

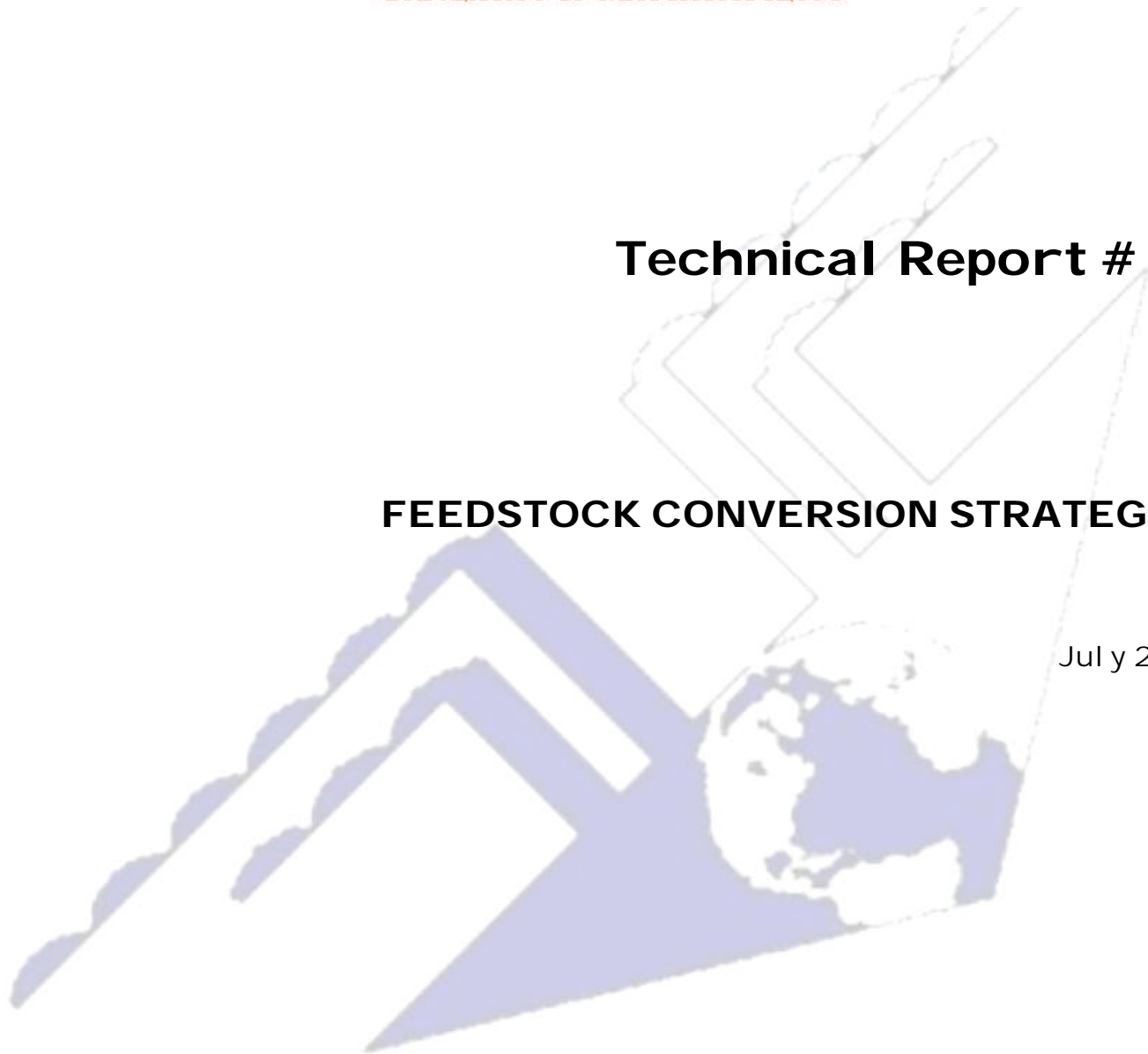
CHELSEA CENTER FOR RECYCLING AND ECONOMIC DEVELOPMENT

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FEEDSTOCK CONVERSION STRATEGIES

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FEEDSTOCK CONVERSION STRATEGIES

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The Chelsea Center for Recycling and Economic Development, a part of the University of Massachusetts' Center for Environmentally Appropriate Materials, was created by the Commonwealth of Massachusetts in 1995 to create jobs, support recycling efforts, and help the economy and the environment by increasing the use of recyclables by manufacturers. The mission of the Chelsea Center is to develop an infrastructure for a sustainable materials economy in Massachusetts, where businesses will thrive that rely on locally discarded goods as their feedstock and that minimize pressure on the environment by reducing waste, pollution, dependence on virgin materials, and dependence on disposal facilities. Further information can be obtained by writing the Chelsea Center for Recycling and Economic Development, 180 Second Street, Chelsea, MA 02150.

EXECUTIVE SUMMARY

Background

This report builds on the 1998 *Strategic Plan to Promote the Use of Recyclable Materials in Massachusetts* by further evaluating several feedstock conversion opportunities it identified. (The Plan was prepared under contract to the Chelsea Center for Recycling and Economic Development by a team led by Dorn & Associates.) Boisson & Associates prepared this report under contract to the Chelsea Center. It evaluates ten distinct feedstock conversion opportunities against six criteria addressing the potential results, the likelihood of securing company commitments, the available supply of recycled feedstock, the production technology, the economics of making the conversion and the demand for recycled content products.

Recommended Priorities

Each feedstock conversion opportunity was assigned one of three levels of priority, as follows:

High Priority -- These are opportunities that the Chelsea Center should definitely pursue. Based on the evaluation criteria used in this report, they appear to be prime candidates for success. They can yield significant results, and the Chelsea Center, in combination with other Massachusetts organizations and companies, is well positioned to promote them. High priority opportunities include:

- Use of tire shreds or chips in civil engineering applications; and
- Use of mixed-color container glass in abrasives and other ground glass applications.

Medium Priority -- These are opportunities that the Chelsea Center should consider pursuing, depending on the availability of resources for feedstock conversion. They could potentially yield significant results, but are more challenging and less likely to succeed than the high priorities. In general, additional research or market development assistance is required to improve the feasibility of feedstock conversion projects, based on the evaluation criteria used in this report. Medium priority opportunities include:

- Use of mixed wastepaper by board, tissue and corrugating medium mills;
- Use of scrap textile shoddy by nonwoven textile producers;
- Use of crumb rubber in molded product applications; and
- Use of crumb rubber in rubber/thermoplastic blends.

Low Priority -- These are opportunities that the Chelsea Center should not pursue at this time. They have a low probability of success and/or have potential results that are uncertain or insignificant. Low priority opportunities include:

- Use of recycled market pulp by specialty and printing & writing mills;
- Use of crumb rubber in road applications;
- Use of glass aggregate in paving and civil engineering applications; and
- Use of scrap glass by brick, tile and cement producers.

Recommended Strategies

The feedstock conversion strategies below represent this report's overall recommendations. They form a single, coherent approach that can be sustained over time, even as the Chelsea Center's priorities for targeted conversion projects change. Consistent with the priority rankings discussed above, it is recommended that the Center apply these strategies in the short-term to the two high priority feedstock conversion opportunities and, as resources allow, also to the four medium priority opportunities as identified above.

Strategy #1 -- Continue to issue funding solicitations to support any type of feedstock conversion project that satisfies the evaluation criteria.

Funding solicitations specifically targeting feedstock conversion projects provide an excellent incentive for companies to actively pursue feedstock conversion. The Chelsea Center should remain open to proposals from any company, while putting extra effort into marketing the solicitations to its top priority companies.

Strategy #2 – Maintain a prioritized list of targeted companies that could choose to convert to recycled feedstock.

The evaluations of each feedstock conversion opportunity in Chapter Three describe the targeted companies that could be good candidates to convert to using recycled feedstock. Some of these lists are fairly large, however, and could be refined through additional research.

Strategy #3 – Aggressively market funding solicitations to companies targeted for feedstock conversion.

In addition to mailing them the solicitation, the Center can enlist marketing support from the potential manufacturers of recycled materials, advertise in industry trade publications, post to industry web sites, attend conferences and make direct phone calls to candidate firms.

Strategy #4 -- Package and disseminate case studies and technical information on feedstock conversion opportunities.

These information materials can be disseminated via the channels identified for funding solicitations above under Strategy #4. Additional marketing channels include workshops (jointly sponsored by trade associations or other appropriate organizations); partnerships with training programs already recognized by the targeted industry and presentations at industry conferences.

Strategy #5 – Continue to implement a range of market development strategies to help establish the market conditions conducive to feedstock conversion.

Broad, industry-wide feedstock conversion efforts should be reserved for those industry sectors that appear to be ripe for conversion, after the Chelsea Center has documented product characteristics, economic and technical issues, and developed relationships with key companies.

Strategy #6 – Enlist support from recycled material suppliers to promote feedstock conversion.

Recycled material suppliers are natural and essential partners in feedstock conversion efforts. The Chelsea Center should continue to develop strong working relationships with these and other interested firms and enlist their support in marketing funding and other services to companies targeted for conversion. The Chelsea Center could consider establishing a network of organizations and companies with specific feedstock conversion objectives.

Strategy #7 -- Continue to coordinate with state agencies to assist companies to secure regulatory approvals, promote procurement contracts and access assistance programs.

Massachusetts is fortunate to have dedicated recycling market development staff in three critical agencies: the Department of Environmental Protection, the Highway Department and the Operational Services Division. Additionally, the Recycling Market Development Steering Committee provides one vehicle for this coordination and the Northeast Recycling Council provides a vehicle for coordination on a regional basis.

Strategy #8 -- Encourage purchasing commitments from large, private purchasers.

While product marketing is properly the domain of producers, the Chelsea Center should be on the look-out for particular opportunities where their influence may help to encourage large contracts that can serve as an anchor for feedstock conversion.

Strategy #9 -- Monitor developments affecting feedstock conversion opportunities.

The Chelsea Center should periodically review its list of targeted feedstock conversion opportunities and priorities and the strategies it is employing. Since recycling markets are regional and market developers are active in neighboring states, the Center should consider co-organizing a regional forum to review opportunities in conjunction with the Northeast Recycling Council.

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1. INTRODUCTION

In 1998 the Chelsea Center, on behalf of the Commonwealth of Massachusetts, published the *Strategic Plan to Promote the Use of Recyclable Material in Massachusetts* (henceforth referred to as the Strategic Plan). Prepared by a team lead by Dorn & Associates,¹ the Strategic Plan summarized markets for eight types of recycled materials (broken down by typical commodity), established priorities and recommended strategies to increase overall recycled material demand in Massachusetts. One recommendation was to encourage existing companies to convert from virgin to recycled feedstock. The Plan identified several opportunities and suggested strategies and five broad actions to pursue the opportunities. This report builds on the Strategic Plan by further evaluating these opportunities and recommending more detailed priorities and strategies for the Chelsea Center's feedstock conversion efforts.

