. Modern Corporations originally compensated for this problem by making reduced-size medium-density bales. Although bale ties no longer snapped, the reduced-size medium-density bales kept Modern Corporations from achieving sufficient bale densities to fully load trucks to their legal weight limit (usually a payload of approximately 40,000 pounds). This density deficit resulted in inefficient transfer of processed plastic bottles to market because additional truck trips were required.

In order to overcome this problem, Modern Corporations installed a perforator/flattener adjacent to its sorting conveyor, and over one of its plastics bunkers, allowing sorted grades of plastics to be perforated and flattened prior to baling. Figure 4-3 shows the perforator/flattener installed at Modern’s facility.

![Figure 4-3 Perforator/Flattener](image-url)

Modern installed a perforator/flattener to improve plastic bottle bale density, reducing shipping costs.
Perforated and flattened plastic bottles exerted less pressure during and after baling, enabling Modern to produce full-size high-density bales that wouldn’t snap bale ties. As a result, more baled plastic bottles fit in trucks after perforator/flattener usage than before, as Figure 4-4 illustrates.

As Figure 4-4 shows, the perforator/flattener was very effective in helping Modern improve the quantity of baled plastics it could load on trucks. As Table 4-3 illustrates, Modern Corporations was able to save 1 cent per pound for plastic bottles that were processed through the perforator/flattener.

Modern Corporations saved 1.0 cent for every pound of plastic bottles it processed through the perforator/flattener.

<table>
<thead>
<tr>
<th>Modern Corporations Cost Optimization Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost Category</strong></td>
</tr>
<tr>
<td><strong>Incremental Costs (Reductions)</strong></td>
</tr>
<tr>
<td>Baling Cost</td>
</tr>
<tr>
<td>Freight Costs</td>
</tr>
<tr>
<td>Operation and Maintenance</td>
</tr>
<tr>
<td>Depreciation</td>
</tr>
</tbody>
</table>

Table 4-3

Modern Corporations saved 1.0 cent for every pound of plastic bottles it processed through the perforator/flattener.

1 Based on processing 240,000 pounds per year of natural HDPE bottles through the perforator/flattener.

2 $6,275 total capital cost depreciated over five years.

These savings result from improved operational efficiencies and transportation economies. Operational efficiencies resulted because pre-flattened plastic bottles allowed more plastics to be fed into the baler’s feed chamber per cycle, allowing bales to be made at a much faster rate, which lowered baling costs. Transportation economies resulted because
denser bales allowed more baled plastic bottles to be loaded on trucks. The increased bale densities also benefited Modern Corporations’ reclamation market by lessening baled natural HDPE bottle handling costs. While the reclaimer couldn’t quantify the cost savings, bales can be off-loaded from trucks and fed into the reclaim system at a faster rate than before.

**Handler Improvement Strategy Evaluation**

Installing a perforator/flattener at Modern Corporations was effective because baler throughputs were improved and more baled plastics fit on trucks after installation than before. This resulted in a net savings of 1 cent for every pound of plastic bottles processed through the perforator/flattener. The critical factor for strategy effectiveness was the ability of the perforator/flattener to effectively flatten and produce air holes in plastic bottles, so plastics could be fed into the baler at an increased rate and greater bale densities could be achieved.

Some drawbacks were noted with the perforator/flattener. The first was a tendency for milk jugs and other large round bottles to ride above, rather than be drawn into, the unit (this may be an isolated problem with the particular model that was used). A second drawback was that perforated detergent bottles leaked residual detergent over equipment, floors, and truck trailers, making the perforator unsuitable for processing pigmented HDPE bottles or unsorted mixed plastic bottles.

**Reclaimers**

Improvement strategies selected for implementation by reclaimers as part of this Project included:

- Auto-sort plastic bottles by resin; and
- Automate the reclamation of recovered plastics.

Pure Tech Plastics and wTe Recycling Corporation are both PET bottle reclaimers that selected the first strategy. The Xerox/Outsource partnership to recycle plastics from old business equipment such as copiers selected the second strategy. As this Project was concluding, Pure Tech Plastics and the Xerox/Outsource partnership were just beginning implementation of their improvement strategies. Consequently, implementation results for Pure Tech Plastics and the Xerox/Outsource partnership were not available at the time this report was prepared. The results of wTe Recycling.

**Drawback:** residual detergent leakage from pigmented HDPE bottles limited use of the perforator/flattener to sorted PET and natural HDPE bottles.
Corporation’s improvement plan implementation is discussed below. Detailed information about strategy implementation for all three reclaimers can be found in Appendix C.

**WTE RECYCLING CORPORATION**

WTE Recycling Corporation reclaims PET bottles. PET PCR must be very pure for many recycled product applications, such as bottles or sheet products. For example, some end users limit PVC contamination in secondary PET streams to 1 PVC bottle for every 100,000 PET bottles (10 parts per million, or ppm). Typical industry specifications for PVC contamination by recycled product application are 10 ppm for bottles and sheet, 20 ppm for strapping, 100 ppm for compounding, and 200 ppm for fiber. Such stringent purity requirements cannot be met by laborers on a manual sorting line because PVC and PET bottles look very much alike. PET bottles that have been manually sorted from the curbside recycling stream typically contain 7,000 ppm of PVC bottles — 35 to 700 times the allowable limit depending on the recycled product application.

Some type of automated PVC bottle removal equipment is a virtual necessity if curbside-recovered PET bottles are to be reclaimed. Because WTE didn’t have automated PVC removal equipment, it was limited to sourcing PET soft drink bottles from deposit/return programs. To overcome this limitation, WTE installed flake-level auto-sort equipment to remove PVC flake contaminants from ground PET bottles. Figure 4-5 on page 4-11 shows the flake-level PVC separator.

After the automated sorting equipment was installed, WTE was able to source and recycle 4 million pounds of curbside-collected PET bottles in addition to the amount of PET soft drink bottles from deposit/return programs it previously recycled. The reclaimed PET it produced met the maximum PVC threshold requirements of its customers.

Because WTE holds its operating data confidential, a detailed economic analysis of the equipment was not possible for this report. WTE did, however, attribute the creation of 2 full-time positions to the additional material throughput allowed by the equipment, and an overall cost reduction of 1 cent per pound of PET PCR produced, primarily because of improved efficiencies and operating margins associated with the increased throughput. WTE is interested in recycling greater quantities of curbside-collected PET bottles in the future.
Two key factors enabled Pure Tech’s improvement strategy to succeed:

- The availability of capital for the purchase of the automated sorting equipment.
- The ability of that equipment to remove contaminants and meet purity requirements.

END PRODUCT MANUFACTURERS

The following sections describe improvement strategies implemented by the end-product manufacturers of Clearplass Containers, Confidential Corporation (the company asked that its identity not be disclosed), Innovative Plastics Corporation, and McKechnie Plastic Packaging, and provide summaries of results. More detailed information about each end product manufacturer’s improvement strategy implementation is included in Appendix C.

CLEARPlass CONTAINERS

Clearplass Containers manufactures plastic bottles and containers from a variety of plastic resins. Clearplass
Containers previously used post-consumer PET for some of its plastic bottles, but wasn’t pleased with the results. It was willing to give PCR a second try, however, and with the assistance of the Project Team, implemented the following improvement strategies:

- Direct use of flake PCR;
- PCR/virgin dry pellet blending; and
- Manufacture of high value-added products with PCR.

Four different batches of PET PCR flake and pellet were obtained and molded at a 25 percent recycled/75 percent virgin ratio into oval PET bottles for testing. Figure 4-6 shows one of many bottles molded. The PET PCR batches included: (1) clean flake from curbside-collected PET bottles; (2) solid stated pellets from soft drink bottles returned through a deposit program; (3) standard pellets from deposit soft drink bottles; and (4) clean flake from deposit soft drink bottles. The batches were obtained from three different reclamation plants.

**Figure 4-6**

Recycled Content PET Bottle

Clearplass Containers conducted plastic bottle manufacturing trial tests with recycled plastics.

---

1 **Solid stating**: a process to improve the properties of PET by continuing the chemical reaction by which PET is made.

Figure 4-7 shows Top Load Strength test results for both recycled content PET bottles and virgin bottles manufactured by Clearplass Containers. Top load strength is a critical shipping factor, because it determines how high boxes of filled PET bottles can be stacked before the bottles on the bottom buckle. Figure 4-7 shows that all recycled content bottles, except those manufactured from deposit soft drink bottle flake,
Recycled content bottles, except those manufactured from deposit flake, exceeded the strength of virgin bottles.

Recycled content bottles manufactured from recycled PET matched the virgin bottles’ resistance to failure, depending on the recycled PET origin and supplier.

1As measured by an internal Clearplass test method. Figures are the mean of 20 samples tested from each batch.
Figures 4-7 and 4-8 illustrate that performance test results can vary depending on the PET PCR origin and supplier. The Project Team did not expect bottles manufactured from deposit flake PET PCR to perform significantly worse than the other recycled content bottles. Its reduced performance is attributed to lower quality PCR from the one reclamation facility. The most notable results, however, are that PET bottles manufactured from PET PCR (with the exception of deposit flake) matched or out-performed virgin PET bottles. To understand how recycled plastic can outperform virgin plastic, one must first understand PET resin chemistry.

PET forms microscopic crystals that strengthen the material — as more crystals form, strength and stiffness increase. Recycled PET tends to form more crystals than virgin PET because:

- Recycled PET molecules have become shorter (and therefore faster) from previous bottle molding and recycling processing, allowing them to form crystals more rapidly; and
- Minor impurities not removed through the reclamation process provide incubation sites where additional microscopic crystals form.

Recycled PET’s tendency to form more crystals and become stronger isn’t necessarily better. If PET bottles become too crystalline and stiff, they can fail when dropped (as illustrated by Figure 4-8).

Manufacturing process conditions (process temperatures and time at those temperatures) also affect crystallization. For example, more crystals form when PET products are produced at hotter temperatures and when PET products are slowly cooled rather than rapidly cooled.

Careful attention to process conditions is always required whether manufacturing recycled or virgin PET products. Skilled manufacturers adjust process conditions to control crystallinity in recycled PET products and achieve the proper balance of strength and impact as part of their day-to-day operations. Proper process adjustments can ensure that PET PCR performs as well as virgin.

PET PCR also proved to provide a significant cost advantage over virgin PET, as Table 4-4 shows.
### Table 4-4

**Clearplass Containers Cost Optimization Analysis**

<table>
<thead>
<tr>
<th>Incremental Cost Category</th>
<th>PCR PET Flake</th>
<th>PCR PET Pellets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin Price Compared to Virgin&lt;sup&gt;1&lt;/sup&gt;</td>
<td>(15) cents per pound</td>
<td>(4) cents per pound</td>
</tr>
<tr>
<td>Average Resin Savings&lt;sup&gt;2&lt;/sup&gt;</td>
<td>(3.75) cents per pound</td>
<td>(1) cents per pound</td>
</tr>
<tr>
<td>Blending Cost</td>
<td>1 cents per pound</td>
<td>1 cents per pound</td>
</tr>
<tr>
<td>Net Production Cost (Savings)</td>
<td>(2.75) cents per pound</td>
<td>0 cents per pound</td>
</tr>
</tbody>
</table>

<sup>1</sup> Bottle grade virgin (solid stated) and PCR (non-solid stated) resins.

<sup>2</sup> Average represents a 25 percent PCR loading.

As Table 4-4 shows, Clearplass was able to manufacture PET bottles with 25 percent PCR content at a cost savings of 2.75 cents per pound, when PCR PET flake was used. Using PCR PET pellets resulted in no net cost or cost savings. As higher levels of PCR flake or pellets are used the average resin savings increases, and the economic comparison becomes more in favor of PCR usage.

Although the PET PCR was able to outperform virgin material at a cost savings, some of the PET PCR had cosmetic issues that Clearplass wants addressed prior to committing to production runs of PET bottles with recycled content. Those cosmetic issues included:

- An almost imperceptible gray cast not found in the virgin plastic; and
- Small particulate contaminants.

The gray cast can be found in PET bottles made with either PCR flake or pellets. The particulates are primarily found in bottles made with PCR flake, because the PET in PCR pellets has been filtered to remove particulates. These cosmetic drawbacks can be alleviated by reclaimers through careful control over or minor modifications to cleaning and finishing processes. These modifications can include running wash lines at a slower pace, changing wash water more frequently, improving water treatment systems, or passing finished flake through contaminant separators more than once. Additional costs incurred by these changes average approximately 1-2 cents per pound to produce a premium grade. If process improvements were implemented, the cost savings exhibited by PCR flake at a 25 percent loading would be eliminated.

Some recycled PET bottles manufactured had cosmetic defects not found in virgin PET bottles.
The willingness of reclaimers to alter their processes to produce a premium grade of PCR would probably vary from reclaimer to reclaimer, and depend on the relationship between the end user and the reclaimer. Obviously, regular large purchasers of recycled material will have a greater likelihood of convincing a reclaimer to alter its processes than would an occasional purchaser. Also, custom processing steps — such as passing PCR flake through contaminant separators more than once — are easy to implement for individual customers. These finishing step changes are more likely implemented than wash system changes would be.

CONFIDENTIAL CORPORATION

Confidential Corporation is an integrated manufacturing company that reclaims plastics and uses the PCR it produces in manufacturing injection molded products. The plastics that are reclaimed include polypropylene from injection-molded products and HDPE from milk jugs and detergent bottles.

Confidential Corporation implemented the following improvement strategies as part of this Project:

- Manufacturing high value-added products with PCR; and
- Selective blending and compounding.

Confidential Corporation was particularly interested in increasing the recycled content in its lines of high value-added crates and recycling bins, particularly for the larger sized products. The HDPE PCR Confidential Corporation uses for these products is quite viscous, even at the high temperatures used to injection mold large parts. As a result, it is very difficult to mold large bins (greater than 14-gallon capacity) without experiencing flow lines, molded-in stress, and inferior properties.

The Project Team worked with Confidential Corporation to develop specific blends and compounding formulations that would enable Confidential Corporation to incorporate additional post-consumer HDPE from New York into its existing products. This technical assistance included:

- Establishing targets for melt flow and performance properties of its large-bin product line;
- Creating three test formulations that would correct the inherent problem of molding large parts from post-consumer HDPE milk bottles; and

The Project Team helped Confidential Corporation overcome problems injection molding PCR by using special formulations.
Completing molding trials to determine the best formulation.

The molding and performance targets were met by blending post-consumer HDPE with a compatible grade of plastic and a lubricant. The melt flow and density of the blend resin were carefully selected to impart the desired properties to the post-consumer HDPE at the lowest possible cost. The lubricant improved the mold flow of the resin, minimizing molded-in stresses. These stresses, if not reduced, can cause products to crack or split, particularly if dropped in cold weather.

The compounded formulations proved successful. The results were higher recycled content levels, improved processability of bottle-grade HDPE, and improved performance (increased impact strength). Confidential Corporation is currently manufacturing recycling bins with these new formulations, and examining the use of the formulations in some of its other value-added crate products.

Figure 4-9 shows a recycled content recycling bin.

Table 4-5 below summarizes the economic costs and benefits of improvement strategy implementation.
Confidential Corporation saved 5 cents per pound using special recycled plastic blends in its recycling bins.

Confidential Corporation now needs to source more post-consumer HDPE from New York curbside recycling programs.

As Table 4-5 shows, Confidential Corporation was able to manufacture bins with PCR at an average resin cost savings of 5 cents per pound compared to virgin HDPE. Confidential Corporation intends to increase its use of PCR HDPE in 1998 by over 40 percent by using the PCR compounds developed in manufacturing its other crate product lines.

**Table 4-5**

Confidential Corporation Cost Optimization Analysis

<table>
<thead>
<tr>
<th>Incremental Cost Category</th>
<th>PCR HDPE Pellets</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCR Flake Production Cost Compared to Virgin¹</td>
<td>(12) cents per pound</td>
</tr>
<tr>
<td>Average Resin Savings²</td>
<td>(9) cents per pound</td>
</tr>
<tr>
<td>Blending/Compounding Cost</td>
<td>4 cents per pound</td>
</tr>
<tr>
<td><strong>Net Production Cost (Savings)</strong></td>
<td><strong>(5) cents per pound</strong></td>
</tr>
</tbody>
</table>

¹ Injection grade virgin HDPE compared to bottle grade flake PCR HDPE.
² Represents an average 75 percent PCR loading across select product lines.

**INNOVATIVE PLASTICS CORPORATION**

Innovative Plastics Corporation manufactures see-through packages through a process called thermoforming, primarily from virgin PVC sheet purchased from outside vendors. The improvement strategy implemented at Innovative Plastics focused on manufacturing high value-added products with PCR.

Innovative Plastics had decided to produce some package lines from PET instead of PVC prior to participating in the Project. Innovative Plastics was interested in changing for two reasons: PET prices have decreased from historical levels, and the general public considers PET to be more environmentally friendly than PVC. Furthermore, post-consumer PVC is not as widely available as post-consumer PET for producing recycled content products. The Project Team provided technical assistance to Innovative Plastics in conducting trial tests using PET PCR sheet. PET and PVC sheet look and perform alike, but need different processing conditions and techniques to convert them into products.

Technical assistance therefore focused on identifying suppliers of PET PCR sheet, and on technical issues relating to different procedures for forming, trimming, and sealing PET sheet products when compared to PVC sheet.
Forming and trimming issues were resolved by considering product performance requirements and selecting sheet gauge, operating temperatures, and the most appropriate PET sheet grade for the application. Because of the improved strength of PET over existing PVC products, less PET (a thinner gauge sheet) was required to manufacture a product with equivalent performance characteristics.

The key technical issue to resolve in the field test was Innovative Plastics’ desire to radio frequency seal thermoformed PET packages like it does PVC packages. Radio frequency sealing joins two layers of plastic by melting the layers together with radio waves. Radio frequency sealing occurs easily for PVC but when the technique is applied to PET, the PET tends to crystallize instead of melting, forming opaque bands rather than sealing the two layers together. This issue was resolved by adding a thin layer of an amorphous virgin material on the 100 percent post-consumer PET material when first making the sheet. The amorphous material welds to itself without crystallizing when exposed to radio frequencies, sealing the PET package. The amorphous material is compatible with the PET package, and doesn’t affect its recyclability.

The improvement strategy implemented at Innovative Plastics demonstrated that quality issues and technical issues related to forming, trimming, and sealing of PET PCR could be overcome. Innovative Plastics next wanted to verify that part production cost was less for PET PCR than virgin PVC. PET is a stiffer material than the PVC that Innovative Plastics purchases. Because it is stiffer, the packages made by Innovative Plastics can be down-gauged by about 15 percent, requiring less material, yet providing equal or even better performance. Table 4-6 below summarizes the comparative costs of producing virgin PVC and PET PCR thermoformed packages.

Table 4-6
Innovative Plastics Cost Optimization Analysis

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Virgin PVC</th>
<th>PET PCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheet Price</td>
<td>72 cents per pound</td>
<td>68.75 cents per pound</td>
</tr>
<tr>
<td>Conversion Cost</td>
<td>25 cents per pound</td>
<td>26.5 cents per pound</td>
</tr>
<tr>
<td>Scrap Credit</td>
<td>(3.75) cents per pound</td>
<td>(7.5) cents per pound</td>
</tr>
<tr>
<td><strong>Net Production Cost</strong></td>
<td><strong>$93.25 cents per pound</strong></td>
<td><strong>$87.75 cents per pound</strong></td>
</tr>
</tbody>
</table>

Innovative Plastics was able to manufacture packages from recycled PET at a cost savings of over 20 percent compared to the virgin PVC.

\[1\text{Amorphous: a material that doesn’t form crystals.}\]
As Table 4-6 shows, Innovative Plastics could manufacture PET PCR packages at a significant savings (23 percent) compared to PVC under the raw material price conditions that existed at the time the Project was conducted.

**McKechnie Plastic Packaging**

McKechnie Plastic Packaging manufactures plastic bottles for use in the automotive, household cleaner, health and cosmetic, medical, industrial, and specialty chemical industries. Although McKechnie was already using some melt blended recycled HDPE, the Project Team identified several improvement strategies that could be implemented by McKechnie, including:

- Manufacture high value-added end products with PCR;
- Use PCR/virgin dry pellet blends;
- Direct use of flake PCR; and
- Bulk receipt and handling of PCR.

These improvement strategies would allow McKechnie to significantly reduce costs and improve material performance by eliminating intermediate processors producing recycled material blends, a function that McKechnie itself was capable of doing at reduced cost. McKechnie also had equipment that would allow it to produce multi-layer bottles, giving it additional flexibility to use recycled content directly in the inner layer of plastic bottles, instead of purchasing blended or compounded recycled resins.

McKechnie is a large company with significant in-house expertise. Rather than continue with the Project, McKechnie chose to pursue implementation at its own pace and timetable, using internal resources. Shortly after McKechnie made this decision, it announced a 20 percent reduction in costs resulting from using recycled content in the inner layer of a tri-layer plastic bottle. These bottles were produced using McKechnie's multi-layer bottle manufacturing equipment. Some of the cost savings came from only using expensive custom colorants in the outer layer of the tri-layer bottles, saving costs. While the Project Team didn’t have an opportunity to participate in evaluating the effectiveness of the improvement strategies, or documenting implementation costs, McKechnie demonstrated that it can manufacture high-value added end products with PCR with reported cost savings.
**END PRODUCT MANUFACTURER IMPROVEMENT STRATEGIES EVALUATION**

Effective strategies implemented at end product manufacturers included:

- Manufacturing high value-added end products with PCR;
- Direct use of flake PCR; and
- Selective blending and compounding.

Several key factors made these strategies effective, including:

- Careful selection of raw material suppliers (PCR quality can vary markedly between suppliers);
- Expert technical advice about production process changes to account for differences between virgin and PCR;
- The capability to store and blend multiple materials;
- Access to low-cost or on-site material and product testing labs;
- Provision of free (to the end product manufacturer) PCR for pilot tests;
- Machine-time access for pilot tests;
- A virgin/PCR material cost differential substantial enough to provide an economic incentive to use PCR; and
- A commitment by the company to incorporate recycled content into the company’s products.

**UNIMPLEMENTED, INEFFECTIVE, OR UNFEASIBLE STRATEGIES**

None of the implemented improvement strategies proved to be totally ineffective, although in some cases effectiveness was limited (as previously discussed). Alternatively, some Project participants chose not to implement the recommended improvement strategies. Reasons for not doing so varied, but ranged from inability to obtain financing, to concerns that the proposed strategies would be ineffective or unfeasible. Circumstances surrounding each of the unimplemented strategies and obstacles to implementation are discussed below.
COMMUNITY/COLLECTOR — COLUMBIA COUNTY

Three improvement strategies were proposed for implementation by Columbia County:

- Increase householder participation in recycling;
- Motivate householders to remove caps; and
- Motivate householders to step on bottles.

These three strategies were successfully implemented by the Town of Lewiston for its curbside recycling program. Columbia County, however, is a rural county that collects recyclables through a set of eight attended solid waste and recycling drop-off sites. Approximately half of the residents of the County deliver their solid waste and recyclables to the sites. The remainder subscribe to individual collection services, or receive municipally-provided collection services.

The County's collection system provides for personal interaction between residents and the drop-off site staff, resulting in good participation in recycling and a high quality of delivered recyclables. The County did not feel that the costs associated with conducting a separate media/marketing campaign for plastics would produce significant enough gains to justify the expense.

HANDLERS

SCHENECTADY COUNTY

One improvement strategy was proposed for the Schenectady County materials recovery facility — to bulk ship unwashed flake that the County would produce from sorted HDPE bottles. The implementation plan included installation of a grinder and pneumatic system to fill bulk sacks with the unwashed flake. Although Schenectady County originally intended to implement the plan, the intended market, Union Carbide (Piscataway, NJ), closed its recycling plant. Schenectady County was not confident that there was sufficient market demand for unwashed flake without Union Carbide, and abandoned implementation.

One possible way for Schenectady County to overcome the barrier of limited market demand would be to identify one or more established reclaimers to enter into long-term supply agreement with. To ensure competitive prices, agreements could be tied to a market index for baled material, plus a
markup for the value added by grinding.

Some reclaimers are reluctant to enter into long-term agreements unless they can first obtain product samples to evaluate quality, or are guaranteed a method to correct quality or specification deficiencies. One of the best ways to overcome reclaimer quality concern obstacles is for the handler to develop a close partnering relationship with a reclaimer. This relationship could include an agreement where the reclaimer actually specifies the make and model of the grinder to be installed and provides training for the handler’s personnel to ensure its material quality requirements are met.

Columbia County/Resource Recovery Systems, Inc.

Columbia County owns a MRF in Claverack and contracts with Resource Recovery Systems, Inc. for operation and marketing of processed materials. The following improvement strategies were identified for implementation at the MRF.

- Grind and wash HDPE bottles; and
- Bulk ship clean HDPE flake.

Columbia County and RRS\(^1\) intended to implement these improvement strategies by installing a wash line for HDPE bottles at the MRF, but several events contributed to an eventual decision not to pursue joint implementation. These obstacles included:

- Questionable economics for a low capacity reclaim system;
- Inability to agree upon shared capital costs and material revenues; and
- Concerns over the ability of a low-cost, low-capacity reclaim system to produce a clean flake material of sufficient quality to compete with PCR produced by other reclaimers.

The first obstacle was questionable economics for a low capacity reclaim system. The Columbia County MRF was baling less than one million pounds of HDPE per year at the time the Project was conducted. An economic analysis revealed that a 50 percent increase in HDPE bottles would be required to reach a reasonable pay back period of less than 7 years for a low-cost reclaim design RRS had developed. While RRS believed it could have imported baled HDPE from the other MRFs it operates to make up for the material shortfall, additional transport costs to do so would have been incurred.

\(^1\)RRS: Resource Recovery Systems, Inc.
The second obstacle was also related to economics. RRS and Columbia County have a public-private partnership in place at the MRF. This means that any changes must be negotiated and jointly agreed upon, including capital cost and fee arrangements. The current fee structure allows for 80 percent of the revenues from the sale of materials to revert back to the County. Because RRS would be funding a significant portion of capital costs associated with installing the wash line and would incur additional operating costs for the additional processing that it would perform, RRS wanted to retain a much larger share of the sales revenues. This arrangement was not acceptable to Columbia County.

The third obstacle was a concern about the ability of low-cost reclaim lines to produce competitive-quality HDPE PCR flake. RRS has developed a low-cost, low-capacity reclaim system capable of producing a clean flake material that it believes will be of sufficient quality to effectively compete with the PCR produced by other reclaimers. Because the system developed by RRS has not yet been assembled and tested, RRS' system would be riskier than a known and tested alternative. Some equipment supply companies offer alternative low-cost, low-capacity systems. These systems, however, have not yet proven able to produce the equivalent clean flake quality level of state-of-the-art systems used by full-scale reclaimers.

These technical concerns do not rule out the ability of a low-cost, low-capacity MRF reclaim system to be successful. Some producers of plastic products do not require top quality materials, and may be more interested in lower quality material if it is accompanied by a price discount. This price discount also works against already challenging economies of scale.

The Project Team is aware of an instance where a joint-venture MRF/reclaim operation has been successfully established. In that instance, a plastic lumber company relocated its manufacturing line inside a county-owned MRF, and uses some of the plastics that are sorted by the MRF in manufacturing a line of plastic lumber products. In that instance, however, plastics are not washed prior to manufacture.

**RECLAIMER — CLEARVUE POLYMERS, INC.**

One improvement strategy was proposed for Clearvue Polymers Inc. — add equipment for bulk receipt and handling of PCR flake and pellets. Clearvue intended to implement the
plan, but was unable to obtain financing for the required equipment.

END PRODUCT MANUFACTURER — BO-MER MANUFACTURING

Bo-Mer Manufacturing was the only end product manufacturer that chose not to implement improvement strategies recommended by the Project Team. Bo-Mer manufactures thermoformed products, including industrial dunnage and material handling trays. The Project Team proposed that Bo-Mer implement the following improvement strategy: manufacture high value-added end products with PCR. The strategy was projected to reduce system operating costs and enhance performance for certain material handling products.

Bo-Mer initially intended to implement the proposed improvement strategy, but senior management was restructured just prior to implementation. This restructuring led to the loss of the company’s president, who was the primary point-of-contact for the Project. Implementation failed to move forward after the loss of Bo-Mer’s president.

Obstacle: Lack of capital for plan implementation.

Obstacle: Key company personnel turnover.
Pilot implementation of improvement strategies by Project participants yielded positive results. Specific conclusions about improvement strategy effectiveness, contributing success factors/obstacles, and transferability are discussed below.

### EVALUATION OF STRATEGIES

Table 5-1 provides a summary of the strategies recommended for implementation by Project participants, and an evaluation of their success. The previous results section described the basis for each evaluation.

<table>
<thead>
<tr>
<th>Project Participant</th>
<th>Improvement Strategy</th>
<th>Estimated Savings (cents/lb.)</th>
<th>Project Evaluation (cents/lb.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communities/Collectors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of Schenectady</td>
<td>Increase householder participation in recycling</td>
<td>1.4</td>
<td>Inconclusive</td>
</tr>
<tr>
<td></td>
<td>Householders remove caps</td>
<td>1.1</td>
<td>Inconclusive</td>
</tr>
<tr>
<td></td>
<td>Householders step on bottles</td>
<td>3.5</td>
<td>Inconclusive</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>6.0</td>
<td>(13.6)^4</td>
</tr>
<tr>
<td>Columbia County</td>
<td>Increase householder participation in recycling</td>
<td>1.4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Householders remove caps</td>
<td>1.1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Householders step on bottles</td>
<td>3.5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Town of Lewiston/Modern Corp.</td>
<td>Increase householder participation in recycling</td>
<td>1.4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Householders remove caps</td>
<td>1.1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Householders step on bottles</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>6.0</td>
<td>(13.6)^4</td>
</tr>
<tr>
<td>Handlers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columbia County &amp; Resource</td>
<td>Integrate reclamation</td>
<td>2.0</td>
<td>Unfeasible</td>
</tr>
<tr>
<td>Recovery Systems Inc.</td>
<td>Bulk ship clean HDPE flake</td>
<td>3.4</td>
<td>Unfeasible</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5.4</td>
<td></td>
</tr>
<tr>
<td>Modern Corp.</td>
<td>Automate the handling of collected plastics</td>
<td>not estimated</td>
<td>1.0</td>
</tr>
<tr>
<td>Schenectady County</td>
<td>Bulk ship unwashed, sorted flake from handler</td>
<td>2.5</td>
<td>Unfeasible</td>
</tr>
<tr>
<td></td>
<td>to reclaimer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Excludes recycling education program costs.
2 The Project participant deemed the strategies uneconomical when educational costs were included.
3 Not separately determined.
4 Includes operational savings of 3.9 ¢/lb. and educational program costs of 17.5 ¢/lb. Additional costs per incremental pound were 14.0 ¢/lb. operating costs, and 142 ¢/lb. education program costs.
5 The strategies were deemed technically and economically unfeasible for a low-cost low-capacity reclaim line.
6 Limited unwashed HDPE flake market diversity made the strategy unfeasible.
As Table 5-1 shows, recycling education and awareness program costs are not trivial, and should not be ignored when considering recycling program promotion. Improving householder participation (and plastic bottle capture) in Lewiston proved to be more effective in reducing costs than estimated in 16 Tactics for Cost Optimization. Alternatively, householders stepping on bottles did not show the cost savings in 16 Tactics for Cost Optimization, primarily because few householders began stepping on plastic bottles as a result of Lewiston’s plastic bottle recycling education and awareness campaign.

The factor that contributed to effective implementation of Modern’s handler improvement strategy was the ability of a perforator/flattener to effectively flatten and produce air holes in plastic bottles, so bales could be made more rapidly and greater bale densities could be achieved.

wTe experienced only 1 cent per pound cost savings for automated sorting of plastic bottles by resin, not the 3 cents per pound estimated in 16 Tactics for Cost Optimization. The 3 cents
Section 5

Conclusions

per pound is based on automated sorting of plastic bottles in a materials recovery facility, which in many cases is not practical because of the throughputs needed for the capital outlay incurred.

Clearplass Containers did not experience the 4.7 cents per pound estimated in 16 Tactics for Cost Optimization for PCR/virgin dry pellet blends, primarily because the 4.7 cents per pound is dependent on avoided costs associated with multi-layer bottle molding. Alternatively, Clearplass Containers did achieve a savings of 2.75 cents per pound using flake PCR as opposed to the 1.3 cents per pound estimated in 16 Tactics for Cost Optimization. The greater savings occurred because Clearplass did not melt filter the PCR, as 16 Tactics for Cost Optimization assumes.

