

**Measures of Wood Resources in Lower Michigan:
Wood Residues and the Saw Timber Content of Urban Forests**

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SUMMARY

Fifteen hundred interviews were conducted in the early spring of 2006 with a random sample of businesses in fourteen counties that include and surround Detroit, Ann Arbor, and Lansing, Michigan. The purpose of the survey is to determine the type and number of companies that either generate or use eight types of wood residue for the calendar year 2005. An equally important purpose is to provide recommendations regarding questions and sample design to those considering conducting urban wood residue surveys in the future.

In the summer of 2005, a ground survey of urban trees was conducted to determine the potential saw log content of the urban forests in the same area. Knowledgeable observers report the loss of saw logs contained in trees felled by natural occurrences, such as the EAB, and by human actions, such as residential and commercial development. The prevailing view is that urban saw logs are of little if any value. This survey provides estimates of the actual abundance, distribution, quality, and accessibility of urban saw timber.

The results of these surveys provide aggregate estimates for 2005 of the flow of wood residue through businesses and the stock of urban saw timber contained in the area's trees. For both Michigan businesses and state and local governments, the results could identify where opportunities exist to make the better use of underutilized wood fiber. Another issue raised by this study is the need in urban areas for a coordinated system that routinely monitors and supports the recovery of wood residue from all sources.

Business Survey

Survey Respondents

Approximately one out of three businesses were randomly selected from the list of 20,101 businesses thought to be potential generators or users of wood residue. The sample was stratified by county to insure that each was represented in the sample. The gross sample size is 7,007. Of the 2,373 contacts made by telephone, 1,500 agreed to be interviewed while 873 refused to participate. Of the completed 1,500 interviews, 420 (28%) indicated that they either generated or used wood residue. The remaining 1,080 (72%) stated that they did not do either. The distributions at the most specific Line-of-Business level for refusals and for respondents were statistically the same. For this reason, estimates of totals include refusals.

Sufficient data were obtained on 5 of the 8 residues: pallets, skids, and shipping crates, edgings and cutoffs, chips and shavings, construction debris, and tree trunks, limbs, and stumps. Data collected on dunnage were insufficient for analysis. Separate attempts were made to contact six railroad companies operating in the study area. Only two responded: one uses the rail lines of other companies and the other could not separate tie replacements for the study area from their national data. The rest did not return the calls. Utility companies did not return calls either, so there are no data on utility poles removed from service in 2005.

Just over one-third of the respondents (36.2%) are in the construction industries. Another one-fourth (26.7%) are in machinery manufacturing. Along with companies in freight transportation (13.4%) and building materials (6.1%), these four industries account for just over 8 out of 10 (82.4%) of the respondents to the survey. The rest are spread out over 16 other industry groups.

Down to the Line-of-Business level, respondents in each of five major industries reported both generating and not generating residue. This is most puzzling for building construction

companies all of whom presumably use the same basic wood materials. For several reasons, claims by construction companies that they generated no residue are not treated as plausible and these companies are treated as generators in some residue estimates.

Residue Generated in 2005

Excluding railroad ties and utility poles, approximately 2,600 companies in total generated about 7.5 million cubic yards of residue in the fourteen county study area in 2005. This amount would fill 354 football fields to a depth of 10 feet (the height of the crossbar on the goal posts). About half (51%) was construction debris while just over one-third (35%) was edgings and cutoffs. The rest consisted of pallets (7%), chips and shavings (6%), and tree debris (1%). Among those companies that paid for removal, the total was \$8.8 million.

As shown in the Table below, less than one-fifth of pallets were discarded while over four-fifths of pallets were reused or recycled. Sixty percent of edgings and cutoffs were discarded as waste while the remaining 40% was reused. Sixty-three percent of the construction debris was discarded while the remaining 37% went to other companies and individuals. Just over half of chips and shavings were discarded while the rest was used. For tree debris, 61% was discarded while 39% was used.

Residue	Total Amount Generated (cubic yards)	Percent Used	Total Amount Used (cubic yards)	Percent Discarded	Total Amount Discarded (cubic yards)	Of Total Amount Discarded, Amount Sent to Landfills (cubic yards)	Percent of Total Discarded Residue Sent to Landfills
Pallets, Skids, Shipping Crates	505,000	84%	424,000	16%	81,000	15,000	19%
Edgings and Cutoffs	2,646,000	40%	1,058,000	60%	1,588,000	675,000	43%
Chips, Shavings, Sawdust	480,000	48%	230,000	52%	250,000	108,000	43%
Construction Debris	3,828,000	37%	1,416,000	63%	2,412,000	1,302,000	54%
Tree Trunks, Limbs, Stumps	84,000	53%	45,000	47%	39,000	5,000	13%
Totals	7,543,000	42%	3,173,000	58%	4,370,000	2,105,000	48%

In total, just under 4.4 million cubic yards of residue were discarded as waste in 2005, 58% of the total 7.5 million cubic yards generated. Of the 4.4 million cubic yards discarded, just over 2.1 million cubic yards, or about 48%, ended up in landfills. The rest of what was discarded was either burned or disposed of in other unspecified ways. Of the total 7.5 million cubic yards generated, 2.1 cubic yards, or 28%, went to area landfills.

Pallets, Skids, and Shipping Crates

All companies together generated about 3 million pallets in 2005. Automobile manufacturers alone generated an estimated 1.9 million pallets. Probably 90% of these were reused or recycled. All the other companies generated about 1.1 million. Based on 6 pallets per cubic yard, a total of 505,000 cubic yards were generated. Just over three-fourths of the generators were machinery manufacturers, lumber dealers, construction companies, freight haulers, and furniture stores. Among them, 73% of the pallets were reused or recycled while 27% went to landfills, were burned, or were otherwise disposed of as waste. For all the companies together, 84% of the pallets were reused, 16% were not.

Other than the automobile manufacturers (for whom no expenses were reported or estimated), generating companies spent less than \$1 million in 2005 on disposal. They avoided removal costs by giving the pallets away (limited anecdotal evidence suggests the automobile manufacturers gave theirs away at no cost to themselves). The large majority of pallets were taken by other companies. In general, pallets are either repaired and reused or ground into mulch. Hauling distance averaged 10 miles. Many companies also reused their own pallets as pallets.

Companies interviewed that accepted pallets were not in the recycling industry (none of those companies agreed to participate). Instead, most are machinery manufacturers. One possible reason that these companies accept pallets is that they are engaged in an ancillary business activity that reduces disposal costs or even generates a small profit, not too unlikely since recycling is reported to be the most profitable part of the wood pallet business. However, as a group, they are not as adept as recyclers, often accumulating large inventories. Several report not being able to find pallet recyclers. An opportunity exists here for recyclers to focus more on this industry as a source.

Edgings and Cutoffs

A total of 615 companies generated just over 2.6 million cubic yards of edgings and cutoffs. Not surprisingly, two-thirds of the companies are in the construction business. Two-thirds of all 615 companies paid an estimated total of \$1.4 million for removal. The remaining third paid nothing. Among those who paid, just over one-third used their own trucks for hauling an average distance of 12 miles to disposal sites. Among those who did not pay, about three-fourths avoided removal costs by giving the material away. An estimated 40% of the material was reused while the 60% was not. About two-thirds of all of the companies did make some use of their own edgings and cutoffs, the rest did not. The main uses were as building materials and heating fuel.

Chips and Shavings

Overall, 324 companies generated 480,000 cubic yards of chips and shavings. Just under half was reused while just over half was discarded as waste. Three-fourths of these companies were either in construction, wood products manufacturing, or industrial machinery manufacturing. About 4 out of 10 companies paid just under one-half million dollars to dispose the material they generated. The other 6 out of 10 either gave the material away or, in a minority of cases, were paid for it. Among those that disposed of their chips and shavings as waste, about three-fourths used landfills. About 1 out of 4 recycled, mainly as mulch.

Construction Debris

An estimated 1,161 companies, mostly in building construction, generated about 3.8 million cubic yards of construction debris. Only one-third was reused, the other two-thirds were discarded. Three-fourths of these companies paid about \$5.4 million for disposal. The other one-fourth paid nothing, mainly by giving the debris away. Among those who paid, about one-third used their own trucks for hauling while the rest relied on other companies. The average hauling distance was 58 miles, far more than the distances traveled by companies that generated other kinds of residue. Most of the discarded debris went to landfills. Roughly half the companies did not reuse while the others did, mainly as building material.

Trees, Trunks, and Stumps

An estimated total 96 companies, mainly in the construction business, generated about 84,000 cubic yards of tree debris. Just over half were used while the rest was discarded. Just under half paid for removal -- about \$700,000 in total. Slightly more than half disposed of the debris at no cost to themselves, mainly by burning. Half hauled the debris to disposal sites in their own trucks, the other half in trucks belonging to other companies. The average hauling distance was 9 miles. Just over half made no use of the tree debris. Among those that did, the most frequent use was firewood. There is no clear indication of whether more or less ash trees were removed in 2005 compared to the previous year, probably because companies were unable to distinguish ash from other hardwood species.

Wood Residue Market

Just over 6 out of 10 (62.4%) responding companies stated there was no market for their residue. About 2 out of 10 (20.9%) thought a market either existed or was developing. The rest did not know. The most frequently cited reason for no market is that the wood cannot be separated from the foreign material to which it is attached.

Among the 61 companies that believed a market was developing, just over three out of ten (34.4%) indicated that identifying buyers was the principal impediment to further market development.

Among the companies that indicated there was a developed or developing market, just over half (53.4%) thought residue prices varied less than gasoline prices. Far fewer (15.9%) thought residue prices varied about as much or more. Price volatility is not an impediment to the further development or operation of the residue market.

Well over half (61.4%) of the 88 companies felt they were getting enough price information. But 24 companies, just over another one-fourth (27.3%), felt they were not getting enough. The rest (11.4%) did not know. Among the 24 not getting enough information, somewhat over half (54.2%), cited identifying buyers as the single most important additional information they needed.

Sampling and Questionnaire Recommendations

1. When defining the study population, the list of businesses to be sampled for major urban areas can be with little loss limited to the following:

- tree service companies (SIC 0783);
- construction (SIC's 15, 16 and 17);
- machine manufacturing (SIC 35);

lumber and wood products (SIC 24);
wood furniture (SIC 25);
freight transportation (SIC 42);
building supply and mobile home companies (SIC 52);
food stores (SIC 54); and,
home furniture stores (SIC 57).

2. The sample should be stratified by SIC codes to insure that all potential generators and users of residue are drawn into the sample. To insure an adequate number of responses consideration should be given to disproportionate sampling among strata with few companies. Stratifying by region is far less useful than by industry when estimating total residues generated and used.

3. When considering companies to supply a list of businesses, request totals for the study area by two-digit SIC code for the same time to see if there is much variation. If the numbers are about equal in total and across SIC codes, consider the company with the lowest price per business that provides names, addresses, and telephone numbers. Lower prices may be available from companies that do not draw samples. (The organization conducting the interviews should be able to draw a sample from the population list.) No matter how often companies update their roster of businesses, there will be a substantial number that can never be contacted owing to wrong numbers and business failure. In addition, some listed as businesses that have telephone numbers can never be reached bringing into question whether these are real businesses.

4. In addition to companies drawn into a sample, other companies that generate and accept substantial amounts of residue should be separately identified and included in estimates of totals. While their selection is deliberate and not part of the sampling procedure, they should not be excluded, especially if they are very unlikely to be selected. The major examples in this study are the three major automobile manufacturers, railroad companies, and utility companies. This applies to all areas for utility poles and railroad ties since the companies that generate them are so few in number compared to the study population that they are unlikely to be selected into the sample. In general, regional industry specialties that may be substantial generators or users, such as the automobile industry in southern Michigan, should be included.

5. Select a sample size at least sixteen times the target number of completed interviews with generators and users. In this study, completed interviews with 1,000 generators and users would have required a total sample size of about 16,000 businesses.

6. To forestall possible confounding interpretations, the first question used in this survey to determine whether a company is a generator or user of wood residue could have been even more precise by indicating that ownership of the waste and responsibility for disposal are irrelevant: what counts is whether the respondent's company engaged in work that produced wood waste or whether the company's business is to accept and process wood waste (such as pallet recyclers). This could be further specified by a preceding question that asks whether wood is any part whatsoever of the company's production process. Respondents in industries that are likely generators who give a negative answer should be asked how they are able to conduct their business without generating wood waste.

7. Questions should be added that directly request of all responding companies the amounts of residues they send to landfills, burn, and otherwise discarded as waste.

8. Although they are similar in function, pallets/skids and shipping crates are not the same in form and should be treated in separate sets of questions.

9. Dunnage should be included only when warranted by the industry base of the urban area being surveyed.

10. Railroad and utility companies should be selected and contacted separately. To increase the likelihood that these companies will respond to calls and requests for data, senior governmental officials should make initial calls to company executives requesting their cooperation.

Urban Tree Survey

Harvesting saw timber from urban trees puts the trees to their highest end-use. Currently, however, most urban wood ends up in landfills or is used for wood chips or biomass fuel. Recent economic losses imposed by the Emerald Ash Borer highlight the well known value of urban forests, not the least of which is their value as a source of lumber.

To assess the general feasibility of harvesting urban wood, a regional estimate of urban saw timber quantity, quality, and availability was developed for the 13-county area in southeastern Lower Michigan. Four types of urban areas were selected and separately sampled: low-intensity, high-intensity, roads and paved areas (such as parking lots), and parks and golf courses.

The total standing urban saw timber in 2005 in the 13 counties was about 327 million board feet. Of this total, 72% percent, or 235 million board feet, was judged as accessible. About 56% was easily accessible while another 16% was moderately so, meaning that some extraction costs and risks would be incurred but neither would be prohibitive. The remaining 28% was rated difficult, essentially so costly and risky as to be inaccessible.

More specifically, 93.5% of all saw timber on parks and golf courses is judged easily accessible while less than 1% is difficult to access. Almost 90% of saw timber along roads and in paved areas was rated as easily accessible, although street trees are about 4 times (2.1% versus 0.5%) more likely to be rated as difficult than trees on parks and golf courses. The main complication is extracting wood from large trees whose crowns are closely intertwined with utility wires. High intensity urban areas pose a greater challenge, although less than 4% of this saw timber is considered difficult to access. By sharp contrast, about half of all saw timber in low intensity urban areas is rated as difficult.

Conservatively, about 4.7 million board feet is estimated to come available each year in the study area from dead and dying trees. This is enough to supply the minimum annual needs of 5 small saw mills. This amount would be enough to build 362 average-sized homes.

Wood quality of urban hardwoods was comparable to that found in Michigan's forests, although the absolute volume was nine times less. While there are many potential concerns with harvesting urban trees for saw timber: low availability, poor wood quality and logistical concerns regarding harvesting urban wood, the results of this study suggest that many of them may be unfounded. The quality of wood in urban softwoods was generally low, but then softwoods comprised only 10% of urban wood.

The strength of some urban wood may be less than their forest counterparts primarily because of the greater quantity of juvenile wood found in open grown urban trees. This was not examined in this study and would require additional research to confirm.

While arborists and small private landowners may not be able to bear the costs of harvesting urban saw timber, governmental agencies and departments could expand their efforts to utilize urban wood to offset tree removal costs and as a material source for public park furniture and

buildings. A step in this direction would be to train municipal foresters to grade trees thereby identifying those of saw log quality.

The economics of commercial timber harvesting versus harvesting urban timber suggest that urban wood should be viewed as a supplemental source of lumber and not as a replacement. Its use can support the costs of tree removal and replacement and disposal. If the 13 county area here in Michigan is similar to other urban areas across the nation, there is a substantial amount of available for wood products.

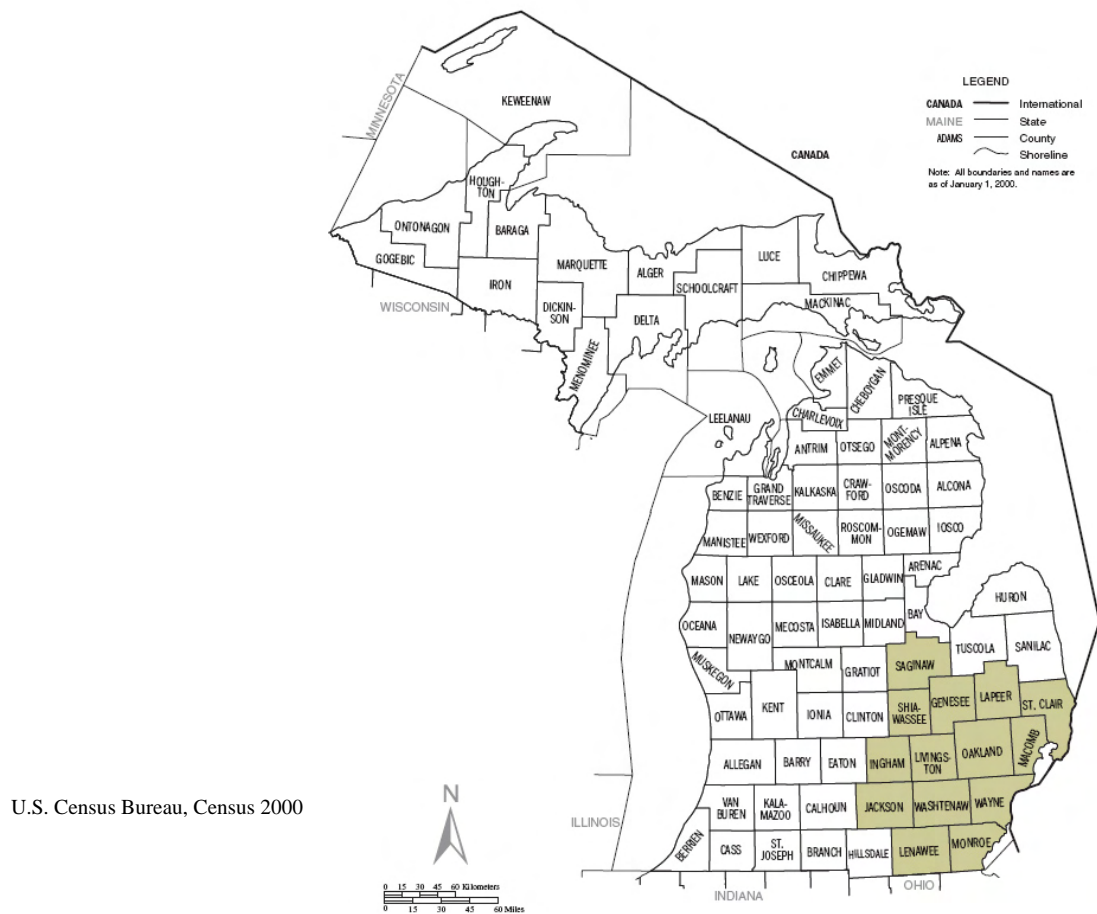
Part One: Wood Residues

Study Purpose

Fifteen hundred interviews were conducted in the early spring of 2006 with a random sample of businesses in fourteen counties that include and surround the Detroit, Ann Arbor, and Lansing Michigan areas. Listed in Table 1 below are the counties that were among twenty that at the time of selection were under a state imposed quarantine to prevent the spread of the Emerald Ash Borer (EAB).

The primary purpose of this survey is to determine for the calendar year 2005 the type and number of companies that either generate or use nine distinct types of wood residue, including that generated by the loss of ash trees to the EAB, and to estimate the amounts they generated and used for 2005.¹

Michigan Counties Selected for the 2006 Wood Residue Business Survey



¹The phrase "wood waste" was used in the questionnaire. The phrase "wood residue" used in its place in this report has the same meaning.

An equally important purpose is to provide recommendations regarding questions and sampling to those considering urban wood residue surveys. This is the first study of its kind for an urban area. Several important lessons were learned that could improve future surveys based on telephone interviews and samples drawn from commercial business lists.

In the summer of 2005, a ground survey of trees was conducted to determine the potential saw log content of the Detroit, Ann Arbor, and Lansing urban forests. The tree survey area covered all of the counties listed above in the map except Saginaw which was added to the business survey after the field work for tree survey had been completed.

Urban foresters, tree service companies, utility companies, and land developers, among others familiar with urban trees, often report the loss of saw logs contained in trees felled by natural occurrences, such as the EAB, and by human actions, such as residential and commercial development. Even so, the prevailing view is that, compared to commercial logging, urban saw logs are of much less value because of the foreign material embedded in them, possible inherent structural weakness of trees that grow in open spaces, supply that is irregular and difficult to predict, and the expense of transporting to saw mills small numbers of logs scattered widely throughout a large urban area. This part of the study addresses these issues for urban wood in the thirteen county area by directly estimating the actual abundance, distribution, quality, and accessibility of urban saw timber.

Together, the results provide aggregate estimates for 2005 of the flow of wood residue through businesses and the stock of urban saw timber contained in the area's trees. For both Michigan businesses and state and local governments, the results identify where markets have already developed for wood residue and where opportunities might still exist to make both the best private and public use of wood fiber still being underutilized or discarded. The urban forest survey reflects a change in the conventional view that only standing urban trees have value and that once down what is not discarded as green waste in urban landfills is at most only good for firewood and mulch. Knowing the stock provides a basis for estimating the amount of lumber that could flow into the area's stream of usable wood fiber.

This study arose from an immediate goal among federal, state, and local governments to contain the EAB and thereby save as many of Michigan's ash trees as possible. A related and equally important goal is to put to best use what cannot be saved.

From a broader perspective, this report highlights the value and uses of urban wood fiber from major sources: where it is in use and where better use might be made of it. From the broadest perspective, this report should draw attention to possible ways government and business can best use the only indigenous natural resource available in the nation's urban areas.

The long-run issue raised by this study is the need in urban areas across the nation for a coordinated system, in place and active, that routinely supports and provides incentives for the recovery of wood residue from all sources. This system can be comprised of local and regional agencies acting through coordinating groups such as the Southeast Michigan Resource Conservation and Development Council in southeastern Michigan. In the short-run, such organizations can quickly disseminate information about what can be done with extraordinary supplies of wood residue created by episodic storms and infestations. Over the long run, and aside from natural disasters, they can support both public uses and the private market utilization of the more predictable flow of wood residue from all sources.

Finally, for those interested in conducting equivalent surveys in other urban areas, this project provides a comprehensive wood residue questionnaire and identifies business sampling

methods and survey costs that should be kept in mind. The urban forest survey method is described but not recommended except to those who have both the highly specialized knowledge needed to draw a satellite-based multi-stage area probability sample and have trained crews that can apply the sampling technique and measurement methods on the ground. The description of the methods does provide enough information to judge proposals from those who might be capable of conducting such a survey.

In the following sections, sampling methods are described as are the respondents to the business survey by type of wood residue. The methods and results of the urban forest survey are then described. The report closes with a summary and implications of the study findings.

II. Study Population, Sample Selection, and Responses by County and Type of Business

In survey research, the study population consists of members of a precisely defined group all of whom are the subjects of the study. Among the many possibilities, study populations can consist of individuals, families, governmental agencies, private companies, or urban trees. Whatever its membership, the study population must be precisely defined: there can be no ambiguity about who, or what, belongs. The definition is most often based on what and where something is: in this study, urban trees and businesses that generate or use wood residue in the selected counties in and around Detroit, Ann Arbor, and Lansing.

Information about the study population can be gathered from either a census of the entire population or from a random sample of it. Unless the population is small relative to the amount of funds and time available for a study, the usual procedure is to draw a random sample from the population. Information is then collected from only those drawn into the sample. Survey results based on sample data and statistics are generalized to the population as study findings.

Survey measures are also anchored in time. Both the business and tree surveys are cross-sectional. While both apply to 2005, they are based on information available at the time of collection: early spring of 2006 for the business survey and mid-summer of 2005 for the tree survey. A single cross-sectional sample, like a photograph, captures a moment in time and is not well-suited to measuring changes over time. Measures of changes in the flow of wood residue through businesses in southeastern Michigan or changes in the quantity, quality, and accessibility of urban tree saw logs would require a longitudinal study based on either multiple cross-sectional samples of businesses and urban trees conducted over a period of years or panels each consisting of one-time samples of businesses and urban trees followed for a period of years.

At its simplest, a sampling frame consists of a direct list or combined lists of the population members from which a final sample is drawn in a single round or stage of selection. When such a list is not available, more complex frames can include indirect lists and related information for a multi-stage selection of the final sample. Lists of businesses in the United States are available and are used as sampling frames. By contrast, there are no lists or inventories of individual urban trees. Here, the sampling frame consists of stages of collection that start with satellite images and end with the on-ground random selection of individual trees into a sample of urban trees.

Regardless of how a study population is ideally defined, the sampling frame established by actual contacts sets the population boundaries because the frame consists of those who can be actually or at least possibly be reached or those things such as trees that can actually be directly measured. Most often the frame does not consist of everything we want but just what we can actually get to. The difference between the two is the coverage rate. A 100 percent rate means that the ideal and actual are equal. Under-coverage refers to a sampling frame that does not

include all the members who belong to the study population while over-coverage refers to the inclusion of those who did not belong.

Sampling Frame

The ideal sampling frame for the business survey is a complete roster by name, address, telephone number, industry, and county of all those legitimate and operating businesses that either generated or used wood residue in 2005. A random sample would be drawn from this roster and representatives of each business would be interviewed by telephone. Under ideal circumstances, an interview would be completed with every business. Both the coverage rate and the response rate would equal 100 percent. Rarely, if ever, do surveys meet this ideal.

While there are companies throughout North America that sell lists or directories of business that include each firm's name, address, telephone number, location, county, and industry (as well as other kinds of information such as number of employees and year started), none provide the very specific information that would allow companies generating or using wood residue to be distinguished from all the others who do not. The closest piece of information that can be used to make this distinction is the Standard Industrial Classification (SIC) code number.

Originally created in 1937 and last updated in 1987, SIC codes were used by the U.S. Government to categorize companies by the primary and secondary products and services they produce. The original SIC system consists of four hierarchically arranged categories beginning with the letters A through K that represent eleven distinct divisions: for example, A represents Agriculture, Forestry, and Fishing. Thereafter, two, three, and four-digits progressively represent more specific categories of companies whose products and services are increasingly similar: for example, 01 is the Major Group for Agricultural Production Crops, 018 is the Industry Group for Horticultural Specialties, and 0181 is the Industry for Ornamental Floriculture and Nursery Products.

The original SIC four-level code has been extended by companies offering business financial and marketing services. One of if not the most widely used is from D&B (formerly Dun & Bradstreet). D&B added two sets of two-digits each to more narrowly categorize companies offering similar products and services. The first two-digit code is sub-industry and the second set is line-of-business code, the most specific: for example, 0181 99 02 is the D&B code for Sod Farms. While the original SIC code is no longer maintained by the U.S. Government (which began in 2000 to switch to the NAICS code as part of the NAFTA Agreement), the D&B's extended version is widely used by companies in the U.S., around the world, and still by some agencies and departments of the U.S. Government. Many companies, including the one that supplied the list for this study, use the D&B extended code.

The extended SIC codes can be used to approximately identify Industries, Sub-Industries, and Lines-of-Business that are likely generators and users. What we considered likely for this study was based in part on a state-wide wood residue survey conducted via mailed questionnaire by the Wisconsin Department of Natural Resources in 1992.² Responses by industry to that survey permitted us to eliminate some industries at the two-digit level (for example, medical services) as likely generators or users. At the same time, the study also allowed us to identify likely generators and users.

²Vern A. Everson and Nicholas R. Hubing. October, 1993. *Wisconsin Wood Residue Study*, Bureau of Forestry, Wisconsin Department of Natural Resources, Publ-FR-075-93.

In addition, we relied on a panel of employees of the State of Michigan who as a group are familiar both with recycling in general and with wood fiber recycling in particular. An employee of the USDA Forest Service, also very familiar with urban wood residue issues, served on the panel. The panel relied on a consultant who has over ten years experience searching for wood residue sources throughout southern and central Michigan to supply fuel for a 40 MW wood-fired power plant in Genesee County. His list of specific companies, identified by SIC code, was an important contribution to the sampling frame for this survey.

Using the D& B extended SIC code, specific codes were selected that would generate a sampling frame list of businesses consisting of the most likely generators and users of wood residue. Overall, our aim was to be specific as possible while erring on the side of being too inclusive. We ended up using only four and eight-digit codes representing industries and lines-of-businesses, respectively. The four-digit code was used when there was doubt about what Line-of-Business to select and the eight-digit code when we felt most confident about the Line-of-Business. Listed in Table 1 are the codes and corresponding Major Groups and Lines-of-Businesses for the fourteen county study area. Only primary product and service codes were used.

This list was not tailored to the types or distribution by type of businesses specifically expected in the survey area. Nevertheless, given the size of the combined Detroit, Ann Arbor, and Lansing area, most though not necessarily all should be represented in the sample.³ In general, most should be represented in samples for large urban areas the size of Detroit while fewer, perhaps far fewer, could be expected for samples of smaller urban areas, cities, and towns.

The study population is specific businesses not specific employees of each business. Interviews were conducted with those who answered the telephone call and were willing to answer the questions. In a few cases, call-backs were made to reach the most informed employees if those who answered first did not feel they could answer the questions. The interview began with a screening question intended to separate businesses that either generated or accepted wood residue in 2005 from those that did not.

At the time the initial sample was drawn, there were 20,101 telephone numbers of businesses in the fourteen counties whose primary SIC codes matched the sampling frame codes. Table 2 gives the distribution by county of the sampling frame list of businesses. About eight out of ten are in a half of the fourteen counties (in bold): 81.4% are in Oakland, Wayne, Macomb, Genesee, Washtenaw, Livingston, and Ingram. Table 3 gives the distribution by two-digit SIC codes for Major Groups. Three Major Groups (in bold) account for just under three-fourths of the total: 72.8% are in Building Construction (15), Industrial & Commercial Machinery & Computer Equipment (35), and Motor Freight Transportation (42).

Though the total for this survey is exact, totals will vary across companies that supply these lists owing to differences in data collection methods, sources of business information, and the timing of updates. Prices per business selected also vary, often substantially, depending on what information is requested. When considering companies to supply a list of businesses, request totals for the study area for the same point in time to see if there is much variation. Totals are

³ Only 10 of the 162 different codes in the sampling frame were absent from the actual list of businesses. Missing are those that produce Glass Containers (3221), Structural Clay Products (3259), Vitreous China (3262), Mining Machinery and Equipment (3532), Cordwood (50990201), Logs, hewn ties, posts, and poles (50990204), Pulpwood (50990205), Roundwood (50990206), and Supermarkets greater than 100,000 square feet, not otherwise part of a chain of stores (54110102). The three most likely reasons why these ten are missing are either that there are none of these businesses in the fourteen counties, the company, InfoChase that supplied the list inadvertently missed some or all of them, or the companies by their own actions kept themselves off of all such listings.