Boisson & Associates prepared this report under contract to the Chelsea Center. The report evaluates ten feedstock conversion opportunities involving four material types (glass, paper, rubber and textiles).² The Strategic Plan provides detailed market information on each of these materials. To avoid redundancy, this report includes only information that has changed since 1998 or that is critical to the evaluation. Chapter Two summarizes the feedstock conversion opportunities evaluated, the evaluation criteria and information sources used. Chapter Three evaluates each feedstock conversion opportunity and, finally, Chapter Four consolidates findings and presents recommended priorities and strategies. Appendix A comprehensively lists the persons interviewed. Appendix B compares the recommendations of this report to those in the Strategic Plan.

2. METHODOLOGY

Feedstock Conversion Opportunities Considered

"Feedstock conversion" is a recycling market development buzzword referring to a company's decision to convert some or all of their raw material supply from virgin to recycled materials. It is an attractive strategy because it increases recycled material use in existing businesses while directly reducing virgin materials use. Feedstock conversion opportunities can be distinguished by three elements: the type of companies that can make the decision to convert; the type of recycled material they can use and the type of product they can produce. Each of these elements can be defined in many different ways. The feedstock conversion opportunities identified in the Strategic Plan mention at least 12 different types of companies, nine different sub-grades of four broadly defined material types and 14 different products. To facilitate evaluation and minimize redundancy, this report regroups these into ten distinct opportunities:

1. Substitution of mixed for high-grade wastepaper in paperboard, tissue and corrugating medium mills.
2. Use of recycled market pulp in specialty and printing & writing paper mills.
3. Use of scrap textile shoddy by nonwoven product manufacturers.
4. Use of tires or tire shreds or chips in civil engineering projects.

5. Use of crumb rubber in roads and other paving applications.
6. Use of crumb rubber by molded rubber product manufacturers.
7. Use of crumb rubber in rubber/thermoplastic blends.
8. Use of scrap glass in ground glass applications.
9. Use of scrap glass in civil engineering projects.
10. Use of scrap glass by brick, tile or concrete manufacturers.

These opportunities are described in more detail in Chapter Three. The first opportunity does not, strictly speaking, involve a conversion from virgin to recycled materials. It was included in the Strategic Plan because it increases demand for an ubiquitous recycled material with currently poor demand while allowing the current recycled feedstock to be used in higher value-added applications.

Evaluation Criteria

Each feedstock conversion opportunity is evaluated against the following six criteria:

- **Significant Results** -- Are the potential market development, economic and/or environmental results significant?
- **Commitment** -- Is it likely that targeted companies will make a commitment to pursue the feedstock conversion opportunity?
- **Supply Infrastructure** -- Can recycled feedstock supplies be increased at an acceptable quality and price to fuel conversion projects?
- **Proven Technology** -- Is the production technology required for conversion proven and available?
- **Economic Incentive** -- Can feedstock conversion be expected to reduce feedstock costs or have other positive impacts on the targeted companies' profitability?
- **Customer Driven** -- Is there demand for, or at least openness to, recycled content by the customers of the companies targeted for feedstock conversion?

These criteria are roughly equivalent to those used in the Strategic Plan, but are tailored to more specifically address feedstock conversion opportunities. They were developed after reviewing past feedstock conversion efforts in New York, California, North Carolina and Minnesota. While other analysts might define different criteria, the author believes these accurately indicate the most important challenges to successful feedstock conversion projects. While the criteria are here applied to broad categories of businesses and products, they are most effectively applied to a particular company considering a particular feedstock conversion opportunity. Ideally, the Chelsea Center would target its resources to projects satisfying all of these criteria.

Information Sources

Information sources used for this evaluation include documents readily available in print or on the Internet from the Chelsea Center, state and federal market development programs, industry associations and trade publications. This was augmented by over 50 telephone interviews with

representatives of Massachusetts companies, industry experts and market development professionals. The interviews validated and updated the written information and, more importantly, provided a vital "reality check" regarding practical issues and the interest level of Massachusetts' companies in feedstock conversion. A complete list of the persons interviewed appears in Appendix A.

3. EVALUATION OF FEEDSTOCK CONVERSION OPPORTUNITIES

The following sections evaluate each feedstock conversion opportunity. In addition to addressing the evaluation criteria, each section begins with a description of the targeted companies and products and past feedstock conversion efforts, and ends with overall conclusions, assignment of a priority ranking level and suggested actions to promote each opportunity. The priority rankings of high, medium or low are defined and summarized in Chapter Four.

#1 -- Substitution of mixed for high-grade wastepaper in paperboard, tissue and corrugating medium mills

What are the targeted companies and products? Massachusetts has two tissue, five paperboard and two corrugating medium mills³. In addition to board, tissue or corrugating medium, some of these mills produce an eclectic mix of products including absorbent felts, filters, rolls and tubes. The mills are distinguished from those in many other regions by their generally small size and specialized market niches. All of these mills use significant quantities of waste paper, including mixed residential in some cases. The focus in this evaluation is on encouraging greater use of mixed residential wastepaper.

What past recycling market development efforts have targeted these companies? Several studies and projects have explored conversion opportunities in Massachusetts' paper mills. A 1996 study by the Industrial Services Program⁴ included an evaluation of the potential to increase wastepaper use and a 1999 Chelsea-funded survey of mills went into more detail, specifically regarding the use of mixed paper⁵. Following this survey, the Chelsea Center funded two demonstration projects. Creative Paper, Inc. purchased a pulper cleaning system that allowed them to run up to 30% mixed grades in lieu of line kraft replacement pulp⁶ and Erving Paper, Inc, ran a pilot trial testing the potential to use up to 50% mixed wastepaper.⁷ The results were encouraging. The Massachusetts Department of Environmental Protection's (DEP's) Recycling Industries Reimbursement Credit (RIRC) grant program helped fund Creative Paper's purchase of fiber cleaning equipment and also funded a similar effort at the Perkit Folding Box Corporation that increased its use of mixed paper to 4,000 tons per year. Additionally, the Chelsea Center, Massachusetts DEP and various economic development services have actively recruited and/or assisted several paper recycling mill projects. Two other states have undertaken aggressive, systematic feedstock conversion projects aimed at substitution of mixed for higher grade wastepaper feedstock.⁸ Both states, Minnesota and New York, report that achieving sustained and measurable results was difficult.

Are the potential results significant? Maybe. Substitution of low for high-grade wastepaper strengthens overall markets by creating a new market for low-value, hard-to-market materials and also may improve the competitiveness of mills by reducing feedstock costs. The combined capacity of the targeted mills is in the neighborhood of 1,500 tons per week. To illustrate the potential, an average incremental increase in mixed wastepaper use of, say 20% (an aggressive goal) would result in increased mixed wastepaper capacity of about 300 tons per week. While this is not insignificant, it would be achieved only after some effort and pales in comparison with the potential increase in mixed wastepaper demand that might result from the planned opening of a new Newark Group paperboard mill in Fitchburg in 2002 (reportedly up to 1,750 tons of residential mixed paper per week)⁹. A further reason why the impacts are uncertain is the elasticity of the mixed wastepaper market -- that is, supply and demand vary significantly with price. When prices are high, wastepaper processors seek all available supply sources and sort mixed grades into separated, higher grades and mills with flexibility seek lower cost, mixed grades. When prices are low, some loads that could potentially be recycled may be landfilled, processors may choose not to sort high grades from mixed, and mills may shift to higher-grade wastepaper.

Is it likely that targeted companies will make a commitment to pursue the opportunity? Maybe. Mills do have a clear economic incentive, but in most cases are already using mixed wastepaper when market conditions allow. Following on the example of Creative Paper, Perkit and Erving Paper, some mill managers may be open to committing to a project to investigate opportunities, particularly if the full costs of the investigation are covered.

Can supplies be increased at an acceptable quality and price to fuel feedstock conversion projects? Yes. There is a very well developed infrastructure for paper recycling, and the Strategic Plan suggests that mixed wastepaper supplies could increase by as much as 38,000 tons per year by 2002. While the supply of mixed wastepaper is rather fluid and can certainly be increased incrementally, one mill did report current difficulty in obtaining adequate supplies.¹⁰ A major processor said the differential between mixed and old corrugated containers is currently near \$50, and this is driving increased use of mixed grades, and consequent shortages, for the time being.¹¹

Is the production technology required for the conversion proven and available? Yes. In many cases mixed wastepaper can be substituted for higher grades directly with no change in equipment or process. Some mills have tighter quality standards and require either increased scrutiny of fiber supplies or automated or chemical-based cleaning systems to use mixed grades, the latter requiring an investment that must be justified through reduced fiber costs.

Can feedstock conversion be expected to reduce feedstock costs or have other positive impacts on profitability? Yes. This is a clear driver for mills to consider substituting lower grades. Mixed wastepaper can sometimes cost significantly less than higher grades. The experience of Creative Paper, Inc. suggests that, even when investments in new fiber cleaning equipment is required, the conversion can be profitable, at least in some circumstances.

Is there demand for, or at least openness to, recycled content by the product's customers?

Yes. Many consumers of board, tissue and corrugating medium are generally accustomed to recycled content, although the market is driven by cost and performance and is not particularly influenced by "green marketing" strategies.

Conclusions and Suggested Actions -- Encouraging mills to substitute mixed for higher-grade wastepaper should be a medium priority for the Chelsea Center. Although the Chelsea Center and other state agencies have successfully assisted four mills to investigate or complete feedstock conversion, the additional potential is uncertain. And, any additional market impacts may pale in comparison with the planned opening of the Fitchburg board mill. On the other hand, the importance of the paper industry to recycling markets and the state's overall economy merit continued attention.

Suggested actions should the Chelsea Center pursue this opportunity:

- ✓ Contact all mill managers periodically to monitor opportunities and gauge interest. (Since there are relatively few of them and they are so vital to the state's economy and recycling markets, the Chelsea Center should consider doing this regardless of whether it decides to pursue this feedstock conversion opportunity.)
- ✓ Enlist support from wastepaper suppliers in the region.
- ✓ Disseminate information about the two successful demonstration projects to other mills in the state.
- ✓ Target mills that are preparing to invest in mill upgrades (even if unrelated to recycling), since this may be an opportune time to evaluate recycling investments.
- ✓ Ensure that mill managers are informed of all state assistance, especially funds available through the recycling loan program and RIRC.

#2 -- Use of recycled market pulp in specialty and printing & writing paper mills.

