

**RECYCLING AND ECONOMIC DEVELOPMENT:  
A PLAN FOR A COMMUNITY VENTURE**

by

Joel Laevin Weiner

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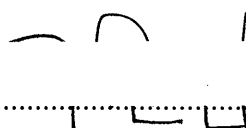
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
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
Signature of Author.....

  
Joel Laevin Weiner  
Department of Urban Studies and Planning  
May 22, 1995

Certified by.....

  
Lawrence Bacow  
Professor, Department of Urban Studies and Planning  
Thesis Supervisor

Accepted by.....

  
Langley Keyes  
Professor, Department of Urban Studies and Planning  
Chairman, MCP Committee

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## **ABSTRACT**

The last three decades in the United States have been marked by a period in which societal needs have increased at a rate greater than this country's resources. In this climate, community-based recycling has been presented as a joint solution to two of society's principal problems: the need to address issues concerning the environment and the need to stimulate economic development in low-income communities.

Two shifts in public policy have precipitated the interest in recycling as a means of generating economic development. First, the emphasis of state recycling programs has shifted from the supply side to the demand side of recycling. Second, there has been a shift in economic development policy from a top-down approach of programs administered by the federal government to an approach that places greater emphasis on local economic development strategies.

This thesis explores the opportunities for recycling to generate economic development by presenting a plan for a community-based, recycling-related venture; specifically, the processing of scrap tires into crumb rubber which can then be used in a variety of new products.

In the case of business development, if the benefits are to be fully realized and sustained, the venture should be profitable or offer considerable job creation. If not, there is little difference between these operations and any number of social and environmental programs dependent on outside sources for support.

Thesis Supervisor: Larry Bacow  
Professor  
Department of Urban Studies and Planning



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## INTRODUCTION

The last three decades in the United States have been marked by a period in which societal needs have increased at a rate greater than this country's resources. This has been demonstrated by the growing number of social programs in competition for a decreasing amount of government support. In this climate, community-based recycling has been presented as a joint solution to two of society's principal problems: the need to address issues concerning the environment and the need to stimulate economic development in low-income communities.

The opportunities of community-based recycling have been promoted by a number of advocacy organizations, including the Institute for Local Self-Reliance and the Center for Neighborhood Technology.<sup>1</sup> They have presented recycling as environmentally responsible with the potential to generate significant economic development. According to these organizations, the collection, processing and remanufacturing of recyclables offers the potential to diminish the local waste stream, reduce the costs associated with waste disposal and decrease demand for virgin materials.<sup>2</sup> They further argue that recycling in cities offers the potential for job creation and increased income, increased tax revenue and other benefits associated with the value added to materials that would otherwise be incinerated or landfilled, or exported to other regions to be processed and manufactured into new products.<sup>3</sup>

Communities have begun to take notice. For over a decade community-based organizations have been involved in both the collection of recyclables, typically through drop-off centers, and in the initial sorting of the recyclable materials collected. In most cases, these programs have met with the active support of local government. Recently, community-based organizations have begun to investigate opportunities of using recycled materials as a feedstock in the manufacturing of new products, a process commonly referred to as scrap-based manufacturing or remanufacturing. Remanufacturing adds additional value to the recyclables and offers the potential for greater job creation.

Two shifts in public policy have precipitated the interest in recycling as a means of creating economic development. First, the emphasis on state recycling programs has shifted from the supply side to the demand side of recycling.

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<sup>1</sup>Reports issued by these organizations include: Institute for Local Self-Reliance (ILSR), Recycling Economic Development Through Scrap-Based Manufacturing (Washington, DC: ILSR, 1994); Center for Neighborhood Technology (CNT), "No Time to Waste," The Neighborhood Works, (special issue) 1989; and CNT, "Beyond Recycling: Materials Reprocessing in Chicago's Economy," The Neighborhood Works, (special issue) 1993.

<sup>2</sup>Recycling Economic Development 10

<sup>3</sup>No Time to Waste 5-11.

Specifically, states, which initially focused on the collection of recyclables, are now focusing on the development of markets for these materials. Second, there has been a shift in economic development policy from a top-down approach of programs developed and administered by federal and state government to an approach that places a greater emphasis on the development of local economic development strategies.

This thesis explores the opportunities for recycling to generate economic development by presenting a plan for a community-based, recycling-related venture; specifically, the processing of scrap tires into crumb rubber which can then be used in a variety of new products. The plan can be found in Chapter Three and includes a description of the business, a discussion of the industry, a detailed analysis of the market and a financial plan for the venture. The chapter concludes with an evaluation of the business.

Earlier chapters provide background. Chapter One begins with a section on economic development, including the need for economic development and various means of responding to this need. It continues with an overview of recycling and municipal solid waste (MSW), including a discussion of actions state and local governments have undertaken to manage MSW, such as recycling. Chapter One concludes with a discussion of job creation and recycling, including examples of organizations that have turned to recycling as a means of generating economic development. Chapter Two provides a detailed description of the scrap tire problem in this country, including a summary of various state scrap tire management programs and a general description of the different markets for scrap tires. Chapter Four contains the conclusion, focusing on lessons learned from the evaluation of the projected business.

## Chapter One

### ECONOMIC DEVELOPMENT AND RECYCLING

This chapter begins with an overview of economic development in this country, highlighting the need, various mechanisms to address this need and examples of both state and local efforts to generate economic development. An overview of solid waste and recycling follows, including a detailed discussion of solid waste management, recycling, the issues for which recycling is a response and the shifting focus of recycling policy. The chapter concludes with a discussion of the potential economic impacts of recycling, highlighting research that has been undertaken in support of recycling as a means of generating economic development as well as examples of community-based recycling ventures.

#### I. Urban Economic Development

##### The Need:

According to the 1994 U.S. Statistical Abstract, in 1993 over 8,700,000 people were unemployed (almost 7 percent of the labor force).<sup>1</sup> The rate of unemployment is frequently used by politicians to celebrate the jobs they have created. In serving this role, the number is a gross underestimate of the actual number of people who are either unemployed or underemployed. In addition to the 8.7 million unemployed in 1993, there were another 6.1 million part-time workers desiring full-time employment and over one million people who had given up on finding work altogether.<sup>2</sup> In total, this brings the number of Americans who are unemployed or underemployed to 16 million, or 13 percent of the labor force.

The increasing numbers of unemployed and underemployed provide an incomplete picture of the economic and social changes that have marked this country's history since World War II. To understand fully the state of employment and earnings in this country, it is necessary to consider the industries in which jobs have been lost as well as those industries which have experienced job growth. One industry that represents a declining share of all employment is manufacturing. Between 1960 and 1980 in the U.S.

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<sup>1</sup>United States Bureau of the Census, Statistical Abstract of the United States: 1994 (14th edition.) Washington, DC, 1994: 395.

<sup>2</sup>Jeremy Rifkin, The End of Work (New York: Putnam, 1995) 11.

manufacturing employment declined by 29 percent.<sup>3</sup> Massachusetts alone lost 23.3 percent of its manufacturing jobs between 1988 and 1994.<sup>4</sup> The number of manufacturing jobs is projected to continue to decline through 2005.<sup>5</sup> Some of these jobs have been replaced with employment in the service industry, a sector that has experienced job growth.

Historically, manufacturing jobs were secure, provided a decent wage and benefits as well as the opportunity for advancement, required a low level of skills upon entry and were located in urban areas. Job creation in the service sector, which includes an increase in a mix of professions ranging from attorneys and consultants to garbage handlers and restaurant workers, has not proved to be an adequate replacement for lost manufacturing jobs. This is due in part to the considerable differences among skills required for these jobs (i.e., for service sector jobs that provide a decent wage and opportunity for advancement, a college or professional degree, or some amount of technical expertise is typically required).

Those service sector jobs that require entry skills similar to manufacturing jobs are quite different in most other aspects. Specifically, they are lower paying with fewer benefits, offer less job security and little opportunity for advancement and have, in most cases, followed the migration of Americans out of larger cities. As a result, a number of service jobs remain vacant during this period of high unemployment.

The increasing levels of unemployment and the shift in available jobs impact not only those currently in the labor force, but also young people who are facing this uncertain future. This lack of opportunity is hitting low-income, inner-city residents the hardest, a group that largely consists of minority populations without the necessary skills to be competitive in today's workforce.

In this climate, federal, state and local government, along with foundations and nonprofit organizations, have undertaken a range of programs designed to generate economic development in low-income, inner-city communities. A discussion of select programs and various players active in economic development follows.

### Economic Development Objectives:

Neighborhood revitalization programs have three primary objectives: job creation, fiscal improvement and physical improvement. The emphasis on job

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<sup>3</sup>Edward J. Blakely, Planning Local Economic Development: Theory and Practice (Newbury Park: Sage Publications, 1989) 24.

<sup>4</sup>Jerry Ackerman, "What Price Good Jobs?," Boston Globe 2 April 1995: 75.

<sup>5</sup>1994 Statistical Abstract, 413.



creation is a direct response to the situation outlined above as well as the growing problem of individuals moving out of communities to find work. Economic development attempts to create jobs through both public employment and private-sector job development, with greater emphasis placed on the latter. So important is the objective of job creation that it is often the principal criteria upon which government and foundations base economic development project selection.<sup>6</sup>

Fiscal improvement is another important objective of economic development. Here the emphasis is on increasing tax revenue and strengthening the fiscal position of the community. This is typically achieved through attracting businesses, existing and new, or through the development of upper-income housing, both of which offer greater tax revenue with less demand placed on public services than middle- and lower-income residential property. Increased revenues will directly benefit only the community where the business locates, while any benefits from job creation are likely to be shared by the surrounding communities.

Another objective of economic development is the physical improvement of communities. As large-scale employers left urban areas, many of their former employees followed, as did related businesses. What has remained are abandoned and underutilized buildings, a neglected infrastructure, a reduced tax base and a core disenfranchised population without the means to leave. Increased crime and drug use have taken root in these neighborhoods. An emphasis on physical improvements is driven by the desire to clean up these communities one building, vacant lot and block at a time. With physical improvements, it is argued, these communities will become more attractive to new businesses and residents, and job creation and increased tax revenues will follow.

In general, economic development policy is intended to address market failure; specifically, the failure of private interests to invest capital in certain areas. To encourage this investment, government and foundations provide subsidies to private investors in these communities. Economic development policies also target local residents through programs ranging from job training to micro-lending.

### Strategies:

There are a variety of strategies employed to foster neighborhood economic development. One source has identified three basic approaches, none of which are mutually exclusive: resident-oriented strategies, business-oriented strategies

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<sup>6</sup>John P. Blair, Urban & Regional Economics (Richard D. Irwin, Inc., 1991) 223.

and place-oriented strategies.<sup>7</sup> The approach taken by different communities will depend on, among other things, the nature of the problems that need to be addressed, the resources at their disposal and the expertise within the community to administer these programs. In most cases, a combination of approaches are employed to achieve the overall goal of neighborhood revitalization.

Resident-oriented strategies place an emphasis on the development of human resources in the community and are a reaction to a history of federal social policies that have proven out-of-touch and insufficient in dealing with the variety of problems being faced at the local level. These strategies acknowledge the value of self-sufficiency and utilize a variety of initiatives to increase the capacity of community residents. A partial list of resident-oriented strategies includes job training and education, micro-enterprise development and the development of entrepreneurial skills. Job training is particularly important in light of changing labor markets. Businesses need a highly skilled workforce and are more likely to locate or remain in communities that can provide one.

A business-oriented strategy is primarily concerned with business development through improved access to capital and markets. This strategy is focused on developing and growing local businesses thereby providing residents of these neighborhoods the means to participate in the larger economic arena. The lack of access to capital is the primary barrier low-income communities face in their revitalization efforts. While federal funding of urban economic development programs has been reduced, there are a variety of policies and programs at all levels of government that address exclusively the intense need for capital in low-income communities, primarily through revolving loan funds. Efforts of foundations, nonprofit community organizations and private concerns have also focused on the need for capital as a crucial means to generate economic development. Specific policies and programs are addressed in more detail below.

Additional business-oriented strategies for neighborhood revitalization are centered around the provision of technical assistance, including research and development, referral services and management assistance and, in the case of business incubators, physical space for small, fledgling ventures. These services help reduce the costs of doing business and are particularly valuable to small businesses in their early stages of development. Small start-up ventures are more likely to be working with a limited knowledge base as well as with limited amounts of capital.

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<sup>7</sup>National Council for Urban Economic Development (CUED), Neighborhood Economic Revitalization: Problems and Solutions (Washington, DC: CUED, 1994) 27. (Referred to below as CUED Report)

In addition to those businesses and individuals that are direct beneficiaries of this economic development strategy, the development of new businesses and growth of existing businesses are likely to have a multiplier effect. That is, these businesses and their employees will become consumers in the community, creating a demand for goods and services that can fuel additional business development and job creation. Multiplier effects calculated for a number of manufacturing industries in Chicago range from 1.2 to 3.2; or, for every new manufacturing job, an additional 1 to 3 jobs are created.<sup>8</sup>

A place-oriented strategy is concerned with both the physical and social condition of the community and targets specific areas for revitalization. This is often achieved through high profile partnerships between the community and leading local institutions like universities and hospitals, or through major private developments such as shopping malls and office buildings. Different revitalization incentives that focus on physical improvements include enterprise zones and an emphasis on commercial redevelopment which includes the provision of tax abatements or credits, tax-exempt financing, write-downs<sup>9</sup>, grants, loans, loan guarantees, interest rate subsidies, bond financing and equity financing.<sup>10</sup> These incentives can improve a business' cash flow, reduce a borrower's financing costs, reduce a lender's risk, ease repayment requirements and provide equity capital to entrepreneurs. Other place-oriented strategies include improving infrastructure and transportation linkages and addressing community development through improved security and the organization of citizen groups and neighborhood clean-up drives.

These three economic development strategies are focused almost exclusively on local development (i.e., working to develop the skills of residents, expanding and creating businesses in the community, and improving the physical condition of the community). These local strategies are distinct from economic development programs that place a greater emphasis on business attraction; an approach that is primarily concerned with immediate job creation. Examples of this approach can be found in the recent inter-state competition to attract automobile manufacturing plants, including South Carolina's new BMW plant which cost the state \$68,421 per job and Alabama's recent success in attracting a Mercedes-Benz plant at a cost of \$153,133 per job.<sup>11</sup> In contrast, an emphasis on the expansion and creation of local businesses is typically less expensive though

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<sup>8</sup>Center for Neighborhood Technology (CNT), "Sustainable Manufacturing," The Neighborhood Works, (special issue) 1990: 6.

<sup>9</sup>Write-downs refer to the process of governments selling property to businesses at below-market prices. These properties may have been accumulated through power of eminent domain in areas with deteriorated and abandoned buildings:

<sup>10</sup>Charles Bartsch, "Government and Neighborhoods: Programs Promoting Community Development," Economic Development Quarterly, 2 (1989).

<sup>11</sup>Ackerman 75.

offers a reduced payoff and may involve greater risks in terms of the long-term success of the business.

Another distinction between neighborhood revitalization programs and high-profile efforts at business attraction is that local economic development efforts target assistance to groups that have had only limited access to traditional sources of financing and support. These groups may be defined by geographic area, gender, race or the type of business. In addition to providing needed capital, these local programs are more likely to be sensitive to the specific needs of their community and can tailor their services accordingly. These programs include enterprise zones and women and minority business programs.

The two approaches to economic development, business attraction and local development, present significant tradeoffs among cost, risk and the number of jobs created. They also represent two different philosophies with one focusing on large steps toward the creation of jobs and the other focusing on smaller, community-based approaches to neighborhood revitalization. Regardless, business development is an important step in the revitalization of communities, whether achieved through the attraction of new businesses from outside the community or through the expansion and creation of businesses within the community.

#### Players in Neighborhood Revitalization:

As mentioned above, economic development programs and policies are undertaken by federal, state and local government as well as foundations and nonprofit community development organizations. What follows is an overview of these players and the services they provide.

As the federal government's role in neighborhood economic development has decreased, nonprofit community-based organizations, commonly referred to as community development corporations (CDCs), have organized to fill the gap. In the past, CDCs were primarily concerned with the development and management of affordable housing, but as these organizations have grown they have expanded their roles to better meet the needs of their communities. A recent survey reported that 2,000 CDCs have been responsible for the creation of almost 90,000 permanent jobs.<sup>12</sup>

CDCs are a particularly effective mechanism for revitalizing communities. Specifically, they can provide leadership, coordinate neighborhood opinion, develop public and private financing packages, assist city planners, develop and manage projects, provide technical assistance and work with various interests to

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<sup>12</sup>CUED Report 4.

identify those areas of greatest need and potential within the community. Unlike outside organizations or private investors, CDCs are likely to have the greatest commitment to the redevelopment of their neighborhoods, the active participation of members of their communities and a history of working within their communities to achieve revitalization. In addition to providing their communities with economic development assistance, CDCs themselves are often recipients of funds which they use to develop their own enterprises.

Other essential players in neighborhood economic development are financial institutions and private investors that provide the capital needed for revitalization to occur. This list includes commercial and investment banks, venture capital corporations, insurance companies and the private-public organizations designed to actively assist in the economic development of communities. This group is strongly influenced by government policies that either enhance or limit their ability to make a profit, and, in the case of the Community Reinvestment Act (CRA), policies that mandate the involvement of banks in meeting all the credit needs of the communities where they do business. CRA, in particular, has driven the participation of banks in the redevelopment of low-income communities.<sup>13</sup> Originally this participation was concentrated on housing finance, but as the role of CDCs has expanded, so has the financing of economic development activities under CRA, including loans for commercial developments, small businesses and job training programs.

Another development in the effort to revitalize low-income neighborhoods has been the establishment of nonprofit community-based organizations whose sole purpose is to finance community development. Collectively referred to as community development financial institutions (CDFIs), these programs include credit unions, community development banks, revolving loan funds, micro-loan funds, minority-owned banks and CDCs.<sup>14</sup>

Foundations, too, have a long history of supporting community economic development. This support includes the provision of general funds to CDCs as well as funds targeted for specific developments or programs. Also, larger foundations have undertaken their own efforts to develop policies and programs to aid in the redevelopment of inner-city communities.<sup>15</sup>

While the role of the federal government in neighborhood revitalization has diminished in the last several years, there are still a number of federal programs that provide considerable assistance to economic development efforts. A list of programs includes Community Development Block Grants (CDBGs), the

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<sup>13</sup>Interview with Ed Campbell, NY Office of Recycling Market Development (1/18/95).

<sup>14</sup>CUED Report 9.

<sup>15</sup>An example of this is the Ford Foundation's establishment of the Local Initiatives Support Corporation, or LISC. LISC raises money from corporations and foundations which it then uses to fund CDC projects.

Neighborhood Development Program, and the programs of the Small Business Administration and Economic Development Administration. The CDBG program is administered by the Department of Housing and Urban Development and provides funding for a variety of neighborhood revitalization activities including public services like crime prevention and education; the provision of public facilities like sewer and water service, and neighborhood centers; and business development. Local governments are the recipients of these grants, which they can pass on to CDCs to implement specific programs. The Economic Development Administration, a branch of the Department of Commerce, provides grants for public works projects that will lead to the creation of jobs.

The Small Business Administration (SBA) sponsors a number of programs that assist small businesses. These include a limited amount of direct lending and the provision of loan guarantees as well as management and technical assistance programs. SBA does not target its programs to specific geographic areas or groups, but rather lobbies and provides for the interests of all small businesses.