Table 1
SIC Codes and Related Industries and Lines-of-Businesses for the
Fourteen County EAB Survey Area

SIC	Industry	SIC	Industry
01	Agricultural Production	2436	Softwood Veneer & Plywood
01819902	Sod Farms	2439	Engineered Wood Members & Trusses
		2448	Wood Pallets, Skids, Containers
07	Agricultural Services	2451	Mobile Home Manufacturers
07830104	Pruning Services, Ornamental Trees	2452	Prefabricated Wood Buildings
07830105	Tree Trimming Services for Public Utility Lines	2491	Wood Preservation
		2493	Reconstituted Wood Products
		2499	Wood Products, NEC
15	Building Construction	25	Furniture & Fixtures
1521	Single Family Construction & Remodeling	2511	Cabinet, Household, Freestanding
1522	Residential Construction	2512	Upholstered Furniture
1531	New Housing Speculative Builders	2515	Mattresses & Bedsprings
		2517	Wood TV, Radio, Sewing Machine Cabinets
16	Heavy Construction, Other than Building	2521	Wood Office Furniture
1611	Highway & Street Construction	2531	Institutional Furniture
16290100	Dams, waterways, docks, & other marine construction	2541	Wood Partitions & Fixtures
16290101	Caisson drilling	2591	Blind & Shade Manufacturers
16290102	Canal construction	2599	Furniture & Fixtures, NEC
16290103	Dam construction	26	Paper & Allied Products
16290104	Dock construction	2611	Pulp Mills
16290105	Drainage system construction	2621	Paper Mills
16290106	Dredging contractor	2653	Corrugated & Solid Fiber Boxes
16290107	Harbor construction		
16290108	Irrigation system construction	32	Stone, Clay, Glass, & Concrete Products
16290109	Levee construction	3211	Flat Glass
16290110	Marine construction	3221	Glass Containers
16290111	Pier construction	3229	Glass, Pressed & Blown
16290113	Waterway construction	3231	Glass Products Made of Purchased Glass
16290200	Railroad & subway construction	3241	Hydraulic Cement
16290201	Cutting of right-of-way	3251	Brick & Structural Clay Tile
16290202	Railroad Railway Roadbed Construction	3253	Ceramic Wall & Floor Tile
16290104	Dock Construction	3255	Clay Refractories
16290111	Pier Construction	3259	Structural Clay Products
16290400	Land Preparation Construction	3261	Vitreous China - Plumbing
16290404	Timber Removal	3262	Vitreous China - Table & Kitchenware
16299903	Land Clearing Contractor	3263	Fine Earth-Ware
		3264	Porcelain Electrical Supplies
17	Construction, Special Trade Contractors	3269	Pottery Products
1751	Cabinet Building & Installation, On-Site	3271	Concrete Block & Brick
17949901	Excavation & Grading, Building Construction	3272	Concrete Products, except Block & Brick
17959902	Demolition, Buildings & Other Structures	3273	Ready-Mix Concrete
		3274	Lime
		3275	Gypsum Products
		3281	Cut Stone & Stone Products
		3291	Abrasive Products
		3292	Asbestos Products
24	Lumber & Wood Products, except Furniture	3295	Minerals & Earths, Ground, Crushed, Pulverized
2421	Sawmills & Planing Mills	3296	Mineral Wool
2426	Hardwood Dimension & Flooring Mills	3297	Non-Clay Refractories
2429	Special (Wood) Products Mills	3299	Nonmetallic Mineral Products, NEC
2431	Wood Window Manufacturing		
2434	Cabinet Building, Stock & Custom		
2435	Hardwood Veneer & Plywood		

33	Primary Metal Industries	3585	Air-Conditioning & Warm Air Heating Equipment & Commercial & Industrial Refrigeration Equipment
3399	Primary Metal Products	3586	Measuring & Dispensing Pumps
35	Industrial & Commercial Machinery and Computer Equipment	3589	Service Industry Machinery, NEC
3511	Steam, Gas, & Hydraulic Turbines, and Turbine Set Units	3592	Carburetors, Piston Rings, & Valves
3519	Internal Combustion Engines, NEC	3593	Fluid Power Cylinders & Actuators
3523	Farm Machinery & Equipment	3594	Fluid Power Pumps & Motors
3524	Lawn & Garden Tractors & Home Lawn & Garden Equipment	3596	Scales & Balances, except Laboratory
3531	Construction Machinery & Equipment	3599	Industrial & Commercial Machinery & Equipment, NEC
3532	Mining Machinery & Equipment (except Oil & Gas)	37	Transportation Equipment
3533	Oil & Gas Field Machinery & Equipment	3711	Motor Vehicles & Passenger Car Bodies
3534	Elevators & Moving Stairways	39	Miscellaneous Manufacturing Industries
3535	Conveyors & Conveying Equipment	3944	Games, Toys, & Children's Vehicles
3536	Overhead Travel Cranes, Hoists, & Monorail Systems	42	Motor Freight Transportation
3537	Industrial Trucks, Tractors, Trailers, & Stackers	4212	Local Trucking, Without Storage
3541	Machine Tools, Metal Cutting	4213	Trucking, Except Local
3542	Machine Tools, Metal Forming	4214	Local Trucking, With Storage
3543	Industrial Patterns	49	Electric, Gas, & Sanitary Services
3544	Special Dies & Tools, Die Sets, Jigs, and Fixtures & Industrial Molds	4911	Electric Services, Power Generation
3545	Cutting Tools, Machine Tool Accessories and Machinist Precision Measuring Devices	49530302	Sanitary Landfills
3546	Power-Driven Hand tools	50	Wholesale Trade, Durable Goods
3547	Rolling Mill Machinery & Equipment	50990200	Wood & wood by-products
3548	Electric & Gas Welding & Soldering Equipment	50990201	Cordwood
3549	Metalworking Machinery, NEC	50990202	Cork products, fabricated
3552	Textile Machinery	50990203	Firewood
3553	Woodworking Machinery	50990204	Logs, hewn ties, posts, & poles
3554	Paper Industries Machinery	50990205	Pulpwood
3555	Printing Trades Machinery & Equipment	50990206	Roundwood
3556	Food Products Machinery	50990207	Shavings, wood
3559	Special Industry Machinery, NEC	50990208	Timber products, rough
3561	Pumps & Pumping Equipment	50990209	Wood chips
3562	Ball & Roller Bearings	52	Building Materials, Hardware, Garden Supply & Mobile Home Dealers
3563	Air & Gas Compressors	5211	Lumber & Other Building Materials
3564	Industrial & Commercial Fans & Blowers & Air Purification Equipment	Dealers	
3565	Packaging Machinery	54	Food Stores
3566	Speed Changers, Industrial High-Speed Drives & Gears	54110100	Supermarkets
3567	Industrial Process Furnaces & Ovens	54110101	Supermarkets, Chain
3568	Mechanical Power Transmission Equipment, NEC	54110102	Supermarkets, Greater than 100,000 Square Feet (Hypermarket)
3569	General Industrial Machinery & Equipment, NEC	54110103	Supermarkets, Independent
3571	Electronic Computers	54110104	Supermarkets, 55,000 - 65,000 Square Feet (Superstore)
3572	Computer Storage Devices	54110105	Supermarkets, 66,000 - 99,000 Square Ft.
3575	Computer Terminals	57	Home Furniture, Furnishings & Equipment Stores
3577	Computer Peripheral Equipment, NEC	5712	Furniture Stores
3578	Calculating & Accounting Machinery, except Computers	59	Miscellaneous Retail
3579	Office Machines, NEC	59899902	Fuel, Wood
3581	Automatic Vending Machines	59991200	Swimming Pools, Hot Tubs, & Sauna Equipment & Supplies
3582	Commercial Laundry, Dry Cleaning, & and Pressing Machines		

Table 2**Distribution of Study Population by County**

County	Number	Percent
Genesee	1,405	7.0%
Ingram	826	4.1%
Jackson	661	3.3%
Lapeer	435	2.2%
Lenawee	430	2.1%
Livingston	841	4.2%
Macomb	3,244	16.1%
Monroe	524	2.6%
Oakland	4,752	23.6%
Saginaw	624	3.1%
Shiawassee	282	1.4%
St. Clair	766	3.8%
Washtenaw	1,153	5.7%
Wayne	4,158	20.7%
Total	20,101	99.9%

usually provided free-of-charge. Some companies can draw samples while others cannot. The cost for a complete list from those that cannot could be more than from companies that charge more per business selected but can draw a sample. In this study, InfoChase, the company selected to provide the list of Michigan businesses, could not draw a sample. After being asked, they agreed to provide the entire list at a substantial discount. Being more exact in the use of four-digit to eight-digit codes further reduces the cost of a list by reducing the number of businesses selected into that sample that are not likely generators or users of wood residue.

Sample

Approximately 1 out of 3 businesses was randomly selected from the 20,101 business in the study population for a total sample size of 7,007. A large sample was drawn with the aim of ultimately conducting 1,000 to 1,200 interviews. The company conducting the interviews was able to reach 1,500 businesses, 25% more than the maximum target of 1,200. However, of the 1,500 interviewed, 420 (28%) indicated that they either generated or used wood residue. The remaining 1,080 (72%) stated that they did not do either. For three possible reasons explained in the section below on the industry by industry responses, the percentage of those who do generate or use may be larger than 28%.

Based on the results of this survey, future surveys that utilize a study population defined by the SIC codes in this study should select a sample size at least sixteen times the target number of completed interviews with generators and users. In this study, completed interviews with 1,000 generators and users would have required a total sample size of about 16,000 businesses.

Table 3**Distribution of Study Population by Two-Digit SIC Code**

SIC	Major Industry Groups	Frequency	Percent
01	Agricultural Production	28	0.1%
07	Agricultural Services	30	0.1%
15	Building Construction	8,802	43.8%
16	Heavy Construction, other than Building	405	2.0%
17	Construction, Special Trade Contractors	1,428	7.1%
24	Lumber & Wood Products, except Furniture	499	2.5%
25	Furniture & Fixtures	239	1.2%
26	Paper & Allied Products	75	0.4%
32	Stone, Clay, Glass, & Concrete Products	506	2.5%
33	Primary Metal Industries	13	0.1%
35	Industrial & Commercial Machinery & Computer Equipment	3,327	16.6%
37	Transportation Equipment	156	0.8%
39	Miscellaneous Manufacturing Industries	73	0.4%
42	Motor Freight Transportation	2,495	12.4%
49	Electric, Gas, and Sanitary Services	138	0.7%
50	Wholesale Trade, Durable Goods	16	0.1%
52	Building Materials, Hardware, Garden Supply & Mobile Home Dealers	831	4.1%
54	Food Stores	289	1.4%
57	Home Furniture, Furnishings & Equipment Stores	710	3.5%
59	Miscellaneous Retail	41	0.2%
	Totals	20,101	100.0%

The sample is stratified by county, otherwise businesses in smaller counties might not have been selected. The assumption made here is that having a business name, a SIC classification, and a working business telephone number did not constitute a legitimate and operating business unless a representative of that business could be contacted directly by voice by telephone (after a maximum of six attempts) during the usual weekday business hours. A business cannot do business if customers cannot communicate with it by telephone.

Even when frequently updated, business lists and the samples drawn from them include former businesses whose telephone numbers are no longer in service as well as those who still have working numbers but are either going out or are out of business. Because of collection or recording errors, lists and samples contain both fax and residential numbers as well. And, there are business numbers where no contact is ever possible; many of these may not be legitimate or real businesses. Numbers that fall into these categories are listed as Unusable in Table 4. Of the base sample of 7,007, 1,531 numbers, or almost 22%, were classified as Unusable. The complete disposition by category of the sample is given below in Table 4.

Sample Disposition

Out of 16,361 calls, a total of 2,373 business contacts were made: on average, about seven calls were required per contact. Of the total, 1,500 interviews were completed with businesses that generated or accepted residue and those that did not. The rest consisted of 873 refusals; 780 upon answering plus 93 terminated before the interview got underway.

The distribution of refusals by county is in Table 5 and by two-digit SIC codes in Table 6.

The remaining 3,101 numbers are classified as possible contacts. Some probably are not functioning businesses and could be treated as Unusable.

The American Association of Public Opinion Research has identified six different methods of calculating a survey response rate.⁴ The methods are based on the following three kinds of surveys: household (not business) surveys where selection is done by the random digit dialing (RDD) method of sampling, in-person household surveys, and mail surveys of specifically named persons.

The minimum rate is the number of completed interviews (I) divided by the sum of completed and partially completed interviews (I + P) plus the number of refusals and terminations and non-contacts and others (R + NC + O) plus all cases of unknown eligibility and other unknowns (UH + UO).

$$RR1_{\min} = \frac{I}{(I + P) + (R + NC + O) + (UH + UO)}$$

The maximum rate is the number of completed and partially completed interviews (I + P) divided by the same (I + P) plus refusals and non-contacts and other unknowns (R + NC + O).

$$RR6_{\max} = \frac{(I + P)}{(I + P) + (R + NC + O)}$$

⁴The American Association for Public Opinion Research. 2004. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*. 3rd edition. Lenexa, Kansas: APPOR, 28 - 29.

Table 4**Final Disposition of Total Business Sample**

<u>Unusable</u>	<u>Number</u>	
Number no longer in service/disconnected	699	
Wrong number/ residential number	152	
Out-of-business	129	
Fax modem	159	
Always no answer	271	
Respondent unreachable	115	
Duplicate number	6	
Other	2	
<u>Subtotal</u>	<u>1,533</u>	21.9%
 <u>Usable</u>		
Possible contacts: no answer, answering machine, respondent not available after six callbacks	3,101	
Refusal upon contact	780	
Termination after initial questions	93	
<u>Subtotal</u> for all refusals	873	
<u>Subtotal for Usable</u>	<u>3,974</u>	56.7%
Completed Interviews	<u>1,500</u>	21.4%
<u>Total Base Sample</u>	<u>7,007</u>	100.0%

There were no partially completed interviews, hence $P = 0$ and has no effect on the rate. The number of refusals and mid-interview terminations are known, are greater than 0, and are a straightforward part of this calculation. Other (O) equivalent cases include households where no interview is possible because of death, physical or mental disabilities, or language problems. For business surveys, this would include businesses closed by retirement or death of the owner or business failure. These are already included in the Unusable category.

What is less straightforward is how to treat the non-contacts (NC). In household surveys based on RDD sampling, NC consists of confirmed households with working telephone numbers where a respondent is never available after the maximum number of callbacks has been made. There is no compelling reason for anyone in a household to ever be available for telephone calls for interviews, or for any other reason. Many probably screen calls using caller ID and do not answer when either they do not recognize the number or when the number is not given. The household can continue to exist without anyone ever answering the telephone for it. This is not so for businesses, at least those that use telephones to directly communicate with current and potential customers. Customers who cannot reach a particular business by telephone to inquire about prices and availability, make purchases, check on the status of orders, or discuss billing problems will soon go to a competitor. And, businesses cut off from customers will soon go out of business, or they are not legitimate and operating businesses to begin with.

Table 5

Distribution of Refusals by County

County	Frequency	Percent
Genesee	65	7.5%
Ingham	43	4.9%
Jackson	20	2.3%
Lapeer	14	1.6%
Lenawee	23	2.6%
Livingston	40	4.6%
Macomb	139	15.9%
Monroe	29	3.3%
Oakland	216	24.7%
Saginaw	27	3.1%
Shiawassee	13	1.5%
St. Clair	28	3.2%
Washtenaw	53	6.1%
Wayne	163	18.7%
Totals	873	100.0%

In this survey, at most the 3,101 Possible Contacts (no answer, answering machine, and respondent not available after six callbacks) could be considered NC's. As shown in Table 7, treating them all this way yields a minimum response rate of 27.4%. Going strictly by the assumption that a telephone number does not represent a legitimate and operating business unless a representative of that business can be directly contacted by telephone during weekday business hours, all 3,114 are unusable category and are dropped from the calculation. This yields a maximum response rate of 63.5%. Midway between these two extremes is a rate of 38.2% which is based on 50% of the possible contacts being dropped following the assumption about operating businesses.

As previously noted in the discussion of the sample, assuming the fourteen county area is at least somewhat representative of other large American cities, an initial sample of 16 businesses for every 1 business that either generates or uses residue is prudent. Completed interviews with 1,000 of these businesses would require an initial sample of about 16,000. The initial sample size should even be higher for smaller urban areas, cities, and towns.

In this study, sample numbers of companies used to estimate the total number of companies in the 14 county area that generated and accepted wood residues is multiplied by the population-to-sample ratio of 3 to 1. Rounded to the nearest whole number, this is the ratio of the initial population of 20,101 to the initial sample of 7,007.

Sample Distribution by County

As calculated from the data in Table 2, among the fourteen counties, seven (in bold) account for about eight out of ten businesses in the study population: 81.4% of the businesses are in Oakland, Wayne, Macomb, Genesee, Washtenaw, Ingham, and Livingston counties. As

calculated using the data in Table 8, the same seven counties in the same order are where most of the responding businesses are located as well. They account for 79.4% of the 1,500 responding

Table 6

Distribution of Refusals by Two-Digit SIC Code

SIC	Major Industry Groups	Frequency	Percent
01	Agricultural Production	1	0.1
07	Agricultural Services	0	0.0
15	Building Construction	296	33.9
16	Heavy Construction, other than Building	11	1.3
17	Construction, Special Trade Contractors	57	6.5
24	Lumber & Wood Products, except Furniture	25	2.9
25	Furniture & Fixtures	9	1.0
26	Paper & Allied Products	6	0.7
32	Stone, Clay, Glass, & Concrete Products	27	3.1
33	Primary Metal Industries	0	0.0
35	Industrial & Commercial Machinery & Computer Equipment	188	21.5
37	Transportation Equipment	18	2.1
39	Miscellaneous Manufacturing Industries	3	0.3
42	Motor Freight Transportation	97	11.1
49	Electric, Gas, and Sanitary Services	8	0.9
50	Wholesale Trade, Durable Goods	0	0.0
52	Building Materials, Hardware, Garden Supply & Mobile Home Dealers	45	5.2
54	Food Stores	39	4.5
57	Home Furniture, Furnishings & Equipment Stores	40	4.6
59	Miscellaneous Retail	3	0.3
	Totals	873	100.0%

businesses. The probability of getting this 2 percentage point difference (81.4% - 79.4%) by chance is .028 or slightly less than 3 out of 100: not statistically different at a significance level of .05 but different at .01 and .001.⁵ As a group, the counties are equally proportionately represented among the responding businesses.

⁵ A single sample proportion test was used.

As also shown in Table 8, out of the 1,500 completed interviews, 28% (420) either generated or used wood residue while 72% (1,080) did not. The same seven counties in the same order account for 78.8% of businesses that either generate or use wood residue and 79.7% of those that did not. The probability of getting this 0.90% difference (79.7% - 78.8%) by chance is .350.⁶ This difference is not even close to being significantly different at .05, .01, or .001. The same seven counties are also equally proportionately represented among those businesses that did generate and use wood residue and those that did not.

The refusals are also a close match with businesses that responded. The seven counties accounted for 82.4% of the refusals and 79.4% of the responding businesses. The probability of getting the three percentage point difference (82.4% - 79.4%) between them is .034 which is insignificant at .05 but significant at .01 and .001.

Table 7

Response Rates by Disposition of Possible Contacts

Minimum Rate: All Possible Contacts Included

Completed Interviews	1,500	27.4%
Refusals and mid-interview terminations	873	16.0%
Possible contacts (NC)	3,101	56.7%
<u>Totals</u>	<u>5,474</u>	100.1%

Mid-Rate: One-Half Possible Contacts Included

Completed Interviews	1,500	38.2%
Refusals and mid-interview terminations	873	22.3%
Possible Contacts (NC)	1,551	39.5%
<u>Totals</u>	<u>3,924</u>	100.0%

Maximum Rate: No Possible Contacts Included

Completed Interviews	1,500	63.5%
Refusals and mid-interview terminations	873	36.5%
Possible Contacts (NC)	0	0.0%
<u>Totals</u>	<u>2,373</u>	100.0%

The distribution by county of those who were contacted but refused to be interviewed is in Table 4. The same seven counties in the same order account for 82.4% of the total refusals. Compared to the proportion of these counties in the study population, the difference of 1 percentage point (82.4 - 81.4) is statistically insignificant at the three significance levels. The probability of getting this difference by chance is .228.

Overall, among the fourteen counties the same group of seven is about equally represented in the study population, businesses that did and did not generate and use wood residues, as well as among businesses that both responded and refused to respond to the survey.

⁶A two-sample difference-of-proportions test was used.

Table 8**Businesses That Did and Did Not Generate/Use Wood Residue by County**

County	Generate/Use Wood Residue	Do Not Generate/Use Wood Residue	County Subtotals and Totals for All Counties
Genesee	46	65	111
	11.0%	6.0%	7.4%
Ingham	26	39	65
	6.2%	3.6%	4.3%
Jackson	15	40	55
	3.6%	3.7%	3.7%
Lapeer	6	27	33
	1.4%	2.5%	2.2%
Lenawee	13	25	38
	3.1%	2.3%	2.5%
Livingston	19	45	64
	4.5%	4.2%	4.3%
Macomb	50	184	234
	11.9%	17.0%	15.6%
Monroe	12	32	44
	2.9%	3.0%	2.9%
Oakland	85	245	330
	20.2%	22.7%	22.0%
Saginaw	21	37	58
	5.0%	3.4%	3.9%
Shiawassee	8	13	21
	1.9%	1.2%	1.4%
St. Clair	14	45	59
	3.3%	4.2%	3.9%
Washtenaw	30	59	89
	7.1%	5.5%	5.9%
Wayne	75	224	299
	17.9%	20.7%	19.9%
Total Numbers	420	1080	1500
Totals Percentages	100.0%	100.0%	100.0%

Sample Distribution by Business Category

As calculated from the data in Table 3, among the twenty Major Industry Groups in the study population, five (in bold) account for just over eight out of ten businesses: 84.0% are in Building Construction (15), Construction, Special Trade Contractors (17), Industrial & Commercial Machinery & Computer Equipment (35), Motor Freight Transportation (42), , and Building Materials, Hardware, Garden Supply & Mobile Home Dealers (52).

Table 9**Distribution of All Respondents by Major Industry Group**

SIC	Major Industry Groups	Frequency	Percent
01	Agricultural Production	5	0.3
07	Agricultural Services	3	0.2
15	Building Construction	435	29.0
16	Heavy Construction, other than Building	23	1.5
17	Construction, Special Trade Contractors	85	5.7
24	Lumber & Wood Products, except Furniture	48	3.2
25	Furniture & Fixtures	25	1.7
26	Paper & Allied Products	10	0.7
32	Stone, Clay, Glass, & Concrete Products	54	3.6
33	Primary Metal Industries	1	0.1
35	Industrial & Commercial Machinery & Computer Equipment	401	26.7
37	Transportation Equipment	5	0.3
39	Miscellaneous Manufacturing Industries	4	0.3
42	Motor Freight Transportation	201	13.4
49	Electric, Gas, and Sanitary Services	11	0.7
50	Wholesale Trade, Durable Goods	4	0.3
52	Building Materials, Hardware, Garden Supply & Mobile Home Dealers	92	6.1
54	Food Stores	22	1.5
57	Home Furniture, Furnishings & Equipment Stores	66	4.4
59	Miscellaneous Retail	5	0.3
	Totals	1500	100.0

As calculated from the data in Table 9, the same five account for 80.9% of the responding businesses. The probability of getting the 3.1 percentage point difference (84.0 - 80.9) between the 2 percentages by chance is .0005, below .05, .01, and .001. The difference is statistically significant.

Compared to the study population, both Building Construction and Industrial & Commercial Machinery & Computer Equipment industry groups are underrepresented in the sample of respondents: a fifteen percentage point gap for Building Construction and a ten percentage point gap for Industrial & Commercial Machinery. For both the percentages are greater in the population than the respondent sample. Variations in response rates across Major Industry Groups are not surprising: type of business, revenue, and number of employees all help explain the variation in a willingness to be interviewed.⁷

⁷Petroni, Rita, Richard Sigman, Diane Willimack, Steve Cohen, Clyde Tucker. December 14, 2004. *Response Rates and Nonresponse in Establishment Surveys -- BLS and Census Bureau*, paper presented to the Federal Statistics Advisory Committee (FESAC).

What was unanticipated is that there would be substantial numbers of companies in the Major Industry Groups that reported they generated or used wood residue and others in the same Group who reported they did not. As shown in Table 10, this applies to 5 Groups out of 20 that in total account for about 8 out of 10 (80.9%) of all the businesses in the sample of respondents. By percentage of generators, they line up in the following descending order:

Building Construction (15): 43.0% indicated that they generated or used residue while the remaining 57.0% reported that they did not;

Building Materials, Hardware, Garden Supply & Mobile Home Dealers (52): 39.1% did generate and 60.9% did not;

Construction, Special Trade Contractors (17): 38.8% did generate and 61.2% did not;

Industrial and Commercial Machinery (35): 15.5% did generate while 84.5% did not;

Motor Freight (42): just 8% indicated that they did generate while the other very large majority of 92% indicated that they did not.

How could some businesses in the same Group -- who offer similar products and services and who presumably receive and use similar materials in production -- generated wood residue in 2005 while others did not? One possible answer is that a diverse mix of somewhat similar businesses is aggregated in the broad two-digit Group: those that all generate residue are included along with others who did not. Perhaps at the most specific Line-of-Business level, businesses are all either generators or not generators. The split at the Group level may be much reduced or even eliminated at the eight-digit Line-of-Business level when only the same businesses are in the same category together.

At this most specific level, a reasonable expectation is that businesses producing the same or nearly the same products and services would use the same materials in production and, therefore, would all either generate or not generate wood residue as a by-product.

Building Construction

This expectation is not supported by the data for the Building Construction (15) Major Industry Group. As shown in Table 11, the Group was disaggregated into its fifteen constituent eight-digit Line-of-Businesses and partitioned by whether or not the respondent indicated the businesses generated wood residue in 2005.

There is no split for five Lines-of-Businesses (in bold) where there are just a handful or less of respondents. Two of them are split.

In the other eight, where the numbers are greater, there is a split between those who reported generating residue and those who did not. The split is fairly even for businesses that construct single-family homes, remodel and repair single-family homes, do new single-family construction, and other residential construction.

Especially for Building Construction especially, these are perplexing numbers. With a very few exceptions, lumber and plywood are the two most common wood materials used in construction, remodeling, and repair, especially of stick-built single-family homes. Both materials come in standard sizes and must be trimmed to fit, hence, there must be waste that in the questionnaire is covered by two categories: construction debris and edgings and cutoffs. There should have been no confusion about what these categories included.

Table 10
Businesses That Did and Did Not Generate/Use
Wood Residue by Major Industry Groups

SIC	Major Industry Groups	Generate Wood Residue	Do Not Generate Wood Residue	SIC Subtotals and SIC Percentages of Total Sample
1	Agricultural Production	1	4	5
		0.2%	0.4%	0.3%
7	Agricultural Services	3	0	3
		0.7%	0.0%	0.2%
15	Building Construction	187	248	435
		44.5%	23.0%	29.0%
16	Heavy Construction, other than Building	5	18	23
		1.2%	1.7%	1.5%
17	Construction, Special Trade Contractors	33	52	85
		7.9%	4.8%	5.7%
24	Lumber & Wood Products, except Furniture	31	17	48
		7.4%	1.6%	3.2%
25	Furniture & Fixtures	11	14	25
		2.6%	1.3%	1.7%
26	Paper & Allied Products	5	5	10
		1.2%	.5%	0.7%
32	Stone, Clay, Glass, & Concrete Products	7	47	54
		1.7%	4.4%	3.6%
33	Primary Metal Industries	1	0	1
		0.2%	0.0%	0.1%
35	Industrial & Commercial Machinery & Computer Equipment	62	339	401
		14.8%	31.4%	26.7%
37	Transportation Equipment	1	4	5
		0.2%	.4%	.3%
39	Miscellaneous Manufacturing Industries	1	3	4
		.2%	0.3%	0.3%
42	Motor Freight Transportation	16	185	201
		3.8%	17.1%	13.4%
49	Electric, Gas, and Sanitary Services	1	10	11
		0.2%	.9%	0.7%
50	Wholesale Trade, Durable Goods	1	3	4
		.2%	0.3%	0.3%
52	Building Materials, Hardware, Garden Supply & Mobile Home Dealers	36	56	92
		8.6%	5.2%	6.1%
54	Food Stores	3	19	22
		0.7%	1.8%	1.5%
57	Home Furniture, Furnishings & Equipment Stores	14	52	66
		3.3%	4.8%	4.4%
59	Miscellaneous Retail	1	4	5
		0.2%	0.4%	0.3%
	Totals	420	1080	1500
		100.0%	100.0%	100.0%

Table 11

**Businesses That Did and Did Not Generate/Use Wood Residue
by Building Construction (15) Line-of-Business**

SIC	Line-of-Business	Generate/Use Wood Residue	Do Not Generate Wood Residue	Totals by Line-of-Business
15210000	Single-Family Housing Construction	73	84	157
		46.5%	53.5%	100.0%
15210100	Single-Family Home Remodeling and Repairs	16	16	32
		50.0%	50.0%	100.0%
15210101	General Remodeling, Single-Family Housing	34	31	65
		52.3%	47.7%	100.0%
15210102	Mobil Home Repair, On-Site	1	1	2
		50.0%	50.0%	100.0%
15210103	Patio and Deck Construction and Repair	2	7	9
		22.2%	77.8%	100.0%
15210104	Repairing Fire Damage, Single-Family Houses	0	5	5
		.0%	100.0%	100.0%
15219901	New Construction, Single-Family Houses	41	58	99
		41.4%	58.6%	100.0%
15220000	Residential Construction, NEC	17	34	51
		33.3%	66.7%	100.0%
15220101	Apartment Building Construction	0	3	3
		.0%	100.0%	100.0%
15220103	Condominium Construction	0	2	2
		.0%	100.0%	100.0%
15220107	Multi-Family Dwellings, New Construction	0	1	1
		.0%	100.0%	100.0%
15220200	Hotel/Motel & Multi-Family Home Renovation & Remodeling	0	1	1
		.0%	100.0%	100.0%
15220201	Remodeling Multi-Family Dwellings	1	1	2
		50.0%	50.0%	100.0%
15310000	Operative Builders	1	2	3
		33.3%	66.7%	100.0%
15319904	Speculative Builders, Single-Family Houses	1	2	3
		33.3%	66.7%	100.0%
	Totals	187	248	435
		43.0%	57.0%	100.0%

One possible explanation is that as a way of getting out of the interview, some respondents selected "No" as their answer to the first question about whether they generated or used wood waste; that is, they used it as a soft refusal. At most, this would seem to apply only to a few respondents since refusing to participate in a telephone interview is easy -- all one has to do, at

most, is indicate an unwillingness to participate or continue and then hang up. Since the interview is not face-to-face, where some additional degree of politeness could be expected, being polite about abruptly terminating a telephone interview is not a problem for respondents.

A second explanation is those answering simply did not know that the businesses that employed them produced wood residue. How one can work in this line of business and not know residue is generated is hard to fathom.

A third possibility is that the "No" respondents, working as subcontractors, interpreted the question to mean that the residue generated was not theirs in the sense that neither they personally nor their companies were responsible for disposal. Even though the question is specific with the use of the phrase "... did your company here in Michigan either generate or accept any wood waste..." , these respondents nevertheless might have thought that the residue was generated by the contractor and not by themselves. Nothing in the results of the questionnaire pre-test suggested that respondents would interpret the question in this manner.

A fourth possibility is that a few companies are using wood material already cut to exact specifications so that little residue is generated in construction and installation.

Even so, to forestall possible confounding interpretations in future surveys, the existing question could be narrowed by indicating that responsibility of disposal is irrelevant. What counts is whether the respondent's company actually engaged in work that produced wood waste. This could be further specified by a preceding question that asks whether wood is any part whatsoever of the company's production process. Since this is a key question, it should be extensively pre-tested to establish its content validity. In addition, respondents in Building Construction who indicate that they generate no residue should be asked a follow up questions on how they are able to build and install without generating debris or edgings and cutoffs.

The split at the Line-of-Business level between those who say they do and do not generate residue is important because it raises the question of whether to include businesses who claim not to generate residue in the estimates of the total amounts of residue generated for 2005 in the fourteen counties. Because the "No" response does not seem plausible, they are included. How they enter the estimates is explained in the sections on responses by types of residues.

Building Materials, Hardware, Garden Supply and Mobile Home Dealers

As given in Table 12, almost 4 out of 10 (39.1%) of the Building Materials businesses represented in the sample of responding businesses generated wood residue while the remaining 6 out of 10 (60.9%) did not.

Among the twenty-two Lines-of-Businesses that comprise the responding businesses in this Group, the 8 (in bold) that produced lumber and lumber products, doors, windows, and garage doors, kitchen cabinets, and home centers account for almost three-fourths (73.9%) of the total. There are splits between those who report generating and not generating residue among all eight. The splits for businesses whose primary products are doors, window, garage doors, and even kitchen cabinets are plausible since not all of these products involve wood. That some home centers do not generate residue because they charge and give customers the cutoffs from lumber and plywood cut to size while others charge only for what is cut and discard the rest plausibly explains this split. The split for Lumber and Other Building Materials is nearly as perplexing as the one for Building Construction businesses. Both handle wood products in standard sizes that have to be trimmed to fit, hence, there must be some residue in the form of cutoffs. Even though a "No" response does not seem very plausible, all Lumber and Other Building Materials businesses will be treated as non-generators.