What are the targeted companies and products? Massachusetts is home to nine printing & writing mills and 13 specialty mills.¹² Based on one industry survey, only one printing & writing and one specialty mill in Massachusetts has on-site wood pulp production capacity, and none currently has deinked pulp production capacity.¹³ While all of these mills have reportedly experimented with recycled pulp, none apparently uses it on a regular basis. As with other Massachusetts mills, these plants specialize in narrow, niche products and offer the capability to retool rapidly to meet customers needs.

What past recycling market development efforts have targeted these companies?

Market development for paper has been a priority for the Chelsea Center and others in Massachusetts for some time. (See the discussion under Opportunity #1, page 3). In the mid-1990s much attention was given to the development of new recycled market pulp mills, including a large facility in Fitchburg. They were developed in large part in response to the efforts of market developers, particularly the creation of state and federal procurement guidelines and several high-profile commitments by private publishers to purchase recycled products. Unfortunately, many of these mills, including the Fitchburg facility, have since failed. The

Newark Group, of Cranford, New Jersey, now has plans to site a graphic board paper machine in this facility.

Are the potential results significant? Maybe. If these high-end mills can be convinced to convert to recycled market pulp, it would tend to strengthen the overall market for wastepaper and might enhance the competitiveness of Massachusetts' mills. However, recycled market pulp would be supplied from out of state (see below), at least initially, so impacts on Massachusetts markets are less clear.

Is it likely that targeted companies will make a commitment to pursue the opportunity? No. Many printing & writing and specialty mills experimented with recycled market pulp in the mid-1990s and there were many problems, especially with inconsistent fiber lengths.¹⁴ These companies are likely to be extremely skeptical about new efforts. This is compounded by the fact that the perceived strength of "green markets" for recycled printing & writing paper has weakened, despite continuing efforts to enforce and promote state and federal procurement requirements.

Can supplies be increased at an acceptable quality and price to fuel feedstock conversion projects? Probably, but only incrementally and from out-of-state sources. Eastern suppliers of recycled market pulp now include only three mills, one in Auburn, Maine, one in West Virginia and one in Burrows, New York.¹⁵ Pulp from the Auburn mill is reportedly being used in house, and pulp from the other two companies is reportedly being used primarily in tissue and board mills, not high-end paper grades. Quality remains a paramount concern. To meet the needs of high-end producers, some recycled market pulp producers may need to install automated fiber quality equipment. While they can consistently produce pulp with long fibers, this directly increases residual waste products and has a negative impact on their profitability.

Is the production technology required for the conversion proven and available? Yes. In general, if their stringent supply specifications are met, printing & writing mills and specialty mills can use recycled market pulp with no additional investment in equipment.

Can feedstock conversion be expected to reduce feedstock costs or have other positive impacts on profitability? Yes. In general, mills can reduce their feedstock costs by purchasing recycled market pulp instead of purchasing or manufacturing wood pulp. Concerns over profitability center on the ability of mills to sustain high quality standards for their finished products.

Is there demand for, or at least openness to, recycled content by the product's customers? No, except for federal and state purchasing. The predominant perception is apparently that demand by large, private publishers for recycled content printing & writing paper is very weak, and that federal and state procurement efforts are not significant enough to drive large-scale conversions.

Conclusions and Suggested Actions -- Promoting the use of recycled market pulp should be a low priority for the Chelsea Center as long as there is no recycled market pulp producer in the state, or until a specific opportunity with a high potential for success is identified. Such an opportunity would probably require a significant purchasing commitment by a publisher with specialized requirements of the type typically met by Massachusetts' niche producers.

Suggested actions should the Chelsea Center pursue this opportunity:

- ✓ Contact mill managers periodically to monitor opportunities (since there are relatively few of them and they are so vital to the state's economy and recycling markets, the Chelsea Center should consider doing this regardless of whether it pursues this opportunity).
- ✓ Enlist a supplier of recycled market pulp to assist in promoting feedstock conversion.
- ✓ Explore the potential for existing mills with pulping capacity to sell recycled pulp in a regional market.
- ✓ Facilitate large-scale commitments by consumers by meeting with potentially large users and promoting recycled content paper use by state and local agencies. (Coordinate such efforts with state and national *Buy Recycled Business Alliance* members.)
- ✓ Update state and private purchasing agents as new recycled products become available.

#3 -- Use of scrap textile shoddy by nonwoven product manufacturers.

What are the targeted companies and products? This section focuses on the potential for companies in the nonwoven fabric industry to convert to using shoddy instead of virgin fibers. Nonwoven fabrics are broadly defined as "sheet or web structures bonded together by entangling fiber or filaments mechanically, thermally or chemically. They are flat, porous sheets that are made directly from fibers, not woven or knitted and they do not require converting the fibers into yarn."¹⁶ A vast range of products are produced with nonwovens, including disposable diapers, sanitary napkins & tampons, sterile wraps, caps, furniture upholstery, padding and backing wall in automotive trunks. Shoddy is produced from the scrap textile material that is left over after reusable clothing and wiping rag grade materials are separated from a mixed recycled textile stream. It is typically used in stuffing, padding, and other products with relatively forgiving feedstock specifications. Because of the many products produced, nonwovens manufacturers can be classified in many Standard Industrial Classification (SIC) codes.¹⁷ The Chelsea Center's manufacturer database was searched for several SIC codes. For the sole SIC code defined for nonwovens (2297, Nonwoven Fabrics) there were only five Massachusetts companies. But including 11 other textile-related SICs that likely include many nonwovens manufacturers, there were a total of 240 businesses.¹⁸ Additional research is required to better characterize the nonwovens industry and identify which segments might be the best candidates to use scrap textiles. One researcher suggested that pads, needlepunch, flocking and insulating products might have the highest potential.¹⁹ A nonwovens industry representative indicated that certain nonwovens products are probably not candidates for shoddy use, such as wet-lay, melt-spun and spun-bonded products.²⁰

What past recycling market development efforts have targeted these companies? The Chelsea Center sponsored a research study on the use of one particular textile waste stream, involving a mix of spandex, cotton and other fibers. The study attempted to produce yarn but it was of poor quality and wastes were high. The study also produced a nonwoven (absorbent) product with good results.²¹

Are the potential results significant? Yes. Increased shoddy demand could directly help to boost overall textile recycling in the state and boost production at the state's sole shoddy supplier, or encourage new shoddy supply operations at existing textile recycling facilities. This could add a small number of jobs and value-added to the state economy.

Is it likely that targeted companies will make a commitment to pursue the opportunity?

No. Industry experts are very skeptical about the prospects for opening new markets for shoddy. Reasons for this include a trend towards higher quality standards and competition with other materials such as synthetic polymers. The nonwovens industry is very diverse and the tremendous product range has vastly different requirements for feedstock. Finding interested producers may depend to a large extent on finding a good match between a particular product and a particular stream of scrap textiles. To enter higher value markets, a consistent source of high-quality fiber will be required, and this will be difficult to guarantee.

Can supplies be increased with acceptable quality and price to fuel feedstock conversion projects? Yes, at least for end-users with forgiving specifications necessitating incremental increases in supply. The sole producer of shoddy in Massachusetts (Mill Tex) has indicated that it could easily increase production and is interested in establishing new customers. The Strategic Plan estimates that overall textile recycling could increase by as much as 78,000 tons by 2002, and that between 12% and 20% could be available to produce shoddy. Since Mill Tex only produces about 6,250 tons per year²², this would probably be an unattainable increase in the short term, but significant growth is surely possible. And, other textile recycling companies in the state might consider producing shoddy should new markets open. Quality concerns can vary significantly, depending on the end user and the source of materials. While quantity may not be a problem, satisfying the stringent quality requirements of many nonwoven producers may be quite challenging. Testing and characterization of supplies against the specific needs of potential new users will likely be required.

Is the production technology required for the conversion proven and available? Yes, but supplies must be matched carefully with end-user demands and be consistently met.

Can feedstock conversion be expected to reduce feedstock costs or have other positive impacts on profitability? Yes, nonwovens manufacturers can generally reduce their raw material feedstock costs by converting to shoddy from virgin fiber or other products. However, concerns over profitability center on their ability to meet stringent quality standards while using scrap textile shoddy.

Is there demand for, or at least openness to, recycled content by the product's customers? No. In general, consumers of nonwovens fabrics have increasing expectations regarding quality and performance, are not accustomed to recycled content, and are not driven by a "green marketing ethic."²³ Apart from a handful of nonwovens manufacturers already using shoddy, there is very little interest. Moreover, finding nonwovens producers in Massachusetts who are willing to consider converting to scrap textiles may be particularly difficult because, similar to the state's paper producers, these facilities tend to be small, niche operations that are particularly sensitive to feedstock performance characteristics.²⁴ Moreover, specifications are increasingly stringent for fiber suppliers and there is likely to be much skepticism about recycled supplies²⁵.

Exceptions to this rule may be automotive companies and "green building" companies, which are increasingly interested in recycled products. Nonwovens are used as formed insulation and padding in many automotive components, in upholstery and in trunks, and in certain wall or furniture insulation, for example.

Conclusions and Suggested Actions -- Converting nonwovens manufacturers to use shoddy should be considered a medium priority for the Chelsea Center. The potential for success with this opportunity is directly dependent on a commitment by the state's sole shoddy producer, Mill Tex, to work with the Chelsea Center to expand its customer base. Moreover, the diversity of the shoddy stream and the range of nonwovens producers means that pursuing this opportunity requires additional research and will likely be challenging.

Suggested actions should the Chelsea Center pursue this opportunity:

- ✓ Encourage the one shoddy supplier in the state, Mill Tex, to work closely with the Center, while inviting participation from other textile recyclers in the state.
- ✓ Document the range of nonwovens companies and segment the industry into strategic sectors to help allocate resources. Use information on current shoddy customers to identify key industry segments.
- ✓ Encourage research to identify and overcome barriers to the increased use of shoddy in nonwoven manufacturing.
- ✓ Document the range of shoddy specifications capable of being produced by Mill Tex and/or other suppliers in the state.
- ✓ Document case studies of existing customers of Mill Tex and other shoddy producers nationwide and use this information in marketing the concept.
- ✓ Research "green marketing" opportunities for shoddy in the automotive products and green building industries.
- ✓ Launch an aggressive program to market the concept and survey the industry, with the goal of securing commitments to participate in a feedstock conversion program.
- ✓ Offer funding to cover testing, demonstrations and marketing assistance to companies as an incentive.
- ✓ Coordinate efforts with the Operational Services Division's pilot purchase program to test use of recycled content nonwovens in particular markets.

#4 -- Use of whole tires, shreds or chips in civil engineering projects.