The federal government is currently involved in an enterprise zone program which has designated nine areas as empowerment zones and 95 as enterprise communities. These zones will receive a combination of tax incentives and grants. The empowerment zones, which include Detroit, New York and Chicago, will receive \$100 million, while enterprise communities, including Boston, will receive less (possibly in upwards of \$70 million). The tax incentives are intended to provide tax relief to businesses located within these zones and to encourage the expansion of businesses into these zones. Other features of the enterprise zone program include a tax credit to employers outside these zones who employ persons who live in the zones and program allowing taxpayers to deduct contributions to select CDCs.

State government also impacts economic development through a variety of programs and policies. Two programs in Massachusetts illustrate the kind of support state's provide local economic development efforts. The first is a series of initiatives undertaken by the Massachusetts Community Development Finance Corporation (CFDC), a quasi-public investment corporation that provides financing for small businesses and real estate projects in low-income communities.<sup>16</sup> Recipients of CFDC funds must be located in communities serviced by CDCs. CFDC's programs include a Venture Capital Fund that provides financing to existing businesses, a Minority and Women Contractor Bond Support Program that provides technical and financial assistance to women and minority building contractors, and an Urban Initiative Fund that

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<sup>16</sup>Massachusetts Community Development and Finance Corporation (CFDC) 1994 Year in Review (Boston: CFDC, 1995).

provides loans and technical assistance to minority-owned businesses as well as grants to nonprofit organizations.

Another program undertaken by Massachusetts designates certain corporations, a category that can include individuals and CDCs, as urban redevelopment corporations. The program, outlined in Chapter 121A of Massachusetts General Laws, exempts eligible organizations from paying property taxes for a period of 15 years on projects that have a "public purpose". Historically, housing has been the primary focus of this program, but more recently economic development projects have been seen as having a public purpose, so eligible for 121A status.<sup>17</sup>

Local government efforts to foster neighborhood revitalization typically focus on business development and job training. In Boston, the Economic Development and Industrial Corporation (EDIC) operates three industrial parks; provides businesses assistance with licensing, permitting and zoning; and, perhaps most importantly, assists businesses of varying size and need with access to financing.<sup>18</sup> The financing is provided through two affiliate agencies that manage a range of programs including the Small Business Fund Program which provides up to \$15,000 in financing and a program that provides tax exempt bonds for industrial development with no limit on the amount that can be borrowed. In addition, EDIC supports a number of education, job training and human service programs.

### Conclusion:

While there are a variety of strategies employed to foster neighborhood revitalization, the objectives of these strategies are the same – the creation of jobs and the fiscal and physical improvement of communities. The need for local economic development has increased as labor markets have shifted leaving low-income, inner-city communities increasingly isolated from job opportunities; a condition resulting from both a lack of necessary skills and the actual movement of potential employers from central cities to the suburbs. In response, efforts have been undertaken to provide inner-city residents with job training and to create employment opportunities within neighborhoods, either through the attraction of existing businesses to communities or through the creation of new local businesses. Increasingly, these services are being delivered by CDCs with government support. CDCs are seen as best able to target assistance to those groups with the greatest need.

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<sup>17</sup>Massachusetts General Laws, Chapter 121A (Boston: Executive Office of Communities & Development).

<sup>18</sup>Economic Development and Industrial Corporation (EDIC) of Boston: General Information (Boston: EDIC).

While governments have been addressing this need for local economic development, they have also been responding to the need to manage increasing amounts of solid waste in a climate where traditional means of waste management have come under attack.

## II. Solid Waste Management

Any discussion of waste should be understood as part of a much larger discussion of the impact humans have on the environment. Waste, defined here as materials for which there is no useful purpose, is a concept that has existed only as long as humans; specifically, since humans first began to trade a life of hunting and gathering for an agrarian-based subsistence.

Before there was waste, there was recycling, or the conversion and reuse of one's discards. It has only been since our ancestors began to settle, during the Stone Age, that the concept of waste came into existence. Discards from increasing numbers began to collect, rather than being left in limited quantity over a large geographic area. These growing settlements, combined with the increased use of bronze, clay, cloth, gold, stone and other materials, contributed not only to the increased concentration of discards, but also to the expanding contents of these discards. The possessions crafted from the clay, bronze and other elements would not decompose like the plant and animal discards, and the extraction and processing of these materials had their own associated discards. Garbage was born.

This section begins with an examination of the recent history of solid waste generation and management in this country, including a discussion of the environmental and political aspects of waste. A discussion of recycling follows, including an explanation of the recycling process and an overview of government recycling programs and benefits of recycling.

### Municipal Solid Waste Generation:

With the exception of brief periods of recession, generation of municipal solid waste (MSW) has increased steadily in this country for as long as anyone has kept track.<sup>19</sup> An increase in population and economic activity (measured in gross domestic product, or GDP) as well as changes in lifestyles are all factors that

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<sup>19</sup>MSW, as it is defined by EPA's *Characterization of Municipal Solid Waste in the United States: 1994 Update*, includes containers and packaging, durable goods, nondurable goods, food scraps, yard trimmings and miscellaneous inorganic wastes from residential, commercial, institutional and industrial sources. MSW does not include wastes from other sources like construction and demolition debris, automobile bodies, municipal sludges, combustion ash and industrial process wastes that might also be disposed in municipal waste landfills or incinerators.



contribute to the generation of MSW. Between 1960 and 1993 in the United States, population grew 1.08 percent per year, GDP grew an average of 2.94 percent per year and MSW generation increased 2.66 percent per year.<sup>20</sup> For MSW, this represents a total increase of almost 120 million tons of residential and commercial solid waste. The total MSW generated in 1993 exceeded 206 million tons, or 4.4 pounds per person per day, and is projected to reach 218 million tons by the year 2000.<sup>21</sup> This number gives the United States the distinction of generating more garbage per year, both per person and in total, than any other nation on earth.<sup>22</sup>

The amount of MSW generated annually is not in itself a problem for society.<sup>23</sup> Rather, it is the disposal of this waste that has proven to be such a difficult and high-profile issue. Historically, MSW has been disposed of in a number of ways, including open air burning, ocean dumping, disposal in unlined landfills and open air dumps, and in polluting incinerators. This began to change in 1965 with the passage of the Solid Waste Disposal Act, the first federal law that required environmentally sound methods for disposal of MSW. The law began as an amendment to the Clean Air Act and was primarily a response to a popular means of waste disposal at the time: open air burning.<sup>24</sup>

As a result of the Solid Waste Disposal Act, which included funding for the research and development of environmentally sound waste disposal methods, open air burning and other of the most environmentally harmful waste-handling practices were severely limited or no longer permitted.<sup>25</sup> Society turned, instead, to burying their waste in landfills. The increased regulation of incinerator emissions facilitated this shift.

Since the Solid Waste Disposal Act, the federal government has passed a number of laws addressing solid waste management, including the Resource Recovery Act in 1970 (which amended the Solid Waste Disposal Act and contained the first nationwide recycling initiative); the Resource Conservation and Recovery Act (RCRA) in 1976; and, amendments to RCRA in 1986 and 1992. While RCRA's primary focus is on the management of hazardous waste, the law has facilitated EPA's involvement in solid waste management, including the development of guidelines for state management of solid waste and the

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<sup>20</sup>United States Environmental Protection Agency (EPA), Office of Solid Waste, Characterization of Municipal Solid Waste in the United States: 1994 Update (Washington, DC: EPA, 1994) 129. (Referred to below as EPA Solid Waste Report)

<sup>21</sup>EPA Solid Waste Report 29 & 105.

<sup>22</sup>Richard Denison & John Ruston, Recycling and Incineration (Washington, DC: Island Press, 1990) 34-35.

<sup>23</sup>The environmental problems of virgin materials extraction is primarily a problem of production and our consumptive society as opposed to a problem of waste. They are, however, related.

<sup>24</sup>United States Environmental Protection Agency (EPA), Office of Solid Waste, Guide to Environmental Issues (Washington, DC: EPA, 1995) 28. (Referred to below as EPA Guide)

<sup>25</sup>Judd Alexander, In Defense of Garbage (Westport: Praeger, 1993) 8.

provision of grants and technical assistance to further assist state and local governments with their efforts in solid waste management.<sup>26</sup>

These regulations have done much to address the most harmful waste disposal practices of the '50s, '60s and '70s, but there remains an ongoing debate about the environmental impacts of the primary means of waste disposal in this country: landfills and incinerators.

### Landfills:

Landfills are open pits in which MSW is dumped. Once filled, they are permanently covered, a process referred to as capping. For the last 33 years, this has been the fate of over 60 percent of MSW discarded annually. In 1993, 62.4 percent of this country's MSW was disposed of in landfills.<sup>27</sup>

The popularity of landfills increased as old, polluting municipal incinerators were shut down. Landfills were thought to represent an improved alternative to dirty incinerators whose smokestacks polluted the air, both visually and literally. However, as the amount of waste sent to landfills grew, so did awareness of the environmental threats associated with this method of waste disposal.

Historically, landfills were unlined and poorly managed (primarily the result of a lack of understanding of hydrology and the characteristics of waste rather than any intent to pollute the environment). As such, landfills have been sources of groundwater and surface water contamination, soil contamination and air pollution. The primary source of air pollution is methane gas which represents 50 to 60 percent of the total gas released and can cause explosions if allowed to concentrate. Carbon dioxide, which represents 40 to 50 percent of the gas released, contributes to global warming. Other gases, many of which contain toxic materials, are released in much smaller quantities. In addition, there are typically foul odors associated with the gases released at landfills.

Leachate, the source of potential groundwater and surface water contamination, is the liquid waste that is produced in landfills. It is generated when rainfall percolates through the solid waste, dissolving contaminants contained within the waste, much of which is toxic, including lead, cadmium, mercury and vinyl chloride.<sup>28</sup> Liquids disposed of in landfills also contribute to the leachate. Depending on the levels of rainfall and hydrological characteristics

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<sup>26</sup>Susan Miriam Minter, "Linking Environmental Policy with Economic Development: A Case Study in Urban Recycling," thesis, MIT, 1991, 9.

<sup>27</sup>EPA Solid Waste Report 92. The numbers are given for 1960, 1970, 1980 and 1990-93. With the exception of 1970 and 1980, which were 72% and 81% respectively, the number ranged from 62% to 64%.

<sup>28</sup>Massachusetts Department of Environmental Protection (DEP), Massachusetts Solid Waste Master Plan 1994 Update (Boston: DEP, 1994) 33. (Referred to below as DEP Solid Waste Report)

of the area where the landfill is sited, as well as the construction of the landfill, there is a serious risk that leachate will contaminate both the groundwater and surface water in the area. This contamination poses a particular threat to the quality of drinking water and to the health of aquatic life in nearby lakes and streams.

In response to the concerns of leachate contamination, RCRA placed a ban on the construction of new unlined landfills. In their place, environmentally sound "sanitary" landfills were required. These are to include groundwater monitoring as well as liners made from plastic membrane or clay to limit the flow of leachate out of landfills. Also, landfills are encouraged to be sited on land that does not drain into groundwater or open bodies of water, and runoff controls have been developed to reduce the amount of rainfall entering landfills. Daily management practices have changed as well. Solid waste is packed tighter and the waste is covered daily with a layer of soil or compost. Both measures limit the opportunity for leachate to move through the landfill.<sup>29</sup>

While our understanding of the environmental impacts of landfills and how to manage the problem has increased tremendously, this increased knowledge has not been reflected consistently in the construction of new landfills. Further, older, unlined landfills make up the majority of the approximately 5,500 landfills currently in operation in the United States.<sup>30</sup>

The development of environmentally sound designs for landfills has been an evolving process. Early experiments with different liner materials and controls were just that - experiments. Even "sanitary" landfills have been a source of measurable pollution. While fewer than 12 percent of MSW landfills monitor for surface water contamination, 60 percent of those that do have been found to contaminate surrounding lakes and streams.<sup>31</sup>

Another problem with the management of the environmental risks associated with landfills is that compliance with federal requirements has been left to the states where enforcement has been inconsistent. As of 1990, only one-third of the states had regulations specifying landfill liners for new MSW landfills and less than two-thirds specified any leachate control.<sup>32</sup> Currently, only 1 out of 6 existing MSW landfills is lined and significantly less have leachate collection systems.<sup>33</sup>

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<sup>29</sup>The increased compaction of waste disposed of in landfills is also done to best utilize limited landfill space, and the daily cover of dirt serves the additional role of pest control.

<sup>30</sup>Alexander 158.

<sup>31</sup>Denison 5.

<sup>32</sup>Denison 5.

<sup>33</sup>Denison 5.

Even when the most advanced means of pollution control are incorporated into new landfills, including double liners, runoff control and leachate collection systems, and the monitoring of both leachate and groundwater contamination is undertaken, there remains considerable uncertainty over their long term environmental safety. It is highly unlikely a liner will forever prevent leachate from escaping.<sup>34</sup>

This risk of contamination is a particular concern in states where groundwater levels are close to the surface, as is the case in Massachusetts which disposed of 19 percent of its MSW in landfills in 1992.<sup>35</sup> A recent state survey identified over 100 unlined landfills in Massachusetts, not all of which were still in operation. The problems of ground- and surface water contamination as well as the problem of gas releases have been identified at a number of these landfills. In response, the state's Department of Environmental Protection (DEP) issued regulations in 1990 mandating minimum performance and design standards for liners, caps and groundwater monitoring. Additional requirements were that all operating landfills had to install liners and leachate control systems. The regulations were intended to prohibit the expansion of all unlined landfills and to encourage their demise. In 1992, DEP took a step further in this direction and issued an order requiring all unlined landfills to stop operation by the beginning of 1994 unless given permission to continue.<sup>36</sup>

#### Incineration:

While the open air burning and uncontrolled incineration of wastes fell out of favor in the late '60s and '70s, the incineration of waste has slowly made a comeback in this country. This is, in part, the result of improved combustion technologies that reduce pollution, a reduction in landfill capacity (particularly acute in the East) along with an increased awareness of the environmental risks associated with landfills, and the promoting of incineration for its potential to generate energy.

In 1960, 31 percent of our MSW was incinerated. By 1980, this number had dropped to 9 percent.<sup>37</sup> Old incinerators were shut down in response to the public's growing concern over air pollution, a concern manifested by increased regulations of air emissions, including the regulation of incinerator ash under the Clean Air Act.

For early incinerators, no attempt was made to capture the toxic particles generated from the burning of solid waste. Instead, dangerous chemicals,

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<sup>34</sup>Minter 11.

<sup>35</sup>DEP Solid Waste Report 22.

<sup>36</sup>DEP Solid Waste Report 34.

<sup>37</sup>EPA Solid Waste Report 92.

including dioxins and heavy metals, were released into the environment. New incinerators have attempted to address this problem with the development of pollution control technology that traps the toxic particles before they are released through the smokestack. Fabric filters and scrubbers are used to trap the particles. In addition, incinerator emissions are carefully monitored to maintain safe levels.

Another reason for the increased popularity of incineration of solid waste has been the decline in the use of landfills. This has been primarily a condition of the environmental risks associated with landfills documented above, including the contamination of ground- and surface water by leachate. These risks, particularly acute in unlined landfills, have resulted in the shutting down of thousands of landfills as well as the intense resistance to the siting of new "sanitary" landfills. As a result, remaining landfill space in many areas is limited and alternative means of waste disposal have had to be found. It should be noted that this scenario is specific to certain geographic areas, such as New England and other densely populated, urban areas. These areas were the first to return to incineration and, not coincidentally, produce the majority of this country's MSW. Further, they are for the most part serviced by older landfills nearing capacity and have neither the popular support nor land reserves needed to site new landfills.<sup>38</sup>

The factor that has likely most driven the resurgence of incineration has been its redefinition from waste disposal to energy recovery. New incineration technology burns the solid waste at extremely high temperatures (exceeding 2,400° F) generating electric power in the process. These new facilities are no longer referred to as trash incinerators; instead, they are called waste-to-energy facilities (WTE) or resource recovery plants.

In addition to significantly reducing the amount of waste sent to landfills by 60 to 80 percent depending on the type of facility and quality of the burn, the burning of MSW is a particularly effective means of dealing with the organic material in MSW that is the primary contributor to toxic leachate. Also, new incinerators help pay for themselves through the sale of electricity which can generate as much as 25 percent of the revenue for most plants.<sup>39</sup>

The level of interest and enthusiasm for this apparently win-win scenario is reflected in the considerable increase in both the number of incinerators, or WTE facilities, in operation, and the amount of MSW that is managed through burning. Depending on the source, there are an estimated 125 to 160 incinerators

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<sup>38</sup>Land reserves refer to the vast amount of open space that can be found in the western half of the United States. This land is isolated from populated areas and, as such, is a more likely candidate for a landfill than sites located in and around large metropolitan area.

<sup>39</sup>Alexander 163.

currently in operation, with another one hundred in the planning stage.<sup>40</sup> In addition, the amount of MSW managed through incineration has increased in the United States to 33 million tons per year in 1993, or 16 percent of the total. This represents an increase of almost 20 million tons per year from the 14 million tons that was disposed of through incineration in 1980.<sup>41</sup>

As discussed above, the percent of MSW incinerated is much larger in some areas of the country. In Massachusetts, for example, 47 percent of its MSW is disposed of through combustion, almost 3 times the national average.<sup>42</sup>

But as the popularity of incineration has grown, so has concern over the environmental risks associated with the combustion of solid waste. Of particular concern are the health risks from the residue that collects in the bottom of the incinerator's burning chamber, commonly referred to as bottom ash. Among these concerns are the high levels of several toxic metals in the ash and the greater opportunity for the ash to be dispersed in the environment where it can be inhaled or ingested more readily than unburned MSW.<sup>43</sup>

Opponents of incinerators have expressed considerable concern over the handling of bottom ash, both in terms of its removal and transportation from the incinerator, and with its disposal. During its removal from the facility, small amounts of bottom ash escape into the air, and, until very recently, bottom ash was treated as MSW (i.e., it was primarily disposed of in landfills) and, in some cases, used in the production of asphalt paving. This changed in May 1994 when the Supreme Court ruled that incinerators must test their ash for toxic chemicals and treat it as hazardous waste if these chemicals are found.<sup>44</sup>

The toxic chemicals found in bottom ash, and in the limited amount of emissions released from smokestacks, include dioxins which are known carcinogens, and a number of heavy metals, such as lead, cadmium and mercury, which can cause health problems ranging from central nervous system disorders to respiratory damage. To further complicate understanding of these emissions, the amount released as well as the mix varies from state to state and among incinerators within the same state. Each state has issued their own set of pollution control limits and different incinerators employ a different pollution control measures.<sup>45</sup> Even in those states that have tested incinerator emissions,

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<sup>40</sup>Michael D. Lemonick, "Burned Up Over Toxic Ash from Incinerators," Time May 16, 1994; or Dennison 7.

<sup>41</sup>EPA Solid Waste Report 92.

<sup>42</sup>DEP Solid Waste Report 22.

<sup>43</sup>Denison 177.

<sup>44</sup>Lemonick.

<sup>45</sup>Newsday, Rush to Burn: Solving America's Garbage Crisis?, (Washington, DC: Island Press, 1989) 13.

they do so infrequently because of the considerable cost of these tests. In Florida, the cost of testing a single incinerator exceeds \$100,000.<sup>46</sup>

Advocates point to the relatively low risks from exposure to these chemicals when compared to the risks people take everyday in crossing the street, smoking cigarettes or taking a drink. However, this argument fails to consider the only limited understanding of the long-term effects of these chemicals, not to mention any synergistic effects that have yet to be examined.

Opponents downplay the energy recovery abilities of incinerators, noting that unprocessed MSW contains significantly less energy value than coal or fuel oil, and that power plants operated by utility companies earn profits through the sale of electricity, while WTE facilities are dependent on payments for accepting garbage. They also point out that incineration is not a replacement for landfilling. The bottom ash generated during the burning of MSW must be landfilled, and many components of the waste stream, including construction and demolition debris and large appliances, cannot be processed by incinerators.