Table 12

**Building Materials, Hardware, Garden Supply, and Mobile Home Dealers
That Did and Did Not Generate/Use Wood Residue by Lines-of-Business**

SIC	Line-of-Business	Generate Wood Residue	Do Not Generate Wood Residue	Totals by Lines-of-Businesses
52110000	Lumber and Other Building Materials	9	19	28
		32.1%	67.9%	100.0%
52110100	Lumber Products	4	1	5
		80.0%	20.0%	100.0%
52110101	Flooring, Wood	1	0	1
		100.0%	.0%	100.0%
52110104	Planing Mill Product and Lumber	0	1	1
		.0%	100.0%	100.0%
52110105	Siding	0	2	2
		.0%	100.0%	100.0%
52110200	Door and Window Products	3	5	8
		37.5%	62.5%	100.0%
52110201	Door, Storm: Wood or Metal	1	2	3
		33.3%	66.7%	100.0%
52110203	Garage Doors: Sales and Installation	2	2	4
		50.0%	50.0%	100.0%
52110207	Windows, Storm: Wood or Metal	1	2	3
		33.3%	66.7%	100.0%
52110400	Prefabricate Buildings	0	1	1
		.0%	100.0%	100.0%
52110402	Modular Homes	0	1	1
		.0%	100.0%	100.0%
52110500	Masonry Materials and Supplies	1	1	2
		50.0%	50.0%	100.0%
52110501	Brick	2	0	2
		100.0%	.0%	100.0%
52110502	Cement	0	3	3
		.0%	100.0%	100.0%
52110506	Sand and Gravel	0	2	2
		.0%	100.0%	100.0%
52110507	Fencing	0	2	2
		.0%	100.0%	100.0%
52119901	Bathroom Fixtures, Equipment, and Supplies	0	1	1
		.0%	100.0%	100.0%
52119902	Cabinets, Kitchen	2	4	6
		33.3%	66.7%	100.0%
52119903	Closets, Interiors and Accessories	1	0	1
		100.0%	.0%	100.0%

52119906	Electrical Construction Materials	1	0	1
		100.0%	.0%	100.0%
52119907	Fencing	2	2	4
		50.0%	50.0%	100.0%
52119908	Home Centers	6	5	11
		54.5%	45.5%	100.0%
Totals		36	56	92
		39.1%	60.9%	100.0%

Table 13

Construction and Special Trade Contractors (17) That Did and Did Not Generate/Use Wood Residue by Lines-of-Business

SIC	Line-of-Business	Generate Wood Residue	Do Not Generate Wood Residue	Totals by Lines-of-Businesses
17510000	Carpentry Work	11	24	35
		31.4%	68.6%	100.0%
17510100	Cabinet and Finish Carpentry	4	3	7
		57.1%	42.9%	100.0%
17510101	Cabinet Building and Installation	3	2	5
		60.0%	40.0%	100.0%
17510102	Finish and Trim Carpentry	1	2	3
		33.3%	66.7%	100.0%
17510200	Window and Door Installation and Erection	0	2	2
		.0%	100.0%	100.0%
17510201	Garage Store Installation or Erection	4	3	7
		57.1%	42.9%	100.0%
17510202	Window and Door (Prefabricated) Installation	3	5	8
		37.5%	62.5%	100.0%
17519901	Framing Contractor	0	1	1
		.0%	100.0%	100.0%
17949901	Excavation & Grading, Building Construction	5	8	13
		38.5%	61.5%	100.0%
17959902	Demolition, Buildings & Other Structures	2	2	4
		50.0%	50.0%	100.0%
	Totals	33	52	85
		38.8%	61.2%	100.0%

Construction and Special Trade Contractors

By its very nature carpentry involves wood, work that no matter how precisely it is done still generates wood residue. As can be seen in Table 13, that about two-thirds of the businesses in Carpentry Work (17510000) report not generating residue is, on the face of it, not plausible either. The same can be said of the rest of these Lines-of-Business with the possible exception of Garage Door Installation (17510201), Excavation and Grading (17949901), and Demolition (17959902), all three of which could be done without generating wood residue. As with Building Construction and Lumber and Other Building Materials, these businesses, minus the three exceptions, are included in the residue estimates for the fourteen counties.

Industrial & Commercial Machinery & Computer Equipment

The expectation that all of the same businesses either generate or do not generate residue was not contradicted as much by the data for Industrial & Commercial Machinery & Computer Equipment (35).

The splits between generators and non-generators are not nearly as pronounced as they are in Building Construction. The total 401 responding businesses are spread over 128 Lines-of-

Table 14

Industrial & Commercial Machinery and Computer Equipment (35) Businesses That Did and Did Not Generate/Use Wood Residue by Selected Lines-of-Business

SIC	Industry Groups	Generate Wood Residue	Do Not Generate Wood Residue	Totals by Lines-of-Businesses
35410000	Metal Cutting Machine Tools	2	8	10
		20.0%	80.0%	100.0%
35430000	Industrial Patterns (for forming and molding metal)	4	9	13
		30.8%	69.2%	100.0%
35440000	Special Dies, Tools, Jigs, and Fixtures	3	30	33
		9.1%	90.9%	100.0%
35440100	Special Dies and Tools	1	28	29
		3.4%	96.6%	100.0%
35449902	Industrial Molds	1	9	10
		10.0%	90.0%	100.0%
35990303	Machine Shops, Jobbing and Repair	17	72	89
		19.1%	80.9%	100.0%
	Totals for Selected Six Lines-of-Business	28	156	184
		15.2%	84.8%	100.0%
	Totals for Entire Group	62	339	401
		15.5%	84.5%	100.0%

Business, too many to be presented in a single table. However, the individual Lines were examined. Twenty-eight out of 128 are split while the other 100, in each numbering no more than a handful at most, were not. Of the 28 that are split, the half-dozen Lines with the most respondents account for fewer than one-half (45.9%) of the total. As can be seen in Table 14, the splits between those who generated and those who did not in the six Lines tilts toward those who did not.

Given the nature of these businesses, that a few could generate residue while the majority did not is plausible. Perhaps only a few generated wood residue (15.2%) in preparing machines for shipment or receiving parts packed in crates and on pallets that required disposal. In their own view, the rest (84.8%) used or received so little wood that they did not deem the amounts, if any, worth reporting.

Motor Freight Transportation

As shown in Table 15, of the 201 responding Motor Freight businesses, only 16 (8.0%) generated residue while the other 185 (92.0%) reported that they did not. While these generating businesses will be included in the estimates of residue for the fourteen counties, future residue surveys could eliminate this Group as a significant source.

All Other Industry Groups

Out of the twenty Major Industry Groups listed in Table 9, the five discussed above account for 8 out of 10 (80.9%) of the total sample. Because of the small numbers involved, the other fifteen Groups that account for the remaining 2 out of 10 (19.1%) are not described.

Table 15

**Motor Freight Transportation That Did and Did Not
Generate/Use Wood Residue by Lines-of-Business**

SIC	Line-of-Business	Generate Wood Residue	Do Not Generate Wood Residue	Totals by Lines-of-Businesses
42120000	Local Trucking, With Storage	3	62	65
		4.6%	95.4%	100.0%
42120101	Animal Transport	0	1	1
		.0%	100.0%	100.0%
42120200	Liquid Transfer Services	0	1	1
		.0%	100.0%	100.0%
42120202	Petroleum Haulage, Local	0	1	1
		.0%	100.0%	100.0%
42120400	Moving Services	1	12	13
		7.7%	92.3%	100.0%
42120401	Furniture Moving, Local, Without Storage	0	1	1
		.0%	100.0%	100.0%
42129903	Delivery Service, Vehicular	1	9	10
		10.0%	90.0%	100.0%
42129905	Dump Truck Haulage	0	7	7
		.0%	100.0%	100.0%

42129906	Garbage Collection and Transport, No Disposal	1	1	2
		50.0%	50.0%	100.0%
42129907	Hazardous Waste Transport	0	1	1
		.0%	100.0%	100.0%
42129908	Heavy Machinery Transport, Local	0	2	2
		.0%	100.0%	100.0%
42129909	Light Haulage and Cartage, Local	2	5	7
		28.6%	71.4%	100.0%
42129910	Mail Carriers, Contract	0	1	1
		.0%	100.0%	100.0%
42129912	Steel Hauling, Local	0	3	3
		.0%	100.0%	100.0%
42129913	Truck Rental, With Drivers	0	2	2
		.0%	100.0%	100.0%
42130000	Trucking, Except Local	2	42	44
		4.5%	95.5%	100.0%
42139901	Automobiles, Transport and Delivery	1	8	9
		11.1%	88.9%	100.0%
42139903	Contract Haulers	2	8	10
		20.0%	80.0%	100.0%
42139904	Heavy Hauling, NEC	0	3	3
		.0%	100.0%	100.0%
42139905	Heavy Machinery Transport	0	2	2
		.0%	100.0%	100.0%
42139906	Household Goods Transport	0	1	1
		.0%	100.0%	100.0%
42139907	Less-Than-Truckload (e.g., FedEx)	0	1	1
		.0%	100.0%	100.0%
42139909	Mobile Homes Transport	1	0	1
		100.0%	.0%	100.0%
42140000	Local Trucking With Storage	1	11	12
		8.3%	91.7%	100.0%
42149901	Furniture Moving, Local, With Storage	1	0	1
		100.0%	.0%	100.0%
Totals		16	185	201
		8.0%	92.0%	100.0%

III. Responses by Wood Residue Category

The first question asked of businesses contacted by telephone was whether they primarily generated or accepted wood waste in the following eight categories:

1. Pallets, skids, and shipping crates;
2. Dunnage (wood used in packing to support and protect items being shipped);
3. Edging and cutoffs (for example, either from making wood products such as trim and molding or cutting those products to length);
4. Chips, shavings, and sawdust (for example, from making wood products such as lumber);
5. Tree residues -- that is, tree trunks, limbs, and stumps;
6. Construction debris (for example, cutoffs from framing and wood sheathing);
7. Railroad ties, and
8. Telephone poles.

Out of the total 1,500 businesses contacted, 420 (28%) indicated that they did one or the other during the calendar year 2005. Of the 420, 373 (88.8%) primarily generated and 47 (11.2%) primarily accepted wood waste.

As shown in Table 16, an adequate number of responses were obtained from the 373 businesses that primarily generated residue for 5 of the 8 categories: pallets, skids, and shipping crates, edgings and cutoffs, chips and shavings, tree residue, and construction debris. Only 4 businesses generated dunnage. In future surveys, dunnage could be included in a separate category or combined with shipping crates.

None of the responding companies either generated or accepted railroad ties or telephone poles. The reason both are absent is that the Major Groups, Railroad Transportation (SIC 40), and Communications (SIC 48), were inadvertently omitted from the sampling frame. However, because only a handful of railroad and utility businesses would have been included, the probability of one or more being selected into the sample is very small.

This raises an important issue for future urban residue surveys. Railroads, utilities, and any other individual companies who are few in number but likely large generators should be separately identified and included in the sample even though this violates the basic requirement of probability sampling that every member of the study population have the same known chance of being selected into the sample as every other member. Because the companies are deliberately included, the chance of being selected is 1.0, whereas the chance for all the other businesses is less, perhaps considerably less, than 1.0.⁸ Even so, being likely large contributors warrants their separate selection. That this has been done should be clearly explained.

As given in Table 17, pallets, skids, and shipping crates (hereafter, pallets) made up three-fourths (74.5%) of the total among the 47 companies that primarily accepted residue. The remaining one-fourth was thinly spread across the other six categories. No one accepted tree trunks, limbs, and stumps.

⁸ This is a variation on a stratified sample where the known probabilities of selection across the strata would be directly weighted by the amount of residue generated in each stratum: specifically, the chances of selection would be directly proportional to the amounts generated. However, if the amounts generated were known there would be no need for a survey. The second best procedure is to include those thought to be major contributors and query them separately.

Table 16**Businesses That Primarily Generate Wood Residue**

Response	Frequency	Percent
Chips, shavings, sawdust	62	16.6%
Construction debris	136	36.5%
Dunnage	4	1.1%
Edgings, cutoffs	74	19.8%
Pallets, Skids, Shipping Crates	83	22.3%
Railroad ties	0	0.0%
Telephone poles	0	0.0%
Tree trunks, limbs, and stumps	14	3.8%
Subtotal	373	100.1%
Primarily accepts wood residue	47	11.2%
Primarily generates wood residue	373	88.8%
Totals	420	100.0%

Table 17**Businesses That Primarily Accept Wood Residue**

Response	Frequency	Percent
Chips, shavings, and sawdust	1	2.1%
Construction debris	5	10.6%
Dunnage	1	2.1%
Edgings and cutoffs	1	2.1%
Pallets, Skids, Shipping Crates	35	74.5%
Railroad ties	1	2.1%
Telephone poles	3	6.4%
Tree trunks, limbs, and stumps	0	0.0%
Subtotal	47	99.9%
Primarily accepts wood residue	47	11.2%
Primarily generates wood residue	373	88.8%
Totals	420	100.0%

Types of Residue

Businesses that identified themselves as primary generators were all asked questions in the following categories (see Appendix A for the specific questions and Appendix C for the frequency distributions by question):

1. How was the amount of wood residue disposed of measured?
2. How much was disposed of?
3. Were payments made for removal or were the companies paid for the residue?
4. What were the amounts paid for removal or residue?
5. Did the responding company or some other company transport the residue?
6. Was any of the material sent to a landfill?
7. If so, how far away is the landfill?
8. How much was reused by the company and how was it reused?

Businesses that accepted residue were also asked how they measured the amounts they received, what and how much they accepted, major sources, how much is and is not reused, what the reuses are, and reasons for not re-using more. They were also asked what, if anything, government could do to encourage greater usage.

Of the 8 types of wood residue identified in the survey, an adequate number of responses were obtained for five:

1. pallets;
2. edgings and cutoffs;
3. chips, shavings, and sawdust;
4. tree residues; and,
5. construction debris.

Only 4 companies indicated that they generated dunnage, too few to be statistically meaningful. Unless a survey such as this one is being conducted in major port of entry, where both dunnage and familiarity with it are common, this category should be either dropped or combined with shipping crates. The combination would require measures only by volume or weight since dunnage is not a distinct structure like a pallet and cannot be counted in discrete numbers.

No responses were obtained for either railroad ties or utility poles. The results reported below are for the five categories for which adequate numbers were obtained.

Adjustments to the Number of Respondents

Adjustments for Question Non-Response

For estimates of totals, adjustments in the number of reporting companies are made for Don't Know (DK) and Refusal responses to specific questions (hereafter, question non-response refers to either DK, Refusals, or both). In general, question non-responses are allocated among the responses by the distribution across the responses. For example, to a specific question, if 5 companies answered "Yes", 10 answered "No", and 6 did not respond, then 2 would be added to 5 and 4 added to 10 reflecting the one-third/two-thirds division among those who answered the question with either a "Yes" or "No". The adjusted distribution would be 7 "Yes" and 14 "No". The total number remains the same. Question non-responses are not allocated among responses where non-response is worth noting as a separate answer to a question.

Adjustments for Survey Refusals

A total of 873 companies refused to be interviewed. The frequencies for the survey refusals across the 20 Major Industry Groups that are part of the sampling frame for this study are given in column C in Table 21 (and in Table 16).

Among the 373 companies that were primary generators, 30 also generated specific secondary residues in addition to and different from their primary residues. Together, 373 companies totaled 403 (373 + 30) sources of primary and secondary residue. Because the numbers are too small to use, 7 dunnage generators were subtracted leaving a net total of 396 primary and secondary sources (given by Major Industry Group in column E in Table 21).

Of the 1,500 companies that responded to the survey, 26.4% (396/1,500) were sources of residue. Assuming 26.4% of the refusals also would have been primary and secondary sources initially adds another 230 (.264 x 873). When these 230 sources are distributed across the 20 Major Industry Groups and then apportioned for each Group by residue type the total increases to 236 (the reason for the increase by 6 and the details of the calculations are both provided in footnote 2 in Table 21). The total number of actual and possible sources of residue is 632.

When made, adjustments for question non-response and survey refusals are based on the assumption that the distribution of answers among non-respondents to specific questions as well as among those who refused to be interviewed would be the same as those who did respond to the questions and did participate in the survey. That they did not respond to a question or participate in the survey sets these companies apart from those who did. The risk in making this assumption is that had they responded they might have given answers different from those who participated. However, leaving them out would have created residue and expenditure estimates that are far too conservative. The choice here is to include them and accept the risk of the assumption.

Adjustments for survey refusals are not made when only the numerical or percentage frequencies for a question are examined. Since adding survey refusals increases the totals but leaves the percentages unchanged except for rounding, there is no point in doing so when totals are not being examined.

The distributions for survey refusals (column C, Table 21) and respondents (column E) who generated residue were compared for the 20 Major Industry Groups using the Kolmogorov-Smirnov (K-S) two-sample test.⁹ As applied here, for a given significance level, the K-S test determines whether two independent samples came from two separate populations (survey refusals and respondents) that share the same distribution for a particular measure. In this case, the measure is the frequencies across the 20 Major Industry Groups. Using a two-tailed test and a significance level of .05 (.05/2 or .025 for each tail of the distribution), the probability of getting a K-S Z statistic of 0.949 is 0.329, well above .025. Given the closeness of the sample distributions, the two separate population distributions by Major Groups for survey refusals and

⁹ The χ^2 test is widely used to determine whether two or more independent samples have been drawn from the same population or from two or more populations with the same distribution for the variable being examined. One drawback to this test is that the frequency per cell (the intersection of a row and column) should not be less than 5. Several distributions in this study have cell frequencies below this minimum. Since the K-S test is based on a cumulative frequency distribution, there is no minimum per cell. In addition, the test has high power-efficiency and is in all cases more powerful than the χ^2 test. For confidence intervals, a confidence level of 95% is used. For single sample tests and comparisons of two samples, the two-tailed K-S test is used with a significance level of .05. This means that the probability of getting the K-S Z statistic must be below .025 (.05/2) to be considered statistically significant. See Sidney Siegel and N. John Castellan, Jr. *Nonparametric Statistics for the Behavioral Sciences*, 2nd edition, McGraw-Hill, Boston, 1988, pgs. 144-151.

residue generators are statistically the same. This lends indirect support to the assumption that the distribution of answers among survey refusals would be the same as those for residue generating sources.

Companies That Primarily Generate Pallets, Skids, and Shipping Crates¹⁰

Disposal Measures and Amounts

Eighty-five companies disposed of pallets. For 83, these were primarily what they disposed of while for the remaining 2 pallets were secondary.

As given in Table 18, of the 85 companies, 33 (40.0%) are in Industrial & Commercial Machinery and Computer Equipment, 11 (14.1%) are Lumber & Other Building Materials Dealers, 8 (9.4%) in Building Construction, and 6 each (7.1%) for Motor Freight Transportation and Furniture Stores. These 5 Major Industry Groups account for just over three-fourths (77.7%) of companies in all the other remaining Groups. The other 19 (22.4%) are spread out in very small numbers across 11 other Major Industry Groups.

The additional 54 sources bring the total to 139. Multiplying by the population-to-sample ratio of 3 to 1 yields a population estimate of 417 sources of pallets in the 14 county area in 2005.

Table 18
Disposition of Pallets by Major Industry Group/Industry

SIC	Major Industry Group/Industry	Frequency	Percent
35	Industrial & Commercial Machinery and Computer Equipment	34	40.0%
52: 5211	Building Materials, Hardware, Garden Supply & Mobile Home Dealers: Lumber & Other Building Materials Dealers	12	14.1%
15	Building Construction	8	9.4%
42	Motor Freight Transportation	6	7.1%
57: 5712	Home Furniture, Furnishings & Equipment Stores: Furniture Stores	6	7.1%
	Subtotal	66	77.7%
	All Others	19	22.4%
Totals		85	100.1%

As shown in Table 19, among those who identified how pallets were measured, the most frequent answer is by number. By about a two-to-one ratio (31 ÷ 15), more pallets were counted than were measured by truck/container loads. Only 1 company measured by weight. However, the largest percentage, 42.4%, did not know (DK) how the pallets were measured and another 2.4% refused to answer. A total of 38 companies gave these two answers.

¹⁰ Both pallets and skids are in form and function near-perfect substitutes for one another, hence, they can validly be counted together. While wooden shipping crates perform a similar function, by form they are not close substitutes because they are differently and often custom constructed and are not as easily reused in their original form. Crates are sufficiently different that counting them with or as pallets and skids is open to question. Since a typical crate requires more wood than a typical pallet, counting crates as pallets leads to a consistent underestimate of the amount of wood residue generated and accepted. In this report, all three are lumped together which results in the treatment of crates as if they were pallets in the calculation of amounts generated and received. Worth considering in future residue surveys is creating a separate category for crates with questions tailored to their form, construction, quantity of wood content, and ease of recycling and reuse.

The 38 question non-responses are allocated on the same 2 to 1 ratio between numbers of pallets and truck/container loads. These adjusted numbers, shown also in Table 19, are based on the assumption that the disposal proportions for the non-respondents are the same as those who answered. As adjusted, about two-thirds counted pallets while the remaining companies measured by truck/container loads.

Table 19
Disposition of Pallets by Type of Measure:
Unadjusted and Adjusted for Question Non-Response

Measured by:	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
Number of pallets, skids, shipping crates	31	36.5%	57	67.1%
Truck/container loads	15	17.7%	27	31.8%
Weight	1	1.2%	1	1.2%
DK	36	42.4%		
Refusal	2	2.4%		
Totals	85	100.2%	85	100.1%

After allocating the 38 companies that did not know or refused to answer among the three measurement methods, 57 counted by number, 27 by truck/container loads, and 1 by weight. The amount by weight is trivial compared to the others and is not included in subsequent estimates.

The 54 additional companies who refused to be interviewed are allocated by type of measure using the adjusted percentages in Table 19. This raises the total for those who measure by number to 93, by truck load to 44, and by weight to 2. The results shown in Table 20.

Table 20
Disposition of Pallets Type of Measure:
Adjusted for Survey Refusals

Measured by:	Frequency	Percent
Number	93	66.9%
Truck/container loads	44	31.7%
Weight	2	1.4%
Total	139	100.0%

As shown in Table 22, among the adjusted total of 93 who measured by numbers of pallets, 78 disposed of between 0 and 200 pallets during a typical month. Three disposed of between 200 and 400 and 3 more between 400 and 600. The remaining 9 responded with numbers for the entire year. Since their yearly totals are trivial compared to the yearly estimate, they are not included in the total calculation.

Table 21

**Survey Refusals, Residue Generators, and Adjusted Total Generators
by Major Industry Groups and Types of Residue**

(A) SIC	(B) Major Industry Groups	(C) Survey Refusals	(D) Possible Primary & Secondary Residue Sources Among Survey Refusals	(E) Actual Primary & Secondary Residue Sources	(F) Pallets, Skids, Shipping Crates (5)	(G) Edgings, Cutoffs (4)	(H) Chips, Shavings, Sawdust (1)	(I) Tree Trunks, Limbs (8)	(J) Construction Debris (2)
01	Agricultural Production	1	1	1	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)
07	Agricultural Services	0	3	4	0 (0)	0 (0)	3 (2)	1 (1)	0 (0)
15	Building Construction	296	111	190	8 (5)	45 (26)	15 (9)	14 (8)	108 (63)
16	Heavy Construction, other than Building	11	3	4	1 (1)	0 (0)	0 (0)	2 (1)	1 (1)
17	Construction, Special Trade Contractors	57	19	32	3 (2)	10 (6)	4 (2)	1 (1)	14 (8)
24	Lumber /Wood Products, except Furniture	25	19	33	0 (0)	9 (5)	22 (13)	0 (0)	2 (1)
25	Furniture &Fixtures	9	6	10	3 (2)	3 (2)	2 (1)	0 (0)	2 (1)
26	Paper &Allied Products	6	2	3	1 (1)	0 (0)	2 (1)	0 (0)	0 (0)
32	Stone, Clay, Glass, & Concrete Products	27	3	5	4 (2)	0 (0)	1 (1)	0 (0)	0 (0)
33	Primary Metal Industries	0	1	1	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)
35	Industrial & Commercial Machinery & Computer Equipment	188	29	48	34 (20)	3 (2)	10 (6)	0 (0)	1 (1)
37	Transportation Equipment	18	1	1	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)

39	Miscellaneous Manufacturing Industries	3	1	1	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)
42	Motor Freight Transportation	97	7	12	6 (4)	0 (0)	0 (0)	2 (1)	4 (2)
49	Electric, Gas, and Sanitary Services	8	0	0	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
50	Wholesale Trade, Durable Goods	0	0	0	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
52	Building Materials, Hardware, Garden Supply & Mobile Home Dealers	45	19	34	12 (7)	9 (5)	4 (2)	0 (0)	9 (5)
54	Food Stores	39	2	3	2 (1)	0 (0)	1 (1)	0 (0)	0 (0)
57	Home Furniture, Furnishings & Equipment Stores	40	8	13	6 (4)	3 (2)	4 (2)	0 (0)	0 (0)
59	Miscellaneous Retail	3	1	1	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)
	Subtotals	873	236	396¹	85	82	68	20	141
	Possible Source Subtotals			236²	54	48	40	12	82
	Total: Actual + Possible			632	139	130	108	32	223

¹ A total of 373 companies generated primary wood residue. Among these, 32 companies generated secondary residue as well. Of the 32 secondary generators, 30 identified the types of residue while 2 did not. The total for primary and secondary sources is 405. Minus the 2 DK's and another 7 for dunnage, excluded because of the small number reporting, leaves a net total of 396 primary and secondary residue sources.

² The 396 sources are 26.4% of the 1,500 companies interviewed. Using this percentage to initially estimate the number of potential sources among the refusals yields 230 (.264 x 873). The 230 potential sources are distributed across the 20 Major Industry Groups using the percentage for each Group of the total 396 for all the Groups. For example, 47.98% (190/396 x 100) of all actual sources are in Building Construction (SIC 15). Among the 230 possible sources, 110 are in Building Construction (.4798 x 230). The initial 230 possible sources are apportioned across the other 19 Major Groups the same way. The results are in column D. The estimates of possible residue sources by Major Group were then further apportioned across the five types of residue using the percentage for each residue of the total of all actual residue sources by Major Group. For example, the 45 actual sources of Edgings and Cutoffs in Building Construction are 23.68% of the 190 total sources of all five residues for Building Construction. Multiplied by the 110 possible sources of Edgings and Cutoffs in Building Construction yields 26 possible sources of Edgings and Cutoffs in Building Construction. These calculations were done for all five residue types across all Major Groups. The possible number of sources is given in parentheses for each residue type by Major Group. Due to rounding, the total for all possible sources is 236, 6 more than the initial estimate of 230.

Table 22

**Disposition of Pallets by Number:
Unadjusted and Adjusted for Survey Refusals**

Number of Pallets	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
0 - <200	26	83.9%	78	83.9%
200 - <400	1	3.2%	3	3.2%
400 - <600	1	3.2%	3	3.2%
Totals for 2005	3	9.7%	9	9.7%
Total	31	100.0%	93	100.0%

The sample average for companies that count numbers of pallets is 121 pallets per firm per month.¹¹ When multiplied by 84 (the number of companies reporting monthly amounts) and then by 12 (months in a year), the total to the nearest 1,000 for the sample companies is 122,000 pallets.

Table 23

**Disposition of Pallets by Number of Truck/Container Loads:
Adjusted for Question Non-Response and Survey Refusals**

Number of Loads	Frequency	Percent
0 - <10	36	81.8%
20 - <30	4	9.1%
30 - <40	4	9.1%
Totals	44	100.0

Using the adjusted number from Table 20, 44 companies measured their monthly disposal by truck/container loads. As shown in Table 23, of these, 36 (81.8%) disposed of up to 10 truckloads on average per month. The remaining 8 were equally divided between 20 to 30 and 30 to 40 loads. Rounded to the nearest whole load, the sample average for these companies is 8 loads per company per month. When multiplied by 44 (the adjusted number of companies) and then by twelve (months), the estimate for 2005, rounded to the nearest 100, is 4,200 loads.

To the nearest cubic yard, the average volume of trucks hauling pallets is 10 cubic yards. Assuming 6 pallets (6" x 3' x3') fit into a cubic yard, a truck or container with a 10 cubic yard capacity can carry 60 pallets per load. Multiplied by 4,200 loads, yields a total of 252,000 pallets generated by the sample companies who measure by the truck and container load.

Together the sample companies that measured by number and volume generated a total of 374,000 pallets. Multiplied by the population-to-sample ratio of 3 to 1 yields a population total of 1,122,000 pallets.

¹¹Unless otherwise noted, averages are calculated from grouped data using mid-point values for the ranges in each distribution. For example, in Table 22, the mid-points are 100, 300, and 500, respectively, for the three ranges 0 - <200, 200 - <400, and 400 - <600.

Automobile Manufacturers

The nation's largest domestic automobile manufacturers have plants in the study area. Given the size of their operations, they are likely generators of large amounts of pallets. Eighty-three companies and company divisions were listed among the roster of all companies selected by SIC as the sampling frame for this survey. Of those, 32 (38.6%) were drawn into sample. This percentage is slightly greater than the sampling percentage of 34.9% (7007/20101). Of the 32, one answered No to the generation question and the rest were non-respondents.

Given their size and their initial refusal to participate in the survey, a separate attempt was made to obtain data from each company on the quantity of pallets they generated in 2005. A General Motors representative reported that GM generated 11,462 tons in all of their Michigan facilities. Using an average of 30 pounds per pallet, they generated about 764,000 pallets in 2005. Essentially all of their pallets were either recycled, reused, or reclaimed: only a very few (0.3% of the total) ended up in landfills. No data were provided on exactly who accepted the pallets or whether GM paid for removal or was paid for the pallets (or both).¹² GM also reported generating 4,667 tons of other wood residue. Neither the types of residue nor the disposition were reported.

A representative of the Ford Motor Company declined to provide information. The representative of Daimler-Chrysler did respond but could not provide any data on either pallets or wood waste in general. Nevertheless, these two companies generated and disposed of a substantial number of wood pallets. Based on the experience of a major pallet recycler in Detroit, the assumption here is that Ford generated one-half of the amount in 2005 that GM did (382,000) and that Daimler-Chrysler generated about the same amount as GM (another 764,000).¹³ The total for the three companies is 1,910,000 pallets, an amount that significantly exceeds the estimated total for all of the rest of the companies in the study area combined.

Including the separate estimate for the automobile companies, an estimated total of 3,032,000 pallets were generated in the 14 counties in 2005. Assuming 6 pallets to a cubic yard, an estimated total of 505,000 cubic yards were generated.

Disposal Payments and Removal

Only three companies reported being paid for their pallets and the amounts were negligible. The standard procedures are either to pay for pallets to be removed or to give them away at no removal cost.

The total number of companies is adjusted upward by the 54 companies who are likely pallet generators among the 873 who refused to respond to the survey. This raises the total to 139 sources. The adjusted distribution by type for the 139 sources is given in Table 25. Payments by

¹²From a different source, GM reported that in 2005 pallets and other wood residue from its facility in Pontiac, Michigan were accepted by a company in southeast Michigan that produced mulch (http://www.gm.com/company/gmability/sustainability/reports/05/600_environment/5_fifty/650na.html).

¹³Provided by Chuck Foster of Auto Pallets and Boxes of Detroit by telephone conversation February 14, 2007. Mr. Foster believes the estimate for all companies other than the three automobile manufacturers is low because both the number of pallets per load and the number of loads per average month in 2005 are far too low. Based on his experience, an average load of 300 pallets (versus 60) and 100 loads per month (versus 8) would be typical for 2005. The total generated using these numbers is roughly 16 million pallets. Mr. Foster's company is one of the largest and his monthly figures are far above the average based on this survey. Nevertheless, his experience suggests that the 3 million pallet estimate is conservative.

adjusted frequencies are given in Table 26 where the original distribution, adjusted for question non-responses, was used to allocate the 57 companies across the three payment ranges.

As given in Table 24, a little more than one-third (35.3%) of the companies disposing of pallets paid for removal. By contrast, almost exactly half (50.6%) either incurred no expense or were paid for the pallets. The rest (14.2%) indicated that they either did not know (11.8%) or they refused to answer the question (2.4%). The 12 companies that selected the last two responses were allocated among those that did respond. These adjusted numbers are also adjusted frequencies are given in Table 26 where the original distribution, adjusted for question non-responses, was used to allocate the 57 companies across the three payment ranges.

Based on frequencies given in Table 26, removal payments by companies averaged \$382/month. When multiplied by 57 (the adjusted number of companies) and 12 (months in a year), the total for 2005 is \$261,300 for the companies in the sample. Multiplied by the population-to-sample ratio of 3 to 1, the total is about \$784,000. This excludes the unknown amount spent by the three automobile manufacturers.

Table 24

**Pallet Disposal by Type of Removal:
Unadjusted and Adjusted for Question Non-Response**

Type of Removal	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
Company paid for removal	30	35.3%	35	41.2%
Removed at no cost to company	39	45.9%	45	52.9%
Another company paid	4	4.7%	5	5.9%
DK	10	11.8%		
Refusal	2	2.4%		
Totals	85	100.1%	85	100.0%

Table 25

**Pallet Disposal by Type of Removal:
Adjusted for Survey Refusals**

Type of Removal	Frequency	Percent
Company paid for removal	57	41.0%
Removed at no cost to company	74	53.2%
Another company paid	8	5.9%
Totals	139	100.0%

About one-fifth (19.1%) of the companies in the unadjusted sample used their own trucks to haul pallets to another site. The remaining four-fifths (81.0%) relied on trucks provided by others. The average hauling distance was 10 miles.