What are the targeted companies and products? This opportunity includes the use of tire shreds or chips in civil engineering applications such as lightweight fill, septic drainage systems, landfill drainage, ventilation or daily cover, drainage pads, playground surfaces or use of whole tires in erosion control, artificial reefs or playgrounds. The companies in a position to make these conversion decisions include as many as 733 engineering firms and a myriad of consultants, suppliers and other firms involved in various aspects of this eclectic group of projects.²⁶ Additional research is required to better define and narrow the list of candidate firms. Some of these applications, such as lightweight fill, may involve road construction companies (discussed below under Opportunity #5). State agencies may be the most important entity

capable of taking actions to move this opportunity forward. Massachusetts Highway Department must approve lightweight fill, and the Department of Environmental Protection must issue *beneficial use determinations* or otherwise approve each application.

What past recycling market development efforts have targeted these companies? The Chelsea Center, along with many other groups in and out of state, has aggressively promoted civil engineering applications for tires. A vast amount of documentation is available on civil engineering uses from the Scrap Tire Management Council, the CWC, the Environmental Protection Agency's Jobs Through Recycling web site and other sources. Chelsea Center efforts include a study of the environmental impacts of lightweight fill,²⁷ and a follow-up demonstration being conducted by the University of Massachusetts Dartmouth to investigate tire shreds in subsurface leaching systems,²⁸ and a demonstration of tires chips in three Massachusetts playgrounds (in conjunction with the Operational Services Division). So far, the demonstration is showing positive results and significant untapped market growth potential. The Chelsea Center is also sponsoring a series of workshops for local and state engineers to increase awareness about using tire chips and shreds. The use of tires in civil engineering applications is a growing target for market development programs around the country, particularly in the Southeast where use of tire shreds or chips in septic systems is increasingly common. A wide variety of reports have advocated use of whole tires in a myriad of applications, but actual use appears to have been sporadic at best.

Are the potential results significant? Yes. These applications hold the potential to establish a long-term, economic market for large quantities of scrap tires, and to help alleviate Massachusetts of its tire pile problem. The potential impacts of using whole tires is far less since they are likely to be used sporadically.

Is it likely that targeted companies will make a commitment to pursue the opportunity? Yes. Tire recycling experts agree that engineers and others in a position to purchase tire shreds or chips for civil engineering applications will readily use them, given the price and performance advantages. Additional research should be conducted with engineering firms to confirm this conclusion.²⁹ Three applications appear to have particularly high potential: lightweight fill, septic drainage and playground surfaces.

Can supplies be increased at an acceptable quality and price to fuel feedstock conversion projects? Yes. The Strategic Plan suggests that the supply of newly disposed tires could increase from 121,000 tons per year in 1997 to 133,000 tons per year by 2002, and at least seven million tires are in tire piles throughout the state. Although Massachusetts' supply of newly disposed tires is entirely recycled (largely as fuel), civil engineering may provide a superior, higher-value and more environmentally beneficial use, and it also may provide an economic market for stockpiled supplies of old discarded tires.

Is the production technology required for the conversion proven and available? Yes, although regulatory hurdles may inhibit some applications. The technology for producing tire shreds or chips acceptable for these uses is available and straightforward. The applications themselves are also well understood and the materials behave in ways that are similar, or superior, to the rock, plastic or other virgin materials they replace. Although *beneficial use*

determinations are needed for many applications, the DEP has granted one broad BUD to Commonwealth Recycling, LLC that covers most civil engineering applications with the notable exception of septic drainage systems, and a series of more narrow BUDs have been issued to Routhier Tire, Inc.³⁰ DEP staff have indicated that a BUD will not need to be issued for septic systems, since they are covered under existing Title V regulations.³¹

Can feedstock conversion be expected to reduce feedstock costs or have other positive impacts on profitability? Yes. Again, analysts agree that tire shreds or chips can not only reduce costs but perform better in many of these applications, particularly lightweight fill, septic systems and playground surfaces.³²

Is there demand for, or at least openness to, recycled content by the product's customers? Yes, once regulatory approval is obtained. Most customers of engineering products rely on their supplier – the engineering and other firms responsible for designing such systems – to determine which materials are appropriate. As long as cost and performance are demonstrably positive, customers will likely be willing to try the recycled products.

Conclusions and Suggested Actions -- Civil engineering applications for tire shreds or chips should be considered a high priority. The applications hold the promise to create a large, economic market for large quantities of the state's newly discarded tires (many of which are currently incinerated) and also for the state's stockpiled tires. And the Chelsea Center, along with Massachusetts DEP and private recycling companies, is well positioned to expand use in the short-term. Uses for whole tires should be pursued where opportunities arise, but hold less promise for steady, large scale, economic use.

Suggested actions should the Chelsea Center pursue this opportunity:

- ✓ Continue to work closely with the state's tire recyclers to test, demonstrate and market this opportunity.
- ✓ Assist suppliers and developers in securing appropriate permits and approvals from DEP and other agencies as necessary.
- ✓ Target lightweight fill, septic systems and playground surfaces, while continuing to research and stay abreast of opportunities in other civil engineering applications.
- ✓ Solicit proposals for testing, demonstrations and other feedstock conversion efforts.
- ✓ Compile case studies from other states and document the advantages of tire shreds or chips. Use this information to promote the products to potential users in an aggressive marketing campaign.
- ✓ Solicit assistance from the Scrap Tire Management Council and others with a vested interest.
- ✓ Coordinate a pilot-purchasing program with the State Operational Services Division.

#5 -- Use of crumb rubber in roads and other paving applications.

What are the targeted companies and products? Crumb rubber can be used in rubber modified asphalt in roads, playgrounds and parking lots, or in cold patch and other paving applications. (Tire shreds can be used in road construction as lightweight fill or base aggregate. These are

discussed in civil engineering applications above.) The most significant customer is Massachusetts Highway Department since, in addition to being a potentially huge purchaser, it literally sets the standards for local and private projects through its lists of approved products and published specifications. A search of businesses by SIC found 434 Massachusetts companies classified in SIC 1611, Highway and Street Construction and 30 companies classified in SIC 2951, Asphalt Paving Mixtures and Blocks. Local government public works and roads departments are also potential customers.

What past recycling market development efforts have targeted these companies? A massive amount of effort has been put into promoting the use of recycled products in road construction. (See the discussion in Opportunity #4 above.) In the late 1990s great enthusiasm swelled for rubber modified asphalt as a result of the Intermodal Surface Transportation Act (ISTEA), which for a time required the use of recycled products in federally funded roads. That provision was stricken however, and the enthusiasm has waned. The DEP has funded a two-year Recycling Coordinator position within the Massachusetts Highway Department who monitors and encourages recycled product use. Massachusetts Highway Department has approved rubberized asphalt sealers and maintains a specification for rubberized asphalt for use in stress absorbing membrane interlayers. However, progress in using crumb rubber in Massachusetts' roads has been very slow, lagging far behind many other states. Between 1996 and 1998, Massachusetts Highway Department used a total of 277 tons of rubberized products. Erickson Materials, Inc., was a producer of crumb rubber that was recently acquired by Rouse, Inc.³³ The facility, however, is not currently designed to supply crumb rubber suitable for use in road applications³⁴, and Rouse is planning to move the operations out of Massachusetts due to problems in finding an appropriate site.

Are the potential results significant? Yes. Use of crumb rubber in roads holds immense potential to consume large quantities of tires in relatively high value markets.

Is it likely that targeted companies will make a commitment to pursue the opportunity?

No. Several experts agreed that New England, and Massachusetts in particular, is not likely to see significant use of rubber modified asphalt in the near term.³⁵ Experiments were done in the 1990s, but reactions were not entirely positive.

Can supplies be increased at an acceptable quality and price to fuel feedstock conversion projects? Yes. Particularly given the current glut of supplies of crumb rubber and continuing expansion of production capacity, supplies will be plentiful. The closest supplier of crumb rubber for roads may be in Pennsylvania. A large, new producer in South Carolina is expected to further flood the market with supplies and drive prices lower.

Is the production technology required for the conversion proven and available? Yes.

Experience with crumb rubber use is well documented through literature involving projects throughout the nation. However, continued demonstrations and testing in Massachusetts would likely be required prior to any large-scale use.

Can feedstock conversion be expected to reduce feedstock costs or have other positive impacts on profitability? Maybe. This is a subject of considerable debate. Advocates indicate that RMA

costs more in the short-term, but that long-term costs may be reduced since roads can be expected to last longer and require less maintenance. Some detractors have contradicted this view, however, arguing that even if true, government agencies currently evaluate economics on an initial cost basis.

Is there demand for, or at least openness to, recycled content by the product's customers? No. As discussed above, state and other road construction engineers in Massachusetts are generally extremely skeptical of rubber modified asphalt products.

Conclusions and Suggested Actions -- Tires in road applications, with the exception of tire shreds or chips in lightweight fill discussed separately, should be considered a low priority. This is because of the low probability of encouraging State and other road engineers to specify rubber modified asphalt and because of the existence of better alternatives, particularly civil engineering applications. One expert, Michael Blumenthal of the Scrap Tire Management Council, suggests focusing on civil engineering applications, and to a lesser extent, molded rubber products for the near term, while staying abreast of developments in road construction and potential opportunities to make progress which may arise down the road.

Suggested actions should the Chelsea Center pursue this opportunity:

- ✓ Enlist support from tire recyclers and crumb rubber suppliers both in and out of state.
- ✓ Monitor efforts of rubber modified asphalt advocates and maintain a dialog with state roads officials. If opportunities arise, support or even fund efforts to use recycled rubber in roads.
- ✓ Document and publicize successes in other states.
- ✓ Fund additional tests and demonstration projects in cooperation with Massachusetts Highway Department.
- ✓ Seek product approvals and adoption of specifications by Massachusetts Highway Department for a range of rubberized products as an ultimate goal.

#6 -- Use of crumb rubber by molded rubber product manufacturers.

What are the targeted companies and products? Crumb rubber can be used by molded rubber product producers to make a range of products such as parking stops, delineator bases and a myriad of components and finished products. A search of the Chelsea Center's manufacturers database found only four companies in SIC 3061, Molded Extruded and Lathe-Cut Mechanical Rubber Goods, and 55 companies in SIC 3069, Fabricated Rubber Products. Additional research is required to narrow this list to the companies who are truly candidates to use recycled rubber, and to identify other companies in other SIC classifications.

What past recycling market development efforts have targeted these companies? The Operational Services Division conducted a pilot purchase of recycled rubber gym flooring that resulted in a purchasing contract with an out-of-state producer. Other than this no Massachusetts market development efforts were identified that specifically targeted molded rubber producers. New York State did target molded rubber producers in a feedstock conversion effort. (Discussed below.)

Are the potential results significant? Maybe. At least initially, quantities of crumb rubber used are likely to be modest. However, over time, molded product manufacturers may hold the potential to create a relatively high-value, steady long-term market for crumb rubber that could boost the economic vitality of Massachusetts producers.