Additional environmental concerns with incineration stem from the long-term agreements communities must enter into with the private operators of these facilities. To secure the investment of the incinerator's developers, communities typically guarantee the delivery of a minimum quantity of waste. This ensures a steady supply of revenue, as communities are paying sizable fees for the processing of their waste, and also that the incinerators function properly.<sup>47</sup>

As a result of these agreements, incinerators are seen as competing with alternative forms of waste management, including waste reduction and recycling. Specifically, communities are not willing to pay substantial penalties to incinerator operators to support increased recycling, which also costs the community. Incinerator opponents have an additional concern with the voracious appetites of incinerators; specifically, the burning of waste imported from outside their communities and out-of-state. This is a concern incinerators share with landfills which, especially in the West, have begun to receive MSW from states to the east.

### The Politics of MSW Management:

There is no consensus on the environmental risks associated with the landfilling and incinerating of solid waste. There are debates on whether there is a problem, the scope of the problem, and what, if anything, should be done. One issue in which there should be no debate is that the United States will generate

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<sup>46</sup>Newsday 13.

<sup>47</sup>Incinerators need a steady supply of waste to operate efficiently.

increasing amounts of MSW (as discussed earlier, there is a positive correlation among waste generation, population and gross domestic product).

This waste will have to be managed and, as a result, in part, of environmental risks, management by landfills and incineration will be increasingly limited. The environmental concerns with landfills and incinerators, real or perceived, coupled with additional concerns, including the associated odors and increased transportation as well as fear of declining property values, have fueled the public's resistance to the construction of new landfills and incinerators. Across the United States hundreds of local groups have organized in opposition to both the development of new landfills and incinerators as well as to the continued operation of existing facilities. This resistance has been particularly strong in the Northeast, Midwest and other densely populated areas of the country.

Since 1978, an estimated 14,000 landfills have closed.<sup>48</sup> This number will grow as unlined landfills are required to shut down and as older landfills reach their capacity. While new landfills are still being sited, primarily in Western states with fewer people and more land, it can be expected that the importation of MSW from other states will be strongly resisted. Residents of host states do not want their states to be seen as dumping grounds for other states. This is also true among host communities within states. In addition, high transportation costs might discourage the shipping of waste over great distances.

The construction of new incinerators, too, has slowed down. Since 1985, opposition has thwarted the development of 270 plants in the United States while only 68 have been built.<sup>49</sup> In addition to the environmental risks, incinerators are very large, typically consisting of a series of buildings, some over 15 stories high, with smokestacks reaching hundreds of feet into the air. Incinerators are also very costly, both to build and to operate. Construction costs increase with the capacity of the incinerator and can typically run into the hundreds of millions of dollars. Further, the disposal fees paid by communities committed to using incinerators can increase significantly if waste volumes are lower than expected. This has been a problem for a number of communities throughout the country.<sup>50</sup>

Siting landfills and incinerators away from populated areas might be an initial response to these concerns, however, this involves some tradeoffs. There are very practical reasons why these facilities have traditionally been sited in proximity to densely populated urban areas; these areas represent the greatest source of waste. High transportation costs and convenience have kept these

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<sup>48</sup>Denison 4.

<sup>49</sup>Lemonick.

<sup>50</sup>Jeff Bailey, "Incinerator, Short on Waste, Becomes Burden: Connecticut Site's Woes Reflect Wider Problem as Trash Trails Forecast," Wall Street Journal 12 November 1993, sec A: 5B.



facilities in close to urban areas. These same high costs might help drive the development of waste management alternatives.

The reason the siting of landfills and incinerators has not always been a problem is that historically they were built in areas that were unpopulated and undeveloped, or in low-income, inner-city communities that were unorganized and had poor political representation. These were typically communities of color. Today, most urban areas that remain undeveloped or underutilized are either highly valued as open space, or are intended to be developed as office/hotel/retail/residential centers that will create jobs and contribute to the physical environment of the city. Also, a growing environmental justice movement has fueled the clean-up of inner-city hazardous waste sites and other environmentally contaminated industrial lands. Low-income, minority communities have become increasingly organized and resistant to all but the "cleanest" industries locating in their neighborhoods.

Resistance to the landfilling and incinerating of waste as a long-term solution to solid waste management has fostered the development of possible alternatives, including dumping the waste in outer space and the use of manmade lightning to turn waste into blocks of glass.<sup>51</sup> A more realistic alternative that is currently practiced is often referred to as integrated solid waste management.

#### Integrated Solid Waste Management:

Integrated solid waste management refers to the EPA hierarchy of waste management practices:

- waste reduction;
- recycling;
- combustion (or incineration); and,
- landfilling.

Waste reduction, also known as waste prevention or source reduction, refers to reducing the amount or toxicity of trash before the point of generation (i.e., before the products or packages have been manufactured). Waste reducing activities include: 1) designing new products or packages to require less materials or less toxic materials; 2) modifying current practices to reduce amounts of products or packages used; 3) reusing already manufactured products or packages; and, 4) increasing product-life.<sup>52</sup>

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<sup>51</sup>Associated Press, "Manmade Lightning May Recycle Trash," Boston Globe 22 April 1995: 10.

<sup>52</sup>EPA Solid Waste Report 86.

Waste reduction also includes the composting of non-product organic wastes such as food wastes and yard trimmings. While EPA has not quantified the impact of source reduction activities, waste reduction is increasing as companies look to cut costs, meet federal guidelines related to materials use and look to manufacture more environmentally friendly products. EPA has, however, measured the increase in composting in the United States: in 1993, 3.1 percent (6,500,000 tons) of the MSW generated was composted. This number is expected to increase to 5.1 percent by the year 2000.<sup>53</sup>

Recycling refers to the conversion and reuse of waste to create new products. As an alternative to landfilling and incineration, the amount of waste recycled each year in the United States has increased steadily since 1960. In 1992, recycling surpassed incineration to become the second most prevalent means of waste management nationwide.<sup>54</sup> A detailed discussion of recycling follows.

### III. Recycling

The increase in the amount of MSW recycled each year in this country is a reflection of: 1) growing public awareness of the solid waste problem and the importance of recycling in addressing this problem; 2) increasing awareness among governments of the important role recycling can play in solid waste management as demonstrated by various programs and policies; and, 3) increasing markets for recyclables which adds value to the materials.

The amount of MSW recycled in this country doubled between 1980 and 1990 to almost 28 million tons.<sup>55</sup> In 1993, the number increased to over 38 million tons, or 18.6 percent of MSW generated.<sup>56</sup> As the rate of recycling has increased, so has society's understanding of waste, including the amount generated, the source of the waste and the various materials that comprise MSW.

#### MSW Characterization & Materials Recycled:

Municipal solid waste, as it is defined by EPA's *Characterization of Municipal Solid Waste in the United States: 1994 Update*, includes durable and nondurable goods, containers and packaging, yard trimmings, food scraps and miscellaneous inorganic wastes from residential, commercial, institutional and industrial sources. MSW does not include construction and demolition debris, automobile

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<sup>53</sup>EPA Solid Waste Report 92 & 115. Numbers do not include backyard composting. The projection for year 2000 assumes a 30 percent recovery scenario.

<sup>54</sup>EPA Solid Waste Report 115. In 1993, almost 19% of MSW was recovered for recycling while 16% was incinerated.

<sup>55</sup>EPA Solid Waste Report 92.

<sup>56</sup>EPA Solid Waste Report 92.

bodies, municipal sludges, combustion ash and industrial process wastes that might also be disposed in landfills and incinerators.

These products fall into a number material categories, including paper and paperboard, plastics, metals, glass, wood, food and yard trimmings, and rubber. A percentage of each of these materials is diverted from the waste stream and recycled. The amounts recycled depend on the specific material, including the efforts required to collect and process the material, and the markets for the material once recycled.

Paper and paperboard represent the largest component of MSW, comprising 37.6 percent of the total MSW generated in the United States in 1993, or almost 78 million tons.<sup>57</sup> Paper wastes include newspaper, office paper, mail, plates and cups, books and magazines, and various paper containers and packaging, such as bags and cardboard boxes. Thirty-four percent of paper and paperboard waste generated in 1993 was recycled back into many of the products listed above as well as toilet paper, paper towel, particle board and writing pencils.<sup>58</sup>

Plastics represent a fast-growing segment of MSW, increasing from just 2.5 percent of the waste stream in 1970 to 9.3 percent of the total MSW generated in 1993.<sup>59</sup> Plastics are used in a variety of products and packaging ranging from small appliances and carpets to assorted containers and bags. While only 3.5 percent of the total amount of plastic discards were recycled in 1993, some plastic containers were recycled in greater percentages.<sup>60</sup> In particular, 41 percent of soft drink bottles manufactured from polyethylene terephthalate (PET) were recycled in 1993 as well as 23.6 percent of milk and water bottles manufactured from high-density polyethylene (HDPE).<sup>61</sup> Products manufactured from these recycled plastics include carpeting, building insulation, clothing and detergent bottles.

Metals in MSW, of which ferrous metals are the largest category by weight, comprised 8.3 percent of the total MSW generated in the United States in 1993.<sup>62</sup> During the same year, over 30 percent of this material was recovered from the waste stream and recycled.<sup>63</sup> Metals from appliances and automobiles as well as from food and drink cans and other containers were recycled into cans, automobile parts, i-beams and sheet metal.

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<sup>57</sup>EPA Solid Waste Report 5.

<sup>58</sup>EPA Solid Waste Report 35.

<sup>59</sup>EPA Solid Waste Report 29.

<sup>60</sup>EPA Solid Waste Report 41.

<sup>61</sup>EPA Solid Waste Report 41.

<sup>62</sup>EPA Solid Waste Report 29.

<sup>63</sup>EPA Solid Waste Report 29-30.

The source of glass in MSW is primarily food and beverage containers. Additional sources include electronic equipment, furniture and appliances. In 1993, glass accounted for over 13 million tons of MSW, or 6.6 percent of the total.<sup>64</sup> Twenty-two percent of this glass was recycled into a variety of products, including glass containers, fiber glass insulation, flat glass and as an additive in asphalt.<sup>65</sup>

Wood waste accounts for 6.6 percent of the total MSW generated in 1993.<sup>66</sup> Sources of wood waste include furniture, cabinetry and wood packaging like crates and pallets. In 1993, 9.6 percent of this waste was recycled into furniture products, animal bedding, particle board, refurbished pallets, mulch and other products.<sup>67</sup>

Scrap tires account for the majority of rubber found in MSW. Historically, scrap tires have made up a little over 1 percent of the total MSW generated each year in this country, or 2,870,000 tons.<sup>68</sup> At an average weight of 20 pounds per passenger tire, this number is equivalent to the generation of over 250 million tires annually. In 1993, almost 30 percent of discarded tires were recycled.<sup>69</sup> A number of markets exist for recycled rubber, including assorted civil engineering applications, its use to manufacture new rubber products and as an additive in asphalt. A detailed discussion of scrap tire management and markets can be found in Chapter Two.

### Recycling Process:

As recycling has increased, society's methods of handling materials for recycling have grown more efficient and sophisticated. In general terms, this system includes the collection of the materials, the sorting or separating of different materials, any initial processing that might be required to prepare the materials for reuse and the use of the recyclables to manufacture new products. At each stage value is added to the materials. What follows is a discussion of the stages of recycling: collection, processing and remanufacturing.

Collection: The collection of recyclables first involves their separation from the waste stream. There are a number of ways to collect materials to be recycled. One method is curbside collection, widely considered the most effective means of increasing the amount of materials collected. In this process, generators of MSW separate recyclables from the trash and place them in bins, either a single bin in

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<sup>64</sup>EPA Solid Waste Report 35.

<sup>65</sup>EPA Solid Waste Report 37.

<sup>66</sup>EPA Solid Waste Report 46.

<sup>67</sup>EPA Solid Waste Report 46.

<sup>68</sup>EPA Solid Waste Report 45.

<sup>69</sup>Mark Phillips, "Scrap Tire Numbers Revised," Tire Review March 1995: 70.

which the recyclables commingle or in different bins thereby separating the materials. These bins are placed on the curb on a regular basis where the materials are picked up like the trash. There are currently more than 6,600 curbside recycling programs throughout the country.<sup>70</sup>

Other options for the collection of recyclable materials are drop-off and buyback centers. Drop-off centers have been a particularly popular means of organizing recycling. Large bins are placed in central locations to collect materials for recycling. Individuals bring their recyclables to these centers and deposit them in the appropriate bins.

Buyback centers refer to drop-off centers that provide cash for the materials they receive. This incentive increases the quantity of materials collected as well as provides a source of income in the inner-city communities where these centers are typically located. In addition to collecting the recyclables, buyback centers might be involved in the processing of materials as well. Curbside collection programs are generally seen as more effective in increasing the amount of materials recovered than drop-off and buyback centers which require additional effort of the individual.

**Processing:** Processing represents the next stage of recycling. The degree of processing the recyclables require depends upon, among other things, the specific material, its expected use and the manner in which the material was collected. In terms of collection, if the recyclables have been allowed to commingle, they will need to be separated. Also, if materials are not collected and transported with care, there is the risk they will arrive in poor condition (i.e., contaminated or, in the case of glass, broken). In this case, it is necessary to clean the recyclables and prepare them for reuse. Facilities that accept collected materials and process them for end-markets are commonly referred to as material recovery facilities (MRFs).

MRFs are typically large facilities that process a variety of materials, including newspaper and office paper, magazines, glass and assorted metals and plastics. In addition to sorting, which is typically done by hand, MRFs employ machinery to prepare the recyclables for end-markets. These machines include balers, magnets, crushers, grinders and trommels. Typically, paper is baled, plastics are ground into flakes, metals are sorted and crushed and glass is cleaned and crushed into cullet. MRFs play an important role in the development of markets for recyclables. Successful MRFs are able to guarantee manufacturers a steady supply of clean, high quality materials for use in the production of new products.

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<sup>70</sup>Robert Steuteville, "The State of Garbage in America," BioCycle May 1994: 30.

**Scrap-Based Manufacturing and Market Development:** The final stage in the process is the actual recycling of materials into new products which are then used by consumers. This is achieved through the use of recycled materials as feedstock in the production of new goods. This stage, commonly referred to as scrap-based manufacturing or remanufacturing, is the most important, for without reuse, recycling has not occurred.

Accordingly, market development for recyclables has been an area of increasing interest among both policy-makers and entrepreneurs. First, with materials being collected, markets must be found for them. The alternative, stockpiling recyclables in warehouses, may be an acceptable short-term solution while markets are being developed, but creates its own set of problems. Further, it is in the best interests of groups involved in the collection and processing of recyclables to make these activities as economical as possible. These groups include the local governments and businesses paying for the collection of recyclables; the businesses and organizations actively involved in the collection, processing and/or remanufacturing of the materials; and, the advocates and policy-makers who support recycling.

Entrepreneurs have been attracted to scrap-based manufacturing for a variety of reasons. First, recycled materials can be less expensive than the virgin materials for which they are a substitute and offer the same performance. This is true for many uses of recycled scrap tires. Second, there has been increasing demand for products with recycled content, driven in part by a growing environmental awareness among consumers and by changes in government procurement practices that favor recycled products. Finally, in some cases, there is additional assistance available to businesses using recycled materials. This includes grants, technical assistance and other incentives available from organizations and government agencies interested in supporting the development of markets for recyclables.

The growing government interest in market development for recyclables is a natural outgrowth of the government's work to facilitate the collection of materials for recycling.

### **Recycling Programs and Policy:**

Many state and local governments have been active proponents of recycling, particularly in the Northeast and other areas confronting limiting alternatives for waste disposal. This support includes mandatory recycling laws, recycled content laws, legislation (including bottle bills intended to generate revenue to support recycling), and the funding and staffing of various programs intended to increase the amount of materials recycled. Forty-three states have set recycling goals which are driving their recycling-related activities. These goals range from

20 percent of MSW generated annually in Maryland to 70 percent in Rhode Island.<sup>71</sup>

Massachusetts, which has established a statewide recycling goal of 46 percent by the year 2000, has developed a ten-point Recycling Plan that is illustrative of the initiatives many states have undertaken in their own efforts to achieve recycling goals. The Recycling Plan is funded by unredeemed bottle deposits resulting from implementation of the statewide Bottle Bill.<sup>72</sup> Programs contained in the plan include:

- **Municipal Recycling and Composting Equipment Grants:** intended to assist municipalities in obtaining recycling and composting equipment;
- **Public Recycled Procurement Campaign:** designed to increase state government purchases of recycled products;
- **Public Recycling Education Campaign:** intended to support the dissemination of educational materials to increase public awareness of recycling;
- **Investment Loan Fund:** intended to stimulate the development and expansion of recycling-related industries through the provision of technical assistance and credit enhancement to companies; and,
- **Higher Education Fund:** intended to fund studies on source reduction and recycling issues.<sup>73</sup>

In Massachusetts and over 34 other states, government policies and programs have gradually shifted focus from an emphasis on the supply side to the demand side of recycling.<sup>74</sup> One reason for this shift is that most states have already adopted comprehensive solid waste laws addressing recycling. As the supply of recyclables has increased, market prices for many of these materials have dropped. An emphasis on market development has the potential to increase the price of recyclables, thereby improving the bottom line of recycling programs. Another reason for this new interest in recycling market development is the increasing recognition that scrap-based manufacturing can generate economic development, including the creation of jobs. A discussion of the economic development potential of recycling can be found in the final section of this chapter.

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<sup>71</sup>Steuteville 32.

<sup>72</sup>DEP Solid Waste Report ii.

<sup>73</sup>DEP Solid Waste Report iii.

<sup>74</sup>Steuteville 30.

Specific initiatives states have undertaken to address market development include the provision of tax incentives, grants, loans and technical assistance to recycling-related businesses. These programs are frequently overseen by recycling market development offices housed within state departments of commerce or economic development. In addition to the services listed above, these offices also serve as advocates for scrap-based businesses within state government. One state office, the California Integrated Waste Management Board (CIWMB), has developed the Recycling Market Development Zone program to increase demand for recycled materials. CIWMB provides scrap-based manufacturers that locate within one of the 29 designated zones low interest loans, marketing and technical assistance, and information on financing strategies.<sup>75</sup> Each zone offers its own package of benefits in addition to the benefits offered by CIWMB.

Recent federal recycling policies have followed the lead of the states and have also focused on market development and job creation in the recycling industry. Under one program, EPA's "Jobs Through Recycling," four states are sharing approximately \$2 million to create Recycling Business Assistance Centers (RBACs). RBACs will provide a variety of services to the recycling industry with an emphasis on economic development and job creation. The federal funding will be issued as one year grants with the expectation that each year a different group of states will receive the funding.<sup>76</sup> The "Jobs Through Recycling" program will also provide grants of \$74,000 each to nine states to hire Recycling Economic Development Advocates to work out of state departments of commerce or economic development.<sup>77</sup> In addition to these efforts, the federal government continues to support recycling through procurement practices that favor recycled products.

### Recycling Benefits:

The benefits traditionally associated with recycling are environmental. These include the benefits of reduced incineration and landfilling of MSW discussed earlier in this chapter. Also, there are environmental benefits derived from the substitution of virgin raw materials for recycled materials and the reduction in the additional energy required to process virgin materials.

There are a number of environmental costs associated with the extraction and processing of virgin materials. The scope of these costs vary depending on the material. In general, these impacts include air and water pollution, damage to millions of acres of land and the generation of increasing amounts of solid

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<sup>75</sup>California Integrated Waste Management Board (CIWMB), Recycling Market Development Zone: Program Overview (Sacramento: CIWMB, 1994).

<sup>76</sup>Steuteville 33.

