# THE SCRAP TIRE PROBLEM:
# A PRELIMINARY ECONOMIC ANALYSIS

FINAL REPORT

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# THE SCRAP TIRE PROBLEM:
# A PRELIMINARY ECONOMIC STUDY

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# SECTION 1

## INTRODUCTION

In the wake of the recent tire stockpile burns in Winchester, Virginia and Everett, Washington, public concern is growing over the manner in which we dispose of automobile and commercial tires. The cost of extinquishing and cleaning up those fires in addition to the other costs of scrap tire disposal have prompted some observers to call for increased federal efforts to mitigate these expenses. Specifically, it has been suggested that the U.S. Environmental Protection Agency (EPA) take a more active role in assuring that scrap tires are disposed of in an environmentally safe manner and in reducing the number of tires bound for disposal.

Under E.O. 12,291, increased EPA activity in this area would be economically justified if the social benefits of more appropriate disposal are at least equal to the social costs of the actions. This draft report provides a preliminary analysis of the economic justification for Federal agency action. Specific emphasis will be on social benefits to assist EPA in determining whether there is an economic basis to the problem and therefore need for new research or analysis.

### Background

Annually in the U.S. between 200 to 250 million tires are replaced on automobiles, trucks, and commercial vehicles. The scrap tires flow to a number of end points. Some are retreaded and sold again, others are used as fuel supplements. The vast majority of scrap tires, however, are discarded directly into the environment in landfills and open tire stockpiles or are randomly dumped. All of these disposal routes involve private costs such as transportation and processing and social costs in the form of risks to human health and the environment. Social costs are particularly associated with disposal into the environment where, for example, stockpiled tires can catch fire and burn indefinitely or provide breeding grounds for disease-carrying mosquitoes.

To the extent that the private and social costs of tire disposal are reflected in the price of new tires the market place will determine an economically appropriate mix of final disposal end-points for scrap tires. In this case, there would be no economic justification for government programs to redirect the disposal of scrap tires from, say, open dumps to some form of recycling. However, as is the situation for many forms of post-consumer solid waste, consumers may not bear the full cost of disposing the tires. Market failures, such as the existence of public goods or subsidies for municipal disposal of tires, may impede appropriate pricing. Disposal costs to consumers may be artificially low, resulting in a wide range of impacts including too many new tires being purchased or too few tires being disposed of in environmentally safe ways.

Without benefit of formal analysis, it has typically been assumed in past scrap tire research that true disposal costs are not fully paid by consumers and that the private and social costs of the current disposal mix justify government programs to increase recycling or re-use of tires. In the mid-1970s a number of research projects were funded by EPA and other government agencies to evaluate alternative technologies relying on scrap tires as inputs. These studies, prompted by rapidly rising energy prices, investigated the relative costs of outputs relying on scrap tires versus primary materials. For example, where tires were used as a substitute for virgin petroleum inputs in energy production or road surfacing materials. In general, this research indicated that with various levels of government support a large number of scrap tires could be removed from environmental disposal with savings in national energy expenditures and other costs.[1/] The justification was predicated on the assumption that the savings in direct and indirect costs of disposal would offset the program's costs. At least three studies attempted to estimate the level of social cost savings (or benefits of government intervention), documenting relatively high values in the form of resource savings and reduced disposal costs. None of these studies included other environmental or health costs such as tire fires or disease from mosquitoes. To date, the impact of this research on government policy has been minimal, due in large part, to greater concern over hazardous waste disposal and declining energy prices. However, increased understanding of the other risks associated with scrap tire disposal has led to some revitalized interest in the problem.

This study was undertaken to make, within the time and budget constraints imposed, a more complete accounting of the social costs of scrap tire disposal, to evaluate the economic framework, and examine the nature and extent of any economic inefficiences. The primary data and information base for the research were past studies and informal discussions with knowledgeable experts. There is little original data generated, although some existing data has been modified to fit the economic social cost and social benefit calculus. Throughout the draft report, every effort has been made to highlight uncertainties in the data and the analysis, which are in some cases formidable, and to suggest areas of research that might offer clearer insights into the problem.

This draft report is divided into five major sections. Section 2, summarizes major research findings. Section 3 contains a brief description of the major economic links in the generation and disposal of scrap tires and a review of the major disposal end points for scrap tires. A preliminary analysis of the social costs of these disposal end points is presented in Section 4. Section 5 presents is a largely qualitative analysis of alternative government programs to influence the tire disposal process. The final section highlights several future research directions that might be usefully pursued in order to better understand the nature and solution to the problem.

## SECTION 2

## FINDINGS AND CONCLUSIONS

Of the approximately 240 million tires traded in each year, almost 70% or 170 million tires are disposed of directly into the environment. The most common disposal end point is privately and publicly owned stockpiles, which account for around 100 million tires annually. Approximately 28 million tires are disposed of in landfills, and 38 million tires are randomly dumped on roadsides or in rural areas. While these estimates alone are quite large, they do not include the huge backlog of scrap tires from previous years. The stock of tires from past stockpiling has been estimated to be over 2 billion.,

### Social Cost Estimates

These figures would suggest the potential for large social costs. Based entirely on the expected costs of tire fires and the health costs associated with mosquitoes which breed in tires, annual social costs associated with current disposal methods are estimated to be in the range of $7 to $8 million or approximately $0.004 per tire. There are several potential social cost elements (such as aesthetics) for which no reliable estimates could be obtained. In addition, there is some uncertainty over several key assumptions made in the calculations.

This relatively low social cost estimate is not surprising given the basis for its calculation and certain characteristics of the scrap tire market. Unlike other forms of post-consumer solid waste, there are centralized collection points for used tires, generally new tire retailers. These provide an avenue for passing disposal costs on to consumers (because retailers pay to rid themselves of collected tires), a practice which seems to be on the increase. Rising costs of landfilling tires and few apparent impediments to passing costs directly on to the consumer mean that disposal expenditures, one large class of possible social costs, are being largely internalized.*/

Second, once disposed of in a landfill or in an open dump, whole tires are largely inert. They pose few direct threats to human health and the environment, except in cases where tire piles catch fire or where the tires become breeding grounds for mosquitoes or other pests. Shredded, landfilled tires are also relatively stable; they do not leach or contaminate the soil or water supplies. Although stockpiled or randomly dumped tires are an eyesore, they are typically located in rural or heavily industrialized areas thus reducing aesthetic damage.

The annual social cost estimate described in this draft report is a crude national average and does not reflect the wide regional and even local variations in the private and social costs of scrap tire disposal. The implication is that what may not be justified on a national level, may be critical in areas of the country where mosquito problems, for example, are particularly prevalent. In addition, there is little doubt that different assumptions and a more comprehensive analysis could change the social cost estimate. Perhaps the most significant set of assumptions concern public expenditures on disposal and other risk reduction measures, the annual frequency and size of tire fires, and the aesthetic costs of stockpiled tires. To the extent that many areas of the country still subsidize municipal disposal of tires, the social costs estimates reported here would have to include these non-internalized disposal costs. A large number of small fires all around the country may also increase substantially the social cost element. Improved information on these assumptions represents an important avenue for further research.

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* As we will note later in this report, savings in disposal costs as a result of increased recycling are part of the economic benefits of activities designed to reduce tire disposal.

Future Cost Factors

The estimates provided in this draft report are based on past experiences with scrap tire disposal. Predicting future trends in social costs is much more difficult. Several factors can be identified, however, that could affect the relative level of costs in the future. First, there appears to be an increasing tendency to price the disposal of scrap tires in landfills at such a level as to insure that few or no tires are brought to landfills. The net effect of such a policy is to increase the number of tires stockpiled or randomly dumped, assuming no change in the demand for scrap tires as inputs to production processes. Because the evidence suggests that properly landfilled tires may pose fewer environmental and health costs than other disposal options, it is likely that social costs per tire disposed will increase over time. This may also occur if the supply of available landfill sites diminishes as seems reasonably predictable. Second, increased regulation of stockpiles to minimize fires and other hazards, may perversely lead to an increase in arson or abandonment of existing piles as owners attempt to minimize their costs.