Is it likely that targeted companies will make a commitment to pursue the opportunity?

Yes. One producer, Acushnet Rubber, is interested in exploring opportunities to use recycled rubber.³⁶ Apart from this one company, finding producers interested in exploring feedstock conversion may be difficult. While there is a price advantage for using recycled rubber, it is relatively unproven and there is generally no clear "green marketing" incentive. New York State's Empire State Development conducted an aggressive feedstock conversion effort targeting molded rubber product producers. According to the project manager, after mailing hundreds of information packets, following up repeatedly with companies, sponsoring an informational workshop and offering a range of technical and financial assistance, they were unable to secure any commitments to use or even explore the potential for feedstock conversion³⁷.

Can supplies be increased at an acceptable quality and price to fuel feedstock conversion projects? Yes. There is currently an oversupply of crumb rubber, with even more capacity coming on line through a major new plan in South Carolina. This is expected to further decrease crumb rubber prices to all time lows and ensure a plentiful supply on the national market.

Is the production technology required for the conversion proven and available? Yes, although use of recycled crumb rubber is not widespread and testing and demonstrations are likely to be required to address the concerns of potential users and to develop technologies specifically appropriate to each producer.

Can feedstock conversion be expected to reduce feedstock costs or have other positive impacts on profitability? Yes. Recycled crumb rubber is likely to significantly reduce feedstock costs.

Is there demand for, or at least openness to, recycled content by the product's customers? No. Since recycled content molded rubber products are relatively uncommon, there is little awareness and openness among most customers. An exception may be government purchasing programs targeting products like wheel chocks or delineator bases.

Conclusions and Suggested Actions -- Molded products should be considered a medium priority. The potential results may be significant, but only in the long term. And, although it is a very challenging opportunity, there is already at least one in-state producer that may be willing to explore opportunities.

Suggested actions should the Chelsea Center pursue this opportunity:

- ✓ Enlist support from crumb rubber suppliers.
- ✓ Fund targeted research to work with Acushnet Rubber (and/or others) to characterize markets for recycled content molded rubber products.

- ✓ Sponsor a research project to comprehensively evaluate the range of molded products to identify the best candidates for recycled content production.
- ✓ Document case studies of molded product producers using crumb rubber based on customers of crumb rubber producers around the country.
- ✓ Determine the economics around the transport of this material, and possibly work with crumb rubber manufacturers in-state to encourage them to make different grades of rubber to meet the market needs.
- ✓ Depending on the results of the above research, aggressively promote feedstock conversion through marketing materials, and targeting technical and financial assistance programs to test and demonstrate conversions.
- ✓ Provide funding as an incentive for companies to explore feedstock conversion projects.

#7 -- Use of crumb rubber in polymer applications.

What are the targeted companies and products? -- This opportunity was added to the study because it is the subject of a Chelsea Center technical report examining the production of blended rubber polymers.³⁸ It involves blending crumb rubber with thermoplastics such as polypropylene (PP) to make materials with very diverse characteristics and uses. Potential companies that could convert to using rubber polymers are presumably current consumers of thermoplastics in a wide array of markets. Two products evaluated in the study were roofing and flooring. Additional research is required to better characterize and evaluate the potential production and use of rubber/plastic blends.

What past recycling market development efforts have been undertaken? Other than the Chelsea Center technical report, no previous efforts targeting rubber polymers were identified.

Are the potential results significant? Maybe. While the application is unlikely to consume large quantities of scrap rubber in the short-, or possibly even long-term, it is a potentially very high value market. This market could help boost long-term markets for crumb rubber and may also have significant economic benefits if a new supplier establishes operations in Massachusetts.

Is it likely that targeted companies will make a commitment to pursue the opportunity? Maybe. Additional research is required.

Can supplies be increased at an acceptable quality and price to fuel feedstock conversion projects? No. Although supplies of crumb rubber are sufficient (See discussion under Opportunity #6 above), there are currently no producers of rubber/plastic blends. Researchers at the University of Massachusetts, Lowell are interested in licensing the technology to firms, but are first focused on initial commercial testing and demonstrations.

Is the production technology required for the conversion proven and available? No, not yet. See above.

Can feedstock conversion be expected to reduce feedstock costs or have other positive impacts on profitability? Maybe. The University of Massachusetts study cited competitive prices in the

two markets it investigated, but these conclusions need to be expanded upon and tested commercially.

Is there demand for, or at least openness to, recycled content by the product's customers?
Maybe. It is still unclear how open potential users will be to a new material with an unproven track record and few producers.

Conclusions and Suggested Actions -- Rubber polymers should be considered a medium priority. While there is still considerable uncertainty regarding its future, the Chelsea Center has made an initial investment and it is worth expending the relatively low resources required to explore the next steps.

Suggested actions should the Chelsea Center pursue this opportunity:

- ✓ Provide funding to the University of Massachusetts Lowell researchers to take the testing and demonstration to the next level, including pilot commercial scale production.
- ✓ Conduct a market research study to characterize the potential market for rubber/plastic blends and gauge the level of difficulty of penetrating those markets.
- ✓ Determine the economics around the transport of this material, and possibly work with crumb rubber manufacturers in-state to encourage them to make different grades of rubber to meet the market needs.
- ✓ Conduct a survey of existing polymer producers to gauge the interest in licensing the UMASS technology and producing rubber/plastic blends in Massachusetts.

#8 -- Use of scrap glass in ground glass applications.

What are the targeted companies and products? The ground glass applications considered include abrasives (e.g., sandblasting), reflective paint, stucco and surface treatments. This report focuses on abrasives since the state's sole supplier of glass for these markets is aggressively targeting that market. A search of the Chelsea Center manufacturer database identified 28 companies in SIC 3291, Abrasive Products. These companies may be potential producers or vendors of glass abrasives, and may actually be better classified as competitors. A wide range of companies use abrasives and government purchasers may be well positioned to influence this market. For example, the Massachusetts Turnpike Authority purchases abrasives to service their fleet of heavy equipment annually. Additional research is required to better characterize the Massachusetts markets for abrasives and other ground glass applications. The discussion below is focused on mixed color container glass. Unlike the other two types of glass discussed in the Strategic Plan (plate glass and cathode ray tubes or CRTs), mixed color container glass has been approved for use in many applications through a universal *beneficial use determination* issued by the Massachusetts Department of Environmental Protection.

What past recycling market development efforts have targeted these companies? Abrasives and other ground glass applications have received a large amount of attention by market developers across the nation, particularly by the CWC. A Washington company, TriVitro, has worked extensively with CWC staff and, among the panoply of potential markets for mixed color glass,

has targeted abrasives.³⁹ A large amount of information is available documenting ground glass and other alternative glass markets considered in this report. This material may be found on the CWC web site, the U.S. Environmental Protection Agency's Jobs Through Recycling web site, through a database of alternative glass markets maintained by John Reindl of Dane County, Wisconsin and other sources. The Massachusetts DEP, through the Recycling Industries Reimbursement Credit grant program, funded Unical USA, Inc. to purchase equipment required to meet scrap glass specifications for abrasives and other ground glass applications. DEP also issued a *beneficial use determination* approving the use of mixed-color broken container glass as a replacement for crushed stone or gravel in aggregate material in a variety of uses. The Massachusetts Highway Department has also approved the use of mixed-color container glass as a processed glass aggregate and recycled reflective glass beads. The Department has used between 50 and 300 tons per year reflective glass beads over the past three years.⁴⁰ No use of glass aggregate was reported. There is a state contract for recycled glass beads (used in roadway paint) that is administered on a multi-state basis by Maine, with a vendor in Pennsylvania (Potter Industries).

Are the potential results significant? Yes. Ground glass applications hold the potential to create relatively high-value markets for materials that have been historically difficult or impossible to market. In some cases ground glass might replace another waste material. For example, one potential abrasives user said they currently use a material known as "black beauty," that is derived from foundry slag. However, the total market for abrasives is apparently so large that new scrap glass supplies can be used without detrimentally impacting use of these other waste materials. (The market is, however, highly competitive.) While ground glass applications initially will likely involve only mixed-color container glass, they hold potential to be extended to plate glass as well.

Is it likely that targeted companies will make a commitment to pursue the opportunity? Maybe. Ground glass can perform well and provide cost savings that will be attractive to many users.⁴¹ One potential user, an official with a Massachusetts Turnpike Authority equipment depot, expressed great enthusiasm for scrap glass as an abrasive material. On the other hand, market developers in Washington state report great competition within the abrasives market and high resistance to new products, even among government purchasers vested with "environmental purchasing" policies.⁴²

Can supplies be increased at an acceptable quality and price to fuel feedstock conversion projects? Yes. The Strategic Plan suggests that mixed glass supplies could increase from about 11,000 tons per year to about 13,500 tons per year. However, actual supplies are somewhat elastic and could increase over and above this amount if a value-adding market were established. One limiting factor on mixed color supply that has changed since the Strategic Plan was prepared, is the addition of an automated sorter at the main glass beneficiator, CRA Recyclers. This could have the effect of improving the ability to sort glass by color, thus reducing the amount of mixed glass available in the market. However, the one Massachusetts glass processor interested in ground glass for alternative markets, Unical USA, Inc., states they could increase supplies significantly, drawing on out of state recovery if necessary. Glass must be processed to strict specifications to allow use in most ground glass applications, and only Unical, at the moment, seems interested in selling into these markets.

Is the production technology required for the conversion proven and available? Yes, although further testing and demonstrations are likely required. In most cases, including abrasives, processed scrap glass is used directly to replace other materials with no change to the process.

Can feedstock conversion be expected to reduce feedstock costs or have other positive impacts on profitability? Yes. Scrap glass can in most cases provide significant cost savings to users.⁴³

Is there demand for, or at least openness to, recycled content by the product's customers? Maybe. While government purchasing may be especially important to opening this market, there may be resistance from users.

Conclusions and Suggested Actions -- Ground glass applications should be considered a top priority. They hold the potential to create relatively high value-added markets for hard to market materials, starting with mixed-color container glass and possibly later for plate glass too.

Suggested actions should the Chelsea Center pursue this opportunity:

- ✓ Establish a dialog with Unical USA, Inc. in expanding the market for ground glass.
- ✓ Fund independent testing and demonstrations as necessary to document the product in Massachusetts.
- ✓ Prepare case studies documenting experience with abrasives and other ground glass applications in other states.
- ✓ Conduct a study to document the abrasives market and potential users in Massachusetts.
- ✓ Conduct a broad marketing effort promoting conversion among abrasives users.
- ✓ Encourage the Massachusetts Highway Department and other state agencies to specify scrap glass as abrasives and other ground glass products as approved products.
- ✓ Work with Operational Services Division staff to establish glass abrasives as a priority in government purchasing.