TRANSFERABILITY

In general, there was nothing special about the Project participants, such as proprietary or patented technologies, that would prohibit any of the improvement strategies from being implemented by similar entities.

In some cases the products manufactured by end product manufacturers may restrict transferability. For example, food safety concerns may keep some product manufacturers from using recycled plastics, unless a supplier of recycled resin can be found that has obtained a letter of non-objection from the U. S. Food and Drug Administration. Appendix F further describes the food safety concerns and the process for obtaining an FDA letter of non-objection.

In addition to food safety concerns, processing methods and product geometry may inhibit some product manufacturers from using PCR. For example, an injection molder of large thin-wall products would not be able to use 100 percent recycled post-consumer plastic from plastic bottles because of differences in the processability of the virgin high-flow and the recycled low-flow resins.

At this point it may be useful to make a general comment about Project participants’ motivation to implement improvement strategies from the implementation plans. The more a Project participant (1) made a commitment to (“bought into”) the project, and (2) became involved in the process of shaping the implementation plan according to its goals, objectives, and

1FDA: U. S. Food and Drug Administration.
resources, the more likely a Project participant was to actually implement the plan. In essence, the more a Project participant established ownership of the implementation plan as it was being developed, the more likely the plan was to be implemented. This should be kept in mind when considering transferring the goals and concepts from this Project to other situations.

Other key issues relating to transferability include:

- The availability of low cost capital for implementation; and

- Access to technical assistance through consultants or a recycling extension service.

Plastics recycling companies typically operate on low margins because they are dealing in commodity materials. The plastics recycling industry is also immature, and doesn’t have the track record that other industries have. These two facts place many plastics recycling companies in a higher risk category for access to capital, raising the cost of that capital. For many plastics recycling companies, access to low- or no-cost capital is essential if they are to implement capital-intensive improvement strategies. Access to low- or no-cost capital can be provided in several ways, including:

- low or no interest loans;

- loan guarantees;

- tax exemptions for recycling equipment/facilities;

- research and development assistance; and

- grants to purchase capital equipment for demonstration projects promoting new technologies.

Research and development assistance can include free test materials, rented machine time, material and prototype testing services, etc., which can encourage companies to recycle materials or try recycled materials in their products with limited financial risk.

A second key issue, access to expert technical assistance, is also critically important if the results of this Project are to be transferred effectively. Processing recycled plastics typically brings a whole new set of issues to be considered when compared to virgin alternatives, particularly if the recycled material is of a different grade or resin type from the virgin alternative. Technical assistance can keep companies from having to “reinvent the wheel,” and can help companies avoid
Section 5

Conclusions

pitfalls, select the best equipment, and utilize processing techniques that lead to successful outcomes. Without technical assistance, companies can quickly become discouraged if initial trials do not achieve the desired outcome, with the conclusion that PCR doesn't work for their application. The provision of technical assistance also ensures that the time spent developing new protocols for using recycled material is minimized, ensuring minimal disruption to existing operations.

Technical assistance can be provided in two ways. Outside technical experts can be hired to provide that technical assistance, as was the case for this Project. Ongoing technical assistance can also be provided through a recycling extension service or business assistance center. If ongoing technical assistance is provided, it may be desirable to involve a regional university that could provide low-cost material and prototype testing services as well.

A final conclusion affecting transferability is that sufficient time must be allotted to implement the strategies in this report. Long lead times are needed to identify appropriate improvement strategies, prepare a plan, obtain financing, and ultimately implement the strategies. This Project, by example, spanned approximately two years through its various phases. Moreover, several participants continue to implement various strategies after this report was completed.

In summary, most of the improvement strategies evaluated in this Project proved to optimize costs. While some of the improvement strategies are easy to implement, many others require low cost capital or technical assistance to ensure successful implementation. Many states, recognizing the need to spur recycling economic development, have set out to perform projects similar in nature to New York’s Plastics Recycling Cost Optimization Project.
Section 6

Recommendations

This Project was able to demonstrate and confirm plastic bottle recycling system cost savings associated with several improvement strategies. The participants in this Project, though, represent just a small portion of all entities involved in the New York post-consumer plastics recycling chain. To lower overall system costs and maximize the sustainability of New York’s recycling infrastructure, the valuable lessons from this Project need to be transferred to other entities in the State’s recycling chain. While many of the improvement strategies apply only to entities recycling plastics, several are broad enough to also benefit the general recycling community, including entities recycling other materials.

New York should consider promoting widespread implementation of successful project strategies:

- Through workshops, an internet web page, and other means;
- By facilitating access to low cost capital (essential for this industry, which operates on low margins); and
- By providing specialized technical assistance to support strategy implementation.
| Plastics Recycling Cost Optimization Project | New York State Department of Economic Development |
PHASE 1 - IDENTIFY POTENTIAL PROJECT PARTICIPANTS AND IMPROVEMENT STRATEGIES

IDENTIFY POTENTIAL PROJECT PARTICIPANTS

The Project Team identified appropriate municipalities, collectors, handlers, reclaimers, and end product manufacturers that were willing to participate in the Project by establishing a set of desired criteria; evaluating various entities against those criteria; and hosting regional meetings to obtain buy-in and a commitment from potential Project participants.

DESIRED CRITERIA

Six primary criteria were agreed upon between the Project Team and ORMD, and used to target and select appropriate Project participants. Those criteria included identifying:

1. Entities operating within the State of New York;
2. Entities with business relationships with other New York companies;
3. Entities from each step along the recycling chain;
4. Entities that were proactive and willing to try to improve their operations;
5. Entities able to access the necessary resources to implement the optimization strategies; and
6. Entities working with PET or HDPE bottle or extrusion-grade resins.\(^1\)

The first two criteria served to generally limit the number of entities being considered for inclusion in the Project to New York entities. Given the mission of ORMD, and because the Project was sponsored and funded in part by the State of New York, it was only appropriate that entities with New York operations were given the first opportunity to participate in the project.

The second and third criteria were established as a result of feedback from the American Plastic Council’s (“APC”) Cost Optimization Study. In that study, participants from each step of the post-consumer plastics recycling chain (bottle manufacturers, collectors/haulers, handlers, reclaimers, and end product manufacturers) were asked to brainstorm methods for improving the cost-efficiency of plastics recycling. Participants in the APC study noted that several of the cost optimization tactics developed as part of that study could not have been identified without such group interaction. In fact, many

\(^1\) PET and HDPE are two types of plastics that are commonly used for the production of packaging products. Furthermore, because plastic bottles are most commonly targeted by New York recycling programs, the Project focused on entities working with bottle-grade or closely related extrusion-grade PET and HDPE resins.
of the tactics identified require coordination with — and in some cases equipment or process modifications by — two or more entities along the post-consumer plastics recycling chain for successful implementation. To ensure success, the Project Team targeted entities from all steps in the post-consumer plastics recycling chain — in particular those with business relationships that were already established, to promote the likelihood of joint participation in the Project.

The fourth and fifth criteria used to select Project participants focused on identifying entities that had the desire and necessary resources to implement optimization strategies. Because this Project was intended to be not just a study, but an exercise in actually implementing cost optimization strategies in the field, it was critical to select entities that had the best potential for implementation.

Finally, because of the desire of ORMD to strengthen markets for post-consumer plastics already being collected, the sixth criterion focused on entities either already working with PET and HDPE bottles or able to use recycled plastics from PET or HDPE bottles in the products they manufacture.

**EVALUATION OF POTENTIAL PROJECT PARTICIPANTS**

Once selection criteria had been established, the Project Team began the process of narrowing potential Project participants down to a select list. First, general information about potential participants had to be obtained. This information came from industry databases relating to plastics recycling and manufacturing.

R. W. Beck maintains databases of plastics recycling information on communities, handlers, and reclaimers for the American Plastics Council. Those databases were searched to create a short-list of handlers and reclaimers. The Society of the Plastics Industry also maintains a database of plastics industry manufacturing companies. Information from that database, along with the internal knowledge and expertise of the ORMD, was used to create a short-list of end product manufacturers.

**MEETINGS TO DISCUSS THE PROJECT GOALS AND IMPLEMENTATION STEPS WITH POTENTIAL PROJECT PARTICIPANTS**

The short-listed companies (handlers, reclaimers, and end product manufacturers) were then contacted by the Project Team to explain the Project and gauge their level of interest level in participating in the Project. Those businesses that indicated an interest in participating were asked to attend a meeting to discuss the Project goals, the potential improvement strategies that could be implemented, and their expected roles in the Project.

To foster two-way communication, meeting attendees were also asked to discuss how they envisioned that the Project could benefit their companies. Interaction/cooperation among the Project participants was considered crucial to the Project's success. The meetings, therefore, were structured so that potential collectors, handlers, reclaimers, and end product manufacturers could network and discuss how improvement strategies could be implemented on a cooperative basis.
Appendix A  Project Methodology

Because New York is a large state, and because of the desire to keep the group size small (to promote interaction), two regional meetings were held — one in Albany and one in Syracuse. Approximately ten company representatives attended each meeting. A copy of the meeting agenda and presentation materials is included in Appendix B.

Based on the results of the regional meetings, and the desire of meeting attendees to participate in the Project, ORMD and the Project Team selected companies for further participation in the Project. A total of thirteen entities were selected initially for further participation. Because of the outstanding success of the Project as it progressed, another five entities were included, raising the total number of Project participants to eighteen. Table A-1 lists alphabetically by type the selected Project participants.

Table A-1
Project Participants

<table>
<thead>
<tr>
<th>Collector/Community</th>
<th>Handler</th>
<th>Reclaimer</th>
<th>End Product Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Schenectady</td>
<td>Columbia County &amp; Resource Recovery Systems Inc.</td>
<td>Clearvue Polymers Inc.</td>
<td>Bo-Mer Manufacturing</td>
</tr>
<tr>
<td>Columbia County</td>
<td>Modern Corp.</td>
<td>Outsource/Xerox Corp.</td>
<td>Clearplass Containers Inc.</td>
</tr>
<tr>
<td>Modern Corp./Town of Lewiston</td>
<td>Schenectady County</td>
<td>Pure Tech Plastics Inc.</td>
<td>Confidential Corp.</td>
</tr>
<tr>
<td>Modern Corp./City of Niagara Falls</td>
<td>Western Finger Lakes Solid Waste Management Authority</td>
<td>wTe Recycling Corp.</td>
<td>Innovative Plastics Corp.</td>
</tr>
<tr>
<td></td>
<td>Xerox Corp.</td>
<td></td>
<td>MCKechnie Plastic Packaging</td>
</tr>
</tbody>
</table>

The list of Project participants represented a cross-section of entities along the post-consumer plastics recycling chain, including collector/communities, handlers, reclaimers, and end product manufacturers. Many of the entities had business relationships, or in some cases functioned at different levels of the recycling chain. For example, Modern Corporation functions as both a collector and handler. Modern Corporation also supplies Confidential Corporation with HDPE. Confidential Corporation also functions on two levels, serving as both a reclaimer and an end product manufacturer. For the purposes of this Project, however, the assistance provided to Confidential Corporation was primarily focused on improving its ability to increase its use of recycled plastics as an end product manufacturer.
IDENTIFY COST OPTIMIZATION AND QUALITY IMPROVEMENT STRATEGIES

Concurrent with selecting Project participants, the Project Team assembled a portfolio of cost optimization and quality improvement strategies that could be used by entities in the post-consumer plastics recycling chain to improve productivity and increase the recovery/value of PCR.

Because of ORMD’s interest in building on existing research and demonstration efforts, the Project Team initially prepared its portfolio of cost optimization and quality improvement strategies from the following sources:

- The Project Team’s previous experience; and
- 16 Tactics For Cost Optimization, a document produced by the American Plastics Council’s Cost Optimization Committee for benefit of the plastics recycling industry.

Additionally, during the course of the Project, the Project Team developed several innovative strategies for upgrading the physical properties (and thus the value) of PCR plastics to end users. A description of cost optimization and quality improvement strategies that were assembled by the Project Team can be found in Section 3 of this report.

PHASE 2 - IMPLEMENTATION OF QUALITY AND COST OPTIMIZATION STRATEGIES

As the first step in implementing quality and cost optimization strategies, members of the Project Team visited Project participant sites. Because each site is laid out differently, and performs different processes, there was no cookie-cutter set of quality and cost optimization strategies that could be implemented by each participant. Each participant required individualized attention in evaluating which improvement strategies were most suited for their unique circumstance. Next, based on the results of the site visits and the input and desires of the Project participants, the Project Team prepared implementation plans for each participant. Finally, the Project Team provided technical assistance in implementing the improvement strategies. Each of these steps are described in detail in the sections that follow.

ON-SITE VISITS WITH PROJECT PARTICIPANTS

On-site visits were scheduled with the eighteen entities that were selected to participate in the Project.

The site visits were held at each entity’s facility, and were attended by at least one Project Team professional. The visits were used to (1) evaluate the type of process/operation used at each facility; (2) determine which, if any, of the cost optimization and quality improvement strategies could be implemented at each facility; and (3) lay the groundwork for development of any pilot program test protocols.

Information collected as part of the on-site visits included the following:
Appendix A

DEVELOP IMPLEMENTATION PLANS FOR FEASIBLE STRATEGIES

After visiting each Project participant, the Project Team prepared an individual implementation plan for implementing the cost saving or quality improving strategies that were identified as being technically and economically feasible. The purpose of the implementation plan was to assist the Project participants in implementing those cost optimization and/or quality improvement strategies. The implementation plans included discussions of the following elements:

- Current operations;
- Strategy to be implemented;
- Estimated incremental capital and operating costs to implement strategy;
Plastics Recycling Cost Optimization Project

New York State Department Of Economic Development

- Additional material processing requirements and associated costs necessary to upgrade PCR properties to meet specifications for premium applications (i.e. additional processing to allow PCR to substitute for virgin resin);
- Estimated cost savings/quality improvement that may result from implementing the strategy, including a return-on-investment analysis;
- Conceptual plant modifications required to implement the strategy;
- Time frame for implementing the strategy;
- Impact(s) on other recovery chain entities; and
- Potential funding sources.

It should be noted that the implementation plans were prepared with significant input from each Project participant, so that the plans were highly applicable to the goals, objectives, and resources of each participant. This ensured the best opportunity for actual implementation.

PILOT IMPLEMENTATION OF SELECTED COST SAVING STRATEGIES

Each Project participant reviewed its implementation plan, and considered whether it would move forward with actual implementation of the strategies discussed in the plan. Not all Project participants were willing or able to implement their plans. In some cases, significant cost savings were projected to result from implementation of a particular cost saving strategy; however, limited financial resources restricted some Project participants from implementing their plans.

For those Project participants that decided to implement a particular strategy, the Project Team provided implementation assistance, as required. Assistance that was provided included the following:

- Functioning as a liaison between Project participants to facilitate working relationships, including obtaining material samples for pilot program test runs;
- Assisting end product manufacturers in incorporating PCR in their processes, including adjustments to process conditions and blending, alloying, compounding, and other upgrading techniques;
- Investigating the use of complementary grades of PCR in order to attain the highest possible levels of recycled content;
- Identifying equipment suppliers;
- Analyzing the results of pilot program tests runs;
- Designing community recycling educational materials;
- Gathering before and after data to measure strategy effectiveness; and
- Providing other technical assistance as required to implement the plan.
This appendix contains implementation plans for each project participant. The implementation plans are in the following order:

- Communities/Collectors
  - City Of Niagara Falls/Modern Corporations
  - City Of Schenectady
  - Columbia County
  - Town Of Lewiston/Modern Corporations

- Handlers
  - Columbia County & Resource Recovery Systems Inc.
  - Modern Corporations
  - Schenectady County Solid Waste Management District
  - Western Finger Lakes Solid Waste Management Authority
  - Xerox Corporation

- Reclaimers
  - Clearvue Polymers Inc.
  - Pure Tech Plastics, Inc.
  - wTe Recycling Corp. (omitted at the company’s request)
  - Xerox Corporation

- End Product Manufacturers
  - Bo-Mer Manufacturing
  - Clearplass Containers
  - Confidential Corporation (omitted at the company’s request)
  - Innovative Plastics Corporation
  - Mckehnie Plastic Packaging
City of Niagara Falls/Modern Corporations
Implementation Plan

STATE OF NEW YORK
Department of Economic Development
Office of Recycling Market Development

August, 1997
CURRENT OPERATIONS DESCRIPTION

The City of Niagara Falls began a new curbside recycling program in March 1997 after revamping its solid waste management program. Previously, the City had a thirty year disposal contract with BFI whereby the City paid a fixed annual price (with inflation adjustments) for disposal of all municipal solid waste ("MSW"). MSW was collected by City employees, and delivered to BFI’s landfill. Because of the fixed price for disposal, the City would have incurred a substantial increase in total solid waste management system costs if it had implemented a curbside recycling program at that time.

The City’s new solid waste management system is less expensive than the old system, and includes a curbside recycling program. In the new system all collection, processing, and disposal functions for solid waste and recyclables are performed by the Modern Corporations. Modern owns and operates a landfill, a materials recovery facility for recyclables, and a waste tire processing facility. With the change over between collection systems, Modern hired many of the City’s sanitation workers that had collected solid waste as City employees. Recycling program education is cooperatively shared between Modern and the City.

The City of Niagara Falls has a population of over 60,000 people. Those individuals live in approximately 24,000 single-family homes and 4,000 multi-family homes. Curbside recycling service is currently only provided to the residents of single-family homes, although everyone can recycle certain beverage containers through New York’s bottle bill program.

Recyclables from single-family homes are set out by the City’s program participants in a single 14 gallon recycling bin. The following materials are accepted in the recycling program: container glass, steel cans, aluminum cans and trays, old newspapers, old corrugated containers, magazines, junk mail, boxboard, catalogs, telephone directories, and all plastic screw-top containers.

Modern uses semi-automated Labrie Top Select 1000/2000s with a bubble tailgate for its collection vehicles. The vehicles have a capacity of 34 cubic yards, use a single-person collection crew, and cover an average route size of just under 1,000 homes. Modern collects from each home once per week on a Monday through Friday weekday, depending on where in the City the home is located. Collected recyclables are partially sorted at the curb into separate truck compartments. Modern estimates the overall residential recycling participation rate to be approximately 75 percent,
although collection day setouts vary from 45 to 55 percent depending on the neighborhood. Collected recyclables are delivered to a materials recovery facility ("MRF"), which is owned and operated by Modern. Because the Labrie collection vehicles have a large capacity and use a one-person crew, the trucks rarely fill before the end of the collection day.

PROPOSED IMPROVEMENT STRATEGY

Potential plastics recycling improvement strategies that could be implemented by collectors focus on improving quality, cost-efficiency, and/or program effectiveness. Overall quality of recyclables collected by Modern is quite good, so little can be done to significantly improve quality, although some additional improvements could be made to encourage program participants to properly prepare accepted materials.

The City could increase program cost-efficiency by increasing the amount of plastic bottles collected in existing routes the City. Finally, the City could improve effectiveness by collecting plastics from those parts of the City not currently served by the recycling program, including multi-family residences and commercial establishments. Because Niagara Falls is a resort area, it is particularly rich in establishments with commercial kitchens, therefore targeted plastics could include commercial size HDPE buckets, bottles, and jars.

The R. W. Beck Project Team would first recommend that the City attempt to improve the cost-efficiency of the existing single-family curbside recycling system. This could be done by improving two key contributors to a program’s efficiency: first, participation rates could be increased; second, program participants could be encouraged to increase the recovery (capture) of all types and amounts of accepted plastic bottles. The greatest gains will be experienced in parts of the City where participation and capture are lower than average. A cursory review of recycling data has shown that the Monday collection routes are achieving a recycling rate that is on average only 60 percent of the recycling rates of the other parts of the City.

The City and Modern have already taken one step to ensure the greatest capture of plastic recyclables by accepting all plastic screw-top containers (i.e. bottles). Studies have shown that a recycling program that accepts all plastic bottles (versus one that only accepts #1 and #2 plastic bottles) diverts the largest amount of plastic bottles, largely because plastic recycling has been made easier and less confusing for program participants.

This implementation plan proposes to increase participation and capture by conducting a special education and awareness campaign that focuses on plastics, particularly in the neighborhoods with Monday collection of recyclables (approximately 4,800 homes). It is suggested that the education and awareness campaign use new brochures (door hanger type) that would emphasize participation in plastic bottle recycling and drive home the message that all types of plastic bottles are desired for collection. The door hangers should also stress the need to rinse the bottles, remove (and dispose) of the caps, and flatten the bottles.
Although an educational and awareness campaign that uses door hangers is more expensive than one that distributes brochures through some other means (e.g., direct mail), door hangers are much more likely to be read and therefore are expected to be more effective.

Table 1 shows the estimated impact that the proposed education and awareness campaign could have on the amounts of plastic bottles that are collected from the Monday routes. It is anticipated that participation in recycling and capture of plastic bottles could increase so that the plastic bottle diversion rate for the Monday routes would equal the plastic bottle diversion rate for the rest of the City.

Table 1
Collection Program Improvement Objectives
(Estimated Annual Amounts, for Monday Routes in the City of Niagara Falls) 1

<table>
<thead>
<tr>
<th>Material</th>
<th>Estimated Current Annual Diversion (tons)</th>
<th>Diversion Increase (percent)</th>
<th>Estimated Resulting Annual Diversion (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1-#7 Bottles</td>
<td>18</td>
<td>60</td>
<td>30</td>
</tr>
</tbody>
</table>

1 Estimates are based on March, May, and July 1997 recycling and disposal information from Niagara Falls. Estimates are for approximately 4,800 homes with curbside collection on Mondays.

STRATEGY IMPACTS
The primary goal of implementing the strategy is to improve the cost-efficiency of recycling collection. Secondary goals are to improve the quality of collected materials and increase the amounts of recyclables that are recovered. The impact of implementing the strategy can be looked at from two perspectives: (1) the impact on operations; and (2) the impact on economics.

IMPACT ON OPERATIONS
The primary goal of improving the cost-efficiency of recycling collection will be accomplished by attempting to boost participation in recycling and capture of plastic bottles. If successful, this would increase the time it would take to service the Monday routes because of more stops and more volume of recyclables. One way to minimize the impact on operations of the projected increase in the volume of recyclables to be collected (and also on collection economics, for that matter) is to include a step-on-it message as part of the education and awareness campaign. Studies have demonstrated that flattening plastic bottles can reduce their volume by up to 50 percent, though even the most aggressive step-on-it campaign will not
motivate everyone to flatten their plastic bottles. A more realistic estimate of actual overall volume reduction found in practice is between 5 and 25 percent, with the higher reduction amounts occurring in those programs that provide recurring education on the importance of flattening plastic bottles through a variety of media.

Because the main thrust of this implementation plan is to encourage residents to recycle #1-#7 plastics, information about proper material preparation will be secondary. For that reason, a conservative 5 percent reduction was used for volume reduction estimates. Therefore, an estimated overall 55 percent volumetric increase in plastics recovery could occur (60 percent increase with a 5 percent volume reduction factor). The overall increased volume will, of course, impact collection activities because trucks will fill faster and it will take more time to collect the additional setouts.

Even though the education and awareness campaign will focus exclusively on plastic bottles, increased participation in recycling is expected to impact the amount of all materials recovered, and not just plastic bottles. The increased participation could result in an overall 60 percent increase in the recovery volume of all recyclables.

The increased volume of recyclables is not expected to significantly impact Modern's operations because its Labrie trucks currently have sufficient available capacity at the end of the collection day for the additional materials.

If the estimated increases in participation and capture are achieved, the time required to collect recyclables will increase by an estimated 30 percent because there will be more stops from which to collect materials. The time increase is not proportional on a one-to-one basis to the increase in participation because the trucks are already spending “unproductive” time driving by non-participating homes. The additional time may have to be covered by Modern by adding an additional truck and driver to the Monday collection routes, by working longer hours, or by redrawing the routes.

In order to measure the actual effect on collection operations of the education and awareness program, accurate records of collection time and expense would need to be kept by the Modern Corporation prior to and after distribution of the brochures. A sample tool that could be used by Modern to track collection time is attached, entitled Recycling Collection Vehicle Route Form.

Increases in recycling participation and capture can be measured through existing recycling reports provided by Modern to the City. Because seasonal effects can influence monthly recycling amounts, the City and Modern should compare the percent difference between before and after recycling figures for the Monday routes to the percent difference (because of seasonal affects) in recycling figures for its other collection routes. Subtracting the two figures will adjust for seasonal influences.
IMPACT ON ECONOMICS

Two types of costs will be incurred in implementing this plan: one-time costs associated with the educational effort, and recurring costs associated with impacted collection operations.

Production and distribution of educational door hanger brochures for this implementation plan is proposed initially for only the City’s Monday routes (approximately 4,800 homes). The incremental one time special education program costs for this implementation plan, as estimated by R. W. Beck, are summarized in the table below.

<table>
<thead>
<tr>
<th>Estimated Educational and Awareness Program Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brochures</td>
</tr>
<tr>
<td>Design</td>
</tr>
<tr>
<td>Printing (4,800 door hangers)</td>
</tr>
<tr>
<td>Distribution</td>
</tr>
<tr>
<td><strong>Total Estimated Education and Awareness Program Costs</strong></td>
</tr>
</tbody>
</table>

Identical brochures (with the exception of City name, logo, and telephone number) have already been designed in an earlier phase of the New York State Quality and Cost Optimization Project. Therefore, the design costs were estimated to be minimal. The estimated printing costs assume a $500 set-up fee, and production costs (including 2-color printing and paper cutting) of $0.75 per door hanger. We have assumed no out-of-pocket distribution costs because of the City would use existing AmeriCorps*VISTA assets that are already at the City.

Changes in recurring costs associated with collecting increased amounts of recyclables can be compared in many ways, some of which include: incremental cost in dollars per year, incremental cost in dollars per ton, and fully allocated cost in dollars per ton.

Because one of the goals of the implementation plan is to reduce the per-ton cost of recycling collection, it is recommended that Modern calculate and compare before and after recurring collection costs on a fully allocated cost per ton basis. A fully allocated rather than an incremental cost per ton basis is recommended because the incremental basis is very sensitive to short term route and timing specifics, whereas the fully allocated cost per ton basis provides a more consistent long term basis of comparison by spreading the full collection costs over all materials that are collected.

A sample tool that could be used by Modern to calculate and compare before and after recurring collection costs is attached to this implementation plan, and is entitled Worksheet for Estimating Fully Allocated Collection Costs.
IMPLEMENTATION SCHEDULE

It is anticipated that design, production, and distribution of the educational brochures could be completed by October 15, 1997. The educational campaign should be implemented as soon as possible to capitalize on the newness of the City’s recycling program, before recycling participation and non-participation habits become ingrained.

EFFECT ON OTHER RECOVERY CHAIN BUSINESSES

The implementation team for this strategy would consist of representatives from the City of Niagara Falls and Modern Corporations. The effect on other businesses in the recovery chain is less pronounced and indirect.

Increasing the amount of plastic bottles (and other recyclables) set out will increase the amount of recyclables to be collected on the existing routes and the amounts to be processed by the MRF. Cost per ton to collect materials on the Monday routes should decrease. The MRF has the ability to process additional amounts of recyclables, and doing so will improve the cost-efficiency of its existing processing operations. Encouraging residents to flatten their plastic bottles will have several positive impacts at the MRF:

- More delivered material can be stored in existing tipping areas; and
- Flattened bottles are easier to grasp and sort by hand.

On a national and regional level, there is excess capacity to reclaim post-consumer plastic bottles. Increasing the amounts of recyclables to be recovered will benefit reclaimers and end users of recovered materials by supplying needed raw materials.

POTENTIAL FUNDING OPTIONS

A few options are available for funding this project. The City could pay the printing costs out of its own budget. Because of its interest in providing support to municipalities in the area of plastics recycling, the American Plastics Council has expressed a willingness to provide assistance in designing and potentially contributing to the printing of the brochures to be used as part of the education and awareness effort in this project.

Ongoing education is important to reinforce and maintain high levels of participation, capture, and high quality of recovered materials because of the transient nature of urban and suburban populations. For this reason, the City and Modern should continue to provide follow-up education and awareness efforts. Implementation of the educational effort described in this plan for other homes in the City would need to be funded by the City and Modern unless funds are available through other mechanisms.
City of Schenectady
Implementation Plan

STATE OF NEW YORK
Department of Economic Development
Office of Recycling
Market Development

January 1996
CURRENT OPERATIONS DESCRIPTION

The City of Schenectady is located in up-state New York near Albany, and has a population of over 65,000. The City offers curbside collection services to 26,000 single-family and multi-family homes.

Recyclables are collected by one-person City collection crews and are delivered to the Schenectady County materials recovery facility ("MRF"), which is operated by the Schenectady County Soil and Water Conservation District (SWCD). The MRF is located approximately six miles from the City, although it takes collection crews between 45 minutes to an hour to travel to and from the MRF, including time to off-load the collected recyclables. Approximately half of all recyclables delivered to the MRF are collected by the City. In addition to operating the MRF, the SWCD also markets the processed recyclables.

The City asks residents to set their recyclables out in two recycling containers, one for paper and one for commingled containers. The City does not provide recycling containers to residents, therefore residents must purchase their recycling containers from local retailers. The City requires the recycling containers to be less than 32 gallons in capacity and to have lids, which helps to cut down on contamination of paper by rain or snow. Stickers must be applied to the recycling containers to distinguish them from refuse containers. Many recycling containers are typically small garbage cans, which have a greater capacity than most standard curbside bins; this local feature would allow for program expansions with a minimal effect on setouts. The City estimates the residential recycling participation rate to be approximately 70 percent.

Recyclables are collected commingled using two different collection vehicles — one for paper and one for commingled containers. Manual side-loading compacting vehicles collect old newspapers, old magazines, junk mail, old telephone directories, brown bags, and old corrugated containers. Manual side-loading (non-compacting) 23 cubic yard collection vehicles are used to collect steel cans, aluminum cans, #1-#7 plastic bottles, aseptic/gable-top containers, and glass containers. The City of Schenectady reports contamination levels to be one percent or less due to an aggressive "leave it in the bin" strategy for undesired materials, where City collection crews leave behind materials considered to be contaminants. The City does not tag the undesired materials though, which may cause some confusion for program participants over the acceptability of certain materials, resulting in reduced recycling of certain desired materials (particularly for confusing materials like plastics).
PROPOSED IMPROVEMENT STRATEGY

Potential plastics recycling improvement strategies that could be implemented by collectors focus on improving quality, cost-efficiency, and/or program effectiveness. Overall quality of recyclables collected by the City is quite good, so little can be done to significantly improve quality, although some additional improvements could be made to encourage program participants to properly prepare accepted materials.

Collection efficiency can often be improved by compacting plastic bottles on collection vehicles to reduce their volume so that collection vehicles can minimize the time spent making multiple trips to the MRF. Because New York is a container-deposit state, the amounts of aluminum cans and glass and plastic beverage bottles that are collected in the City's program are limited. Even though the available recyclables are limited, the relatively small size of the City's container collection vehicles (23 cubic yards) causes the vehicles to fill before all homes on the routes have been serviced. However, the additional amount of time it would take to separate the plastic bottles from other recyclables and place them into a dedicated on-board compactor does not offset the relatively short amount of time required to travel to the MRF and unload recyclables.

There are two other areas where potential significant improvements to plastics recycling could be made that would improve collection efficiency and program effectiveness: first, participation rates could be increased; second, program participants could be encouraged to increase the recovery (capture) of all types and amounts of accepted plastic bottles, many of which are being disposed instead of recycled by participating homes.

This implementation plan proposes to increase participation and capture by conducting a special education and awareness campaign that focuses on increasing the recovery of plastic bottles, although reinforcement of proper plastic bottle preparation should also be included. It is suggested that the education and awareness campaign use new brochures (door hanger type) that would emphasize plastic bottle recycling and drive home the message that all types of plastic bottles are desired for collection. The door hangers should also stress the need to rinse the bottles, remove (and dispose) of the caps, and flatten the bottles. Although an educational and awareness campaign that uses door hangers is more expensive than one that distributes brochures through some other means (e.g., direct mail), door hangers are much more likely to be read and therefore are expected to be more effective.