Third, increased energy prices would likely increase future demand over current levels for scrap tires as substitute energy inputs, particularly in road surfacing and direct burner feed. A variety of technologies and industrial uses are available to use scrap tires as an energy substitute. However, the current relative cost-competitiveness of scrap tires to coal and petroleum products does not make widespread use of tires economically attractive. No attempt has been made for this study to empirically estimate the possibility of this scenario. Moreover, even with increased energy prices, the demand for scrap tires as production inputs is a function of the supply of tires available within an economic range of transportation and apparent consumer preferences. It appears that these two factors have in the past been major impediments to increased recycling or re-use of scrap tries.

Finally, increased retreading of tires also has the potential to reduce the supply of scrap tires. The current constraints on the percentage of tires retreaded are a mix of technical concerns (such as increased use of radial tires, and poor tire casing quality, often from underinflating tires) and economic factors (most importantly, increased competition from new inexpensive tires from Europe). In addition, there is still a general consumer preference for new tires even if a retread is a close substitute and substantially cheaper. It is not clear if or when these barriers will be lowered.

There is little question that technologies exist that could consume the annual production of scrap tires as well as a large portion of the existing stock. The nature and extent of the constraints to the application of these uses suggest, however, that even with full internalization of the social costs estimated in this report, few additional tires would be recycled. On the other hand, some low level federal government programs appear to be justified on the basis of benefits from social costs reduction and might help overcome some of the current limitations. For example, procurement guidelines demonstrating the relative economics of asphalt rubber road surfacing in some situations might help counter the apparent reluctance of state and local purchasing officials to consider non-conventional road maintenance products. An education campaign directed at automobile owners concerning proper tire maintenance might increase the supply of r&readable scrap tires at a relatively low cost.

# SECTION 3

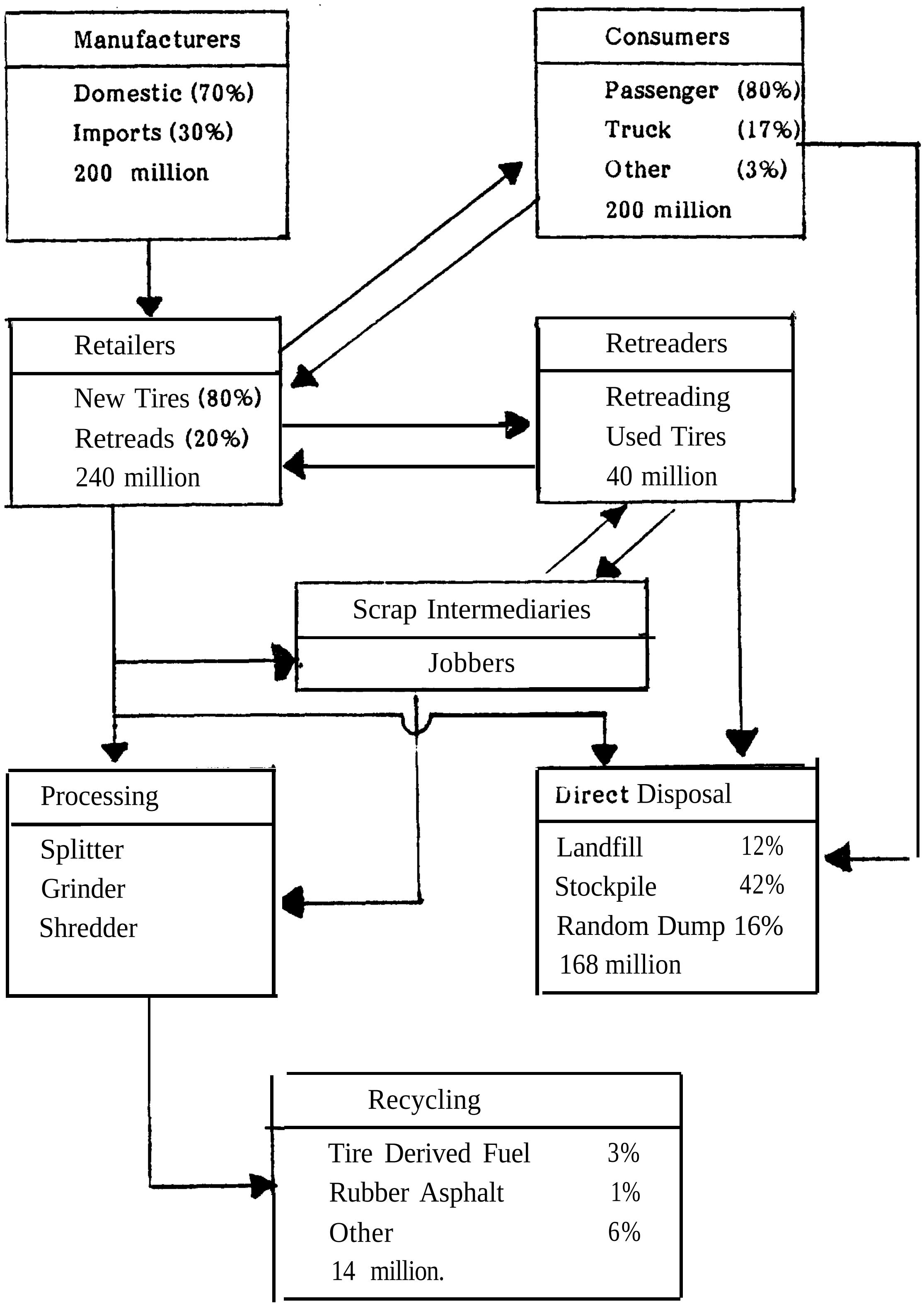
# ECONOMICS OF SCRAP TIRE MARKETS

## INTRODUCTION

Approximately 240 million tires are disposed of annually in the United States. This estimate is fairly consistent throughout the literature, but is not based on a particularly firm accounting. The figure is generally based on one of two assumptions: that there is approximately one tire disposed each year for every individual in the U.S. or that there is one tire disposed of each year for every new or retreaded tire manufactured. While there is general agreement as to the total number of tires disposed each year, there is some uncertainity as to where they go. Due to a lack of data and the numerous scenarios by which scrap tires can be disposed, it is difficult to account for all 240 million. After reviewing earlier studies on scrap tire disposal and discussions with representatives from the Rubber Manufacturers Association (RMA), the National Tire Dealers and Retreaders Association (NTDRA), and retailers, a conventional tire market model was developed that is, on the average, broadly representative of the disposal flow. Figure 1 depicts these flows and identifies the major economic interactions.

New tires are distributed: as original equipment on new vehicles or as replacement tires by retailers. Discussions with manufacturers indicate that about 72% of new tires are sold by retailers with the remaining 28% sold as original equipment.

Figure 1. Scrap Tire **Disposal** Flow Chart



From this volume flows the three major sources for scrap waste: (1) tires manufactured in the United States for passenger cars, trucks, and buses and used once; (2) imported tires used once; (3) discarded retreads. The first step in the disposal chain is determined by the choices confronting the consumer who is deciding what to do with his worn tires. Typically, the overriding consideration is convenience. Estimates show that about 95% of consumer-disposed tires are returned to the retail outlet where the new tires are purchased. Traditionally, retailers have accepted used tires as a service to their customers. There is some indication, however, that this service is being limited especially among the smaller dealers. The remaining 5% of consumer disposed tires are destined to become swings and sandboxes or put into municipal refuse collection or simply dumped indescriminately.

The first decision confronting the retailer is how best to get rid of the used tires. The available options and their costs will vary with state and local regulations and the regional demand for scrap tires as a raw material. Generally, a price must be paid to have scrap tires hauled away. The following scenario is broadly representative of the disposal flow for the majority of scrap tires at the retail level. A collector or "jockey" is contracted for a per-tire fee. Estimates show this fee ranges from $0.25 to $1.00. It is at this point that retreadable tires are first separated from the total scrap collection. The jockey divides the tires into three groups: (1) those with enough tread life left to be deemed saleable; (2) those with the potential for retreading or at least without obvious flaws; (3) those that are unusable. Estimates indicate that only 60% to 70% of all scrap tires are actually inspected for their retreadability and of that number only about one in five are potentially retreadable. Prices for retreadable tire casings vary from $2.00 to $3.00 for passenger car tires.