<sup>77</sup>Steuteville 33.



waste.<sup>78</sup> In the case of the timber industry, which logs approximately 1.7 billion cubic meters of wood annually to be used in a variety of wood products, the environmental impacts include soil erosion, deforestation, flooding, damage to wildlife habitat and the destruction old growth forests.<sup>79</sup> Deforestation, in particular, is contributing to rising carbon dioxide levels and the threat of global warming. In 1990, paper mills used almost 22 million tons of scrap paper, sparing the equivalent of approximately 370 million trees in the process, as well as the environmental damage associated with the logging of these trees.<sup>80</sup>

Also, the use of recycled materials generally requires less energy and water than the use of virgin materials; a condition of the reduced processing needed to bring recycled and virgin materials to the same point in the production process.<sup>81</sup> In the case of paper production, debarking, chipping and pulping trees is significantly more energy and water intensive than the re-pulping of waste paper. One evaluation undertaken by the Institute for Local Self-Reliance (ILSR) found that for six industries, including aluminum, plastics and paper, the reduced energy use achieved with the replacement of virgin materials for scrap materials ranged from highs of 32 percent to 97 percent.<sup>82</sup>

In addition to the environmental benefits of recycling, there is growing recognition of the economic development and job creation benefits of recycling; specifically, of scrap-based manufacturing. This has been demonstrated, in part, by the shift in recycling policy addressed above. An overview of the economic impacts of recycling follows, including a discussion of specific community-based recycling ventures.

#### **IV. Economic Impacts of Recycling**

There are three kinds of economic development benefits that can be produced through recycling: job creation, job retention and a reduction in local costs of MSW disposal. The creation and retention of jobs can be achieved at each stage of the recycling process identified above. In addition to the labor required to collect and separate materials for recycling, jobs are also created by the need to transport the materials through each stage of the recycling process. The last stage of the recycling process, the use of the materials to manufacture new products, has the greatest potential to create jobs.<sup>83</sup>

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<sup>78</sup>John E. Young, Discarding the Throwaway Society (Washington, DC: Worldwatch Institute, 1991) 8.

<sup>79</sup>Young 11.

<sup>80</sup>ILSR 12.

<sup>81</sup>ILSR 12.

<sup>82</sup>ILSR 12.

<sup>83</sup>National Council for Urban Economic Development (CUED), Economic Development Opportunities from Recycling and Environmental Technology (Washington, DC: CUED, 1992) 5.

### Impact on Job Creation:

In the collection of recyclables, jobs are created whether the program is run as a drop-off or buyback center, or as a curbside collection program. Among the low skill jobs created at this stage are drivers, helpers, cashiers, route supervisors and vehicle maintenance workers. Curbside collection programs are frequently contracted out to private waste hauling businesses, while drop-off and buyback centers have been managed by both private businesses and nonprofit community organizations. The latter group, which includes CDCs in the Bronx and Chicago, has been attracted to these operations by their relatively low start-up costs as well as the potential to generate jobs.

A majority of MRFs, which have start-up costs frequently exceeding \$5 million, have been developed by private businesses or state governments that typically turn over the operation of these facilities to private contractors.<sup>84</sup> However, a small number of nonprofit community groups have also begun to get involved in the processing of recyclables, attracted by the potential for greater job creation and the increased value added to the materials. Jobs created at the processing stage include unloaders, sorters, machine operators, forklift drivers and sales representatives. Additional jobs have been created in the construction industry as the number of MRFs being built throughout the country has increased.

As discussed above, scrap-based manufacturing is the most important component of the recycling process (i.e., it is necessary for the job creation in the collection and processing stages to be sustained and to grow, and offers the greatest potential for recycling-related job creation).<sup>85</sup> Manufacturing jobs, which include all types of factory work, typically require a higher level of skills and may offer a higher wage as well as the opportunity for advancement.

A study undertaken by ILSR estimated the number of jobs created per 15,000 tons per year of material handled at each stage of recycling. The results were as follows: approximately 30 jobs were created from the collection of recyclables; approximately 20 jobs were created from the processing of recyclables; and, over 1,000 jobs were created from the manufacturing of end products using recyclables.<sup>86</sup> A study commissioned by the Northeast Recycling Council (NERC) looking at the value added to recyclable materials in the Northeast found similar results, though only considered job creation in the processing and manufacturing stages of recycling. The study found that for the over 100,000 recycling-related jobs in the Northeast region of the United States (not including employment

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<sup>84</sup> Andrew Reamer, "Creating Jobs From Trash," *Commentary* Winter 1991: 22.

<sup>85</sup> Reamer 22; and ILSR 5.

<sup>86</sup> ILSR 6.

created by the collection of recyclables), 25 percent were in processing firms and 75 percent were in manufacturing firms.<sup>87</sup>

The approximately 100,000 recycling jobs identified in the NERC study represent almost 3 percent of the total manufacturing sector jobs in the Northeast.<sup>88</sup> In Massachusetts, the collection and processing of recyclables combined with scrap-based manufacturing account for over 10,000 jobs, or over 2 percent of the total number of manufacturing jobs in the state.<sup>89</sup> With the national unemployment rate at approximately 6.7 percent in 1993 and 6.9 percent in Massachusetts for the same year, these jobs are making important contributions to the economy.<sup>90</sup>

#### Scrap-Based Manufacturing and Inner-City Communities:

The development of recycling-related businesses may offer particular economic benefits to inner-city communities. These communities have received a disproportionate share of the loss of manufacturing jobs and are increasingly isolated from jobs created in the service sector, either geographically because the jobs are being created outside their communities or because inner-city residents do not possess the required skills. However, as locations for scrap-based manufacturers, in many cases inner-city communities have advantages over suburban and rural communities. First, urban areas represent the greatest source of MSW and by siting manufacturing plants close to the source, high transportation costs can be avoided. Second, most urban cities have a surplus of manufacturing facilities that are underutilized or have been abandoned. Manufacturers who locate in these areas are typically able to lease or purchase facilities at a significantly reduced cost. Third, inner-city communities have an abundant work force with skill-levels that match the needs of the manufacturers. Finally, as addressed earlier in this chapter, in most large, urban cities there are a range of incentives available to businesses creating jobs in low-income, inner-city neighborhoods.

A number of urban community development corporations are trying to capitalize on the benefits of scrap-based manufacturing by developing their own recycling-related ventures, or by attempting to attract scrap-based businesses to their neighborhoods. Three CDCs actively involved in this area are the South Bronx 2000 Local Development Corporation, Bethel New Life, Inc. and the Banana Kelly Community Improvement Association.

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<sup>87</sup>Northeast Recycling Council (NERC), Value Added to Recyclable Materials in the Northeast (Brattleboro: NERC, 1994) 5.

<sup>88</sup>NERC 4.

<sup>89</sup>DEP Solid Waste Report 7.

<sup>90</sup>United States Bureau of the Census 395 & 399.

Bronx 2000: Located in the South Bronx, Bronx 2000 is the largest and most well known community organization involved in recycling-related ventures.<sup>91</sup> Its initial foray into recycling began in 1982 when it developed both a MRF and a buyback center. Both operations are run by a for-profit subsidiary, R2B2. The MRF takes in source-separated recyclables from residential and commercial sources and has saved local businesses over \$3 million in disposal costs.<sup>92</sup> In addition, R2B2 has paid out more than \$3.8 million dollars to its employees and to individuals, groups and businesses who have brought recyclables to its buyback center.<sup>93</sup>

Bronx 2000's most recent recycling venture, Big City Forest, began operation as a for-profit subsidiary in 1994. The business receives discarded wood pallets and other wooden shipping materials from which it produces new pallets, butcherblock furniture and flooring using the reclaimed wood. Big City Forest, which currently has over 20 employees, expects to produce 150,000 recycled pallets a year and has opened retail and wholesale outlets to sell its recycled furniture and flooring.<sup>94</sup>

In addition to these enterprises, Bronx 2000 has formed a public-private partnership with New York State's Office of Recycling Market Development and the U.S. EPA to establish a statewide center for developing recycling enterprises and creating jobs. The Empire State Center for Recycling Enterprise Development received one of four grants issued by EPA as part of its "Jobs Through Recycling" initiative discussed earlier in this chapter. The center will attempt to build on the successes of Bronx 2000's recycling-related enterprises.

Bethel New Life: A church-based community development corporation in Chicago, Bethel New Life became involved in recycling in 1984 when it opened a buy-back center in West Chicago as a means of putting money into the community. In 1992, Bethel opened a MRF to capitalize on the increasing curbside collection of recyclables in the surrounding area. Bethel entered into a contract with Browning-Ferris to guarantee a steady supply of materials. Almost from the start the operation ran into difficulty. The recyclable materials were coming from greater distances than expected and, as a result, they were arriving at the MRF in poor quality (i.e., dirty, mixed and broken). The facility was not equipped to handle materials in this condition and Bethel eventually closed the business.<sup>95</sup> Bethel has leased the facility to a minority-owned business recycling

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<sup>91</sup>Reamer 22.

<sup>92</sup>Recoverable Resources/Boro Bronx 2000, Inc., (Bronx: South Bronx 2000 Local Development Corporation).

<sup>93</sup>Recoverable Resources.

<sup>94</sup>Big City Forest, Inc., (Bronx: South Bronx 2000 Local Development Corporation).

<sup>95</sup>Interview with Steve Steinhoff, Bethel New Life (1/19/95).

of high grade paper. As part of the lease, the business has agreed hire local workers through Bethel.

As a result of its experience with the MRF, Bethel is getting away from the business side of recycling and is focusing instead on development. Specifically, the organization is currently involved in the development of a West Chicago industrial park for scrap-based manufacturers. Bethel has purchased 6 acres of land in a Federal Empowerment Zone which it is in the process of cleaning up, and has an option for an additional 8 acres. In exchange for donating land and/or assisting businesses with financing, Bethel will receive an equity stake in each operation.<sup>96</sup> Bethel will also assist businesses with permitting and job training. The organization is actively negotiating with a number of scrap-based manufacturers about the possibility of locating a facility at the industrial park.

Banana Kelly: A community development corporation located in the South Bronx, Banana Kelly has joined forces with the Natural Resources Defense Council (NRDC) and two paper companies to propose the largest community-based recycling venture to date: the Bronx Community Paper Company. This facility would remove ink from scrap paper generated in New York City, creating pulp that can be used to make recycled paper. The two paper companies, which have contributed \$550,000 to develop the proposal, need the pulp, and NRDC is interested in saving trees. The facility would be located on a 19 acre section of an abandoned rail yard in Harlem and is expected to hire 180 to 200 local workers which Banana Kelly would train.<sup>97</sup> An additional 100 jobs are expected to be created from related social services. NRDC and Banana Kelly are currently seeking funding for the \$100 million plant.

Both Bethel's and Banana Kelly's involvement in recycling are through community-joint ventures (i.e., they are working with private firms to develop or attract scrap-based manufacturing facilities in their communities). This arrangement offers a number of benefits to both CDCs and businesses. CDCs are able to limit their risk, including their financial investment, and can avoid the need to become experts in specific businesses. Private firms gain a strong local ally and may receive help with permitting, hiring and job training as well as increased access to financing.

#### Impact on MSW Disposal Costs:

In addition to the potential to create jobs, recycling also offers the potential to reduce the costs associated with local MSW disposal. This is particularly true in densely populated areas that generate significant amounts of solid waste and are running out of landfill space. While this benefit has not yet been realized, as

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<sup>96</sup>Steinhoff.

<sup>97</sup>John Holusha, "Paper Recycling Plant Planned for South Bronx," The New York Times 6 May 1994: D5.

markets for recyclable materials grow, recycling programs will increasingly become self-supporting.

This trend has been exhibited recently in Massachusetts which opened one of the largest MRFs in the country in 1990. The state has contracted out responsibility for operating the facility to private firms and has had to pay an annual cost of approximately \$1.65 million in fixed charges, fees and market guarantees associated with the operation of the MRF.<sup>98</sup> However, in the most recent round of bids from private firms to operate the facility, the low bid offered Massachusetts enough money to cover the state's share of the operating costs. The private firm that offered this low bid is confident that the demand for recycled materials is strong enough to justify this arrangement. In particular, in Massachusetts the supply of recycled paper, which accounts for 65 percent of the waste brought into the MRF, has been in such short supply that manufacturers have had to import it from other states.<sup>99</sup>

#### Value Added:

At each stage of the recycling process value is added to the materials. In the case of old newspaper (ONP), ILSR estimates the value in dollars per ton for collected ONP to be \$5; for processed ONP to be \$15; and, for end products using ONP to range from \$35 to \$570 per ton.<sup>100</sup> "In general terms, the greater the value added by a facility, the greater the economic benefits, either through greater revenue brought to the community, or through the creation of more and/or higher skill-jobs."<sup>101</sup> Accordingly, the more processing that is done locally, the greater the benefit to the community. In the Northeast, over \$7.2 billion of value is added to recyclables through processing and manufacturing.<sup>102</sup> In Massachusetts, the Department of Environmental Protection (DEP) estimates that the collection of recyclables accounts for over \$50 million worth of economic activity each year.<sup>103</sup> DEP further estimates that the in-state processing and manufacturing of these materials contributes an additional \$500 million each year to the state's economy.<sup>104</sup>

#### Barriers to Economic Development:

Given the potential economic advantages of recycling, it makes sense for communities to do all they can to capture these benefits. However, there are a

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<sup>98</sup>Associated Press, "State Officials Say Latest Bid Proves Recycling is Paying Off," Boston Globe 22 September 1994.

<sup>99</sup>Associated Press D5.

<sup>100</sup>ILSR 7.

<sup>101</sup>ILSR 6.

<sup>102</sup>NERC 5.

<sup>103</sup>DEP Solid Waste Report 7.

<sup>104</sup>DEP Solid Waste Report 7.

number of barriers that can prevent communities from realizing the full economic benefit of recycling programs. The first set of barriers concern the supply of materials; specifically, it is essential that recyclables are collected in sufficient quantity and delivered to manufacturers in good quality. Manufacturers in all areas depend on a steady supply of materials that meet their specifications. Another barrier to the growth of recycling programs are technical barriers to the processing of recyclables. Considerable effort has gone into the design and manufacturing of products to perform well in a variety of conditions. As a result, it can be difficult to break these products down into materials for recycling. Other barriers to the economic development benefits of recycling include uncertain demand for the recycled materials and for recycled products. For firms to be willing to invest in the development of these products, they have to be convinced there is enough demand. Current efforts of many government recycling programs are intended to address these barriers.

## V. Conclusion

Two shifts in public policy have created an opportunity. The shifts are a growing emphasis on community-based economic development and an increase in recycling (and recycling market development) to manage solid waste. There is an opportunity to combine these policies. The federal government and a number of state governments have recognized this potential and are actively pursuing programs in this area. Entrepreneurs and nonprofit community organizations have responded, investing millions of dollars in recycling-related ventures. The potential for CDC involvement has received particular attention since these organizations have as a central mission the economic development of their communities, and CDCs are seen as an increasingly effective mechanism to deliver this assistance.

The next chapter presents a detailed overview of a particular recyclable material: scrap tires. Markets are addressed, as are public policies driving market development. This discussion is a prelude to Chapter Three which presents a plan for a community venture in the recycling of scrap tires.





## Chapter Two

### SCRAP TIRE MANAGEMENT AND MARKETS

This chapter focuses on a specific recyclable material: scrap tires. It begins with an overview of the scrap tire problem in the United States. A discussion of disposal methods and select state scrap tire management programs follows. The chapter concludes with a detailed discussion of the various markets for scrap tires.

Scrap tires comprise approximately 1 percent of the waste stream but represent a disposal problem far greater than this number suggests. Unlike other components of the nation's municipal solid waste (MSW) around which markets have developed, markets for scrap tires have been slow to appear. While glass, paper and select plastic waste represent much larger percentages of the total amount of MSW, these products readily lend themselves to being recycled and are diverted from landfills and incinerators in large numbers to find new life in a wide range of products and applications.

Scrap tires, on the other hand, have historically been stockpiled or landfilled, with small numbers being recycled into playground equipment and other specialty products, or used in a variety of civil engineering projects. This can, in part, be linked to the difficulty in breaking scrap tires down into materials that can be reused and for which a reuse has some value.

Tires are built to last. Today's radial tires average 40,000 miles compared to an average life of 23,000 for the bias tire that preceded it.<sup>1</sup> To achieve this increased performance, tire design and composition have grown increasingly complex to include both synthetic and natural rubber, steel and polyester fiber. The average steel-belted radial passenger tire, which accounted for approximately 83 percent of all passenger tires sold in 1990, contains over 12 pounds of natural and synthetic rubber and 2 pounds of steel.<sup>2</sup>

The problem of scrap tire management has increased for a number of reasons, not the least of which is that the number of scrap tires generated annually has increased. According to EPA, approximately 242 million scrap tires are generated each year, or one tire for every man, woman and child in the United States. This number does not include tires that are retreaded or reused. Presumably, as our population grows so will the number of scrap tires. Society's

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<sup>1</sup>Michael J. French, The U.S. Tire Industry: A History (Boston: Twayne, 1991) 101.

<sup>2</sup>Scrap Tire Management in Massachusetts: Questions and Answers for Municipal Waste Management Officials (Boston: Massachusetts Department of Environmental Protection, 1991) 2.

increasing dependence on cars and trucks as its primary mode of transportation will only contribute to the problem.

Additional reasons for the growth of the problem has been the realization that scrap tires are not a benign waste. When landfilled, whole tires do not decompose, but take up valuable room and trap gases which can result in the tires rising to the surface and breaking the landfill cover. Stockpiled scrap tires, the fate of an estimated 2 to 3 billion tires nationwide, collect rainwater, creating an ideal breeding ground for mosquitoes and a nesting area for a variety of rodents. Stockpiled tires also represent a significant fire hazard. When they catch fire, they can burn out of control for months, releasing significant amounts of thick, black smoke and a hazardous oily residue.

In the past decade, states have begun to recognize the serious nature of the scrap tire problem. Forty-eight states have addressed scrap tire management with legislation. A primary action has been the banning of whole tires from landfills, with a number states banning scrap tires altogether. Other efforts include developing programs to find markets for scrap tires, identifying and cleaning up stockpiles, providing grants to support market development and educational efforts, and assessing a tax on the sale of new tires to support these various state programs. Specific state programs as well as successful efforts at market development are discussed below.

The market has begun to respond to government actions. An estimated 40 to 55 percent of scrap tires generated in 1994 were diverted from the waste stream.<sup>3</sup> This represents a notable increase from the 15 percent recycled in 1992 and the 30 percent recycled in 1993.<sup>4</sup>

What follows is a brief description of the process by which scrap tires are discarded, a description of select state scrap tire management programs, including Massachusetts, and an exhaustive list of uses for discarded tires. For the most part, uses for scrap tires represent emerging markets, the exception being reuse and retreading, and civil engineering applications for whole tires.

## **I. Disposal of Scrap Tires**

The United States Department of Energy estimates that 85 percent of discarded tires are from automobiles, 15 percent are trucks tires and less than 1 percent represent specialty tires, including tires from military vehicles, airplanes

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<sup>3</sup>"Scrap Tire Solutions on the Rise," Scrap Tire News December 1994: 1.

<sup>4</sup>Phillips 70.

and construction equipment.<sup>5</sup> Sources of discarded tires nationally are found in Table 2.1.

**Table 2.1: Sources of Discarded Tires**

<b>Source</b>	<b>Percent of Total</b>
Dealerships/Retreaders	65%
Auto Wreckers	15%
Auto Service Stations	12%
Other <sup>6</sup>	8%

SOURCE: Scrap Tire Management in Massachusetts: Questions and Answers for Municipal Waste Management Officials (Boston: Massachusetts Department of Environmental Protection, 1991) 2.