In order to demonstrate the effectiveness of the proposed education and awareness campaign, R. W. Beck recommends that the City first conduct the education effort in one test district, while keeping the other four districts as controls. This phased-in approach will allow the City of Schenectady to compare month-to-month percentage increases for the test district to any month-to-month changes for the four districts not tested by comparing before/after recyclables processing figures from the MRF for the different types of plastic bottles that are collected in each district.
Table 1 shows the estimated impact that the proposed education and awareness campaign could have on the amounts of plastic bottles that are collected. It is anticipated that participation in recycling could increase from 70 to 77 percent and that the capture of plastic bottles could increase from 48 percent to 61 percent, resulting in an estimated increase in the recovery of plastic bottles of 9.8 tons per year (a 39 percent increase) for the average collection.

Table 1
Collection Program Improvement Objectives
(Annual Amounts, Estimated for One Collection District)

<table>
<thead>
<tr>
<th>Material</th>
<th>Available for Recovery</th>
<th>Current Collection</th>
<th>Increase Participation</th>
<th>Increase Capture</th>
<th>Est. Resulting Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(tons)</td>
<td>(tons)</td>
<td>(percent)</td>
<td>(percent)</td>
<td>(tons)</td>
</tr>
<tr>
<td>PET Bottles</td>
<td>7.8</td>
<td>2.3</td>
<td>70 → 77</td>
<td>41 → 55</td>
<td>3.3</td>
</tr>
<tr>
<td>Natural HDPE Bottles</td>
<td>41.3</td>
<td>15.0</td>
<td>70 → 77</td>
<td>52 → 70</td>
<td>22.3</td>
</tr>
<tr>
<td>Pigmented HDPE Bottles</td>
<td>19.5</td>
<td>7.0</td>
<td>70 → 77</td>
<td>51 → 55</td>
<td>8.3</td>
</tr>
<tr>
<td>#3-#7 Bottles</td>
<td>5.5</td>
<td>0.6</td>
<td>70 → 77</td>
<td>14 → 18</td>
<td>0.8</td>
</tr>
<tr>
<td>Total</td>
<td>74.1</td>
<td>24.8</td>
<td>70 → 77</td>
<td>48 → 61</td>
<td>34.6</td>
</tr>
</tbody>
</table>

1 Estimates based on a district of 5,200 homes times average plastic bottle availability from How to Collect Plastics for Recycling by the American Plastics Council, for a demographically comparable area with container deposit legislation (Massachusetts data).

2 Increased capture rates are typical of upper level capture rates found in bottle bill states.

**STRATEGY IMPACTS**

The goal of implementing the strategy is to improve the quality of collected materials, increase the amounts of recyclables that are recovered, and reduce the per-ton cost of recycling collection (overall collection costs will likely increase because recycling is generally more costly than disposal in most parts of the Country). The impact of implementing the strategy can be looked at from two perspectives: (1) the impact on operations; and (2) the impact on economics.

**IMPACT ON OPERATIONS**

One way to minimize the impact on operations of the projected increase in the volume of recyclables to be collected (and also on collection economics, for that matter) is to include a step-on-it message as part of the education and awareness campaign. Studies have demonstrated that flattening plastic bottles can reduce their
volume by up to 50 percent, though even the most aggressive step-on-it campaign will not motivate everyone to flatten their plastic bottles. A more realistic estimate of actual overall volume reduction found in practice is between 5 and 25 percent, with the higher reduction amounts occurring in those programs that provide recurring education on the importance of flattening plastic bottles through a variety of media.

Because this implementation plan proposes an effective one-time educational effort, a conservative 10 percent reduction was used for volume reduction estimates. Therefore, an estimated overall 25 percent volumetric increase in plastics recovery is estimated to occur (39 percent increase with a 10 percent volume reduction factor). The overall increased volume will, of course, impact collection activities because trucks will fill faster.

Even though the education and awareness campaign will focus exclusively on plastic bottles, increased participation (estimated to increase from 70 to 77 percent) is expected to impact the amount of all materials recovered, and not just plastic bottles. The increased participation is estimated to result in an overall increase in the recovery volume of all containers, including plastic bottles, of 4.6 cubic yards (a 16 percent increase) per route, given the current average City route size of 1,730 homes.

Container collection vehicles for the City of Schenectady currently fill before completion of the collection routes, and unload recyclables at the MRF at least once per day, and sometimes two times per day, depending on the amount of materials set out on a particular route (the City does not require trucks to unload at the MRF a second time if the truck is less than half full at the end of the collection route). Therefore, the additional recyclables collected by implementing this plan may or may not require more frequent unloading, depending on current collection levels for each particular route. Because paper materials are collected separately in compacting vehicles, the additional volume of paper will be simply compacted into the existing on-board space, so there should be no need for more frequent unloading of paper materials.

If the estimated increases in participation and capture are achieved, the time required to collect recyclables will increase because there will be more stops from which to collect materials. The additional time is estimated to be half an hour per day per collection vehicle, given the current route size, for both the commingled container and the paper materials collection vehicles. Additional time (from 45 minutes to an hour) may be required by the commingled container collection vehicles if additional trips to the MRF are required.

In order to measure the actual effect of the education and awareness program, accurate records of collection time and expense would need to be kept by the City of Schenectady prior to and after distribution of the brochures. A sample tool that could be used by the City to track collection time is attached, entitled Recycling Collection Vehicle Route Form. The MRF in turn would need to keep accurate records on the tonnages of recyclables processed for the test and control districts prior to and after distribution of the brochures. (This would require the MRF to store and process recyclables from Schenectady's one test district separately from
materials from Schenectady's other districts and from other collectors; also, the City of Schenectady would need to deliver pilot district recyclables separately from recyclables collected in other districts by delivering all pilot route recyclables to the MRF at the conclusion of each pilot district route.)

**IMPACT ON ECONOMICS**

Two types of costs will be incurred in implementing this plan: one-time costs associated with the educational effort; and recurring costs associated with impacted collection activities.

Production and distribution of educational door hanger brochures for this implementation plan is proposed initially for only one of Schenectady's five districts (approximately 5,200 homes), as a pilot program. The incremental one time special education program costs for this implementation plan, as estimated by R. W. Beck, are summarized in the table below.

<table>
<thead>
<tr>
<th>Estimated Educational and Awareness Program Costs</th>
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</thead>
<tbody>
<tr>
<td><strong>Brochures</strong></td>
</tr>
<tr>
<td>Design</td>
</tr>
<tr>
<td>Printing (5,200 door hangers)</td>
</tr>
<tr>
<td>Distribution</td>
</tr>
<tr>
<td><strong>Total Estimated Education and Awareness Program Costs</strong></td>
</tr>
</tbody>
</table>

The estimated printing costs assume a $500 set-up fee, and production costs (including 2-color printing and paper cutting) of $0.75 per door hanger. Distribution is assumed to cost 30 cents per door hanger. Additional program runs for the other collection districts in Schenectady would only cost $5,960 if run separately, because the design of the brochures is a one-time expense. Larger program runs (i.e., for all of the remaining districts together) are estimated to cost $5,585 per district (a total of $22,340 for the remaining four districts).

Changes in recurring costs associated with collecting increased amounts of recyclables can be compared in many ways, some of which include:

- Incremental cost in dollars per year;
- Incremental cost in dollars per ton; and
- Fully allocated cost in dollars per ton.

Because one of the goals of the implementation plan is to reduce the per-ton cost of recycling collection, it is recommended that the City calculate and compare before and after recurring collection costs on a fully allocated cost per ton basis. A fully
allocated rather than an incremental cost per ton basis is recommended because the incremental basis is very sensitive to short term route and timing specifics, whereas the fully allocated cost per ton basis provides a more consistent long term basis of comparison by spreading the full collection costs over all materials that are collected.

A sample tool that could be used by the City to calculate and compare before and after recurring collection costs is attached to this implementation plan, and is entitled Worksheet for Estimating Fully Allocated Collection Costs.

IMPLEMENTATION SCHEDULE

It is anticipated that design, production, and distribution of the educational brochures could be completed by February 28, 1996. The educational campaign should be implemented as soon as possible because Schenectady County is considering making program changes to accept additional materials in the County recycling program, such as textiles and additional types of post-consumer residential paper. Additional education programs by the County could increase participation in current collection programs and mask the effects of the proposed plastic bottle education campaign, making accurate before/after measurements difficult.

EFFECT ON OTHER RECOVERY CHAIN BUSINESSES

The implementation team for this strategy would consist of representatives from the City of Schenectady Bureau of Waste Collection and the SWCD (MRF operator), since those two entities are most directly affected by this implementation plan. The effect on other businesses in the recovery chain is less pronounced and indirect.

Increasing the amount of plastic bottles (and other recyclables) collected will increase the amount of recyclables to be processed by the MRF. The MRF has the ability to process additional amounts of recyclables, and doing so will improve the cost-efficiency of its existing processing operations. Encouraging residents to flatten their plastic bottles will have several positive impacts at the MRF:

- More delivered material can be stored in existing tipping areas;
- Flattened bottles are easier to grasp and sort by hand; and
- Flattened bottles provide better cushioning of glass containers in commingled systems, resulting in reduced glass breakage.

On a national and regional level, there is excess capacity to reclaim post-consumer plastic bottles. Market demand for other materials has also been strong recently. Increasing the amounts of recyclables to be recovered will benefit reclaimers and end users of recovered materials by supplying needed raw materials.
POTENTIAL FUNDING OPTIONS

Because of its interest in providing support to municipalities in the area of plastics recycling, the American Plastics Council has expressed a willingness to provide assistance in designing and potentially contributing to the printing of the brochures to be used as part of the education and awareness effort. The National Association for Plastic Container Recovery (NAPCOR) also has some excellent resources that could be used to encourage flattening plastic bottles.

Ongoing education is important to reinforce and maintain high levels of participation, capture, and high quality of recovered materials because of the transient nature of urban and suburban populations. For this reason, the City should consider including funding for follow-up education and awareness efforts in its annual recycling program budget. Implementation of the educational effort described in this plan for other collection districts not included in the pilot would need to be funded by the City unless funds are available through other mechanisms.
COLUMBIA COUNTY
IMPLEMENTATION PLAN

STATE OF NEW YORK
Department of Economic Development

Office of Recycling
Market Development

February 1996
COLUMBIA COUNTY
IMPLEMENTATION PLAN

POST-CONSUMER PLASTICS COLLECTOR

CURRENT OPERATIONS DESCRIPTION

Columbia County is located in the eastern part of Up-State New York, between the Hudson River and the State of Massachusetts. The County is predominantly rural, and has a population of approximately 60,000. The largest municipality in the County is the City of Hudson, which has approximately 8,000 residents.

Due to its rural nature, Columbia County operates eight municipal solid waste (MSW) and recycling collection sites throughout the County. The County estimates that approximately half of the County residents deliver their MSW and recyclables to the sites instead of paying for collection services. The MSW and recycling collection sites are open during scheduled hours, and are staffed by attendants. The sites are locked after hours. Because the sites are staffed, and residents visit the sites to dispose of their MSW, participation in recycling and the quality of recyclables delivered by residents to the sites is very high. For those that do not use the sites, four private companies offer MSW and recycling collection services, either by municipal contract (in the larger municipalities) or by individual subscription for those that prefer collection services.

The County accepts a wide range of materials in its recycling program, including:

- **Commingled paper**, which includes old corrugated containers, boxboard, old magazines, old telephone directories, junk mail, office paper, old newspapers, and Kraft bags; and

- **Other commingled recyclables**, which includes plastic bottles and containers (#s 1, 2, 3, and 5), glass containers, aluminum cans, steel cans, aseptic containers, aluminum foil, and metal hangers.

At the collection sites, commingled paper recyclables and other commingled recyclables are deposited into separate roll-off containers for transfer to the Claverack Materials Recovery Facility (MRF) for processing. The MRF is operated by Resource Recovery Systems, Inc. under a 20 year contract.

The County is in charge of public education and awareness for the recycling program, and does its own layout and design of educational materials. The County credits the effectiveness of its educational materials for the success of its recycling program.
PROPOSED IMPROVEMENT STRATEGY

Because much of the recyclables collected in Columbia County are delivered by residents to the County's monitored MSW and recycling collection facilities, little can be done with a specific implementation plan to improve collection efficiency, quality of delivered recyclables, or participation in the County-operated part of the recycling program. Personal interaction between an informed site monitor and residents is the least costly and most effective way to improve any current deficiencies in recycling. For example, to encourage recycling participation the site monitor could ask residents the following question: "Do you have any recyclables for me today?"

There is a potential to improve participation in and awareness of recycling for the other County residents that utilize collection services instead of the MSW and recycling collection facilities. However, because of the extent of subscription services in the County (some residents choose to subscribe only to MSW collection services and not to recycling collection services), and because the four local private haulers operate independently from the County, it would be difficult to target and implement a specific quality improvement strategy. Also, because recyclables are collected commingled, separating out and compacting plastics would not be likely to improve collection efficiency for the haulers. The best way for the County to improve collection of recyclables would be to use mass media to encourage general participation in recycling and proper preparation of recyclables, including flattening plastic bottles.

Because the County prefers to do its own layout and design of recycling educational materials, the best implementation strategy to potentially improve plastics recycling education in Columbia County would be to offer technical assistance to the County in evaluating its educational materials and to provide off-the-shelf artwork. Educational materials potentially could be created or improved so that residents are reminded of which plastic containers are accepted in the program, and are encouraged to rinse plastic containers, remove and dispose of caps, and flatten plastic bottles.

STRATEGY IMPACTS

One impact of implementing a step-on-it message would be that the volume of collected plastic containers is reduced. Studies have demonstrated that flattening plastic bottles can reduce their volume by up to 50 percent, though even the most aggressive step-on-it campaign will not motivate everyone to flatten their plastic bottles. A more realistic estimate of actual overall volume reduction found in practice is between 5 and 25 percent, with the higher reduction amounts occurring in those programs that provide recurring education on the importance of flattening plastic bottles through a variety of media.

Other strategy impacts should be a reduced level of contaminants, and improved marketability of plastic recyclables.
IMPLEMENTATION SCHEDULE

This plan could be implemented immediately, depending on Columbia County’s schedule for producing new print materials or other educational programs.

EFFECT ON OTHER RECOVERY CHAIN BUSINESSES

By implementing the strategy in this implementation plan, the quality of Columbia County’s recovered plastics should improve. Improved quality will ensure that Columbia County and its MRF operator (RRS) will receive premium prices from and have preferential access to recycling markets. Improved collected quality will also improve the quality of the clean HDPE flake that Columbia County and RRS plan to produce under another implementation plan that is included in this project. Encouraging residents to flatten their plastic bottles will have several positive impacts at the MRF that is operated by RRS:

- More material can be stored in existing tipping areas;
- Flattened bottles are easier to grasp and sort by hand; and
- Flattened bottles provide better cushioning of glass containers in commingled systems, resulting in reduced glass breakage.

POTENTIAL FUNDING OPTIONS

Because of its interest in providing support to municipalities in the area of plastics recycling, the American Plastics Council has expressed a willingness to provide assistance in designing and potentially contributing to the printing of education and awareness brochures used as part of this project.

This project also includes twenty hours of technical assistance to Columbia County. Ongoing education is important to reinforce and maintain high levels of participation, capture, and high quality of recovered materials. For this reason, Columbia County should consider including funding for continuing education and awareness efforts in its annual recycling program budget.
Town of Lewiston/
Modern Corporations
Implementation Plan

STATE OF NEW YORK
Department of Economic
Development
Office of Recycling
Market Development

January 1996
TOWN OF LEWISTON/MODERN CORPORATIONS
IMPLEMENTATION PLAN

POST-CONSUMER PLASTICS COLLECTOR

CURRENT OPERATIONS DESCRIPTION

Modern Corporations is located in Western New York, near Niagara Falls. The company provides collection and processing services for municipal solid waste ("MSW") and recyclables to several of the small towns and villages in the local area, as well as to individual homes in areas where provision of services are at the discretion of home-owners and are subscription-based. Recycling program education is also typically performed by Modern.

One of the larger municipalities that Modern collects recyclables from is the Town of Lewiston. The Town of Lewiston has a population of approximately 15,500 people consisting of 4,000 households. It should be noted that Modern uses several different collection vehicles and methods in serving the various communities in the area. This implementation plan focuses specifically on Modern’s collection methods used in the Town of Lewiston (the “Town”) and provides a detailed analysis specific to the Town’s particular set of circumstances. The concepts covered by this implementation plan, however, can be similarly extended by Modern to each of its particular service areas with certain modifications. The following discussion describes Modern’s operation in the Town and other facts relating to the Town’s curbside recycling program.

Recyclables are set out by the Town’s program participants in a single 14 gallon recycling bin, which is frequently supplemented with Kraft bags for paper materials or overflows of containers. Modern estimates the residential recycling participation rate to be approximately 70 percent, although collection day setouts vary from 45 to 55 percent depending on the neighborhood. Until recently, Modern collected container glass, steel cans, aluminum cans, old newspapers, old corrugated containers, magazines, and PET and HDPE bottles. Because of a recent program expansion, Modern now accepts junk mail, boxboard, catalogs, telephone directories, and all plastic screw-top containers.

Modern uses two different types of recycling collection vehicles in the Town, depending on route conditions of population density and maneuvering room:

- Semi-automated Labrie Top Select 1000/2000s with a bubble tailgate for a vehicle capacity of 34 cubic yards, using a single-person collection crew; and
- MSW packer trucks towing a compartmentalized recycling trailer for a recyclables capacity of 18 cubic yards, using a three person crew to co-collect MSW and recyclables.
Modern collects from all homes in the Town on Monday of each week, using three Labrie trucks and three packer/trailer trucks. The average route size is 600 to 700 homes. Collected recyclables are delivered to a materials recovery facility (“MRF”), which is owned and operated by Modern. The MRF is located relatively close to the Town, so it typically takes collection crews less than 45 minutes to travel to and from the MRF, including time to off-load the collected recyclables.

Because the Labrie collection vehicles have a large capacity and use a one-person crew, the trucks rarely fill before the end of the collection day. The packer/trailer trucks, however, typically fill and need to be emptied more than once per day.

**PROPOSED IMPROVEMENT STRATEGY**

Potential plastics recycling improvement strategies that could be implemented by collectors focus on improving quality, cost-efficiency, and/or program effectiveness. Overall quality of recyclables collected by Modern is quite good, so little can be done to significantly improve quality, although some additional improvements could be made to encourage program participants to properly prepare accepted materials.

Collection efficiency can often be improved by compacting plastic bottles on collection vehicles to reduce their volume so that collection vehicles can minimize the time spent making multiple trips to the MRF. Because New York is a container-deposit state, the amounts of aluminum cans and glass and plastic beverage bottles that are collected in Modern’s program are limited. Even though the available recyclables are limited, the relatively small size of some of Modern’s container collection vehicles (18 cubic yards for the tow-behind trailer) causes the vehicles to fill before all homes on the routes have been serviced. However, the additional amount of time it would take to separate the plastic bottles from other recyclables and place them into a dedicated on-board compactor does not offset the relatively short amount of time required to travel to the MRF and unload recyclables.

There are two other areas where potential significant improvements to plastics recycling could be made that would improve collection efficiency and program effectiveness: first, participation rates could be increased; second, program participants could be encouraged to increase the recovery (capture) of all types and amounts of accepted plastic bottles, many of which are being disposed instead of recycled by participating homes.

Modern has already taken one step to greatly increase the capture of plastic recyclables by broadening the types of plastics accepted to include all plastic screw-top containers (i.e. bottles). Studies have shown that switching from a recycling program that just accepts #1 and #2 plastic bottles to one that accepts all plastic bottles can greatly increase the recovery of plastic bottles, largely because plastic recycling has been made easier and less confusing for program participants. The actual amount of the increase depends on the quality and frequency of the public education program before and after the program changes.
This implementation plan proposes to increase participation and capture by conducting a special education and awareness campaign that focuses on reinforcing Modern's program expansion for plastics. It is suggested that the education and awareness campaign use new brochures (door hanger type) that would emphasize plastic bottle recycling and drive home the message that all types of plastic bottles are desired for collection. The door hangers should also stress the need to rinse the bottles, remove (and dispose) of the caps, and flatten the bottles. Although an educational and awareness campaign that uses door hangers is more expensive than one that distributes brochures through some other means (e.g., direct mail), door hangers are much more likely to be read and therefore are expected to be more effective.

Table 1 shows the estimated impact that the proposed education and awareness campaign could have on the amounts of plastic bottles that are collected. It is anticipated that participation in recycling could increase from 70 to 72 percent and that the capture of plastic bottles could increase from 72 percent to 76 percent, resulting in an estimated increase in the recovery of plastic bottles of 3.2 tons per year (an 8 percent increase) for the Town.

**Table 1**

*Collection Program Improvement Objectives*

*(Annual Amounts, Estimated for the Town of Lewiston)*

<table>
<thead>
<tr>
<th>Material</th>
<th>Available for Recovery</th>
<th>Collection in 1995</th>
<th>Increase Participation</th>
<th>Increase Capture</th>
<th>Est. Resulting Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1-#2 Bottles</td>
<td>77.8</td>
<td>42.2</td>
<td>70 → 72</td>
<td>77 → 80</td>
<td>44.8</td>
</tr>
<tr>
<td>#3-#7 Bottles</td>
<td>6.2</td>
<td>0.5</td>
<td>70 → 72</td>
<td>10 → 25</td>
<td>1.1</td>
</tr>
<tr>
<td>Total</td>
<td>84.0</td>
<td>42.7</td>
<td>70 → 72</td>
<td>72 → 76</td>
<td>45.9</td>
</tr>
</tbody>
</table>

1. Estimates based on collection of recyclables from 4,000 homes in the Town of Lewiston times a factor to account for the Town’s greater than average living unit density times average plastic bottle availability from How to Collect Plastics for Recycling by the American Plastics Council, for an area with container deposit legislation (Massachusetts data).

2. Because #3-#7 bottles were not desired for collection in 1995, the beginning capture rate ideally should have been zero (i.e. no contamination).

**STRATEGY IMPACTS**

The goal of implementing the strategy is to improve the quality of collected materials, increase the amounts of recyclables that are recovered, and reduce the per-ton cost of recycling collection (overall collection costs will likely increase...
because recycling is generally more costly than disposal in most parts of the Country). The impact of implementing the strategy can be looked at from two perspectives: (1) the impact on operations; and (2) the impact on economics.

**IMPACT ON OPERATIONS**

One way to minimize the impact on operations of the projected increase in the volume of recyclables to be collected (and also on collection economics, for that matter) is to include a step-on-it message as part of the education and awareness campaign. Studies have demonstrated that flattening plastic bottles can reduce their volume by up to 50 percent, though even the most aggressive step-on-it campaign will not motivate everyone to flatten their plastic bottles. A more realistic estimate of actual overall volume reduction found in practice is between 5 and 25 percent, with the higher reduction amounts occurring in those programs that provide recurring education on the importance of flattening plastic bottles through a variety of media.

Because the main thrust of this implementation plan is to inform residents about the change in plastics accepted in the program, information about proper material preparation will be secondary. For that reason, a conservative 5 percent reduction was used for volume reduction estimates. Therefore, an estimated overall 3 percent volumetric increase in plastics recovery is estimated to occur (8 percent increase with a 5 percent volume reduction factor). The overall increased volume will, of course, impact collection activities because trucks will fill faster.

Even though the education and awareness campaign will focus exclusively on plastic bottles, increased participation (estimated to increase from 70 to 72 percent) is expected to impact the amount of all materials recovered, and not just plastic bottles. The increased participation is estimated to result in an overall increase in the recovery volume of all containers, including plastic bottles, of 0.7 cubic yards (a 4 percent increase) per route, given the current average route size of 600 to 700 homes.

The increased volume of recyclables is not expected to significantly impact Modern’s operations because both its Labrie trucks and its tow-behind trailers currently have sufficient available capacity at the end of the collection day for the additional materials.

If the estimated increases in participation and capture are achieved, the time required to collect recyclables will increase because there will be more stops from which to collect materials. The additional time is estimated to be twelve minutes per day per collection vehicle, given the current route size.

In order to measure the actual effect of the education and awareness program, accurate records of collection time and expense would need to be kept by the Modern Corporations prior to and after distribution of the brochures. A sample tool that could be used by Modern to track collection time is attached, entitled Recycling Collection Vehicle Route Form. The MRF in turn would need to keep accurate records of the tonnages of recyclables processed for the Town. Because seasonal effects can influence monthly recycling amounts, Modern should compare the
percent difference between before and after recycling figures for the Town of Lewiston to the percent difference (because of seasonal affects) in recycling figures for its other collection routes. In addition, a capture rate analysis would be useful to further measure the effectiveness of the education program. In order to perform a capture rate analysis, Modern would need to separate plastic recyclables from MSW in order to determine the percent of plastic recyclables that are being recycled of all recyclables that are available for recycling.

**IMPACT ON ECONOMICS**

Two types of costs will be incurred in implementing this plan: one-time costs associated with the educational effort; and recurring costs associated with impacted collection activities.

Production and distribution of educational door hanger brochures for this implementation plan is proposed initially for only the Town (approximately 4,000 homes), as a pilot program. The incremental one time special education program costs for this implementation plan, as estimated by R. W. Beck, are summarized in the table below.

<table>
<thead>
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</tr>
<tr>
<td>Printing (4,000 door hangers)</td>
</tr>
<tr>
<td>Distribution</td>
</tr>
<tr>
<td><strong>Total Estimated Education and Awareness Program Costs</strong></td>
</tr>
</tbody>
</table>

The estimated printing costs assume a $500 set-up fee, and production costs (including 2-color printing and paper cutting) of $0.75 per door hanger. Distribution is assumed to cost 30 cents per door hanger.

Changes in recurring costs associated with collecting increased amounts of recyclables can be compared in many ways, some of which include:

- Incremental cost in dollars per year;
- Incremental cost in dollars per ton; and
- Fully allocated cost in dollars per ton.

Because one of the goals of the implementation plan is to reduce the per-ton cost of recycling collection, it is recommended that Modern calculate and compare before and after recurring collection costs on a fully allocated cost per ton basis. A fully allocated rather than an incremental cost per ton basis is recommended because the
incremental basis is very sensitive to short term route and timing specifics, whereas the fully allocated cost per ton basis provides a more consistent long term basis of comparison by spreading the full collection costs over all materials that are collected.

A sample tool that could be used by Modern to calculate and compare before and after recurring collection costs is attached to this implementation plan, and is entitled Worksheet for Estimating Fully Allocated Collection Costs.

**IMPLEMENTATION SCHEDULE**

It is anticipated that design, production, and distribution of the educational brochures could be completed by March 31, 1996. The educational campaign should be implemented as soon as possible because Modern has already begun accepting the additional materials.

**EFFECT ON OTHER RECOVERY CHAIN BUSINESSES**

The implementation team for this strategy would consist of representatives from the Modern Corporations. The effect on other businesses in the recovery chain is less pronounced and indirect.

Increasing the amount of plastic bottles (and other recyclables) collected will increase the amount of recyclables to be processed by the MRF. The MRF has the ability to process additional amounts of recyclables, and doing so will improve the cost-efficiency of its existing processing operations. Encouraging residents to flatten their plastic bottles will have several positive impacts at the MRF:

- More delivered material can be stored in existing tipping areas; and
- Flattened bottles are easier to grasp and sort by hand.

On a national and regional level, there is excess capacity to reclaim post-consumer plastic bottles. Market demand for other materials has also been strong recently. Increasing the amounts of recyclables to be recovered will benefit reclaimers and end users of recovered materials by supplying needed raw materials.

**POTENTIAL FUNDING OPTIONS**

Because of its interest in providing support to municipalities in the area of plastics recycling, the American Plastics Council has expressed a willingness to provide assistance in designing and potentially contributing to the printing of the brochures to be used as part of the education and awareness effort. The National Association for Plastic Container Recovery (NAPCOR) also has some excellent resources that could be used to encourage flattening plastic bottles.

Ongoing education is important to reinforce and maintain high levels of participation, capture, and high quality of recovered materials because of the
transient nature of urban and suburban populations. For this reason, Modern should continue to provide follow-up education and awareness efforts. Implementation of the educational effort described in this plan for other communities and homes serviced by Modern would need to be funded by Modern unless funds are available through other mechanisms.
CURRENT FACILITY OPERATIONS DESCRIPTION

The Claverack Materials Recovery Facility (MRF) is located in Columbia County, New York, and is operated by Resource Recovery Systems, Inc. (RRS). Columbia County and RRS have a twenty-year partnership for operation of this MRF. The MRF predominantly serves towns, businesses, and trash haulers in Columbia County, but also receives recyclable materials from the Cities of Rensselaer and Albany, New York; Greene County, New York; Berkshire County, Massachusetts; and Litchfield County, Connecticut. RRS and Columbia County are currently working to increase the amount of recyclable materials delivered to the MRF through expansion of the existing MRF service area.

Recyclables are delivered to the MRF in two pre-sorted categories: paper materials and commingled containers. The paper materials that are accepted include: old newspapers (ONP); old magazines; and Kraft bags and old corrugated containers (OCC). The commingled containers that are accepted include: steel and tin cans; aluminum cans; clear and green colored #1 PET plastic bottles; natural and pigmented #2 HDPE plastic bottles; #3 PVC plastic bottles; milk containers and drink boxes; and flint, amber and green glass containers.

Paper materials delivered to the MRF are first separately deposited onto a designated section of the tipping floor. A front-end loader operator pushes the paper onto an infeed conveyor to the elevated paper sorting line. The sorting process for the paper is as follows:

- OCC/Kraft bags and magazines are pulled from the conveyor by laborers and deposited in chutes leading to dedicated storage bunkers. This material is baled periodically during the day on a batch basis. These bales are placed in storage until a transfer trailer load of each paper type is accumulated for shipment to an end market user.

- Because the ONP composes the greatest volume of the paper grades, it remains on the conveyor to be fed directly to the baler. After baling, it is loaded via fork-lift into transfer trailers (or into the storage-awaiting-shipment area).

Commingled containers are deposited onto the tipping floor separately from the paper materials. The commingled containers are pushed by the front-end loader operator into a receiving hopper that deposits the material onto an inclined feed conveyor. This conveyor leads to the elevated commingled container sorting line. The sorting process for the commingled containers is as follows:
Lightweight materials (plastic bottles, milk cartons, drink boxes, and aluminum cans) are sorted by laborers and deposited into dedicated storage bins alongside the baler feed conveyor.

Steel and tin cans are passed under a magnet where these materials are captured and deposited in a storage bunker.

Glass containers are removed from the elevated sorting conveyor by laborers and placed into storage bins below the sorters. Each color of glass is then crushed on a batch basis with the different colored cullet conveyed to separate concrete storage bunkers.

The material remaining on the sorting conveyor is considered to be contaminants and is deposited into a dumpster for disposal.

As the storage bunkers for the natural and pigmented HDPE, mixed colored PET, PVC, milk cartons and drink boxes, aluminum cans, and steel and tin cans reach capacity, each material is gravity fed onto the infeed baling conveyor for baling. The baling of the separated containers is scheduled at times when the baler is not being used for newspaper or other paper materials.

RRS currently markets all processed plastic bottles in baled form. Natural HDPE bottles are the predominant type of plastic container processed at the MRF. Table 1 illustrates the average quantities of HDPE containers currently processed at the MRF for the past operating year.

<table>
<thead>
<tr>
<th>Container Type</th>
<th>Current Throughput (lb./yr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural HDPE Bottles</td>
<td>436,800</td>
</tr>
<tr>
<td>Pigmented HDPE Bottles</td>
<td>459,200</td>
</tr>
<tr>
<td>Total</td>
<td>896,000</td>
</tr>
</tbody>
</table>

**PROPOSED FACILITY QUALITY IMPROVEMENT STRATEGY**

The quality improvement strategy that RRS and Columbia County would like to implement consists of further processing natural and pigmented HDPE plastic bottles into a clean flake form. RRS proposes to design and install a new operating system that would perforate and flatten, slit, flake and clean the natural and pigmented HDPE bottles, eliminating the need to bale this material. The operating contract between RRS and Columbia County states that Columbia County is to receive 80 percent of the product sales revenue, net of transportation, for all tonnage attributable to the County. Therefore, if the MRF produces a higher value product (i.e., clean natural and pigmented HDPE flakes versus the baled bottles), the County would directly receive the majority of the increase in revenue.
Moreover, implementing this new operating strategy would eliminate the need for intermediate handling of the natural and pigmented HDPE bottles by several different companies. Currently, the baled natural and pigmented HDPE bottles are sent to an intermediate processor who grinds the baled materials into a dirty flake. This material is then transported to a reclaimer where the flakes are washed, dried and prepared as feedstock for the manufacture of new recycled-content plastic product. By preparing the natural and pigmented HDPE bottles on-site at the MRF into a clean flake, this material can be directly marketed to the resin manufacturer, eliminating the need for multiple handling prior to re-use.