Following inspection, the jobber scraps the non-retreadable tires, seeking the least-cost option to maximize his profit from selling the retreadable casings. The retreaders, after further inspection, scrap the unusable tires (via a similar jobber arrangement or other options available) and retread the remainder. Retreaded tires sell for about $17 to $22 depending on the type of tire. Virtually all disposal options require the collection and transportation of tires to the point of storage, disposal, use, or processing. Collection cost depends on distance, mode of transportation, and the amount of handling required. The major cost in the collection of scrap tires is estimated to be handling rather than hauling fees.[2/] Final cost estimates for dealers to dispose of their collection vary regionally and are a function of the method of final disposal and the other factors discussed in this section.

The system described here is frequently complicated by jockeys selling to jockeys, retreaders doing their own collections, new tire manufacturers providing retreading services for dealers, and retreaders selling tires which fail their inspections to other retreaders with less rigorous standards, and so on.[3/] In all instances, the scrap tire itself is viewed as having very little economic value relative to the retreadable casing.

Tire Disposal Alternatives

There are six major tire disposal end points which are representative of the total disposal mix: landfills, stockpiles, random dumps, retreads, asphalt mixtures, and energy feeds. The first three end points account for a significant portion of disposed tires. Asphalt mixtures and energy feeds represent the most economical and technically feasible options that could absorb a significant portion of the tires being disposed.

TABLE 1. Estimated Annual Scrap Tire Disposal Distribution

Assuming Annual Disposal of 240 Million Tires

| | Percent | Million Tires |
|---|---|---|
| Landfill | 12% | 28.8 |
| Stockpile | 42 | 100.8 |
| Random Dump | 16 | 38.4 |
| Retreads | 20 | 48.0 |
| Tire Derived Fuel | 3 | 7.2 |
| Asphalt Rubber | 1 | 2.4 |
| Other | 6 | 14.4 |

While there is some data on the number of tires going to retreading, tire derived fuel and asphalt rubber production, and other recycling options there is none distinguishing the number going to landfills, stockpiling, or random dumping. A cumulative 70% distribution is a common estimate cited in previous studies, but a more complete allocation of this total among the three on a national 'level was not found.[4/] The only breakdown identified during this research was a statewide survey conducted by the Minnesota Pollution Control Authority (MPCA) in 1979. That study estimated that of the 70% discarded in the environment, 12% go to landfills, 42% go to stockpiles and the remaining 16% are assumed to be randomly dumped (See Table 1). While it can be argued that Minnesota disposal patterns may not be representative of the nation as a whole, the total distributions established by the study were consistant with those found in other studies.[5/] For example, a 1983 Department of Energy study, which developed a tire generation model, found that the average annual tire disposal rate in Minnesota was equal to the national average. Based on the above considerations and the lack of alternative information, the estimated Minnesota distributions were assumed to be representative of the nation as a whole.

The following discussion provides some insights into why only an estimated 36% of the tires being disposed annually are recycled and where the most potential for increased recycling lies.

1. Landfills --

Because the current interest in scrap tires focuses on landfills, it is commonly assumed that the majority of scrap tires are landfill&. Considering the lower costs of other disposal methods and the problems with landfilling, this does not appear likely. The MPCA study indicates that only 12% of used tires are disposed of at municipal, county or private landfills. Nationally, this would account for approximately 29 million tires. Tires are bulky, extremely durable, and biologically inert. To a landfill operator, these characteristics translate into a basic nuisance and increased costs for special handling. Whole tires, incorporated in a landfill, spring back to their former shape after compaction, and due to their buoyant composition tend to work their way to the surface of landfills. These difficulties coupled with the rising costs of land for new landfill sites are resulting in an increasing number of landfill operators refusing tires altogether. Shredding tires prior to land filling is an effective but costly solution.

Previous studies estimates that processing costs for landfilling whole scrap tires range from $0.02 to $0.06 per tire. [6/] Operating cost differentials between landfilling whole tires versus shredded tires were not readily available, however the addition of a shredder has been estimated to increase operating costs by $20,000 to $40,000 per year. On a national level, tipping fees or dumping charges have been estimated to vary from

$0 to $5.00. The bulk of landfills charge a fee for disposal that appears to average about $1.00 per tire.[7]

2. Stockpiles - -

The Minnesota survey suggests that stockpiling is the most common form of scrap tire disposal. Nationally, at least 100 million tires are stockpiled every year in addition to the estimated 2 billion already stockpiled nationwide. There are several incentives for stockpiling. First, given the relatively high charges for landfilling, collectors are willing to pay the lower price to dump elsewhere. Several studies indicate that stockpile owners charge anywhere from $0.15 to $0.25 per tire for making disposal space available. Second, absent state or local regulations, the costs of operating a stockpile are quite low, involving only the cost of land in the simplist case. Third, many stockpile owners collect tires for speculative purposes, believing the tires will someday become more valuable either as fuel, as energy prices rise, or as raw materials for recycling technologies.

A 1983 Department of Energy (DOE) survey identified at least 35 stockpiles nationwide of 100,000 tires or more.[8] An additional 23 piles of between 2,000 and 100,000 tires were also located. The existence of hundreds of small or unreported accumulations of tires across the nation should also be assumed if the total stock of tires is actually 2 billion. In the DOE survey, tire piles were identified in almost every state, but the heaviest concentrations appear to be in the mid-Atlantic states and in southern California. Four of the ten largest piles were found in California. Several states (Colorado, Connecticut, Florida, Georgia, Missouri, New Hampshire, New Jersey, Oregon, and Utah) have laws and regulations specifically addressing stockpiling of tires. These regulations tend to focus on fire risks and/or health considerations such as rats and mosquitoes and tend to be relatively lax in either requirements and/or enforcement.

3. Random Dumping --

It is impossible to estimate directly the number of tires that are disposed of annually on roadsides, in streams or rivers, in hidden ravines or other areas. The Minnesota survey suggests that, nationally, around 16% or 38 million tires are randomly dumped. As the direct costs are virtually zero (except for transportation expenses), the disposal incentives are quite obvious. However, since most states prohibit such actions, the low direct costs are offset somewhat by the expected costs of being caught and fined. The chilling effect is that communities with high landfill disposal fees for tires have experienced increased random dumping. This suggests that either the expected costs of random dumping are not very high to begin with or as the direct and expected cost differential between land fill costs and the expected costs of random dumping widens, there is an increased incentive to use the latter disposal method.

4. Retreads --

Data from the NTDRA show an annual average of 43 million retread tires being produced over the last ten years. Retreading serves as a source reduction option and because the energy requirements to produce a retreaded tire are 30% that of producing a new tire, it has been argued that retreading provides a resource conservation benefit as well. Estimates indicate that only about 60% to 70% of all scrap tires are actually inspected by scrap tire brokers or retail operators for retreadability. Of that number, only about one in five is ultimately suitable for retreading. Industry representatives argue that the most significant limitations to increased retreading are the availability of retreadable casings and competition from cheap, off-brand foreign imports. Increased preference for steel belted radials over bias belted has also dramatically altered the retreading market. Radials are significantly more difficult to retread, as they require a more precise molding fit in the retread process.

5. Asphalt rubber --

Techniques for incorporating reclaimed rubber into asphalt have been in existence for over 50 years. One industry source estimates that 1.25 million to 1.6 million scrap tires per year are used to make rubber asphalt products. Although the use of asphalt rubber paving techniques is widespread in Europe, in the United States considerable debate over the merits of the process has slowed expansion'of the industry.[9] Proponents of the process argue that asphalt rubber offers substantially longer pavement life and reductions in maintenance costs. In addition, depending on the technique used, rubber may introduce greater flexibility, resistance to moisture damage and skid control. Experimentation in the late 1960s in Arizona used rubber in combination with asphalt as a binder on chip seal coats (SAM) in an effort to prolong the life of deteriorating road surfaces. Other techniques use ground tires in road building as an aggregate or in the surface itself as an asphalt additive or binder.