Sixteen out of 21 companies that paid for removal sent their pallets to landfills (question 7.A.1.). Seven out of 39 that avoided disposal costs burned or otherwise disposed of their pallets

(question 7.B.). In total, a confirmed 23 out of 85 sample companies (27.1%) treated pallets as waste while the other 62 (72.9%) did not. Using these two percentages and the 1,122,000 pallets generated by the 617 companies, about 818,000 pallets were reused and about 304,000 were discarded (these calculations are based on the assumption that the percentages reused and discarded are the same as the percentages of companies that reused and discarded). The best evidence is that the three automobile companies reused or recycled 90% of the pallets they generated. This means that of the estimated 1,910,000 they generated, 1,719,000 were reused and 191,000 were not. Taken together, all 620 companies reused or recycled 2,538,000 (83.7%) and discarded 494,000 (16.3%). In cubic yards, using 84% and 16%, respectively, they reused or recycled 424,000 cubic yards and discarded 81,000 cubic yards. Of the amount discarded, 15,000 cubic yards, or 18.8% (16/85), were disposed of in landfills.

As shown in Table 27, the 74 sample companies that avoided removal costs did so by giving away about three-fourths (74.4%) of the pallets to individuals and to other companies. Adding the 5.4% that were recycled or reused, almost 80% were reused in some fashion. Less than one-fifth (17.6%) were burned or tossed instead of being reused. By contrast, among those that paid for removal, about three-fourths sent their pallets to landfills.

Table 26

**Company Paid For Removal:
Adjusted for Question Non-Response and Survey Refusals**

Removal Payments	Frequency	Percent
\$0 - <\$500	51	89.5%
\$1,000 - <\$1,500	3	5.3%
\$1,500 - <\$2,000	3	5.3%
Totals	57	100.1%

Among the original 85 responding companies in the sample, just over two-thirds (69.4%) indicated that they did reuse their own pallets while just over one-fourth (27.1%) did not. The rest (3.5%) did not know. Among the 55 companies that did make use of their own pallets, reuse averaged almost half (47.5%). The large majority (85.5%, adjusted for non-response) reused pallets as pallets, the rest were reduced to parts and fiber for other uses such as heating fuel and land cover (questions 9 and 9.A.).

Table 27

**How Pallets Are Removed At No Cost to Companies:
Adjusted for Survey Refusals**

Type of Removal	Frequency	Percent
Given away to public/employees	44	59.5%
Given away to other companies	11	14.9%
Burned	9	12.2%
Trashed/dumped/thrown away	4	5.4%
Recycled/reused	4	5.4%
DK	2	2.7%
Totals	74	100.1%

Overall in 2005, an estimated 420 companies (including the 3 automobile manufacturers) in the 14 county area generated just over 3 million pallets. Excluding the three automobile manufacturers, about three-fourths of the pallets were generated by companies that manufacture machinery and computer equipment, sell lumber and other building materials, construct buildings, haul freight, and sell furniture. About 6 out of 10 of these companies disposed of their pallets at no cost to themselves while the remaining 4 out of 10 paid in total about three-quarters of a million dollars for removal. Among the majority of companies that incurred no disposal cost, about three-fourths did so by giving their pallets away. Among those who reused pallets, about two-thirds reused them as pallets. The rest were reduced to parts and fiber.

Companies That Primarily Accept Pallets, Skids, and Shipping Crates

Of the 420 companies that either generated or accepted wood waste, 47 (11.2%) reported they accepted. Of the 47, 35 (74.5%) primarily accepted pallets. The remaining 12 companies were almost evenly spread out over the other categories in numbers too small to be statistically useful. Hence, the analysis that follows is only for pallets. None of the accepting companies were asked whether they secondarily accepted another kind of wood waste.

As shown in Table 28, 40% of the companies that accepted pallets are in the Major Industry Group that manufactures Industrial & Commercial Machinery & Computer Equipment (SIC 15). Other than a slight concentration in Building Construction (14.3%), the rest of the companies are spread thinly across the remaining 9 Major Industry Groups. The distribution of companies was statistically even based on a one-sample K-S test (the K-S $Z = .121$, well above .025) across the 29 Line-of-Businesses, the most specific 8-digit code. This means that the slight concentration in Building Construction occurred by chance alone and has no statistical significance. In the study population, companies would be spread evenly across all Line-of-Businesses.

SIC code 2448 that includes companies that recycle pallets was included in the sampling frame. Eighteen companies were drawn into the sample from the 53 in the study population. Four were contacted. Two refused to be interviewed and the other two indicated that they neither generated nor accepted wood waste.

None of the companies that stated they primarily accepted pallets are in Major Industry Groups or Lines-of-Business that one would expect. They are all in businesses that also generate pallets. Nevertheless, not only did the 35 companies indicate that they primarily accepted pallets but they also answered all of the additional questions about how they measured what they accepted, how much they received on a monthly basis, their major sources, what they did with what they accepted, why more is not reused and recycled, and what government might do to encourage recycling. There is no indication that either the initial and subsequent questions were misunderstood. Each question about wood waste accepted clearly refers to what was accepted, not generated. Nevertheless, there is a possibility that those responding for accepting firms did not fully understand the intent of the initial question about generating versus accepting wood waste in general and pallets in particular. The distributions for both the two-digit Major Industry Group (K-S $Z = .880$) and the eight-digit Line-of-Business (K-S $Z = .307$) for the 83 that generated and the 35 that accepted pallets are statistically the same. Thus, a reasonable inference is that these are the same kinds of companies whose representatives in the survey followed two different interpretations of the same question.

Table 28**Companies That Primarily Accept Pallets as Wood Waste
by Major Industry Group**

SIC	Major Industry Group	Frequency	Percent
15	Building Construction	5	14.3%
16	Heavy Construction, other than Building	1	2.9%
17	Construction, Special Trade Contractors	1	2.9%
25	Furniture & Fixtures	2	5.7%
26	Paper & Allied Products	2	5.7%
32	Stone, Clay, Glass, & Concrete Products	2	5.7%
35	Industrial & Commercial Machinery & Computer Equipment	14	40.0%
42	Motor Freight Transportation	2	5.7%
49	Electric, Gas, and Sanitary Services	1	2.9%
52	Building Materials, Hardware, Garden Supply & Mobile Home Dealers	3	8.6%
57	Home Furniture, Furnishings & Equipment Stores	2	5.7%
	Totals	35	100.0%

And additional explanation is that some though not all of the 35 companies have through experience developed ways of handling pallets to the point where they accept and process some of what they accept from other companies. This is certainly plausible since, as noted in the section above, some generators also reused their pallets. Nine out of 35 (25.7%) reported making further use of pallets as building materials, fuel, mulch, and as pallets. Of these, 3 completely reused the pallets they accepted while the other 6 partially reused theirs. There was no clear pattern among the small number of responses on reasons pallets were not fully reused. That pallet recycling is not these companies primary or secondary line-of-business does not prevent them from reusing and recycling what they can as an ancillary business activity that reduces disposal costs or even generates a small profit. Bush, Reddy, and Araman (1998) report that the National Wooden Pallet and Container Association has identified pallet recycling as the most profitable sector in the wood pallet industry.¹⁴ Some of these companies might have developed ways to capture these profits for themselves.

¹⁴Robert J. Bush, Vijay S. Reddy, and Philip A. Araman. 1998. *Pallets: A Growing Source of Recycled Wood*, paper presented at The Use of Recycled Wood and Paper in Building Applications Conference, Madison, WI, September, 1996, p. 26.

Sixteen out of the 35 companies (45.7%) reported that they accepted and permanently held pallets as waste. Ten of the 16 (62.5%) stated that some or all of what they held was reusable while the remaining 6 (37.5%) indicated that none were. Since a substantial majority felt that some to all were reusable, the question is why did they not either reuse them or send them to recyclers who would. The same question can be asked of the 6 who held pallets they felt to be unusable. (The other 10 out of 35 did not know what became of the pallets their companies accepted.)

When all 35 were asked how much could be reused, one-third (12) thought none could while two-thirds felt that all or some could. The single most frequently cited reason (8 companies) why more pallets are not reused is the expense of hauling to recyclers. Among ways more pallets could be reused, the most frequent cited answer was finding new uses. Though listed as an answer, finding a recycler was not mentioned. About half (17) of the 35 responding companies felt that the most important action that state and local governments could take to promote greater use of wood waste in general is to provide more market information.

Worthwhile follow-up question in future surveys should address why these companies apparently made no attempt to dispose of their pallets, how many they tend to hold, and what happens when the inventory eventually exceeds storage space and must be reduced. A key question is why they simply did not contact nearby recyclers since this information is readily available in phone books, on the Internet, and from governmental sources such as the Michigan Department of Environmental Quality. This question also can be asked about the 13 generating companies that disposed of pallets as waste (Table 27). Five respondents among receiving companies thought government might provide more information about recycling. No one mentioned government regulations as an obstacle to disposal.

Regrettably, the survey data do not reflect practices among pallet recyclers since none agreed to participate. The data instead reflect practices among companies that are not primarily or secondarily in this business. Since data from and comparisons with pallet recycling companies would have been very useful, future surveys should disproportionately sample SIC 2448 to increase the chances that at least some recyclers are found who would be willing to participate in a survey.

The 35 companies that accepted pallets are 2.3% of the 1,500 companies interviewed. Multiplied by 873 survey refusals yields an additional 20 companies that possibly would have accepted pallets in 2005. Adding the 20 possible companies to the 35 that responded brings the total to 55 companies in the Major Groups listed in Table 28. When multiplied by the population-to-sample ratio of 3 to 1, the total is 165.

The 53 companies in the study population that are in the pallet business (SIC 2448) are separate from the 165 possible plus interviewed total. Adding these 53 brings the total population of companies that actually and would have possibly accepted pallets in 2005 to 218. The estimates below are based only on what the 55 sample companies did and would have done with the pallets they accepted. Since recyclers are likely to follow very different practices they are not included.

Of the 218, approximately 1 out of 4 companies that accept pallets is in the business of recycling and re-using them. Falk and McKeever (2004)¹⁵ have concluded that pallet recycling

¹⁵Robert H. Falk, David B. McKeever. "Recovering Wood for Reuse and Recycling: A United States Perspective", Proceedings, European COST E31 Conference, *Management of Recovered Wood*, Christos Th. Gallis (ed.), April 22-24, 2004, Thessaloniki, Greece, p 37.

is among the most notable successes in solid wood recycling. They report that less than 1% of recovered pallets end up in landfills as solid waste. If this applies to the pallet recycling companies in the study area then essentially no pallets accumulate as waste, are burned, or go to landfills. Three out of four of the 218 companies that are not in the pallet recycling business nevertheless do recycle and reuse some but not all of what they accept. An important question, already raised above, is why the three-fourths majority have not found a way to connect with the one-fourth that would accept and fully use the majority's pallets. Such a market connection would both divert pallets from landfills and reduce if not eliminate the inventory of pallets held as waste.

Table 29

**Acceptance of Pallets by Type of Measure:
Unadjusted and Adjusted for Survey Refusals**

Measured by:	Unadjusted Frequency	Percent	Adjusted Frequency
Number	24	68.6%	38
Truck/container	8	22.9%	13
Weight	3	8.6%	4
Total	35	100.1%	55

Measures of Amounts Accepted

As shown in Table 29, about two-thirds of the companies measured pallets they accepted by the number. Just over one-fifth measured by the truckload while the rest measured by weight proportions across the three ways of measuring are statistically the same as the one for companies that accept pallets (Table 21). The probability of getting a K-S Z statistic of .408 is .996, far above .025.

As shown in Table 30, among the adjusted total of 38 who measured the number of pallets, 22 accepted between 0 and 200 during a typical month. One each accepted between 200 and 400 and 1,400 and 1,600, respectively. No yearly totals were reported. The average for companies that count pallets is 182 pallets per company per month. When multiplied by 38 (companies) and by 12 (months), the total to the nearest 1,000 is 83,000 pallets.

Table 30

**Number of Pallets Accepted in an Average Month:
Unadjusted and Adjusted for Question Non-Response and Survey Refusals**

Pallets Accepted per Month	Unadjusted Frequency	Adjusted Frequency: Non-Response	Adjusted Frequency: Survey Refusals	Adjusted Percent: Survey Refusals
0 - <200	21	22	35	89.7%
200 - <400	1	1	2	5.1%
1,400 - <1,600	1	1	2	5.1%
DK	1			
Total	24	24	38 (39)*	99.9%

*Rounding of frequencies adjusted for survey refusals based on percentages adjusted for question non-response yields a sum of 39. The average and standard deviation were calculated using the sum of 39. The other calculations are based on a sum of 38.

As shown in adjusted numbers in Table 31, 8 companies accepted between 0 and 20 truckloads and 3 between 20 and 40. Two accepted 400 or more (treated as 400 in the calculation of the grouped average). Rounded to the nearest whole load, the average for these companies is 27 loads per company per month. When multiplied by 13 (companies) and 12 (months) the total is 4,212 truck and container loads of pallets.

Based on the adjusted frequencies in Table 32, to the nearest cubic yard, the average volume of trucks and containers hauling pallets to these companies is 24 cubic yards (the "100 or more" responses are treated as 100 in the calculation). Assuming as before that 6 pallets fit into a cubic yard, trucks and containers with a 24 cubic yard capacity can carry 144 pallets per load. Multiplied by the number of loads yields a total to the nearest 1,000 of 607,000 pallets.

Adding the number and truckloads yields about 690,000 pallets for the sample companies. Multiplying by the population-to-sample ratio of 3 to 1 yields a total of about 2.1 million pallets.

Table 31

**Number of Truck/Container Loads Accepted in an Average Month:
Unadjusted and Adjusted for Question Non-Response and Survey Refusals**

Number of Loads	Unadjusted Frequency	Adjusted Frequency: Non-Response	Adjusted Frequency: Survey Refusals	Adjusted Percent: Survey Refusals
0 - 20	4	5	8	61.5%
20 - 40	2	2	3	23.1%
400 or more	1	1	2	15.4%
DK	1			
Total	8	8	13	100.0%

Table 32

**Truck/Container Volume in Cubic Yards:
Unadjusted and Adjusted for Survey Refusals**

Cubic Yards	Unadjusted Frequency	Percent	Adjusted Frequency: Survey Refusals	Adjusted Percent: Survey Refusals
0 - <10	5	62.5%	8	57.1%
10 - <20	1	12.5%	2	14.3%
30 - <40	1	12.5%	2	14.3%
100 or more	1	12.5%	2	14.3%
Total	8	100.0%	13 (14)*	100.0%

*Rounding of frequencies adjusted for survey refusals yields a sum of 14. The average and standard deviation were calculated using this total. The other calculations are based on a total of 13.

Table 33

Major Sources of Accepted Pallets

Pallet Sources	Unadjusted Frequency	Percent
Michigan businesses	14	40.0%
Businesses in other states	14	40.0%
Michigan governments	2	5.7%
Other state governments	1	2.9%
Other	4	12.4%
Total	35	101.0

An estimated 165 companies accepted 2.1 million pallets in 2005 while 420 companies generated about 3 million pallets. The 2.1 million estimate understates the total accepted because none of the 53 pallet recycling companies responded; hence, their total is not included. That what they accepted exceeds what is generated is reflected in the 42.9% of pallet sources reported to be from sources outside Michigan (40.0% for outside businesses and 2.9% for outside governments).

Though the survey data provide no direct way of measuring the amounts available, the opportunity seems to exist for recyclers to obtain more pallets from the companies that accept but do not recycle as a primary business, especially from those who hold pallets as waste. From the perspective of the companies not in the recycling business, finding recyclers and the cost of transportation seem to be the major barriers that separate them from recycling companies.

Finally, to the extent that state and local governments can do anything to tighten the market connections, providing additional information, especially on how transportation costs might be reduced, seems most promising. With some encouragement and modest support from government, recyclers themselves could also make additional efforts to connect, focusing also on ways both to reach companies that hold pallets and to reduce transportation costs.

Edgings and Cutoffs

Disposal Measures and Amounts

As given in Table 34, 82 companies primarily and secondarily disposed of edgings and cutoffs. Not surprisingly, 55 or two-thirds (67.1%) of them are in the construction industries. Nine companies (11.0%) manufacture wood products while another 9 (8.1%) sell lumber and other building materials. The remaining 9 are split evenly between makers of wood partitions and fixtures, manufacturers of metal and woodworking machinery, and furniture stores.

Another 48 companies also generated edgings and cutoffs when survey refusals are added, bringing the sample total to 130 (see Table 21 above for the calculation).

As discussed earlier (page 33), that 248 companies in the Building Construction Group (SIC 15) did not generate any residue does not seem plausible given the essential role of wood in the very nature of what these companies do. The split between generators and non-generators persisted down to the 8-digit Line-of-Business level. To the same degree, this argument applies to the Construction, Special Trade Contractors Group (SIC 17) as well. To a lesser degree, it also applies to Industrial & Commercial Machinery & Computer Equipment (SIC 35), Motor Freight Transportation (SIC 42), and to Building Materials, Hardware, Garden Supply & Mobile Home Dealers (SIC 52). However, using only the numbers for the two construction Groups, the sample total is raised by 75 to 205.¹⁶ Multiplied by the population-to-sample ratio of 3 to 1 yields a conservative population estimate of 615 companies in the fourteen county area that generated edgings and cutoffs in 2005.

Table 34

Disposition of Edgings and Cutoffs by Major Industry Group and Industry

SIC	Major Industry Group/Industry	Frequency	Percent
15: 1521, 1522, 1531	Building Construction: Single Family Construction & Remodeling, Residential Construction, New Housing Speculative Builders	45	56.8%
17: 1751	Construction, Special Trade Contractors: On-Site Cabinet Building & Installation	10	13.5%
24: 2421, 2426, 2431, 2434, 2452	Lumber and Wood Products, except Furniture: Sawmills & Planing Mills, Hardwood Dimension & Flooring Mills, Hardwood Dimension & Flooring Mills, Special (Wood) Products Mills, Wood Window Manufacturing, Cabinet Building, Stock & Custom, Prefabricated Wood Buildings	9	8.1%
25: 2541	Furniture & Fixtures: Wood Partitions & Fixtures	3	2.7%
35: 3535, 3541, 3553	Industrial & Commercial Machinery and Computer Equipment: Conveyors & Conveying Equipment, Machine Tools, Metal Cutting, Woodworking Machinery	3	4.1%
52: 5211	Building Materials, Hardware, Garden Supply & Mobile Home Dealers: Lumber & Other Building Materials Dealers	9	12.2%
57: 5712	Home Furniture, Furnishings & Equipment Stores: Furniture Stores	3	2.7%
Totals		82	100.1%

¹⁶Of the 190 primary (175) and secondary (15) sources of residue in SIC 15, 45 (23.7%) generated edgings and cutoffs. That percentage of the 248 companies who indicated that they did not generate residue is 59. Of the 32 primary and secondary sources of residue in SIC 17, 10 (31.3%) generated edgings and cutoffs. That percentage of the 52 companies who indicated that they did not generate residue is 16. The sum of the two is 75 companies.

As shown in Table 35, the question non-responses are allocated between the two ways of measuring amounts of edgings and cutoffs generated by primary and secondary sources using the proportions for those that responded. These adjusted percentages were then used to calculate the division between truck loads and weight shown in Table 36 for the total adjusted for survey refusals and non-generators.

Table 35

**Disposition of Edgings and Cutoffs by Type of Measure:
Unadjusted and Adjusted for Question Non-Response**

Type of Measure	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
Truck/container	54	65.9%	78	95.1%
Weight	3	3.7%	4	4.9%
DK	25	30.5%		
Totals	82	100.1%	82	100.0%

Table 36

**Disposition of Edgings and Cutoffs by Type of Measure:
Adjusted for Survey Refusals and Non-Generators**

Type of Measure	Frequency	Percent
Truck/container loads	195	95.1%
Weight	10	4.9%
Total	205	100.0%

Table 37

**Disposition of Edgings and Cutoffs by Number of Truck/Container Loads:
Unadjusted and Adjusted for Question Non-Response, Survey Refusals, and Non-Generators**

Number of Loads	Unadjusted Frequency	Unadjusted Percent	Adjusted	Percent
>0 - <20	37	77.1%	155	79.5%
20 - <40	4	8.3%	16	8.2%
40 - <60	2	4.2%	8	4.1%
80 - <100	2	4.2%	8	4.1%
220 - <240	1	2.1%	4	2.1%
280 - <300	1	2.1%	4	2.1%
DK	1	2.1%		
Subtotal	48	100.1%	195	100.1%

Using the adjusted frequencies in Table 37, the sample average is (to the nearest whole load) 27 loads per company per month. When multiplied by the 195 companies, by 12 months, and then rounded to the nearest 1,000 loads, the total is 63,000 loads.

Table 38**Volume of Trucks or Containers Used to Haul Edgings and Cutoffs:
Adjusted for Question Non-Response**

Cubic Yards	Unadjusted Frequency	Percent	Adjusted Frequency	Percent
0 - <10	22	40.7%	26**	48.2%
10 - <20	10	18.5%	11	20.4%
20 - <30	11	20.4%	12	22.2%
30 - <40	3	5.6%	5	9.3%
100 or more*	2	3.7%		
DK	6	11.1%		
Totals	54	100.0	54	100.1%

* Two respondents reported volumes for trucks and containers that were too large for what actually exists. The two were placed in the 30 to 40cubic yard interval, the largest otherwise mentioned.

**Initial rounding of frequencies left the total at 53. The frequency for the lowest range is increased by 1 to bring the total to 54.

Using the frequencies in Table 38, the average volume of trucks and containers used to haul edgings and cutoffs is (to the whole cubic yard) 14 cubic yards. Assuming full truck and container loads, the average for the 195 sample companies is 882,000 cubic yards.¹⁷ Multiplied by the population-to-sample ratio of 3 to 1 yields a total of 2,646,000 cubic yards of edgings and cutoffs.

Disposal Payments and Removal

As given in Table 39, adjusted for question non-response, almost exactly two-thirds of the sample companies paid for removal while the remaining one-third incurred no expense. Adjusted for survey refusals and non-generators in Table 40, 135 companies paid for removal, 67 disposed of edgings and cutoffs at no cost to themselves, while 3 were paid.

Table 39**Edgings and Cutoffs Disposal by Type of Removal:
Unadjusted and Adjusted for Question Non-Response**

Type of Removal	Unadjusted Frequency	Percent	Adjusted Frequency	Adjusted Percent
Company paid for removal	53	64.6%	54	65.9%
Removed at no cost to company	27	32.9%	27	32.9%
Another company paid	1	1.2%	1	1.2%
DK	1	1.2%		
Totals	82	99.9%	82	100.0%

¹⁷ Using an equal mix of plywood (776 pounds/cubic yard) and Douglas fir (891 pounds/cubic yard) as representatives by weight of edgings and cutoffs, a cubic yard would weight 834 pounds. Multiplied by 4,158,000 cubic yards yields a total estimated weight of about 1.7 million tons. The total estimated weight for the all companies that measured edgings and cutoffs by weight is trivial compared to the estimated weight for those who measured by truck or container load. The same is so if weight was converted to cubic yards. Hence, the estimated amount for those who measured by weight is excluded.

Table 40

**Edgings and Cutoffs Disposal by Type of Removal:
Adjusted for Question Non-Response, Survey Refusals, and Non-Generators**

Type of Removal	Adjusted Frequency	Adjusted Percent
Company paid for removal	135	65.9%
Removed at no cost to company	67	32.9%
Another company paid	3	1.2%
Totals	205	100.0%

Table 41

**Company Paid for Removal:
Adjusted for Question Non-Response, Survey Refusals, and Non-Generators**

Removal Payments	Unadjusted Frequency	Percent	Adjusted Frequency	Adjusted Percent
>\$0 - < \$500	43	81.1%	127	94.1%
\$500 - < \$1,000	2	3.8%	5	3.7%
\$1,000 - <\$1,500	1	1.9%	3	2.2%
DK	7	13.2%		
Totals	53	100.0%	135	100.0%

Among the 135 who paid for removal, the average monthly payment was \$291 per company per month. When the average is multiplied by 135 (the adjusted number of companies), 12 (months), and then rounded to the nearest \$1,000, the total is \$471,000. Multiplied by the population-to-sample ratio of 3 to 1, 405 companies in the fourteen county area in 2005 spent a total of \$1,413,000. Another 201 disposed of theirs at no cost to themselves. No data on payments either way are available for 9 companies.

Table 42

**How Edgings and Cutoffs Are Removed At No Cost to Companies:
Adjusted for Survey Refusals**

Type of No Cost Removals	Frequency	Percent
Given away to public/employees	120	58.5%
Given away to other companies	32	15.6%
Burned	26	12.7%
Trashed/dumped/thrown away	11	5.4%
Recycled/reused	11	5.4%
DK	5	2.4%
Totals	205	100.0%

As shown in Table 42, about three-fourths (74.1%) of the companies who avoided removal costs did so by giving the material away to the public, their own employees, and to other companies. Just 11 companies (5.4%) specifically recycled while 37 companies (18.1%) burned or discarded the material. No company was paid for its edgings and cutoffs.

Thirty-four out of 53 companies that paid for removal sent their edgings and cutoffs to landfills (question 15.A.2.). Fourteen out of 27 that avoided disposal costs did so by burning or otherwise disposing of the material as waste (question 15.B.). A confirmed total of 48 out of 80 companies, 60.0%, discarded edgings and cutoffs as waste while the other 40% did not. Thirty-four out of 80 (42.5%) sent their edgings and cutoffs to landfills. Assuming these percentages reflect the percentages for the amounts reused and discarded means that about 1,058,000 were used and 1,588,000 cubic yards were discarded. Of the latter, 675,000 cubic yards, or 42.5%, went to landfills.

Thirty-seven percent of the companies in the unadjusted sample used their own trucks to haul edgings and cutoffs to other places. The remaining 63% used trucks provided by other companies.¹⁸ Based on numbers adjusted for question non-response (question 15.A.3.), edgings and cutoffs were hauled to landfills that were on average 12 miles away. Worth noting here is that the average 10 mile drive to dispose of pallets does not statistically differ from the average 12 mile drive to dispose of edgings and cutoffs.¹⁹ Even though these companies are in different industries and may be distributed differently throughout the 14 county area, they are driving about the same distance to dispose of their respective wood residues.

About one-third (34.2%) of the companies in the unadjusted sample of 82 reported that they made no use of their edgings and cutoffs while the remaining two-thirds (65.9%) did find uses (question 16). Companies that did averaged reusing just over one-third (37.0%). Just over one-fourth (27.8%) reused the material as heating fuel while the largest percentage, 29.6%, used or reused the material in building (question 17). Two other reported uses are as land cover and mulch.

Overall, an estimated 615 companies generated just over 2.6 million cubic yards of edgings and cutoffs in the 14 county area. Not surprisingly, two-thirds were in the construction business. Close to 1.6 million cubic yards was discarded and just over 1 million was used reused. Two-thirds of all 615 companies paid an estimated total of \$1.4 million for removal. The remaining third paid nothing. Among those who paid, just over one-third used their own trucks for hauling an average distance of 12 miles to disposal sites. Among those who did not pay, about three-fourths avoided removal costs by giving the material away. Only 1 out of 20 companies recycled whereas 1 out of 5 burned or otherwise disposed of the material as waste. About two-thirds of all of the companies did make some use of their own edgings and cutoffs, the rest did not. The main uses were as building materials and heating fuel.

¹⁸ One company split hauling fifty-fifty with another company and the other used a dumpster. Both are classified as having used hauling services provided by other companies.

¹⁹ The difference-of-means test for statistically independent samples was used to compare the average driving distances. The probability of getting the 2 mile difference by chance is .143 assuming equal population variances and .120 assuming unequal population variances. Either way, the probability is clearly greater than the usual significance levels for either a two-tailed or one-tailed test.

Chips and Shavings

Disposal Measures and Amounts

As shown in Table 43, among the 68 sample companies that disposed of chips and shavings, 28.0% are in construction, 32.4% in lumber and wood products manufacturing, and 14.7% in industrial, commercial, and computer equipment manufacturing. These three together account for three-fourths (75.1%) of all the companies that generated chip and shavings. The rest are spread in small numbers across 8 other industry groups.

Another 40 also generated chips and shavings when survey refusals are added. This brings the sample total to 108 (see Table 21 for the calculations). Multiplied by the population-to-sample ratio of 3 to 1 raises the total estimated population of companies in the 14 county area to 324.

Table 43

Disposition of Chips and Shavings by Major Industry Group and Industry

SIC	Major Industry Group/Industry	Frequency	Percent
07: 0783	Agricultural Services: Pruning and Trimming Services	3	4.4%
15: 1521, 1522	Building Construction: Single Family Construction & Remodeling, Residential Construction	15	22.1%
17: 1751	Construction, Special Trade Contractors: On-Site Cabinet Building & Installation	4	5.9%
24: 2421, 2426, 2429, 2431, 2434, 2452, 2499	Lumber and Wood Products, except Furniture: Sawmills & Planing Mills, Hardwood Dimension & Flooring Mills, Special Wood Products Mills, Wood Window Manufacturing, Cabinet Building, Prefabricated Wood Buildings, Wood Products NEC	22	32.4%
25: 2521	Furniture and Fixtures: Wood Office Furniture	2	2.9%
26: 2621, 2653	Paper & Allied Products: Paper Mills, Corrugated & Solid Fiber Boxes	2	2.9%
32: 3272	Stone, Clay, Glass, & Concrete Products: Concrete Products, except Block and Brick	1	1.5%
35: 3524, 3543, 3553, 3569, 3599	Industrial & Commercial Machinery and Computer Equipment: Lawn & Garden Tractors & Home Lawn & Garden Equipment, Industrial Patterns, Woodworking Machinery, General Industrial Machinery & Equipment, NEC, Industrial & Commercial Machinery & Equipment, NEC	10	14.7%
52: 5211	Building Materials, Hardware, Garden Supply & Mobile Home Dealers: Lumber & Other Building Materials Dealers	4	5.9%
54: 5411	Food Stores: Supermarkets	1	1.5%
57: 5712	Home Furniture, Furnishings & Equipment Stores: Furniture Stores	4	5.9%
Totals		68	100.1%

As shown in Tables 44 and 45, about three-fourths of the sample companies measured the amount of chips and shavings they disposed of by truck and container. The remaining one-fourth measured by weight.

Using the frequencies in Table 46, the average number of loads (to the nearest whole load) is 16 per company per month. When multiplied by 83 companies, 12 months, and then rounded to the nearest 1,000 loads, the total is 16,000 loads for the sample companies in 2005.

Table 44

**Disposition of Chips and Shavings by Type of Measure:
Unadjusted and Adjusted for Question Non-Response**

Type of Measure	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
Truck/container	33	48.5%	52	76.5%
Weight	10	14.7%	16	23.5%
DK	24	35.3%		
Refusals	1	1.5%		
Totals	68	100.0%	68	100.0%

Table 45

**Disposition of Chips and Shavings by Type of Measure:
Adjusted for Survey Refusals**

Type of Measure	Frequency	Percent
Truck/container loads	83	76.5%
Weight	25	23.5%
Total	108	100.0%

From the frequencies in Table 47, the average volume of trucks and containers used to haul chips and shavings is to the whole cubic yard 10 cubic yards. Assuming full truck and container loads, the total for the 83 sample companies is 160,000 cubic yards.²⁰ Multiplied by the population-to-sample ratio of 3 to 1 yields a total of 480,000 cubic yards of chips and shavings.

Disposal Payments and Removal

As given in Table 48, adjusted for survey refusals, half of the sample companies disposed of chips and shavings at no cost to themselves. Four out of ten paid for removal while the remaining 1 out of 10 was paid by other companies.

From the distribution in Table 49, for the 44 companies who paid for removal, the average monthly payment was \$284 per company per month. Multiplied by the 44 who paid, 12 (months), and then rounded to the nearest \$1,000, the total is \$150,000. Multiplied by the population-to-sample ratio of 3 to 1, 132 companies in the 14 county area spent \$450,000. Thirty companies received a total of about \$74,000 in payments from other companies (calculated from question 19.C.). The remaining 162 companies disposed of their chips and shavings at no cost to themselves.

²⁰ Adjusted for survey refusals, 25 companies disposed of a total of about 15 tons. Assuming an equal mix of chips and shavings weighs 470 pounds per cubic yard (metrokc.gov/dnr/swd/business/documents/Conversions.pdf), 624,000 cubic yards would weigh about 147,000 tons. The amount measured by weight is trivial by comparison and is not included in the total.

Table 46
Disposition of Chips and Shavings by Number of Truck/Container Loads:
Unadjusted and Adjusted for Survey Refusals

Number of Loads	Unadjusted Frequency	Percent	Adjusted for Question Survey Refusals	Percent
>0 - <20	26	86.7%	71*	85.5%
20 - <40	1	3.3%	3	3.6%
40 - <60	1	3.3%	3	3.6%
120 - <140	1	3.3%	3	3.6%
220 - <240	1	3.3%	3	3.6%
Totals	30	99.9%	83	99.9%

*Initial rounding of frequencies left the total at 72. The frequency for the lowest range is reduced to 71 to bring the total to 83.