The primary steps in producing a clean natural and pigmented HDPE flake at the MRF include:

- Perforating and flattening the containers;
- Cutting the flattened containers into strips;
- Eliminating contaminants (such as other types of plastics) to ensure quality;
- Cleaning the strips of natural and pigmented HDPE plastic in a closed-loop washing cycle;
- Drying the strips of natural and pigmented HDPE plastic; and
- Flaking the strips of natural and pigmented HDPE plastic to meet or exceed New York resin manufacturer’s market standards for post-consumer clean flake plastic.

The proposed modifications to the MRF for processing whole natural and pigmented HDPE bottles into clean flakes are as follows:

- Install new doors in the floors of the natural and pigmented HDPE storage bins. This would allow RRS to either bale the sorted natural and pigmented HDPE bottles or send the bottles to the wash/flaking system.
- Install a new dedicated conveyor for the existing natural and pigmented HDPE storage bins to transfer the bottles to the north end of the MRF.
- Install a transfer conveyor to deliver either the natural or pigmented HDPE plastic bottles to an elevated conveyor with a magnetic head pulley and screen to capture grit (glass and fines) and stray metals prior to being fed to a new perforator.
- Install a perforator to not only puncture the bottles, but also flatten them prior to being sent to the new cutting equipment. The northwestern portion of the MRF has space available to house the new processing equipment.
- Install an elevating and cleaning conveyor to the slitter equipment. The slitter would first slice the whole bottles into strips and then remove large contaminants such as metals or glass via a screen prior to sending the strips to the closed-loop washing system.
COLUMBIA COUNTY AND RRS, INC. IMPLEMENTATION PLAN

- Install a closed-loop washing system to wash the dirty strips of either natural or pigmented HDPE plastic, then dry them prior to being transferred to the granulator for flaking.

- Install a granulator to flake the clean dry strips of either natural or pigmented HDPE plastic. After flaking, the clean flakes are deposited pneumatically into one of two new storage silos approximately 25 feet high and 14 feet in diameter. Each silo would be located outside to the north of the MRF near the new processing equipment.

- Install a conveyor to transfer the clean flakes from the silos to the buyer’s container or truck. The storage silos would allow the MRF to send various sized loads to the different resin manufacturers. Load sizes could potentially vary from a Gaylord box for inspection purposes to full trailer loads.

Although an effective recycling education program is established for the MRF service area, RRS and Columbia County has stated in their Concept Paper for Recycling Investment Program, dated September 29, 1995, that they would increase their education effort such that the population served by the MRF would have a better understanding of the plastic recycling efforts at the MRF. With this greater education effort, it is RRS’s and Columbia County’s goal to reduce contaminants delivered to the MRF, thus leading to more efficient processing and an overall increase in the amount of commodities to be marketed.

COSTS FOR PROPOSED STRATEGY

The incremental capital costs, as estimated by RRS and equipment representatives are summarized in the Table 2. It is R. W. Beck’s opinion that the capital costs presented herein appear to be reasonable based upon similar MRF retrofits that we are familiar with. The incremental capital costs shown in this plan do not include overhead, profit or tax expenses that would be incurred if this plan is implemented.
Table 2
Implementation Strategy
Incremental Capital Costs

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Incremental Capital Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bin discharge conveyor</td>
<td>$11,186</td>
</tr>
<tr>
<td>Perforator feed conveyor</td>
<td>$12,468</td>
</tr>
<tr>
<td>Perforator</td>
<td>$10,000</td>
</tr>
<tr>
<td>Cleaning conveyor</td>
<td>$10,043</td>
</tr>
<tr>
<td>Slitter</td>
<td>$18,000</td>
</tr>
<tr>
<td>Gates for bins</td>
<td>$6,950</td>
</tr>
<tr>
<td>Hydraulic system</td>
<td>$6,070</td>
</tr>
<tr>
<td>Flaker</td>
<td>$14,000</td>
</tr>
<tr>
<td>Piping from flaker to wash</td>
<td>$2,025</td>
</tr>
<tr>
<td>Electrical panels</td>
<td>$6,900</td>
</tr>
<tr>
<td>Silos</td>
<td>$34,000</td>
</tr>
<tr>
<td>Washer system</td>
<td>$52,000</td>
</tr>
<tr>
<td>Silo load/unload systems</td>
<td>$15,000</td>
</tr>
<tr>
<td>Piping for load/unload systems</td>
<td>$5,400</td>
</tr>
<tr>
<td><strong>Total Equipment Cost</strong></td>
<td><strong>$204,042</strong></td>
</tr>
<tr>
<td>Freight for equipment</td>
<td>$3,160</td>
</tr>
<tr>
<td>Engineering/contractors/miscellaneous labor</td>
<td>$21,900</td>
</tr>
<tr>
<td>Installation</td>
<td>$12,700</td>
</tr>
<tr>
<td><strong>Total Capital Costs</strong></td>
<td><strong>$241,802</strong></td>
</tr>
</tbody>
</table>

The equipment for the slitting, washing, flaking and storing operations for producing a clean flake would have the capability to handle double the current level of natural and pigmented HDPE plastic bottles processed at the MRF. Although RRS and Columbia County are currently trying to expand the MRF’s service area to increase the supply of commingled recyclables, no additional contractual obligations have been obtained for the MRF. It should be noted that RRS has stated that it has hired a feedstock manager in an effort to increase the amount of material processed at the facility. However, a sourcing analysis for additional recyclable materials was not developed as part of this plan. Therefore, we are unable to verify RRS and Columbia County’s ability to attract additional volumes of commingled recyclables over and above those currently being processed.

RRS has also indicated that the tipping area at the MRF will be enlarged to allow increased throughput of recyclable materials including greater volumes of natural and pigmented HDPE. RRS representatives have stated that they plan on expanding the tipping floor regardless of whether the flake/wash system is installed. As a result, the cost for this tipping floor enlargement is not included in this implementation plan.

For the purposes of this plan, analyses have been prepared assuming current throughput levels, as well two additional scenarios for 50% and 100% increases in the current throughput of natural and pigmented HDPE at the MRF.
The operation and maintenance activities for the proposed wash/flake system were assumed by RRS and R. W. Beck to increase incrementally by $0.05 per pound of natural and pigmented HDPE plastic bottles processed at the MRF. This incremental increase in cost accounts for expenses such as: electrical and water consumption; blade sharpening for the granulator and slitter; disposal of material lost during processing; lubrication of moving equipment; spare parts; chemicals for washing (i.e., caustics); and labor.

Based on discussions with plastic resin manufacturers, the incremental increase in value for the clean natural and pigmented HDPE flakes is estimated to be $0.10 per pound. However, approximately 10 percent of the total HDPE whole bottles processed, is assumed to be lost due to contaminants such as grit, moisture, caps, glass, and non-HDPE plastics.

The analyses prepared for the proposed MRF modifications are summarized in Table 3. Please note that all the figures provided in these analyses are annual costs and revenues. Additionally, these values are nominal (i.e., they do not include adjustments for inflation or the time value of money).

### Table 3
**Implementation Strategy - Base Case Analyses**

<table>
<thead>
<tr>
<th>Line</th>
<th>Annual Revenue (Cost)</th>
<th>HDPE Throughput Levels: Current Throughput</th>
<th>50% Increase</th>
<th>100% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Throughput</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Inputs/Outputs:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Input Pounds of HDPE Bottles</td>
<td>896,000</td>
<td>1,344,000</td>
<td>1,792,000</td>
</tr>
<tr>
<td>2</td>
<td>LESS: Process Loss ¹</td>
<td>(89,600)</td>
<td>(134,400)</td>
<td>(179,200)</td>
</tr>
<tr>
<td>3</td>
<td>Output Pounds of Clean HDPE Flake</td>
<td>806,400</td>
<td>1,209,600</td>
<td>1,612,800</td>
</tr>
<tr>
<td><strong>Revenue:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Clean Flake HDPE Revenue Stream ($/Year)²</td>
<td>$161,280</td>
<td>$241,920</td>
<td>$322,560</td>
</tr>
<tr>
<td>5</td>
<td>LESS: Baled HDPE Revenue Stream ($/Year)³</td>
<td>(89,600)</td>
<td>(134,400)</td>
<td>(179,200)</td>
</tr>
<tr>
<td>6</td>
<td>Incremental Revenue ($/Year)</td>
<td>$71,680</td>
<td>$107,520</td>
<td>$143,360</td>
</tr>
<tr>
<td>7</td>
<td>LESS: Incremental Operating Costs ⁴</td>
<td>(44,800)</td>
<td>(67,200)</td>
<td>(89,600)</td>
</tr>
<tr>
<td>8</td>
<td>LESS: Depreciation ⁵</td>
<td>(34,543)</td>
<td>(34,543)</td>
<td>(34,543)</td>
</tr>
<tr>
<td>9</td>
<td>Net Revenue ($/Year)</td>
<td>($7,663)</td>
<td>$5,777</td>
<td>$19,217</td>
</tr>
<tr>
<td>10</td>
<td>Net Revenue ($/Pound)</td>
<td>($0.010)</td>
<td>$0.005</td>
<td>$0.012</td>
</tr>
<tr>
<td><strong>Return on Investment:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Return on Investment (%) ⁶</td>
<td>-3.2%</td>
<td>2.4%</td>
<td>8.0%</td>
</tr>
<tr>
<td>12</td>
<td>Pay Back Period (Years) ⁷</td>
<td>9.0</td>
<td>6.0</td>
<td>4.5</td>
</tr>
</tbody>
</table>
Assumes a process loss of 10 percent of incoming HDPE bottle feedstock due to dirt, moisture, floor sweeps, and other contamination.

Assumes an average value of $0.20/pound for clean HDPE flake (weighted average of natural and pigmented) over an entire economic cycle.

Assumes an average value of $0.10/pound for baled HDPE bottles (weighted average of natural and pigmented) over an entire economic cycle.

Assumes the annual incremental operating costs to grind and wash HDPE to be $0.05/pound of input HDPE processed (Line 1).

Assumes $241,802 in incremental capital costs and a seven year life.

Net revenues (Line 9) divided by incremental capital costs ($241,802).

Incremental capital costs ($241,802) divided by incremental revenues (Line 6) less incremental operating costs (Line 7).

Assuming the MRF continues to process the same quantities of natural and pigmented HDPE bottles, the MRF would experience a loss of approximately $7,700 per year on the incremental investment in the grind/wash line. If throughput levels are increased by 50% and 100%, annual revenues would increase by $5,800 and $19,200, respectively.

In summary, as the throughput of HDPE bottles increases, the net revenues for the wash/flake system increases. The break-even point for this implementation strategy, based on the assumptions discussed above, is somewhere between current throughput levels and a 50% increase in throughput levels.

A sensitivity analysis was also performed to illustrate a larger value increase for the clean HDPE flakes. In the base case analyses, this increase was estimated to be $0.10 per pound. For this sensitivity, the value increase for the clean HDPE flakes was assumed to be $0.12 per pound. The results of this sensitivity analysis are summarized in Table 4.
**COLUMBIA COUNTY AND RRS, INC. IMPLEMENTATION PLAN**

**Table 4**

**Implementation Strategy**

Sensitivity Analysis for Changes in HDPE Flake Value Increase

<table>
<thead>
<tr>
<th>Line</th>
<th>Annual Revenue (Cost)</th>
<th>HDPE Throughput Levels:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Current</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Throughput</td>
</tr>
<tr>
<td>Inputs/Outputs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Input Pounds of HDPE Bottles</td>
<td>896,000</td>
</tr>
<tr>
<td>2</td>
<td>LESS: Process Loss¹</td>
<td>(89,600)</td>
</tr>
<tr>
<td>3</td>
<td>Output Pounds of Clean HDPE Flake</td>
<td>806,400</td>
</tr>
<tr>
<td>Revenue:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Clean Flake HDPE Revenue Stream ($/Year)²</td>
<td>$177,408</td>
</tr>
<tr>
<td>5</td>
<td>LESS: Baled HDPE Revenue Stream ($/Year)³</td>
<td>(89,600)</td>
</tr>
<tr>
<td>6</td>
<td>Incremental Revenue ($/Year)</td>
<td>$87,808</td>
</tr>
<tr>
<td>7</td>
<td>LESS: Incremental Operating Costs⁴</td>
<td>(44,800)</td>
</tr>
<tr>
<td>8</td>
<td>LESS: Depreciation⁵</td>
<td>(34,543)</td>
</tr>
<tr>
<td>9</td>
<td>Net Revenue ($/Year)</td>
<td>$8,465</td>
</tr>
<tr>
<td>10</td>
<td>Net Revenue ($/Pound)</td>
<td>$0.010</td>
</tr>
<tr>
<td>Return on Investment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Return on Investment (%)⁶</td>
<td>3.5%</td>
</tr>
<tr>
<td>12</td>
<td>Pay Back Period (Years)⁷</td>
<td>5.6</td>
</tr>
</tbody>
</table>

¹ Assumes a process loss of 10 percent of incoming HDPE bottle feedstock due to dirt, moisture, floor sweeps, and other contamination.

² Assumes an average value of $0.22/pound for clean HDPE flake (weighted average of natural and pigmented) over an entire economic cycle.

³ Assumes an average value of $0.10/pound for baled HDPE bottles (weighted average of natural and pigmented) over an entire economic cycle.

⁴ Assumes the annual incremental operating costs to grind and wash HDPE to be $0.05/pound of input HDPE processed (Line 1).

⁵ Assumes $241,802 in incremental capital costs and a seven year life.

⁶ Net revenues (Line 9) divided by incremental capital costs ($241,802).

⁷ Incremental capital costs ($241,802) divided by incremental revenues (Line 6) less incremental operating costs (Line 7).

Assuming the MRF continues to process the same quantities of natural and pigmented HDPE bottles, the MRF would experience increased revenues of approximately $8,500 per year on the incremental investment in the grind/wash line. If throughput levels are increased by 50% and 100%, annual revenues would increase by $30,000 and $51,500, respectively.
IMPLEMENTATION SCHEDULE

It is estimated that a total of 18 months would be required to fully implement this plan. It is anticipated that this schedule would include the following activities:

- Four months to fabricate and install the new processing equipment and to perform any modifications to existing processing equipment for producing clean plastic flakes.
- 12 months for natural and pigmented HDPE flake production and marketing. The 12 month period is necessary to document the seasonal influences on operations, maintenance, product handling and markets.
- Two months for RRS to prepare a final report that addresses: processing flow for producing plastic flakes; new and modified equipment capital costs; operating and maintenance costs including avoided baling costs; value added to products; and public response.

With the exception of the MRF plant manager, the implementation team for this plan would consist of representatives from the corporate headquarters for RRS located in Centerbrook, Connecticut. Peter Karter (Chief Executive Office) and Elizabeth Karter (President) would be co-project managers for the proposed implementation plan. Roberto Lama (Director of Engineering), would oversee the engineering, design and installation of the equipment.

The operations and maintenance activities associated with the proposed implementation plan would be lead by Jeffrey Fister, who currently is acting as the MRF Plant Manager. Steve Anderson, the RRS Marketing Manager, would be in charge of marketing the clean natural and pigmented HDPE flakes and other processed plastic commodities from the MRF. Finally, Toby Goodrich (Marketing and Project Development for RRS) would serve as the primary contact for this implementation plan. In addition, Mr. Goodrich would be responsible for preparing a report illustrating the operation results for implementing this plan.

EFFECT ON OTHER RECOVERY CHAIN BUSINESSES

The modifications to the MRF for producing natural and pigmented HDPE flakes will directly affect the HDPE secondary processing market. Because the natural and pigmented HDPE will already be flaked and cleaned at the MRF, this plan will provide the means to bypass the secondary processor. In addition, this will allow the MRF to eliminate the expense of transporting the baled natural and pigmented HDPE to the secondary processor. Finally, this plan will indirectly affect the post-consumer resin manufacturing market.

POTENTIAL FUNDING OPTIONS

Three potential funding options exist for the modification of the Claverack MRF to allow natural and pigmented HDPE flaking.
The first option includes the Recycling Investment Program through the New York State Department of Economic Development, Office of Recycling Market Development. This program was devised for entities that collect, handle, reclaim and/or manufacture post-consumer plastics. The program's goals are to establish a more cost-effective post-consumer plastic reclamation infrastructure in New York and to expand the base manufacturers capable of using post-consumer plastic as a feedstock supplement or substitute. Entities interested in receiving a grant from this program must submit applications to the Office of Recycling Market Development for their consideration. RRS and Columbia County submitted an application for the flaking and cleaning modifications at their MRF on September 29, 1995.

The second option would be for RRS or Columbia County to provide funding through internal sources. As a third option, RRS could apply for private financing from a leasing agency.
Modern Corporations
Implementation Plan

STATE OF NEW YORK
Department of Economic Development
Office of Recycling Market Development

February 1996
CURRENT OPERATIONS DESCRIPTION

Modern Corporations is located in Western New York, near Niagara Falls. The company operates a materials handling facility for collected recyclables, although it provides collection services for municipal solid waste (MSW) and recyclables as well.

The design of Modern's handling facility is simple and flexible, with bunkers for tipping recyclables, an elevated sorting platform and conveyor (with four sort bunkers for recyclables/trash), and a horizontal baler that can be fed either from the sorting conveyor discharge or directly from a floor level feed conveyor. With this arrangement, Modern can positively sort, negatively sort, or perform no sorting of recyclables prior to baling.

Because Modern only has four sort bunkers for recyclables or trash, its ability to sort is limited, so it requires collectors to deliver recyclables to it already separated by material type in the following categories: glass containers, cans, plastics, and paper. Modern accepts the following specific materials for processing: glass containers, steel cans, aluminum cans, old newspapers, old corrugated containers, magazines, junk mail, boxboard, catalogs, old telephone directories, and all plastic screw-top containers.

Collectors that deliver materials to Modern's facility tip each category of recyclables into one of five bunkers. Those recyclables that need additional separation prior to being baled, such as the paper recyclables, are loaded onto a feed conveyor that discharges the recyclables onto an elevated horizontal sorting platform and conveyor, where they are manually separated and deposited into sort bunkers. The positively separated materials are then individually loaded onto a separate feed conveyor that directly feeds the baler.

Recyclables that do not require additional separation by Modern, such as plastic screw-top containers, are loaded onto the feed conveyor that supplies the sort line so that contaminants can be removed. The negatively sorted recyclables then travel to the end of the sort line, where they are fed directly into the baler.

PROPOSED IMPROVEMENT STRATEGY

Modern uses a horizontal baler manufactured by American Baler to densify its recyclables for economical shipping to market. When baling plastic bottles, Modern has experienced multiple instances when full size plastics bales burst apart because
the shape memory of the plastic bottles and air trapped inside PET bottles generated enough pressure to snap the bale wires. Because of this problem, Modern produces smaller sized bales so that the bales will not burst apart. Unfortunately, this results in inefficient loading of the bales inside of trucks so that only 30,000 pounds can be shipped to market at a time instead of a full 40,000 pound load. According to Modern, the design of its baler does not allow it to double the number of wires used to hold the bale together.

This implementation plan proposes to install a plastics perforator densifier in Modern's facility in order to allow Modern to produce full size bales (30 X 48 X 60 inches) of a density that will allow it to fit 40,000 of baled plastics onto trucks. The plastics perforator densifier will be used by Modern to perforate (so that air cannot be trapped inside) and pre-flatten (so that the shape memory of the plastic bottles will be reduced) its plastic bottles before baling, so that pressure inside the plastic bales will be reduced. The reduced bale pressure will allow Modern to produce full size bales and fill trucks to or near to their weight limits.

A second benefit of pre-flattening the plastic bottles is that more plastic can be placed into the baling chamber on each bale cycle because of the higher density of the flattened plastics. This will allow Modern to produce full size and weight bales in a much shorter period of time, because less cycles are required to produce a full size bale. Also, the flattened bottles will occupy less bunker space, so more plastic bottles can be stored before running plastic bottles in the baler.

**CAPITAL AND OPERATING COSTS**

Modern currently receives approximately 600,000 pounds of plastic bottles per year at its handling facility. Because the company recently began accepting all screw-top containers, it is likely that Modern will handle even more plastics in 1996. In order to reduce its costs of handling plastics, it is recommended that Modern install a plastics perforator flattener. The capital cost to implement this strategy is summarized in Table 1.

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Implementation Strategy Capital Costs</strong></td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
</tr>
<tr>
<td>Prodeva Plastics Perforator Densifier (2,000 lbs/hr capacity)</td>
</tr>
<tr>
<td>Controls, hopper, guarding</td>
</tr>
<tr>
<td>Engineering</td>
</tr>
<tr>
<td>Delivery</td>
</tr>
<tr>
<td>Installation, electrician</td>
</tr>
<tr>
<td><strong>Total Capital Costs</strong></td>
</tr>
</tbody>
</table>
Engineering costs are assumed to be 10 percent of equipment costs, and installation costs are assumed to be 7.5 percent of equipment costs. The base equipment cost for the perforator flattener was supplied by Prodeva, Inc., an industry leader in supplying perforator flatteners.

The capital costs shown above do not include any provisions for additional in-feed or take-away conveyors because this implementation plan recommends that the perforator flattener either straddle two or be mounted in one of the sort bunkers under the sorting platform. The advantages of doing this will be discussed later under the Conceptual Facility Modifications section of this implementation plan.

Table 2 summarizes the results of an investment analysis for this implementation plan. Please note that the cost figures that are shown are presented on an incremental (net) annual basis. Additionally, the figures are nominal (i.e. they do not include adjustments for inflation or the time value of money).

**Table 2**

<table>
<thead>
<tr>
<th>Line</th>
<th>Annual Cost Savings (Cost)</th>
<th>Net Change in Proposed Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs/Outputs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Plastic Bottles Processed (Pounds)</td>
<td>600,000</td>
<td></td>
</tr>
<tr>
<td>Costs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Baling ($/Year)</td>
<td>$3,750</td>
<td></td>
</tr>
<tr>
<td>3 Shipping ($/Year)</td>
<td>4,000</td>
<td></td>
</tr>
<tr>
<td>4 Densifier O&amp;M ($/Year)</td>
<td>(1,500)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$6,250</td>
<td></td>
</tr>
<tr>
<td>5 LESS: Depreciation</td>
<td>(1,255)</td>
<td></td>
</tr>
<tr>
<td>6 Net Cost Savings ($/Year)</td>
<td>$4,995</td>
<td></td>
</tr>
<tr>
<td>7 Net Cost Savings ($/Pound)</td>
<td>$0.008</td>
<td></td>
</tr>
<tr>
<td>Return on Investment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Return on Investment (%)</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>9 Pay Back Period (Years)</td>
<td>1.25</td>
<td></td>
</tr>
</tbody>
</table>

1 Assumes an hourly cost to bale of $20 per hour ($15 per hour labor and benefits, and $5 per hour bale wire and utilities), and baling of 1,600 pounds per hour of loose plastics compared to 3,200 pounds per hour of pre-densified plastics.

2 Assumes an average freight cost of $800 per truck-load, with 30,000 per load before pre-densification and 40,000 pounds per load after pre-densification.

3 Assumes $6,275 in incremental capital costs and a five year life.

4 Net cost savings (Line 6) divided by incremental capital costs ($6,275).

5 Incremental capital costs ($6,275) divided by net cost savings ($4,995).

Loose plastic bottles have a density of approximately 30 pounds per cubic yard. If the plastic bottles are passed through a perforator densifier, their density increases to approximately 70 pounds per cubic yard. The resulting increase in density (over
double) means that the baler's charging chamber can be filled with over twice the weight of undensified loose plastics, which results in the ability to produce full-weight bales in approximately half the time that otherwise would be required because less bale compaction cycles are required. Assuming an hourly incremental cost to bale of $20 per hour ($15 per hour for labor and benefits, and $5 per hour for bale wire and utilities), and baling of 1,600 pounds per hour of loose plastics compared to 3,200 pounds per hour of pre-densified plastics, baling pre-densified plastic bottles would save Modern $3,750 per year.

Assuming that full size bales can be produced, Modern would only need to ship 15 truckloads (at 40,000 pounds per load) of baled plastics per year instead of 20 (at 30,000 pounds per load). According to Modern, a per load estimate for shipping plastic bottles to market of $800 is reasonable. At $800 per load, Modern could save $4,000 per year in freight costs.

Operation and maintenance of the plastics perforator flattener is estimated to be $1,500. Annual depreciation on the full capital cost of the perforator flattener, assuming a five year life with no salvage value, is $1,255 ($6,275/5). As can be seen from Table 2, the cost savings far exceed the depreciation and operation and maintenance costs, resulting in estimated net cost savings of $4,995 per year, or an 80 percent return on investment (a pay back period of 1.25 years).

IMPLEMENTATION SCHEDULE

Provided Modern decides to implement this plan by the end of February, it is anticipated that engineering, shipment, and installation of the perforator flattener could be completed by April 30, 1996 (within 60 days).

CONCEPTUAL FACILITY MODIFICATIONS

Figure 1, shown on the following page, illustrates the layout of Modern's handling facility. Because Modern would like to maintain the flexibility of its facility, the perforator densifier could not be located directly in line with the sorting line or either of the existing in-feed conveyors since Modern uses those pieces of equipment to process more than just plastics, and the perforator densifier is only designed to process plastics.

In order to minimize the cost for additional conveyors and minimize additional handling costs, R. W. Beck recommends that Modern mount the perforator densifier on the back side of the sorting conveyor, flush with the sorting platform floor. A sheet metal hopper/guarding should be installed that is flush with the level of the sorting conveyor. Modern would then be able to feed plastic bottles onto the sorting conveyor, and could use a diverter bar to direct the plastic bottles directly into the perforator flattener hopper so that no manual labor would be required. If Modern mounts the perforator densifier so that it straddles two sort bunkers, a pivoting discharge chute could be mounted under the perforator densifier unit so that
flattened plastic bottles could be directed to each of two bunkers. This would allow Modern to select which bunker the flattened plastic bottles are directed to, which could be desirable if Modern ever wishes to sort plastic bottles by resin type in the future.

**Figure 1**
Modern Corporations Facility Layout

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**EFFECT ON OTHER RECOVERY CHAIN BUSINESSES**

The implementation team for this strategy would consist only of representatives from the Modern Corporations. The effect on other businesses in the recovery chain is less pronounced and indirect, although greater bale densities and larger bale sizes would require less handling of Modern's bales by reclaimers for an equivalent amount of material. The perforator flattener should also aid in stripping caps and base cups from plastic bottles, which would increase the yield for reclaimers.
POTENTIAL FUNDING OPTIONS

Funding to implement this plan could be obtained from several different sources. First, because the capital investment required to implement this plan is not great, Modern would likely be able to implement this plan using its own operating income.

Second, the New York State Department of Economic Development, Office of Recycling Market Development, administers the Recycling Investment Program. This program was devised to provide grants to entities that collect, handle, reclaim and/or manufacture using post-consumer plastics. It allows those companies to establish a more cost-effective post-consumer plastic reclamation infrastructure in New York and to expand the base manufacturers capable of using post-consumer plastic as a feedstock supplement or substitute. Entities interested in receiving a grant from this program submit applications to the Office of Recycling Market Development for their consideration. The next cycle for applying for the grants will be in the summer of 1996.

Third, the American Plastics Council considers equipment demonstration projects on a case-by-case basis. There is a possibility that American Plastics Council would consider providing partial funding for this implementation plan.
Schenectady County Soil and Water Conservation District Implementation Plan

State of New York
Department of Economic Development
Office of Recycling Market Development

January 1996
The Schenectady County Materials Recovery Facility is located in up-state New York, and is operated by the Schenectady County Soil and Water Conservation District (SWCD). Recyclables collected within the County, predominantly from the City of Schenectady, are processed at this MRF. In addition to operating the MRF, the SWCD also markets the processed recyclables. The Schenectady County Planning Department (the "Planning Department") serves as the contact agency for the SWCD with regard to the MRF. In addition, the Planning Department is responsible for grant applications, publicity, research and development, and policy input for the MRF.

Recyclables are delivered to the MRF in two pre-sorted categories: paper materials and commingled containers. The paper materials accepted include old newspapers, old magazines, mixed office paper and old corrugated containers. The commingled containers accepted include: steel and tin cans; aluminum cans; clear and green #1 PET plastic bottles; natural and mixed color #2 HDPE plastic bottles; gable-top containers; and flint, amber and green glass containers. Although #3 through #7 plastic bottles are not targeted for collection, they are frequently delivered to the MRF with the other commingled containers. Because the SWCD has a market for the mixed plastic bottles, it bales these materials rather than disposing them.

Paper recyclables that are delivered to the MRF are first deposited onto a designated section of the tipping floor. A front-end loader operator pushes the paper materials onto an infeed conveyor where laborers standing on an elevated sorting platform sort the various grades of paper. Old corrugated containers, magazines and mixed office paper are sorted from the conveyor and deposited by laborers down chutes to dedicated storage bunkers. These grades of paper (other than newspaper) are baled periodically during the day on a batch basis. These bales are placed in storage until a transfer trailer load of each paper type is accumulated for shipment to the end market. Because the newspaper comprises the greatest volume of the various paper grades received, it remains on the conveyor and is directly fed to the baler for baling. Once the newspaper is baled, it is directly loaded via fork-lifts into transfer trailers.

Commingled containers are separately deposited onto the tipping floor. The commingled containers are pushed by the front-end loader onto an infeed conveyor that transfers the material to the an elevated sorting line. Natural HDPE bottles are removed by laborers at the first sort station and deposited down drop-chutes leading to a dedicated storage bunker. In a similar fashion, the second and third sort
stations are used to separate mixed color HDPE bottles, mixed color (clear and green) PET bottles and gable top containers, respectively. The remaining material on the conveyor is then conveyed past a magnet to capture the steel and tin cans. These cans are then dropped into a separate storage bunker.

Following the magnetic separation process, the remaining material is air classified to remove aluminum cans from the glass and waste material on the conveyor. Any #3 through #7 plastic bottles are removed by laborers and placed into boxes located on the sorting platform for later consolidation and baling. In addition, any waste material or unacceptable material delivered to the MRF are removed from the sorting line.

At this point, the only material that should be on the conveyor is commingled glass containers. Laborers separate out the flint glass, which is separately conveyed to a dedicated roll-off container. The mixed color glass containers that remain on the main sorting conveyor are fed into a glass pulverizing unit, and then are deposited into a separate storage bunker.

As the storage bunkers for the natural HDPE, mixed color HDPE, PET, gable-top containers, and steel and tin cans each reach capacity, the material is pushed by the front-end loader operator onto the infeed baling conveyor for baling. The baling of the separated containers is scheduled when the baler is not being used to bale newspaper or other type of paper commodity.

**PROPOSED FACILITY QUALITY IMPROVEMENT STRATEGY**

The SWCD currently markets all processed plastic bottles in baled form. The quality improvement strategy that SWCD would like to implement addresses further processing of natural HDPE plastic bottles into a flake form. Currently, natural HDPE bottles are the predominant type of plastic container processed at the MRF. The SWCD estimates for the 1994 calendar year the following plastic container tonnages processed:

- Mixed color PET: 19.6 tons;
- Natural HDPE: 137.3 tons;
- Mixed color HDPE: 73.5 tons; and
- Mixed number 3 through 7 plastic bottles: 4.7 tons.

Therefore, the natural HDPE bottles comprised approximately 58 percent of all of the plastic containers processed during calendar year 1994.

Based on the tonnages received during the first six months of calendar year 1995, the SWCD projected the plastic container tonnages that would be delivered to the MRF in calendar year 1996. The projected plastic container tonnages to be processed at the MRF for calendar year 1996 are as follows:
Mixed color PET: 29.1 tons;  
Natural color HDPE: 194.1 tons;  
Mixed color HDPE: 90.9 tons; and  
Mixed number 3 through 7 plastic bottles: 6.9 tons.

Thus, the natural HDPE bottles are projected to comprise approximately 60 percent of all the plastic containers processed during calendar year 1996.