#9 -- Use of scrap glass as aggregate in paving and civil engineering projects.

What are the targeted companies and products? Similar to tire shreds or chips discussed under Opportunities #4 and #5 above, glass can be processed for use as a replacement to aggregate in a variety of paving, road construction and civil engineering applications. These uses include road base, cold patch, glasphalt, septic system drainage systems, ventilation systems, landfill cover and others. (Glass aggregate can also be used in production of brick, tiles or cement products, covered under Opportunity #10 below.) The targeted companies are the same as for tire chips, discussed as potentially including as many as hundreds of engineering firms, road and paving and asphalt companies. Additional research is required to better characterize the markets for different applications. Perhaps most important, once again, are Massachusetts state agencies including the Highway Department that can approve and/or use many of these products and the Department of Environmental Protection which regulates many of these applications and can approve *beneficial use determinations*. Both Massachusetts DEP and the Highway Department have formally approved use of processed glass aggregate in many applications.

What past recycling market development efforts have targeted these companies? Market developers have long promoted glass as aggregate. See the discussion of ground glass under opportunity #8.

Are the potential results significant? Yes. Using glass as aggregate in various applications can help create a market for hard-to-market materials that are currently often landfilled, including mixed color container glass and plate glass. Most aggregate uses, however, are very low value compared to recycling glass into containers or abrasives and other ground glass applications, and should be viewed as a market of last resort for the lowest quality material.

Is it likely that targeted companies will make a commitment to pursue the opportunity? Maybe. In certain applications such as drainage medium, landfill ventilation and cover and road base, glass can perform well and, if suppliers are willing to sell it at a competitive price, it is likely that at least some users will likely be open to experimenting with it. Several landfill operators have already used scrap glass as cover and in drainage applications.

Can supplies be increased at an acceptable quality and price to fuel feedstock conversion projects? Yes. See discussion of ground glass under opportunity #8.

Is the production technology required for the conversion proven and available? Yes. A tremendous amount of work has been documented testing and demonstrating all types of glass aggregate products.

Can feedstock conversion be expected to reduce feedstock costs or have other positive impacts on profitability? No. In most applications glass suppliers will be hard-pressed to compete with existing products on price.

Is there demand for, or at least openness to, recycled content by the product's customers? Maybe. Many potential users will be open to experimenting with glass. Proponents argue that once users see the performance and cost advantages of processed glass aggregate, they will use it in large quantities.

Conclusions and Suggested Actions -- Glass as aggregate should be considered a low priority. Like ground glass, it has potentially significant results, but it is far less economically attractive to scrap glass suppliers and is therefore more challenging to succeed. Where landfilling is the only alternative and a source of glass is available, such as mixed color residue from processing facilities, aggregate uses may be desirable. However, the Chelsea Center should focus on higher value uses like abrasives.

Suggested actions should the Chelsea Center pursue this opportunity:

- ✓ Establish a dialog with Unical USA, Inc. Glass and other potential suppliers to promote glass aggregate uses.
- ✓ Target non-roads applications such as drainage and ventilation medium while monitoring developments and potential opportunities at Massachusetts Highway Department.

- ✓ Document case studies, experiences and benefits of glass-as-aggregate in Massachusetts and other states.
- ✓ Solicit proposals to fund conversion projects from Massachusetts companies, covering testing, demonstration and other assistance.
- ✓ Broadly market the opportunity and the funding solicitation to engineering firms, landfill operators, septic system contractors and other appropriate companies.

#10 -- Use of scrap glass by brick, tile or concrete manufacturers.

What are the targeted companies and products? Scrap glass can also be used as aggregate in brick, tile or concrete products. According to the Strategic Plan, Massachusetts is home to six ceramic and wall tile manufacturers and four brick manufacturers. A search of the Chelsea Center manufacturers database showed 14 businesses classified as SIC 3271, Concrete Block and Brick, as well as 62 companies classified in SIC 3272, Concrete Products, Except Block and Brick. These companies could potentially replace a portion of their current aggregate materials with glass. Glass can also provide a decorative component to brick and tile, in addition to structural qualities typically associated with aggregate.

What past recycling market development efforts have also targeted these companies? Like the other glass opportunities, a wide range of market development activity has encouraged use of glass aggregate in these products. (See Opportunity #8.) Several companies have investigated or are operating as dedicated recycled glass tile manufacturers. This report investigates the use of scrap glass in existing companies currently using stone, sand and other feedstock and does not consider dedicated recycled glass tile production. The Chelsea Center has had discussions in the past with Futuristic Tiles, a non-Massachusetts company with a proprietary technology for producing recycled glass tiles and with Great Harbor Designs, a recycled glass tile producer in New York.

Are the potential results significant? Yes. Potentially large quantities of glass could be used. (See discussion under Opportunity #8.)

Is it likely that targeted companies will make a commitment to pursue the opportunity?

No. There is likely to be little interest in experimenting since producers are long accustomed to traditional feedstocks that are cheap and plentiful. Additional research is required to further explore opportunities among Massachusetts companies and, specifically, to investigate the use of glass as a decorative additive in brick and tile products.

Can supplies be increased at an acceptable quality and price to fuel feedstock conversion projects? Yes. See Opportunity #8.

Is the production technology required for the conversion proven and available? No. While some research and demonstrations have been completed, there is little if any commercial production of brick or concrete using scrap glass in the U.S. While glass tiles are produced, they are produced in dedicated recycled glass tile plants, not in traditional ceramic tile plants. Producers could likely develop viable technology systems, but testing and demonstration is surely necessary.

Can feedstock conversion be expected to reduce feedstock costs or have other positive impacts on profitability? Maybe. The Strategic Plan suggests that brick and tile producers would gain a significant economic advantage from using recycled glass aggregate through reduced feedstock costs. However, generally, the feedstock used for brick, tile and concrete is cheap and plentiful and recycled glass will need to compete at a relatively low price that may press suppliers' profitability. Using glass as a decorative characteristic may enhance certain product lines, but additional research is required to evaluate the economics of such uses.

Is there demand for, or at least openness to, recycled products by the product's customers? Maybe. Most consumers of brick, tile and concrete are driven strictly by performance and cost, and beyond that are probably oblivious to the composition of these products. One exception is structural products purchased by engineers or architects and scrutinized for performance characteristics. Another type of exception is architects involved in "green building" projects who may have a preference for recycled content products. Additional research is required to characterize the Massachusetts market for recycled brick, tile and concrete products.

Conclusions and Suggested Actions -- Brick, tile and concrete should be considered a low priority. Like glass aggregate in roads and civil engineering applications, this opportunity is far more challenging than ground glass applications, even though it does hold promise for significant results. Unlike roads and civil engineering applications, it is less proven and could be significantly more economic.

Suggested actions should the Chelsea Center pursue this opportunity:

- ✓ Enlist support from Unical USA, Inc. in opening glass aggregate markets (and invite other potential suppliers to participate).
- ✓ Target the addition of new lines of glass-containing products at existing facilities that compete in high-end markets.
- ✓ Document case studies, experiences and benefits of glass-as-aggregate in Massachusetts and other states.
- ✓ Solicit proposals to fund feasibility studies for adding new glass-containing product lines from existing Massachusetts companies.
- ✓ Narrowly market the opportunity and the funding solicitation to the small number of brick, tile and cement producers in Massachusetts and follow-up with personal phone calls or visits.

4. ANALYSIS AND RECOMMENDATIONS

This chapter consolidates and compares the findings for each of the opportunities evaluated in the previous chapters and presents recommended priorities and strategies for future Chelsea Center feedstock conversion efforts.

Comparative Analysis of Opportunities

Table One summarizes and compares the findings for each feedstock conversion opportunity. Following are some key findings:

- ✓ The Chelsea Center's past and current efforts are already successfully driving many feedstock conversion activities. Specifically, by funding research, product testing, demonstrations and educational workshops, the Center is providing the essential work required in order to implement feedstock conversion opportunities such as civil engineering applications for tires and use of mixed wastepaper by low-grade paper mills.
- ✓ A necessary condition for the feasibility of feedstock conversion is often a supplier's willingness to develop new product lines and market them to new customers. For each feedstock conversion opportunity considered in this report, there exists one or more recycled material supplier interested in working with the Chelsea Center on feedstock conversion projects.
- ✓ Some opportunities, notably use of scrap textile shoddy by nonwovens producers (#3), use of crumb rubber in molded products (#6) and polymer/rubber blends (#7) require additional research to better understand the markets, potential companies who could convert and the demand for recycled content products.
- ✓ At least two opportunities have a high probability of success in the short-term (civil engineering uses for tires, #4 and ground glass applications, #8).
- ✓ Support from other state agencies, especially the Department of Environmental Protection and the Massachusetts Highway Department, is critical to the success of several feedstock conversion opportunities.

Table 1. Summary Comparison of Feedstock Conversion Opportunities

Opportunity	Significant Results?	Commitment Likely?	Supply Available?	Proven Technology?	Economic Incentive?	Demand Driven?	Recommended Priority
1. Board, tissue & medium mills (mixed wastepaper)	Maybe	Maybe	Yes	Yes	Yes	Yes	Medium
2. Specialty & printing & writing mills (recycled market pulp)	Maybe	No	Probably	Yes	Yes	No	Low
3. Nonwoven textile producers(shoddy)	Yes	No	Yes	Yes	Yes	No	Medium
4. Civil engineering projects (whole tires, shreds or chips)	Yes	Yes	Yes	Yes	Yes	Yes	High
5. Roads & paving (crumb rubber)	Yes	No	Yes	Yes	Maybe	No	Low
6. Molded products (crumb rubber)	Maybe	Yes	Yes	Yes	Yes	No	Medium
7. Polymer applications (crumb rubber)	Maybe	Maybe	No	Maybe	Maybe	Maybe	Medium
8. Ground glass applications (scrap glass)	Yes	Maybe	Yes	Yes	Yes	Maybe	High
9. Paving & Civil engineering applications (glass aggregate)	Yes	Maybe	Yes	Yes	No	Maybe	Low
10. Brick, tile & cement (glass aggregate)	Yes	No	Yes	No	Maybe	Maybe	Low

Recommended Priorities

Table One summarizes the recommended priority ranking for each feedstock conversion opportunity. The rankings of high, medium or low, are described below:

High Priority -- These are opportunities that the Chelsea Center should definitely pursue. Based on the evaluation criteria used in this report, they appear to be prime candidates for success. They can yield significant results, and the Chelsea Center, in combination with other Massachusetts organizations and companies, is well positioned to promote them.

Medium Priority -- These are opportunities that the Chelsea Center should consider pursuing, depending on the availability of resources for feedstock conversion. They could potentially yield significant results, but are more challenging and less likely to succeed than the high priorities. In general, additional research or market development assistance is required to improve the feasibility of feedstock conversion projects, based on the evaluation criteria used in this report.