Table 47

Volume of Trucks or Containers Used to Haul Chips and Shavings:
Adjusted for Question Non-Response and Survey Refusals

Cubic Yards	Unadjusted Frequency	Percent	Adjusted Frequency	Percent
0 - <10	23	69.7%	64	77.1%
10 - <20	3	9.1%	8	9.6%
20 - <30	1	3.0%	3	3.6%
30 - <40	1	3.0%	8	9.6%
100 or more*	2	6.1%		
DK	3			
Totals	33	99.9%	83	99.9%

*Two respondents reported volumes for trucks and containers that were too large for what actually exists. The two were placed in the 30 to 40 interval, the largest otherwise mentioned.

Table 48

Chips and Shavings Disposal by Type of Removal:
Adjusted for Survey Refusals

Type of Removal	Adjusted Frequency	Adjusted Percent
Company paid for removal	44	40.7%
Removed at no cost to company	54	50.0%
Another company paid	10	9.3%
Totals	108	100.0%

Among the 26 companies that paid for chips and shavings removal, 20 used landfills (question 19.A.2.). Of the 34 that incurred no disposal cost, 11 either burned or otherwise disposed of theirs (19.B.). Out of 60 companies that reported, 31, or 51.7%, discarded while 29, or 48.3%, did not. Twenty-six out of 60 (43.3%) companies sent their chips and shavings to landfills. Projecting these percentages onto the total of 480,000 cubic yards generated, about 230,000 were used and 250,000 were discarded. Among the latter, 108,000 (43.3%) cubic yards were sent to landfills.

Table 49

**Company Paid for Removal:
Adjusted for Question Non-Response and Survey Refusals**

Removal Payments	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
>\$0 - <\$500	24	85.7%	42	95.5%
\$500 - <\$1,000	1	3.6%	1	2.3%
\$1,000 - <\$1,500	1	3.6%	1	2.3%
DK	2	7.1%		
Totals	28	100.0%	44	100.1%

Just over 4 out of 10 companies (42.6%) avoided disposal costs by giving their chips and shavings away to the public, their own employees, and to other companies. Just over 3 out of 10 (31.5%) either burned or disposed of the material as waste. Among those that disposed, just over three-fourths sent their material to landfills. The remaining companies (25.9%) either recycled or reused their chips and shavings. And, among these companies, just over half (54.6%) used the material as mulch. Just over a fifth (22.7%), used the material as heating fuel. Minor uses were made as animal bedding and land cover.

About three-fourths (76.9%) relied on other companies to haul their material to disposal sites. The remaining one-quarter used their own trucks. Based on numbers adjusted for question non-response (question 19.A.3.), to nearest mile, the average distance to disposal sites is 18 miles, 6 miles further than the average for companies that generated edgings and cutoffs and 8 miles further than companies that generated pallets. The distances for companies that generated edgings and cutoffs and chips and shavings are about the same. The driving distance for pallets is less than it is for chips and shavings.²⁰

²¹ The difference-of-means test for statistically independent samples was used to compare the average driving distances. The probability of getting by chance the 6 mile difference between companies that generated edgings and cutoffs versus those that generated chips and shavings is .020, assuming equal population variances, and .034, assuming unequal population variances. At a significance level of .05 for a two-tailed test, the difference is just barely significant assuming equal population variances. Assuming unequal variances, the difference is not significant. Both drive about the same distance. Compared to companies that generated pallets, the probability of getting an 8 mile difference by chance is .015 for equal variances and .011 for unequal variances. Either way, the difference is significant. Companies that generated chips and shavings drove further than those that generated pallets.

Table 50

**How Chips and Shavings Are Removed At No Cost to Companies:
Adjusted for Survey Refusals**

Type of No Cost Removal	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
Given away to public/employees	13	38.2%	21	38.9%
Given away to other companies	1	2.9%	2	3.7%
Burned	6	17.7%	9	16.7%
Trashed/dumped/discarded	5	14.7%	8	14.8%
Recycled/re-used	9	26.5%	14	25.9%
Totals	34	100.0%	54	100.0%

Overall, an estimated 324 companies generated 480,000 cubic yards of chips and shavings in the 14 county area. Three-fourths of these companies were either in construction, wood products manufacturing, or industrial machinery manufacturing. About 4 out of 10 companies paid just under one-half million dollars to dispose the material they generated. The other 6 out of 10 either gave the material away or, in a minority of cases, were paid for it. Among those that disposed of their chips and shavings as waste, about three-fourths used landfills. About 1 out of 4 recycled, mainly as mulch.

Construction Debris

Disposal Measures and Amounts

As shown in Table 51, among the 141 sample companies that disposed of construction debris, the large majority (76.6%) are in Building Construction (SIC 15). When the other two construction Groups, SIC 16 and 17, are added the total comes to 87.2 %. The remaining 12.7% is spread in across the five other Groups.

Another 82 also generated construction debris when survey refusals are added. This brings the sample total to 223 (see Table 21 for the calculations).

As discussed previously (page 33), that 248 companies in the Building Construction Group (SIC 15) did not generate any residue does not seem plausible given the essential role of wood in the very nature of what these companies do. As also noted previously, the split between generators and non-generators persisted down to the 8-digit Line-of-Business level. This also applies to the 52 companies in Construction, Special Trade Contractors Group (SIC 17) who claimed they did not generate wood residue. Using only the numbers for the two construction Groups, the sample total is raised by 164 to 387.²² Multiplied by the population-to-sample ratio of 3 to 1 yields a population estimate of 1,161 companies in the fourteen county area that generated construction debris in 2005.

Table 51

Disposition of Construction Debris by Major Industry Group and Industry

SIC	Major Industry Group/Industry	Frequency	Percent
15: 1521, 1522, 1531	Building Construction: Single Family Construction & Remodeling, Residential Construction, Residential Construction, New Housing Speculative Builders	108	76.6%
16: 1611	Heavy Construction, Other Than Building: Highway & Street Construction	1	0.7%
17: 1751, 1795	Construction, Special Trade Contractors: Cabinet Building & Installation, On-Site, Demolition, Buildings & Other Structures	14	9.9%
24: 2431, 2499	Lumber and Wood Products, except Furniture: Wood Window Manufacturing, Wood Products, NEC	2	1.4%
25: 2511, 2541	Furniture and Fixtures: Cabinet, Household, Freestanding, Wood Partitions & Fixtures	2	1.4%
35: 3599	Industrial & Commercial Machinery and Computer Equipment: Industrial & Commercial Machinery and Computer Equipment, NEC	1	0.7%
42: 4212, 4213	Motor Freight Transportation: Local Trucking, Without Storage, Trucking, Except Local	4	2.8%
52: 5211	Building Materials, Hardware, Garden Supply & Mobile Home Dealers: Lumber & Other Building Materials Dealers	9	6.4%
Totals		141	99.9%

²²Of the 190 primary (175) and secondary (15) sources of residue in SIC 15, 108 (56.8%) generated construction debris. That percentage of the 248 companies who indicated that they did not generate residue is 141. Of the 32 primary (31) and secondary (1) sources of residue in SIC 17, 14 (43.8%) generated edgings and cutoffs. That percentage of the 52 companies in SIC 17 who indicated that they did not generate residue is 23. The sum of non-generators is 164 companies.

As shown in Tables 52 and 53, the distribution by type of measure, adjusted for question non-response, survey refusals, and non-generators, overwhelmingly favors trucks/containers: just under 9 out of 10 use trucks/containers while only about 1 out of 10 weigh the debris they generate.

Table 52

**Disposition of Construction Debris by Type of Measure:
Unadjusted and Adjusted for Question Non-Response**

Type of Measure	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
Truck/container	88	62.4%	125	88.7%
Weight	11	7.8%	16	11.4%
DK	41	29.1%		
Refusal	1	0.7%		
Totals	141	100.0%	141	100.1%

Table 53

**Disposition of Construction Debris by Type of Measure:
Adjusted for Survey Refusals and Non-Generators**

Type of Measure	Frequency	Percent
Truck/container	343	88.6%
Weight	44	11.4%
Totals	387	100.0%

Table 54

Disposition of Construction Debris by Number of Trucks/Container Loads: Unadjusted and Adjusted for Question Non-Response, Survey Refusals, and Non-Generators

Number of Loads	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
0 - <20	69	78.4%	304	88.6%
20 - <40	5	5.7%	23	6.7%
40 - <60	2	2.3%	8	2.3%
80 - <100	1	1.1%	4	1.2%
100 - <120	1	1.1%	4	1.2%
Total for 2005*	2	2.3%		
DK	8	9.1%		
Totals	88	100.0	343	100.0%

*Placed in the 0 to 20 interval.

Based on the adjusted frequencies from Table 53, the sample companies averaged 14 loads per company per month. For 2005, rounded to the nearest 1,000 loads, the average is 58,000 loads for the 343 sample companies.

Table 55**Volume of Trucks or Containers Used to Haul Construction Debris: Unadjusted and Adjusted for Question Non-Response, Survey Refusals, and Non-Generators**

Cubic Yards	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
0 - <10	30	34.1%	125	36.4%
10 - <20	10	11.4%	43	12.5%
20 - <30	23	26.1%	93	27.1%
30 - <40	12	13.6%	50	14.6%
40 - <50	3	3.4%	12	3.5%
70 - <80	1	1.1%	20*	5.8%
80 - <90	1	1.1%		
140	1	1.1%		
1,800	1	1.1%		
4,800	1	1.1%		
DK	4	4.6%		
Refusal	1	1.1%		
Totals	88	99.8 %	343	99.9%

*Four respondents reported volumes for trucks and containers that were too large for what actually exists. These were placed in the 70 to 80 cubic yard interval, the largest that seems to be in use on US highways.

Using the adjusted frequencies from Table 55, the average volume for truck and containers to the nearest cubic yard is 22 cubic yards. Assuming full loads, the average for the 343 sample companies is 1,276,000 cubic yards. Multiplied by the population-to-sample ratio of 3 to 1 yields a total of 3,828,000 cubic yards of construction debris generated in 2005.²³

Disposal Payments and Removal

A very large majority (85.1%) paid for the removal of the debris they generated, averaging \$514 per month per company. Only a relatively few (13.1%) disposed of debris at no expense to themselves. And, only a handful was paid (1.5%), and it was a negligible amount.

Table 56**Construction Debris Disposal by Type of Removal: Unadjusted and Adjusted for Question Non-Response, Survey Refusals and Non-Generators**

Type of Removal	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
Company paid for removal	117	83.0%	292	85.1%
Removed at no cost to company	19	13.5%	46	13.4%
Another company paid	2	1.4%	5	1.5%
DK	2	1.4%		
Refusal	1	0.7%		
Totals	141	100.0%	343	100.0%

²³ As with the other types of debris, the amount measured by weight is negligible and not included.

The total amount paid by the 292 sample companies was \$1,801,000. Multiplied by the population-to-sample ratio of 3 to 1, 876 companies spent \$5,403,000.

Table 57

**Construction Debris Removal Payments:
Adjusted for Question Non-Response, Survey Refusals, and Non-Generators**

Removal Payments	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
>\$0 - <\$500	82	70.1%	226*	77.4%
\$500 - \$1,000	15	12.8%	42	14.4%
\$1,000 - <\$1,500	4	3.4%	10	3.4%
\$1,500 - <\$2,000	2	1.7%	5	1.7%
\$3,500 - <\$4,000	2	1.7%	5	1.7%
\$4,000 - <\$4,500	1	0.9%	2	0.7%
\$6,500 - <\$7,000	1	0.9%	2	0.7%
DK	10	8.6%		
Totals	117	100.1	292	

*To compensate for a rounding error, adjusted up by 1 for a total of 292.

Just under one-third (31.8%) of the companies in the unadjusted sample used their own trucks to haul their debris to disposal sites. The rest (68.2%) relied on trucks provided by other companies. Based on numbers adjusted for question non-response, the average driving distance to the sites was about 58 miles, far greater than for the other types of debris discussed above. As between other companies and landfills, a large majority (84.1%) of the debris was hauled to landfills.

Of the 117 companies that paid for removal, 73 sent their debris to landfills (question 29.A.2.). Of the 19 that avoided disposal costs, 12 burned or otherwise disposed of their debris (question 29.B.). In total, 85 out of 136 companies (62.5%) discarded their debris while the remaining 51 (37.5%) did not. Seventy-three out of 136 (53.7%) sent their debris to landfills. Projecting the percentage division between those who did and those who did not discard debris onto the total of 3,828,000 cubic yards generated, about 1,416,000 cubic yards were reused and 2,412,000 cubic yards were not. Of the amount discarded, 1,285,000 (53.7%) cubic yards went to landfills.

Among the 51 sample companies who avoided disposal costs, just over one-third (36.8%) did so by giving the debris to employees and other companies. Just under two-thirds (63.2%) either burned or discarded their debris as waste.

Adjusted for question non-response, just over half (52.5%) of the companies did not reuse any of the debris they generated. The rest averaged reusing only about one-fifth (21.6%) of what they generated. Of what was reused, 40% of the debris was as building materials, 17.1% in other unidentified ways, and 15.7% as heating fuel.

An estimated 1,161 companies, mostly in building construction, generated about 3.8 million cubic yards of construction debris in the 14 county area. Three-fourths of the companies paid about \$5.4 million for disposal. The other one-fourth paid nothing, mainly by giving the debris away. Among those who paid, about one-third used their own trucks for hauling while the rest relied on other companies. The average hauling distance was 58 miles, far more than the

distances traveled by companies that generated pallets, edgings and cutoffs, and chips and shavings. Most of the discarded debris went to landfills. About 2.4 million cubic yards were discarded and 1.4 cubic yards were reused.

Tree Trunks, Limbs, and Stumps

Disposal Measures and Amounts

As shown in Table 58, 17 of the 20 (85.0%) sample companies that primarily and secondarily generate tree debris are in the construction industries. Only 2 are in motor freight and only 1 is in the tree care industry. A likely and simple explanation of construction company involvement is that they must remove trees to make way for whatever they are building.

A useful source of information on tree residue is companies in the tree removal business. To be as specific as possible in this study, only companies in the eight-digit line-of-business Pruning Services for Ornamental Trees (SIC 07830104) and Tree Trimming Services for Public Utilities (07830105) were included. The purpose of being this specific was to avoid the extra expenses of mailing cover letters and making telephone calls to a great many (probably a majority of) companies in the Ornamental Shrub and Tree Services Industry (SIC 0783) whose business does not include tree removals. The consequence of being this specific is that only 30 companies were included in the study population. Of the 30, 10 were drawn into the sample, consistent with a one-third sampling of the population. Of the 10, 3 were interviewed (2 placed themselves in the category of primary generators of chips and shavings), 1 number was no longer in service, and 6 were working numbers where no one was contacted before the survey ended.

In the future, those conducting telephone-based urban wood residue surveys should consider the option of defining the study population to include all of the Ornamental Shrub and Tree Services Industry. However, while this option may garner more companies involved in tree removal it will also raise the project cost for cover letters and, more significantly, for many more telephone calls made to companies who will not qualify. Based on the questions used in this survey, tree care companies that do remove trees should fall into the group of those who accept debris, not generate it, as long as they interpret the question to mean that they accept tree debris as their primary business and are not generating companies (such as those in construction) that create the need for removal or own what needs to be removed.

Table 58

Disposition of Tree Trunks and Limbs by Major Industry Group and Industry

SIC	Major Industry Group/Industry	Frequency	Percent
07: 07830105	Agricultural Services: Tree Trimming Services for Public Utility Lines	1	5.0%
15: 1521, 1522, 1531	Building Construction: Single Family Construction & Remodeling, Residential Construction, New Housing Speculative Builders	14	70.0%
16: 1611	Heavy Construction, Other Than Building: Highway & Street Construction	2	10.0%
17: 1794	Construction, Special Trade Contractors: Excavation & Grading, Building Construction	1	5.0%
42: 4212, 4213	Motor Freight Transportation: Local Trucking, Without Storage, Trucking, Except Local	2	10.0%
Totals		20	100.0%

Another 12 companies also generated tree residue when survey refusals are added, bringing the total to 32 (see Table 21 above for the calculation). Multiplied by the population-to-sample ratio of 3 to 1 yields a population estimates of 96 companies that generated tree debris.

As shown in Table 59, question non-responses are allocated between the two ways of measuring the amount of tree residue, truck/container and weight, using the proportions of those that responded to the question. Consistent with the other types of debris, the large majority of companies (90.6%) measured by the truck/container load. Only 3 measured by weigh. The amounts were trivial and not included in the estimates of total amounts generated.

Table 59

**Disposition of Tree Trunks and Limbs by Type of Measure:
Unadjusted and Adjusted for Question Non-Response and Survey Refusals**

Type of Measure	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
Truck/container	10	50.0%	29	90.6%
Weight	1	5.0%	3	9.4%
DK	9	45.0%		
Totals	20	100.0%	32	100.0%

Table 60

**Disposition of Tree Trunks and Limbs by Number of Truck/Container Loads:
Adjusted for Question Non-Response and Survey Refusals**

Number of Loads	Frequency	Percent
>0 - <20	29	100.0%

Using the frequency for the single interval in Table 60, companies disposed of 10 loads per month. For all companies, the total to the nearest 100 loads is 3,500 for 2005.

Table 61

**Volume of Trucks/Containers Used to Haul Tree Trunks and Limbs:
Adjusted for Question Non-Response and Survey Refusals**

Cubic Yards	Adjusted Frequency	Adjusted Percent
0> - <10	23	79.3%
10 - <20	3	10.3%
20 - <30	3	10.3%
Totals	29	99.9%

Using the frequencies in Table 61, the average volume of the trucks and containers used to haul tree debris (to the nearest whole cubic yard) 8 cubic yards. Assuming full truck and container loads, the average for the 29 sample companies is 28,000 cubic yards. Multiplied by the population-to-sample of 3 to 1 yields a total of 84,000 cubic yards of tree debris.

Disposal Payments and Removal

As given in Table 62. just over 4 out of 10 (43.8%) companies paid for removal. Their payments averaged \$1,393 per company per month. The total for the 14 sample companies is \$234,000. Expanded by the population-to-sample ratio of 3 to 1, the total is \$702,000 for all of 2005. Exactly half incurred no expense while just a few (6.3%) were paid (\$78,000 in total for the year).

Among the 7 companies that paid for removal, 2 used landfills (question 23.A.2.). Five of 8 who avoided disposal costs burned or otherwise discarded their debris (question 23.B.). Seven of 15, or 46.7%, disposed of tree debris as waste while the remaining 8, or 53.3%, did not. Two of 15 (13.3%) companies used landfills. Projected onto the total of 84,000 cubic yard, about 45,000 cubic yards were used and 39,000 were not. Of the latter, about 5,200 (13.3%) cubic yards went to landfills.

Table 62

**Tree Trunk and Limb Disposal by Type of Removal:
Adjusted for Question Non-Response and Survey Refusals**

Type of Removal	Unadjusted Frequency	Unadjusted Percent	Adjusted Frequency	Adjusted Percent
Company paid for removal	7	35.0%	14	43.8%
Removed at no cost to company	8	40.0%	16	50.0%
Another company paid	1	5.0%	2	6.3%
DK	4	20.0%		
Totals	20	100.0%	32	100.1%

Table 63

**Company Paid for Removal:
Adjusted for Survey Refusals**

Removal Payments	Frequency	Percent
<\$0 - <\$500	10	71.4%
\$3,000 - <\$3,500	2	14.3%
\$5,000 - <\$5,500	2	14.3%
Subtotal	14	100.0%

Table 64

**How Tree Trunks and Limbs Are Removed At No Cost to Companies:
Adjusted for Question Non-Response and Survey Refusals**

Type of No Cost Removal	Frequency	Percent
Given away to public/employees	2	12.5%
Burned	10	62.5%
Trashed/dumped/discarded	2	12.5%
Recycled/re-used	2	12.5%
Totals	16	100.0%

About half used their own trucks to haul tree debris away while the other half relied on trucks provided by other companies. Based on numbers adjusted for question non-response, the average hauling distance is 9 miles (to the nearest mile). This distance does not differ significantly from either the average 10 mile drive to dispose of pallets or the 12 mile drive to dispose of edgings and cutoffs. It does differ significantly from the 18 and 58 mile drives to dispose of chips and shavings and construction debris, respectively.

Eleven of the 20 (55.0%) companies in the unadjusted sample made no use of the tree debris. Of the 9 who did, 4 used it as firewood and 1 for mulch. None of the companies sawed any of the tree trunks into lumber.

In the unadjusted sample, the split was about even on whether more or less ash trees had been removed in 2005 compared to the previous year. Ten of the unadjusted sample of 20 companies did not know, a reflection perhaps of their not being able to identify the species as ash. When asked what they did with the ash (a question asked of all respondents regardless of whether they could identify the species), almost half of the companies (45.0%) in the unadjusted sample did not know. A fourth sold the debris as firewood. Again, no company sawed the logs into lumber.

An estimated total of 96 companies, mainly in the construction business, generated about 84,000 cubic yards of tree debris in 2005. Just under half paid for removal -- about \$700,000 in total. Slightly more than half disposed of the debris at no cost to themselves, mainly by burning. Half hauled the debris to disposal sites in their own trucks, the other half in trucks belong to other companies. The average hauling distance was 9 miles. Just over half made no use of the tree debris. Of the slightly less than half that did, most used the debris as firewood. There is no clear indication of whether more or less ash trees were removed in 2005 compared to previous year, probably because companies were unable to distinguish ash from other hardwood species. Though the project cost would be greater, those conducting urban wood residue surveys should consider including the entire Ornamental Shrub and Tree Services Industry in the study population. Using the questions from this survey, qualifying companies would be classified as accepting not generating tree debris.

Markets and Prices for Wood Residue

All 420 companies who generated wood residue were asked whether there was either no market, a developing, or a fully developed market for their particular residue. Of all the companies, 262 saw no market while 88 indicated that there was either a developing or developed market. Sixty-one companies did not know and 9 refused to answer. In terms of percentages, as given in Table 65, about 6 out of 10 (62.4%) judged there to be no market. About 2 out of 10 (20.9%) thought a market either existed or was developing.

Reasons for No Wood Residue Market

As given in Table 66, among the 262 companies that saw no market, 11.5% identified foreign materials attached to wood residue as the reason their residue lacked market value. Another 16.8% see the expense of separating the residue from other material as a barrier. Between the two groups, just over 1 out of 4 (28.3%) believe there is no market because of the foreign material attached to the wood and the cost of removing it. Other than the expense of separating wood from other materials, the two major reasons are the low volumes produced by individuals companies (15.3%) and the perception (17.9%) that there are no products for which this residue is a usable resource input.

Transporting the residue is not much of a problem: only a dozen companies (4.6%) identified this as an issue. About as many see poor quality and small pieces (a total of 10.3%) as reasons for no market.

Adding the question non-responses to those that had not considered whether there was a market, at most 14.9% have not given this any thought. This means that 85.1%, a very strong majority, have given the possibility of a market at least some thought.

In Table 67, market possibilities are cross-tabulated by Major Industry Group. The most frequently cited reasons for no market among companies who indicated there was no market was calculated for the largest number of companies by individual and grouped SIC codes. Construction companies were grouped together as were lumber and wood products and furniture companies.

In the combined construction industries (SIC 15, 16, 17), just under two-thirds (63.1%) of the 142 companies see no market for the residue they generated. The most frequently cited reason (21.1%) is that there is no cost-effective way to separate the wood residue from other material.

Among the lumber and wood products (SIC 24) and furniture (SIC 25) companies, just under two-thirds (64.3%) of the 27 companies indicated that they felt there was no market for their residue. Two near equally cited reasons are low volume (22.2%) and no products for which this material is a usable input (25.9%).

Among the 36 companies in the industrial and commercial equipment industry (SIC 35), the same two reasons were cited almost equally: low volume (27.8%) and no end-use products (22.2%).

Finally, among the 28 companies in building materials (SIC 52), one-fourth (25.0%) cited a lack of a cost-effective way to separate wood from non-wood waste. Just under one-fifth (18.5%) cited no end-use products.

Developing and Developed Markets

Among the 61 companies that believed a market was developing, just over three out of ten (34.4%) indicated that identifying buyers was the principal impediment to market development. By contrast, only 2 companies (3.3%) thought finding sellers was a problem. About two out of ten (21.3%) did not identify a reason while about 1 out of 10 (9.8%) identified high transportation costs. The remaining companies gave a variety of answers in small numbers for each.

Among the 88 companies that indicated there was either a developing or developed market, just over half (53.4%) thought residue prices varied less than gasoline prices. Far fewer (15.9%) thought residue prices varied about as much as gasoline and only a very few (2.3%) thought residue prices varied more. A significant minority (28.4%) did not know which varied the most. The 16 companies that thought residue prices varied as much or more than gasoline prices were asked to identify reasons. Six (37.5%) identified unpredictable swings in supply and demand as the reason. The rest of the responses were thinly spread out over other answers and non-response.

Well over half (61.4%) of the 88 companies felt they were getting enough price information. But 24 companies, just over another one-fourth (27.3%), felt they were not getting enough. The rest (11.4%) did not know whether they were getting enough information. Among the 24 not getting enough information, somewhat over half (54.2%), cited identifying buyers as the single most important additional information they needed. This answer stands out in that none of the other responses were cited nearly as many times. As significant is the response to the question about how likely these companies would be to recycle if they had more information, principally about buyers. Nearly all (91.3%) indicated they would be more likely to recycle if they had the information they needed. As one respondent stated it:

To be able to coordinate and bring together buyers and seller. Not sure how to inform buyers that there are sellers and to inform sellers that there are buyers. Needs to be some kind of clearing house for that information.

Table 65

Market for Wood Residue

Market for Wood Residue	Frequency	Percent
No market	262	62.4%
Developing market	61	14.5%
Fully developed market	27	6.4%
DK	61	14.5%
Refusal	9	2.1%
Total	420	100.0%

Table 66**Reasons for No Market for Wood Residue**

Reasons	Frequency	Percent
Contains preservative	4	1.5%
Coated with paint	3	1.2%
Contains glue	2	0.8%
Attached to metal, shingles, non-wood material	5	1.9%
Contains metal & non-wood material	16	6.1%
No cost-effective way to sort wood from non-wood waste	44	16.8%
Wood waste too expensive to transport	12	4.6%
Other: low volume	40	15.3%
Other: no good end product	47	17.9%
Other: poor quality (rotten)	13	5.0%
Other: not profitable	11	4.2%
Other: pieces too small	14	5.3%
Other: never considered & not aware of options	10	3.8%
Other: miscellaneous	12	4.6%
DK	26	9.9%
Refusal	3	1.2%
Totals	262	100.1%

Table 67**Market for Wood Residue by Major Industry Group**

SIC	Major Industry Group	No Market	Developing Market	Developed Market	Don't Know	Refusal	Subtotals By SIC
01	Agricultural Production	1	0	0	0	0	1
		100.0%	.0%	.0%	.0%	.0%	100.0%
07	Agricultural Services	1	2	0	0	0	3
		33.3%	66.7%	.0%	.0%	.0%	100.0%
15	Building Construction	115	31	11	25	5	187
		61.5%	16.6%	5.9%	13.4%	2.7%	100.0%
16	Heavy Construction, other than Building	3	1	0	1	0	5
		60.0%	20.0%	.0%	20.0%	.0%	100.0%
17	Construction, Special Trade Contractors	24	2	1	5	1	33
		72.7%	6.1%	3.0%	15.2%	3.0%	100.0%
24	Lumber & Wood Products, except Furniture	20	6	1	4	0	31
		64.5%	19.4%	3.2%	12.9%	.0%	100.0%
25	Furniture & Fixtures	7	2	2	0	0	11

		63.6%	18.2%	18.2%	.0%	.0%	100.0%
26	Paper & Allied Products	2	1	2	0	0	5
		40.0%	20.0%	40.0%	.0%	.0%	100.0%
32	Stone, Clay, Glass, & Concrete Products	4	1	2	0	0	7
		57.1%	14.3%	28.6%	.0%	.0%	100.0%
33	Primary Metal Industries	1	0	0	0	0	1
		100.0%	.0%	.0%	.0%	.0%	100.0%
35	Industrial & Commercial Machinery & Computer Equipment	36	7	4	14	1	62
		58.1%	11.3%	6.5%	22.6%	1.6%	100.0%
37	Transportation Equipment	0	0	1	0	0	1
		.0%	.0%	100.0%	.0%	.0%	100.0%
39	Miscellaneous Manufacturing Industries	0	0	0	1	0	1
		.0%	.0%	.0%	100.0%	.0%	100.0%
42	Motor Freight Transportation	9	3	1	1	2	16
		56.3%	18.8%	6.3%	6.3%	12.5%	100.0%
49	Electric, Gas, and Sanitary Services	0	1	0	0	0	1
		.0%	100.0%	.0%	.0%	.0%	100.0%
50	Wholesale Trade, Durable Goods	0	1	0	0	0	1
		.0%	100.0%	.0%	.0%	.0%	100.0%
52	Building Materials, Hardware, Garden Supply & Mobile Home Dealers	28	2	1	5	0	36
		77.8%	5.6%	2.8%	13.9%	.0%	100.0%
54	Food Stores	1	0	0	2	0	3
		33.3%	.0%	.0%	66.7%	.0%	100.0%
57	Home Furniture, Furnishings & Equipment Stores	9	1	1	3	0	14
		64.3%	7.1%	7.1%	21.4%	.0%	100.0%
59	Miscellaneous Retail	1	0	0	0	0	1
		100.0%	.0%	.0%	.0%	.0%	100.0%
	Subtotals by Response	262	61	27	61	9	420
		62.4%	14.5%	6.4%	14.5%	2.1%	100.0%

Additional Comments

The final question asked in each interview was whether respondents wanted to add to their answers or make suggestions or comments about the subjects covered by the survey. The purpose of this question is to allow respondents an opportunity to mention anything that occurred to them during the interview that was not covered by the questions asked. Of 420 companies, 340, or about eight out of ten (81.0%), had nothing to add. Eighty (19.0%) chose to make additional comments. The general tenor of the comments on wood residue (not all respondents stayed on this subject) and what happens to the residues is that they wished more of what they generated could be recycled and reused. Cost-effective ways to separate wood from other

materials and to transport small amounts seem to be issues of main concern as well. A flavor of their views can be gained from the following verbatim comments.

"I think it would (be) worthwhile to investigate the ability for people with a small business to be able to bring their small amount of wood waste to a central location. I think this would be more cost effective for the small business owner than taking it to a landfill or paying to have someone come and dispose of it."

"I wish someone would come up with a use for the pallets so they don't have to go to the landfills."

"If there was a local drop off point to bring pallets to so people could just use them again or for some other type of project."

"They want us to do something about the waste but they want to charge to dispose of the wood waste. They need to make it cost efficient for the consumer to dispose of the wood waste. If I could I would rather burn it than to pay for a dump truck to take it to a land fill. And, they need to have numerous places for people to be able to take their wood waste to a close facility. With the cost of gas it is not worth paying for gas to dispose of wood waste."

"The only thing I could say is that contractors bring their wood waste to the landfill because they don't know of any other thing to do with it except burn it. It is such a waste of wood. I was at the landfill one day dumping my wood waste and someone was there that told me about a place that recycled wood waste and that it was not expensive. It would be nice if more information was provided to companies about places that recycle wood waste."

"The most expensive cost in construction is removal of the construction debris. If a lower cost could be provided for removal of the debris it would be helpful for the consumer. I think that Michigan should look into the waste cap in Wisconsin because they provide low cost disposal of wood waste for the consumer."

"I don't know if wood could be used as a fuel. We take all our steel to a steel yard and (it) gets melted down and reused. It would be nice if wood could be (used) as fuel if we could drop it off at a wood salvage yard. After they burn it down they could dispose of the nails."

"It would be nice if there were a free recycling center and not have to pay. The city picks up the cardboard for free and it would be nice if they would also pick up the wood for free."

"(I) want someone to invent a car to run on waste wood."

Part Two: Saw Timber Content of Urban Forests

Introduction

The value of trees in urban areas has been given considerable attention, in particular for improving aesthetics, environmental quality (McPherson et al. 1999) and property values (Scott and Betters 2000). For example, recent studies have highlighted the significant contribution of urban trees to carbon sequestration (Johnson and Gerhold 2001, Nowak and Crane 2002). The wood products potential of urban trees is typically not fully realized (Bratkovich 2001, Solid Waste Association of North America, 2002, Sherrill 2003), although sometimes among the listed values for them (Scott and Betters 2000), often related to a perceived lack of quality wood in urban trees, logistical issues associated with harvesting commercial wood that may make it economically unattractive or infeasible, and an associated lack of social infrastructure geared toward utilizing or recycling urban wood.