Given the high tonnages of natural HDPE bottles, the SWCD is interested in installing a granulator in order to add value to this material and allow for greater processing flexibility. The granulator will also create additional baling time for other recyclable commodities. This could potentially allow the SWCD to accept new types of recyclable materials and/or process greater volumes of acceptable recyclable materials which currently require baling.

The SWCD also states that another reason for implementing this strategy is to eliminate the need for intermediate processing of the natural HDPE bottles. Currently, the baled natural HDPE bottles are sent to an intermediate processor who grinds the baled materials into a dirty flake. This secondary processor then transports the dirty flake to a reclaimer where the flake is washed, dried and prepared as feedstock for manufacturing a new recycled-content plastic product. By granulating the natural HDPE bottles on-site at the MRF, this material can be directly marketed to the reclaimer for a higher price, eliminating the requirement for a secondary processor.

The SWCD proposes the following modifications to the commingled container process line at the MRF to provide for the ability to grind their separated natural HDPE:

- The purchase and installation of one granulator with a fan take-away system. The purpose of the granulator would be to produce 3/8 inch flakes from the whole natural HDPE bottles. This granulator would be placed in the first storage bunker under the commingled containers sorting conveyor. The fan take-away system would be used to blow the granulated flakes through a four inch tube to the MRF's north side into the bagging area. The material would then be loaded into heavy-duty shipping sacks. The proposed area for bagging would be located outside of the MRF adjacent to the existing flint glass roll-off storage container. Minor modifications to the existing MRF wall would be necessary to attach the tubing for the fan take-away system to the granulator.

- The fabrication of a metal "Y" chute to be attached to the bottom of the existing chute in the first storage bunker of the commingled containers process line. This chute would have a manual diverter latch that would allow the sorted natural HDPE bottles to be sent either directly to the granulator or to the storage bunker. The diverter on the chute would provide flexibility to the operator for the processing of the natural HDPE bottles.
The following modifications for the bagging area: (1) a paved surface for cyclone and motor equipment, and fork-lift maneuvering dimensions of approximately 60 by 30 feet; and (2) a new pre-fabricated low maintenance building to protect equipment from the weather (approximate size 20 feet by 30 feet).

Demolition of the old salt shed (currently located adjacent to the north side of the MRF). Removal of this building would allow easy access to the existing flint glass roll-off and the bagging area.

Replacement of the fencing on the northwest side of the MRF to allow the flint glass roll-off storage container to be serviced via the west side of the MRF rather than through the main entrance.

It should be noted that additional education regarding contamination of natural HDPE bottles should be conducted to help ensure that a quality flake product is produced to sell to end-markets. These education efforts should encourage participants to remove and dispose the bottle caps, rinse the bottles, and prevent storage of any hazardous materials or insulin needles in the bottles they separate for recycling collection.

**CAPITAL AND OPERATING COSTS FOR PROPOSED STRATEGY**

The incremental capital costs for the proposed strategy, as estimated by the SWCD, equipment supplier representatives, and R. W. Beck, are summarized in Table 1.

<table>
<thead>
<tr>
<th>Implementation Strategy</th>
<th>Capital Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Site Preparation</strong></td>
<td></td>
</tr>
<tr>
<td>Demolition of Salt Shed</td>
<td>$3,500</td>
</tr>
<tr>
<td>Fence Modification</td>
<td>$2,500</td>
</tr>
<tr>
<td>Paving</td>
<td>$3,000</td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>Granulator</td>
<td>$12,700</td>
</tr>
<tr>
<td>Fan Take-Away System</td>
<td>$11,100</td>
</tr>
<tr>
<td>Spare Parts for Granulator (Knives and spare screen)</td>
<td>$1,100</td>
</tr>
<tr>
<td>&quot;Y&quot; Diverter Chute</td>
<td>$500</td>
</tr>
<tr>
<td>New Pre-Fabricated Shed for Bagging Equipment</td>
<td>$6,000</td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$1,823</td>
</tr>
<tr>
<td><strong>Delivery Costs</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$500</td>
</tr>
<tr>
<td><strong>Total Capital Costs</strong></td>
<td>$42,723</td>
</tr>
</tbody>
</table>

Notes for Table 1 appear on the following page.
For this analysis, it was assumed that the MRF would process and granulate 194.1 tons or 388,200 pounds of natural HDPE bottles each year.

Direct costs for implementation of this strategy include typical operating expenses such as electricity, knives and screen replacement, lubrication of equipment, purchasing of bags, and bag replacement. This analysis assumes that these additional operating costs would be completely offset by savings associated with existing operational costs for the baling of this material.

Therefore, the only difference in direct operating expenses for this analysis would be for twice per year replacement of the knives and screen on the granulator and for polypropylene bags used for the shipment of the flaked material. Representatives of Supersack Container have estimated that each shipment bag would cost $20. Assuming: (1) each bag will hold 800 pounds, (2) 388,200 pounds of natural HDPE flake is produced at the MRF per year, (3) 10 percent of the bags would need to be replaced after each shipment, and (4) one complete spare set is required during transportation, then a total of 100 bags would be required each year.

Because the natural HDPE bottles would normally be fed directly into the granulator, some labor savings would be achieved because the front-end loader operator would no longer need to remove the loose sorted natural HDPE bottles to the infeed baling conveyor. However, this savings was assumed to be negligible.

Discussions with end markets in New York State revealed that the increase in revenues from producing dirty natural HDPE flakes is approximately 5 cents per pound as compared to baled natural HDPE bottles. It should be noted that this revenue increase is highly dependent on the quality of HDPE dirty flake produced. If the product does not meet the resin manufacturer’s specifications, additional revenues could be reduced to as little as $0.02 per pound, or the product may be deemed completely unacceptable. Therefore, separate analyses were performed assuming both a high quality and a lower quality flake is produced.

The analysis for the proposed MRF modifications is summarized in Table 2. Please note that all the figures provided in these analyses are annual costs and revenues. Additionally, these values are nominal (i.e., they do not include adjustments for inflation or the time value of money).
Table 2
Implementation Strategy

<table>
<thead>
<tr>
<th>Line</th>
<th>Annual Revenue (Cost)</th>
<th>Proposed Operations Assuming High Quality Flake</th>
<th>Proposed Operations Assuming Low Quality Flake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outputs:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Natural HDPE Flake (Pounds/Year)</td>
<td>388,200</td>
<td>388,200</td>
</tr>
<tr>
<td>Additional Revenue:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Incremental Revenue ($/Year)</td>
<td>$19,410</td>
<td>$7,764</td>
</tr>
<tr>
<td>3</td>
<td>Replacement Parts</td>
<td>(2,200)</td>
<td>(2,200)</td>
</tr>
<tr>
<td>4</td>
<td>Shipment Bags</td>
<td>(2,000)</td>
<td>(2,000)</td>
</tr>
<tr>
<td>5</td>
<td>LESS: Depreciation</td>
<td>(6,103)</td>
<td>(6,103)</td>
</tr>
<tr>
<td>6</td>
<td>Net Revenue ($/Year)</td>
<td>$9,107</td>
<td>($2,539)</td>
</tr>
<tr>
<td>7</td>
<td>Net Revenue ($/Pound)</td>
<td>$0.023</td>
<td>($0.007)</td>
</tr>
</tbody>
</table>

Return on Investment:

<table>
<thead>
<tr>
<th>Line</th>
<th>Return on Investment (%)</th>
<th>Pay Back Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>21.3%</td>
<td>-5.9%</td>
</tr>
<tr>
<td>9</td>
<td>2.8</td>
<td>12.0</td>
</tr>
</tbody>
</table>

1 Assumes an additional revenue of $0.05 per pound of high quality natural HDPE dirty flake and $0.02 per pound of low quality natural HDPE dirty flake (versus baled material).
2 Replacement parts include twice per year replacement of the knives and screen for the granulator.
3 Assumes 100 shipment bags would be required each year at a cost of $20 per bag.
4 Assumes $42,723 in incremental capital costs and a seven year life.
5 Net revenues (Line 7) divided by incremental capital costs ($42,723).
6 Incremental capital costs ($42,723) divided by incremental revenues (Line 2) less incremental operating costs (Line 3 + Line 4).

Assuming the MRF continues to process the same amount of natural HDPE bottles in the following years after 1996 and that a high quality flake can be produced, it would take slightly less than three years to pay back the investment. However, if the natural HDPE dirty flake is of a lower quality with high contamination rates, it would take twelve years to pay back the investment, long after the useful life of the equipment has expired.

IMPLEMENTATION SCHEDULE

Based on discussions with the SWCD and equipment supplier representatives, the total time to design, purchase, install and start-up the new granulator and fan take-away system would be 2 to 3 months. However, it should be noted that this schedule is highly dependent on the approval process for demolishing the salt shed building on-site and the time at which the equipment is actually ordered. Assuming
that the salt shed is demolished at the same time the equipment is ordered, a three
month installation schedule appears to be reasonable based on industry standards
for retrofits to existing MRFs.

The implementation team for this strategy would consist of representatives from the
SWCD, the Planning Department and the City of Schenectady Bureau of Waste
Collection. The director of the SWCD will be the project manager with the MRF
supervisor and the Planning Department Recycling Coordinator as project team
members.

CONCEPTUAL FACILITY MODIFICATIONS FOR PROPOSED
STRATEGY

The three major modifications required at the MRF for the proposed strategy
include: the existing natural HDPE storage bunker; the north wall of the MRF
adjacent to the existing flint glass roll-off storage container; and the demolition of
the salt shed area outside the main building.

The three modifications are summarized below:

- A metal "Y" chute will be welded onto the bottom of the existing chute to allow
  natural colored HDPE bottles to be fed into the granulator or the storage bunker.
  Electrical hook-ups and brackets for the granulator will also have to be installed.

- The building wall would have to be modified to allow a 4 inch tube to pass
  through to the bagging area for the natural colored HDPE flakes. In addition,
  installation of the piping would be required.

- The salt shed would have to be demolished and the fence on the northwest
  boundary of the MRF site would have to be modified to allow the flint glass roll-
  off storage container to be serviced from the northwest side of the MRF. Once
  the salt shed building is removed, the bagging area would be constructed.

The bagging area construction would include pouring a concrete pad approximately
60 feet by 30 feet for placement of the cyclone and fan motor for the flake bagging
system and for fork-lift maneuvering. This equipment would be placed in a simple
pre-fabricated building approximately 20 feet by 30 feet to protect the equipment
from the weather elements.

EFFECT ON OTHER RECOVERY CHAIN BUSINESSES

The modification to the MRF for granulating natural HDPE bottles will affect both
the HDPE secondary processing market and the post-consumer resin manufacturing
market. For the processing market, the MRF will be able to bypass the intermediate
processor because the natural HDPE will already be granulated at the MRF. This
will allow the MRF to eliminate the expense of transporting the baled natural HDPE to the intermediate processor.

POTENTIAL FUNDING OPTIONS

Three potential funding options exist for the modification of the Schenectady to allow natural colored HDPE granulating.

The first funding option for the proposed modifications includes the Recycling Investment Program through the New York State Department of Economic Development, Office of Recycling Market Development. This program was devised for entities that collect, handle, reclaim and/or manufacture post-consumer plastics, to establish a more cost-effective post-consumer plastic reclamation infrastructure in New York and to expand the base manufacturers capable of using post-consumer plastic as a feedstock supplement or substitute. Entities interested in receiving a grant from this program submit applications to the Office of Recycling Market Development for their consideration. The SWCD submitted an application for the granulation modifications at their MRF on October 2, 1995.

The second potential funding option would be from internal SWCD or Planning Department sources. Based on the analysis provided in this plan, funding could be requested from the SWCD or the Planning Department for the modifications.

As a third funding option, the SWCD could apply for private financing from a leasing agency.
CURRENT OPERATIONS DESCRIPTION

Western Finger Lakes Solid Waste Management Authority (the "Authority") is located in Western New York, less than one hour's drive to the east of Rochester. The Authority operates a materials handling facility for collected recyclables, and serves as a regional plastics recycling facility, sorting and baling mixed rigid plastics from other handling facilities in Western New York. In fact, only 20 percent of all plastics processed come from the Authority's home county of Wayne. Loose or compacted plastics also come from Yates, Seneca, and Schuyler Counties. Baled mixed plastics come from further distances.

The heart of the Authority's $660,000 handling facility is a modified new $400,000 Countec Recycling Systems sort system. A schematic of the system is shown in Figure 1 on the following page. All fiber products (newspapers, corrugated containers, magazines, and mixed paper) are manually sorted on a dedicated fiber line. Commingled containers are fed up a separate line, beginning with an incline conveyor, that feeds a trommel. Ferrous containers are then separated by a magnetic overhead conveyor, and briquetted. All remaining containers pass through an air classifier that separates out heavies (glass) onto a glass sort line, and all other "lights" onto a containers sort line. All other remaining sorts are manual, with positive sorts (in the following order) for natural HDPE bottles, pigmented HDPE bottles, PET bottles (clear), injection grade plastic tubs, #3-#7 plastic bottles, and gable-top poly-coated paper cartons. Because New York is a bottle-bill state, few deposit containers (green PET soft drink bottles, aluminum cans, etc.) are collected and therefore processed through the Authority's facility.

Sorted fiber and containers are individually fed by a bucket loader into a well-used KMF single-ram horizontal baler. The Authority has a new higher capacity horizontal baler on order, which should be delivered in September, 1997. The new baler will be installed at the end of the fiber line, which will allow negatively sorted fiber to be fed automatically into the baler.

The Authority make innovative use of local low-cost labor in order to gain a competitive advantage over other handlers, and serve as a regional sorting facility for plastics and fiber products (when fiber markets are good). Only five full time employees (including supervisory personnel) are allocated to operating the facility. Other labor sources include temporary employees, individuals supplied by the Department of Social Services, and inmates from the county jail.
PROPOSED IMPROVEMENT STRATEGY

The Authority has some facility improvement strategies in mind. First is an automated transfer system to convey sorted containers to the new baler. This system would be composed of a floor-level horizontal transfer conveyor (already in the Authority's possession) that the Authority plans to install underneath the sort platform at the back of the container sort bunkers. This conveyor will be fed by at least three automated bunker unloading conveyors— one for HDPE natural bottles, one for HDPE pigmented bottles, and one for PET bottles. The floor level horizontal transfer conveyor will allow for a final opportunity to improve the quality of the sorted plastic before baling them. The containers would then be lifted with a feed conveyor to an elevated (18 feet high) transfer conveyor that would discharge onto an elevated reversible transverse conveyor that would feed the baler.

The second improvement is to install a new feed conveyor and bale breaker. The current container feed system is at capacity, and cannot handle additional baled
plastics that the Authority would like to process. Because the container sort line can handle additional material, the Authority would like to add a bale breaker (so that bales won’t need to be broken apart by hand) with an associated feed conveyor and trommel that would feed plastics directly up to the sort conveyor, bypassing the current feed system that was designed for loose commingled containers.

R. W. Beck feels that both proposed improvements have merit. The first improvement in particular should improve the efficiency of feeding the new baler while improving the quality of the processed plastics. The second improvement (bale breaker and feed conveyor) would enable the Authority to process additional plastics, improving overall revenues and efficiencies of the facility.

**CAPITAL COSTS**

The capital cost to implement this strategy is summarized in Table 1.

<table>
<thead>
<tr>
<th>Automated Transfer Equipment</th>
<th>Equipment</th>
<th>Installation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunker unload/transfer conveyors (already procured)</td>
<td>$0</td>
<td>$700</td>
<td>$700</td>
</tr>
<tr>
<td>Feed conveyor (20 foot elevation)</td>
<td>12,500</td>
<td>400</td>
<td>12,900</td>
</tr>
<tr>
<td>Elevated cross conveyor (30 feet long)</td>
<td>14,000</td>
<td>1,500</td>
<td>15,500</td>
</tr>
<tr>
<td>Controls</td>
<td>2,000</td>
<td>500</td>
<td>2,500</td>
</tr>
<tr>
<td>Facility modifications (modify three bunkers)</td>
<td>2,000</td>
<td>1,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Freight</td>
<td>2,000</td>
<td></td>
<td>2,000</td>
</tr>
<tr>
<td>Engineering</td>
<td>1,200</td>
<td></td>
<td>1,200</td>
</tr>
<tr>
<td><strong>Automated Transfer Equipment Total Capital Costs</strong></td>
<td><strong>$33,700</strong></td>
<td><strong>$4,100</strong></td>
<td><strong>$37,800</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Debale/Line Feed Equipment</th>
<th>Equipment</th>
<th>Installation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debaler</td>
<td>$56,500</td>
<td>$1,000</td>
<td>$57,500</td>
</tr>
<tr>
<td>Feed conveyor</td>
<td>8,000</td>
<td>400</td>
<td>8,400</td>
</tr>
<tr>
<td>Trommel/declumper</td>
<td>8,000</td>
<td>500</td>
<td>8,500</td>
</tr>
<tr>
<td>Controls</td>
<td>1,200</td>
<td>400</td>
<td>1,600</td>
</tr>
<tr>
<td>Facility modifications (barricades, etc.)</td>
<td>800</td>
<td>300</td>
<td>1,100</td>
</tr>
<tr>
<td>Freight</td>
<td>2,000</td>
<td></td>
<td>2,000</td>
</tr>
<tr>
<td>Engineering</td>
<td>400</td>
<td></td>
<td>400</td>
</tr>
<tr>
<td><strong>Automated Transfer Equipment Capital Costs</strong></td>
<td><strong>$76,900</strong></td>
<td><strong>$2,600</strong></td>
<td><strong>$79,500</strong></td>
</tr>
</tbody>
</table>

**Total Capital Costs**

<table>
<thead>
<tr>
<th></th>
<th>Equipment</th>
<th>Installation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Automated Transfer Equipment</strong></td>
<td><strong>$110,600</strong></td>
<td><strong>$6,700</strong></td>
<td><strong>$117,300</strong></td>
</tr>
</tbody>
</table>

W:\006716\031430\PLANS\FINGERLAKES.DOC R. W. Beck, Inc. 3
It should be noted that the capital costs of some pieces of equipment (i.e., the baler, unload/transfer conveyors, and reversible transverse conveyor) are not included in Table 1 because they have either already been procured, or because their cost has been allocated to processing other materials such as paper.

Table 2 summarizes the results of an investment analysis for this implementation plan. Separate analyses were first completed for the automated transfer equipment, the bale breaker, and the new feed conveyor to ensure that each proposed piece of equipment provided an economic benefit (the feed conveyor only provided an economic benefit if it allowed at least five percent more plastics to be processed). The separate analyses were then combined into the one analysis shown below in Table 2.

The Authority currently processes approximately 2,500,000 pounds of plastic bottles per year at its handling facility. Because it would like to significantly increase the amount of plastics processed, the analysis was completed for three scenarios: existing throughput, 50 percent additional throughput, and 100 percent additional throughput. Please note that the cost figures that are shown are presented on an incremental (net) annual basis. Additionally, the figures are nominal (i.e., they do not include adjustments for inflation or the time value of money).

<table>
<thead>
<tr>
<th>Line</th>
<th>Annual Revenue (Cost)</th>
<th>Current Throughput</th>
<th>50% Increase</th>
<th>100 % Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Inputs/Outputs:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Plastic Bottles Processed (Pounds)</td>
<td>2,500,000</td>
<td>3,750,000</td>
<td>5,000,000</td>
</tr>
<tr>
<td></td>
<td><strong>Revenues:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Incremental Revenue ($/Year)</td>
<td>$6,250</td>
<td>$156,875</td>
<td>$307,500</td>
</tr>
<tr>
<td>3</td>
<td>Operating Costs ($/Year)</td>
<td>12,000</td>
<td>(109,500)</td>
<td>(231,000)</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>$18,250</td>
<td>$47,375</td>
<td>$76,500</td>
</tr>
<tr>
<td>4</td>
<td>LESS: Depreciation</td>
<td>(16,757)</td>
<td>(16,757)</td>
<td>(16,757)</td>
</tr>
<tr>
<td>5</td>
<td>Net Revenue ($/Year)</td>
<td>$1,493</td>
<td>$30,618</td>
<td>$59,743</td>
</tr>
<tr>
<td>6</td>
<td>Net Revenue ($/Pound)</td>
<td>$0.001</td>
<td>$0.008</td>
<td>$0.012</td>
</tr>
<tr>
<td></td>
<td><strong>Return on Investment:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Return on Investment (%)</td>
<td>1%</td>
<td>26%</td>
<td>51%</td>
</tr>
<tr>
<td>8</td>
<td>Pay Back Period (Years)</td>
<td>6.4</td>
<td>2.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

1 Assumes an 11.8 cents per pound purchase-to-sales margin for additional material processed and 0.25 cent per pound of additional revenues for improved quality.

2 Assumes 0.5 cent per pound of reduced manual bale-breaking costs, 0.02 cents per pound for new equipment net operation and maintenance costs, and 10.2 cents per pound processing costs for new material.

3 Assumes $117,300 in incremental capital costs depreciated over seven years.

4 Net revenue (Line 5) divided by incremental capital costs ($117,300).

5 Incremental capital costs ($117,300) divided by net revenue (Line 5).
As Table 2 shows, even at no additional throughput the proposed facility modifications will pay for themselves in less than seven years. With increases of 50 percent and 100 percent, the payback period would be 2.5 and 1.5 years respectively.

The figures shown in Table 2 are based on several assumptions. First, it is assumed that the Authority's purchase-to-sales margin for baled plastics is 11.8 cents per pound. The margin for typical materials recovery facilities that sort delivered plastics is approximately 14 cents per pound. The 2.2 cents per pound benefit experienced by the Authority is thought to be a result of its utilization of low cost labor such as individuals supplied by the Department of Social Services, and inmates from the county jail. Should the Authority lose the use of those sources of low cost labor, the economics shown in the investment analysis will change, and the Authority would lose its ability to cost-effectively source and process mixed plastics from other facilities.

Other assumptions used in the analysis include assuming that the time and expense (e.g. operations and maintenance costs for the loader) to feed plastics into the baler with the loader will be equal to the time and expense to feed the baler with the automated transfer system, with an additional benefit that the individual operating the system will be able to pick remaining contaminants. The improved quality is assumed to result in a net 0.25 cent per pound of additional revenue. We also assumed that operation and maintenance costs for the bale breaker and direct line feed equipment would be 0.02 cents per pound. Finally, we assumed that processing costs for increases in plastics would be 10.2 cents per pound.

IMPLEMENTATION SCHEDULE

The Authority is scheduled to receive and install its new baler by the end of September. Provided that the Authority decides to implement this plan and obtains funding for the implementation by the end of September, it is anticipated that engineering, shipment, and installation of the proposed equipment could be completed by November 30, 1997.

CONCEPTUAL FACILITY MODIFICATIONS

Figure 1, shown on page 2, illustrates the general layout of the Authority's handling facility, including the layout of the proposed equipment. Although the bale breaker, feed conveyor, and trommel are shown parallel to the existing feed system, they can also be installed at a right angle to that shown. A parallel layout as shown would make it easier to direct waste removed by the trommels to a single waste container. Alternatively, a system at right angles would provide for a more open tipping floor and easier access to the current system feed.

In order to allow for automated unloading of the bunkers, the bunkers would have to be enclosed and modified with sloping sides so that the sorted plastics would flow down by gravity onto a floor level conveyor inside each bunker. The bunker
conveyors could either discharge onto a floor level transfer conveyor located underneath the current sort platform, or else they could elevate a few feet so that the transfer conveyor could be mounted at waist level. The second option would allow for easier final picking of contaminants from the plastics. The transfer conveyor would then discharge onto a feed conveyor located just past the last bunker that would elevated the plastics approximately 18 feet. The elevated plastics would then fall to a transfer conveyor (elevated 18 feet to allow for vehicle traffic underneath).

Existing plans call for a reversible transverse conveyor as part of fiber line modifications to allow for direct loading of unbale fiber into open top trucks. The elevated plastics transfer conveyor is shown discharging onto the reversible fiber conveyor for feeding into the baler. It should be noted that this arrangement will not allow simultaneous baling of plastics and loading of an open top truck with fiber. In order to allow simultaneous operations, a longer plastics transverse conveyor would be needed that could directly feed into the new baler.

EFFECT ON OTHER RECOVERY CHAIN BUSINESSES

The implementation team for this strategy would consist of representatives from the Authority. The effect of the proposed changes at the Authority on other businesses in the recovery chain is expected to be positive. Most smaller handlers in New York lack the capability to efficiently sort plastics to market specifications, and should benefit by being able to forward their unsorted plastics to a centralized facility that is able to utilize low cost labor unavailable to them. Because the Authority accepts all rigid plastic containers, this should also allow communities to broaden the plastic types that they accept in their programs. Finally, the Authority has proven that it can provide better quality baled plastics than most other handlers. This will improve the economics of recycling for reclaimers and end-product manufacturers.

POTENTIAL FUNDING OPTIONS

Funding to implement this plan could be obtained from several different sources. First, the New York State Department of Economic Development, Office of Recycling Market Development, administers the Recycling Investment Program. This program was devised to provide grants to entities that collect, handle, reclaim and/or manufacture using post-consumer plastics. It allows those companies to establish a more cost-effective post-consumer plastic reclamation infrastructure in New York and to expand the base manufacturers capable of using post-consumer plastic as a feedstock supplement or substitute. Entities interested in receiving a grant from this program submit applications to the Office of Recycling Market Development for their consideration. The next cycle for grant applications is due August 6, 1997.

Second, the Authority could pursue funding from internal sources.
CURRENT OPERATIONS DESCRIPTION

Xerox Corporation is a multinational marketer and producer of state-of-the-art business machines, including copy machines, printers, and telex machines. Xerox also produces a wide variety of business machine accessories.

In Utica, New York, Xerox operates a satellite facility called the Low Complexity Manufacturing Group. This site is the return center for Xerox's used toner bottles from customers throughout Eastern United States. The high-density polyethylene (HDPE) bottles all arrive in pre-labeled boxes by UPS. There are three primary bottles being returned, the 5090, 1075, and 4850. Each designation refers to the Xerox copier model for which it is used. The returned bottles generally contain a small residual amount of dry toner.

Xerox's toner bottles are blow-molded from fractional melt HDPE homopolymer. There are natural in color and, as such, are very similar in composition to the natural post-consumer HDPE bottles collected in many residential recycling programs. The toner bottle weights vary from 7.0 ounces for the 4850 bottle to about one pound for the 5090 bottle.

This Low Complexity Manufacturing Group receives about 11,500 used toner cartridges per week. All are inspected for any defects or damage that would make the bottle unsuitable for reuse. The majority are cleaned and shipped back to Xerox's Rochester, NY plants for refilling and reuse in copy machines.

About 12% of the returned bottles are taken out of service for various quality reasons. These bottles are currently being given away to a local recycling company in the form of whole bottles. The Utica facility does not currently have size reduction equipment.

The following is an estimate of the volume of toner bottles available for recycling:

- 5090 Copier bottle - 7000 per week x 12% = 840 bottles/week
- 1075 Copier bottle - 3000 per week x 12% = 360 bottles/week
- 4850 Copier bottle - 1500 per week x 12% = 180 bottles/week

Based on Xerox estimates, about 2.0-2.5 million bottles per year are currently returned to Utica, NY for reuse. Therefore, the current annual volume available for recycling is 240,000-300,000 bottles.
The Utica facility cannot currently economically recycle toner bottles because they do not have a plastics grinder. HDPE must be size reduced to 3/8 inch to be salable. The plant attempted to purchase and install a grinder recently. However, an internal analysis added so much safety equipment and noise controls that the capital cost became excessive. The Utica plant manager could not justify the investment.

PROPOSED IMPROVEMENT STRATEGY

Xerox has projected increases in the return rate of used toner bottles such that 3.0-4.0 million bottles per year will be shipped to the Utica Facility. This would equal 2.25-3.0 million pounds of HDPE per year, or 275,000-360,000 pounds per year of HDPE collected for recycling. In addition, Xerox estimates that another 500,000 pounds per year of HDPE from end caps and small bottles will be available for recycling.

At a project kick-off meeting in Utica, NY, various options were discussed to overcome the short-term recycling problem (lack of regrind capability) and the long-term problem (identification of premium markets).

The following facility quality improvement strategies were identified to correct both the short-term and long-term excess toner bottle recycling problems:

- Investigate toll grinding;
- Resolve internal concerns;
- Identify other extrusion opportunities within Xerox for post-consumer content; and
- Investigate marketing of the recycled HDPE from toner bottles to other New York based companies.

**Investigate toll grinding.** Xerox should investigate toll grinding as an interim step for size reduction of excess post-consumer HDPE toner bottles. This will allow the recyclable material to be transported to regional plastic converters or recyclers. These companies will then upgrade and/or convert the HDPE to new recycled-content products.

**Resolve internal concerns.** Xerox also should resolve the internal concerns that led to the excessively high cost regrind equipment for the Utica, NY facility. Toll grinding is an interim step until the internal issues are resolved. There is precedent within Xerox to install safe and affordable grinding systems at another site. The details of that installation will be determined and applied to Utica. Assuming the grinder will be installed, investigate reuse in toner bottles at Voplex in Canaidaga, NY, where the toner bottles are manufactured.

**Identify other extrusion opportunities within Xerox for post-consumer content.** One option already identified by Xerox is a thermoformed drum cover for the 5012 copier. A sample of this part was provided by Xerox – it is a black thin-gauge part, 18" x 12" size weighing 85 grams, and identified by the SPI Code as HDPE. The
performance specifications for this part will be reviewed to ascertain whether it would be feasible to use the toner cartridge regrind without compromising performance.

Investigate marketing of the recycled HDPE from toner bottles to other New York based companies. The R.W. Beck Team has been assisting the New York Department of Economic Development on value-added recycling within New York since 1985. A number of converters of HDPE have been contacted and several have been directly involved in this Post-Consumer Plastics Optimization Program. In particular, Tulip Corporation, Clearvue Resource Management, and McKechnie Plastic Packaging are good candidates. Potential use at these companies will be dependent on meeting product specifications and volume requirements.

The ultimate disposition of Xerox’s excess HDPE will incorporate the same value-added recycling approach used for other New York companies that participated in this program. The R.W. Beck team will objectively analyze the various options and recommend those that are expected to provide premium value and long-term stability to Xerox Corporation.

IMPLEMENTATION SCHEDULE

The quality improvement strategies outlined in this Implementation Plan will be completed during the Third and Fourth Quarters of 1997. It may not be possible to report on actual production costs and recycling rates due to certain unknown issues - primarily, the resolution of questions regarding safe grinder installation and delivery/installation of the grinder. However, all detailed analyses and evaluation of recycling options for value-added applications will be completed before year-end 1997.

CONCEPTUAL FACILITY MODIFICATIONS

It is premature to propose facility modifications or capital and operating costs before the internal safety issues are finalized relative to the Utica Facility grinder. The basic equipment should cost less than $20,000. However, noise reduction controls, safety shutdown switches, and other add-ons can escalate capital requirements. These issues will be resolved as the project progresses.

EFFECT ON OTHER RECOVERY CHAIN BUSINESSES

The installation of size reduction equipment will increase the available supply of post-consumer HDPE from Utica, NY to nearly 400,000 pounds per year, based on projections by Xerox. This material is very similar to the post-consumer HDPE bottle grade collected by many residential recycling programs. It is the goal of this project to recycle this material into value-added products at Xerox or to other plastic converters who incorporate recycled HDPE in their premium products.
POTENTIAL FUNDING OPTIONS

It would be premature to discuss funding options before equipment requirements are better understood.
CLEARVUE POLYMERS INC.
IMPLEMENTATION PLAN

STATE OF NEW YORK
Department of Economic Development

Office of Recycling
Market Development

January 1996
CURRENT FACILITY OPERATIONS DESCRIPTION

Clearvue Polymers Inc. (Clearvue) is located in Amsterdam, New York, just outside the capital city of Albany. Clearvue reclaims different grades of post-consumer plastics and prepares those plastics for re-use by plastic product manufacturers. Clearvue predominantly serves materials recovery facilities (MRFs) and intermediate processing centers located in New York that handle post-consumer plastics.

Clearvue is currently processing approximately eight million pounds per year of #2 HDPE plastics. Clearvue estimates that 90 percent of the total plastics handled at this facility is HDPE. The three grades of HDPE that Clearvue processes are natural, mixed color, and yellow-orange-white (YOW) colored plastics. Approximately 20 percent of the total HDPE processed into pellets at Clearvue is natural HDPE.