Resistance to rubber asphalt techniques has centered on two concerns: cost differentials between traditional asphalt mixes and rubber asphalt mixes and the superiority of rubber as an asphalt enhancer. Cost estimates reviewed for this study show that differentials vary substantially by technique and the cost and availability of the rubber input. While some techniques use traditional asphalt laying methods, other processes require special equipment for applications raising capital cost significantly. Manufacturers claim the benefits of increased performance outweigh the higher front-end costs. The cost advantage of asphalt rubber depends heavily on the estimated life extension of the road surface and the avoided road repair costs. The legitimacy of these estimates can only be established once the surface has failed. Documentation of such life-cycle benefits is increasingly available but because every asphalt application must be formulated with consideration of terrain, climate etc., it is difficult to make generalizations about specific successes and/or failures of a particular technique. Estimates indicate that the addition of 5 percent rubber to all new asphalt used in road building or road repair in the United States would absorb the current annual output of scrap tires[10/]

6. Tire Derived Fuel (TDF) --

Tires have an energy content in the range of 14,000 to 15,000 Btu's per pound (as compared to coal with around 12,000 Btu's per pound), making it a particularly attractive fuel source. A tremendous amount of research has been conducted on the potential for energy generation via TDF but its use in the U.S. is still limited by the relatively low price of substitute energy inputs. Current estimates show only about 3% of scrap tires going to alternative fuel uses. Manufacturers with a need for high temperature processing, such as cement producers and wood processors, are the most common users of tire derived fuel.

The technical barriers are not significant for using TDF. In fact, research and practical experience have shown that few boiler modifications are required for operations with a coal-fired grate system, provided the mix does not exceed 10% tire derived fuel. [11/] The economic success of scrap tire utilization as TDF depends on several fac tors: access to a reliable supply of shredded tires in a uniform fuel feed - usually 2" chips, the cost differentials among the fuel alternatives, and the cost differentials between on site handling of two fuels.

## SECTION 4

## SOCIAL COSTS OF SCRAP TIRES DISPOSAL

### INTRODUCTION

The current methods of scrap tires disposal in the U.S. have been associated, empirically and otherwise, with a wide range of potential social costs. The operative definitions of social costs range from lost energy conservation to health impacts. In this section we will adopt an economic definition of the social costs from disposal of scrap tires and provide a preliminary evaluation of their relative magnitude. The information generated will be crucial in determining the relative economic justification for a federal role in attempting to alter current disposal patterns.

Social costs of private actions are typically thought of as the direct or indirect costs, imposed by those actions which, are not internalized into their price. In very simple terms if the disposal of a tire increases the risk of an adverse health effect, a cost is imposed on effected individuals. Presumably those people would be willing to pay some amount to avoid that risk. That dollar amount is the health cost of disposing of the tire. If the price of disposing of the tire includes that cost element, the market will tend to efficiently determine whether the tire should be disposed of or recycled. If the disposal price does not include the expected health cost, a different price signal is sent to the disposer and, in the aggregate, too many tires will be disposed of in a way harmful to health. In this case, the health cost is not internalized and instead, becomes a social cost under the definition adopted for this draft report.

The review of the literature identified several possible effects of scrap tire disposal that have often been interpreted as the social costs of scrap tire disposal (or alternatively, the social benefits of increased recycling of tires.) The most often cited classes of potential costs include: the disposal costs of landfilling tires, the energy or natural resource value lost through landfilling, the health or environmental costs imposed by stockpiled-tire fires, the health impacts from the mosquito and vermin breeding habitat provided by piled tires, and the aesthetic damages associated with stockpiled or randomly dumped tires. The extent to which these potential costs can actually be considered social costs and their magnitude are discussed below.

Disposal Costs of Landfilling

The conventional wisdom is that reductions in the direct and indirect costs of landfilling tires represent one important benefit of increased recycling. These costs are typically assumed to include processing and land acquisition as well as potential environmental insults from landfill operation. For example, one study (in discussing the size of a scrap tire product charge) estimated that costs of proper landfilling and disposal were approximately $0.02 per pound of tire or around $0.40 per tire. This calculation is interpreted to represent the social value of landfilling which minimizes environmental risk.

The correct interpretation of landfilling costs as social costs (as defined here) is not as straightforward as the calculation would suggest. In terms of the definition used in this report, landfill disposal costs are only social costs to the extent that they are not internalized into the costs of new tires. As was suggested in Section 3, there is a growing tendency on the part of landfill operators, private and public, to charge disposal fees for landfilled tires. The actual social cost is then the difference between the disposal charge and the direct environmental costs associated with disposal. There are several reasons to believe that this difference is relatively small. First, as noted earlier, the current trend appears to be to set charges high enough at least to cover direct costs and, increasingly, at a level higher than direct costs to discourage tires from being brought to landfills simply to eliminate the nuisance element. Second, the environmental and health costs associated with landfilling tires appears to be rather small. Tires tend to be very inert solid wastes; they do not decompose or leach toxic substances into the surrounding environment. The qualities of tires that make them such a disposal nuisance, also limit their potential environmental or health impact. The landfilling of shredded tires poses few environmental risks, except in terms of using up increasingly scarce landfill space (a cost element that should be included in the disposal charge). Landfilling of whole tires may pose some risk if they rise to the surface and, for example, provide breeding grounds for mosquitoes. It is also possible that stockpiling tires prior to disposal at a landfill involves the risk of fire or adverse health effects. Nevertheless, the available evidence suggests that these are not particularly significant risks.

The expected value of these environmental and health costs should be included in the disposal charge at landfills or they would constitute social costs. The fact that many landfills are charging more than the direct costs of landfilling suggests that these classes of costs may already be implicitly incorporated in the charge. Without an empirical measure of the environmental and health costs of landfills, it is impossible to actually determine if in fact this is the case. The difference between the $0.40 cost of proper landfilling and the average $1.00 disposal charge for landfilled tires found in previous studies is some indication that these social costs are being. covered in the charge. Based on this reasoning, it is assumed for the purpose of this study that the uninternalized social costs of landfilling are negligible. Of course, there is some uncertainty surrounding this conclusion. The available disposal-charge data used is a limited Sample of charges at various landfills around the country. If many landfill operations have zero fees or relatively low charges for tires, the estimate of social Costs could be significantly more important.

Viewed in a broader context than that adopted for this report, current tire disposal expenditures do, however, represent an opportunity cost of our current disposal methods. If more tires were recycled and fewer disposed, the resulting reduction in disposal expenditures would be a real economic benefit. Resources devoted to disposal would be fixed for other uses. In weighing the economic efficiency of alternative Federal programs to increase recycling, these savings would be particularly important. While, we did not for the purposes of this report attempt to formally quantify the nature of disposal expenditure savings, a rough illustrative estimate can be constructed. If we assume an average retail disposal charge of $0.50 per tire, a recycling program which reduced annual tire disposal by $100 million, would result in $50 million savings. We discuss disposal expenditures again later in the report in terms of aesthetic damages and the need for additional research.

Costs of Lost Energy or Natural Resources Values

It is relatively common in the scrap tire literature to see references to the energy and natural resource savings that would result from increased recycling. The argument is turned around as representing the social costs of tire landfilling. If tires are shredded and buried their energy value is lost to society. Since tires that are randomly dumped or stockpiled are not physically lost (at some price of extraction), they presumably are not included in this argument.