The perceived lack of value for urban trees comes from legitimate concerns about foreign objects in urban trees such as nails, stone or even signage (Sherrill 2003). However, the advent of portable saw mills with inexpensive and easy to change blades (e.g., Wood-Mizer®, Bratkovich 2001), as well as routine metal detection equipment on saw mill feed lines (Kerry Murphy, Weyerhaeuser Inc. personal communication), greatly reduces the impact of foreign objects in urban tree wood. Wood quality is also an important issue, however. Many urban trees are not growing under optimal conditions for saw timber production due to stressful site conditions and exhibit an open growth form that promotes short bole lengths and large branch knots which reduces wood quality (DeBell et al. 1994, Uusitalo and Isotalo 2005). The main logistical problem for harvesting urban wood is that it primarily comes available through the random death of trees and is only in abundant supply via catastrophic mortality events, e.g., the recent large-scale mortality of urban trees caused by exotic, invasive tree pests, including emerald ash borer (*Agrilus plannipennis*) (Poland and McCullough 2006) and Asian long-horned beetle (*Anoplophora glabripennis*) (Nowak et al. 2001). Other logistical concerns relate to the accessibility of urban trees for commercial harvest, since they may have to be cut into small sections to be removed safely; felling urban trees in log lengths may create excessive liability due to nearby hazards (but see Sherrill 2003 for suggestions on efficient and safe removal).

Recent studies by Bratkovich (2001) and Sherrill (2003) have compiled evidence suggesting that harvesting urban saw timber is not only feasible, but may also be profitable. However, no previous study has systematically estimated both the potential availability and quality of urban saw timber over a geographic region. Without specific information regarding wood quality and availability, it is difficult to generalize about the potential for harvesting saw timber from urban trees.

The goal of this study was to quantify the abundance, quality and accessibility of urban saw timber urban wood in southeastern Lower Michigan using systematic inventory procedures across different urban land types and land ownerships (both public and private land). Motivation for this research arose from an immediate need to address economic losses associated with an abundance of dead and dying street, park and backyard trees, killed by emerald ash borer in southeastern Lower Michigan, and a general desire to comprehend the potential scope of recovering urban saw timber.

Methods

Study Area

The study area was comprised of urban portions of 13 counties in southeastern lower MI (Table 1, listed in descending order of urban land cover), which constitute the core 13 counties quarantined by the Michigan Department of Agriculture to control the spread of emerald ash borer (the beetle has since spread beyond this region). A statewide land use / land cover (LULC) classification system (IFMAP, MDNR 2003) was used to define urban areas in the 13-county region. Four of thirty-seven IFMAP classes were deemed to represent an “urban” condition: (1) Low-intensity urban; (2) High-intensity urban; (3) Roads / Paved (which includes areas appurtenant to roads and large paved areas such as parking lots) and (4) Parks and Golf Courses; the first three explicitly comprise urban types in IFMAP and the last was added to represent developed green space appurtenant to urban land use. The remaining IFMAP classes were combined into one “non-urban” stratum that was not considered as part of potential sample space (Table 1). For this study, only roads and paved areas associated with urban areas were of interest; wood from trees representing other roads and paved areas (e.g., roads traversing farm fields) was not of interest. The fraction of all roads and paved areas that were urban, as opposed to other roads, was approximated as proportional to the total land area that was under high intensity and low intensity urban land use (Table 1). Thus, the total urban land area was estimated for each county as the sum of high and low intensity land use, parks and golf courses and “urban” roads and paved areas (Table 1).

Inventory Methods

A stratified, multi-stage sampling technique (Shiver and Borders 1996) was used to assess the quality and quantity of saw timber over different portions of the urban landscape. An accuracy assessment by NOAA CSCC-CAP (2003) suggested that IFMAP most accurately represented LULC types when classified map pixels (30 m x 30m) were aggregated into larger homogeneous blocks (at least 90m x 90m). Thus, the grid of Michigan public survey quarter-quarter sections (QQSs) were chosen to define large (402m x 402m) primary sample units from which representative urban areas could be selected.

Random QQSs were chosen within the 13-county area. If the randomly selected QQS was composed of a relatively homogeneous block of one of three urban types (either high-intensity urban, low-intensity urban or parks and golf courses), then it was accepted as a sample location; if not it was rejected. The roads & paved LULC type was excepted because it never formed relatively homogeneous blocks but was a linear network which traversed portions of QQS blocks. Instead, roads & paved areas were sampled within randomly selected blocks dominated by either high intensity or low intensity urban areas, such that only urban roads and paved areas would be sampled (as described previously).

Field crews visited each selected QQS sample unit and systematically sampled a variable number of variable-area plots that combined to cover urban portions of the total QQ area. The field crew began from an arbitrarily determined point along the edge of a QQS (generally determined by road access) and then moved across the QQS systematically in a serpentine pattern. Permission to sample on private land was obtained in the field, or occasionally in advance; a portion of potential sample space was not sampled due to lack of landowner permission. Variable area rectangular plots were systematically established using one of the following three methods applied to the four different IFMAP LULC classes:

Table 1

**Urban Land Use Composition in 13 Counties in Southeastern Lower Michigan
Based on a Statewide Classified Satellite Image (IFMAP, MDNR 2003)**

<i>County</i>	Area (ha)	Parks & Golf Courses	High Intensity Urban	Low Intensity Urban	Roads and Paved Areas		Percent Urban	Percent Non-urban
					Urban	Other		
Wayne	166,482	2.24%	15.29%	13.17%	5.72%	14.37%	36.42%	63.58%
Macomb	125,359	1.99%	8.62%	10.53%	2.13%	9.01%	23.27%	76.73%
Oakland	234,912	1.89%	5.93%	8.72%	1.33%	7.72%	17.87%	82.13%
Genesee	168,203	0.60%	4.06%	6.69%	0.69%	5.75%	12.04%	87.96%
Ingham	145,169	0.54%	3.16%	3.32%	0.33%	4.70%	7.34%	92.66%
Washtenaw	187,041	0.93%	2.14%	2.65%	0.22%	4.38%	5.94%	94.06%
Livingston	151,581	0.55%	1.77%	2.26%	0.16%	3.88%	4.74%	95.26%
Monroe	144,466	0.07%	2.12%	2.08%	0.20%	4.60%	4.47%	95.53%
Jackson	187,313	0.55%	1.08%	2.31%	0.12%	3.49%	4.05%	95.95%
St. Clair	190,407	0.22%	1.20%	2.02%	0.12%	3.61%	3.56%	96.44%
Shiawassee	140,056	0.05%	1.18%	1.18%	0.09%	3.90%	2.51%	97.49%
Lenawee	197,129	0.00%	0.71%	1.29%	0.07%	3.66%	2.08%	97.92%
Lapeer	171,666	0.05%	0.40%	1.18%	0.04%	2.40%	1.66%	98.34%
13-county area	2,209,786	0.77%	3.61%	4.44%	0.51%	5.82%	9.32%	90.68%

1. If the area was either high or low intensity urban residential or commercial, each ownership was considered a variable area plot. Lot dimensions (property boundaries within the QQS) were approximated by a rectangle and all trees inside the rectangle were part of the potential sample population (including all buildings, paved and mowed areas within the property boundaries).
2. Roads / Paved areas were measured as variable area rectangles bounded by the outer edge of sidewalks, curbs or pavement; as such they included, pavement sidewalks, and mowed areas, if they were between the sidewalk and the curb or pavement. Trees that were growing outside of this envelope (most typically trees that were planted along the sidewalk, between the sidewalk and a lawn or structure) were not considered as road trees / paved area trees (these trees ended up in one of the other urban stratum).
3. If the area was a park or a golf course, then, beginning from an arbitrary starting point along the edge of the QQS the field crew defined a series of plot boundary lines that were approximately equidistant between two areas of treed space (e.g., two rows of planted trees along a fairway) creating variable area rectangular plots which included intervening areas between groups of trees or isolated trees (e.g., mowed grass).

The third stage of sampling involved selecting sample trees of all species within plots that were ≥ 20 cm (8") stem diameter at breast height (1.37m (4.5 ft.)). A 20 cm diameter was chosen as a typical cutoff for defining a saw log. Live, dying and standing dead trees were all measured; stumps were also measured at stump height (typically about 10 to 20 cm (4 to 8")). On each tree selected, the following was recorded for estimating saw timber quantity, quality and accessibility: species (if identifiable, e.g., on stumps and dead trees), diameter at 1.37m above ground height, total tree height, total merchantable saw timber log length to an approximately 20

cm top diameter outside bark (DOB) (measured with a Wheeler® pentaprism), and the number of 2.4 m (8') merchantable branch logs in a tree's crown with a minimum 20 cm small end diameter DOB in the tree's crown (8' is the standard log length on Michigan timberlands).

To assess wood quality a saw log grade was assigned using six grading classes for hardwoods (Rast et al., 1973), (0) no saw volume, (1) grade 1 saw timber, (2) grade 2 saw timber, (3) grade 3 saw timber, (4) construction grade and (5) local use class, which aligned with tree grading classes used by the U.S.D.A. Forest Service in the national forest inventory (Miles et al., 2001). Only four grading classes were used for softwoods: (0) no saw volume, (1) grade 1 saw timber, (2) grade 2 saw timber, and (3) grade 3 saw timber, consistent with common softwood grading rules (Avery and Burkhart, 1994). Crown logs were not graded due to lack of an objective standard for doing so (e.g., Rast 1973).

To assess the accessibility of merchantable wood in it, each tree was classified into one of three accessibility classes representing the effort that would be involved in extracting the timber from the tree:

1. Easily accessible = tree could be cut into relatively long sections and could be felled with minimal risk of property damage; cut sections could be loaded readily onto a vehicle for transport.
2. Moderately accessible = tree could be cut into merchantable-length sections, but would require additional effort with enhanced risk of property damage to access; cut sections would have to be transported a modest distance to be loaded onto a vehicle for transport (a truck could not drive up near the tree).
3. Difficult to access = much of the tree would have to be cut into sub-merchantable lengths to remove and/or trees could not be accessed without major effort (e.g., a large tree build into a deck) or a high likelihood of property damage.

Data Analysis

Tree Wood Volume Estimation

Stem measurements were used to estimate the total merchantable saw timber round wood volume (m^3) in each sample tree from 0.15 cm stump height to an approximate 20 cm top diameter outside bark, with Smalian's formula (Avery and Burkhart 1994). An individual taper model for each tree derived from its top diameter and DBH was used to account for stem taper during volume calculations (change in stem diameter over log length was extrapolated to predict stump diameter outside bark for each tree). A species-level constant bark factor model, predicting wood volume inside bark from wood volume outside bark, was used to estimate solid wood and bark volumes from total volume (Smith 1985). Exotic tree species were assigned a bark factor of a species in the same genera with an equivalent bark type. Recovered sawn lumber volume in standing trees was computed using the tree's taper model and the International ¼" Board-foot rule for variable length logs (Freese, 1973), so that recovered saw lumber could be compared to cubic round wood volume estimates (i.e., accounting for losses due to sawing). Crown wood board-foot volume was estimated using a model relating the basal area (BA_i , ft^2) and the number of merchantable 8' saw logs (L_i) in the crown of a tree to its International ¼" board foot volume (V_{Si}): $V_{Si} = 19.30 (BA_i L_i)^{0.74}$, derived from felled and dissected trees on MI DNR timberlands (MacFarlane, unpublished).

Scaling Up Individual Tree Estimates to the 13-County Region

Average saw timber volume per hectare (m^3 and board feet) was estimated from the number of sample trees ≥ 20 cm DBH on a sample plot with an area a_i . The contribution of each sample tree to per hectare estimates were weighted according to its selection probability, which was proportional to the size of the variable area plot on which it occurred (Shiver and Borders 1996); the variance of sample means was also weighted in the same way. Estimates from each of the LULC classes were then combined to estimate the overall urban condition for the 13-county region, using typical procedures for combining stratum in stratified sampling (Shiver and Borders 1996), with contributions of plots from each LULC weighted by the fraction of urban area they comprised (Table 1).

Results

Overall, 76 urban QQSs were surveyed and 1,887 stems & stumps ≥ 20 cm were measured, translating into a mean density of 12.8 [± 2.1 standard error] stems & stumps ha^{-1} (5.8 [± 0.8 se] ac^{-1}) across the 13-county urban area; 89.7% were healthy, live trees, 6.3% were classed as dying, 3.7% were stumps and 0.3% were dead, standing trees. Estimated density values for LULC's were 9.5 [± 3.1], 13.7 [± 3.5], 18.8 [± 4.2] and 20.3 [± 3.7] stems & stumps ha^{-1} , for high intensity urban, low intensity urban, parks and golf courses and roads and paved areas, respectively. At least 68 species (with ≥ 20 cm) representing 36 genera were found (some trees were only identified to their generic scientific name and species could not be identified for all stumps); each was assigned to a species-product class (see Appendix D) based on USDA Forest Inventory and Analysis groupings (Miles et al. 2001) for analysis.

Urban Wood Volume Grade and Species Products

The mean urban (round) wood volume across the 13-county area in tree stem sections ≥ 20 cm DBH was estimated to be 7.9 [± 1.3] $\text{m}^3 \text{ha}^{-1}$ (117.2 ± 19.9 $\text{ft}^3 \text{ac}^{-1}$), about 31% of which was graded as having no saw timber value (grade 0, Table 2) due to major rot, defects and other problems (see Rast et al. 1973). Approximately 56% of all graded (not including crown wood) softwood volume per acre was deemed as having no saw timber value, while only 35% of potentially commercial hardwood stems were graded as unfit for saw timber products (Table 2). About 73% of all stems of “non-commercial” species (Table 1) were rated as unsuited for saw timber. Less than 5% of red oak, white oak and walnut wood were rated as having no value, while a large proportion of hard (58%) and soft maple (42%) wood was graded as having no saw timber value.

About 60% of mean urban wood volume was saw timber grade (grades 1 through 5, Table 2) amounting to 4.7 $\text{m}^3 \text{ha}^{-1}$ [± 0.9] (67.7 [± 13.3] $\text{ft}^3 \text{ac}^{-1}$). Mean saw timber (round) wood volume translated into 1,364 board feet per urban hectare (552 bd.ft. ac^{-1}) of sawn lumber using the International 1/4” rule (a conversion ratio of 290 bd.ft. per cubic meter of wood (8.2 bd.ft. per ft^3)). Most (93%) of urban softwood saw timber volume was graded in the lowest class (grade 3). This was likely due to the greatly increased size and density of branch knots in open-grown coniferous trees which are reflected in softwood grading rules (DeBell et al. 1994, Uusitalo and Isotalo 2005). In general, a smaller proportion of urban hardwood saw timber volume was in lower grade classes than in higher grade classes (11% grade 1, 13% grade 2, 24% grade 3 and 48% grade 5) except for grade 4, construction grade, which comprised only 4%. The latter reflects reservations by field technicians regarding the potential strength and durability of urban-grown saw timber trees (i.e., these were conservatively placed in grade 5).

Table 2

Mean Volume ($\text{m}^3 \text{ha}^{-1}$) of Tree Stem and Branch Sections ≥ 20 cm Diameter in Urban Areas of SE Lower Michigan by Species-Product Class and Wood Products Grade (Crown Logs Were Not Graded)

Spp-product class	Volume ($\text{m}^3 \text{ha}^{-1}$)							Total Volume	Total Saw Grade (1-5)	Percent Crown Wood
	Main stem						Crown			
	0	1	grade		4	5				
<i>Softwoods</i>										
spruce-fir	0.3177	0.0000	0.0021	0.2831	0.0000	0.0000	0.0000	0.6029	0.2852	0.00%
white-red pine	0.1619	0.0000	0.0035	0.1128	0.0000	0.0000	0.0032	0.2812	0.1162	1.13%
other pine	0.1218	0.0079	0.0193	0.0173	0.0000	0.0000	0.0012	0.1675	0.0445	0.74%
other softwoods	0.0046	0.0000	0.0000	0.0389	0.0000	0.0000	0.0002	0.0437	0.0389	0.44%
Douglas-fir	0.0025	0.0000	0.0000	0.0040	0.0000	0.0000	0.0000	0.0065	0.0040	0.00%
All softwoods	0.6084	0.0079	0.0249	0.4560			0.0046	1.1018	0.4887	0.42%
<i>Hardwoods</i>										
soft maple	1.0385	0.0032	0.0737	0.0918	0.0069	0.8172	0.4131	2.4444	0.9928	16.90%
poplar	0.0951	0.2366	0.1398	0.2550	0.0034	0.0390	0.0586	0.8275	0.6738	7.08%
red oak	0.0070	0.0309	0.1040	0.2458	0.0210	0.2405	0.0000	0.6494	0.6423	0.00%
ash	0.0718	0.0924	0.0853	0.0203	0.0164	0.2527	0.0162	0.5550	0.4670	2.92%
other soft hardwoods	0.1844	0.0179	0.0000	0.1010	0.0229	0.2421	0.0505	0.6188	0.3839	8.16%
white oak	0.0130	0.0181	0.0130	0.1157	0.0352	0.1037	0.0596	0.3583	0.2856	16.65%
hickory	0.0555	0.0000	0.0017	0.0956	0.0371	0.0308	0.0152	0.2359	0.1652	6.44%
walnut	0.0016	0.0248	0.0747	0.0254	0.0000	0.0329	0.0037	0.1632	0.1578	2.26%
other hard hardwoods	0.0810	0.0050	0.0088	0.0333	0.0101	0.0928	0.0424	0.2735	0.1501	15.52%
hard maple	0.2082	0.0013	0.0175	0.0376	0.0184	0.0622	0.0142	0.3594	0.1370	3.96%
basswood	0.0399	0.0142	0.0197	0.0019	0.0000	0.0657	0.0209	0.1624	0.1016	12.88%
birch	0.0064	0.0000	0.0000	0.0000	0.0000	0.0622	0.0024	0.0710	0.0622	3.34%
yellow poplar	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0001	0.00%
All hardwoods	1.8025	0.4444	0.5383	1.0235	0.1715	2.0418	0.6969	6.7189	4.2195	10.37%
<i>Non-commercial</i>	0.0633	0.0000	0.0089	0.0056	0.0000	0.0094	0.0116	0.0989	0.0239	11.75%
All spp-product classes	2.4742	0.4523	0.5721	1.4851	0.1715	2.0512	0.7131	7.9196	4.7322	9.00%

About 89% of all saw timber volume ($4.2 \text{ m}^3 \text{ha}^{-1}$) was comprised of wood from commercially recognized hardwood species, 10% from commercial softwood species ($0.5 \text{ m}^3 \text{ha}^{-1}$) and the remaining 1% from non-commercial species (Table 2). About one-quarter of all commercial hardwood saw timber was comprised of soft maple alone, and nearly two-thirds was comprised of soft maple, poplar, ash and red oak (Table 2). Urban walnut, red oak and poplar trees had more than double the average proportion of high grade wood (grades 1-3) in them, whereas the majority of saw timber from soft maples (silver, red and Norway) and other hard- and other soft- hardwood species (mostly honey locust and elm, respectively) was rated in the lowest lumber grade classes (4 and 5; Table 2). More than three-quarters of all softwood saw timber was comprised of spruce-fir and white and red pines of low quality.

Across all species product-classes about 9% of mean urban wood volume (Table 2) was composed of crown logs of variable (unknown) quality amounting to $0.7 [\pm 0.2] \text{ m}^3 \text{ha}^{-1}$ ($10.2 [\pm 2.4] \text{ ft}^3 \text{ac}^{-1}$) of saw timber volume. The $0.7 \text{ m}^3 \text{ha}^{-1}$ of crown wood translated into 176 board feet ha^{-1} (72 bd.ft. ac^{-1}) of ungraded urban saw timber. Over half of this ($0.4 \text{ m}^3 \text{ha}^{-1}$) was found in the crowns of soft (mostly silver) maples trees. Honey locust, cottonwood, elm, and white oak trees also had significant amounts of saw grade branch wood. Non-commercial species (mostly

willow, and ornamental apple and cherry trees) had a significant proportion of their potential sawn timber in their crowns, but the absolute amounts were trivial. Urban softwoods also had insignificant amounts of saw grade branch wood (Table 2), which was not surprising given their naturally excurrent growth form.

Regional Urban Saw Timber Abundance

The overall weighted mean urban saw timber volume for stem and crown wood in the 13-county area was estimated to be $5.4 \text{ m}^3 \text{ ha}^{-1}$, or 1,540 board feet ha^{-1} accounting for conversion of round wood to dimensional lumber. There was considerable variation in saw timber volume both between and within different urban LULC's. Mean graded saw timber volume was $3.0 [\pm 1.2]$, $5.3 [\pm 1.6]$, $7.8 [\pm 2.1]$ and $7.4 [\pm 1.7] \text{ m}^3 \text{ ha}^{-1}$, respectively, for high intensity urban, low intensity urban, parks and golf courses and roads and paved areas. Estimated crown wood saw timber volume for high intensity urban, low intensity urban, parks and golf courses and roads and paved areas was $0.4 [\pm 0.2]$, $0.7 [\pm 0.3]$, $1.0 [\pm 0.3]$ and $2.1 [\pm 0.6] \text{ m}^3 \text{ ha}^{-1}$, respectively. Scaled up to the 13-county region this amounts to a total standing volume of 1.15 million m^3 of urban saw timber (about 327 million board feet of dimensional lumber). See Table 3 below.

Accessibility

In order to successfully recover saw timber from a tree, the tree must be accessible, i.e., able to be felled, cut in sections of merchantable length and delivered to a sawmill (in urban areas portable sawmills can ease the latter burden). Accessibility was not equal across all urban land types (Obviously, it should be much easier to harvest wood from street and parkland trees than from around homes and offices). About 93.5% of all saw timber on parks & golf courses was considered easily accessible and less than 1% difficult to access. Almost 90% of saw timber along roads and paved areas was rated as easily accessible, although street trees were about 4 times (2.1% versus 0.5%) more likely to be rated as difficult to access than trees on parks and golf courses, with the main complication being extracting wood from occasional large trees whose crowns are closely intertwined with utility wires. High intensity urban areas posed a greater challenge for extracting saw timber from trees, although less than 4% of this saw timber was considered difficult to access. By sharp contrast, about half of all saw timber in low intensity urban areas was rated as difficult to access. This reflects the close proximity of many large trees to hazards (sense Matheny and Clark 1994), such as homes or fences, in low intensity urban areas, that would necessitate extraordinary measures to harvest trees in standard log lengths. Based on the weighted contribution of each of the four urban LULC's to total urban area (Table 1), it was estimated that about 56% of all urban saw timber in the 13-county area was easily accessible, another 16% would require some additional measures to extract that would add additional costs (moderately accessible) and the remaining 28% difficult (for most intents and purposes considered inaccessible). As shown in Table 3, of the total standing urban saw timber about 72% was considered accessible for extraction, amounting to 825 thousand m^3 of urban saw timber (about 235 million board feet of dimensional lumber).

Annual Yield

The 825 thousand m^3 of urban saw timber that is accessible in the 13-county areas, includes all standing trees, virtually all of which would not be harvested until the trees that contain them were dead, or at minimum dying. Thus, to calculate the availability of urban saw timber on an annual basis, it was necessary to estimate the rate at which trees would become available. However, mortality rates and removal rates could not be directly assessed from the data collected for this study (stumps, e.g., represent death events from different years and may be ground up and seeded over, and thus, might not be tallied at all). Instead, recent estimates by Nowak et al.

(2004), on general trends and specific tree removal and mortality rates were combined with the data presented here and used to make reasonable estimates of urban saw timber availability on an annual basis.

Table 3

**Saw Timber Volume Estimates for Urban Portions of
13 Counties in Southeastern Lower MI**

County	Saw Timber Volume (m³)		
	Total Standing	Accessible	Annual Yield
Genesee	109,358	78,738	1,575
Ingham	57,569	41,450	829
Jackson	41,013	29,529	591
Lapeer	15,426	11,107	222
Lenawee	22,094	15,908	318
Livingston	38,813	27,945	559
Macomb	157,526	113,419	2,268
Monroe	34,835	25,081	502
Oakland	226,736	163,250	3,265
Shiawassee	18,971	13,659	273
St. Clair	36,594	26,348	527
Washtenaw	60,017	43,212	864
Wayne	327,415	235,739	4,715
13-county area	1,146,368	825,385	16,508

Nowak et al. (2004) suggested that standing trees in apparently good condition die at a rate of about 1.4% per year. The latter rate was used to describe mortality in the “live” category in this study; 1.4% of the 89.7% of urban stems per acre or 1.3%. Trees with crown deterioration, equating roughly to “dying” trees in this study, had a mortality rate of about 6.4% (Nowak et al. 2004), which equates to 0.4% more of the trees in this study. Ignoring the stumps, another 0.3% can be tallied from dead standing trees that have not yet be removed. All totaled, it can be expected that about 2% of the accessible volume would come available annually, which translates into about 16,500 m³ (or about 4.7 million board feet) of urban saw timber per year available in the 13-county study area (Table 3).

Discussion

The methods presented here allowed for a regional estimate of urban saw timber to be developed, extrapolated via urban land area estimates derived from satellite photography. Data describing urban land cover are generally widely available (e.g., the entire U.S., Nowak et al. 2006), thus, these methods could be replicated almost anywhere. To the extent that average per hectare estimates derived from urban areas in southeastern lower Michigan are representative of broader regional species composition and urban tree demographic structure, these specific estimates could be further extrapolated outside of this specific region. However, the overall weighted-estimates are also sensitive to the relative make-up of urban areas (e.g., a different ratio of high- versus low- intensity urban areas), such that per hectare estimates for urban LULC's would need to be re-weighted accordingly.

Over 16 thousand m³ of urban saw timber is estimated to come available each year in the 13-county study area. To put this number in perspective, small modern saw mills process about 3 to 10 thousand m³ of wood per year annually (Pascal Kamdem, Michigan State University, personal communication). Assuming a minimum of 3 thousand m³ to remain viable, all of the potentially available wood in the 13 counties that comprise southeastern Lower Michigan could support the minimum annual needs of 5 of these mills. The 4.7 million board feet of lumber annually available in urban trees in this region is equivalent to the amount of wood used to build 362 average-sized homes (Falk 2002).

The quality of wood in urban softwoods was generally low based on the grading standards applied, which was not surprising given the importance of maintaining small branch knots along the main stem of coniferous trees to softwood quality; a condition most likely to be met when trees are forest grown (DeBell et al. 1994, Uusitalo and Isotalo 2005). However, most urban saw timber (~90%) inventoried came from commercially viable hardwood timber species, 60% of which was considered saw grade quality. While *non-commercial* species comprise a trivial proportion of large trees, wood from exotic species did comprise a substantial proportion of urban wood (e.g., Siberian elm, Norway maple and horse chestnut), raising potential concerns regarding their utilization (e.g., commercial kiln drying procedures have not been developed for them). However, wood from many of these species are already commercially viable (Norway maple is considered a valuable hardwood in Germany; Jurek and Wihs 1998) and some North American vendors have been able sell wood from exotic tree species at a premium (<http://www.urbantreesalvage.com/support.html>).

One aspect of urban wood quality, not addressed in this study, is that of the mechanical properties of urban wood. Mackes et al. (2005) found that the modulus of rupture and modulus of elasticity were both lower in open grown trees, primarily due to a greater quantity of juvenile wood, which suggests a potentially lower strength for “urban” wood. Further research would have to be done to specifically measure wood properties of urban versus forest –grown trees.

The estimates of urban saw timber presented here are likely conservative, based on the definitions of urban area used in this study. The use of a land use/land cover image to define urban areas likely underestimates the number of trees in urban areas, relative to definitions based on political boundaries such as city limits or census districts (e.g., Nowak et al. 2006), which, if used, would have included wood from trees growing in forested areas within urban zones. In a recent study Fang et al. (2006) demonstrated that land use maps were more likely to misclassify urban areas (in Chicago) as forested than the reverse, because of the fact that many houses were beneath a canopy of trees. Hence, the population of urban trees was narrowly defined on an area basis.

Estimates were also likely conservative based on definitions of what portion of urban wood qualified as extractable sawn wood products. Low intensity urban areas comprised almost half of all urban area in the 13-county region (Table 1) and almost 50% of the wood in these areas was rated as difficult to access, due to a frequent close proximity of large trees to potential hazards (e.g., homes). Sherrill (2003) proposed reasonable guidelines for safely extracting urban wood and commercial arborists safely remove such trees all the time; thus, a larger proportion of wood from these trees may actually be accessible. Advances in sawing technology might also allow portions of some of the wood rated as grade 0 to be utilized for saw timber. Typical modern saw mills often dissect logs into a variety of component parts of different grades, such that the visually-based whole log or tree stem grading rules employed (e.g., Rast et al. 1973) may be overly conservative. Estimates also did not include the solid wood products potential of trees smaller than 20 cm diameter. Advances in wood technology have greatly expanded the potential for smaller trees (LeVan-Green and Livingston 2001). However, by extrapolating volume

estimates for trees of different sizes measured in this study it was estimated that trees < 20 cm contribute only about 3% to the total unprocessed volume, thus smaller diameter urban trees would likely contribute very little additional lumber.

Since most saw timber is harvested from forest-grown trees, it may be useful to compare the quality and availability of urban saw timber with that available from forests. Based on data from the U.S.D.A. Forest Inventory and Analysis program (Unit 4, Michigan, cycle 6, 2004), 5,055 board feet ac^{-1} (12,486 bd.ft. ha^{-1}) of graded saw timber is available on an average forested acre in southern Lower Michigan, which is about 9 times what was estimated for an average urban acre (552 bd.ft. ac^{-1}). Ignoring softwoods in our study, which were not graded into all 5 USDA Forest Services tree grades (see Methods), about 59% of all forest-grown board feet were in factory grade classes (1, 2, and 3) and 41% in the construction and local use classes (grades 4 and 5), compared to 54% and 46%, respectively for urban hardwood saw timber volume. Within the upper saw grades, forest- versus urban- grown hardwood saw timber volume was 14% vs. 10% in grade class 1, 19% vs. 12% in grade class 2 and 27.0% vs. 32% for grade class 3, respectively. Thus, in an absolute sense, there are clearly many more saw timber quality trees in forested vs. urban areas, but these results suggest only a small difference in wood quality relative to large (900%) decrease in wood quantity, when one harvests hardwood trees in urban versus forested areas.

Despite the potential availability of urban saw timber wood demonstrated here, there are still outstanding logistical problems regarding successful capitalization of it, including costs of extraction, handling and variation in supply. One fact regarding urban trees is the inevitability of their removal once they become dead or diseased, because they represent a liability (a hazard, sense Matheny and Clark 1994) as well as diminishing aesthetic values (Scott and Betters 2000). Nowak et al. (2004) estimated that 17% of all dead standing trees in Baltimore, Maryland were removed over a two-year period, or about 8.5% per year. This suggests some consistent level of urban wood will be available for harvest over time.

While it may not be realistic to expect arborists and small, private landowners to bear the logistical or financial burden of harvesting urban saw timber, clearly public entities could expand the current level of efforts. For example, the Community and Urban Forest Inventory and Management (computer) Program was recently created to help communities in California to inventory tree volume and calculate value for their urban forests (Pillsbury and Gill 2003). It has already been demonstrated on smaller scales that internal utilization of dead and dying municipal trees can offset the costs of tree removal and allow reduced infrastructural costs, such as the purchase of wood for park benches and picnic pavilions (Bratkovich 2001). Training municipal foresters to grade trees would be an important first step toward differentiating the value of dead and dying trees. The alternative is to continue to put valuable wood products contained in urban trees to some lesser use (e.g., firewood), or, as a worst case, into a landfill (urban wood waste comprises about 17% of all waste received at U.S. landfills; Solid Waste Association of North America, 2002).

Conclusion

Recent economic losses associated with the destruction of urban trees by wood-boring forest pests such as the emerald ash borer highlights the well known value associated with urban forests, not the least of which may be the valuable wood in the trees. While there are many potential concerns with harvesting urban trees for saw timber: low availability, poor wood quality and logistical concerns regarding harvesting urban wood, the results of this study suggest that many of them may be unfounded. Harvesting urban wood is certainly less efficient relative to commercial logging in forests because, even if abundant, urban wood may be scattered around

a large metropolitan area in smaller saleable units, greatly increasing the cost of consolidating and transporting it. However, it may not be prudent to view urban wood as an alternative to wood derived from forests. Rather it might best be viewed as a supplementary source of wood that may help to offset the social and economic costs of urban tree removal and urban wood waste disposal to private landowners and government entities. Clearly, if southeastern Lower Michigan is similar to other regions nationwide, a substantial amount of wood products volume is available for use in urban areas.