Bales of the different grades of HDPE plastic bottles are delivered to Clearvue and placed in storage for processing. The process flow for the baled HDPE grades is as follows:

- Bales are sent to a bale breaker where the bale wires are removed and the bottles are conveyed to a declumper to separate the bottles. The bale wires are sent to a wire chopper for recycling.

- The separated bottles are conveyed to an elevated sorting platform where laborers separate the different HDPE plastic bottles by color and type and deposit them into dedicated storage bunkers. The separated material is then sent to grinders, is aspirated to remove labels and fines, and then is auger conveyed to Gaylord boxes. Each Gaylord box of flaked HDPE material is then placed into inventory prior to washing.

- Each color stream of HDPE flake is removed from inventory and washed separately in a heavy agitation cycle designed by Clearvue. Cold water is used for both the natural and mixed color HDPE flake; however, caustic is added to the natural HDPE flake when washing.

- After washing, the flake is spin dried to remove excess wash water. The flake then pass through a sink/float system to remove further contaminants. The flake is spin dried, followed by a heated air tumble drying cycle, and then finally aspirated. The clean flake is deposited into Gaylord boxes.
The clean flake is sent to a six-inch extruder with a water ring pelletizer to produce plastic pellets. Manual screen changers in series are used to remove final contaminants. One of the pellet streams is then pneumatically conveyed to an 180,000 pound capacity silo for bulk storage and/or shipment. Because Clearvue only has one silo, the other pellet streams are deposited into Gaylord boxes for batch storage and shipment.

Clearvue also produces plastic cores which are used by the converting industry. These cores use some of the pellets Clearvue produces as raw material.

Clearvue states that approximately 98 percent of all the clean plastic flake produced at the facility are processed into pellets or extruded cores. The remaining clean flake is sold to other product manufacturers.

PROPOSED FACILITY QUALITY IMPROVEMENT STRATEGY

The process of manually transferring the dirty flake, clean flake, and pellets for each of the different HDPE colors and taking inventory during each step is not only time consuming, but requires a large area for maneuvering all of the filled Gaylord boxes. As a result, additional volumes of plastics are not able to be processed at the facility, due mainly to unavailable floor space.

In order to process greater volumes of plastics and improve efficiencies, Clearvue would like to install storage silos for both dirty and clean HDPE flake. These silos would eliminate the need for Gaylord boxes to store dirty and clean flake prior to the next processing step at the facility. By freeing up some of the floor space, this would allow Clearvue to receive and process additional material, and allow greater maneuvering area for material handling. Based on our site visit and discussions with Clearvue, R.W. Beck estimates that installation of the silos will free approximately 30 percent of the floor space for other activities.

The proposed modifications to the Clearvue facility include installation of six storage silos (each having a 90,000 pound capacity) with an evacuation blower system for transferring the materials. Three of the silos would be used to store dirty flake of natural, mixed color and YOW HDPE. The remaining three silos would be used to store clean flake of natural, mixed color and YOW HDPE.

CAPITAL AND OPERATING COSTS FOR PROPOSED STRATEGY

The incremental capital costs for the proposed strategy, as estimated by Clearvue and equipment representatives, are summarized in Table 1. These costs include only the incremental costs that would be experienced if this strategy is implemented. In addition, the capital costs shown do not include overhead, tax expenses, or profit that would be realized if this plan is implemented.
Clearvue believes that the addition of these storage silos would provide a more efficient material transportation system (i.e., material handling costs would be reduced). In addition, Clearvue has stated that these modifications may allow them to increase the output of their facility by 50 percent (to 12 million pounds per year), thus making their entire system more efficient. It should be noted that Clearvue does not have any additional contractual obligations from MRFs or other processors of HDPE bottles for this additional HDPE bottle volume.

Therefore, two scenarios are presented in the analysis of the proposed improvements. The first assumes that no additional material is processed at the facility (i.e., processing remains at 8 million pounds per year). The second assumes that Clearvue is able to increase the throughput by 50 percent to 12 million pounds per year.

Clearvue has stated that its current allocated variable costs, which generally reflect material handling costs, are approximately $200,000 per year. With these improvements and assuming no increase in the throughput of the facility, Clearvue believes that these costs can be reduced by $50,000 (to $150,000 or $0.0188 per pound of material produced). This analysis assumes that allocated variable costs would be $225,000 ($0.0188 per pound for 12 million pounds) for the increased throughput case.

In addition to the reduced material handling costs, other changes to costs and revenues would be expected to the extent that the throughput can be increased. These include:

- Increased revenue for the additional pellets produced (the analysis assumes the additional material produced will be sold for $0.30 per pound);
- Increased cost to purchase the additional bales of input material (the analysis assumes bales of HDPE are purchased for $0.10 per pound);

---

Table 1
Capital Costs

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyor</td>
<td>$11,000</td>
</tr>
<tr>
<td>Silos (6 @ $17,000)</td>
<td>$102,000</td>
</tr>
<tr>
<td>Silo load/unload systems</td>
<td>$15,000</td>
</tr>
<tr>
<td>Piping for load/unload systems</td>
<td>$5,400</td>
</tr>
<tr>
<td>Concrete Pad</td>
<td>$2,000</td>
</tr>
<tr>
<td><strong>Total Equipment Cost</strong></td>
<td><strong>$135,400</strong></td>
</tr>
<tr>
<td>Freight for equipment</td>
<td>$3,000</td>
</tr>
<tr>
<td>Engineering/contractors/miscellaneous labor</td>
<td>$3,500</td>
</tr>
<tr>
<td><strong>Total Capital Costs</strong></td>
<td><strong>$141,900</strong></td>
</tr>
</tbody>
</table>

1 Equipment cost includes installation.
Increased direct operating costs (including water, electricity, etc.) to process the additional material (the analysis assumes these costs to be $0.05 per pound of input material).

The analysis for the proposed modifications to the Clearvue facility is summarized in Table 2. Please note that all the figures provided in these analyses are incremental annual costs and revenues. Additionally, these values are nominal (i.e., they do not include adjustments for inflation or the time value of money).

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Implementation Strategy</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Incremental Inputs/Outputs: (Pounds/Year)</th>
<th>HDPE Throughput Level:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current Throughput</td>
<td>50% Increase</td>
</tr>
<tr>
<td>Incremental Inputs/Outputs: (Pounds/Year)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>HDPE Bottles</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>LESS: Process Loss (^1)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Clean HDPE Flake</td>
<td>0</td>
</tr>
<tr>
<td>Incremental Revenue ($/Year):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>HDPE Pellets (^2)</td>
<td>$0</td>
</tr>
<tr>
<td>4</td>
<td>LESS: Baled HDPE (^3)</td>
<td>$0</td>
</tr>
<tr>
<td>5</td>
<td>Net Revenues</td>
<td>$0</td>
</tr>
<tr>
<td></td>
<td>LESS: Incremental Operating Costs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Direct Operating Costs (^4)</td>
<td>$0</td>
</tr>
<tr>
<td>7</td>
<td>Other Variable Costs (^5)</td>
<td>$50,000</td>
</tr>
<tr>
<td>8</td>
<td>LESS: Depreciation (^6)</td>
<td>($14,190)</td>
</tr>
<tr>
<td>9</td>
<td>Net Revenue ($/Year)</td>
<td>$35,810</td>
</tr>
<tr>
<td>10</td>
<td>Net Revenue ($/Pound)</td>
<td>N/A (^7)</td>
</tr>
</tbody>
</table>

Return on Investment

<table>
<thead>
<tr>
<th>Line</th>
<th>Return on Investment (%) (^8)</th>
<th>Pay Back Period (Years) (^9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>25.2%</td>
<td>2.8</td>
</tr>
<tr>
<td>12</td>
<td>328%</td>
<td>0.3</td>
</tr>
</tbody>
</table>

\(^1\) Assumed to be 10% of input HDPE bottles (Line 1).
\(^2\) Revenues estimated to be $0.30 per pound of HDPE pellets produced.
\(^3\) Costs of input baled HDPE estimated to be $0.10 per pound.
\(^4\) Direct operating costs assumed to be $0.05 per pound of input material.
\(^5\) Other variable costs (including material handling costs) are assumed to decrease by $50,000 under the current throughput scenario (from $200,000 to $150,000). For the 50% increased throughput scenario, incremental operating costs assumed to be $225,000 (or $0.0188 per pound of input material), which represents a $25,000 increase from current costs.
\(^6\) Assumes a 10 year useful life for equipment.
\(^7\) Net revenue on a per pound basis not calculated for this scenario because the incremental throughput is zero. Net revenue divided by current throughput is $0.005.
\(^8\) Net revenues (Line 9) divided by incremental capital costs ($137,900).
\(^9\) Incremental capital costs ($137,900) divided by incremental net revenues (Line 5) less incremental operating costs (Lines 6 and 7).
Assuming Clearvue continues to process the same amount of HDPE (8 million pounds per year), the return on investment would be approximately 26% with a payback of slightly less than 3 years. However, if Clearvue can increase the amount of HDPE processed by 50 percent, the return on investment would increase to 383% with a payback of approximately 4 months.

IMPLEMENTATION SCHEDULE

Clearvue estimates that a total of seven months would be required to fully implement this plan. The seven month schedule is anticipated to include the fabrication and installation of all the new processing equipment and any modifications to existing processing equipment for producing HDPE pellets or extruded cores.

The implementation team for this strategy would consist of representatives from Clearvue. Doug Wadsworth would be the project manager for the proposed implementation plan and would serve as the primary contact for the Office of Recycling Market Development. Jeff Phillips would serve as the chief engineer and would be responsible for the fabrication and installation of the proposed equipment.

CONCEPTUAL FACILITY MODIFICATIONS FOR PROPOSED STRATEGY

In addition to the installation of the six new silos and loading/unloading system (as discussed above), electrical hook-ups and necessary conveyors would also have to be installed as part of this bulk handling system.

EFFECT ON OTHER RECOVERY CHAIN BUSINESSES

These modifications to Clearvue will affect both MRFs and the post-consumer product manufacturing market. With the bulk handling system installed at Clearvue, the facility will be able to accept greater amounts of baled HDPE bottles, and will be able to supply more material to manufacturers of recycled HDPE products.

POTENTIAL FUNDING OPTIONS

Two potential funding options exist for the modification of the Clearvue facility for the bulk handling system.

The first funding option for the proposed modifications includes the Recycling Investment Program through the New York State Department of Economic Development, Office of Recycling Market Development. This program was devised for entities that collect, handle, reclaim and/or manufacture post-consumer plastics, to establish a more cost-effective post-consumer plastics reclamation infrastructure.
in New York and to expand the base manufacturers capable of using post-consumer plastics as a feedstock supplement or substitute. Entities interested in receiving a grant from this program submit applications to the Office of Recycling Market Development for their consideration; however, the deadline for applying for funds in fiscal year 1996 has passed.

The second and more likely option for Clearvue to pursue would be to fund the costs of these modifications through additional internal investment, or through private financing from a leasing agency or other external lender.
Pure Tech Plastics, Inc.
Implementation Plan

STATE OF NEW YORK
Department of Economic Development

Office of Recycling
Market Development

February 1996
CURRENT FACILITY OPERATIONS DESCRIPTION

Pure Tech Plastics, Inc. (Pure Tech) currently processes deposit sourced PET bottles (approximately 80 percent from New York) at its East Farmingdale, New York facility. The company prefers deposit sourced PET bottles because the definition of "acceptable" PET bottles under the deposit system limits the quantity of PVC bottles, which are similar in appearance and weight to the PET bottles found in the feedstock stream. Currently, Pure Tech's facility does not have the ability to adequately remove contaminants, such as PVC bottles, from a non-deposit stream of PET bottles during processing in order to meet stringent end-market quality specifications.

Pure Tech obtains its deposit bottles in two forms: Bales of PET bottles, which account for 55 percent of its current feedstock; and shredded PET bottles from reverse vending machines, which account for 45 percent of its current feedstock. Pure Tech processes its baled material in the following manner:

- Bales of PET bottles are broken apart in a bale breaker, which discharges the bottles into a trommel. The trommel removes gross contaminants such as broken glass, stones, caps, etc., and further breaks apart clusters of PET bottles before they are fed to the sorting line.
- The sorting line conveys the bottles past four laborers who remove contaminants and color sort the bottles into clear and green PET bottle streams.
- Each color-sorted PET stream is then sent to a granulator where the bottles are ground into a nominal flake size of 0.375 inches or less; elutriated to remove labels, fines, and other light contaminants; and deposited into a Gaylord™ box for transfer to the washing area.
- The ground PET flake is delivered to the wash line, where it is cleaned. The capacity for washing is estimated to be 3,500 pounds per hour of clean flake produced.
- After washing, the PET flake is dried in a heated centrifugal spin drier.
- The clean flake is then sampled for quality, and packaged for distribution; if PVC levels are above 5 parts per million, the flake is passed through a microsort PVC separator to reduce the PVC level to market specifications.
- Approximately 75 percent of the finished clean PET flake is then sold nationwide into high-value applications such as new PET bottles, sheet packaging, and
strapping; the remaining 25 percent of the flake is sold into lower-value fiber applications.

The shredded PET that is received is processed separately from baled material. It does not go through the bale breaker or sorting station, but does go through the rest of the processing steps that are listed above.

**PROPOSED FACILITY QUALITY IMPROVEMENT STRATEGY**

Although PureTech has the capacity to reclaim approximately 30 million pounds per year of PET bottles, it currently has only been able to source approximately 18 million pounds per year of deposit material, causing it to operate its East Farmingdale facility at 60 percent of capacity. The relatively low capacity utilization experienced by Pure Tech (compared to virgin resin producers) has raised the overall per-pound processing cost to reclaim PET for Pure Tech. Pure Tech’s capacity utilization is not out of line with that of other domestic PET reclaimers, which average approximately 55 percent.

Since it is unlikely that additional deposit laws will be passed in other states (none have been passed for over ten years), Pure Tech feels that the best way to reduce its unit cost is to increase the throughput of PET processed by its facility through sourcing "custom" PET bottles (PET bottles of a custom shape that contain products such as liquor, mouth wash, edible oils, bottled water, etc.), which are experiencing rapid growth in the marketplace, and are increasingly being collected in most community recycling programs. Because New York PET reclaimers are not currently sourcing custom PET bottles, those bottles are currently leaving New York State to be reclaimed by out-of-state processors.

The similar clarity and specific gravity properties of PVC bottles and PET bottles make manual and low-tech mechanical sorting techniques unreliable. Because PET bottles collected from curbside and drop-off collection programs typically have a higher rate of PVC contamination (up to seven percent) than do deposit sourced PET soft drink bottles (virtually no PVC contamination), Pure Tech would require high-tech automated PVC separation equipment in order to meet stringent customer limits on contamination when processing those bottles.

Pure Tech has indicated that the PVC contamination levels for its customers' applications generally are less than 5 parts per million (ppm). With the installation of whole bottle automated PVC separation equipment, Pure Tech anticipates that utilization of its facility would greatly increase, because it would be able to process curbside and drop-off PET bottles in addition to its standard deposit sourced PET bottles.

To allow processing of curbside and drop-off PET bottles to meet final quality specifications, and to reduce the cost of sorting PET bottles by color, Pure Tech proposes to modify the PET process lines at its East Farmingdale, New York facility. The proposed modifications include:
Purchase and installation of two whole bottle PVC separation units from Magnetic Separation Systems, Inc. (MSS). These separation units would be placed in series after the bale breakers, prior to color-sorting or granulating the whole PET bottles, so that the majority of all the PVC bottles would be separated out. MSS has tested the effectiveness of having two of its PVC separation units in-line. The results illustrate that the normal PVC contamination range of up to seven percent is reduced to approximately 5 ppm in the PET bottle stream. Because many of Pure Tech's customers require less than 5 ppm PVC, Pure Tech would need to send the ground PET stream through an existing microsort PVC separator if test results show PVC levels of 5 ppm or higher.

Purchase and installation of one MSS binary PET color sort unit. One binary PET color sort unit would be located after the PVC separation units to automatically separate out colored PET from clear PET. The color sort unit is estimated to sort PET bottles with an effectiveness of 90 to 95 percent. Because Pure Tech's customers require clear PET to be 99.98 percent clear, two sorters would still be required down-stream of the color sort unit (one for clear only).

Installation and modification of the existing process equipment at Pure Tech's East Farmingdale, New York facility will be managed and performed by Pure Tech employees.

Pure Tech has established the following performance targets for its East Farmingdale, New York facility after installation of the whole bottle PVC and PET color separation units:

- To purchase as much as 12 million additional pounds per year of curbside collected PET bottles from recycling programs in New York or other states and/or from privately collected PET bottles.
- To produce up to 9.8 million additional pounds per year of post-consumer PET resin in flake form for sale to high quality bottle, sheet, fiber and engineering resin applications.
- To reduce unit costs and increase revenues via automated sorting and higher facility capacity utilization. Sorting costs would be reduced by $0.014 per pound or $180,000 annually at the current facility throughput. Additional net revenues, assuming an additional 12 million pounds of curbside PET bottles are processed, would be $1.4 million.

It should be noted that the above performance targets are, in fact, only targets and are not based on any specific purchasing agreements for post-consumer PET bottles. It is estimated by R. W. Beck that between 5 and 10 million pounds of curbside and drop-off PET bottles are recovered in New York State each year. In order for Pure Tech to meet its sourcing goal of 12 million pounds it would need to source material from other states. Thus, the realization of these targets depends on the ability of Pure Tech to obtain additional PET bottles from curbside and drop-off collection programs that are operated inside and outside of New York, and process those bottles at its East Farmingdale, New York facility.
CAPITAL AND OPERATING COSTS FOR PROPOSED STRATEGY

The incremental capital costs, including start-up costs, were estimated by Pure Tech, equipment supplier representatives, and R. W. Beck. Engineering costs were estimated to be 10 percent of the equipment costs. Installation costs were estimated to be 7.5 percent of the equipment costs. Equipment and delivery cost estimates were provided by the suppliers of the equipment. The total incremental capital costs are summarized in Table 1.

Table 1
Implementation Strategy
Capital Costs (Including Start-Up)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Capital Costs (Including Start-Up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Bottle Separation System from MSS;</td>
<td></td>
</tr>
<tr>
<td>2 required at $150,000 each (5,000 lbs/hr capacity)</td>
<td>$300,000</td>
</tr>
<tr>
<td>Binary PET Color Sort Unit from MSS</td>
<td>90,000</td>
</tr>
<tr>
<td>Conveyors and Accumulating Bin</td>
<td>50,000</td>
</tr>
<tr>
<td>Bottle Singulator</td>
<td>25,000</td>
</tr>
<tr>
<td><strong>Total Equipment Costs</strong></td>
<td><strong>$465,000</strong></td>
</tr>
<tr>
<td>Engineering Expense</td>
<td>46,500</td>
</tr>
<tr>
<td>Installation</td>
<td>34,875</td>
</tr>
<tr>
<td>Delivery Costs</td>
<td>4,000</td>
</tr>
<tr>
<td>Start-Up and Training Costs</td>
<td>10,000</td>
</tr>
<tr>
<td><strong>Total Capital Costs</strong></td>
<td><strong>$560,375</strong></td>
</tr>
</tbody>
</table>

Operating costs were estimated by Pure Tech. The cost to sort, grind, and elutriate as reported by Pure Tech based on its annual processing of 18 million pounds of PET bottles is $1,530,000. The cost for washing is $1,584,000. These costs include both fixed and variable costs. The fixed portion, which would not change with changes in throughput of the facility, consists of costs such as rent, payments for existing capital equipment, property taxes, and general and administrative costs and salaries. The variable portion of the operating costs, which changes proportionately with changes in throughput of the facility, consists of direct labor, utilities, maintenance, detergents, etc.

The respective variable operating costs as reported by Pure Tech for the existing sorting/grinding and washing operations at the facility were $990,000, or $0.055 per pound of PET that is ground ($990,000 divided by 18 million pounds), and $1,152,000, or $0.080 per pound of washed PET flake that is produced (1,152,000 divided by 14.4 million pounds). It is estimated that installation of automated color sorting will allow Pure Tech to reduce its unit operating cost to sort/grind PET bottles from $0.055 to $0.041 cents per pound.

The reduction in operating costs would result from only having two people per shift allocated to the sort/grind operation instead of six. Pure Tech would not have a net loss of jobs, however, if it is able to increase its throughput to 30 million pounds per year because it would need to add six people (a third shift) on the wash lines, which
would be a net gain of four positions. It also should be noted that the labor required for the wash portion of the plant is of a higher skill level than the menial sorting labor.

The analysis for the proposed modifications to the Pure Tech facility in East Farmingdale, New York is summarized in Table 2. Please note that all the figures provided in the analysis are incremental annual costs and revenues. Additionally, these values are nominal (i.e., they do not include adjustments for inflation or the time value of money).

### Table 2
Implementation Strategy Investment Analysis

<table>
<thead>
<tr>
<th>Line</th>
<th>Annual Revenue (Cost)</th>
<th>Proposed Operations Assuming Increased Throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Inputs/Outputs:</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Additional PET Bottles Purchased</td>
</tr>
<tr>
<td>2</td>
<td>LESS: Process Loss</td>
<td>(2,400,000)</td>
</tr>
<tr>
<td>3</td>
<td>Output PET Flake Produced</td>
<td>9,600,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Revenue:</td>
</tr>
<tr>
<td>4</td>
<td>Clean PET Flake Revenue Stream ($/Year)</td>
<td>$4,608,000</td>
</tr>
<tr>
<td>5</td>
<td>LESS: Purchase of PET Bottles ($/Year)</td>
<td>(2,040,000)</td>
</tr>
<tr>
<td>6</td>
<td>Incremental Revenue ($/Year)</td>
<td>$2,568,000</td>
</tr>
<tr>
<td></td>
<td>LESS: Incremental Operating Costs</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Grinding Operation</td>
<td>(444,000)</td>
</tr>
<tr>
<td>8</td>
<td>Washing Operation</td>
<td>(768,000)</td>
</tr>
<tr>
<td>9</td>
<td>LESS: Depreciation</td>
<td>(80,054)</td>
</tr>
<tr>
<td>10</td>
<td>Net Revenue ($/Year)</td>
<td>$1,275,946</td>
</tr>
<tr>
<td>11</td>
<td>Net Revenue ($/Pound)</td>
<td>$0.133</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Return on Investment:</td>
</tr>
<tr>
<td>12</td>
<td>Return on Investment (%)</td>
<td>228%</td>
</tr>
<tr>
<td>13</td>
<td>Pay Back Period (Years)</td>
<td>0.4</td>
</tr>
</tbody>
</table>

1. Of the total PET material received, Pure Tech estimates that approximately 20 percent is lost during the grinding and washing operations due to contamination and processing losses/residues.
2. Assumes an average value of $0.48/pound for clean PET flake over an entire economic cycle.
3. Assumes an average cost of $0.17/pound for baled PET bottles over an entire economic cycle.
4. Assumes the annual incremental operating costs to sort/grind PET to be $0.041 per pound of input PET bottles processed (Line 1).
5. Assumes the annual incremental operating costs to wash PET to be $0.080 per pound of output PET flake produced (Line 3).
6. Assumes $560,375 in incremental capital costs and a seven year life.
7. Net revenues (Line 10) divided by incremental capital costs ($560,375).
8. Incremental capital costs ($560,375) divided by incremental revenues (Line 6) less incremental operating costs (Lines 7 and 8).
The net incremental revenues generated by the proposed modifications are estimated to be approximately $1.3 million per year. This analysis shows that reduced sorting costs and the higher utilization rate of the facility would result in a lower unit cost for processing, more than offsetting the capital expenditures for the facility modifications.

Curb sourced PET bottles generally can be purchased for $0.03 to $0.10 per pound less than deposit sourced bottles. For the purpose of this analysis, it was assumed that Pure Tech only uses the curb sourced material to supplement rather than replace existing sources of PET material.

As was mentioned earlier, up to seven percent of PVC contaminants, or up to 840,000 pounds per year of PVC, are expected to be delivered in the PET feedstock. As part of processing the PET bottles, the PVC containers would be removed and could be marketed separately. For the past five years, the post-consumer PVC container market has valued PVC source separated bottles at $0.10 per pound. Thus, an additional revenue stream of up to $84,000 could be realized by Pure Tech for the PVC containers. However, to produce a marketable stream of PVC containers Pure Tech would need to sort out contaminants from the PVC stream (primarily PET contaminants), and install a baler for the PVC. Because this would be a separate business decision for Pure Tech, the potential PVC revenue stream was not included in this analysis, nor was the cost to dispose of the PVC bottles included should Pure Tech decide not to recycle these bottles.

It is estimated by R. W. Beck that from 5 to 10 million pounds of curb and drop-off PET bottles are recovered in New York State each year. In order for Pure Tech to meet its sourcing goal of 12 million pounds it would need to source material from other states. Assuming the Pure Tech facility is able to attract an additional 12 million pounds of curb PET bottles for feedstock, the payback period for the incremental capital costs required for the proposed modifications would be 0.4 years (5 months).

IMPLEMENTATION SCHEDULE

Based on discussions with Pure Tech and equipment supplier representatives, the overall time to design, purchase, install and start-up the new PVC separation and color sorting equipment would be six months. It would take Pure Tech additional time after the equipment installation to develop sourcing arrangements so that it is operating at full capacity. Furthermore, Pure Tech expects that it would refrain from making a final decision about implementing this plan until after it hears back from the New York State Department of Economic Development, Office of Recycling Market Development concerning a Recycling Investment Program grant that it intends to apply for. Because Pure Tech would not receive notification of a potential grant award until September of 1996, the earliest the equipment would be operational would be after the first quarter of 1997.
The purchase of the equipment would be concurrent with the design phase of this implementation strategy to shorten the implementation schedule. In addition, Pure Tech has stated that the engineering and installation of the PVC separation and PET color sort equipment and associated components would be executed by Pure Tech employees or sub-consultants selected by Pure Tech. By performing these tasks in-house, Pure Tech estimates that they should be able to reduce potential schedule complications that typically arise when interacting and organizing services provided by a variety of independent contractors.

Sorting operations will need to be ceased for a brief period during the installation of the PVC whole bottle separation units and color sort unit. Washing and grinding operations, however, could continue for presorted deposit material and shredded reverse vending material. The length of installation time will depend on the following: (1) availability of employees for installation of the equipment; (2) the number of shifts per day that the installation is performed; and (3) the degree of preparatory work that has been completed prior to the delivery and installation of the equipment.

**CONCEPTUAL FACILITY MODIFICATIONS FOR PROPOSED STRATEGY**

The one area that will be modified at the facility is the sorting/grinding area. The following modifications will be required:

- Move the granulators to allow placement of the two whole bottle PVC separation units after bottle breaker in grinding line. Depending on the volumes of PVC captured at the facility when processing curbside and drop-off program PET bottles, Pure Tech may want to consider purchasing a baler for the PVC bottle material. Because of the uncertainty in PVC bottle volumes, the cost for a dedicated PVC baler is not included in the proposed Pure Tech facility modifications.

- Install necessary take-away conveyors for the PVC bottles and transfer conveyors for the color sorted PET bottles at the following processing locations: (1) from the bottle breaker to the first PVC separation unit; (2) from the first to the second PVC separation unit; (3) from the second PVC separation unit to the color sort unit; and (4) from the color sort unit to the granulator infeed conveyor.

The actual building where the grinding operations are located would not require modifications for installation of the proposed equipment. However, existing equipment within the building would have to be relocated by Pure Tech personnel for installation of the whole bottle PVC and PET color separation units. At Pure Tech’s discretion, the existing manual sorting line could be kept to allow for facility flexibility (i.e. the ability to manually separate PET bottles from mixed PET and HDPE bottles, or as a backup to the automated sorting equipment).
EFFECT ON OTHER RECOVERY CHAIN BUSINESSES

The modification to the Pure Tech facility for automated PVC separation and PET color sorting will affect PET handlers (i.e., materials recovery facilities), PET reclaimers, and post-consumer PET product manufacturers. For handlers, the Pure Tech facility will be able to process not only deposit sourced PET bottles, but also their curbside and drop-off collected PET bottles. This will allow a greater number of handlers within New York and the surrounding states to utilize the Pure Tech facility as their PET market instead of sending their material to other reclaimers. Other reclaimers will find the market for baled material to be more competitive, particularly because Pure Tech sells its material to higher value added applications and so can pay more for baled material. Finally, post-consumer PET product manufacturers will be able to produce additional high value PET products from Pure Tech's clean flake.

POTENTIAL FUNDING OPTIONS

Three potential funding options exist for the installation PVC and PET color separation equipment at the Pure Tech facility in East Farmingdale, New York. The first is the Recycling Investment Program through the New York State Department of Economic Development, Office of Recycling Market Development. This program was devised for entities that collect, handle, reclaim and/or manufacture post-consumer plastics. It allows these companies to establish a more cost-effective post-consumer plastics reclamation infrastructure in New York and to expand the base manufacturers capable of using post-consumer plastic as a feedstock supplement or substitute. Entities interested in receiving a grant from the program submit applications to the Office of Recycling Market Development for its consideration. Both Pure Tech and its co-implementor, the Town of Babylon, intend to submit an application for the whole bottle PVC and PET color separation modifications at its East Farmingdale, New York facility in the spring of 1996.

A second funding option could be Pure Tech's own internal resources, including sales of additional company stock. Finally, Pure Tech could apply for private financing.
WTe Recycling Corporation
Implementation Plan

STATE OF NEW YORK
Department of Economic Development
Office of Recycling
Market Development

January 1996
Xerox Corporation
Implementation Plan

STATE OF NEW YORK
Department of Economic Development

Office of Recycling
Market Development

June, 1997
CURRENT OPERATIONS DESCRIPTION

Xerox Corporation is a multinational marketer and producer of state-of-the-art business machines, including copy machines, printers, and telex machines. Xerox also produces a wide variety of business machine accessories.

Xerox has several waste reduction programs in-place for Information Technology (IT) Equipment, including a reclamation site in Rochester, NY. Field returned equipment is delivered to a Rochester location operated by Xerox’s vendor – Outsource Enterprises. If the used equipment cannot be reconditioned, it is scrapped and the plastic content is recovered for recycling. Currently, the plastic components are being inventoried in gaylord boxes until new equipment is installed to identify, sort, clean, and grind them.

An overall description of the current process flow is presented below. The R.W. Beck Project Team, under the New York Post-Consumer Plastics Optimization Program is providing process recommendations, technical and marketing assistance.

The current facility consists of two workstations and one grinder. The process is totally manual using learning-disabled employees who are trained to complete the following steps:

Identify each part by resin type and combine components from the same resin in gaylords. This is currently done by resin identification code, which is embossed in molded parts. Unfortunately, not all parts are coded and broken sections may be missing the coded.

The primary sort is PC/ABS parts, which are about 50% of the incoming plastic. These are set aside for future processing. Polystyrene may also be separated in the future as it amounts to 33% of the plastic. ABS and Noryl, the remaining plastics, are not targeted for recovery at this time.

The operators also clean the parts of any liquid contaminants, solid particles, or dust. They also remove labels, if possible, by scrapping or rubbing them off.

Sorted like plastics are combined in gaylord boxes until enough material is available to run a "campaign" through the grinder.

The product is then accumulated for resale to regional plastic recyclers.

The current operation was set up as a pilot facility to demonstrate feasibility of a manual identification, sort, clean, and grind operation. It has also allowed Xerox to
determine operating costs and quality standards for the recovered IT Equipment flake. It will not be run on a continuous basis until 1) a resin identification unit is available to sort unmarked plastics and 2) the operation is automated.

**PROPOSED IMPROVEMENT STRATEGY**

While the Xerox pilot project with Outsource Enterprises was successful in proving the technical viability of converting scrap plastic parts into a recycled feedstock, the scale of operation was too small to adequately process all incoming material. To make plastics recycling economically viable at Outsource, sufficient capacity must be installed to process incoming materials on a continuous basis.

The goal of the facility improvements is to provide this automated capacity and produce top quality resin. The intended use of the recovered resin is as recycled-content in visible business machine components, such as copier housings and front panels. The primary quality requirements for these molded parts are that the clean flake is essentially contaminant-free and color can be controlled.

Xerox has carefully considered several strategic approaches to installing this plastics reclamation facility and meet customers' requirements. A two-phase project is envisioned where Phase I would include the basic process steps of disassemble, sort by plastic type, clean, and grind. Phase II would add the downstream steps of blend, reformulate, and mold.