The validity of the lost energy value perspective hinges on assumptions, often unstated, concerning market imperfections in the pricing of energy inputs and other natural resources. For example, uncertainty concerning future supply and demand for energy inputs (in the absence of contingent markets-for these goods) might suggest that energy inputs are underpriced and therefore do not rely heavily enough on scrap tires as substitutes. On the other hand, if the energy markets are working reasonably efficiently, any lost energy or natural resource value in tires must be quite low, perhaps zero, or more tires would be recycled. It is beyond the scope of this study to review the literature on energy pricing, except to note that the market is characterized by several possible inefficiencies. Further, the market presently reflects the possibility of a future positive value for the energy content in scrap tires through the speculative activities of stockpilers. Even if, because of inefficient energy pricing, too many tires are produced and too few recycled, the estimated 2 billion tires currently stocked in the U.S. suggests that the lost energy value of an additional landfilled tire or the energy gain from the additional retreaded tire is probably close to zero. On the basis of this brief analysis, it is assumed for the purposes of this draft report that the lost energy value of scrap tire disposal or new tire production is not an economically significant component of social costs.

## Health Costs

The threat of disease from mosquitoes breeding in randomly dumped or stockpiled tires is the greatest potential health impact identified with current disposal methods with the possible exception of tire fire emissions. Once moisture collects inside an exposed tire it is virtually impossible to remove and this dark, damp environment is an ideal habitat for mosquitoes which carry La Crosse encephalitis. In addition, it is often argued that tire piles provide breeding grounds for rats and other vermin. (Social costs associated with this latter possibility were not estimated here.)

La Crosse encephalitis cases have been reported in 24 states but tend to be focused in the upper mid-western region of the U.S., particularly Minnesota, Wisconsin, Ohio, and Iowa. The disease causes a swelling of the brain tissue with symptoms of acute headaches, high fever, and nausea. Children under the age of 15 are the most likely to suffer from serious consequences if bitten by an infected mosquito. The mosquito that carries the disease breeds in rotting tree holes, scrap tires, and other closed containers which gather moisture. Follow-up studies conducted on 69 diagnosed cases in 1981-82 showed that tires were present in 72.5% of the cases and were considered the "predominant source" of the virus 54% of the time.[12/]

Although there is no vaccination or cure for the disease, treatment is available. Clinical treatment costs have been estimated by one source to be approximately $20,000 per case. Since 1963, over 1,000 cases of La Cross encephalitis have been confirmed nationally by the Center for Disease Control (CDC). An average of 150 cases are confirmed annually. A spokesman for the La Crosse County Wisconsin Health Department, reported that the disease, which is difficult to diagnose, goes undetected up to 70% of the time. The disease is endemic, that is, it appears year after year in the same locale rather than in periodic epidemics. One researcher at the CDC expressed puzzlement over why the disease was not more widespread. Recovery can be expected in most cases, but long term, subtle damages -- learning disabilities and general lethargy -- are suspected. There have been nine reported fatalities from La Crosse encephalitis.

In this study, the numbers presented above were used to provide a rough estimate of the expected health costs associated with random dumping and stockpiling of tires. The estimate and assumptions are outlined in Table 2. It was assumed that 270 cases of La Crosse encephalitis are contracted annually. Using the $20,000 per case figure, the total annual health costs associated with current scrap tire disposal, were estimated to be approximately $5.4 million. This estimate does not include the costs associated with death or long-term, difficult-to-prove damages such as reduced mental skills. Further, the $20,000 estimate is a cost-of-illness measurement that may not reflect the true economic cost of the disease. Finally, the costs of efforts to reduce the risks of encephalitis, such as public education, spraying, and increased efforts to collect randomly dumped tires, are not considered in the total cost.

TABLE 2. Calculation of Estimated Social Costs of **Encephalitus**

| | | |
|---|---|---|
| 1. | CDC average annual number of cases reported. | 150 |
| 2. | Estimate of actual cases confirmed and reported. | 30% |
| 3. | Actual number of cases (1. divided by 2.) | 500 |
| 4. | Est. number of tire related cases | 54% |
| 5. | Annual tire related cases (3. times 4.) | 270 |
| 6. | Cost per clinical case diagnosed. | $20,000 |
| 7. | Annual cost of treating tire-related cases. | $ **5,400,000** |

Health and Environmental Costs of Tire Fires

Although generally very stable, tires can burn. They are extremely difficult to ignite, and equally difficult to extinguish. Tires fires not only result in nuisance and property damages, but also represent a potential health and environmental risk in the form of liquid and gaseous emissions. The risk of these damages is most closely associated with tire stockpiling where the concentration of tires is greatest and the access for fire-fighting equipment the most restricted.

For example, in 1983 and 1984, two of the largest stockpiles in the United States were ignited. At both fires, the first in Winchester, Virginia, the second in Everett, Washington, efforts to extinguish the fire with water and foam were fruitless and eventually abandoned in favor of efforts to simply limit damages. While tires can be burned cleanly in controlled boiler fires, the fires that break out in stockpiles are not hot enough to produce a clean fire. In uncontrolled fires, burning tires emit solvents and poly-nucleic aeromatic hydrocarbons (PAHs), many of which are carcinogenic. There is also a "pyrolylic" effect - melting while burning - causing the tires to emit both sooty smoke and oily liquids. In Virginia and Washington, both fires were located near rivers necessitating significant efforts to collect the oil in order to prevent contamination of surface and ground waters.

The potential for air and water contamination caused by burning tires implies that even a small stockpile fire may entail health and environmental costs. However, no data was available on the annual frequency or size of fires. Further, there is virtually no available data on the range or type of direct health or environmental risks associated with tire fires. (Although for the Virginia and Washington fires some air pollution emissions data were collected and reported.) For this study, data on the control and cleanup costs associated with the Winchester and Everett burns were used to derive an indirect estimate of the social costs associated with all tire fires.

TABLE 3. Control and Containment Expenditure Estimates
from the Winchester, Virginia Tire Burn

| | | |
|---|---|---|
| I. | EPA Contracts | |
| | Oil Containment contractors | $ 970,000 |
| | State of Virginia | 120,000 |
| | Frederick County | 85,000 . |
| | 3M Corporation | 145,000 |
| | AS1 Systems Inc. | 37,000 |
| | | **$1,357,000** |
| II. | Inter-Agency Agreements | |
| | U.S. Coast Guard | $113,000 |
| | Federal Aviation Administration | 16,000 |
| | U.S. Navy | 1,500 |
| | NASA | 500 |
| | | $131,000 |
| | Mission Support | |
| | Technical Assistance Team | $130,000 |
| | Consulting Fees | 17,000 |
| | | $300,000 |
| | Gross Expenditures | **$1,788,000** |

The Winchester tire fire occurred at a privately owned stockpile of 5 to 7 million tires covering about five acres in rural Virginia. The fire started in October 1983, and continued to burn and smolder through July 1984. The cause of the fire remains unknown, but arson is suspected.[13/] Because of the magnitude of the fire and uncertainties over the threat to public health and the environment, the U.S. Environmental Protection Agency undertook efforts to monitor, control, and contain the fire.

The costs outlined in Table 3 are based on an estimate provided by the EPA Region III On-Site Coordinator.[14/] Contracts with the state of Virginia, Frederick County, the 3M Corporation, the U.S. Forest Service and Alligins Systems Inc. were entered into by EPA for fire-fighting equipment, support facilities, site security, a synthetic oil containment liner and foam to keep the run-off oil from igniting. Expenditures for these contracts totaled $1,357,000. In addition EPA had several inter-agency agreements with the U.S. Coast Guard, the Federal Aviation Administration, the U.S. Navy, NASA and the EPA Navy, NASA and the EPA Technical Assistance Team to provide a wide range of support services. In all, a. total of 180 people and 44 agencies and contractors at the federal, state, and local level were directly involved the control efforts. A spokesman for EPA Region III quoted the total expenditures for control and containment of the fires as $1.788 million. Given the complexity of the task and the large number of parties involved it is unlikely that the $1.8 million fully accounts for all expenditures at the Winchester site. For example, costs incurred by the American Petroleum Institute which provided technical assistance and advice on the collection and processing of the tire run-off are not included in the total. The pyrolytic oil run-off from the fire was in such great quantities that 731,950 gallons were collected. The oil was later sold to waste-oil recyclers for a total of $300,000. Although all the tires were destroyed there remains a considerable amount of ash and residue on the site. No time or cost estimates are available for the cleanup effort necessary to restore the site to its original state.