While the vast majority of scrap tires are generated by consumers and businesses using passenger tires, this group is responsible for only a small percentage of the tires actually discarded. Rather, it is the automobile and tire industry that discards most scrap tires which they remove from the motor vehicles of their customers at the time of new tire sales. Service stations and tire dealers may charge a fee for the disposal of scrap tires. Regardless, most businesses pay a tipping fee to have the tires removed and disposed of.

To dispose of discarded tires, auto dealerships, service stations and related businesses use tire hauling companies, often referred to as tire jockeys, who charge anywhere from \$.50 to \$1 per passenger tire and considerably more for truck tires. The tire jockey will typically cull each load of discarded tires to identify those which can be reused or retread. He sells these to used tire dealers and retreading businesses. The remaining tires are then disposed of in a variety of ways, including landfilling, stockpiling and illegal dumping. An increasing number of scrap tires are being recycled or are having their energy recovered: enterprises in which some tire haulers have become involved.

The fate of scrap tires is increasingly determined by state policies that have both limited the disposal options for scrap tires and have opened up new markets for the recycled rubber material. A discussion of select state scrap tire management programs follows.

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<sup>5</sup>California Integrated Waste Management Board (CIWMB), Market Development Status Report: Tires (Sacramento: CIWMB, 1993) 11. (Referred to below as CIWMB Report)

<sup>6</sup>Other sources of scrap tires include consumers, companies and fleet vehicle garages.

## II. State Scrap Tire Management Policy

Minnesota was the first state to address scrap tire management through legislation when it passed The Scrap Tire Law in 1984. Included in the laws requirements are: a complete ban on the disposal of tires in landfills; a \$4 tax on vehicle title transfers to fund stockpile cleanup programs and a grant/loan program for companies reusing, recycling, or processing tires; and a number of policies addressing the collection, selling and hauling of tires.<sup>7</sup>

Since 1985, 47 states have followed Minnesota's lead and addressed scrap tire management with legislation.<sup>8</sup> Of the total of 48 state scrap tire programs, 26 ban tires from landfills and 46 include market development incentives, including loans, loan guarantees, grants, tax credits, price preferences and favorable procurement policies.<sup>9</sup>

In Massachusetts, annual scrap tire generation is estimated to range between 4.5 and 6 million.<sup>10</sup> In addition, there are an estimated 7.5 to 20 million tires stockpiled at sites throughout the state.<sup>11</sup> A study prepared for the Northeast Recycling Council (NERC) estimates that scrap tire processing and manufacturing using scrap tires account for 98 jobs in the state.<sup>12</sup> The study also found that scrap tire processing and related manufacturing in Massachusetts account for almost \$30 million in value added to the scrap tires.<sup>13</sup> Among the state's policies to address scrap tire management are a ban on the disposal of whole tires in landfills and an exemption of solid waste regulations for scrap tire collection facilities that are recycling the tires. In addition, the state is working to develop markets for all recyclables, including scrap tires, and the Massachusetts Highway Department is testing the use of rubber in asphalt. Table 2.2 highlights New England states' scrap tire management programs.

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<sup>7</sup>United States Environmental Protection Agency (EPA), Office of Solid Waste, State Scrap Tire Programs: a Quick Reference Guide (Washington, DC: EPA, 1993). (Referred to below as EPA State Report)

<sup>8</sup>Alaska and Delaware are the two states without formal scrap tire management plans.

<sup>9</sup>David Riggle, "Finding Markets for Scrap Tires" BioCycle March 1994: 41.

<sup>10</sup>DEP Solid Waste Report 59; and Scrap Tire Users Directory 67.

<sup>11</sup>DEP Solid Waste Report 59; and Scrap Tire Users Directory 67.

<sup>12</sup>NERC 4.

<sup>13</sup>NERC 9.

**Table 2.2: Highlights of New England States' Scrap Tire Management Programs**

State	Scrap Tire Program	Other Activities
Connecticut	<ul style="list-style-type: none"> <li>• State has a 10% price preference for products made from recycled materials.</li> <li>• Tires may be accepted at landfills until there are sufficient facilities with tire recycling capabilities.</li> <li>• All tire storage facilities must be licensed with the state Department of Environmental Protection.</li> </ul>	<ul style="list-style-type: none"> <li>• Exeter Energy Project, one of two tire-to-energy facilities in the country, is located in Sterling, CT and burns 300 tons of scrap tires a day. It receives scrap tires from throughout New England.</li> </ul>
Maine	<ul style="list-style-type: none"> <li>• Scrap tire haulers must be licensed.</li> <li>• A \$1/tire advance disposal fee paid on the retail sale is used to fund stockpile cleanup and scrap tire recycling grant and loan programs.</li> <li>• There are no restrictions placed on the disposal of scrap tires.</li> </ul>	<ul style="list-style-type: none"> <li>• The number of pulp and paper mills in the state provide a sizable market for tire-derived fuel.</li> </ul>
Massachusetts	<ul style="list-style-type: none"> <li>• Whole tires are banned from landfills.</li> <li>• Scrap tire collection facilities that recycle scrap tires are exempt from state solid waste regulations.</li> </ul>	<ul style="list-style-type: none"> <li>• The state highway department is currently testing the use of rubber in asphalt.</li> </ul>
New Hampshire	<ul style="list-style-type: none"> <li>• Whole tires are banned from landfills.</li> <li>• The collection and disposal of scrap tires may only be undertaken by state-approved contractors.</li> </ul>	
Rhode Island	<ul style="list-style-type: none"> <li>• A \$.50/tire tax is collected on new tire sales to fund grant and research programs on scrap tire disposal and recycling as well as educational and technical assistance programs addressing a number of hard-to-dispose materials.</li> </ul>	
Vermont	<ul style="list-style-type: none"> <li>• Tires are banned from disposal in landfills.</li> <li>• Market development grants are available for new products using recycled materials.</li> <li>• Loans are available to businesses involved in the processing of scrap tires, or manufacturing using scrap tires.</li> </ul>	<ul style="list-style-type: none"> <li>• The Agency of Transportation is currently experimenting with the use of shredded tires for slope stabilization as well as the use of rubber in asphalt.</li> </ul>

SOURCE: United States Environmental Protection Agency (EPA), Office of Solid Waste, State Scrap Tire Programs: a Quick Reference Guide (Washington, DC: EPA, 1993).

One state program, the California Integrated Waste Management Board (CIWMB), has been organized to develop markets for recyclable materials, including discarded tires. CIWMB administers the California Tire Recycling Management Fund which issued \$1 million in grants in FY 1993-94 to fund

business development, innovative research and local government assistance in the area of tire recycling.<sup>14</sup>

As discussed in Chapter One, the federal government's current involvement in solid waste management was established by the Resource, Conservation and Recovery Act (RCRA). Among RCRA's mandates was that EPA prepare guidelines for the purchase of retread tires in federal agencies and agencies using federal funds to purchase supplies. Current federal law requires all federal agencies that purchase tires "to implement a preference program favoring the purchase of retread tires or tire retreading services to the maximum extent practicable."<sup>15</sup> In addition, EPA's Office of Solid Waste has produced several reports on scrap tire management and markets as well as worked with states in their development of policies to manage scrap tires.

More than any other factor, state programs limiting the disposal options for discarded tires have played a significant role in the development of markets for scrap tires. As disposal options have been reduced, markets have had to be found.

### **III. Markets for Whole Tires: Reuse and Retreading**

#### **Reuse:**

Reuse refers to the use of discarded tires for their original purpose (i.e., one person's discarded tires are placed on another's vehicle). Typically, these tires have enough tread remaining to allow for additional miles of driving. EPA estimates that 10 million tires are reused each year.<sup>16</sup> If demand were greater, EPA estimates that more than twice as many discarded tires could qualify for reuse.<sup>17</sup>

#### **Retreads:**

Retreads extend the life of the discarded tire by reusing the tire casing. New tire treads are applied to the casings after the old treads have been removed using a buffer. These buffings, named for the process by which the old tread is removed, can be recycled into a variety of new rubber and composite products.

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<sup>14</sup>California Integrated Waste Management Board, List of Board-Sponsored Projects in Progress: Tire Recycling Program Grantees for FY 1993-94 (Sacramento: CIWMB, 1994) 5.

<sup>15</sup>United States Environmental Protection Agency (EPA), Region 5, Scrap Tire Handbook (Chicago: EPA, 1993) 3. (Referred to below as Scrap Tire Handbook)

<sup>16</sup>Scrap Tire Handbook 1.

<sup>17</sup>United States Environmental Protection Agency (EPA), Office of Solid Waste, Markets for Scrap Tires (Washington, DC: EPA, 1991) 20. (Referred to below as EPA Market Report)

With proper maintenance, retread tires offer the same performance and safety as new tires.

Typically, discarded tires are inspected by tire handlers to determine their suitability for retreading. This is based on the type of tire (medium and heavy truck tires are more likely to be selected because of the high cost of new tires) and the quality of the casing (i.e., the side walls must not be damaged).

According to the Tire Retread Information Bureau, approximately 32.6 million retreaded tires were sold in North America in 1994, including 6.4 million retreaded passenger tires, 8 million retreaded light truck tires and 17.2 million retreaded medium and heavy tires.<sup>18</sup> These numbers represent a continued decline in the number of retreaded passenger tires being sold and a slight increase in the sale of both retreaded light truck tires and medium and heavy truck tires.<sup>19</sup>

Reasons for the decline in sales of retreaded passenger tires include: an increase in competition from cheaper new tires, products of both foreign and domestic producers; a perception that retreaded tires are inferior to new tires and are unsafe; an increase in the number of tires produced that are unsuitable for retreading (i.e., while truck tires are designed for retreading, most passenger tires are not); the additional investment in equipment and inventory required of retreaders because of the increasing variety of new tires produced (e.g., before radial tires, 60 percent of tires were retread); a decreasing number of tire outlets that carry retreads; and, a shortage of good passenger tire casings.<sup>20</sup> This shortage of good casings has plagued the markets for light truck tire retreads as well.<sup>21</sup>

Sales of truck tire retreads have increased because of the significant cost savings they offer. A new front tire for a garbage truck might cost \$560. This tire can be retreaded for \$130, representing a savings of \$330.<sup>22</sup> The tires required for huge earth moving machines can cost as much as \$28,000 new. These same tires can be retreaded for less than \$18,000.<sup>23</sup> Retreading just one of these tires represents a savings of \$10,000. When this savings is multiplied by the number of tires on the vehicle, the lifetime of the vehicle and the number of vehicles in the fleet, the savings is significant. Typically, a truck tire can be retreaded 2 to 4 times depending on how well the tire has been maintained during use. Despite

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<sup>18</sup>Tire Retread Information Bureau (TRIB), 1995 Fact Sheet on Retreaded Tires (Pacific Grove: TRIB).

<sup>19</sup>CIWMB Report 20.

<sup>20</sup>CIWMB Report 21.

<sup>21</sup>Mark Phillips, "Retreaders Advance at Retreat," Tire Review March 1995: 32.

<sup>22</sup>Mary B. Sikora, "A Little Retreading Goes a lot of Miles," Resource Recycling December 1990: 50.

<sup>23</sup>Tire Retread Information Bureau (TRIB), Retreading Provides Monster Savings for Monster Tires (Pacific Grove: TRIB).

the considerable savings and ease with which truck tires can be retreaded, the Tire Retread Information Bureau estimates that up to 30 percent of truck tires that are scrapped could be retreaded.<sup>24</sup>

In addition to representing a cost savings, retreading tires saves energy. One new truck tire requires approximately 22 gallons of oil, most of which is found in the casing of the tire which is reused. Only 7 gallons of oil are used when a truck tire is retreaded, representing a savings of 15 gallons of oil.<sup>25</sup> Similarly, about 7 gallons of oil are required to produce a new passenger tire, while a retreaded passenger tire uses only 2 1/2 gallons of oil. The Tire Retread Information Bureau estimates that retreading conserves more than 400 million gallons of oil annually.<sup>26</sup>

Retreaded tires are the choice of many trucking fleets and shipping companies, including Federal Express and United Parcel Service; are used on earth moving machines, off-road-vehicles and school buses; and, are used by the majority of commercial airlines. Further, since a 1993 Executive Order mandating the use of retreaded tires on government vehicles, retreaded tires have found an even wider audience.

Today, a significant increase in the number of discarded tires being retreaded appears unlikely. In the trucking industry, where there is a considerable cost savings and an educated consumer, the markets are mature with little room for expansion. Also, the industry is currently experiencing a shortage of good truck tire casings. In the case of retreaded passenger tires, sales are decreasing, the cost savings are limited and the consumer has little information on the benefits of retread tires. While groups like the Tire Retread Information Bureau are attempting to address this knowledge gap, they cannot halt the influx of inexpensive imported passenger tires that currently make the retreading of passenger tires uneconomical.

#### **IV. Markets for Whole Tires: Civil Engineering and Miscellaneous Applications**

The Scrap Tire Management Council estimates that approximately 9 million discarded tires in 1994 were used in civil engineering projects, almost 4 percent

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<sup>24</sup>Tire Retread Information Bureau (TRIB), New Materials and Technology for Repairs on Truck Tires (Pacific Grove: TRIB) 3.

<sup>25</sup>Tire Retread Information Bureau (TRIB), Retread Tire Program Means Big Savings for Utility (Pacific Grove: TRIB) 3.

<sup>26</sup>1995 Fact Sheet.



of the 242 million tires discarded that year.<sup>27</sup> This number is projected to increase to 15 to 25 million by 1996.<sup>28</sup>

#### Artificial Reefs / Marine Habitat:

Since the 1960s, government agencies and private organizations have been involved in the construction of artificial reefs throughout the United States. When tires have been used, ballast is attached to the tires which are then strung together and submerged off-shore or in lakes. Artificial reefs can range in size from a few tires to over one million tires. They are used to improve marine life habitat and, in turn, sports and commercial fishing conditions.

Opportunities for artificial reef construction to utilize scrap tires are limited. Most reefs that were needed have been built and less expensive substitute materials like rock and concrete rubble are available for additional reef construction. However, CIWMB has recently approved a grant to a company to build a "sea-floor farm" off the coast of Newport Beach, CA. The farm plans to use 30,000 tires to facilitate the growth of mussel beds.<sup>29</sup>

#### Breakwaters:

Breakwaters are used to protect marinas as well as shorelines and marshlands subject to erosion. They are placed offshore where they lessen the impact of the waves before they reach the shore. In one technology, whole tires are bundled together after they are filled with plastic or foam rubber. With an average size of 300 tires, breakwaters represent a relatively small market for scrap tires, consuming approximately 30,000 to 50,000 tires per year.<sup>30</sup>

#### Erosion Control:

Whole tires have been banded together and buried on unstable slopes (like highway shoulders) to reinforce the slopes and control erosion. While this use has met with success in California and elsewhere and offers a significant cost savings over alternative materials, it utilizes relatively few scrap tires and has met with resistance in areas of high visibility.<sup>31</sup>

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<sup>27</sup>Scrap Tire Use/Disposal Study 1994 Update (Washington, DC: Scrap Tire Management Council, February 1995) ii. (Referred to below as Scrap Tire Update)

<sup>28</sup>Scrap Tire Update ii. ...

<sup>29</sup>CIWMB Report 39. ...

<sup>30</sup>EPA Market Report 32.

<sup>31</sup>EPA Market Report 33.

### Crash Barriers:

While the use of whole tires as highway crash barriers has been studied with positive results, this does not represent a widespread use. State transportation departments generally prefer the use of sand-filled crash barriers which offer similar performance and are easier to erect and dismantle as well as transport.

### Playground Equipment:

Tire playgrounds are an inexpensive alternative to other playground materials like wood. However, playground equipment represents a very limited market for scrap tires. EPA estimates that if the market for playground equipment were completely developed, less than one million tires per year would be required.<sup>32</sup>

## **V. Markets for Split Tires**

Splitting tires involves the removal of both the bead and the tread. A stamp or punch is then used to produce new products, including floor mats, shoe soles, belts, assorted automobile parts, dock bumpers and fishing and farming equipment.<sup>33</sup> These products represent niche markets and, as such, consume only a limited amount of scrap tires. This market generally uses only bias ply tires or fabric bodied radial tires. With the increasing popularity of steel belted radial tires, it is unlikely this market segment will increase substantially. The Scrap Tire Management Council estimates that split tire products account for the recycling of approximately 8 million scrap tires generated annually, or 3.5 percent of the market.<sup>34</sup>

## **VI. Markets for Shredded Tires**

### Tire-Derived Fuel:

In 1994 an estimated 101 million tires were used as fuel nationwide.<sup>35</sup> This use currently represents the largest market for scrap tires and is expected to remain the largest market in the near future.

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<sup>32</sup>EPA Market Report 33.

<sup>33</sup>EPA Market Report 34.

<sup>34</sup>Scrap Tire Update 2.22.

<sup>35</sup>Scrap Tire Update ii.

Tires contain a significant amount of oil: 7 gallons per passenger tire and 22 gallons per truck tire. A passenger tire has an energy equivalent to roughly 2 gallons of gasoline and, pound for pound, contains approximately 5,000 BTUs' more energy than coal . In addition, scrap tires are less expensive than most fuel sources and produce fewer emissions when burned.

Scrap tires can be used as fuel in two forms: as whole tires or as tire-derived fuel (TDF), depending on the nature of the combustion facility and available equipment. TDF refers to scrap tires that have been processed (shredded, ground or chipped) into pieces measuring 1 to 6 inches in length and 1 to 2 inches in width. Depending on the type of combustion facility for which it is being produced, metal may or may not be removed from TDF.

The advantages of burning whole scrap tires for fuel include the cost-savings associated with not having to process the tires which EPA estimates is between 17.9 and 24.4 cents per tire.<sup>36</sup> However, for reasons including the high cost of the equipment needed to deliver whole tires into the combustion facility, most facilities that use scrap tires for energy are burning the already shredded TDF.

There are primarily three types of combustion facilities that can use tires as fuel: power plants, cement kilns, and pulp and paper mill boilers. To date, scrap tires can be used to generate power in two ways: through dedicated tire-to-energy facilities and as a supplemental fuel in utility and industrial boilers.<sup>37</sup> The use of TDF in utility and industrial boilers, which provided a market for 22 million scrap tires in 1994, is considered experimental in some types of boilers.<sup>38</sup> There are currently two tire-to-energy facilities in the United States burning whole tires to generate power, including the Exeter Energy Project in Sterling, Connecticut. Together they consumed 15 million scrap tires in 1994.<sup>39</sup>

Cement kilns, which used 37 million scrap tires for fuel in 1994, are well suited to use either whole or shredded tires as a supplementary fuel source (the form of the tires depends on the specific facility's equipment).<sup>40</sup> As a result of high operating temperatures as well as the make-up of cement, no residue is left after the burning of tires. Also, cement kilns can switch among fuels with relative ease, depending on cost and availability, whereas other combustion facilities may require a significant capital investment to burn tires.

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<sup>36</sup>EPA Market Report 27.

<sup>37</sup>Michael H. Blumenthal, "Tires," The McGraw-Hill Recycling Handbook, ed. Herbert Lund (New York: McGraw-Hill, 1993) 18.21.

<sup>38</sup>Scrap Tire Update ii.

<sup>39</sup>Scrap Tire Update ii.

<sup>40</sup>Scrap Tire Update ii.