Although specific details of the process flow were to be subsequently developed, the following process steps were deemed essential to meet Xerox's quality requirements:

1) Resin Identification – a state-of-the-art infrared spectrometry unit capable of rapid (less than three seconds) identification of unmarked IT Equipment plastics at an accuracy of 99% or better.

2) Conveying equipment – as production rates increase, automatic conveyance of sorted plastic components to the size reduction equipment is required.

3) Metal Separation – a tunnel type metal separator to detect both ferrous and non-ferrous attachments and/or fasteners that must be removed prior to the grinding step.

4) Size reduction – an integrated shredder/grinder system to efficiently reduce large plastic components to standard 3/8-inch flake. An industrial guillotine or band saw will also be purchased to break down very large components, such as copy machine side panels, to a manageable size.

5) Finishing – a continuous metal separation unit will be installed to ensure that the clean flake is "metal-free". A fines removal unit will be installed to produce a uniform particle size distribution.

6) Blending – a hopper blender with internal screw auger will be installed to homogenize lots of the same recovered resin to improve consistency and quality.
In addition, the RIP Application is to include essential secondary equipment, such as hand tools, work benches, sample thieves, hand trucks, scales, and finished product packaging equipment. Several improvements to the existing building are also included to facilitate safe and efficient handling of raw materials and products.

R.W. Beck will provide the following technical support to Xerox during the RIP Application step and subsequent business development:

1) Provide detailed process flow and equipment recommendations for the IT Equipment Reclamation Line at Outsource Enterprises. The basic steps are outlined above; however, reliable and cost-effective equipment must now be selected. These recommendations will be based on R.W. Beck's recycling industry experiences and the track records of equipment vendors. As this industry is still in the nascent stage, proper selection of equipment is key to successful recovery of high quality resins, such as those required by Xerox and its customers.

2) Develop specific quality recommendations to ensure that the post-consumer resins will qualify for value-added applications. The common fault of many unsuccessful recycling programs is that product quality is not tailored to meet the specifications of premium applications. As a result, the recovered plastic resins must compete in low-price commodity uses against cheaper resins, such as industrial scrap. The focus of Xerox's recycling program will be to differentiate the product from commodity grades so that the program can be economically-driven.

3) Identify premium markets that exist for the PC/ABS and polystyrene materials recovered at Outsource Enterprises. Although a major goal of this project is to close-loop recycle these plastics back into Xerox cosmetic parts, there may be periods of time when merchant sale of these products is advantageous. This could occur early on in the project before these products are approved for use in Xerox cosmetic parts. It could also result due to market factors or a supply/demand imbalance.

These recommendations will incorporate the same value-added recycling approach used for other New York companies that participated in this program. The R.W. Beck team will objectively analyze the various options and recommend those that are expected to provide premium value and long-term stability to Xerox Corporation.

**IMPLEMENTATION SCHEDULE**

The RIP application for the Xerox Quality Improvement Strategies was submitted on August 5, 1997 to the State of New York Department of Economic Development. It is anticipated that a positive response will be received on or about October 10, 1997. The detail work outlined in this Implementation Plan will begin after that date. The R.W. Beck input will be provided to Xerox during Fourth Quarter of 1997.
CONCEPTUAL FACILITY MODIFICATIONS

The conceptual facility modifications for this Quality Improvement Program are projected to require $175,000 of capital. The capital cost is a "not-to-exceed" estimate while the operating costs are will be refined as the project progresses and the disposition of these recyclable streams is determined.

EFFECT ON OTHER RECOVERY CHAIN BUSINESSES

The installation of the proposed automated reclamation line for IT Equipment plastics will create an increased supply of recovered materials. The effect on other recovery chain businesses will be minimal. However, it is the goal of this project to recycle this material into value-added products at Xerox or to other new York-based plastic converters. This will create new opportunities to incorporate post-consumer plastics in durable products.

POTENTIAL FUNDING OPTIONS

It would be premature to discuss funding options before equipment requirements are better understood.
CURRENT FACILITY OPERATIONS DESCRIPTION

Bo-Mer Manufacturing Company is a privately held custom manufacturer of thermoformed plastic products. A variety of industrial dunnage and material handling trays are produced for storage, protection, and shipment of industrial parts at the Auburn, New York facility. Its principal customer base is within New York State and includes major manufacturers of components for automobiles, computers, appliances, electronics, furniture, and medical, photographic, and imaging equipment.

The company purchases pre-slit sheet for the majority of its production, most of which is heavy gauge (greater than 0.050 inches) in thickness. Thinner gauge sheet is purchased in rollstock form as well. Thermoforming capabilities cover sheet thickness from 0.025 to 0.500 inches and blank sizes from 8 inches by 8 inches to 6 feet by 10 feet. The Bo-Mer facility is 44,000 square feet in size and includes both pressure and vacuum forming units.

The primary material used in Bo-Mer's products is extrusion grades of high density polyethylene. High molecular weight grades are used for material handling products designed for large and abrasive components, such as automotive engines. Fractional melt grades of high density polyethylene (similar to that used to produce detergent bottles) are used to transport lighter weight components (such as fuel injectors). About four hundred pounds per hour of various material handling products are currently being produced.

The company also thermoforms ABS, polyvinyl chloride, and polystyrene sheet into computer and electronic housings, point of purchase displays, and mass transit body panels.

In general, the process flow at Bo-Mer is as follows:

- Bo-Mer currently does not have sheet extrusion capability and purchases all of its raw material from custom sheet suppliers. Heavy gauge is supplied as cut sheet, stacked, and palletized. Thin gauge sheet is supplied in rolls. All material is quality inspected prior to acceptance and transfer into inventory.

- Thermoforming is performed at any of eleven machines depending on sheet form, size, thickness, and product complexity. There are two 4-station rotaries, three 3-station rotaries, two roll-fed machines, and four single station units. A 4-station machine operates in the following sequence: (1) loading and unloading of
sheet; (2) pre-heating, if necessary; (3) final heating; and (4) forming. The 3-station machines combine pre-heating and final heating into one step.

- Heavy gauge sheet is transported to the thermoforming area as discrete cut sheets. Each sheet is manually placed in the clamping frame in preparation for part production.

- At a predetermined time, the rotary machine transfers the sheet to the heating station(s) where forced convection hot air ovens raise the sheet temperature to the optimum for pressure forming. Cycle times are proportional to the sheet thickness and are governed by the maximum allowable surface temperature of the resin from which the sheet is made.

- The heated sheet is then rotated to the forming station where air pressure is used to force the flexible material into a female mold that creates the shape of the finished part. The two sides of the mold are released by hydraulically controlled platens and the formed part begins to cool with forced air.

- The formed sheet is now rotated to the load/unload station to complete the cooling process. When the sheet is sufficiently cooled to retain its shape and dimensions, it is manually removed from the clamping frame and the cycle starts over.

- The product is then transferred to one of several trimming stations where excess material is removed. In addition, any sawing, drilling, or routing can be done to incorporate cut-outs, slots, openings, or holes that are required in the final part.

PROPOSED FACILITY QUALITY IMPROVEMENT STRATEGY

The barriers that currently inhibit Bo-Mer from using post-consumer high density polyethylene are twofold: 1) without extrusion capacity, Bo-Mer is dependent on current suppliers who have not developed recycled-content heavy gauge sheet, and 2) Bo-Mer is concerned that recycled HDPE will not form properly and, due to its additional heat history, is inferior to virgin.

If these barriers could be overcome, the potential use of post-consumer HDPE at Bo-Mer is in excess of one million pounds per year (at an average of 25% recycled content). The following quality improvement strategy will be implemented to get Bo-Mer started in forming PCR sheet products:

- Identify existing and developmental material handling products that could be potentially produced from post-consumer HDPE sheet without performance compromise. An additional, and critical, consideration is that the post-consumer HDPE be melt compatible with the existing virgin sheet grade.

Performance as a material handling tray is related to tray design, thickness, and resin properties. When considering the incorporation of recycled HDPE, its resin properties must be matched to those required in the finished product. Otherwise, product stiffness, impact and stress crack resistance, or abrasion resistance are reduced.
Bo-Mer Manufacturing Company Implementation Plan

Bo-Mer's current line of material handling trays includes several heavy duty applications which require high molecular weight HDPE. The major benefits of these grades are exceptional impact strength, especially at cold temperatures, plus very high abrasion and stress crack resistance. This material is much tougher than extrusion grades of HDPE used to make bottles being curbside collected. Therefore, these heavy duty applications are not candidates for recycled-content sourced from community recycling programs. (However, similar grades of HDPE are used for blow molding 55-gallon drums -- a clean source from this application could be used.)

The fractional melt grades of post-consumer HDPE sourced from detergent, fabric softener, bleach, and other cleanser bottles are a copolymer grade. They are, by design, very high in stress crack resistance and impact strength and have good abrasion resistance. Being fractional melt, they are designed for extrusion processing and, aside from high molecular weight HDPE, are the toughest grade of HDPE available.

Formability of the recycled content sheet is very important to Bo-Mer. Successful thermoforming of HDPE is dependent on the material’s melt temperature, glass transition temperature, melt strength, and specific heat. If the recycled portion is not melt compatible with the virgin portion, the sheet will not form properly and product properties will be inferior.

Bo-Mer and the R.W. Beck team have begun the process of carefully selecting material handling products where resin and melt compatibility exists with curbside collected HDPE. As indicated, only post-consumer HDPE copolymers are suitable for these applications. HDPE collected from milk, juice, and water jugs will not be considered. The goal is to select two to three products where the incorporation of PCR will neither compromise performance nor formability.

- Identify and work with a custom sheet extruder of heavy gauge HDPE to get samples of 25% content sheet manufactured. The candidates for providing this sheet are few because of the niche nature of heavy gauge sheet extrusion. However, preliminary discussions with St. Jude Polymer in Frackville, PA. are encouraging. Bo-Mer is also discussing this option with a current supplier, Primex. Attempts to locate a New York-based custom extruder of heavy gauge sheet have not been successful in spite of searches in data bases within New York and at the American Plastics Council.

- Post-consumer HDPE copolymer will be sourced from Clearvue Resource Management, Ltd. In Amsterdam, New York. As most sheet extruders have material handling equipment designed for both flake and pellet feed, the use of clean flake will be emphasized to avoid the negative effects of an additional heat history on the post-consumer HDPE. A color-controlled PCR flake is desirable to produce products with consistent color.

- Although this implementation program is based on selecting a post-consumer resin that is melt compatible with Bo-Mer's current virgin grades of HDPE, the recycled-content sheet will exhibit slightly different heating, strength, and
formability characteristics. On-site technical assistance will be provided by R.W. Beck, as needed, to assist with adjusting process conditions or cycle time to produce the same high quality sheet as virgin. Technical assistance will also be provided in setting up appropriate side-by-side testing of the recycled-content sheet versus a virgin control.

The primary benefit of this program to Bo-Mer is to establish a linkage between reclaimers, such as Clearvue, who generate a clean high quality grade of post-consumer HDPE and a set of products, material handling trays, that represent a premium application for extrusion grades of HDPE. Although the perception is that recycled plastics are low quality, this program will demonstrate that clean post-consumer HDPE can be substituted for virgin if it is positioned in the right product and processed under the right conditions.

CONCEPTUAL FACILITY MODIFICATIONS AND CAPITAL AND OPERATING COSTS FOR PROPOSED STRATEGY

As discussed above, the Bo-Mer program involves providing technical and operating assistance to incorporate post-consumer HDPE in several products without sacrificing performance. It is not expected that equipment or facility modifications will be required to thermoform recycled content sheet. If the demonstration run indicates a need for new equipment, it will be identified and appropriate cost data developed.

EFFECT ON OTHER RECOVERY CHAIN BUSINESSES

This demonstration program will require creating a linkage between a custom sheet extruder(s) and recycler, such as Clearvue Resource Management. Once established, a premium market for post-consumer HDPE (copolymers) will be created. This will expand the current markets for each of these companies and increase the demand for HDPE bottles from New York-based collection programs.

IMPLEMENTATION SCHEDULE

The thermoforming trials at Bo-Mer will be scheduled for the first quarter of 1996, dependent upon equipment availability. The R. W. Beck project team will provide technical assistance during this program and be on-site when critical forming and trimming operations are completed.
Clearplass Containers Incorporated
Implementation Plan

STATE OF NEW YORK
Department of Economic Development
Office of Recycling Market Development

January 1996
CURRENT FACILITY OPERATIONS DESCRIPTION

At Penn Yan, New York, Clearplass Containers, Inc. produces a variety of blow molded plastic containers for the food, medical, pharmaceutical, cosmetic, and toiletry industries. Its primary business is injection blow and stretch blow molding of PET into bottles, jars, and other clear packaging. The company's PET products include an extensive line of stock bottles and jars ranging from a few ounces to one gallon in volume.

The company currently uses about one million pounds per year of virgin PET to produce their products. The primary resin used is an FDA-approved, high molecular weight PET copolymer with an Intrinsic Viscosity (IV) of 0.80. Intrinsic viscosity is a rough measurement of the material's molecular weight and relates directly to its properties and processability.

The overall flow of resin through the Penn Yan facility is shown in the attached Raw Material/PCR Process Flow Chart. The company operates nine injection blow molding machines and four stretch blow molding machines, predominately for PET. The extrusion blow molding machines are used for other materials, such as high density polyethylene, that have sufficient melt strength for extrusion processing.

In general, the PET process flow is as follows:

- Incoming resin primarily is purchased in Gaylord containers which are inspected and certified as to meeting purchase specifications. All PET is purchased in pellet form. According to a predetermined schedule, the resin is transported by forklift vehicles to a material loading area. From this point, the raw material enters a totally enclosed and automated series of process steps.

- The first step in processing PET is drying to a moisture content of less than 0.005%. Resin is vacuum conveyed and metered from the Gaylord's into a hopper dryer designed to meet this moisture specification. Typically, a batch of PET is dried for four hours at 300°F with extremely dry air (at a dew point of -40°F). This step is critical because residual moisture will hydrolyze PET during the molding process causing a significant loss in strength and optical properties.

- Following drying, resin is automatically conveyed to a dedicated weigh feeder for the appropriate molding machine. Several of Clearplass' blow molding units are equipped to incorporate a secondary additive or colorant, as required.
The dried PET pellets are mechanically fed into the injection molding unit where they are melted and homogenized prior to being injected into the appropriate mold cavity. The melted resin reaches a temperature of 510°F before entering the mold which is held at 220°F. The injection molded preform (test tube shape with threads at the opening) is allowed to cool to a temperature (about 200°F) where the PET has sufficient melt strength to be blow molded or stretch blow molded. The latter process is used for larger bottles and involves stretching or orienting the PET molecules to light-weight the bottles and improve clarity, barrier properties, and impact strength. (This is the same process that was invented by Du Pont in the 1970s and became the accepted method for producing the clear and unbreakable soda bottles.)

The injection molded preforms are automatically indexed into a female bottle mold and either blow molded (air assisted) or stretch blow molded (both air and push rod assisted) into the bottle shape. The finished bottle is mechanically discharged from the mold (upon cooling to 160°F) and conveyed toward a packing station, where operators inspect bottles, retain several for quality control checks, remove those where visual quality is poor, and pack the product in approved shipping boxes for the customer. In some cases, the bottles are transported to a separate labeling area before being packed for shipment.

Clearplass' injection molding process generates very little waste once it is running at normal operating conditions. This is typical of injection blow molding operations where there is concise control of material flow and mold pressure. However, there are off specification bottles manufactured during startup and, occasionally, during a run. These are internally recycled unless the customer specifies otherwise.

Clearplass currently has two customers which specify post-consumer content in their containers. Clearplass has purchased small quantities of depolymerized post-consumer PET from its resin supplier but found this material to be costly. The company also ran a trial with post-consumer PET purchased from a domestic recycler. However, this material did not mold into containers that were of a quality acceptable to their customers (due to black specks, gels, and discoloration).

The company has established a corporate goal to implement a program to maximize use of post-consumer PET. Included in this program are needs to identify ways to obtain PCR that will be cost-effective, meet their performance specifications, and, ideally be an FDA-approved material. Clearplass is aware that increasing their use of post-consumer PET may require an investment in crystallizing dryers or melt filters and additional operating controls. It is willing to undertake a trial run of clean flake versus pellets from New York-based recyclers and perform limited testing and analysis.
PROPOSED FACILITY QUALITY IMPROVEMENT STRATEGY

As indicated above, the principal barrier to Clearplass using post-consumer PET has been the inability to source bottle quality resin at competitive prices. In one case, depolymerized PET, there was a premium of 10 cents per pound over virgin (at a 25% post-consumer content). In the other, the quality of the post-consumer PET was inferior.

At the August 1995 on-site meeting, the company learned that there are New York-based companies who can supply blow molding grades of post-consumer PET. There was also a discussion regarding the fact that there are two primary grades of post-consumer PET -- fiber and blow molding. The fiber grade resin contains slightly higher residual contaminants such as aluminum, PVC, and inerts, that can be tolerated in fiber production. Recyclers that supply blow molding accounts process this material through one or more finishing steps to upgrade the material quality.

Clearplass proposes to run a trial on one commercial blow molding line to determine if it possible to produce high quality blow molded containers using New York-based post-consumer PET. The proposed trial program is designed to test PET that originated from both curbside and redemption programs. Technical assistance will be provided by the R. W. Beck team to adjust processing conditions to mold a high quality container with optical and performance properties similar to virgin.

The objectives of this proposed quality improvement program are as follows:

- To determine if curbside collected PET is of sufficient quality to stretch blow mold high performance containers at commercial rates. This relatively new source of recycled PET is being collected at rapidly increasing rates within the state of New York. The intrinsic viscosity of curbside PET, more specifically custom PET bottles, is slightly better than redemption material (soda bottles which are typically a 0.74 IV). Therefore, clean post-consumer PET from these sources would be an excellent feedstock for recycled-content containers.

- To demonstrate that post-consumer PET from redemption sources can be processed effectively on stretch blow molding equipment. The lower intrinsic viscosity of post-consumer PET changes several key resin characteristics such as melt strength, crystallization rate, and stiffness. Appropriate adjustments in operating conditions will be required to mold a quality preform and condition the preform prior to blow molding the finished container.

- To evaluate whether post-consumer PET in clean flake form is a viable alternative to pelletized material. There is generally a 7-10 cent per pound cost advantage to using clean flake versus pellets. In addition, clean flake will have a higher intrinsic viscosity and better optical properties than pellets because it has been through one less heat history. On the other hand, pellets have been melt filtered (reducing particulate contamination) and have improved flow properties and higher bulk density than clean flake. These tradeoffs will be evaluated to
determine which form of recycled PET provides the best balance of cost and performance.

- To identify cost-effective sources of post-consumer PET that is FDA quality. Clearplass produces numerous containers manufactured from virgin resin certified as meeting all FDA regulations. A supply of this grade of PET in post-consumer form would permit the company to incorporate 25% recycled content (or more) in many of its products.

The overall target for this Quality Improvement Program is to increase Clearplass' use of post-consumer PET to 20% of its production within two years and 40% within five years. Given modest growth in current business over this time frame, Clearplass would become a major New York-based consumer of post-consumer PET. It must be noted, however, that realization of this target is dependent on the availability of bottle-quality post-consumer PET on a consistent bases and the ability to adjust operating conditions to produce the high quality containers that are Clearplass' trademark.

CONCEPTUAL FACILITY MODIFICATIONS AND CAPITAL AND OPERATING COSTS FOR PROPOSED STRATEGY

It is premature to present facility modifications or capital and operating costs before the demonstration run is completed. At the on-site meeting, we did identify two capital equipment needs, a crystallizing dryer and melt filter. Since then, it has been determined that post-consumer PET flake, from bottles, will have sufficient crystallinity for conventional drying. Therefore, a crystallizing dryer will not be required. Other types of PET flake, such as amorphous PET from thermoforming trim scrap, will become sticky and cause flow problems if they are not crystallized first.

The use of clean flake PET will likely require a melt filtration unit to ensure that particulate matter does not become entrained in the product. Besides the obvious problems, nozzles becoming plugged and contamination specks in the product, any particulate matter can serve as a nucleator and change the crystallization rate of PET. The result is variability in bottle properties which cannot be tolerated. Although no engineering estimates have been made, these units would likely run less than $10,000 per blow molding machine.

The demonstration run is designed to determine the operating conditions and facility modifications required to run both pelletized and flake PCR. Capital and operating costs can then be presented based on the specific requirements of the Penn Yan facility.
EFFECT ON OTHER RECOVERY CHAIN BUSINESS

The demonstration run(s) will determine the form (flake or pellet) and types (redemption or curbside of post-consumer PET) that can be successfully run at Clearplass Containers, Inc. This will, hopefully, create a New York-based market for high quality post-consumer PET and demand for product being recovered by major recycler, such as wTe Recycling Corporation and Pure Tech Plastics, Inc. It will also determine if this high quality market can absorb the increasing supply of custom bottles being curbside collected by New York communities.

IMPLEMENTATION SCHEDULE

The specifics of the demonstration run(s) will be laid out in January 1996 and the run(s) themselves completed during the First Quarter of 1996. The actual timing will be dependent on equipment availability in early 1996. The post-consumer trial materials will be requested from both wTe Recycling Corporation and Pure Tech Plastics, major New York-based recyclers of PET.

The initial trials will be run on pelletized post-consumer PET to establish the different operating parameters required to manufacture high quality blow molded containers. Both curbside and redemption material will be tested to compare optical and performance differences in bottles molded with post-consumer PET from these two sources. It is anticipated that bottles will be produced at minimum 25% and 50% content. If these results are encouraging, a trial will be run at 100% post-consumer content to test for feasibility.
Innovative Plastics Corporation
Implementation Plan

STATE OF NEW YORK
Department of Economic
Development

Office of Recycling
Market Development

January 1996
CURRENT FACILITY OPERATIONS DESCRIPTION

Innovative Plastics Corporation is a custom thermoformer of visual display and protective packaging. The company is a leader in the design and manufacture of all-plastic clamshells and hinged packaging that replace difficult to recycle blister cards. The hardware, cosmetic and toiletry, small appliance, office supply, medical, pharmaceutical, photographic, automotive, and telecommunication industries are all customers of Innovative.

The majority of Innovative’s current products are made with polyvinyl chloride (PVC). In sheet form, PVC is an excellent material for these applications. It is relatively inexpensive, has excellent optical properties, a good balance of stiffness and impact strength, and is easy to thermoform, trim, and, if required, radio frequency seal. However, PVC is perceived as an environmentally unfriendly material, especially on the international front.

The increasing demand for post-consumer content PET packaging is being driven by environmental pressures against PVC and the ever expanding and well publicized recyclability of PET. Consumer product companies are requesting that disposable packaging meet both their performance and environmental needs. The availability of lower cost (than virgin) post-consumer PET allows this material to compete with virgin PVC.

The increasing availability of post-consumer PET and marked improvements in its quality have created an alternative material choice for thermoformers of visual packaging. Virgin PET sheet is too expensive to compete with virgin PVC sheet in most markets. The incorporation of post-consumer PET into virgin PET sheet minimizes the cost advantage of PVC. This creates an opportunity for Innovative Plastics to provide major consumer product companies with an alternative packaging material based on recovered PET bottle resin.

In general, the following is the process flow at Innovative Plastics for producing visual packaging from PVC sheet:

- Polyvinyl chloride is purchased in rolls of sheet stock from calendered PVC sheet producers, including American Mirrex, Ex-Tech Plastics, and Klockner-Pentaplast of America. Sheet thickness is typically 7.5 to 40 mils (thousandths of an inch) and about 18” to 32” wide. Incoming rolls undergo a series of quality control checks prior to being approved for thermoforming and credited to inventory.
Innovative Plastics Corporation Implementation Plan

- Although each of Innovative’s fourteen thermoformers are slightly different, the process steps are similar. Roll fed thermoformers, such as those at Innovative, are also referred to as continuous sheet formers because all processing is done in-line. The basic steps are as follows: the roll of sheet is mounted into a take-off station; the edges of the sheet are clamped into chain-fed pins to feed the sheet; infrared radiant heated ovens raise the sheet temperature to that required for thermoforming (normally 280º-285º F for PVC); the heated, flexible sheet is forced into a female mold by vacuum or air pressure; trim is automatically cut away by steel rule dies; and operators remove parts from the sheet for quality checks, nesting, and packaging.

- In some cases, Innovative will also insert and seal a customer’s consumer product into the newly formed package. This stand-alone operation is very cost-effective for customers as it eliminates the need for a contract packager, thereby reducing packaging and shipping costs. When PVC packages require a heat seal, radio frequency sealers are used to rapidly weld edges together.

Innovative Plastics has successfully thermoformed and heat sealed PETG with only minor adjustments in heating, forming, trimming, and sealing conditions. PETG is a special copolymer of PET and, essentially, is an amorphous plastic with processing behavior like PVC. It is, however, even more expensive than PET or PVC. PET and post-consumer PET, on the other hand, are much tougher than PVC making them difficult to form and trim. PET packages also tend to stick together when nested for shipment and do not easily heat seal by radio frequency.

Proposed Facility Quality Improvement Strategy

Innovative Plastics has several opportunities to implement a “high visibility” program to thermoform recycled PET packaging for nationally recognized customers, such as Kodak and Gillette. Although PET is more difficult to thermoform and trim than PVC, Innovative is confident that a quality package can be made from post-consumer PET sheet.

We propose to complete a demonstration run(s) to determine the best combination of post-consumer content sheet and processing conditions required to produce high quality visual packaging. Technical assistance will be provided by the R. W. Beck team to accomplish this objective.

The following program is proposed to improve the quality, formability, and sealability of recycled content PET sheet and to develop post-consumer content packages that can compete with PVC on a performance basis:

- Several existing or developmental PVC packages (to be selected by Innovative) will be chosen for this demonstration. The selection will include packages where there is strong customer demand for an equivalent package made from an alternative material with post-consumer content.
The starting point for this program will be a detailed review of the key mechanical property requirements of the application. Once these targets are known, a determination of the required PET sheet thickness and intrinsic viscosity will be made. In some cases, the PVC sheet properties will become the target and a PET sheet gauge will be selected to meet that target.

This step is difficult because of the resin chemistry involved. PVC is an amorphous material, which means that the properties of the finished part are largely determined by the resin's properties as opposed to processing conditions. On the other hand, PET is a crystallizable material and the finished product's properties are highly dependent on the intrinsic viscosity of the sheet, as well as thermoforming temperature, mold temperature, cycle time, and degree of orientation. All these factors will be considered in this technical evaluation designed to determine the equivalent sheet thickness for PET.

- The production of consistently high quality thermoformed parts is, first and foremost, dependent on receiving sheet that is extruded from high quality, homogeneous resin. Fortunately, the New York Post-Consumer Optimization Program provides access to two New York-based recyclers of high quality post-consumer PET — wTe and Pure Tech International. Material will be requested from both companies for the demonstration run(s).

- The second requirement for making high quality thermoformed parts is that the extruded sheet be consistent and homogeneous. This might seem redundant, but high quality PET resin, virgin or post-consumer, can easily be heat degraded or hydrolyzed if very stringent drying, temperature, and process controls are not followed. Extruded sheet will be sourced from companies which have demonstrated experience in supplying consistent, high quality sheet.

- The third key requirement for making high quality thermoformed parts is to have specifications for key properties, such as PET intrinsic viscosity plus sheet dimensions, tolerances, and impact strength. Intrinsic viscosity is extremely important as it relates to processing temperatures, melt strength, mechanical properties, crystallization rate, and sealability. Processing conditions will be adjusted to control crystallinity and orientation of PET sheet and, as a result, produce high quality thermoformed parts.

- As indicated above, PET is a tougher material than PVC. Therefore, it is more difficult to die cut. For example, when Innovative recently thermoformed and trimmed 125,000 pounds of 20-mil PET sheet, the steel rules had to be changed out seven times. A similar run with PVC would not require any change outs. Although this is characteristic of PET, process conditions and formulation changes will be recommended to minimize this problem.

- Innovative's strategy of producing all-plastic packages, in most cases, requires heat sealing of two plastic surfaces. In the case of PVC, radio frequency sealing is very effective and an economic method to weld the package. Innovative has been able to radio frequency seal PETG, but not PET. PETG is an amorphous
material with a very slow crystallization rate and will radio frequency seal. On the other hand, Innovative's experience has been that PET tends to crystallize, rather than melt, when exposed to radio frequencies.

There are a number of factors that influence PET crystallization rate, including its extrusion and processing history, intrinsic viscosity and chemistry, quality, sheet thickness, and the level of radio frequencies used. Each of these factors will be reviewed by the R. W. Beck Project Team and an optimum set of sealing conditions will be recommended and demonstrated.

The goal of this demonstration program for Innovative Plastics will be to minimize the processing barriers to increased use of post-consumer-content PET in visual packaging. These cost and quality improvements will speed the penetration of recycled-content PET packaging in the marketplace. At a 25% recycled content, Innovative can consume, in the near term, two million pounds of recycled-content PET sheet.

CONCEPTUAL FACILITY MODIFICATIONS AND CAPITAL AND OPERATING COSTS FOR PROPOSED STRATEGY

As discussed above, the Innovative Plastics program involves providing technical and operating assistance to incorporate post-consumer PET in several visual packages without sacrificing performance. It is premature to present facility modifications or capital and operating costs before the demonstration run is completed. If a need for equipment modifications is required to satisfactorily process PET, it will be identified and appropriate cost data developed.

EFFECT ON OTHER RECOVERY CHAIN BUSINESS

The demonstration run(s) will determine the form (flake or pellet) and types (redemption or curbside) of post-consumer PET than can be successfully run at Innovative Plastics Corporation. This will require creating a linkage between a custom sheet extruder(s) and major recyclers, such as wTe Recycling Corporation or Pure Tech Plastics, Inc. If successful, a New York-based market for high quality post-consumer PET will be created.

IMPLEMENTATION SCHEDULE

The demonstration run(s) will be scheduled for the first quarter of 1996, dependent on equipment availability at Innovative Plastics. After a technical review of optimum formulation, thickness, and intrinsic viscosity requirements, samples of recycled-content PET sheet will be requested in January 1996. The R. W. Beck project team will provide technical assistance during this demonstration program and be on-site when critical forming, trimming, and sealing trials are undertaken.
CURRENT FACILITY OPERATIONS DESCRIPTION

McKechnie Plastic Packaging produces 2 ounce through 255 ounce extrusion blow molded plastic bottles for the food, automotive, household cleaner, health, medical, industrial, and specialty chemical markets. McKechnie molds bottles from high and low density polyethylene, polypropylene, polyvinyl chloride, and post-consumer high density polyethylene at the Philmont, New York facility.

Not only is McKechnie a custom stock manufacturer, but it designs and builds production molds and also decorates bottles for its customers. Capabilities include screen printing and three types of label application: pressure sensitive, heat transfer, and sleeve.

The company currently uses about two million pounds per year of post-consumer HDPE in their products. This material is pre-blended by its resin supplier, Paxon Polymer Company, and provided in pellet form at a 25% recycled content level. The primary sources of the post-consumer HDPE are KW Plastics Recycling and Union Carbide Corporation.

Periodic problems have occurred when contaminants in the recycled-content resin show up as black specks or gels on the bottle surface. McKechnie is very concerned about bottle performance and quality and, at this time, is hesitant about increased use of PCR.

At the on-site meeting, McKechnie was informed that there are different grades and qualities of post-consumer HDPE in the marketplace. A recommendation was made that McKechnie use clean recycled flake because the additional heat history from pelletization reduces key properties of the post-consumer HDPE.

PROPOSED FACILITY QUALITY IMPROVEMENT STRATEGY

As a current user of post-consumer HDPE, McKechnie is well-positioned to expand its current opportunities. In addition, McKechnie also has the ability to manufacture tri-layer bottles, but has not developed new business from this competitive advantage.

The principal barrier to McKechnie’s use of post-consumer HDPE has been the concern regarding PCR quality. The risk being that recycled HDPE could shut down molding machines or result in bottle failures. There is also a contractual arrangement that is a barrier to increase usage of PCR.
McKechnie Plastic Packaging Implementation Plan

At the on-site meeting, we agreed to explore the following technical and cost improvement tactics:

- McKechnie’s current supplier provides a dry pellet blend of PCR and virgin HDPE. Upcharges for pre-blending could be avoided because McKechnie is equipped to blend on-site. McKechnie could complete a trial with 100% PCR to evaluate cost savings and quality issues versus the dry pellet blend.