The Everett, Washington fire began September 1984 and was not officially put out until February 1985. Estimates of the number of tires at the site when the fire broke out range from 1 million to 1.5 million. As in the case of the Winchester fire, the cause of the burn is unknown but arson is suspected. At the time of the fire the site was publicly owned, but the tires had been accumulated by a private collector who had intended to sell ground rubber for fuel. Unlike Winchester, the EPA did not finance the control efforts. Except for some monitoring conducted by an EPA Emergency Response Team, Washington State agencies paid for and conducted the control and containment efforts. A complete summary of state costs was not available, but the Washington State Department of Ecology On-Site Coordinator estimated costs of "at least $1 million."[15/] Although no contract has been signed, a firm contacted by Washington state estimated that almost an additional $2 million would be required to cleanup the site.

The total direct costs such as fire fighting, security, oil collection and emissions monitoring for control and containment of the two fires are in the range of $3 million. Costs to cleanup the ash and residue at the two sites can be expected to add another $2 to $3 million for a total expenditure of between $5 and $6 million. Extrapolation of this information to the annual social costs of current stockpiling is limited because of the uncertainty of the number, size, and location of each stockpile as well as the probability of fire at any given site.

Any estimate of total expenditures to control all tire fires occurring each year in the U.S. (and, therefore, social costs) based on these two case studies will, of course, be highly speculative for all the reasons discussed in this section. Lacking any better information though, a very crude estimate of social costs might be in the range Of around $2 million dollars per year. It is submitted that this cost errs on the low side given the potential for many smaller fires for which remedial actions were undertaken but remain undocumented.

Aesthetic and Nuisance Damages

Earlier in the report, it was suggested that aesthetic costs of stockpiled tires might be low since tire piles tend to be located in rural or industrially zoned areas. [For the remainder of this discussion we will treat nuisance damages as in the same class as aesthetic damages.1 Of course, this begs the issue of random dumping. Further, the unsightly nature of discarded tires and the nuisance of having to handle tires are certainly two reasons why people are willing to pay for some form of disposal. Every year millions of dollars are spent by local governments, individuals, and firms to rid themselves of tires. Presumably, this expenditure represents, in a rough way, the desire to reduce the full range of possible social costs associated with disposing of tires by some alternative method (such as simply dumping the tires). Since the non-aesthetic social costs of not recycling tires appears to be quite low, one might argue that the difference between what is spent and the non-aesthetic/non-nuisance costs must be the value of reductions in aesthetic damages. This assumes, of course, that what people are willing to pay to reduce the social costs of tire disposal is at least equal to what they actually pay (be that directly or through tax mechanisms.)

Although this logic is somewhat appealing, its simplicity ignores the rather complex structure of the scrap tire disposal problem and the financing of disposal. Current expenditures to dispose of tires result in a mix of disposal outcomes. Some tires are randomly dumped, possibly reflecting the relatively high costs of capturing all tires; some are sent to landfills where, assuming they are buried, they pose little aesthetic damage; and the largest fraction go to stockpiles. Everything being equal, this mix (including the fraction that goes to recycling) reflects the optimal allocation of scrap tires given the level of expenditures society is willing to make. The stockpiled tires still pose some aesthetic costs (but little nuisance damage except those captured in the expected costs of tire fires) to individuals living in eyesight of the stockpile, passerbys and any others who come into contact with the pile. On the other hand, these damages are significantly less than if the tires were not collected in the first place. Many more people would be subject to the unsightly nature of tires on roadsides, vacant lots, etc.

On the basis of the above discussion, it would appear reasonable to assume that many of the aesthetic costs of disposing a tire are roughly represented by current expenditures made to transport and process tires into one of disposal categories. The most costly alternatives, also appear to be the most effective. The aesthetic costs of tires already disposed are a function of how they were disposed. Tires in stockpiles pose some aesthetic damage, whereas many of the other categories are associated with very little damage. The exception, of course, are randomly disposed tires. It may be reasonable to assume that these tires remain where they are because the costs of moving them outweigh the social value of the aesthetic damages.

In summary, there are two different calculations of aesthetic damage relevant to the estimation of social costs of tire disposal. The first represents willingness to pay to minimize aesthetic (and' nuisance) damage from a tire that is entering the disposal system for the first time. The second represents willingness to pay to further reduce aesthetic damage from a tire that is already in the system and for which some level of expenditure (to reduce damages) has already been made. The former category is almost certainly larger than the latter. This has important implications for judging the relative economic merit of alternative Federal programs to encourage recycling. If the impact of the program is in terms of reducing tires already disposed, the economic benefits of reducing aesthetic damages will be much less than if the program affects current tire disposal.

As in all cases of estimating the value of reduced aesthetic damages, the most appropriate economic method to use is not always clear. We suggested earlier ths t actual expenditures to dispose of tires could be a rough guage of the social costs of aesthetic damages for tires currently entering the disposal system. To the extent that these expenditures are also made to reduce other social costs, however, they would overestimate aesthetic damages; On the other hand, total tire disposal expenditures only represent the social costs reduced by the current distribution of disposal outcomes. Total social costs might well be higher. There is currently no good estimate of the total expenditures made by governments and individuals to dispose of scrap tires. One could be constructed however by averaging new tire price premiums for disposal across the country and adding on the cost incurred by local governments to pickup household or commerical tires and to cleanup randomly disposed tires.

The aesthetic costs of already-disposed tires could be most directly estimated through the application of contingent valuation methods around scrap tire piles or solid waste landfills containing tires or in an analysis of property value differentials around tire stockpiles and comparable properties with no stockpiles. Ignoring the computational difficulties and theoretical questions associated with both of these techniques, a larger problem may exist. Because tire stockpiles are increasingly associated with the risk of fire, either method would have to be carefully specified so as to isolate aesthetic damages from the willingness to pay to avoid the risk of fire and the potential health damages. Given the relatively high costs of contingent valuation studies (perhaps in the range of several hundred thousand dollars) and the methodological difficulties inherent in conducting property value studies, it is not clear whether such formal analyses could be justified on a cost/benefit basis. A cruder alternative may be to compare the costs of stockpiling with the costs of the next less expensive but aesthetically benign disposal alternative (for example, shredding and landfilling or some recycling option). Any cost differential could be interpreted as the least value for aesthetic and nuisance damage reduction necessary to justify fewer stockpiles. Without some sort of baseline, of course, there is no good way to know whether this indirect estimate is too high or too low. However, a very low number or very high number might, in a rough sense, provide some clues as to whether aesthetic and nuisance damages would have to be large in order to justify some alternative form of disposal.

## Summary

The discussion on social costs identifies several potential categories relevant to scrap tire disposal. Dollar estimates are obtained for only two: expected control and cleanup costs for tire fires (as a proxy for health and environmental costs of fires); and the expected treatment costs of health effects from mosquitoes that breed in discarded tires. Based on past experience, the total annual costs associated with these two effects are approximately $7.4 million annually. This estimate reflects those costs resulting from past disposal of tires; specifically, the 2 billion tires that make up the current stock of tires in the U.S. The social costs of current disposal, that is, the additional tires added to the existing stock, can be approximated by dividing the $7.4 million estimate by 2 billion tires, or around $0.004 per tire. If approximately 100 million tires are disposed of in stockpiles and random dumps every year (the disposal options most closely associated with the social cost estimates), an additional $400,000 in social costs will be incurred each year. Of course, appropriate comparison of these costs with the costs of alternative Federal programs would involve discounting over the life of the federal program.

The validity of the $0.004 per tire social cost estimate is highly dependent on the assumptions made throughout this section. For example, public expenditures to dispose of tires or to reduce the environmental and health risk of discarded tires have been assumed to be internalized or ignored all together. Given the information currently at hand, it is difficult to express a high degree of confidence in the estimates as accurately reflecting actual social costs. Additional research on the frequency and size of tire fires coupled with better data on expenditures made by municipal governments to control scrap tire risks would probably contribute the most to accurate and valid estimates.