Over one dozen pulp and paper mills, including a number in Maine, are currently burning dewired TDF as a supplemental fuel. Large mills have the capacity to burn as much as 100 tons of dewired TDF per day, or 3.5 million passenger car tire equivalents per year.<sup>41</sup> In 1994, 27 million scrap tires were used to fuel pulp and paper mill boilers.<sup>42</sup>

#### Landfill Construction and Operation:

While whole tires represent a potential risk to landfills, and a number of state scrap tire management programs have banned the landfilling of scrap tires altogether, the use shredded tires (commonly referred to as tire chips) in the construction and operation of landfills represents a growing market. Specific applications include the use of shredded tires to assist in constructing leachate collection systems and as partial daily cover material. In this latter use, the tire chips are mixed with dirt to increase the compaction of material in the landfill and to allow greater amounts of water to infiltrate the landfill.

#### Other Markets for Shredded Tires:

Additional uses for tire chips represent smaller markets, including their use as a bulking agent for sludge composting, as aggregate to replace stone and gravel road surfaces located at construction and landfill sites or at equestrian and livestock arenas, and as an absorbent for oils, sludges, and chemicals classified as hazardous waste. Also, an increasing amount of tire chips are being used as subgrade fill in the construction of highway shoulders and other fill projects. The viability of any use will depend, in part, on the cost of the particular material, in this case tire chips, compared to the cost of substitute materials. With some of these other markets, the materials for which tire chips would serve as a substitute are less expensive.

### **VII. Markets for Crumb Rubber**

The production of crumb rubber involves the shredding of scrap tires to 3/4-inch chips at which point a magnetic and fiber separator is used to remove steel and polyester fragments from the rubber.<sup>43</sup> The rubber chips are further reduced using a granulator to achieve the desired crumb size. Depending on the application, the crumb might be reduced to a size ranging from 10-mesh to 200-mesh, with the more high-tech uses requiring a finer crumb.

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<sup>41</sup>Blumenthal 18.18.

<sup>42</sup>Scrap Tire Update ii.

<sup>43</sup>The steel is recycled into steel rebar and other products.

Historically, crumb rubber has been produced from buffings generated by retreaders. However, as whole tires are increasingly banned from landfills, and as the demand for crumb rubber grows, more scrap tires will find new life as crumb rubber. To avoid the extra cost of cleaning the tires before processing them, crumb rubber processors generally use tires that have recently been discarded.

Crumb rubber is often mixed with plastic granules and can be incorporated into a wide variety of rubber sheet and molded products including carpet underlay, floor mats, mud guards, pens and bulletin boards, assorted automobile parts and sports equipment. Further, crumb rubber can be used to produce garbage cans, extruded products like sprinkler hoses, and a variety of athletic and playground surfaces.

#### Soil Amendment:

One growing market for crumb rubber is as a soil amendment. In this patented application, a mix of crumb rubber and compost is applied to athletic fields, golf courses, the grounds of outdoor auditoriums and other high traffic outdoor areas. Among the benefits of this product are reduced soil compaction, improved root penetration and density of turf and improved percolation because the crumb rubber makes the soil more porous. Also, less water is required and less fertilizer and pesticides are necessary because the crumb rubber limits weed growth.<sup>44</sup> Another recently patented use for crumb rubber is as a top dressing of turf in high-traffic areas. The crumb rubber protects the crown of the plant, provides cushioning to the surface, helps reduce soil compaction and helps conserve water by allowing it to permeate the surface but reducing the amount of evaporation that would typically occur.

#### Rubber-Modified Asphalt:

The primary use for crumb rubber is as an additive in asphalt. This use, commonly referred to as rubber-modified asphalt (RMA), offers the potential of consuming a significant number of scrap tires generated annually. There are two main processes by which the crumb rubber is used with asphalt: the wet process and the dry process. The wet process involves the blending of asphalt cement with crumb rubber to form an asphalt binder called asphalt rubber (AR). AR can be used as a surface treatment to provide a new surface to an aging road. AR can also be used as a crack/joint sealant in road repair. Finally, AR can be used in a hot mix and applied like conventional asphalt.

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<sup>44</sup>Rebound: Quality Turf Management (Denver: JaiTire Industries, 1992).

In the dry process, the crumb rubber contains both large and small rubber particles and replaces some of the hot aggregate which is then mixed with conventional asphalt cement. In this application, it is not necessary for reinforcing elements of the tire (i.e., steel and fiber) to be removed. Also, because the asphalt binder used in the dry process is the same as that used in conventional asphalt, no special equipment is required to mix and apply the product.

In the United States to date, the wet process has been more widely tested over a longer period of time than the dry process which, if the different applications are used in equal amounts, typically uses two-thirds more rubber per mile of pavement than AR.<sup>45</sup>

The advantages claimed for the use of crumb rubber in asphalt include that it strengthens aging or damaged roads, that it makes roads more resilient, longer lasting and skid-resistant, that it offers reduced noise levels and light reflectivity, that it provides ice resistance and that it makes roads less prone to abrasion. Asphalt containing crumb rubber can cost almost twice as much as conventional asphalt and, as critics point out, there exist no widely accepted findings that the use of crumb rubber in asphalt represents a significant benefit over conventional asphalt.

Advocates respond to concerns about cost in the following ways: 1) comparisons have been based on equal applications while it is likely that less RMA would need to be applied; 2) the costs of producing RMA are increasing less than the costs of producing conventional asphalt; 3) RMA requires less maintenance; and, 4) roads paved with RMA can last twice as long as roads that use conventional asphalt. Also, as the use of crumb rubber in asphalt increases and contractors become more familiar with the product and acquire any additional equipment they need, it can be expected the cost will decrease.

The use of crumb rubber in asphalt received considerable support and attention in 1991 with the passage of the Intermodal Transportation Efficiency Act (ISTEA). Section 1038 mandated the use of crumb rubber in federally funded highway projects beginning in 1994; specifically, 5 percent of each state's federally funded highway projects were to use RMA with this percent increasing by 5 percent each year until 1997 where it would remain at 20 percent. As a result of strong opposition from state highway officials, their national association and conventional asphalt interests, this section has been tabled since 1993 (i.e., no funds can be used to implement or enforce the provisions of Section 1038). It is

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<sup>45</sup>EPA Market Report 37.

unlikely this position will be overturned during the 104th Congress and there is a remote possibility the section will be repealed altogether.<sup>46</sup>

### Playground Surfaces:

An increase in the use of crumb rubber in playground surfaces can be attributed to two reasons. First, local governments' are increasingly cost conscience. Rubberized playground surfaces require limited maintenance and last longer than alternatives like wood chips. Second, a growing number of cities and school districts are electing to comply with the Americans with Disabilities Act which calls for increased wheelchair accessibility. The flat, stationary rubberized playground surfaces allow for much greater maneuverability for wheelchairs. EPA estimates that over 8.6 million scrap tires are utilized in the production of these products annually.<sup>47</sup>

A more detailed discussion of markets for crumb rubber as well as a plan for a crumb rubber venture can be found in Chapter Three.

## VIII. Pyrolysis

Tire pyrolysis refers to the burning of tire chips in the absence of oxygen. This technology decomposes the rubber into three recoverable components: carbon black, oil and gas. The carbon black can be used in, among other things, the manufacturing of new tires and as an ingredient in printing inks and pigments. The oil can be used as low-grade fuel oil, and the gas generated in the process is typically burned to fuel the pyrolysis. While a number of companies are experimenting with the commercialization of pyrolysis, markets are limited due to high start-up costs, inexpensive and abundant alternative materials and the inconsistent quality of materials recovered from the process. The Scrap Tire Management Council estimates that pyrolysis accounted for the use of 100,000 to 400,000 scrap tires in the United States in 1994.<sup>48</sup>

## IX. Conclusion

It can be expected the number of creative and innovative uses for scrap tires will continue to grow as state scrap tire management programs further restrict

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<sup>46</sup>In recent hearings on Capital Hill, Section 1038, along with a number of other pieces of legislation, has been attacked as an unfunded federal mandate. While there has been movement to place a moratorium on any new unfunded federal mandates, it remains to be seen what, if any, laws will be repealed.

<sup>47</sup>EPA Market Report 35.

<sup>48</sup>Scrap Tire Update ii.

the disposal options for discarded tires. Entrepreneurs and inventors will respond, identifying additional markets for whole tires, tire chips and crumb rubber. With the support of state offices of recycling market development and other government offices as well as private banks and foundations, the number of scrap tires-related business will increase.



## Chapter Three

### A PLAN FOR A COMMUNITY VENTURE

As discussed in Chapter Two, a growing number of scrap tires are finding markets as crumb rubber. The tires are reduced by a mechanical process to sizes ranging from 1/4" to 80 mesh and finer.<sup>1</sup> The increasing number of markets for crumb rubber as well as the increased value added to the scrap tires has attracted a growing number of entrepreneurs to the business. In many cases, these businesspeople are already involved in the scrap tire handling business and in the shredding of whole tires for use as fuel, commonly referred to as tire-derived fuel (TDF); or, are manufacturers that use crumb rubber and are choosing to get into the production of the material. In still other cases, entrepreneurs without prior experience in either tire handling or manufacturing with crumb rubber are attracted to the business.

This growing interest in crumb rubber has paralleled, and is a part of, an increased interest in market development for a number of scrap materials, including paper, plastics and wood wastes, as discussed in Chapter One. These opportunities have attracted private investors as well as nonprofit community-based organizations interested in generating economic development. While the motivations of the two groups are different (i.e., private investors are primarily concerned with generating a profit, while community-based organizations are primarily concerned with job creation), the potential outcomes are the same. In addition to the creation of jobs and generation of an operating profit, materials that were previously considered waste can find new life as raw materials used to manufacture new products. This last outcome can prove particularly attractive to nonprofit groups interested in the additional benefit of contributing to the environment. However, if both benefits are to be fully realized and sustained, the business must be profitable.

What follows is a detailed analysis of the potential for a community-based venture in the production of crumb rubber, including a description of a potential business; an analysis of the various markets for crumb rubber, including the potential for market growth; a financial plan for a crumb rubber business; and, a discussion of the viability of this business, in terms of job creation, environmental benefit and profit generation.

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<sup>1</sup>Mesh is the term commonly used to measure the size of crumb rubber. During the production process, the rubber is sized by the mesh or screen over which it passes. The greater the number of openings per linear inch allowing rubber to pass through, the finer the mesh. For example, 30 mesh means there are 30 openings per linear inch.

## I. A Community Crumb Rubber Venture

### The Business:

There are two types of crumb rubber businesses; those that receive whole scrap tires which are then processed into crumb and those that receive small tire shreds, commonly referred to as tire chips, which are then processed into crumb. Those businesses receiving whole tires were likely involved in the scrap tire handling business and in the production of TDF prior to investing in the crumb rubber business. Businesses starting with whole tires have the additional benefits of receiving a tipping fee for each tire they collect and the option to sell the tire chips to pulp and paper mills, cement companies and other industries to be used as fuel.<sup>2</sup> In addition to selling TDF, whole tire processors may also sell tire chips for use in a variety of civil engineering applications including in landfills to help manage leachate and as fill along highway embankments. These additional sources of revenue may permit them to sell the crumb for less than a business processing tire chips for which they are paying.

However, businesses processing crumb from tire chips are able to avoid the additional equipment, labor and real estate costs associated with the collection of whole tires. This equipment typically includes any vehicles needed to transport whole tires to the processing plant and to move the tires once they arrive at the facility, as well as tire debadders and the primary shredding equipment that reduces the whole tires to tire chips. Depending on the quality and size of the chips being produced, more than one machine may be required. Maintenance costs on the equipment can be as high as \$.10 per tire.<sup>3</sup> Further, there is considerably more labor required when handling whole tires, and a much larger facility is needed to both accommodate the additional equipment and to store the bulky tires. Finally, the scrap tire handling business is more mature than the crumb rubber business, so new ventures getting involved at this stage are more likely to meet stiff competition for the collection of whole tires.

Regardless of the stage at which the producer begins to process the scrap rubber into crumb, many crumb rubber businesses also become involved in product development or the marketing of products that use crumb rubber. In addition to the benefit of an added source of income, this allows businesses to create an internal market for the material as well as to become more knowledgeable of the various applications of crumb rubber. Also, the development and production of new products could open inroads into additional markets.

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<sup>2</sup>These businesses charge fees to accept the whole tires. These fees can range from \$.30 to \$1.00 each for passenger tires to \$5.00 per truck tire. Tipping fees for earth moving tires can be significantly higher.

<sup>3</sup>Lloyd Stoyer, "Why Most Tire Shredders Go Broke," Modern Tire Dealer June 1994: 68.

There are four primary processes used to produce crumb rubber: the crackermill process, the granulator process, pulverization and the cryogenic process. In the crackermill process, tire chips are torn apart as they are passed through rotating corrugated steel drums at ambient temperatures. In the granulator process, revolving steel plates shear apart the scrap tire rubber at ambient temperatures. These two processes are the most common. Both are energy intensive and require regular maintenance.

Pulverization incorporates the use of centrifugal acceleration to throw the chips against sides of the containment equipment. The energy is great enough to cause the chips to break apart upon collision. In the cryogenic process, the tire chips (or whole tires) are frozen using liquid nitrogen at which point they are sent through a two-stage hammer mill and are crushed. This method requires less electricity and less equipment. However, the liquid nitrogen is very expensive and is required in sizable quantities -- a pound of liquid nitrogen for every pound of output. Equipment using naturally cooled air as a substitute for liquid nitrogen is currently available, but is widely considered experimental.

#### The System:

The following analysis focuses on a business producing crumb rubber from tire chips as opposed to whole scrap tires. The primary reasons for becoming involved at this stage are to avoid the significantly higher start-up costs required for a whole tire processor and to take advantage of the relatively low cost of tire chips (as low as \$5.00 per ton depending on the quality and area of the country). For community-based businesses, it is particularly desirable to keep costs down.

For this analysis, a granulator processing system from Granutech-Saturn Systems in Shady Grove, Texas has been chosen to produce the crumb rubber. Granutech is the only company that manufactures all the machinery required for a complete turnkey system (i.e., it includes everything needed to start a crumb rubber operation). The principal components of that system are as follows:

- the Model 80 Chipper is the first piece of equipment in the process. 2" tire chips are placed in the hopper and sent through the machine where revolving steel plates reduce the chips to 5/8";
- a magnetic metal separator is located at the end of the Model 80 Chipper and removes 98 percent of the metal from the tire chips;
- the chips are fed by a conveyor into the G3 Granutech Primary Unit which reduces the 5/8" material to 1/4" and removes almost all remaining metal and fiber;

- a series of high output powderizers are used to generate 1/8", 10, 20 and 30 mesh crumb rubber. During this process oversized material is recirculated until it reaches the desired size; and,
- the material is then separated, classified, and routed to an automated weighing and bagging system for shipping.

To produce a finer crumb, additional processing equipment is required. The system described above can process 3,000 pounds of tire chips per hour, or the equivalent of 750,000 passenger tires per year based on two shifts. More expensive equipment can process 2 to 4 times as many tires per year.

This turnkey system is relatively expensive at a cost of approximately \$1.3 million. Many crumb rubber producers are able to put together less expensive systems from a combination of used equipment, new equipment from a variety of suppliers and by designing and constructing their own equipment. However, these custom systems require considerable in-house knowledge and experience (i.e., the business has to know exactly what they need, what they are getting and how to maintain equipment from a number of manufacturers). With individual pieces of such a system costing as much as \$300,000, one bad purchase or the inability to properly maintain the equipment can cause a business to fail.

Granutech has been in the tire processing business longer than most companies and offers extensive product support, including training in the use and maintenance of the equipment as well as a warranty. It is important for any start-up venture to minimize its risk. Without prior experience in the processing of tires, the added security of a Granutech system is worth the additional investment.

#### Pricing:

As a rule of thumb, one can generate 12 pounds of crumb rubber from each 20 pound passenger tire. Accordingly, 60 percent of the throughput will be generated as output. It is possible to capture a greater percentage depending on the quality of the tire chips. With nominal chips, which have not had any fiber or metal removed, the 60 percent rule should apply. With clean chips, which have had most of the fiber and metal removed, it should be possible to generate a greater output. The metal removed during the processing is predominantly steel and can be sold at a price ranging from \$10 to \$40 per ton.<sup>4</sup> For this analysis, it is assumed that tire chips purchased are nominal and that one ton of steel is captured for every ten tons of tire chips processed. The fiber is usually given away.

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<sup>4</sup>Stoyer 69.

The cost of tire chips depend upon size, quality, the quantity purchased and the markets within a given area. In general, the average price for one ton of 2" nominal chips is \$28 with a range of \$5 to \$45 per ton.<sup>5</sup> The price for crumb rubber varies by size, quantity, quality and the markets served. Table 3.1 contains average market prices for assorted sizes of crumb rubber.

**Table 3.1: Average Market Prices for Crumb Rubber**

Size	Average Price	Range
1/4"	\$.09/lb. (\$180/ton)	\$.02 - \$.15/lb. (\$40 - \$300/ton)
3/8"	\$.08/lb. (\$160/ton)	\$.04 - \$.13/lb. (\$80 - \$260/ton)
10 mesh	\$.12/lb. (\$240/ton)	\$.06 - \$.17/lb. (\$120 - \$340/ton)
20 mesh	\$.15/lb. (\$300/ton)	\$.07 - \$.20/lb. (\$140 - \$400/ton)
30 mesh	\$.17/lb. (\$340/ton)	\$.12 - \$.21/lb. (\$240 - \$420/ton)
40 mesh	\$.23/lb. (\$460/ton)	\$.16 - \$.25/lb. (\$320 - \$500/ton)
80 mesh	\$.45/lb. (\$900/ton)	\$.30 - \$.65/lb. (\$600 - 1,300/ton)

SOURCE: 1994 Price & Market Survey conducted by Recycling Research Institute.

**Business Location:**

The Granutech system requires 10,000 square feet of indoor space with a 22' clearance. It is estimated that a business would need an additional 8,500 square feet of indoor space for an office and storage. Storage space is required due to the seasonal nature of the business (i.e., demand for crumb rubber is greatest during the spring, summer and early fall, so storage is required for the rubber produced during the winter).

As a community-based venture, the business would likely seek a location in an inner-city, low-income industrial area. In Dorchester, MA, for example, 8,500 square feet of manufacturing space would currently lease for approximately \$4.00 per sq. ft. For this analysis, it is assumed the space chosen is already equipped with the necessary electrical wiring to support the crumb rubber processing equipment. An important feature for a business of this nature is its proximity to its customers. Further, a crumb rubber business will likely draw customers from its home region and beyond, making proximity to major transportation arteries essential.

**Personnel:**

The employment requirements for crumb rubber businesses are relatively limited. In fact, many equipment suppliers emphasize the minimal labor requirements to prospective customers. It is assumed that three people are

<sup>5</sup>Scrap Tire Users Directory 1995 Edition (Suffield: Recycling Research Institute, 1995) 70.

required to run the Granutech processing equipment. One person is stationed at the infeed, managing the intake of tire chips; another employee manages the outfeed of the crumb rubber, including overseeing the bagging of the material and transferring the crumb rubber to a storage area; and, a third employee serves as a systems operator and troubleshooter with responsibility to run the equipment, including monitoring the throughput rate and the proper operation of the equipment. While some training is required for each of these jobs, they could easily be filled by individuals with limited skills.

The business is assumed to operate two shifts each day thereby creating a total of six low skill jobs. For the financial analysis found later in this chapter, the wage for two workers per shift are each assumed to be \$12 per hour (equivalent to \$33,000 annually including the cost of benefits). The third worker per shift is assumed to draw an hourly wage of \$10 (equivalent to approximately \$27,000 per year with benefits). These wages may be higher than necessary, but reflect the first priority of community development corporations involved in business development: the creation of good jobs.

The business is also expected to have a manager overseeing all aspects of the operation, including purchasing, sales and marketing, personnel, production and distribution. To attract a qualified individual with prior management experience in rubber manufacturing or a related industry, an annual starting salary of \$53,000 including the cost of benefits is assumed.