Low Priority -- These are opportunities that the Chelsea Center should not pursue at this time. They have a low probability of success and/or have potential results that are uncertain or insignificant.

These priority rankings are based on an evaluation considering the full range of businesses and products involved in each opportunity. However, circumstances vary, and it is always possible that a particular company not contacted for this report may be in a position to capitalize on an opportunity more favorably than this general analysis would predict. Consequently, the Chelsea Center should use these priorities to allocate scarce resources towards overall feedstock conversion efforts. However, the Center should remain open to proposals from any company that can demonstrate that it satisfies the evaluation criteria.

Recommended Strategies

The feedstock conversion strategies below represent this report's overall recommendations. They were developed by consolidating the specific actions suggested in Chapter Three and by considering the full range of comments, suggestions and information gleaned while researching this report. The recommended strategies are intended to form a single, coherent approach to promoting feedstock conversion that can be sustained over time, even as the Chelsea Center's priorities for targeted conversion projects change. Consistent with the priority rankings discussed above, it is recommended that the Center apply these strategies in the short-term to the two high priority feedstock conversion opportunities and, as resources allow, also to the four medium priority opportunities as identified above.

Strategy #1 -- Continue to issue funding solicitations to support any type of feedstock conversion project that satisfies the evaluation criteria.

Funding solicitations specifically targeting feedstock conversion projects provide an excellent incentive for companies to actively pursue feedstock conversion and to address their unique concerns and circumstances, for example, conducting product testing or demonstrations, researching equipment needs, economics or markets. The most desirable feedstock conversion projects are those developed by a particular company that satisfy all six evaluation criteria described in Chapter Two, and that include an unequivocal commitment by both management and production staff. The Chelsea Center should remain open to proposals from any company in a position to effect feedstock conversion, while putting extra effort into marketing the solicitations to its top and/or medium priority opportunities. Solicitations may be sent to manufacturing consultants as well, to broaden the range of opportunities and projects. (See Strategies #2 and #3 below.)

Strategy #2 -- Maintain a prioritized list of targeted companies that could choose to convert to recycled feedstock.

The evaluations of each feedstock conversion opportunity in Chapter Three describe the targeted companies that could choose to convert to using recycled feedstock. The list of companies for opportunities #1 and #2, involving the relatively small number of Massachusetts paper mills, is

very straightforward. For each of the remaining opportunities considered in this report, SIC categories are identified for the targeted companies and the Chelsea Center could easily develop a list of businesses by searching its manufacturers database. Some of these lists are fairly large, however, and could be refined through additional research. For example, although this report identifies the SIC categories assigned to engineering firms, it is likely that only a portion of these firms are likely to be involved with the recycled glass and tire products being considered. In each case, the Center can work with the potential recycled materials suppliers to identify which types of firms are most likely to be candidates for conversion.

Strategy #3 – Aggressively market funding solicitations and technical information to companies targeted for feedstock conversion.

The Chelsea Center should make a special effort to market any future feedstock conversion funding solicitations to the companies targeted for feedstock conversion. (See Strategy #2 above.) In addition to mailing them the solicitation, the Center can enlist marketing support from the potential recycled materials suppliers (e.g., Unical Glass, Inc., Routhier Tire, Inc., Mill Tex or wastepaper processors) and end-users. Other marketing opportunities include advertising in industry trade publications, posting to industry web sites, attending conferences and even direct phone calls to candidate firms.

Strategy #4 -- Package and disseminate case studies and technical information on feedstock conversion opportunities.

A tremendous amount of information is available through the Chelsea Center and other sources throughout the country on many of the targeted feedstock conversion opportunities. Through its many research, demonstration and testing projects, the Chelsea Center is contributing greatly to this base of information. For those feedstock opportunities that appear to be most feasible (e.g., the two opportunities identified as high-priority in this report) the Chelsea Center should compile: a) short case studies of existing companies that have converted (these can be found through the customers of Massachusetts recycled material suppliers or from other state market developers); b) short flyers documenting the economic and technical feasibility of conversion; c) a bibliography of information sources; and d) a list of resources available to assist in evaluating and implementing conversion. These information materials can be disseminated via the channels identified for funding solicitations above under Strategy #2. Additional marketing channels include workshops (jointly sponsored by trade associations or other appropriate organizations); partnerships with training programs already recognized by the targeted industry, presentations at industry conferences, and the Chelsea Center web site.

Strategy #5 – Continue to implement a range of market development strategies to help establish the market conditions conducive to feedstock conversion.

Experience in other states shows that, unless considerable up-front work is completed, broad-based feedstock conversion efforts targeting hundreds of companies in the hopes of ultimately securing commitments from one or two are highly resource intensive and prone to failure. As a general rule, prior to aggressively targeting an industry sector for feedstock conversion, it is important to take the time to document the technical and economic characteristics of feedstock

by conducting demonstrations, researching markets and building relationships with key companies critical to success. Broad, industry-wide feedstock conversion efforts should be reserved for those industry sectors that appear to be ripe for conversion (e.g., the two high priority opportunities identified in this report). Again, the Chelsea Center's current actions already support this strategy.

Strategy #6 – Enlist support from recycled material suppliers to promote feedstock conversion.

Recycled material suppliers, for example, Unical USA, Inc, Routhier Tire, Mill Tex or the state's many wastepaper processors, are natural and essential partners in feedstock conversion efforts. The Chelsea Center should continue to develop strong working relationships with these and other interested firms and enlist their support in marketing funding and other services to companies targeted for conversion. The Chelsea Center could consider formalizing these relationships by establishing a network of organizations and companies with specific feedstock conversion objectives. A formalized network could help to raise the profile of efforts by providing a basis for issuing press releases and otherwise publicizing efforts. The objectives may be quantitative (e.g., to increase Massachusetts sales of ground glass abrasives by 5,000 tons per year) or qualitative (to increase awareness and acceptance of ground glass abrasives by potential users).

Strategy #7 -- Continue to coordinate with state agencies to assist companies to secure regulatory approvals, promote procurement contracts and access assistance programs.

Massachusetts is fortunate to have dedicated recycling market development staff in three critical agencies: the Department of Environmental Protection, the Highway Department and the Operational Services Division. In particular, the Massachusetts Department of Environmental Protection and the Massachusetts Highway Department are both in a position to help drive the top priority opportunities. This may be done by clarifying and streamlining the approval process and by encouraging procurement of tire shreds or chips in civil engineering applications and ground glass products like abrasives. Where feasible and where opportunities arise, the Chelsea Center should continue to coordinate with these programs to help potential suppliers and state customers to meet and explore the potential for purchasing contracts. The Operational Service Division's pilot purchasing program is a particularly useful program for initiating procurement of new recycled products. The Recycling Market Development Steering Committee provides one vehicle for this coordination and the Northeast Recycling Council provides a vehicle for coordination on a regional basis.

Strategy #8 -- Encourage purchasing commitments from large, private purchasers.

While product marketing is properly the domain of producers, the Chelsea Center should be on the look-out for particular opportunities where their influence may help to encourage large contracts that can serve as an anchor for feedstock conversion. For example, a single large purchasing contract by an automobile parts producer might encourage a particular nonwovens producer to begin to produce recycled content padding or insulation products. Logical partners in such efforts include the Operational Services Division, the Department of Environmental Protection, the Northeast Recycling Council and the state and national Buy Recycled Business Alliances.

Strategy #9 -- Monitor developments affecting feedstock conversion opportunities.

The Chelsea Center should periodically review its list of targeted feedstock conversion opportunities and priorities and the strategies it is employing. Since recycling markets are regional and market developers are active in neighboring states, the Center should consider co-organizing a regional forum to review opportunities in conjunction with the Northeast Recycling Council.

Because of the importance of the paper industry to the state's economy and to recycling markets, and because of the relatively small number of mills, the Chelsea Center should specifically contact paper mill managers on an annual basis. The goals of these contacts include building and maintaining relationships, updating information on market conditions and gauging interest in feedstock conversion opportunities #1 (mixed paper in tissue and board mills) and, to a lesser extent, #2 (recycled market pulp in high-end mills).

5. NOTES

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- ¹ Additional team members include Andrew Reamer & Associates, Peter Engle and Sustainable Solutions.
- ² The Strategic Plan also includes feedstock conversion opportunities involving mixed plastics. They are not included here since the Chelsea Center is exploring them through a separate contract.
- ³ These figures are from the Strategic Plan, Phase Two Report, Page 34. The number and type of mills in existence, operating and idle is constantly in flux and, consequently, there are many contradictory assessments. Some recent/expected developments since 1998 include the closure of a printing & writing mill in Russell, the closure of a Fitchburg recycled market pulp mill, its sale and its planned reopening in 2002 as a paperboard mill.
- ⁴ *Turning Wastepaper Into Jobs*. Prepared by the Industrial Services Program for the Massachusetts Department of Environmental Protection. February 1996.
- ⁵ *Technical Report #4: Paper Mill Recovered Wastepaper Survey*. Prepared for the Chelsea Center by Gary Diadone, Merrimack Valley Manufacturing Partnership. June 1998.
- ⁶ *Technical Report #15: Creative Wastepaper, Inc. Wastepaper Recovery Project*. Prepared by Gary Diadone, Merrimack Valley Manufacturing Partnership, for the Chelsea Center. February 2000.
- ⁷ *Technical Report #9: Erving Paper Dispersion Pilot Project*. Prepared by Erving Paper for the Chelsea Center. March 1999.
- ⁸ The efforts in Minnesota are documented in *Final Report: Current and Potential Residential Mixed Paper Use at Mills In and Around Minnesota* (and associated technical documents). Prepared by Moore & Associates for the Minnesota Office of Environmental Assistance. April 1999. Randall Coburn, Manager, Empire State Development discussed New York's paper feedstock conversion efforts during a telephone interview on June 20, 2000.
- ⁹ Telephone discussion with Bob Heffernen, North Shore Fiber on June 21, 2000.
- ¹⁰ Telephone conversation with Jeff Comeau, Natick Paperboard, on June 21, 2000.
- ¹¹ Telephone conversation with Jeff Heffernen, North Shore Fiber, Inc., June 22, 2000.