SECTION 5

# ANALYSIS OF ALTERNATIVE FEDERAL PROGRAMS

The following is an overview of possible Federal programs addressing the scrap tire problem. Each policy option is briefly described and analyzed. This analysis is intended to provide a qualitative estimate of the types of programs which might be most useful for addressing the scrap tire problem, and point to the cost and benefit categories which should be quantified in a formal benefit-cost analysis. Benefits are defined as the reduced social costs of tire disposal which depend on the program's impact on the number of tires improperly disposed and estimate of the social cost per tire. Costs refer to administrative and compliance costs.

## Product Charges

Product charges have long been suggested as a mechanism for reducing solid waste streams. Product charges are fees imposed on the sale of products whose disposal might result in harmful environmental effects. They are designed as a means to ensure that the social costs associated with disposal become part of that product's costs to manufacturers and consumers. Product charges may serve to reduce solid waste streams two ways. By internalizing disposal costs they may act as incentives for producers and consumers to shift to more environmentally desirable substitutes, or as a public revenue source which may be used for solid waste management.

It would appear that a product charge on the sale of new tires would serve primarily as a revenue-producing mechanism. Although, there is no reliable, empirical information on the responsiveness of demand and supply for new tires to price changes, it is assumed that tires are relatively price inelastic. To the extent that this is true, a marginal increase (1% or less) in new tire prices would probably have little effect on new tire demand. Of course, if retreaded tires are exempted from the charge there might be a negligible shift to this substitute product. Further, the higher price on new tires might also create an incentive for consumers to take means to improve new tire life. However, the net effect would probably be very small.

What level to set is the most important consideration in the design of a new tire product charge. Since the rationale is the internalization of tire disposal costs, the product charge rate should be set according to the social cost of an improperly disposed tire. It is assumed that the basis for the calculation is the social costs associated with improper disposal such as stockpiling or random dumping and that other disposal mechanisms (e.g., recycling) either do not involve social costs or the costs associated with them are already internalized. For example, it is assumed that the social costs associated with landfilled tires are eventually paid by consumers through disposal charges and general tax revenues.

It may be argued that a product charge based on the annual social costs associated with past, as well as current, improper tire disposal is justified as a means of generating revenue for scrap tire management. A product charge of $.04 per tire could generate the roughly $8 million in social costs associated with past and present stockpiling and random dumping of tires. This charge might be justified on the grounds that current tire consumers should bear the cost of both past and present tire disposal. Such a product charge is an attractive funding option because it forces tire consumers to internalize both past and present disposal costs, but it may not be the most cost-effective mechanism for funding scrap tire management programs. Specifically, the costs associated with fee collection may make it less cost-effective than funding scrap tire disposal out of general tax revenues. For example, EPA funding scrap tire programs would avoid the costs associated with collecting the product charge. The equity considerations of a public financing scheme are relatively neutral given the national scope of the scrap tire problem, even with regional variations.

Subsidies

Properly landfilled scrap tires involve few or no social costs, but the private cost of shredding and preparing tires for landfills is relatively high. Given the high costs of properly landfilling tires, tire disposal prices at many landfills have been set artifically high to deter the flow of tires. Likely impacts of overpricing landfill disposal may be increased stockpiling and random dumping of scrap tires. To offset the perverse incentives created by high landfill disposal prices, Federal subsidies to landfills might be used to help finance the private cost of landfill disposal. For example, capital grants could be provided to landfills (or other shredding locations) for the purchase of tire shredders. (RCRA already provides for a 5% cost subsidy for the purchase of such equipment, although the program has not yet been initiated). Per-unit tire subsidies may also be provided to cover the operating costs of landfill tire disposal operations.

Subsidization of landfill costs would be expected to bring down landfill disposal prices which might reduce the stockpiling and random dumping of scrap tires. The ultimate reduction in tires stockpiled would largely depend upon the magnitude of the cost differential between alternative disposal options and the lower, subsidized, landfill disposal prices. If with subsidization, landfill disposal prices are still greater than stockpile disposal prices, a landfill subsidy program might have minimal benefits in terms of the environmental and health costs averted. Furthermore, a subsidy program would likely be very expensive. The program costs might outweigh program benefits even if a significant reduction in the stockpiling and random dumping of scrap tires occurred.

Federal subsidies could also be provided to private operators recycling scrap tires, such as tire retread manufacturers and companies which use scrap tires for fuels. In fact, this is a primary focus of the RCRA subsidies. It is unclear what impact such subsidies would have on the recycling of scrap tires given the existence of current market barriers.

Procurement Requirements

Alterations in Federal procurement guidelines have often been suggested as a means of including tires in increased efforts to recycle solid wastes. In general, such guidelines require Federal agencies to give preference to products composed of recycled material. Procurement requirements are mandated by the Resource Conservation and Recovery Act, (RCRA) although Federal agencies have not fishished drafting these requirements. Provisions in the Act require the federal government to develop guidelines for increased federal procurement of retreaded tires and reclaimed rubber products. The net effect, of course, is a function of the size of the Federal purchase relative to total sales. While the Federal government is a large single consumer, Federal expenditures in most product categories are still a small fraction of total expenditures. However, Federal procurement specifications are widely duplicated by state and local governments and thus may have a larger aggregate impact. Another procurement approach could involve stipulations which require states receiving federal highway funds to use asphalt rubber mixtures in road building and repair. Currently, Federal highway funds are not tied to the use of specific materials. Exemptions from the rule could be granted after states have shown this use to be impractical for their particular situation.

The direct compliance costs to Federal agencies of procurement requirements for retreaded tires would likely be small. The benefits of such a program would be primarily from averting the social costs associated with tire disposal. Social benefits cannot be determined because it is unclear how many scrap tires such a program would divert from stockpiles and landfills. It is also unclear whether procurement requirements would produce secondary social benefits in the form of reduced net outlays for tires. Although retreads are cheaper than new tires, they do not last as long. In fact, the purchase of retreaded tires may involve an opportunity cost because of the availability of cheap new imported tires.

To the states, the compliance costs to states of procurement requirements involving rubber asphalt road surfacing would include initial capital costs and possibly increased costs of procuring raw materials. However, since rubber asphalt road surfaces potentially last longer than conventional asphalt road surfaces, these costs may be offset by lower life cycle maintenance costs. The benefits of such a program in terms of social costs averted might be substantial, depending on the number of scrap tires absorbed by rubber asphalt road surfacing. For example, it is estimated that if 25% of the conventional binder used in road surfacing mixtures were to be replaced with rubber from tires, approximately 400 million tires would be absorbed annually 16/.

Public and Private Education

One major impediment to an increased retreaded tire market is the consumer use pattern of tending to wear down tires beyond the point of retreadability. A Federally sponsored consumer education program might be used to alter consumer behavior and attitudes toward tire consumption. The retread market is also limited by technological factors related to tire design and the availability of new, inexpensive imported tires. It is thus unclear how much benefit a consumer education program might produce.

Federal education programs might also be aimed at increasing the use of rubber asphalt road surfacing. Demonstration projects designed to educate state highway administrations in the worth of rubber asphalt road surfaces may produce social benefits through the reduction of both backlog scrap tires and new scrap tire output. Such an educational program might be coupled with procurement requirements which tie federal highway funds to state use of rubber asphalt road surfacing. The costs of such a program might be low relative to the potential benefits in terms of environmental and health costs averted.

Government Research and Development

Over the last 10 years, the Federal government has sponsored research and development programs to develop, test, and refine tire-recycling technologies. For example, in the late 1970s and early 1980s the U.S. Department of Transportation sponsored state highway demonstration projects to test the effectiveness of asphalt rubber road surfacing in varying locations characterized by different climates and road uses. The U.S. Department of Energy has sponsored research and development of various resource conservation technologies such as pyrolysis for the recovery of oil from scrap tires. Such programs may hasten the refinement and acceptance of technologies which recover scrap tires. However, although some recycling technologies are currently available they are not cost-competitive because of various market factors. The low price of alternative fuels, uncertain supply of scrap tires, and tire transportation costs may be more important impediments to greater tire recycling than the technological barriers.