APPENDIX A

EAB SURVEY QUESTIONNAIRE

Just recently, your company received a letter indicating that a survey would be conducted among businesses in southern Michigan on the use and disposal of wood waste. I am calling to ask about the amount of wood waste your company generates or receives and what happens to it. We are interested in amounts and disposal for the last calendar year, 2005, at your company's location or locations here in southern Michigan.

For our survey, wood waste falls into eight categories:

1. Pallets, skids, and shipping crates;
2. Dunnage (wood used in packing to support and protect items being shipped);
3. Edging and cutoffs (for example, either from making wood products such as trim and molding or cutting those products to length);
4. Chips, shavings, and sawdust (for example, from making wood products such as lumber);
5. Tree residues -- that is, tree trunks, limbs, and stumps;
6. Construction debris (for example, cutoffs from framing and wood sheathing);
7. Railroad ties, and
8. Telephone poles.

We are interested only in your company's places of business or business locations, such as plants, in this or nearby counties in southern Michigan. (Interviewer: if asked, specific counties are the following:

Genesee	Livingston	Shiawassee
Jackson	Macomb	St. Clair
Lenawee	Monroe	Washtenaw
Ingham	Oakland	Wayne
Lapeer	Saginaw	

1. **Over the entire year of 2005, did your company here in southern Michigan either generate or accept any wood waste in the form of pallets, dunnage, edging and cutoffs, chips and shavings, tree trunks and limbs, construction debris, railroad ties, or telephone poles?**

- Yes. **Go to Q. 2.**
- No. **Thank you for your time. Goodbye.**
- DK. **Interviewer arrange for callback.**
- Refusal. **Thank you for your time. Goodbye.**

2. **Does your company primarily accept wood waste in some form from other companies, organizations, or governmental agencies?**

- Yes. **Go to Q. 3.**
- No. **Go to Q. 5.**
- Refusal. **Thank you for your time. Goodbye.**

3. **What does your firm primarily accept? (Read List).**

- Pallets, skid, and containers
- Dunnage
- Edgings and cutoffs
- Chips, shavings, and sawdust
- Tree trunks, limbs, and stumps
- Construction debris
- Railroad ties
- Telephone poles
- Accept two/more equally (do not mention option; if selected, ask for one type.)
- DK. **Interviewer arrange for callback.**
- Refusal. **Go to Q4.**

4. **Does your company measure the quantity of wood waste it accepts primarily by volume hauled in by truck or in containers, or by its weight, or by the counted number (e.g., 1000 pallets, skids, and containers or 500 railroad ties or 800 telephone poles)?**

- Primarily by truck or container: **Go To Q. 4.A.**
- Primarily by weight: **Go to Q. 4.B.**
- Primarily by the number: **Go to Q. 4.C.**
- DK. **Interviewer arrange for callback.**
- Refusal. **Go to Q. 4.D.**

4.A. Thinking now of the trucks or containers that bring wood waste to your company, what would you say is the typical (average) volume in cubic yards they hold?

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> 0 - <10 | <input type="checkbox"/> 50 - <60 |
| <input type="checkbox"/> 10 - <20 | <input type="checkbox"/> 60 - <70 |
| <input type="checkbox"/> 20 - <30 | <input type="checkbox"/> 70 - <80 |
| <input type="checkbox"/> 30 - <40 | <input type="checkbox"/> 80 - <90 |
| <input type="checkbox"/> 40 - <50 | <input type="checkbox"/> 90 - <100 |

If over 100 cubic yards, ask for respondents' estimate of typical volume of truck or container_____

DK. Interviewer arrange for callback.

Refusal. Go to Q. 4.D.

4.A.1 During a typical (average) month in 2005, about how many truckloads or containers of wood waste would you say your company accepted?

- | | |
|-------------------------------------|-------------------------------------|
| <input type="checkbox"/> >0 - < 20 | <input type="checkbox"/> 200 - <220 |
| <input type="checkbox"/> 20 - < 40 | <input type="checkbox"/> 220 - <240 |
| <input type="checkbox"/> 40 - < 60 | <input type="checkbox"/> 240 - <260 |
| <input type="checkbox"/> 60 - < 80 | <input type="checkbox"/> 260 - <280 |
| <input type="checkbox"/> 80 - <100 | <input type="checkbox"/> 280 - <300 |
| <input type="checkbox"/> 100 - <120 | <input type="checkbox"/> 300 - <320 |
| <input type="checkbox"/> 120 - <140 | <input type="checkbox"/> 320 - <340 |
| <input type="checkbox"/> 140 - <160 | <input type="checkbox"/> 340 - <360 |
| <input type="checkbox"/> 160 - <180 | <input type="checkbox"/> 360 - <380 |
| <input type="checkbox"/> 180 - <200 | <input type="checkbox"/> 380 - <400 |

400 or more , number given _____

Total for 2005 (if only figure available)_____

DK. Go to Q.4.D.

Refusal. Go to Q.4.D.

Go to 4.D.

4.B. During a typical (average) month in 2005, about how many pounds of wood waste, to the nearest thousand, would you say your company accepted?

- | | |
|---|---|
| <input type="checkbox"/> 0 - < 2,000 | <input type="checkbox"/> 24,000 - <26,000 |
| <input type="checkbox"/> 2,000 - < 4,000 | <input type="checkbox"/> 26,000 - <30,000 |
| <input type="checkbox"/> 4,000 - < 6,000 | <input type="checkbox"/> 30,000 - <32,000 |
| <input type="checkbox"/> 6,000 - < 8,000 | <input type="checkbox"/> 32,000 - <34,000 |
| <input type="checkbox"/> 8,000 - <10,000 | <input type="checkbox"/> 34,000 - <36,000 |
| <input type="checkbox"/> 10,000 - <12,000 | <input type="checkbox"/> 36,000 - <38,000 |
| <input type="checkbox"/> 12,000 - <14,000 | <input type="checkbox"/> 38,000 - <40,000 |
| <input type="checkbox"/> 14,000 - <16,000 | <input type="checkbox"/> 42,000 - <44,000 |
| <input type="checkbox"/> 16,000 - <18,000 | <input type="checkbox"/> 44,000 - <46,000 |
| <input type="checkbox"/> 18,000 - <20,000 | <input type="checkbox"/> 46,000 - <48,000 |
| <input type="checkbox"/> 20,000 - <22,000 | <input type="checkbox"/> 48,000 - <50,000 |
| <input type="checkbox"/> 22,000 - <24,000 | |

- 50,000 or more , number given _____ pounds
- Total for 2005 (if only figure available)_____pounds
- DK. **Go to Q.4.D.**
- Refusal. **Go to Q.4.D.**

Go to 4.D.

4.C. During a typical (average) month in 2005, in total, about how many of these did your company accept?

- | | |
|--------------------------------------|--------------------------------------|
| <input type="checkbox"/> >0 - 200 | <input type="checkbox"/> 2000 - 2200 |
| <input type="checkbox"/> 200 - 400 | <input type="checkbox"/> 2200 - 2400 |
| <input type="checkbox"/> 400 - 600 | <input type="checkbox"/> 2400 - 2600 |
| <input type="checkbox"/> 600 - 800 | <input type="checkbox"/> 2600 - 2800 |
| <input type="checkbox"/> 800 - 1000 | <input type="checkbox"/> 2800 - 3000 |
| <input type="checkbox"/> 1000 - 1200 | <input type="checkbox"/> 3000 - 3200 |
| <input type="checkbox"/> 1200 - 1400 | <input type="checkbox"/> 3200 - 3400 |
| <input type="checkbox"/> 1400 - 1600 | <input type="checkbox"/> 3400 - 3600 |
| <input type="checkbox"/> 1600 - 1800 | <input type="checkbox"/> 3600 - 3800 |
| <input type="checkbox"/> 1800 - 2000 | <input type="checkbox"/> 3800 - 4000 |

- Over 4000, number given _____.
- Total for all of 2005 (if only figure offered)_____.
- DK. **Go to Q.4.D.**
- Refusal. **Go to Q.4.D.**

4.D. What one source provided most of the wood waste your company accepted in 2005? We are interested in business and government sources both in and outside of the State of Michigan as well as outside the U.S.

- Businesses in Michigan
- Businesses from other U.S. states outside Michigan
- Canadian businesses
- Michigan state and local governments
- State and local governments from other U.S. states outside Michigan
- State and local governments in Canada
- Other _____

4.E. Does your company use most of the wood waste it accepts to make products or does your company permanently hold most of the wood as waste? By products we mean fuel for heat, electric power generation,

mulch, compost, firewood, pallets, skids, containers, or dunnage, wood products such as lumber and plywood, or building material such as joists.

- Uses most of wood to make products. **Go to Q. 4.E.1, 2, 3.**
- Permanently holds most wood as waste. **Go to Q. 4.F.**
- DK. **Go to Q.4.F.**
- Refusal. **Go to Q.4.F.**

4.E.1 What is the primary product does your company makes from the wood waste it accepts?

- Fuel for heat
- Fuel for electric power generation
- Mulch
- Compost
- Firewood
- Pallets, skids, shipping containers, or dunnage
- Composite wood products such as fiberboard or plywood
- Building material such as joists or framing studs
- Lumber
- Other _____
- DK. **Go to Q.4.E.2.**
- Refusal. **Go to Q.4.E.2.**

4.E.2. In terms of expense, what is the single most important reason that the rest of the wood waste is not being re-used or recycled?

- No reason, our company uses nearly all or all of what we receive
- Wood contains preservatives (for example, Wolmanized, creosote, CCA)
- Wood is coated with paint
- Wood is a glued product (for example, plywood or medium density fiberboard)

- Wood is attached to or contains metal, shingles, or other non-wood material
- Wood waste too expensive to haul to a recycler
- Laws or regulatory rules make recycling/re-use too difficult
- Too difficult (expensive or requires too much labor) to separate wood waste into different types or categories
- Other _____
- DK. **Go to Q.4.E.3.**
- Refusal. **Go to Q.4.E.3.**

4.E.3. In your judgment, what is the single most important action, if there is one, that state or local governments could take to promote the greater use of wood waste?

- None: there is nothing state or local governments can do.
- Provide more information on market for wood waste
- Reduce regulations governing wood waste disposal (write in regulation if identified by respondent)
- _____
- Other _____
- DK. **Go to Q.4.F.**
- Refusal. **Go to Q.4.F.**

4.F. From what you and others in your company have observed, how much of the wood waste your company accepts and holds do you think could be re-used or recycled?

- Little or none. **Go to Q. 4.G.**
- About one-third. **Go to Q. 4.G.**
- About one-half. **Go to Q. 4.G.**
- About two-thirds. **Go to Q. 4.G.**
- All or nearly all of it. **Go to Q. 4.I.**
- DK. **Go to Q. 4.G.**
- Refusal. **Go to Q. 4.G.**

- 4.G. In terms of expense, in your judgment, what is the single most important reason that more wood waste is not being re-used or recycled?
- Wood contains preservatives (for example, Wolmanized, creosote, CCA)
 - Wood is coated with paint
 - Wood is a glued product (for example, plywood or medium density fiberboard)
 - Wood is attached to or contains metal, shingles, or other non-wood material
 - Wood waste too expensive to haul to a recycler
 - Laws or regulatory rules make recycling/re-use too difficult
 - Other_____
 - DK. **Go to Q.4.H.**
 - Refusal. **Go to Q.4.H.**

Go to Q. 4.H.

- 4.H. What single most important way, if any, could more of the wood be re-used or recycled (examples, if needed, are to make wood products, fuel, mulch, lumber or re-use in existing form)?
- None, more cannot be re-used or recycled.
 - Find a way to remove chemicals such as preservatives, paint, glue
 - Find way to remove non-wood material such as metal or shingles
 - Find cost effective way to sort wood waste from non-wood waste
 - Lower costs of transporting waste wood to/from where generated
 - Help in finding local or area recycler
 - Other_____
 - DK. **Go to Q.4.I.**
 - Refusal. **Go to Q.4.I.**
- 4.I. In your judgment, what is the single most important action, if there is one, that Michigan state or local governments could take to promote the greater use of wood waste?
- None: there is nothing state or local governments can do.

- Provide more information on market for wood waste
- Reduce regulations governing wood waste disposal (write in regulation if identified by respondent)_____
- Other_____
- DK. **Go to Q.41.**
- Refusal. **Go to Q.41.**
- NA. **Go to Q.41.**

Go to Q. 41.

5. As wood waste, what does your company primarily dispose of ? By primary I mean what your company disposes of the most.

- Pallets, skids, and shipping crates. **Go to Q. 6.**
- Dunnage. **Go to Q. 10.**
- Edgings and cutoffs. **Go to Q. 14.**
- Chips, shavings, and sawdust. **Go to Q. 18.**
- Tree trunks, limbs, and stumps. **Go to Q. 22.**
- Construction debris. **Go to Q. 28.**
- Railroad ties. **Go to Q. 32.**
- Telephone poles. **Go to Q. 36.**
- DK. Arrange for callback.
- Refusal. **Thank you for your time. Goodbye.**

6. Does your company measure the amount of pallets, skids, and shipping crates it disposes of primarily by their total number, or by the volume hauled by truck or in containers, or by their weight?

- Primarily by number: **Go To Q. 6.A**
- Primarily by truck or container: **Go To Q. 6.B.**
- Primarily by weight: **Go to Q. 6.D.**
- DK. Interviewer arrange for callback.
- Refusal. **Go to Q. 7.**
- None. **Go to Q. 8.**

6.A. During a typical (average) month in 2005, in total, how many pallets, skids, and shipping crates did your company dispose of as wood waste?

- | | |
|--------------------------------------|--------------------------------------|
| <input type="checkbox"/> >0 - 200 | <input type="checkbox"/> 2000 - 2200 |
| <input type="checkbox"/> 200 - 400 | <input type="checkbox"/> 2200 - 2400 |
| <input type="checkbox"/> 400 - 600 | <input type="checkbox"/> 2400 - 2600 |
| <input type="checkbox"/> 600 - 800 | <input type="checkbox"/> 2600 - 2800 |
| <input type="checkbox"/> 800 - 1000 | <input type="checkbox"/> 2800 - 3000 |
| <input type="checkbox"/> 1000 - 1200 | <input type="checkbox"/> 3000 - 3200 |
| <input type="checkbox"/> 1200 - 1400 | <input type="checkbox"/> 3200 - 3400 |
| <input type="checkbox"/> 1400 - 1600 | <input type="checkbox"/> 3400 - 3600 |
| <input type="checkbox"/> 1600 - 1800 | <input type="checkbox"/> 3600 - 3800 |
| <input type="checkbox"/> 1800 - 2000 | <input type="checkbox"/> 3800 - 4000 |

- Over 4000, number given _____.
- Total for all of 2005 (if only figure offered)_____.
- DK. **Go to Q. 7**
- Refusal. **Go to Q. 7**

Go to Q. 7.

6.B. Thinking now of the trucks or containers used to haul pallets, skids, and shipping crates away from your company, what would you say is the typical (average) volume in cubic yards they hold?

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> 0 - <10 | <input type="checkbox"/> 50 - <60 |
| <input type="checkbox"/> 10 - <20 | <input type="checkbox"/> 60 - <70 |
| <input type="checkbox"/> 20 - <30 | <input type="checkbox"/> 70 - <80 |
| <input type="checkbox"/> 30 - <40 | <input type="checkbox"/> 80 - <90 |
| <input type="checkbox"/> 40 - <50 | <input type="checkbox"/> 90 - <100 |

- If over 100 cubic yards, ask for respondents' estimate of typical volume of truck or container_____
- DK. Interviewer arrange for callback.
- Refusal. **Go to Q. 7.**

6.C. During a typical (average) month in 2005, about how many truckloads or containers of pallets, skids, and shipping crates would you say your company disposed of?

- | | |
|------------------------------------|-------------------------------------|
| <input type="checkbox"/> >0 - < 20 | <input type="checkbox"/> 100 - <120 |
| <input type="checkbox"/> 20 - < 40 | <input type="checkbox"/> 120 - <140 |
| <input type="checkbox"/> 40 - < 60 | <input type="checkbox"/> 140 - <160 |
| <input type="checkbox"/> 60 - < 80 | <input type="checkbox"/> 160 - <180 |
| <input type="checkbox"/> 80 - <100 | <input type="checkbox"/> 180 - <200 |

- | | |
|-------------------------------------|-------------------------------------|
| <input type="checkbox"/> 200 - <220 | <input type="checkbox"/> 300 - <320 |
| <input type="checkbox"/> 220 - <240 | <input type="checkbox"/> 320 - <340 |
| <input type="checkbox"/> 240 - <260 | <input type="checkbox"/> 340 - <360 |
| <input type="checkbox"/> 260 - <280 | <input type="checkbox"/> 360 - <380 |
| <input type="checkbox"/> 280 - <300 | <input type="checkbox"/> 380 - <400 |
- Over 400, number given _____
- Total for 2005 (if only figure available)_____
- DK. **Go to Q. 7.**
- Refusal. **Go to Q. 7.**

Go to Q. 7.

6.D. During a typical (average) month in 2005, about how many pounds of pallets, skids, and shipping crates to the nearest thousand, would you say your company disposed of?

- | | |
|---|---|
| <input type="checkbox"/> 0 - < 2,000 | <input type="checkbox"/> 24,000 - <26,000 |
| <input type="checkbox"/> 2,000 - < 4,000 | <input type="checkbox"/> 26,000 - <30,000 |
| <input type="checkbox"/> 4,000 - < 6,000 | <input type="checkbox"/> 30,000 - <32,000 |
| <input type="checkbox"/> 6,000 - < 8,000 | <input type="checkbox"/> 32,000 - <34,000 |
| <input type="checkbox"/> 8,000 - <10,000 | <input type="checkbox"/> 34,000 - <36,000 |
| <input type="checkbox"/> 10,000 - <12,000 | <input type="checkbox"/> 36,000 - <38,000 |
| <input type="checkbox"/> 12,000 - <14,000 | <input type="checkbox"/> 38,000 - <40,000 |
| <input type="checkbox"/> 14,000 - <16,000 | <input type="checkbox"/> 42,000 - <44,000 |
| <input type="checkbox"/> 16,000 - <18,000 | <input type="checkbox"/> 44,000 - <46,000 |
| <input type="checkbox"/> 18,000 - <20,000 | <input type="checkbox"/> 46,000 - <48,000 |
| <input type="checkbox"/> 20,000 - <22,000 | <input type="checkbox"/> 48,000 - <50,000 |
| <input type="checkbox"/> 22,000 - <24,000 | |
- DK. **Go to Q. 7.**
- Refusal. **Go to Q. 7.**

7. **Did your company pay to dispose of the pallets, skids, and crates, were they mainly removed at no cost to your company, or was your company paid for them?** (If respondent indicates that two or three responses apply, ask about the most frequent practice.)

- Our company paid for removal. **Go to Q. 7.A.**
- Removed at no cost to our company. **Go to Q. 7.B.**
- Another company paid for them. **Go to Q. 7.C.**
- DK. **Go to Q. 8**
- Refusal. **Go to Q. 8**

7.A For that typical month, about how much did your company pay for removal (in dollars)?

- | | |
|--|---|
| <input type="checkbox"/> >0 - 500 | <input type="checkbox"/> 5,000 - 5,500 |
| <input type="checkbox"/> 500 - 1,000 | <input type="checkbox"/> 5,500 - 6,000 |
| <input type="checkbox"/> 1,000 - 1,500 | <input type="checkbox"/> 6,500 - 7,000 |
| <input type="checkbox"/> 1,500 - 2,000 | <input type="checkbox"/> 7,000 - 7,500 |
| <input type="checkbox"/> 2,000 - 2,500 | <input type="checkbox"/> 7,500 - 8,000 |
| <input type="checkbox"/> 3,000 - 3,500 | <input type="checkbox"/> 8,000 - 8,500 |
| <input type="checkbox"/> 3,500 - 4,000 | <input type="checkbox"/> 8,500 - 9,000 |
| <input type="checkbox"/> 4,000 - 4,500 | <input type="checkbox"/> 9,000 - 9,500 |
| <input type="checkbox"/> 4,500 - 5,000 | <input type="checkbox"/> 9,500 - 10,000 |
- Total for 2005 (if only figure available)_____
- Over \$10,000/month, amount given_____
- DK. **Go to Q. 8.**
- Refusal. **Go to Q. 8.**

7.A.1. Did your company use its own trucks to transport most of the material to a disposal site or did another company provide trucks?

- Our company provided the trucks
- Another company provided the trucks
- Other_____

7.A.2. Was most of the material sent to a landfill or to another company?

- Landfill
- Another company
- Other_____

7.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where most (over 50%) of your material goes (one-way, if asked).

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> > 0 - 5 | <input type="checkbox"/> >50 - 55 |
| <input type="checkbox"/> > 5 - 10 | <input type="checkbox"/> >55 - 60 |
| <input type="checkbox"/> >10 - 15 | <input type="checkbox"/> >60 - 65 |
| <input type="checkbox"/> >15 - 20 | <input type="checkbox"/> >65 - 70 |
| <input type="checkbox"/> >20 - 25 | <input type="checkbox"/> >70 - 75 |
| <input type="checkbox"/> >25 - 30 | <input type="checkbox"/> >75 - 80 |
| <input type="checkbox"/> >30 - 35 | <input type="checkbox"/> >80 - 85 |
| <input type="checkbox"/> >35 - 40 | <input type="checkbox"/> >85 - 90 |
| <input type="checkbox"/> >40 - 45 | <input type="checkbox"/> >90 - 95 |
| <input type="checkbox"/> >45 - 50 | <input type="checkbox"/> >95 - 100 |

- Over 100 miles, amount given_____
- DK. **Go to Q. 8.**
- Refusal. **Go to Q. 8.**

Go to Q. 8.

7.B. What was the primary way the pallets, skids, and crates were disposed of at no cost to your company?

- Given away to public and/or employees
- Given away to other private companies
- Other_____
- DK. **Go to Q. 8.**
- Refusal. **Go to Q. 8.**

Go to Q. 8.

7.C. For that typical month, about how much was your company paid (in dollars)?

- | | |
|--|---|
| <input type="checkbox"/> >0 - 500 | <input type="checkbox"/> 5,000 - 5,500 |
| <input type="checkbox"/> 500 - 1,000 | <input type="checkbox"/> 5,500 - 6,000 |
| <input type="checkbox"/> 1,000 - 1,500 | <input type="checkbox"/> 6,500 - 7,000 |
| <input type="checkbox"/> 1,500 - 2,000 | <input type="checkbox"/> 7,000 - 7,500 |
| <input type="checkbox"/> 2,000 - 2,500 | <input type="checkbox"/> 7,500 - 8,000 |
| <input type="checkbox"/> 3,000 - 3,500 | <input type="checkbox"/> 8,000 - 8,500 |
| <input type="checkbox"/> 3,500 - 4,000 | <input type="checkbox"/> 8,500 - 9,000 |
| <input type="checkbox"/> 4,000 - 4,500 | <input type="checkbox"/> 9,000 - 9,500 |
| <input type="checkbox"/> 4,500 - 5,000 | <input type="checkbox"/> 9,500 - 10,000 |
- Total for 2005 (if only figure available)_____
 - Over \$10,000/month, amount given_____
 - DK. **Go to Q. 8.**
 - Refusal. **Go to Q. 8.**

8. For a typical (average) month, what percentage of the total number of pallets, skids, and shipping crates would you say your company was able to re-use?

- None. **Go to Q. 40 on Primary and 41/42 on Secondary**
- >0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60

- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100

DK **Go to Q. 9**

Refusal. **Go to Q. 9**

9. Did your company re-use most of the pallets, skids, and shipping crates for shipping and storage or did your company reduce most of them to parts or wood fiber and use that material for something other than shipping and storage?

Reused most in original form. **Go to Question 40 on Primary and 41/42 on Secondary**

Reduced most to parts/fiber and used for something else. **Go to Q. 9.A.**

DK **Go to Question 40 on Primary and 41/42 on Secondary**

Refusal. **Go to Question 40 on Primary and 41/42 on Secondary**

9.A. What was the primary use your company made of the parts and fiber?

Mulch

Livestock bedding

Land cover or fill

Heating fuel

Other _____

DK. **Go to Question 40 on Primary and 41/42 on Secondary**

Refusal. **Go to Question 40 on Primary and 41/42 on Secondary**

Go to Q. 40 on Primary and 41/42 on Secondary

10. Does your company measure the amount of dunnage it disposes of primarily by volume hauled away in trucks or containers or does your company primarily measure the wood waste it disposes of by weight?

Primarily by truck or container: **Go To Q. 10.A.**

Primarily by weight: **Go to Q. 10.C.**

DK. **Go to Q 11.**

Refusal. **Go to Q 11.**

10.A. Thinking now of the trucks or containers used to haul the dunnage away from your company, what would you say is the typical (average) volume in cubic yards they hold?

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> 0 - <10 | <input type="checkbox"/> 50 - <60 |
| <input type="checkbox"/> 10 - <20 | <input type="checkbox"/> 60 - <70 |
| <input type="checkbox"/> 20 - <30 | <input type="checkbox"/> 70 - <80 |
| <input type="checkbox"/> 30 - <40 | <input type="checkbox"/> 80 - <90 |
| <input type="checkbox"/> 40 - <50 | <input type="checkbox"/> 90 - <100 |

If over 100 cubic yards, ask for respondents' estimate of typical volume of truck or container _____

DK. **Go to Q.11.**

Refusal. **Go to Q.11.**

10.B. During a typical (average) month in 2005, about how many truckloads or containers of dunnage would you say your company disposed of?

- | | |
|-------------------------------------|-------------------------------------|
| <input type="checkbox"/> >0 - < 20 | <input type="checkbox"/> 200 - <220 |
| <input type="checkbox"/> 20 - < 40 | <input type="checkbox"/> 220 - <240 |
| <input type="checkbox"/> 40 - < 60 | <input type="checkbox"/> 240 - <260 |
| <input type="checkbox"/> 60 - < 80 | <input type="checkbox"/> 260 - <280 |
| <input type="checkbox"/> 80 - <100 | <input type="checkbox"/> 280 - <300 |
| <input type="checkbox"/> 100 - <120 | <input type="checkbox"/> 300 - <320 |
| <input type="checkbox"/> 120 - <140 | <input type="checkbox"/> 320 - <340 |
| <input type="checkbox"/> 140 - <160 | <input type="checkbox"/> 340 - <360 |
| <input type="checkbox"/> 160 - <180 | <input type="checkbox"/> 360 - <380 |
| <input type="checkbox"/> 180 - <200 | <input type="checkbox"/> 380 - <400 |

Over 400, number given _____

Total for 2005 (if only figure available) _____

DK. **Go to Q. 11**

Refusal. **Go to Q. 11**

Go to Q.11

10.C. During a typical (average) month in 2005, about how many pounds of dunnage to the nearest thousand, would you say your company disposed of?

- | | |
|---|--|
| <input type="checkbox"/> 0 - < 2,000 | <input type="checkbox"/> 12,000 - <14,000 |
| <input type="checkbox"/> 2,000 - < 4,000 | <input type="checkbox"/> 14,000 - <16,000 |
| <input type="checkbox"/> 4,000 - < 6,000 | <input type="checkbox"/> 16,000 - <18,000 |
| <input type="checkbox"/> 6,000 - < 8,000 | <input type="checkbox"/> 18,000, - <20,000 |
| <input type="checkbox"/> 8,000 - <10,000 | <input type="checkbox"/> 20,000 - <22,000 |
| <input type="checkbox"/> 10,000 - <12,000 | <input type="checkbox"/> 22,000 - <24,000 |

- | | |
|---|---|
| <input type="checkbox"/> 24,000 - <26,000 | <input type="checkbox"/> 38,000 - <40,000 |
| <input type="checkbox"/> 26,000 - <30,000 | <input type="checkbox"/> 42,000 - <44,000 |
| <input type="checkbox"/> 30,000 - <32,000 | <input type="checkbox"/> 44,000 - <46,000 |
| <input type="checkbox"/> 32,000 - <34,000 | <input type="checkbox"/> 46,000 - <48,000 |
| <input type="checkbox"/> 34,000 - <36,000 | <input type="checkbox"/> 48,000 - <50,000 |
| <input type="checkbox"/> 36,000 - <38,000 | |

- Over 50,000, number given _____ pounds
- Total for 2005 (if only figure available)_____ pounds
- DK. **Go to Q. 11**
- Refusal. **Go to Q. 11**

11. Did your company pay to dispose of the dunnage, was it mainly removed at no cost to your company, or was your company paid for it? (If respondent indicates that two or three responses apply, ask about the most frequent practice.)

- Company paid for removal. **Go to Q. 11.A.**
- Removed at no cost to company. **Go to Q. 11.B.**
- Another company paid for them **Go to Q. 11.C.**
- DK. **Go to Q. 12**
- Refusal. **Go to Q. 12**

11.A For that typical month, about how much did your company pay for removal?

- | | |
|--|---|
| <input type="checkbox"/> >0 - 500 | <input type="checkbox"/> 5,000 - 5,500 |
| <input type="checkbox"/> 500 - 1,000 | <input type="checkbox"/> 5,500 - 6,000 |
| <input type="checkbox"/> 1,000 - 1,500 | <input type="checkbox"/> 6,500 - 7,000 |
| <input type="checkbox"/> 1,500 - 2,000 | <input type="checkbox"/> 7,000 - 7,500 |
| <input type="checkbox"/> 2,000 - 2,500 | <input type="checkbox"/> 7,500 - 8,000 |
| <input type="checkbox"/> 3,000 - 3,500 | <input type="checkbox"/> 8,000 - 8,500 |
| <input type="checkbox"/> 3,500 - 4,000 | <input type="checkbox"/> 8,500 - 9,000 |
| <input type="checkbox"/> 4,000 - 4,500 | <input type="checkbox"/> 9,000 - 9,500 |
| <input type="checkbox"/> 4,500 - 5,000 | <input type="checkbox"/> 9,500 - 10,000 |

- Total for 2005 (if only figure available)_____
- Over \$10,000/month, amount given_____
- DK. **Go to Q. 12**
- Refusal. **Go to Q. 12**

11.A.1. Did your company use its own trucks to transport most of the dunnage to a disposal site or did another company provide trucks?

- Our company provided the trucks
- Another company provided the trucks
- Other_____

11.A.2. Was most of the dunnage sent to a landfill or to another company?

- Landfill
- Another company
- Other_____

11.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where over 50% of your dunnage goes.

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> > 0 - 5 | <input type="checkbox"/> >50 - 55 |
| <input type="checkbox"/> > 5 - 10 | <input type="checkbox"/> >55 - 60 |
| <input type="checkbox"/> >10 - 15 | <input type="checkbox"/> >60 - 65 |
| <input type="checkbox"/> >15 - 20 | <input type="checkbox"/> >65 - 70 |
| <input type="checkbox"/> >20 - 25 | <input type="checkbox"/> >70 - 75 |
| <input type="checkbox"/> >25 - 30 | <input type="checkbox"/> >75 - 80 |
| <input type="checkbox"/> >30 - 35 | <input type="checkbox"/> >80 - 85 |
| <input type="checkbox"/> >35 - 40 | <input type="checkbox"/> >85 - 90 |
| <input type="checkbox"/> >40 - 45 | <input type="checkbox"/> >90 - 95 |
| <input type="checkbox"/> >45 - 50 | <input type="checkbox"/> >95 - 100 |
- Over 100 miles, amount given_____
 - DK.
 - Refusal.

Go to Q.12

11.B. What was the primary way the dunnage was disposed of at no cost to your company?

- Given away to public and/or employees
- Given away to other private companies
- Other_____
- DK. **Go to Q. 12.**
- Refusal. **Go to Q. 12.**

Go to Q. 12.

11.C. For that typical month, about how much was your company paid?