At least in the initial stages of the venture, it is assumed the services of a crumb rubber broker would be enlisted to help identify markets and find customers for the material. On average, brokers receive \$.01/lb., or \$20/ton, as a commission.

In the crumb rubber business, it can typically take two years for producers to reach capacity (i.e., the point at which they are selling all the rubber being produced).<sup>6</sup> However, even at this point, because of holidays, equipment breakdowns and sales' cycles, no business is ever at 100 percent capacity. In the financial analysis below, gross sales are adjusted by 14 percent to account for these downtimes. Given this time to capacity, it is not expected the business would hire more employees in the foreseeable future. Should the demand exceed supply, a third shift could be added or additional processing equipment purchased. A more realistic scenario would see the business becoming involved in the development and production and/or marketing of new products that use crumb rubber. The following discussion of crumb rubber markets highlights areas that might offer this possibility.

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<sup>6</sup>Interview with Pat Knox, Director of Sales for Environmental Rubber Recycling (5/4/95); and Stoyer 69.

## II. The Market

Most of the markets for crumb rubber can best be described as emerging. As supply has grown with an increase in the number of scrap tires being recycled, the crumb rubber has been aggressively marketed and demand for the material has grown. Specifically, demand for crumb rubber has increased as manufacturers have become more knowledgeable and experienced with the use of the material; as government policies mandating recycling and recycled content have been propagated; as costs of substitute materials have risen; and, as consumer demand for recycled products has increased.

The need to find markets for scrap tires and the increasing demand for crumb rubber has resulted in a growing crumb rubber industry which includes a network of equipment suppliers, crumb rubber brokers, producers of crumb rubber and manufacturers using the material. As is true of most new industries, this group has consisted of a relatively small number of businesses dominated by a few suppliers. However, as is also true of new industries, no one supplier, or group of suppliers, has a lock on the market. On the contrary, as new markets have opened and existing markets have grown, the number of suppliers has increased.

There are generally two sources of crumb rubber: tire buffings generated during the tire retreading process and whole scrap tires that are mechanically reduced. Tire buffings, which are generated when the worn tread is removed from the tire casing being prepared for retreading, have historically been the primary source of crumb rubber, accounting for 75 percent of the market in 1994, or approximately 200 million pounds.<sup>7</sup> However, in recent years, the number of tires being retreaded has leveled off, limiting the quantity of available tire buffings. As a result, any increase in the production of crumb rubber is expected to come from the processing of whole scrap tires.<sup>8</sup>

### Markets:

The national market for crumb rubber increased from 160 million pounds sold in 1992 to approximately 248 million pounds sold in 1994.<sup>9</sup> The market is projected to reach 320 million pounds of crumb rubber sold in 1996.<sup>10</sup> The 1994 markets for crumb rubber can be found in Table 3.2. According to *The 1995 Scrap Tire Users Directory*, in 1994 the markets for crumb rubber were as follows:<sup>11</sup>

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<sup>7</sup>Scrap Tire Update 2.15.

<sup>8</sup>Scrap Tire Update 2.15.

<sup>9</sup>Scrap Tire Update 2.15.

<sup>10</sup>Scrap Tire Update 2.21.

<sup>11</sup>Scrap Tire Users Directory 70.

**Table 3.2: 1994 National Markets for Crumb Rubber**

Asphalt:	91 million lbs. per year or 37 % of the total
Tires:	40 million lbs. per year or 16 % of the total
Molded & Extruded Rubber Products:	22 million lbs. per year or 9 % of the total
Bound Rubber Products:	54 million lbs. per year or 22 % of the total
Athletic/Recreation Surfaces:	32 million lbs. per year or 13 % of the total
Friction Materials: <sup>12</sup>	8 million lbs. per year or 3 % of the total

SOURCE: Scrap Tire Users Directory 1995 Edition (Suffield: Recycling Research Inst., 1995) 70.

Crumb rubber has been used in asphalt in varying degrees throughout the country since the 1960's. As discussed in Chapter Two, the advantages claimed for the use of crumb rubber in asphalt, commonly referred to as rubber modified asphalt (RMA), include the strengthening of aging or damaged roads, increased resiliency, greater life-span and skid-resistance, and reduced noise levels and light reflectivity. There are two ways in which the rubber is used in asphalt: as part of an asphalt rubber binder used to seal coat asphalt or to repair joints and cracks (the wet process), or as an aggregate substitution in an asphalt concrete mix (the dry process). When the crumb rubber is used to create an asphalt rubber binder, a size of 30 to 40 mesh is typically required. When used as an aggregate in asphalt concrete, larger crumb is typically used. In this process, the crumb rubber is a more expensive substitute for concrete, ash or recycled asphalt.

Though RMA can cost almost twice as much as conventional asphalt, a number of states have determined that the benefits justify the costs and are actively pursuing RMA programs, including Arizona, California, Nevada, Texas and Florida. Most other states are currently involved in field trials using rubber in asphalt. In most cases, this interest has been driven by the federal government's support for RMA. Specifically, Section 1038 of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) mandated the use of RMA by states on an increasing percentage of federally funded highway projects. To date, Congress has prohibited "the Federal Highway Administration (FHWA) from expending any funds for the implementation, administration and enforcement of Section 1038."<sup>13</sup> As a result, FHWA has indicated that it will not penalize any state not in compliance with the provisions of the section.

When and if this mandate receives funding, demand for crumb rubber will increase significantly. Approximately 450 million tons of asphalt are laid down each year in the United States, of which 200 million tons are federally subsidized and subject to the provision of Section 1038. EPA notes that "assuming ten pounds of crumb rubber can be derived from one scrap tire, the Act should result

<sup>12</sup>Friction materials is considered a mature market with little growth potential. In this application the crumb is used in brake pads and brake shoes.

<sup>13</sup>Scrap Tire Update 2.17.



in the use of approximately...70 million [tires] in 1997."<sup>14</sup> Had Section 1038 received funding, in 1997 20 percent of federally-funded paving projects would have been required to contain crumb rubber. Seventy million scrap tires is more than 15 times the amount currently used in asphalt, and would account for almost 30 percent of the scrap tires generated annually.

Regardless of the ISTEA mandate, the use of crumb rubber in asphalt is expected to gradually increase over the next five years primarily in those states that have already demonstrated a commitment to its use. This increase will be facilitated by the expected development of performance standards by the American Society for Testing and Materials.

New tire manufacturing can utilize up to 5 percent of crumb rubber per tire, though the amount currently consumed is 2 percent.<sup>15</sup> A very fine crumb is used (smaller than 40 mesh) and is typically concentrated in the tread and sidewall of the tire. With the number of tires sold each year increasing, the amount of crumb used in tires is expected to increase. However, there is some concern over a loss of performance associated with this use, so the extent of the growth of this market is uncertain.

Molded and extruded rubber products include truck bed liners, golf cart fenders, bumpers, assorted automobile parts, shoe soles and carpet underlay. In this application, 30 mesh crumb and finer is added to other polymers, such as plastic, to create new products. This market has increased recently because of the growth of the automobile industry. Also, there has been a considerable amount of research and development into uses of various polymer combinations. As a result, this market is expected to continue to grow.<sup>16</sup>

Bound rubber products are formed using the crumb rubber and an adhesive material. These products include mats, tiles, padding, sheet goods, railroad crossing blocks and patio floor material. Similar to the production of molded and extruded rubber/plastic products, this application also requires finely ground crumb of greater than 20 mesh and represents a growing market.

Crumb rubber can also be used in a variety of athletic and recreational surfaces. In these applications, a less fine crumb is usually required, ranging in size from 1/4" to 20 mesh. Products include playground cover consisting of poured-in place rubber surfaces or loose rubber turf, indoor and outdoor track surfaces, rubberized surfaces used in equestrian arenas and as a soil amendment in athletic fields and high-traffic outdoor areas.

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<sup>14</sup>Scrap Tire Handbook 13.

<sup>15</sup>Scrap Tire Users Directory 70.

<sup>16</sup>Scrap Tire Update 2.19.

As local communities comply with the Americans with Disabilities Act, which encourages increased accessibility for the handicapped, demand for poured-in-place rubber surfaces is expected to increase.<sup>17</sup> Also, the rubberized surfaces offer considerable safety benefits over materials for which it is a substitute, including asphalt, woodchips, sand and peastone. Depending on the specific material and the region of the country, crumb rubber surfaces may also be less expensive than substitutes (especially if maintenance costs are considered). The crumb rubber is an inert material, posing no threat to either the environment or children. The growth of this market will be tied to school budgets, but is expected to increase because of the superior performance of these products.

The use of crumb rubber as a soil amendment is also expected to increase. In this patented application referred to as REBOUND, a mix consisting of one-half crumb rubber and one-half compost is applied in varying degrees of thickness to athletic fields and in high-traffic outdoor areas. The rubber reduces soil compaction, increasing root penetration and allowing for greater groundwater recharge. The result is healthier turf, fields with more bounce and faster drying fields and outdoor concert venues. In addition, this application can provide a cost savings over the life of the product (7 to 13 years depending on use and soil conditions).<sup>18</sup>

Many of the markets for crumb rubber are seasonal. The demand from asphalt and landscape companies as well as manufacturers of assorted outdoor surfaces, all of which represent growing markets, is concentrated in the spring, summer and early fall. Demand from manufacturers of assorted rubber products remain relatively constant throughout the year.

The markets for crumb rubber range from local to international depending on the specific application. In the case of rubber-modified asphalt, this market has been concentrated in the Southwestern part of the United States and in Florida, while the markets that use crumb rubber to manufacture new products are found wherever manufacturers of rubber products are located. The use of crumb rubber in playground and athletic surfaces is national.

It should be noted that for some applications transportation costs can limit the size of the market that is served by a particular producer of crumb rubber. For example, for those products that use the less expensive, larger size crumb (1/4" to 20 mesh), including playground and athletic surfaces, transportation costs limit both the area from which manufacturers will purchase crumb rubber and the area from which the manufacturers of these products will draw customers. For these markets, the shipping costs can take a sizable bite out of the value-added to both the crumb rubber and the products for which it is a

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<sup>17</sup>Interview with Michael Harrington, BAS Recycling (3/29/95).

<sup>18</sup>Riggle 44.

feedstock. In the case of Denver-based JaiTire, which has the patent on the use of crumb rubber as a soil amendment, the company is actively seeking dealers throughout the world because of the high transportation costs involved in shipping this heavy product. In the case of products that use the more expensive and finer crumb rubber (30 mesh and higher), transportation costs will likely comprise a smaller fraction of the value-added to the material and the products that are created from it. Accordingly, these costs are less of an issue. Regardless, conversations with crumb rubber producers and brokers suggest that enlisting the services of a skilled freight broker is often all that is needed to find an affordable way to ship the product anywhere in the country.

### Competition:

Five companies accounted for over 80 percent of the crumb rubber sold in the United States in 1994.<sup>19</sup> Three of these companies, which alone accounted for 40 percent of the crumb rubber sold, are located in California. The largest producer of crumb rubber is Baker Rubber, Inc. based in South Bend, Indiana. In addition to a plant in Indiana, Baker has facilities in Pennsylvania and one in Arizona. Its largest customer, National Rubber Company (NRC), is responsible for over 50 percent of Baker's business.<sup>20</sup> NRC makes assorted molded and extruded rubber products. Other customers include asphalt producers and manufacturers of tires and other rubber products. Rounding out the list of the top five producers of crumb rubber is National Tire Services, Inc. based out of South Chicago Heights, Illinois. Of National's seven facilities, only one is producing crumb rubber. The rest of the facilities are processing scrap tires for fuel. One plant is located in Arizona, another is in Georgia and the rest are in the Midwest, including Illinois, Wisconsin and Minnesota.

Interviews with small- and medium-sized producers of crumb rubber as well as observers of the industry do not suggest any concern with the large market share concentrated among these few suppliers. The markets are growing and smaller producers have shared in this growth. Also, for crumb ranging in size from 1/4" to 40 mesh, the large producers typically charge more for the material. One area where the large producers appear to have an advantage is in the production of very fine mesh (i.e., 80 to 200 mesh). Users of this material require an extremely clean, high quality product and the equipment needed to produce it is very expensive. This market is still relatively small and most producers of crumb rubber have yet to make the investment that is required to produce very fine material.

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<sup>19</sup>Kathy McCarron, "Waste Recovery, Baker Top Rankings of Largest Recyclers," Tire Business 20 February 1995: 12.

<sup>20</sup>Interview with Brian Zuckerman, Zee Enterprises (5/4/95). He is a crumb rubber broker.

There are dozens of small- and medium-sized producers of crumb rubber scattered throughout the country, though there is a conspicuous concentration in the Midwest, South and West Coast regions, and in New York. Many of these businesses are also involved in scrap tire collection, the production of TDF and, to a lesser extent, the manufacturing of new products using crumb rubber.

There are currently no companies actively producing crumb rubber in New England. Between the pulp and paper mills in Maine and a large tire-to-energy facility in Connecticut, the majority of scrap tires generated are recovered for their energy value. One operation, F & B Enterprises in Massachusetts, produces TDF as well as equipment for the fishing industry which it manufactures from scrap tires. But no New England state has embraced the use of rubber in asphalt and there are few businesses using virgin rubber that might turn to crumb rubber as a substitute.

If a crumb rubber business were to locate in New England, it is expected some markets for the material would develop. The use of crumb rubber as a soil amendment and in playground surfaces both offer possibilities. There are thousands of athletic fields and outdoor concert venues located throughout the region and New England's heavy clay soils are particularly prone to compaction. Also, rubberized playground surfaces have received excellent performance evaluations and a small but growing number of cities and towns have begun to take notice.<sup>21</sup> Other markets for crumb rubber would not be expected to develop. In particular, it is unlikely the existence of a crumb rubber business would attract manufacturers of rubber products to New England, nor would the use of rubber in asphalt be expected to increase unless mandated by the federal government.

In terms of the expected development of national markets, as mentioned above the use of crumb rubber in molded and extruded rubber/plastic products has increased significantly in recent years. This has been a result of an increase in the price of new rubber for which the crumb rubber is a substitute. In 1994, approximately 3.5 million tons of new rubber, both natural and synthetic, were sold in the United States.<sup>22</sup> This represented an increase of almost 6 percent from 1993. Approximately 65 percent of this rubber was used to manufacture tires and tire products, 10 percent was used to manufacture automobile parts other than tires and the remaining 25 percent was used to manufacture a variety of products including molded and extruded rubber products.<sup>23</sup>

While it is difficult to arrive at an average price per pound for new rubber because of the various grades sold, prices have more than doubled in the last few

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<sup>21</sup>Interview with Paul Willis, Brookline Parks and Receptions Department (5/3/95).

<sup>22</sup>Interview with Dan Mustico, Rubber Manufacturers Association (5/5/95).

<sup>23</sup>Mustico.

years.<sup>24</sup> This price increase is due, in part, to increased demand associated with increased automobile production and, to a lesser degree, the growing market for prophylactics and latex gloves. More than anything else, this increase in the price of new rubber has driven the market for crumb rubber, which is significantly less expensive.<sup>25</sup>

The 35 percent of new rubber sold in 1994 for non-tire related uses accounts for over 1.2 million tons of rubber. Assuming that crumb rubber could be used as a substitute for new rubber in one-half of these applications, the 120,000 tons of crumb rubber sold in 1994 would represent just 20 percent of the market potential.

### III. Risks

Prior to presenting the financial plan for the projected business, it is important to highlight potential risks associated with the crumb rubber venture that have not been specifically addressed in the plan. First, while every attempt has been made to use conservative, yet realistic, assumptions, it is possible the assumptions are not conservative enough (i.e., all the assumptions made for various operating expenses, such as commissions, utilities, maintenance and advertising, might be too low). The estimate for working capital, in particular, may be low given the projected time to capacity, the expected sales cycles, and the possible demand from suppliers for immediate payment and delay in receiving payment from customers. Second, the cost of tire chips and the prices for crumb rubber will fluctuate with shifts in supply and demand. As the evaluation that follows demonstrates, these changes, in particular, can have a significant impact on the bottom line.

There are a number of considerations that could affect the supply and demand of tire chips, all of which may affect the price. Should state or federal clean air requirements become more stringent, the burning of tires for fuel may be made illegal, or additional pollution control mechanisms may render the process prohibitively expensive. In this scenario, it can be expected the price for tire chips would fall as suppliers scrambled to find new markets. However, it is just as likely demand for tire chips will increase, both for its use as fuel and in a growing number of civil engineering applications, as well as for the raw material used in the production of crumb rubber. In this case, it is expected the price for tire chips would rise.

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<sup>24</sup>Mustico.

<sup>25</sup>Mustico; and Zuckerman.

It is also difficult to guarantee a long-term supply of tire chips. Some regions depend on only a few suppliers. Should they leave the business, the cost of the raw material could increase significantly with the additional shipping costs associated with purchasing from suppliers outside the region.

The average market price for crumb rubber could rise or fall for a variety of reasons. While the demand for the material has increased steadily over the last five years, the supply of crumb rubber has kept pace. Supply will increase as the number of crumb rubber businesses grows and as existing businesses increase their operating capacity. While a rough analysis of market penetration suggests that the potential for growth is significant, this growth is not guaranteed and demand will soften at some point regardless of what happens. When it does, the market price of crumb rubber can be expected to flatten, if not decline. This, however, is a long-term risk. In the short-term there are risks associated with increased competition, both from other producers of crumb rubber and from suppliers of crumb rubber substitutes.

In terms of other crumb rubber suppliers, the greatest risk will come from existing businesses becoming involved in the production of crumb rubber through forward or backward integration. Either arrangement might provide a competitive advantage. Forward integration refers to businesses already involved in scrap tire handling and TDF production becoming crumb rubber producers as well. Among the advantages of this arrangement are a third source of revenue: in addition to the tipping fees for accepting the whole tires and income from the sale of tire chips, these businesses would receive income from the sale of crumb rubber. In that they will have much of the infrastructure required for a crumb rubber business already in place, including a plant, maintenance workers and a sales force, they will have an advantage over new entrants that could allow them to sell the crumb rubber for less. With backward integration, a business currently using crumb rubber may decide to diversify into the production of the material. In this scenario, they would take their own business away from another producer of crumb rubber and would have a guaranteed market for some of the material they are producing. In addition, as users of crumb rubber, they would have an advantage in marketing the commodity to others.

The demand for crumb rubber will also be impacted by the supply and demand for substitute materials, both known and unknown. Depending on the application, this list includes new rubber, woodchips, concrete and sand.

Additional potential risks tied to the production of crumb rubber include any uncertainty over the long-term health or environmental impacts associated with the use of the material. While the use of crumb rubber has been thoroughly tested by federal and state agencies as well as independent organizations, it is

impossible to be completely certain that negative impacts will not surface over long-term use.

There is also the risk that a business may depend on a limited number of customers for the majority of its sales. If these customers go out of business, stop using the material or choose to purchase crumb rubber from another producer, the business will be in trouble. There are, however, advantages to servicing a small number of high-volume customers, including some short-term security and the need for a reduced sales force.

More remote risks include a future where tires are manufactured using a material other than rubber, the production of "super" tires that never wear out, a significant decline in the use of automobiles, or a shift in federal and state solid waste policies that once again make it more economical to landfill scrap tires than to recycle them.

#### IV. Financial Plan

This financial plan for a projected crumb rubber business begins with a summary of the assumptions made in undertaking the analysis, including explanations. A breakdown of total start-up capital requirements and a three year projected income statement follows.