Federal Regulation

Since the greatest portion of the social costs, associated with scrap tire disposal arise from stockpiled and randomly dumped tires, federal regulations on stockpile management are an important policy option for dealing with the scrap tire problem. For example, Federal regulations might require fire breaks in tire piles and spraying of piles for control of mosquitoes. Under current federal law, stockpile regulations would be the responsibility of the states under their solid waste management plans. The costs involved with complying with such regulations may outweigh the potential benefits.

For example, EPA recently required a stockpiler in Medford, Oregon to re-distribute 1.5 million tires and construct fencing to avert the danger of fire. Based on the social costs per tire estimate of **$.004,** the total social costs of this pile are roughly $6,000. The costs of complying with the EPA directive, on the other hand, was estimated at $30,000. Of course, this particular stockpile may not be representative of stockpiled tires in general and may involve much greater social costs per tire then $.004. Nevertheless, this calculation points out that the relatively low social costs associated with stockpiling of scrap tires may not justify Federal regulation of tire disposal. In addition, compliance costs associated with stockpile regulation may encourge the abandonment of stockpiles held for speculative purposes. Regulation compliance costs may therefore create perverse incentives which could lead to greater social costs associated with backlogged scrap tires. The net effect of Federal regulations may thus be only to increase the social costs associated with tire stockpiles.

# SECTION 6

## FUTURE RESEARCH DIRECTIONS

The preliminary research conducted for this study suggests several areas of further study that could help shed additional light on the economic justification for Federal government intervention in the disposal of scrap tires. No attempt is made here to lay out in great detail the specific elements of a research plan. Rather, the individual ideas are grouped into three larger categories. These categories could form the basis for further discussion.

### Economic Savings from Increased Recycling

The rather narrow definition of social costs used in this report (i.e., uninternalized external costs) does not provide a full picture of the range of potential benefits from increased recycling of scrap tires or from source reduction alternatives. Specifically, savings in terms of reduced expenditures to dispose of tires could constitute a significant efficiency gain. This is an empirical issue. That is, most of the recycling disposal options require certain expenditures for handling, transportation, and processing. Savings in landfill expenditures, resulting from increased recycling for example, may be offset by these additional costs. In addition, most of the recycling options require the availability of a dependable source of tires. It is likely that this requirement will translate into increased stockpiling of tires and the associated social and private costs of this disposal method.

Additional research should be conducted on the wider range of economic benefits including social and private cost savings from increased recycling of scrap tires. Specifically, it would be useful to develop a more complete and accurate estimate of actual current public and private expenditures to reduce the social costs of scrap tires. Such an estimate would include, for example, payments by municipal governments and the public to dispose of tires, expenditures by stockpile owners to reduce the social costs of their stockpiles (e.g., in response to regulatory requirements) and other internalized costs of disposal. It would also be useful to determine through informal surveys or case studies, the extent to which direct disposal costs are actually internalized in the price of new tires.

Uninternalized Social Costs

The three major categories of uninternalized social costs evaluated in this study are: expected costs of tire fires, health costs of mosquito induced encephalitis, and aesthetic/nuisance damages remaining in the current tire disposal mix. None of these estimates are perfect and all would benefit from additional research. Further, the list is not complete and would be expanded if a comprehensive social cost estimate were important. Each of these ideas will be treated in turn.

0 Expected costs of Tire Fires - The tire fire cost estimates presented here are national averages extrapolated from only two large tire pile fires. We know very little **about** the frequency and distribution of such fires and have little basis for guessing how often such costs would be incurred. As important, we ignore the possibility of smaller fires for which Federal action is never required. We were not able to locate any central source of data on tire pile fire size, frequency or distribution. Yet, it is possible that such data would be collected on a sampling basis and used to improve the reported estimates.

Another problem with the tire fire estimates is that they are based on expenditures to put out or mitigate the effects of the fire. These expenditures are probably lower bound estimates of willingness to pay to avoid the fires in the first place. Further, the direct expenditure data may not reflect the potential health effects to nearby residents exposed to the fumes or smoke of the fire. S'ome data is available on the constituents of the tire fire smoke, but we know little concerning potential exposures and resulting health effects.

0 Mosquito-induced Health Effects - The encephalitis cost estimates could be improved by the use of more appropriate estimates of the economic value of reduced morbidity risk. It is unclear, however, whether the ultimate estimate would differ greatly from the one reported here. Perhaps, more important, the reported health cost estimate reflects only morbidity costs not willingness to pay to avoid excess risk of death from encephalitis. Most encephalitis cases do not result in death, but we were not able to find much information of risk of premature mortality from the disease. It is possible that improved information on the risk profile of encephalitis would result in a larger estimate of health costs.

0 Aesthetic/Nuisance Damages - This is probably the largest class of damages from scrap tires and their disposal. Yet, we offer little concrete information in this report on the probable economic value of this set of damages. We do describe various alternatives for estimating the economic value of tires coming into the disposal system and tires already disposed and argue that

the application of sophisticated economic methods to isolate the value of aesthetic damages around stockpiles or landfills is probably not worth the cost. On the other hand, it may be possible to estimate what the aesthetic damages would have to be worth in order to justify a specific government program. This would be a useful exercise in combination with one of the research efforts suggested below.

- Other External Costs - Throughout the study, we have focused on the most obvious external costs of our current scrap tire disposal mix. It is possible that more subtle external costs have been overlooked. One suggestion along these lines made by a reviewer, involves the possible reductions in air pollution emissions from current energy sources (primarily coal) when using scrap tires as an alternative energy input. Proper burning of tires results in emissions that are somewhat lower (in terms of criteria air pollutants) than coal emissions. To the extent that Federal recycling efforts were to lead to some level of substitution of energy inputs, total air emissions might be reduced which would represent an obvious social benefit. It might be useful to investigate this externality more carefully in attempt to understand its possible importance.

Federal Policy Alternatives

The analysis in this report of alternative Federal programs to encourage increased recycling of scrap tires is limited in several ways. First, as discussed above, it does not consider savings in disposal expenditures as a result of increased recycling. Second, it is highly qualitative and does not make full use of the available (although perhaps not actually in hand) data on cost differentials. Third, it does not discuss in any great detail policy options that result in source reduction versus increased recycling. Given improved expenditure data, it would advantageous to upgrade the policy section to test some of the hypotheses developed in the report. A limited but still helpful approach might be to construct several hypothetical cases involving scrap tire disposal that are discrete, but would permit a more detailed assessment of the potential costs and benefits of alternative programs. To be valuable, such case studies would have to be conducted in combination with some of the other research suggestions made earlier.

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APPENDIX A

Scrap Tire Research Contacts

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|---|---|
| John Ambler | Department of Commerce |
| Craig Baker | Washington State Department of Ecology |
| John Bidner | National Tire Dealers and Retreaders Association |
| Rick Brown | Congressman Ron Wyden |
| Donna Carlson | President, Asphalt Producers Group |
| Jerome Collins | Department of Energy |
| Thomas Cole | Vice President Tire Division,<br>Rubber Manufacturers Association |
| Jim Dune | Demonstration Projects Division<br>U.S. Department of Transportation |
| Dave Geske | La Crosse County Health Department |
| Bill Gilley | Virginia Health Department |
| Haynes Goddard | Hazardous Waste Engineering<br>Research Laboratory<br>U.S. Environmental Protection Agency |
| Nyla Heath | President, All Seasons Surfacing Corporation |
| Mark Hooper | EPA Region X |
| Mark Hope | Waste Recovery Inc. |
| Steve Jarvela | EPA Region III |
| Norm McTague | Virginia Office of Emergency Services |
| Bill Sanjour | Office of Solid Waste<br>U.S. Environmental Protection Agency |
| Jerry Scharf | Recyclers Association |
| Dr. Wayne Thompson | University of Wisconsin |
| Dr. Ted Tsai | Center for Disease Control |
| Ed Wagner | American Retreaders Association Consumer Services |
| John Washburn | Minnesota Department of Health |
| John White | BF Goodrich |
| Don Wilson | Government Relations,<br>NTDRA |

APPENDIX B

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