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- ¹² See note #3.
- ¹³ *2000 Lockwood-Post's Directory of the Pulp, Paper and Allied Trades*. Published by Miller Freeman. 2000.
- ¹⁴ Telephone conversation with Dale Gubbels, Sirius Pulp, June 16, 2000.
- ¹⁵ Telephone conversation with Bill Moore, Principal, Moore & Associates, June 22, 2000.
- ¹⁶ Definition provided on the web site of INDA, the International Nonwovens and Disposables Association.
- ¹⁷ Standard Industrial Classification codes, frequently abbreviated as SIC codes, are used to classify all operating businesses in the U.S. The SIC system is currently transitioning to the North American Industry Classification System (NAICS) which is harmonized with Mexico and Canada. As of the writing of this report, most databases and economic statistics are still available using the SIC system.
- ¹⁸ The SIC codes searched were: SIC 2261, Finishers of Broadwoven Fabrics & Cotton; SIC 2262, Finishers of Broadwoven Fabrics; SIC 2269, Finishers of Textiles, SIC 2273, Carpets and Rugs; SIC 2295, Coated Fabrics, Not Rubberized, SIC 2297, Nonwoven Fabrics; SIC 2299, Textile Goods, Not Elsewhere Classified; 2392, Miscellaneous Fabricated Textile Products; and SIC 2399, Fabricated Textile Products, Not Elsewhere Classified.
- ¹⁹ *Technical Report #17: Recycling and Reuse of Mixed-Fiber Fabric Remnants*. Prepared for the Chelsea Center by Professor Kenneth Langley, University of Massachusetts Dartmouth.
- ²⁰ Telephone conversation with Mike Greenway, BBA Nonwovens, March 28, 2000.
- ²¹ See note 19.
- ²² Telephone conversation with Barry Kline, Mill Tex, on June 12, 2000.
- ²³ This conclusions was supported by virtually every textile industry person consulted.
- ²⁴ See note 20.
- ²⁵ Ibid.
- ²⁶ These numbers were developed by running a search on American Business Systems for Massachusetts businesses in SIC 8711, within the following extended 2-digit classifications: SIC 8711-05, General Contractors(7 businesses); SIC 8711-06, Engineers (94 businesses); SIC 8711-10, Civil Engineers (416 businesses); SIC 8711-13, Drainage (0 businesses); SIC 8711-20, Environmental Engineers (223 businesses); SIC 8711-23, Municipal (0 businesses); SIC 8711-38, Sanitary Engineers (95 businesses); and SIC 8711-59, Waste Water Treatment (3 businesses).
- ²⁷ *Technical Report #2: Environmental Impacts of Recycled Rubber in Light Fill Applications*. Prepared by Helen S. Liu, et al. University of Massachusetts Lowell for the Chelsea Center. August 1998.
- ²⁸ *Technical Report #12: Preliminary Investigation of Tire Shreds for Use in Residential Subsurface Leaching Field Systems*. Prepared by Sukalyan Sengupta and Heather Miller, University of Massachusetts Dartmouth for the Chelsea Center. October 1999.
- ²⁹ This conclusion was supported in conversations with the following: Michael Blumenthal, Scrap Tire Management Council (June 23, 2000); Randy Coburn (June 13, 2000); Carmen Chevy (June 22, 2000); Thomas Ferreira, F&B Enterprises (June 21, 2000); and George Camougis, consultant to Routhier Tire (June 16, 2000).

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- ³⁰ Beneficial Use Determination #BWPSW13 was issued by the DEP to Commonwealth Recycling (without a date) and includes the following civil engineering applications for tire chips: playground & equestrian track surfaces; drainage material; lightweight fill; and alternative landfill applications.
- ³¹ Telephone discussion with Sean Griffin and Steve Corr, Massachusetts Department of Environmental Protection, June 23, 2000.
- ³² See note 28.
- ³³ Telephone conversation with Michael Blumenthal, Scrap Tire Management Council, June 23, 2000.
- ³⁴ Written comment from Steve Long, Massachusetts Department of Environmental Protection.
- ³⁵ Telephone conversation with Michael Blumenthal, Scrap Tire Management Council, June 23, 2000.
- ³⁶ Telephone conversation with Jack Bailey, Acushnet Rubber, June 12, 2000.
- ³⁷ Telephone discussion with Randall Coburn, June 16, 2000.
- ³⁸ *Technical Report #18: Development of Novel Applications for Using Recycled Rubber in Thermoplastics.* Prepared by H.S. Liu, et al, University of Massachusetts Lowell for the Chelsea Center. March 2000.
- ³⁹ Bob Kirby, and independent consultant formerly with the Clean Washington Center, is currently completing a report summarizing TriVistro's recent experience working to access the abrasives market.
- ⁴⁰ *Recycling and Pollution Prevention Report: 1999 Update.* Massachusetts Highway Department. November 1999.
- ⁴¹ Telephone interview with Bob Kirby, independent consultant, June 16, 2000.
- ⁴² Bob Kirby, Independent Consultant, email correspondence, July 8, 2000.
- ⁴³ Ibid.

APPENDIX A

LIST OF PERSONS INTERVIEWED

Michael Alexander, Northeast Recycling Council
Chuck Allen, International Nonwovens and Disposables Association
Cynthia Andela, Andela Tool & Machine
Jean Andrews, Stiles & Hart Brick Company
Jack Bailey, Acushnet Rubber
Cynthia Barakatt
Michael Blumenthal, Scrap Tire Management Council
Bernard Brill, Textile Recycling Council
George Camougis, Consultant to Routhier Tire
Carmen Chevy, Commonwealth Recycling
Randy Coburn, New York Empire State Development
Jeff Comeau, Natick Paperboard Company
Steve Corr, Massachusetts Department of Environmental Protection
Aaron Davis, American Reclamation Corporation
Ken Dekoto, Haverhill Paperboard Company
Betsy Dorn, Dorn & Associates
Randy Ellithorpe, Bay State Paper
Peter Engel, Independent Consultant
Thomas Ferreira, F&B Enterprises
Mike Greenway, BBA Nonwovens
Sean Griffin, Massachusetts Department of Environmental Protection
Dale Gubbels
Bob Heffernen, North Shore Fiber/Newark Group
Fred Hooper, Materials Technology Center/AMREC
Dana Humphrey, University of Maine
Jennifer Hyde, Hyde & Associates
Bob Kirby, Independent Consultant
Robert Kirby, Independent Consultant
Barry Kline, Mill Tex
Ken Langley, University of Massachusetts Dartmouth
Jessica LeBlanc, Massachusetts Highway Department
Michael Ledger, Bacon Felts
Steve Long, Massachusetts Department of Environmental Protection
Bob Mantyla, Talbert Trading Company
Joey Mead, University of Massachusetts Lowell
Bill Moore, Moore & Associates
Michael Pirolli, P&M Brick & Block Company
Chuck Potash, Crown Vantage, Inc.
Andy Reamer, Reamer & Associates
Bob Reindeau, Unical USA, Inc.
John Reindl, Dane County, Wisconsin
Diane Routhier, Routhier Tire
Jerry Rudd, Byron Weston Company
Bill Ruggieri, Container Recycling Alliance
Brian Smith, Fibermark
Allen Tunnelli, North Carolina College of Textiles
Francis Vicino, Hi-Way Concrete Products Company
Jim Whaling, National Fiber
Art Wyman, Massachusetts Turnpike Authority
Alice Yates, Massachusetts Development

APPENDIX B

COMPARISON OF THIS REPORT WITH THE STRATEGIC PLAN

Comparison of Feedstock Conversion Opportunities Identified

Most of the feedstock conversion opportunities defined in this report correspond directly to those discussed in the Strategic Plan. There are, however, some differences. The following notes clarify how certain opportunities were handled:

- Textiles into insulation or cement -- The Strategic Plan suggests textile shoddy could be used by insulation or cement manufacturers, based on a brief suggestion by Ken Langley of the University of Massachusetts Dartmouth made during workshops. The insulation reference is apparently to formed insulation used in upholstery or automotive applications such as in trunks, and is subsumed within the broader category of nonwovens examined in this report. The cement reference is based on research reports, which could not be identified or further substantiated. Consequently this report does not consider that use.
- Range of markets in certain applications – This report defines some of the feedstock opportunities in terms of broad applications, and then concentrates on a small number of specific markets. For example, although it examines the broad category of ground glass applications, it focuses on abrasives, since the sole in-state supplier of glass for these applications is aggressively targeting this market. This was necessary given limited resources for the investigation.
- Crumb rubber in polymer applications -- This was not mentioned in the Strategic Plan. It was included in this report based on a technical report published by the Chelsea Center suggesting this new, potential market for crumb rubber. Because little information was available about the range of potential users, this evaluation is somewhat less complete than others.

Comparison of Recommendations

The Strategic Plan suggests a broad, two-prong strategy to promote feedstock conversion opportunities. First, improve the economics of recycled product production by disseminating information, funding research and demonstrations, and by providing technical and financial assistance. The Chelsea Center's many programs are already doing this, and since the Plan was completed the Center has targeted many efforts to promoting the feedstock conversion opportunities identified in the Strategic Plan. The second recommended strategy is to promote expansion of markets for recycled content products among "green consumers." The Center has focused here on State purchasing. The Plan also recommended five actions:

1. Compile and periodically update a list of Massachusetts' manufacturers who could potentially decide to convert and gather qualitative and quantitative information on manufacturing processes through surveys and interviews.

2. Prioritize the list of candidate conversion projects and launch an aggressive information dissemination campaign, including: marketing the benefits of feedstock conversion to businesses and to local & state economic developers; maintaining a one-stop source of up-to-date information on feedstock conversion challenges; and providing tools to businesses interested in feedstock conversion such as check lists and conversion steps.
3. Use the Recycling Industries Reimbursement Credit Program to promote feedstock conversion.
4. Promote feedstock conversion as a "green marketing" opportunity by documenting markets and price advantages for recycled products.
5. Continue to provide feedstock conversion grants targeting small businesses.

These actions are defined at a very broad level in the Strategic Plan. In effect, this report completes portions of Action #1 and Action #2 by describing how the Chelsea Center can assemble a database of contact information for feedstock conversion prospects (using its existing in-house database of Massachusetts companies) and by recommending priorities. My recommended priorities and strategies presented in Chapter Four can be viewed as recommended revisions to the Two strategies recommended in the Strategic Plan. My recommendations differ for three reasons: 1) They are based on up-dated information that in some cases contradicts premises used in the Strategic Plan (for example, the Strategic Plan assumed the Fitchburg mill would restart as a recycled market pulp mill, whereas it is being retooled as a board mill); 2) They are based on a more in-depth evaluation of specific feedstock conversion opportunities than was possible in the Strategic Plan, since it considered the entire spectrum of materials and market development opportunities; and 3) as a distinct analyst, the author of this report brings a different set of experience and biases to the effort. Specifically, broad research and efforts to document "green markets" tended to be discounted, since the author believes this is rarely an effective driver for recycled product producers in the absence of strong economic fundamentals. The exceptions to this rule are the State of Massachusetts itself and certain private markets like green buildings and automobile products, which are well-positioned to single-handedly drive several of the feedstock conversion opportunities through dedicated green purchasing.