- McKechnie would explore the use of post-consumer HDPE flake if there are no detriments to its blow molding operations. McKechnie was unaware that clean flake would have better properties than pellets due to having experienced one less heat history. If this trial were successful, a storage silo would be dedicated to PCR and truckload quantities would be ordered. A trial would be completed to compare the cost and performance of clean flake and pellets.

- McKechnie’s tri-layer bottle capacity currently is under-utilized. There is an opportunity to use this equipment to introduce unique recycled-content bottles that are recyclable and McKechnie expressed an interest in exploring this possibility. With McKechnie’s assistance, an analysis of options in certain food, drug, and cosmetic products would be completed to determine which new products represent the best growth opportunities for McKechnie.

CONCEPTUAL FACILITY MODIFICATIONS AND CAPITAL AND OPERATING COSTS FOR PROPOSED STRATEGY

It is premature to present facility modifications or capital and operating costs before demonstration run(s) are completed. The demonstration run(s) would be designed to determine the operating conditions and any facility modifications required to process clean flake and pre-blend PCR with virgin HDPE.

IMPLEMENTATION SCHEDULE

Since the on-site meeting, there has been too little communication from McKechnie to develop an action plan for this facility. The specifics of the demonstration run(s) cannot be detailed until McKechnie provides additional information.

EFFECT ON OTHER RECOVERY CHAIN BUSINESS

The demonstration run(s) will determine the form (flake or pellet) and types of post-consumer HDPE (pre-blend or on-site blend) that can be successfully run at McKechnie Plastic Packaging. This will, hopefully, create a New York-based market for high quality post-consumer HDPE and demand for product being recovered by major recyclers, including Clearvue Resource Management, Ltd.
This Appendix includes additional cost optimization information beyond what is discussed in the text of this report, including:

- Additional cost optimization strategies and best management practices; and
- A reproduction of *16 Tactics For Cost Optimization*, a document produced by the American Plastics Council’s Cost Optimization Committee.

The Ontario Ministry of Environment and Energy, and the Environment and Plastics Industry Council (a council of the Canadian Plastics Industry Association) jointly produced and released a cost optimization and best management practices resource guide as this Project was ending. The guide, entitled *Guide to Resource Conservation and Cost Savings Opportunities in the Plastics Reprocessing Sector*, focuses on improvement strategies at the reclamation stage of the post-consumer plastics recycling chain. Because the guide was published as this Project ended, additional improvement opportunities found in it were unavailable for evaluation in this Project. Table D-1 lists the improvement opportunities discussed in the guide.

### Table D-1
Reclaimer Process and Utility Improvement Opportunities

<table>
<thead>
<tr>
<th>Process Area</th>
<th>Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiving and Bale Breaking</td>
<td>- recycling pallets, wrapping, straps, etc.</td>
</tr>
<tr>
<td></td>
<td>- noise and dust control</td>
</tr>
<tr>
<td></td>
<td>- specify non-baled feedstock</td>
</tr>
<tr>
<td></td>
<td>- cover feedstock stored outside to inhibit UV degradation and reduce water content</td>
</tr>
<tr>
<td></td>
<td>- in winter, bring frozen feedstock inside to thaw before debaling</td>
</tr>
<tr>
<td>Inspection and Segregation of Recyclables</td>
<td>- automated sorting</td>
</tr>
<tr>
<td></td>
<td>- screening</td>
</tr>
<tr>
<td>Size Reduction</td>
<td>- improved shredder design</td>
</tr>
<tr>
<td></td>
<td>- proper blade design to reduce blade wear</td>
</tr>
<tr>
<td></td>
<td>- two-stage size reduction (shred/grind)</td>
</tr>
<tr>
<td></td>
<td>- high efficiency motors</td>
</tr>
<tr>
<td></td>
<td>- microprocessor controls (automatic shut-off, etc.)</td>
</tr>
<tr>
<td></td>
<td>- noise and dust control</td>
</tr>
<tr>
<td></td>
<td>- bulk feeding system</td>
</tr>
<tr>
<td>Ferrous Metal Detection and Separation</td>
<td>- collection &amp; recycling of ferrous scrap</td>
</tr>
<tr>
<td>Process Area</td>
<td>Opportunity</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pre-washing and Granulation</td>
<td>- more efficient grinder designs and models</td>
</tr>
<tr>
<td></td>
<td>- selecting proper unit size</td>
</tr>
<tr>
<td></td>
<td>- two-stage size reduction</td>
</tr>
<tr>
<td></td>
<td>- blade design to reduce wear</td>
</tr>
<tr>
<td></td>
<td>- grinder maintenance</td>
</tr>
<tr>
<td></td>
<td>- microprocessor controls (automatic shut-off, etc.)</td>
</tr>
<tr>
<td></td>
<td>- high efficiency motors</td>
</tr>
<tr>
<td></td>
<td>- cryogenic grinders</td>
</tr>
<tr>
<td></td>
<td>- wet grind</td>
</tr>
<tr>
<td></td>
<td>- noise and dust control</td>
</tr>
<tr>
<td>Electrostatic, Magnetic &amp; Air-</td>
<td>- collection &amp; recycling of aluminum scrap</td>
</tr>
<tr>
<td>Forced Separation</td>
<td>- separation &amp; recycling of other wastes</td>
</tr>
<tr>
<td></td>
<td>- water conservation</td>
</tr>
<tr>
<td></td>
<td>- counter-current washing</td>
</tr>
<tr>
<td></td>
<td>- reuse of rinse water</td>
</tr>
<tr>
<td></td>
<td>- oil/water separation</td>
</tr>
<tr>
<td></td>
<td>- collection &amp; recycling of other resins</td>
</tr>
<tr>
<td></td>
<td>- detergent/surfactant recovery</td>
</tr>
<tr>
<td></td>
<td>- hydrocyclone use</td>
</tr>
<tr>
<td>De-watering/Drying</td>
<td>- use of natural gas dryers or fluidized bed dryers</td>
</tr>
<tr>
<td></td>
<td>- use of smaller heaters</td>
</tr>
<tr>
<td></td>
<td>- use of two-stage dryers</td>
</tr>
<tr>
<td></td>
<td>- microprocessor controls (dewpoint monitors, etc.)</td>
</tr>
<tr>
<td></td>
<td>- high efficiency motors</td>
</tr>
<tr>
<td></td>
<td>- insulate dryers</td>
</tr>
<tr>
<td></td>
<td>- reclaiming and reusing hot air from dryers</td>
</tr>
<tr>
<td></td>
<td>- general maintenance on blowers and dryers</td>
</tr>
<tr>
<td></td>
<td>- preventive maintenance on filters, desiccant</td>
</tr>
<tr>
<td></td>
<td>- molecular sieves and heater elements</td>
</tr>
<tr>
<td></td>
<td>- strip and vacuum diffuser cones</td>
</tr>
<tr>
<td></td>
<td>- inspect all seals and gaskets</td>
</tr>
<tr>
<td></td>
<td>- microwave material drying techniques</td>
</tr>
<tr>
<td></td>
<td>- installation of heat pumps</td>
</tr>
<tr>
<td>Melt Processing</td>
<td>- new single screw designs</td>
</tr>
<tr>
<td></td>
<td>- twin screw extruders</td>
</tr>
<tr>
<td></td>
<td>- new turn-key, high efficiency lines</td>
</tr>
<tr>
<td></td>
<td>- microprocessor controls</td>
</tr>
<tr>
<td></td>
<td>- melt filtering and screen changers</td>
</tr>
<tr>
<td></td>
<td>- use of high efficiency motors</td>
</tr>
</tbody>
</table>
### Process Area

<table>
<thead>
<tr>
<th>Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- reuse of process heat</td>
</tr>
<tr>
<td>- energy recovery from cooling system</td>
</tr>
<tr>
<td>- reuse process cooling water downstream</td>
</tr>
<tr>
<td>- evaporative cooling systems</td>
</tr>
<tr>
<td>- new high efficiency chillers</td>
</tr>
<tr>
<td>- maintaining proper melt temperature (reducing auxiliary heating/cooling requirements)</td>
</tr>
<tr>
<td>- extruder maintenance (addressing screw alignment, screw and barrel wear, etc.)</td>
</tr>
</tbody>
</table>

### General Systems

<table>
<thead>
<tr>
<th>Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- use of high efficiency motors</td>
</tr>
<tr>
<td>- variable frequency (speed) drives on pumps and motors</td>
</tr>
<tr>
<td>- improving frequency of compressed air system</td>
</tr>
<tr>
<td>- process optimization using microprocessor controls</td>
</tr>
<tr>
<td>- power factor improvement</td>
</tr>
<tr>
<td>- use of portable energy monitoring equipment</td>
</tr>
<tr>
<td>- improved plant maintenance and housekeeping</td>
</tr>
<tr>
<td>- plant hygiene and other occupational health and safety concerns</td>
</tr>
<tr>
<td>- energy efficient lighting</td>
</tr>
<tr>
<td>- improved heating, ventilation and air conditioning</td>
</tr>
</tbody>
</table>


Copies of Guide to Resource Conservation and Cost Savings Opportunities in the Plastics Reprocessing Sector can be obtained by contacting the Environment and Plastics Industry Council (Mississauga, Ontario, Canada) at (905) 678-7748 or the Industry Conservation Branch of the Ontario Ministry of Environment and Energy (Toronto, Ontario, Canada) at (416) 327-1454.

The following pages of this appendix include a reproduction of the American Plastics Council’s 16 Tactics for Cost Optimization document. This reproduction provides a detailed discussion of the projected financial impacts of each cost optimization tactic. Additional copies of 16 Tactics for Cost Optimization can be obtained by contacting the American Plastics Council (Washington, DC) at (800) 243-5790.
INTRODUCTION

This appendix presents a detailed discussion of plastics recycling education and awareness campaigns associated with the New York Plastics Recycling Cost Optimization Project. The Project’s objective was to identify and subsequently field test several cost-saving, quality-optimizing, and/or value-adding strategies that could significantly improve the economics associated with the collection, handling, reclamation, and end use of New York generated post-consumer plastics. The American Plastics Council, Inc. sponsored this in-depth analysis in order to (1) analyze changes in the rate of plastics recycling, and (2) evaluate the quality of plastics recovered from residents in the Town of Lewiston and the City of Schenectady, New York, before and after plastics-specific public education and awareness campaigns were launched in each of those municipalities.

The American Plastics Council also desired information about whether an intensive versus a limited education and awareness campaign would produce different results. This information, however, was secondary to attempting to measure before and after changes as a result of the education and awareness campaigns. The public education and awareness campaigns, therefore, were designed differently in each municipality. For this study, an intensive campaign — defined as multiple outreach strategies/media over a short time period — was conducted in the Town of Lewiston. A limited campaign — defined as a single outreach event using a single medium — was conducted in the City of Schenectady.

BACKGROUND ON THE TARGET COMMUNITIES

The Town of Lewiston is a small community, with approximately 15,500 people, living in approximately 4,000 homes. Glass containers, steel cans, aluminum cans, old newspapers, old corrugated containers, magazines, old mail, telephone directories, and all plastic bottles are all accepted for recycling in Lewiston’s recycling program. All program management, public education, collection, processing, and marketing services are provided by a private contractor, the Modern Corporations.

The City of Schenectady, alternatively, has approximately 65,000 people, living in approximately 26,000 single and multi-family homes. The City of Schenectady collects glass containers, steel cans, aluminum cans, old newspapers, old corrugated containers, magazines, old mail, Kraft bags, and all plastic bottles in its recycling program. All program management, public education, and collection services are provided by City employees. Recyclables processing and marketing are provided by the Schenectady County Materials Recovery Facility.
Lewiston and Schenectady both provide once per week same-day collection of municipal solid waste (MSW) and recycling. Lewiston maintains a fixed collection schedule, whereas Schenectady periodically rotates its collection days forward so that it only collects approximately 50 times per year per home, rather than 52 times per year. Both recycling programs accept #1-#7 plastic bottles, although Lewiston broadened its program to accept #3-#7 bottles just a few months before the Project began. It should be noted that New York has a deposit return system that recovers aluminum beverage cans, certain glass bottles, and PET soft drink bottles in addition to the curbside recycling systems operated by Lewiston and Schenectady.

**METHODOLOGY**

The four steps outlined below summarize the methodology used for this in-depth analysis:

- First, a representative collection route in each municipality was selected by officials from the Town of Lewiston and the City of Schenectady;
- Second, initial set-out, participation, quality, and capture data were measured for each selected collection route;
- Third, a plastics recycling education and awareness program (developed cooperatively between R. W. Beck, APC, and each municipality) was conducted in each municipality; and
- Fourth, set-out, participation, quality, and capture data were re-measured shortly after the education and awareness campaigns were completed.

**INITIAL DATA COLLECTION**

Initial data were collected on set-out, participation, capture, and quality of recovered materials. Set-out data were gathered by recording the address of each residence that set out recyclables over a consecutive period of four weeks. Because both communities only collect recyclables once per week, all possible recyclables set-out days were monitored over the four week periods. For Lewiston, the initial data collection period began on March 25, 1996. For Schenectady, the initial data collection period began on May 14, 1996.

Once set-out data collection was complete, average set-out rates were calculated by dividing the total number of set-outs by four times the total number of homes on each collection route. Participation rates were calculated by adding up the total number of residences that set out recyclables at least once over the four week period, divided by the total number of residences on each route.

Initial capture data were gathered by collecting, sorting, and weighing plastic bottles found in both the MSW and recyclables set-outs on a single collection day. The methodology used to gather the data included collecting MSW and recyclables only from residences on the route that set out recyclables. A recyclables collection truck was
designated to assist with the project. This vehicle was immediately followed by an MSW collection truck that collected the MSW set out by the households with recyclables set-outs. MSW set out by residences that did not also set out recyclables was picked up separately later in the collection day and disposed.

Plastic bottles found in both the recycling bins and the MSW of the recycling participants were then separately sorted by type, counted, and weighed. The following sort categories were used:

- PET soft drink bottles;
- PET custom bottles;
- HDPE natural bottles;
- HDPE pigmented bottles;
- PVC bottles;
- LDPE bottles;
- PP bottles; and
- Other bottles.

Data that were indicative of desired quality features were gathered concurrently with the capture data. The quality data gathered in the Town of Lewiston included weighing non-bottle plastic contaminants (such as tubs), counting the number of caps and pumps (contaminants) left on bottles, and quantifying desired material preparation features by counting the number of bottles that appeared to have been flattened by recycling program participants. The quality data gathered in Schenectady only included weighing non-bottle plastic contaminants. The initial quality and capture data were gathered on March 25, 1996 in Lewiston and May 14, 1996 in Schenectady.

### Education and Awareness Campaigns

Once initial data collection was complete, recycling education and awareness campaigns were conducted in each of the two communities. The intensive Lewiston campaign used a variety of outreach media and techniques, and was conducted over a full week beginning on April 13, 1996. The Lewiston campaign consisted of the following:

- A special write-up in the local weekly newspaper’s “Recycling Corner” column (Lewiston/Porter Sentinel, April 13, 1996);
- A half-page advertisement in the local weekly newspaper (Lewiston/Porter Sentinel, April 13, 1996);
- A door-hanger style education brochure that was placed on the front door of homes on the collection route by local boy scouts (April 15-19, 1996);
- A regional newspaper story about the Project (Niagara Gazette, April 19, 1996); and
- An Earth Day open house and education program at the materials recovery facility operated by Modern Corporations, which included a mayor’s challenge to the Town to increase recycling amounts (April 20, 1996).

The campaign conducted in Schenectady consisted of placing a door-hanger style brochure on the front doors of the homes on the route included in the Study. The brochures were distributed in Schenectady on Monday, October 21, 1996 by members of...
Schenectady’s Department of Sanitation staff. The brochures were identical to the ones used in Lewiston, except that Schenectady’s collection schedule was printed on the back of its brochures. No other outreach methods were conducted in Schenectady.

**FINAL DATA COLLECTION**

Set-out, participation, capture, and quality data were re-measured after the education and awareness campaigns were completed, using the same methodology and procedures used to collect the initial data. In Lewiston, data were gathered beginning four weeks after the campaign ended. In Schenectady, final data were gathered beginning only one week after the door-hangers were placed in the community. This accelerated data collection schedule was necessary because of scheduling difficulties and collection schedule changes. Schenectady changed its collection schedule two weeks before and two weeks after data collection as part of its strategy to periodically rotates collection days forward so that it only collects approximately 50 times per year per home, rather than 52 times per year.

**RESULTS**

Plastics recycling improvements were seen in Lewiston after its education and awareness campaign. Schenectady’s results were anomalous. It is likely that the recycling collection schedule changes in Schenectady and the accelerated final data collection schedule (one week after door-hanger distribution) influenced the results, so that they were not representative of the impact of the educational materials on Schenectady’s recycling patterns. Therefore, Schenectady’s results, while included here for completeness, should not be relied upon as a good indicator of how costs can be optimized through recycling public education, nor should they be compared to Lewiston’s results. The following sections describe the detailed results of the education and awareness programs.

**PARTICIPATION AND SET-OUT**

Table E-1 summarizes changes in set-out and participation for the two communities included in the study.

<table>
<thead>
<tr>
<th></th>
<th>Lewiston</th>
<th></th>
<th>Schenectady</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Change</td>
<td>Before</td>
</tr>
<tr>
<td>Set-out Rates</td>
<td>42.7%</td>
<td>47.9%</td>
<td>5.2%</td>
<td>31.5%</td>
</tr>
<tr>
<td>Participation Rates</td>
<td>75.4%</td>
<td>81.7%</td>
<td>6.3%</td>
<td>59.0%</td>
</tr>
</tbody>
</table>
As shown in Table E-1, set-out and participation rates improved in both Lewiston and Schenectady following the education and awareness campaigns, although only Lewiston showed significant increases.

**Plastic Bottle Generation and Recovery**

The amounts and types of plastic bottles that are recovered are related to the availability of plastic bottles for recovery, and how well individuals participating in the recycling program separate all types of plastic bottles for recycling. Figures E-1 through E-4 summarize the average plastic bottle availability and recycling composition percentages for the two communities based on the before and after sort events.
Figures E-1 and E-3 illustrate that over 95 percent of all plastic bottles generated and available for recovery through Lewiston’s and Schenectady’s residential curbside recycling programs are PET and HDPE bottles. Lewiston’s and Schenectady’s recycling programs, however, target all plastic bottles, though not because they seek to recover large amounts #3-#7 plastic bottles. Instead, the primary effect of accepting all plastic bottles is to simplify recycling for participants because they only need to be able to distinguish between bottles and non-bottles, and do not need to learn how to distinguish between resin types. Other studies have shown that making plastic recycling programs user-friendly, through simplifying the process that participants must go through to determine if a container is targeted, will result in higher recovery rates for all types of plastic bottles. Figures E-2 and E-4 illustrate that over 96 percent of the recovered plastic bottles are PET and HDPE bottles.

It should be noted that the availability and recycling figures do not include significant amounts of PET soft drink bottles that are recovered through the New York deposit return system.

**Capture Rate**

Capture rates are a measure of how well individuals in households that recycle understand which materials are desired by the recycling program, and how motivated all individuals in that household are to separate those materials and place them in the recycling bin. Table E-2 presents capture rate information for Lewiston and Schenectady, before and after the education and awareness campaigns were conducted.

### Table E-2
Plastic Bottle Capture Rates

<table>
<thead>
<tr>
<th>Sort Category</th>
<th>Lewiston</th>
<th></th>
<th></th>
<th>Schenectady</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before (percent)</td>
<td>After (percent)</td>
<td>Change (percent)</td>
<td>Before (percent)</td>
<td>After (percent)</td>
<td>Change (percent)</td>
</tr>
<tr>
<td>#1 PET Soft drink Bottles</td>
<td>13.9</td>
<td>44.8</td>
<td>30.9</td>
<td>66.7</td>
<td>55.1</td>
<td>-11.6</td>
</tr>
<tr>
<td>#1 PET Custom Bottles</td>
<td>51.1</td>
<td>59.5</td>
<td>8.4</td>
<td>82.5</td>
<td>78.8</td>
<td>-3.7</td>
</tr>
<tr>
<td>#2 HDPE Natural Bottles</td>
<td>78.7</td>
<td>79.1</td>
<td>0.4</td>
<td>92.7</td>
<td>100.0</td>
<td>7.3</td>
</tr>
<tr>
<td>#2 HDPE Pigmented Bottles</td>
<td>52.0</td>
<td>45.0</td>
<td>-7.0</td>
<td>74.6</td>
<td>62.2</td>
<td>-12.4</td>
</tr>
<tr>
<td>#3 PVC Bottles</td>
<td>0.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>0.0</td>
</tr>
<tr>
<td>#4 LDPE Bottles</td>
<td>0.0</td>
<td>23.6</td>
<td>23.6</td>
<td>26.3</td>
<td>23.4</td>
<td>-2.9</td>
</tr>
<tr>
<td>#5 PP Bottles</td>
<td>11.7</td>
<td>100.0</td>
<td>88.3</td>
<td>68.1</td>
<td>39.9</td>
<td>-28.2</td>
</tr>
<tr>
<td>#7 Other Bottles</td>
<td>44.3</td>
<td>38.2</td>
<td>-6.1</td>
<td>100.0</td>
<td>37.8</td>
<td>-62.2</td>
</tr>
<tr>
<td>Total</td>
<td>54.0</td>
<td>57.6</td>
<td>3.6</td>
<td>81.8</td>
<td>72.7</td>
<td>-9.1</td>
</tr>
</tbody>
</table>
Capture rates were calculated by dividing the amount of plastic bottles recycled by the sum of the amount of plastic bottles recycled and disposed, on an equivalent time basis.\(^1\)

As can be seen in Table E-2, the education and awareness campaign did not result in a large increase in capture in either municipality included in this study. In fact, the data seem to indicate that capture declined rather than increased in Schenectady. This anomalous data for Schenectady may have been a result of the recycling collection schedule changes shortly before and after final data collection in Schenectady.

**Quality**

Figures E-5 and E-6 illustrate the quality data that were gathered before and after the education and awareness campaigns in Lewiston and Schenectady.

In general, quality seemed to improve, although the percentage of flattened bottles seemed to decline slightly in Lewiston rather than increase. There are several possible explanations for the apparent decline of flattened bottles:

- Flattened bottle data were gathered by counting flattened bottles after recyclables had been collected and off-loaded. Some bottles were only partially crushed or flattened, which could have been a result of the collection process and not the result of crushing by program participants. In those cases, a judgement call was made by the sorter of whether the bottle had been deliberately flattened by the householder. Because judgement calls can vary from person-to-person, different individuals at the

\(^1\) Recyclables are set out for collection less frequently than MSW is, meaning that the amount of recyclables in a recycling bin are accumulated over a greater length of time than the recyclables found in MSW. Therefore, it was important to adjust the raw plastic bottle recycling and disposal data to an equivalent time basis in order to obtain accurate capture rate data for comparison. This was done by first dividing the set-out amounts of plastic bottles recycled and disposed by the average set-out frequency for recycling and disposal, respectively.
different sorting events could have interpreted semi-flattened bottles in a way that recorded a decline, when no decline actually occurred.

- The education campaign could have motivated reluctant individuals to begin participating in recycling, although they may not have been willing to perform the additional task of flattening their bottles, feeling that they’ve already done “their part” by participating in the program.
- The education message for flattening bottles came last on the door-hanger, after desired/undesired materials and cap removal, and may have been skipped over by program participants.

The increase in the amount of caps removed from plastic bottles in Lewiston, by nature of the large increase and the lack of a need for judgement calls, seems to be a more reliable indicator that the educational program improved quality than the rate of bottle flattening is. Program participants can also more easily comprehend the importance of discarding caps and pumps, because they are recognizable as a contaminant. Flattening bottles, however, relates to collection efficiency, a concept that is more difficult for program participants to understand and value.

**Cost-Effectiveness of the Education and Awareness Campaigns**

An analysis of the cost-effectiveness of Schenectady’s education and awareness campaign is omitted because of Schenectady’s anomalous diversion data. An analysis for Lewiston is included below in Table E-3. Table E-3 summarizes the pertinent costs and cost reductions (savings) in two ways. The first column (“Cost (Reduction) Per Incremental Pound”) shows incremental changes in cost divided by additional amounts of plastic bottles collected. The second column (“Cost (Reduction) Difference Between Average Pound Costs”) shows the difference between “before” and “after” average costs.

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost (Reduction) Per Incremental Pound</th>
<th>Cost (Reduction) Difference Between Average Pound Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection</td>
<td>23.1 cents per pound</td>
<td>(3.5) cents per pound</td>
</tr>
<tr>
<td>Handling</td>
<td>6.4 cents per pound</td>
<td>(0.4) cents per pound</td>
</tr>
<tr>
<td>Avoided Disposal Tip Fee</td>
<td>(1.6) cents per pound</td>
<td>0.0</td>
</tr>
<tr>
<td>Material Revenue</td>
<td>(13.9) cents per pound</td>
<td>0.0</td>
</tr>
<tr>
<td>Cap Removal Savings</td>
<td>none assumed</td>
<td>none assumed</td>
</tr>
<tr>
<td><strong>Operational Cost Optimization</strong></td>
<td>14.0 cents per pound</td>
<td>(3.9) cents per pound</td>
</tr>
<tr>
<td>Plastics Education Campaign</td>
<td>128.0 cents per pound</td>
<td>17.5 cents per pound</td>
</tr>
<tr>
<td><strong>Net Cost Optimization</strong></td>
<td>142.0 cents per pound</td>
<td>13.6 cents per pound</td>
</tr>
</tbody>
</table>
Appendix E  
Plastics Recycling Education  
And Awareness

1 Efficiency-related impacts from increases in plastic bottles recycled.
2 Per pound values are independent of amount, therefore the difference is zero.
3 Reduced contamination levels provide savings for some handlers and reclaimers of a few cents per pound because less sorters are needed to remove contaminants. The primary contaminant is pigmented caps on natural HDPE bottles. Modern’s market however, is not sensitive to caps — therefore, no savings was assumed.
4 Education campaign costs ($2,000 or 50 cents per home) included printing costs of the door hangers, the newspaper advertisement cost, and incremental costs for plastics specific programs at the Earth Day event, which was already scheduled. Boy Scouts distributed the door hangers as a community service project, so no distribution costs were included. Education campaign costs were divided by total plastics collected in 6 months. This assumes higher total collection levels from education campaign are effective for 6 months before education must be repeated.

As Table E-3 shows, collection became more efficient (column 2), because more plastic bottles were collected while on route (over 15 percent more). The collection bottle increases came from increases in capture, which resulted in more plastic bottles in bins, as well new setouts by householders who previously weren’t participating in recycling. Incremental collection costs increased because it took more time to collect the additional plastic bottles. Handling also became more efficient, because of improvements in economies of scale. Additional bottles to sort and bale, however, increased the incremental handling cost for plastic bottles. Diverting additional plastic bottles from disposal saved $32 per ton, or 1.6 cents per incremental pound. Because the per ton disposal cost is fixed, there were no average disposal cost differences. Plastic bottle material revenues were averaging 13.9 cents per pound during this study. The increases in plastic bottles recycled were not significant enough to command a large-supplier premium for material revenues, so the difference in average material revenues before and after the education program was zero.

Improvements in cap removal by householders may save costs for downstream reclaimers and end product manufacturers who need to remove caps at their own expense. In most cases, reclaimers of PET and pigmented HDPE bottles do not manually remove caps because their reclaim systems perform automatic density separation, or the color doesn’t impact the final PCR produced. Caps are a concern for most natural HDPE reclaimers, who frequently remove caps either manually or with automated equipment. Modern’s particular market for natural HDPE overcolors the PCR produced, so cap removal doesn’t provide an economic benefit in this particular case.

Although Lewiston was able to recycle over 15 percent more plastic bottles, Table E-3 shows recycling added costs when compared to disposal, even before educational costs are considered. This will be true for most communities in the United States. Column 2 does, however, show that recycling became more efficient.

Lewiston’s plastic bottle recycling education and awareness campaign cost $2,000. Other studies (e.g., Palm Beach County, Florida) have shown that recycling education and awareness messages must be periodically repeated in order to maintain gains that are achieved. Repetition is necessary to maintain existing household interest and promote the recycling program to new residents of the community. For the purposes of this report, it was assumed that the education and awareness campaign costs and plastic bottle benefits were accrued over a six month period. Table E-3 shows that the targeted plastics recycling education program’s unit average costs far outweighed the
operational unit average cost reductions that were achieved. Although most communities will see cost increases per incremental pound, some communities may experience reductions in average plastic bottle recycling per pound costs depending on the magnitude of increased recovery and expense of recycling educational programs. There are many factors that drive recycling programs in addition to cost, and each community must consider those factors as well as costs before conducting recycling education and awareness programs.

CONCLUSIONS

This in-depth analysis, though limited in its scope, found that recycling education and awareness campaigns can improve participation in recycling programs and the quality of recovered recyclables, improving the cost-efficiency of plastics recycling and quality of PCR produced. Overall recycling costs were not experienced in Lewiston’s case, however, once recycling education and awareness costs were included.
The use of recycled plastics in food, drug, and cosmetic packaging ("food-contact packaging") falls under the regulatory jurisdiction of the U. S. Food and Drug Administration ("FDA"). Regulations for food, drug, or cosmetic-contact materials are detailed in Title 21 of the Code of Federal Regulations. This law requires that additives, including any packaging material in contact with foods, beverages, drugs, or cosmetics, receive FDA approval prior to their use.

The use of post-consumer recycled plastic resin ("PCR") in food-contact packaging was generally not considered prior to the late 1980s because it was not widely available. The proliferation of curbside recycling programs in the late 1980s and 1990s, however, provided large amounts of PCR with properties suitable for plastic bottle manufacture, because the PCR itself came from plastic bottles. Because the FDA didn’t have regulations in place for the use of PCR in food-contact packaging, and until such a time when it promulgates such regulations, it has established a "No Objection" procedure for qualifying PCR\(^1\) for food, drug, and cosmetic packaging uses.

The FDA’s No Objection procedure allows reclaimers to qualify their PCR for use in food-contact applications on an individual basis, depending on how effective each reclaimer’s equipment, processes, and protocols are for minimizing the risk of contaminants. In order to use PCR in food-contact applications, there must be a negligible risk of contaminants migrating from the container into the product. Current FDA guidelines define this negligible risk as an upper limit dietary exposure level of one-half part per billion. The FDA is concerned that contaminated plastic bottles may enter the recycling stream and subsequently be used for food-contact applications. Potential contaminated bottles could include used milk or soft drink bottles that householders have stored hazardous chemicals in and later placed in their recycling bin.

To ensure a reclaimer’s equipment, processes, and protocols are effective in minimizing the risk of exceeding the upper limit dietary exposure level, the FDA usually requires reclaimers to intentionally contaminate plastic containers with several hazardous surrogate chemicals. These chemicals include toluene, chloroform, lindane, and diazinon. The contaminated containers are then processed through the reclaimer’s system and the PCR produced is tested for residual contaminant concentration and migration.

The FDA also considers other factors besides contaminant concentration and migration test data in evaluating the likelihood of exceeding the upper limit dietary exposure level. These factors include likely consumption amounts of the contained product, whether the PCR will be used in a multi-layer package where the PCR is not in direct contact with the contained product, and the type of contained product (if the PCR is being restricted for certain uses). For example, solid foods are less likely than liquid

\(^1\)The FDA has not been concerned with the recycling of glass and metal containers into recycled-content food-contact containers, because glass and metals are generally impervious to chemicals and are readily cleaned at the temperatures used in their recycling.
foods to be contaminated because less of the food is in intimate contact with the container.

The maximum dietary concentration of one-half part per billion is the primary criterion used by the FDA when reviewing proposed food-contact uses for PCR. In addition, packages made from PCR must meet all regulations for virgin plastics resins and comply with the FDA’s “Good Manufacturing Practice” regulations.

If the FDA is satisfied that an individual reclaimer’s recycling equipment, processes, and procedures produce PCR that is of a suitable purity for use in food-contact packaging, it issues a letter of No Objection. The letter of No Objection, while not explicitly approving the reclaimer’s PCR, states that the FDA does not object to its use in food-contact packaging, under the restrictions (if any) included in the letter. Restrictions may include the use of the PCR only in multi-layer structures where a virgin layer is in contact with the food, or only if plastic bottles from certain controlled sources are recycled (e.g. soft drink bottles from deposit/return systems). The qualification process to obtain a letter of No Objection is arduous — only a select few reclaimers obtain them.