##### Assumptions:

<b>Category:</b>	<b>Assumption:</b>	<b>Explanation:</b>
<b>Equipment:</b>	Granutech-Saturn System	While this turnkey system is expensive at \$1.3 million, the capacity matched with the benefits of having product support from an established company justify the higher cost.
<b>Tire Chips (type &amp; cost):</b>	2" nominal chip at \$25.00/ton	This cost per ton of tire chips represents a conservative estimate based on conversations with producers and the published industry average. <sup>26</sup>

<sup>26</sup>Scrap Tire Users Directory 70.

<b>Market Price for Crumb Rubber:</b>	\$ .13/lb. or \$260/ton	This price represents an average of the average prices for the four sizes of crumb being produced.
<b>Throughput:</b>	3,000 lbs./hour	Based on the published capacity of the equipment.
<b>Output:</b>	1,800 lbs./hour	Based on an estimate of 12 lbs. of crumb rubber in each 20 lb. Tire.
<b>Shifts:</b>	2 eight-hour shifts	Two shifts create twice as many jobs and double the daily output.
<b>Work Week:</b>	5 days a week, 52 weeks per year	
<b>Labor (based on 2 shifts):</b>	4 jobs at \$33,000 including benefits; 2 jobs at \$27,000 including benefits; and 1 job at \$53,000 including benefits	While it is possible to hire workers for less, a priority of community-based ventures is the creation of good quality jobs.
<b>Required Space:</b>	8,500 sq. ft. with 22' clearance	A minimum of 10,000 sq. ft. is required for the processing equipment. An additional 8,500 sq. ft. is assumed necessary for an office and storage.
<b>Rent:</b>	\$4.00/sq. ft.	Interviews with commercial real estate brokers in Boston suggested a range of \$3 to \$6 for industrial space.
<b>Market Price for Recovered Steel:</b>	\$15.00/ton	Based on an industry range of \$5 to \$40 per ton.
<b>Steel Output:</b>	One ton of steel is generated for every ten tons of tire chips processed.	Based on conversations with crumb rubber producers. Also, the average steel-belted radial tire contains 2 pounds of steel.



<b>Adjustment to Gross Sales:</b>	14%	Based on holidays, equipment downtime and sales cycles, gross sales are adjusted by a conservative 14%.
<b>Maintenance:</b>	1.5% of the price of the equipment annually	An industry rule of thumb.
<b>Broker Services:</b>	\$.01/lb. sold	On average, crumb rubber brokers receive a commission of \$.01/lb. they sell. It is assumed that a broker handles one-half of the production.
<b>Taxes:</b>	Income taxes: 18% Payroll taxes: 7.95%	Income taxes are calculated at a conservative 18%. Payroll has been taxed at 7.95%.
<b>Working Capital:</b>	\$142,500	Working capital has been calculated to provide enough funds for all operating expenses to be covered during a three month period with no sales.
<b>Loans:</b>	no loans are required.	For the purpose of this analysis, it is assumed that no loans are required.
<b>Depreciation:</b>	over 25 years with a 10% residual factor	Determined by depreciation schedule set forth in the Internal Revenue Code.

Other assumptions made for which explanations have not been provided include the costs of utilities, office supplies, postage and insurance. In every instance, conservative estimates have been used.

#### Total Start-up Capital Requirements:

The total start-up capital requirements are presented in Table 3.3. At a cost of \$1.3 million, the Granutech system accounts for almost 87 percent of the total start-up capital needed for the crumb rubber business. In addition to the processing equipment, a hi-lo is required to move the tire chips to the equipment area for processing, to move the bagged crumb rubber to the storage area and to load bags of crumb rubber onto trucks at the loading dock. It is assumed a used hi-lo would be purchased at a cost of \$5,500. Other capital requirements include miscellaneous office equipment, such as a computer and printer, a copy machine,

a fax machine and assorted furniture. Working capital has been calculated to be \$142,500, or enough money for all operating expenses to be covered during a three month period with no sales.<sup>27</sup> This money is intended to meet current expenses, offset negative cash flow and insure the continued growth of the business.

**Table 3.3: Total Start-up Capital Requirements**

<b>Major Equipment:</b>	Granutech-Saturn	\$1,300,000
	Turnkey System	
	hi-lo (used)	<u>\$5,500</u>
	Total	\$1,305,500
<b>Other Equipment:</b>	Computer, Software & Printer	\$1,500
	Copy Machine	\$500
	Fax Machine	\$500
	Phone System	\$1,000
	Assorted Office Furniture	\$500
		Total
<b>Other Capital Requirements:</b>	Working Capital	\$142,500
<b>Total Capital Start-up Requirements</b>		<u><b>\$1,452,000</b></u>

**Three Year Income Projection:**

In the 3 year income statement presented in Table 3.4, the crumb rubber venture is assumed to operate at 50 percent capacity in its first year, at 80 percent capacity in its second year and at 100 percent capacity in its third year. However, in each year net sales already reflect an adjustment of 14 percent, so in the third year the actual operating capacity is 86 percent. The operating margin

<sup>27</sup>The amount of working capital has been calculated assuming the business is operating at 100 percent capacity.

**Table 3.4: Three Year Projected Income Statement**

	<b>Year One (@ 50%)</b>	<b>Year Two (@ 80%)</b>	<b>Year Three (@ 100%)</b>
Projected Maximum Gross Sales	\$491,400.00	\$786,240.00	\$982,800.00
<b>Net Sales(with adjustments)</b>	<b>\$422,604.00</b>	<b>\$676,166.40</b>	<b>\$845,208.00</b>
less: Cost of goods sold	\$134,160.00	\$134,160.00	\$134,160.00
<b>Gross Margin</b>	<b>\$288,444.00</b>	<b>\$542,006.40</b>	<b>\$711,048.00</b>
Operating Expense			
Salaries and wages	\$239,000.00	\$239,000.00	\$239,000.00
Payroll taxes	\$19,000.50	\$19,000.50	\$19,000.50
Rent	\$74,000.00	\$74,000.00	\$74,000.00
Utilities	\$46,810.40	\$74,896.64	\$93,620.80
Maintenance	\$9,750.00	\$15,600.00	\$19,500.00
Office Supplies	\$900.00	\$900.00	\$900.00
Commissions	\$16,099.20	\$25,758.72	\$32,198.40
Postage	\$2,000.00	\$2,000.00	\$2,000.00
Freight (pass through)			
Maintenance delivery equipment (hi-lo)	\$1,000.00	\$1,000.00	\$1,000.00
Insurance	\$12,000.00	\$12,000.00	\$12,000.00
Legal and accounting	\$4,800.00	\$4,800.00	\$4,800.00
Depreciation	\$46,800.00	\$46,800.00	\$46,800.00
Other: travel, advertising, promotion	\$25,000.00	\$25,000.00	\$25,000.00
<b>Operating expense total</b>	<b>\$497,160.10</b>	<b>\$540,755.86</b>	<b>\$569,819.70</b>
Other expense			
Loan repayments (w/ interest)	\$0.00	\$0.00	\$0.00
Other expense total	\$0.00	\$0.00	\$0.00
Total expense	\$497,160.10	\$540,755.86	\$569,819.70
Profit (loss) pre-tax	(\$208,716.10)	\$1,250.54	\$141,228.30
Taxes	(\$37,568.90)	\$225.10	\$25,421.09
<b>Net profit (loss)</b>	<b>(\$171,147.20)</b>	<b>\$1,025.44</b>	<b>\$115,807.21</b>
<b>Operating Margin</b>	<b>-40%</b>	<b>0%</b>	<b>14%</b>
<b>Return on Investment</b>	<b>-12%</b>	<b>0%</b>	<b>8%</b>

and return on investment at each operating capacity are presented with the income statement.

## V. Evaluation

The following evaluation of this projected crumb rubber business is based upon a number of criteria: the assumptions that went into the analysis; the profit margins and return on investment associated with the three assumptions about operating capacity; the start-up capital requirements; the number of jobs created; the impact on the environment; and, the risks associated with the business.

### Assumptions:

Those factors that have the greatest impact on the profitability of the business are the capacity at which the business is operating, the cost of tire chips and the market price for crumb rubber. Table 3.5 presents the net profit generated for a number of combinations of prices for crumb rubber and tire chips at 50%, 80% and 100% operating capacity.

**Table 3.5: Net Profit as a Condition of Market Price for Crumb Rubber and Price of Tire Chips**

#### At 50% Operating Capacity

Crumb Rubber (\$/lb.)	Tire Chips (\$/ton)				
	\$15/ton	\$20/ton	\$25/ton	\$30/ton	\$35/ton
\$.11/lb.	-\$179,948	-\$201,950	-\$223,953	-\$245,955	-\$267,957
\$.12/lb.	-\$153,545	-\$175,548	-\$197,550	-\$219,352	-\$241,554
<b>\$.13/lb.</b>	-\$127,143	-\$149,145	<b>-\$171,147</b>	-\$193,149	-\$215,152
\$.14/lb.	-\$100,740	-\$122,742	-\$144,745	-\$166,747	-\$188,749
\$.15/lb.	<b>-\$74,337</b>	-\$96,340	-\$118,342	-\$140,344	-\$162,346

#### At 80% Operating Capacity

Crumb Rubber (\$/lb.)	Tire Chips (\$/ton)				
	\$15/ton	\$20/ton	\$25/ton	\$30/ton	\$35/ton
\$.11/lb.	-\$39,459	-\$61,461	-\$83,463	-\$105,465	<b>-\$127,468</b>
\$.12/lb.	\$2,786	-\$19,217	-\$41,219	-\$63,221	-\$85,223
<b>\$.13/lb.</b>	\$45,030	\$23,028	<b>\$1,025</b>	-\$20,977	-\$42,979
\$.14/lb.	\$87,274	\$65,272	\$43,270	\$21,267	-\$735
\$.15/lb.	<b>\$129,519</b>	\$107,516	\$85,514	\$63,512	\$41,510

At 100% Operating Capacity

Crumb Rubber (\$/lb.)	Tire Chips (\$/ton)				
	\$15/ton	\$20/ton	\$25/ton	\$30/ton	\$35/ton
\$11/lb.	\$54,201	\$32,199	\$10,196	-\$11,806	-\$33,808
\$12/lb.	\$107,006	\$85,004	\$63,002	\$41,000	\$18,997
<b>\$13/lb.</b>	\$159,812	\$137,809	<b>\$115,807</b>	\$93,805	\$71,803
\$14/lb.	\$212,617	\$190,615	\$168,613	\$146,610	\$124,608
\$15/lb.	\$265,422	\$243,420	\$221,418	\$199,416	\$177,413

At an operating capacity of 50 percent, the business would operate at a loss even if the average market price for crumb rubber were to increase by \$.02 per pound and the price of tire chips were to drop by almost one-half. At an operating capacity of 80 percent, if the market price for crumb rubber drops by just \$.01 per pound, with all other assumptions remaining the same, the crumb rubber venture would operate at an annual loss of greater than \$40,000. Even at an unrealistic scenario of 100 percent operating capacity, if the average market price for crumb rubber drops by \$.02 per pound and the price of tire chips was to increase by 17 percent, the business would lose almost \$12,000 annually.

In general, Table 3.5 demonstrates the fragility of achieving an operating profit for this crumb rubber venture. If the assumptions made for the average market price of crumb rubber or the cost of tire chips are slightly off, or should adjustments in the market occur, a projected operating profit can easily become an operating loss.

One assumption made that is likely unrealistic is that no loans would be required to start the business, so there would be no debt service. It is unlikely a community development organization would have available the required capital investment without borrowing money. The addition of loan repayments to the income projections would have a significant impact on both cash flow and net profit.

Net Operating Income and Return on Investment:

Utilization of capacity at 75 to 80 percent for most established businesses is considered realistic. Based on the above income projections, at an operating capacity of 50 percent the crumb rubber business is generating a loss of over \$170,000 annually. The business does not break-even until it is operating at approximately 80 percent of capacity. At 100 percent operating capacity, an unlikely scenario, the business is generating a net profit of \$115,000 which represents a profit margin of 14 percent.

Typically, a return on investment (ROI) that is greater than 20 percent is considered acceptable. This represents a payback of the initial investment over a period of five years. Based on the income projections above, at 80 percent capacity the business is breaking even, so has a ROI of 0 percent. In other words, the initial investment would not be paid back.. Even at a projected operating capacity of 100 percent, the ROI is only 8 percent, or a payback period of almost 13 years.

#### Start-up Capital Requirements:

The start-up capital requirements are projected to be almost \$1.5 million. Given the low profit margins (a negative number until the business is operating at 80 percent capacity) as well as the low ROIs, this number would likely strike any potential investor as particularly high. In fact, the start-up costs might be so high as to rule out the likelihood of the business being undertaken as a community-based venture. This is especially true in light of the limited number of jobs created by the business. Further, there is the chance that the estimated start-up capital requirement is too low. Specifically, the working capital, which has been calculated at approximately \$140,000, may not be enough to cover the projected operating loss for the first year as well as the sales' cycles during the year and the expected delay in payment from customers (with suppliers wanting immediate payment).

#### Jobs Created:

With the business operating two shifts each day, 5 days a week year-round, only 7 jobs are created, 6 of which require relatively low skill-levels. The creation of jobs is the first priority of community groups involved in business development. By any measure, 7 jobs is not a lot. When considered in relation to the \$1.5 million required investment, the limited job creation is even more striking. Based on the start-up capital requirements, the cost for each job created is over \$200,000, or more than twice what South Carolina paid per job to lure a BMW plant to its state.<sup>28</sup> In addition, as a small business that is unlikely to grow in the near future, this crumb rubber venture would not offer any advancement for the workers it does hire (i.e., there is only one front-office job and too few employees to promote anyone to a supervisory position).

#### Environmental Impact:

As detailed in Chapter Two, scrap tires are a serious environmental problem if not properly disposed of or recycled. In landfills, if left whole the tires take up valuable space and may eventually rise to the surface, breaking the landfill cap.

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<sup>28</sup>Ackerman 75.

When stockpiled, whole tires represent a significant fire hazard and serve as breeding grounds for disease carrying mosquitoes and rodents. There are also some concerns about emissions from the burning of scrap tires for fuel, though federal and state studies have concluded that with the proper pollution control measures this risk is minimal. Accordingly, any activities that reduce the number of tires landfilled or stockpiled are contributing to the environment. And, in the case of the crumb rubber business, recycling efforts that offer an alternative to the burning of the rubber may represent an even greater environmental benefit.

With the capacity to process the equivalent of almost 750,000 scrap tires per year (over one million tires if a third shift is added), this business would clearly have a beneficial impact on the environment by helping to reduce the scrap tire problem. Also, as a producer of a commodity to be used in the manufacturing of new products, this business would be working to expand markets for a recyclable material, and, in the process, help raise general awareness of the value of recyclable materials.

#### Risks:

The number of risks associated with the crumb rubber business should not alone discourage investment in the industry. However, in addition, given the low profit margins and low ROI at even 100 percent operating capacity, as well as the low margin for error concerning assumptions made for the cost of tire chips and market price of crumb rubber, collectively these risks are likely too great to attract investors not currently in related businesses.

## **VI. Conclusion**

There are a number of reasons to develop a business. For private firms and individuals, a primary motive is to generate a profit. For community development organizations, job creation is the driving force. Behind a smaller number of business development efforts, the motivating factor may be a strong desire to provide a service, such as recycling, regardless of other considerations. These objectives need not be mutually exclusive and, for some ventures, should not be if the benefits are to be fully realized and sustained.

The projected crumb rubber business would not satisfy the objectives of either private investors nor community development organizations. As to short- and long-term profitability, there are high start-up capital requirements, low profit margins, minimal return on investment even at 100 percent capacity, and a number of market risks which are difficult to evaluate and quantify. Also, even if all the assumptions made are accurate, the business would have to be

operating at 78 percent capacity just to break-even. While the markets for the material are projected to grow, a significant amount of additional capital would be required to take advantage of this growth, including additional equipment to produce more crumb rubber, and this growth is not guaranteed.

As a means of generating jobs, this crumb rubber venture falls considerably short of the expectations of community development organizations, especially in light of the investment required to create each job, over \$200,000. It is likely this large amount of money could be used to better effect elsewhere, such as to fund job training programs, or to develop real estate to attract existing businesses with greater employment needs.

While this projected crumb rubber venture does have a positive impact on the environment, there are no apparent substantial advantages to the recycling of scrap tires (or tire chips) by a small, community-based venture. With a number of large producers throughout the country and a growing interest in crumb rubber production among firms already established in related businesses, an increasing number of scrap tires will be recycled regardless of this particular venture.

The lesson may be that there are compelling reasons not to move forward with most business plans. As evaluated, this is the conclusion one must reach for the crumb rubber business presented herein. Without a reasonable opportunity to make money or the chance to create a large number of jobs, neither the benefits to private investors nor to society justify the investment.



## Chapter Four

### CONCLUSION

The economic development potential of recycling has been promoted by a growing number of advocacy organizations. This thesis has addressed this opportunity by presenting and evaluating a plan for a community-based, recycling venture; specifically, the processing of scrap tires into crumb rubber.

The opportunity to combine objectives of social and environmental policies is compelling. In the past, environmental agencies and advocates have been pitted against the development community in publicized disputes over such issues as wetlands protection, off-shore drilling and, most recently, the protection of endangered species. Conventional wisdom has held that economic benefits can only be achieved with some cost to the environment. The growth of recycling and related industries has suggested otherwise.

As a response to increasing amounts of solid waste, recycling has been responsible for a reduction in the amount of waste sent to landfills and incinerated. And, by increasing the supply of used materials that can serve as a substitute for virgin materials, recycling has contributed to a reduction in the extraction of natural resources. Also, recycling has created jobs at the collection and processing stages and through the manufacturing of new products using a recycled feedstock. Most of these jobs require low skill-levels and many have been filled by low-income, inner-city residents. As a group, these individuals have been most affected by the national decline of manufacturing jobs (as a percent of the total). A corresponding increase in service sector jobs has not proven sufficient to make-up for this loss.

Today, large, urban cities are home to an increasing number of unemployed and underemployed residents. Without the means to support themselves, individuals are dependent on a variety of social services, including public housing, food stamps and welfare. Crime and drug use are increasing, while the physical condition and tax revenues of urban cities are decreasing.

There is a special connection between recycling and urban environments, which are the site of a considerable number of coordinated efforts to generate economic development. Large cities are the greatest source of solid waste, are likely to have the necessary infrastructure in place to accommodate recycling-related ventures, including processing and manufacturing facilities, and have a sizable labor pool with skill-levels and expectations that match the needs of the recycling industry.

While there is considerable potential to combine the objectives of economic development and recycling, there is also ample opportunity for these ventures to fail. For the most part, they are expensive and, at least at the front-end, recycling is dependent on government support, both in the form of policies mandating recycling and government subsidies. All these issues must be carefully weighed when considering whether to turn to recycling as a means for generating economic development.

In the current climate of increasing societal needs and decreasing government support, good intentions are not enough. In the case of business development, if the benefits are to be fully realized and sustained, the venture should be profitable. If not, there is little difference between these operations and any number of social and environmental programs dependent on outside sources for support.

The conservative evaluation of a hypothetical crumb rubber business in the preceding chapter supports this conclusion. While jobs were created and scrap tires recycled, the number of jobs was limited to seven and, given the trend in state scrap tire management, the tires would likely be recycled regardless of the creation of another scrap tire business. Most significant, however, is that the business would probably lose money. As a result, the life of the venture would likely be short, so the jobs created would be temporary, as would the recycling benefits, and the considerable investment required to start the business will have been wasted.

The need for both economic development and environmentally sustainable practices should not be underestimated, and will only increase as a result of increasing automation and worldwide population growth, among other factors. The desire to combine these objectives is understandably strong. Given the importance of each objective separately, their combination should be done only with great care.

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