- | | |
|--|---|
| <input type="checkbox"/> >0 - 500 | <input type="checkbox"/> 5,000 - 5,500 |
| <input type="checkbox"/> 500 - 1,000 | <input type="checkbox"/> 5,500 - 6,000 |
| <input type="checkbox"/> 1,000 - 1,500 | <input type="checkbox"/> 6,500 - 7,000 |
| <input type="checkbox"/> 1,500 - 2,000 | <input type="checkbox"/> 7,000 - 7,500 |
| <input type="checkbox"/> 2,000 - 2,500 | <input type="checkbox"/> 7,500 - 8,000 |
| <input type="checkbox"/> 3,000 - 3,500 | <input type="checkbox"/> 8,000 - 8,500 |
| <input type="checkbox"/> 3,500 - 4,000 | <input type="checkbox"/> 8,500 - 9,000 |
| <input type="checkbox"/> 4,000 - 4,500 | <input type="checkbox"/> 9,000 - 9,500 |
| <input type="checkbox"/> 4,500 - 5,000 | <input type="checkbox"/> 9,500 - 10,000 |
- Over \$10,000/month, amount given_____
- DK. **Go to Q. 12.**
- Refusal. **Go to Q. 12.**

12. What percentage of the total dunnage would you say your company was able to reuse?

- None. **Go to Q. 40 on Primary and 41/42 on Secondary**
- >0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100
- DK **Go to Q. 13.**
- Refusal. **Go to Q. 13.**

13. Did your company re-use most of the dunnage for shipping and storage or did your company reduce most of it to its parts or to wood fiber and use that material for something other than shipping and storage?

- Reused most in original form. **Go to Q. 40 on Primary and 41/42 on Secondary**
- Reduced to parts/fiber and used for something else. **Go to Q. 13.A.**
- DK **Go to Q. 40 on Primary and 41/42 on Secondary**
- Refusal. **Go to Q. 40 on Primary and 41/42 on Secondary**

13.A. What was the primary use your company made of the parts or fiber?

- Mulch

- Livestock bedding
- Land cover or fill
- Heating fuel
- Other _____
- DK. **Go to Q. 40 on Primary and 41/42 on Secondary**
- Refusal. **Go to Q. 40 on Primary and 41/42 on Secondary**

Go to Q. 40 on Primary and 41/42 on Secondary

14. Does your company measure the amount of edgings and cutoffs it disposes of primarily by volume hauled away in trucks or containers or does your company primarily measure the wood waste it disposes of by weight?

- Primarily by truck or container: **Go To Q. 14.A.**
- Primarily by weight: **Go to Q. 14.C.**
- DK. **Go to Q. 15.**
- Refusal. **Go to Q. 15.**

14.A. Thinking now of the trucks or containers used to haul edgings and cutoffs away from your company, what would you say is the typical (average) volume in cubic yards they hold?

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> 0 - <10 | <input type="checkbox"/> 50 - <60 |
| <input type="checkbox"/> 10 - <20 | <input type="checkbox"/> 60 - <70 |
| <input type="checkbox"/> 20 - <30 | <input type="checkbox"/> 70 - <80 |
| <input type="checkbox"/> 30 - <40 | <input type="checkbox"/> 80 - <90 |
| <input type="checkbox"/> 40 - <50 | <input type="checkbox"/> 90 - <100 |

- If over 100 cubic yards, ask for respondents' estimate of typical volume of truck or container _____
- DK. **Go to Q. 15.**
- Refusal. **Go to Q. 15.**

14.B. During a typical (average) month in 2005, about how many truckloads or containers of edgings and cutoffs would you say your company disposed of?

- | | |
|------------------------------------|-------------------------------------|
| <input type="checkbox"/> >0 - < 20 | <input type="checkbox"/> 100 - <120 |
| <input type="checkbox"/> 20 - < 40 | <input type="checkbox"/> 120 - <140 |
| <input type="checkbox"/> 40 - < 60 | <input type="checkbox"/> 140 - <160 |
| <input type="checkbox"/> 60 - < 80 | <input type="checkbox"/> 160 - <180 |
| <input type="checkbox"/> 80 - <100 | <input type="checkbox"/> 180 - <200 |

- | | |
|-------------------------------------|-------------------------------------|
| <input type="checkbox"/> 200 - <220 | <input type="checkbox"/> 300 - <320 |
| <input type="checkbox"/> 220 - <240 | <input type="checkbox"/> 320 - <340 |
| <input type="checkbox"/> 240 - <260 | <input type="checkbox"/> 340 - <360 |
| <input type="checkbox"/> 260 - <280 | <input type="checkbox"/> 360 - <380 |
| <input type="checkbox"/> 280 - <300 | <input type="checkbox"/> 380 - <400 |

- Over 400, number given _____
- Total for 2005 (if only figure available from respondent) _____
- DK. **Go to Q. 15.**
- Refusal. **Go to Q. 15.**

Go to Q.15

14.C. During a typical (average) month in 2005, about how many pounds of edgings and cutoffs to the nearest thousand, would you say your company disposed of?

- | | |
|---|---|
| <input type="checkbox"/> 0 - < 2,000 | <input type="checkbox"/> 24,000 - <26,000 |
| <input type="checkbox"/> 2,000 - < 4,000 | <input type="checkbox"/> 26,000 - <30,000 |
| <input type="checkbox"/> 4,000 - < 6,000 | <input type="checkbox"/> 30,000 - <32,000 |
| <input type="checkbox"/> 6,000 - < 8,000 | <input type="checkbox"/> 32,000 - <34,000 |
| <input type="checkbox"/> 8,000 - <10,000 | <input type="checkbox"/> 34,000 - <36,000 |
| <input type="checkbox"/> 10,000 - <12,000 | <input type="checkbox"/> 36,000 - <38,000 |
| <input type="checkbox"/> 12,000 - <14,000 | <input type="checkbox"/> 38,000 - <40,000 |
| <input type="checkbox"/> 14,000 - <16,000 | <input type="checkbox"/> 42,000 - <44,000 |
| <input type="checkbox"/> 16,000 - <18,000 | <input type="checkbox"/> 44,000 - <46,000 |
| <input type="checkbox"/> 18,000 - <20,000 | <input type="checkbox"/> 46,000 - <48,000 |
| <input type="checkbox"/> 20,000 - <22,000 | <input type="checkbox"/> 48,000 - <50,000 |
| <input type="checkbox"/> 22,000 - <24,000 | |

- Over 50,000, number given _____ pounds
- Total for 2005 (if only figure available from respondent) _____
- DK. **Go to Q. 15.**
- Refusal. **Go to Q. 15.**

15. Did your company pay to dispose of edgings and cutoffs, was it mainly removed at no cost to your company, or was your company paid for it? (If respondent indicates that two or three responses apply, ask about the most frequent practice.)

- Company paid for removal. **Go to Q. 15.A.**
- Removed at no cost to company. **Go to Q. 15.B.**
- Company was paid for them. **Go to Q. 15.C.**
- DK. **Go to Q. 16**
- Refusal. **Go to Q. 16**

15.A For that typical month, about how much did your company pay for removal?

- | | |
|--|---|
| <input type="checkbox"/> >0 - 500 | <input type="checkbox"/> 5,000 - 5,500 |
| <input type="checkbox"/> 500 - 1,000 | <input type="checkbox"/> 5,500 - 6,000 |
| <input type="checkbox"/> 1,000 - 1,500 | <input type="checkbox"/> 6,500 - 7,000 |
| <input type="checkbox"/> 1,500 - 2,000 | <input type="checkbox"/> 7,000 - 7,500 |
| <input type="checkbox"/> 2,000 - 2,500 | <input type="checkbox"/> 7,500 - 8,000 |
| <input type="checkbox"/> 3,000 - 3,500 | <input type="checkbox"/> 8,000 - 8,500 |
| <input type="checkbox"/> 3,500 - 4,000 | <input type="checkbox"/> 8,500 - 9,000 |
| <input type="checkbox"/> 4,000 - 4,500 | <input type="checkbox"/> 9,000 - 9,500 |
| <input type="checkbox"/> 4,500 - 5,000 | <input type="checkbox"/> 9,500 - 10,000 |
- Over \$10,000/month, amount given_____
- Total for 2005 (if only figure available from respondent)_____
- DK. **Go to Q. 16.**
- Refusal. **Go to Q. 16.**

15.A.1. Did your company use its own trucks to transport most of the edgings and cutoffs to a disposal site or did another company provide trucks?

- Our company provided the trucks
- Another company provided the trucks
- Other_____

15.A.2. Were most of the edgings and cutoffs sent to a landfill or to another company?

- Landfill
- Another company
- Other_____

15.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where most (over 50%) of your material goes.

- | | |
|-----------------------------------|-----------------------------------|
| <input type="checkbox"/> > 0 - 5 | <input type="checkbox"/> >25 - 30 |
| <input type="checkbox"/> > 5 - 10 | <input type="checkbox"/> >30 - 35 |
| <input type="checkbox"/> >10 - 15 | <input type="checkbox"/> >35 - 40 |
| <input type="checkbox"/> >15 - 20 | <input type="checkbox"/> >40 - 45 |
| <input type="checkbox"/> >20 - 25 | <input type="checkbox"/> >45 - 50 |

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> >50 - 55 | <input type="checkbox"/> >75 - 80 |
| <input type="checkbox"/> >55 - 60 | <input type="checkbox"/> >80 - 85 |
| <input type="checkbox"/> >60 - 65 | <input type="checkbox"/> >85 - 90 |
| <input type="checkbox"/> >65 - 70 | <input type="checkbox"/> >90 - 95 |
| <input type="checkbox"/> >70 - 75 | <input type="checkbox"/> >95 - 100 |

Over 100 miles, amount given_____

DK. **Go to Q. 16.**

Refusal. **Go to Q. 16.**

Go to Q. 16.

15.B. What was the primary way the edgings and cutoffs were disposed of at no cost to your company?

Given away to public and/or employees

Given away to other private companies

Other_____

DK. **Go to Q. 16.**

Refusal. **Go to Q. 16.**

Go to Q. 16.

15.C. For that typical month, about how much was your company paid?

>0 - 500

500 - 1,000

1,000 - 1,500

1,500 - 2,000

2,000 - 2,500

3,000 - 3,500

3,500 - 4,000

4,000 - 4,500

4,500 - 5,000

5,000 - 5,500

5,500 - 6,000

6,500 - 7,000

7,000 - 7,500

7,500 - 8,000

8,000 - 8,500

8,500 - 9,000

9,000 - 9,500

9,500 - 10,000

Over \$10,000/month, amount given_____

Total for 2005 (if only figure available)_____

DK. **Go to Q. 16.**

Refusal. **Go to Q. 16.**

16. What percentage of the total amount of edgings and cutoffs would you say your company was able to reuse?

- None. **Go to Q. 40 on Primary and 41/42 on Secondary**
- >0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100
- DK **Go to Q. 17.**
- Refusal. **Go to Q. 17.**

17. What was the primary use your company made of the edgings and cutoffs?

- Mulch
- Livestock bedding
- Land cover or fill
- Heating fuel
- Other _____
- DK. **Go to Q. 40 on Primary and 41/42 on Secondary**
- Refusal. **Go to Q. 40 on Primary and 41/42 on Secondary**

Go to Q. 40 on Primary and 41/42 on Secondary

18. Does your company measure the amount of chips and shavings it disposes of primarily by volume hauled away in trucks or containers or does your company primarily measure the chips and shavings it disposes of by weight?

- Primarily by truck or container: **Go To Q. 18.A.**
- Primarily by weight: **Go to Q. 18.C.**
- DK. **Go to Q. 19.**
- Refusal. **Go to Q. 19.**

18.A. Thinking now of the trucks or containers used to haul chips and shavings away from your company, what would you say is the typical (average) volume in cubic yards they hold?

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> 0 - <10 | <input type="checkbox"/> 50 - <60 |
| <input type="checkbox"/> 10 - <20 | <input type="checkbox"/> 60 - <70 |
| <input type="checkbox"/> 20 - <30 | <input type="checkbox"/> 70 - <80 |
| <input type="checkbox"/> 30 - <40 | <input type="checkbox"/> 80 - <90 |
| <input type="checkbox"/> 40 - <50 | <input type="checkbox"/> 90 - <100 |

If over 100 cubic yards, ask for respondents' estimate of typical volume of truck or container_____

DK. **Go to Q. 19.**

Refusal. **Go to Q. 19.**

18.B. During a typical (average) month in 2005, about how many truckloads or containers of chips and shavings would you say your company disposed of?

- | | | |
|-------------------------------------|-------------------------------------|-------------------------------------|
| <input type="checkbox"/> >0 - < 20 | <input type="checkbox"/> 20 | <input type="checkbox"/> 220 - <240 |
| <input type="checkbox"/> 40 - < 60 | <input type="checkbox"/> 240 - <260 | |
| <input type="checkbox"/> 60 - < 80 | <input type="checkbox"/> 260 - <280 | |
| <input type="checkbox"/> 80 - <100 | <input type="checkbox"/> 280 - <300 | |
| <input type="checkbox"/> 100 - <120 | <input type="checkbox"/> 300 - <320 | |
| <input type="checkbox"/> 120 - <140 | <input type="checkbox"/> 320 - <340 | |
| <input type="checkbox"/> 140 - <160 | <input type="checkbox"/> 340 - <360 | |
| <input type="checkbox"/> 160 - <180 | <input type="checkbox"/> 360 - <380 | |
| <input type="checkbox"/> 180 - <200 | <input type="checkbox"/> 380 - <400 | |
| <input type="checkbox"/> 200 - <220 | | |

Over 400, number given _____

Total for 2005 (if only figure available)_____

DK. **Go to Q. 19.**

Refusal. **Go to Q. 19.**

Go to Q. 19

18.C. During a typical (average) month in 2005, about how many pounds of chips and shavings to the nearest thousand, would you say your company disposed of?

- | | |
|---|---|
| <input type="checkbox"/> 0 - < 2,000 | <input type="checkbox"/> 24,000 - <26,000 |
| <input type="checkbox"/> 2,000 - < 4,000 | <input type="checkbox"/> 26,000 - <30,000 |
| <input type="checkbox"/> 4,000 - < 6,000 | <input type="checkbox"/> 30,000 - <32,000 |
| <input type="checkbox"/> 6,000 - < 8,000 | <input type="checkbox"/> 32,000 - <34,000 |
| <input type="checkbox"/> 8,000 - <10,000 | <input type="checkbox"/> 34,000 - <36,000 |
| <input type="checkbox"/> 10,000 - <12,000 | <input type="checkbox"/> 36,000 - <38,000 |
| <input type="checkbox"/> 12,000 - <14,000 | <input type="checkbox"/> 38,000 - <40,000 |
| <input type="checkbox"/> 14,000 - <16,000 | <input type="checkbox"/> 42,000 - <44,000 |
| <input type="checkbox"/> 16,000 - <18,000 | <input type="checkbox"/> 44,000 - <46,000 |
| <input type="checkbox"/> 18,000 - <20,000 | <input type="checkbox"/> 46,000 - <48,000 |
| <input type="checkbox"/> 20,000 - <22,000 | <input type="checkbox"/> 48,000 - <50,000 |
| <input type="checkbox"/> 22,000 - <24,000 | |

- Over 50,000, number given _____ pounds
- Total for 2005 (if only figure available)_____ pounds
- DK. **Go to Q. 19.**
- Refusal. **Go to Q. 19.**

19. Did your company pay to dispose of the chips and shavings, were they mainly removed at no cost to your company, or was your company paid for them? (If respondent indicates that two or three responses apply, ask about the most frequent practice.)

- Company paid for removal. **Go to Q. 19.A.**
- Removed at no cost to company. **Go to Q. 19.B.**
- Company was paid for them. **Go to Q. 19.C.**
- DK. **Go to Q. 20.**
- Refusal. **Go to Q. 20.**

19.A For that typical month, about how much did your company pay for removal?

- | | |
|--|---|
| <input type="checkbox"/> >0 - 500 | <input type="checkbox"/> 5,000 - 5,500 |
| <input type="checkbox"/> 500 - 1,000 | <input type="checkbox"/> 5,500 - 6,000 |
| <input type="checkbox"/> 1,000 - 1,500 | <input type="checkbox"/> 6,500 - 7,000 |
| <input type="checkbox"/> 1,500 - 2,000 | <input type="checkbox"/> 7,000 - 7,500 |
| <input type="checkbox"/> 2,000 - 2,500 | <input type="checkbox"/> 7,500 - 8,000 |
| <input type="checkbox"/> 3,000 - 3,500 | <input type="checkbox"/> 8,000 - 8,500 |
| <input type="checkbox"/> 3,500 - 4,000 | <input type="checkbox"/> 8,500 - 9,000 |
| <input type="checkbox"/> 4,000 - 4,500 | <input type="checkbox"/> 9,000 - 9,500 |
| <input type="checkbox"/> 4,500 - 5,000 | <input type="checkbox"/> 9,500 - 10,000 |

- Over \$10,000/month, amount given_____
- Total for 2005 (if only figure available respondent)_____
- DK. **Go to Q. 20.**
- Refusal. **Go to Q. 20.**

19.A.1. Did your company use its own trucks to transport most of the chips and shavings to a disposal site or did another company provide trucks?

- Our company provided the trucks
- Another company provided the trucks
- Other_____

19.A.2. Were most of the chips and shavings sent to a landfill or to another company?

- Landfill
- Another company
- Other _____

19.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where most (over 50%) of your material goes.

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> > 0 - 5 | <input type="checkbox"/> >50 - 55 |
| <input type="checkbox"/> > 5 - 10 | <input type="checkbox"/> >55 - 60 |
| <input type="checkbox"/> >10 - 15 | <input type="checkbox"/> >60 - 65 |
| <input type="checkbox"/> >15 - 20 | <input type="checkbox"/> >65 - 70 |
| <input type="checkbox"/> >20 - 25 | <input type="checkbox"/> >70 - 75 |
| <input type="checkbox"/> >25 - 30 | <input type="checkbox"/> >75 - 80 |
| <input type="checkbox"/> >30 - 35 | <input type="checkbox"/> >80 - 85 |
| <input type="checkbox"/> >35 - 40 | <input type="checkbox"/> >85 - 90 |
| <input type="checkbox"/> >40 - 45 | <input type="checkbox"/> >90 - 95 |
| <input type="checkbox"/> >45 - 50 | <input type="checkbox"/> >95 - 100 |

Over 100 miles, amount given _____

- DK. **Go to Q. 20.**
- Refusal. **Go to Q. 20.**

Go to Q. 20.

19.B. What was the primary way the chips and shavings were disposed of at no cost to your company?

- Given away to public and/or employees
- Given away to other private companies
- Other _____
- DK. **Go to Q. 20.**
- Refusal. **Go to Q. 20.**

Go to Q. 20.

19.C. For that typical month, about how much was your company paid?

\$ _____/typical month.

- DK. **Go to Q. 20.**
- Refusal. **Go to Q. 20.**

20. What percentage of the total amount of chips and shavings would you say your company was able to reuse?

- None. **Go to Q. 40 on Primary and 41/42 on Secondary**
- >0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100

- DK **Go to Q. 21.**
- Refusal. **Go to Q. 21.**

21. What was the primary use your company made of the chips and shavings?

- Mulch
- Livestock bedding
- Land cover or fill
- Heating fuel
- Other _____

- DK. **Go to Q. 40 on Primary and 41/42 on Secondary**
- Refusal. **Go to Q. 40 on Primary and 41/42 on Secondary**

Go to Q. 40 on Primary and 41/42 on Secondary

22. Does your company measure the amount of trunks, limbs, and stumps, it disposes of primarily by volume hauled away in trucks or containers or does your company primarily measure the trunks, limbs, and stumps it disposes of by weight?

- Primarily by truck or container: **Go To Q. 22.A.**
- Primarily by weight: **Go to Q. 22.C.**
- DK. **Go to Q. 23.**
- Refusal. **Go to Q. 23.**

22.A. Thinking now of the trucks or containers used to haul trunks, limbs, and stumps away from your company, what would you say is the typical (average) volume in cubic yards they hold?

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> 0 - <10 | <input type="checkbox"/> 50 - <60 |
| <input type="checkbox"/> 10 - <20 | <input type="checkbox"/> 60 - <70 |
| <input type="checkbox"/> 20 - <30 | <input type="checkbox"/> 70 - <80 |
| <input type="checkbox"/> 30 - <40 | <input type="checkbox"/> 80 - <90 |
| <input type="checkbox"/> 40 - <50 | <input type="checkbox"/> 90 - <100 |

If over 100 cubic yards, ask for respondents' estimate of typical volume of truck or container_____

DK. **Go to Q. 23.**

Refusal. **Go to Q. 23.**

22.B. During a typical (average) month in 2005, about how many truckloads or containers of trunks, limbs, and stumps would you say your company disposed of?

- | | |
|-------------------------------------|--------------------------------------|
| <input type="checkbox"/> >0 - < 20 | <input type="checkbox"/> 20220<40240 |
| <input type="checkbox"/> 40 - < 60 | <input type="checkbox"/> 240 - <260 |
| <input type="checkbox"/> 60 - < 80 | <input type="checkbox"/> 260 - <280 |
| <input type="checkbox"/> 80 - <100 | <input type="checkbox"/> 280 - <300 |
| <input type="checkbox"/> 100 - <120 | <input type="checkbox"/> 300 - <320 |
| <input type="checkbox"/> 120 - <140 | <input type="checkbox"/> 320 - <340 |
| <input type="checkbox"/> 140 - <160 | <input type="checkbox"/> 340 - <360 |
| <input type="checkbox"/> 160 - <180 | <input type="checkbox"/> 360 - <380 |
| <input type="checkbox"/> 180 - <200 | <input type="checkbox"/> 380 - <400 |
| <input type="checkbox"/> 200 - <220 | |

Over 400, number given _____

Total for 2005 (if only figure available)_____

DK. **Go to Q. 23.**

Refusal. **Go to Q. 23.**

Go to Q. 23.

22.C. During a typical (average) month in 2005, about how many pounds of trunks, limbs, and stumps to the nearest thousand, would you say your company disposed of?

- | | |
|---|---|
| <input type="checkbox"/> 0 - < 2,000 | <input type="checkbox"/> 12,000 - <14,000 |
| <input type="checkbox"/> 2,000 - < 4,000 | <input type="checkbox"/> 14,000 - <16,000 |
| <input type="checkbox"/> 4,000 - < 6,000 | <input type="checkbox"/> 16,000 - <18,000 |
| <input type="checkbox"/> 6,000 - < 8,000 | <input type="checkbox"/> 18,000 - <20,000 |
| <input type="checkbox"/> 8,000 - <10,000 | <input type="checkbox"/> 20,000 - <22,000 |
| <input type="checkbox"/> 10,000 - <12,000 | <input type="checkbox"/> 22,000 - <24,000 |

- | | |
|---|---|
| <input type="checkbox"/> 24,000 - <26,000 | <input type="checkbox"/> 38,000 - <40,000 |
| <input type="checkbox"/> 26,000 - <30,000 | <input type="checkbox"/> 42,000 - <44,000 |
| <input type="checkbox"/> 30,000 - <32,000 | <input type="checkbox"/> 44,000 - <46,000 |
| <input type="checkbox"/> 32,000 - <34,000 | <input type="checkbox"/> 46,000 - <48,000 |
| <input type="checkbox"/> 34,000 - <36,000 | <input type="checkbox"/> 48,000 - <50,000 |
| <input type="checkbox"/> 36,000 - <38,000 | |

- Over 50,000, number given _____ pounds
- Total for 2005 (if only figure available)_____ pounds
- DK. **Go to Q. 23.**
- Refusal. **Go to Q. 23.**

23. Did your company pay to dispose of the trunks, limbs, and stumps, were they mainly disposed of at no cost to your company, or did another company buy them?
(If respondent indicates that two or three responses apply, ask about the most frequent practice.)

- Company paid for disposal. **Go to Q. 23.A.**
- Removed at no cost to company. **Go to Q. 23.B**
- Another company bought them. **Go to Q. 23.C.**
- DK. **Go to Q. 24.**
- Refusal. **Go to Q. 24.**

23.A For that typical month, about how much did your company pay for disposal of the trunks, limbs, and stumps?

- | | |
|--|---|
| <input type="checkbox"/> >0 - 500 | <input type="checkbox"/> 5,000 - 5,500 |
| <input type="checkbox"/> 500 - 1,000 | <input type="checkbox"/> 5,500 - 6,000 |
| <input type="checkbox"/> 1,000 - 1,500 | <input type="checkbox"/> 6,500 - 7,000 |
| <input type="checkbox"/> 1,500 - 2,000 | <input type="checkbox"/> 7,000 - 7,500 |
| <input type="checkbox"/> 2,000 - 2,500 | <input type="checkbox"/> 7,500 - 8,000 |
| <input type="checkbox"/> 3,000 - 3,500 | <input type="checkbox"/> 8,000 - 8,500 |
| <input type="checkbox"/> 3,500 - 4,000 | <input type="checkbox"/> 8,500 - 9,000 |
| <input type="checkbox"/> 4,000 - 4,500 | <input type="checkbox"/> 9,000 - 9,500 |
| <input type="checkbox"/> 4,500 - 5,000 | <input type="checkbox"/> 9,500 - 10,000 |

- Over \$10,000/month, amount given_____
- Total for 2005 (if only figure available)_____
- DK. **Go to Q. 24.**
- Refusal. **Go to Q. 24.**

23.A.1. Did your company use its own trucks to transport most of the them to a disposal site or did another company provide trucks?

- Our company provided the trucks
- Another company provided the trucks
- Other _____

23.A.2. Were most of them sent to a landfill or to another company?

- Landfill
- Another company
- Other _____

23.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where most (over 50%) of your material goes.

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> > 0 - 5 | <input type="checkbox"/> >50 - 55 |
| <input type="checkbox"/> > 5 - 10 | <input type="checkbox"/> >55 - 60 |
| <input type="checkbox"/> >10 - 15 | <input type="checkbox"/> >60 - 65 |
| <input type="checkbox"/> >15 - 20 | <input type="checkbox"/> >65 - 70 |
| <input type="checkbox"/> >20 - 25 | <input type="checkbox"/> >70 - 75 |
| <input type="checkbox"/> >25 - 30 | <input type="checkbox"/> >75 - 80 |
| <input type="checkbox"/> >30 - 35 | <input type="checkbox"/> >80 - 85 |
| <input type="checkbox"/> >35 - 40 | <input type="checkbox"/> >85 - 90 |
| <input type="checkbox"/> >40 - 45 | <input type="checkbox"/> >90 - 95 |
| <input type="checkbox"/> >45 - 50 | <input type="checkbox"/> >95 - 100 |

- Over 100 miles, amount given _____
- DK. **Go to Q. 24.**
- Refusal. **Go to Q. 24.**

Go to Q. 24.

23.B. What was the primary way the trunks, limbs, and stumps were disposed of at no cost to your company?

- Given away to public and/or employees
- Given away to other private companies
- Other _____

- DK. **Go to Q. 24.**
- Refusal. **Go to Q. 24.**

Go to Q. 24.

23.C. For that typical month, about how much was your company paid?

- | | |
|--|---|
| <input type="checkbox"/> >0 - 500 | <input type="checkbox"/> 5,000 - 5,500 |
| <input type="checkbox"/> 500 - 1,000 | <input type="checkbox"/> 5,500 - 6,000 |
| <input type="checkbox"/> 1,000 - 1,500 | <input type="checkbox"/> 6,500 - 7,000 |
| <input type="checkbox"/> 1,500 - 2,000 | <input type="checkbox"/> 7,000 - 7,500 |
| <input type="checkbox"/> 2,000 - 2,500 | <input type="checkbox"/> 7,500 - 8,000 |
| <input type="checkbox"/> 3,000 - 3,500 | <input type="checkbox"/> 8,000 - 8,500 |
| <input type="checkbox"/> 3,500 - 4,000 | <input type="checkbox"/> 8,500 - 9,000 |
| <input type="checkbox"/> 4,000 - 4,500 | <input type="checkbox"/> 9,000 - 9,500 |
| <input type="checkbox"/> 4,500 - 5,000 | <input type="checkbox"/> 9,500 - 10,000 |
- Over \$10,000/month, amount given_____
- Total for 2005 (if only figure available)_____
- DK. **Go to Q. 24.**
- Refusal. **Go to Q. 24.**

24. What percentage of the total amount of the trunks, limbs, and stumps would you say your company was able to reuse?

- None. **Go to Q. 26.**
- >0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100
- DK **Go to Q. 25.**
- Refusal. **Go to Q. 25.**

25. For that typical month in 2005, what did your company do with most of the trunks, limbs, and stumps? Were they cut up for firewood to sell? Ground into mulch to sell? Were they sawed into lumber to sell?

- Over half cut up for fire wood to sell or,
- Over half ground for mulch to sell, or
- Over half sawed into lumber to sell, or
- Over half sold for other use_____

- Over half given away to other private companies to be used for _____
 - Over half given away to the public to be used for _____
 - Over half used by company and/or its employees (Interviewer: ask most frequent use: could be for fuel, source of lumber or mulch, or given to employees).
-

- DK. **Go to Q. 26.**
- Refusal. **Go to Q. 26.**

So far, my questions have been about all species of trees disposed of as wood waste. At this point, I would like to ask two questions about ash trees in particular because of the Emerald Ash Borer infestation here in southern Michigan.

26. Compared to this time last year, is your company getting more ash trees, about the same number as last year, or less?

- More ash trees compared to this time last year
- About the same number as this time last year
- Less than this time last year
- DK. **Go to Q. 27.**
- Refusal. **Go to Q. 27.**

27. For that typical month in 2005, what did your company do with over half the ash tree trunks, limbs, and stumps? Was this material cut up for firewood to sell? Ground up for mulch to sell? Or were they sawed into lumber to sell?

- Over half cut up for fire wood to sell or,
 - Over half ground for mulch to sell, or
 - Over half sawed into lumber to sell, or
 - Over half sold for other use _____
 - Over half given away to other private companies to be used for _____
 - Over half given away to the public to be used for _____
 - Over half used by company and/or its employees (Interviewer: ask most frequent use: could be for fuel, source of lumber or mulch, or given to employees).
-

- DK. **Go to Q. 40 on Primary and 41/42 on Secondary**

- Refusal. **Go to Q. 40 on Primary and 41/42 on Secondary**

Go to Q. 40 on Primary and 41/42 on Secondary

28. Does your company measure the amount of construction debris it disposes of primarily by volume hauled away in trucks or containers or does your company primarily measure the debris it disposes of by weight?

- Primarily by truck or container: **Go To Q. 28.A.**
- Primarily by weight: **Go to Q. 28.C.**
- DK. **Go to Q. 29.**
- Refusal. **Go to Q. 29.**

28.A. Thinking now of the trucks or containers used to haul construction debris away from your company, what would you say is the typical (average) volume in cubic yards they hold?

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> 0 - <10 | <input type="checkbox"/> 50 - <60 |
| <input type="checkbox"/> 10 - <20 | <input type="checkbox"/> 60 - <70 |
| <input type="checkbox"/> 20 - <30 | <input type="checkbox"/> 70 - <80 |
| <input type="checkbox"/> 30 - <40 | <input type="checkbox"/> 80 - <90 |
| <input type="checkbox"/> 40 - <50 | <input type="checkbox"/> 90 - <100 |

- If over 100 cubic yards, ask for respondents' estimate of typical volume of truck or container _____

- DK. **Go to Q. 29.**

- Refusal. **Go to Q. 29.**

28.B. During a typical (average) month in 2005, about how many truckloads or containers of construction debris would you say your company disposed of?

- | | | |
|-------------------------------------|-------------------------------------|-------------------------------------|
| <input type="checkbox"/> >0 - < 20 | <input type="checkbox"/> 20 - <40 | <input type="checkbox"/> 40 - <240 |
| <input type="checkbox"/> 40 - < 60 | <input type="checkbox"/> 60 - <80 | <input type="checkbox"/> 240 - <260 |
| <input type="checkbox"/> 60 - < 80 | <input type="checkbox"/> 80 - <100 | <input type="checkbox"/> 260 - <280 |
| <input type="checkbox"/> 80 - <100 | <input type="checkbox"/> 100 - <120 | <input type="checkbox"/> 280 - <300 |
| <input type="checkbox"/> 100 - <120 | <input type="checkbox"/> 120 - <140 | <input type="checkbox"/> 300 - <320 |
| <input type="checkbox"/> 120 - <140 | <input type="checkbox"/> 140 - <160 | <input type="checkbox"/> 320 - <340 |
| <input type="checkbox"/> 140 - <160 | <input type="checkbox"/> 160 - <180 | <input type="checkbox"/> 340 - <360 |
| <input type="checkbox"/> 160 - <180 | <input type="checkbox"/> 180 - <200 | <input type="checkbox"/> 360 - <380 |
| <input type="checkbox"/> 180 - <200 | <input type="checkbox"/> 200 - <220 | <input type="checkbox"/> 380 - <400 |
| <input type="checkbox"/> 200 - <220 | | |

- Over 400, number given _____

- Total for 2005 (if only figure available) _____

- DK. **Go to Q. 29.**
- Refusal. **Go to Q. 29.**

Go to Q. 29.

28.C. During a typical (average) month in 2005, about how many pounds of construction debris shavings to the nearest thousand, would you say your company disposed of?

- | | |
|---|---|
| <input type="checkbox"/> 0 - < 2,000 | <input type="checkbox"/> 24,000 - <26,000 |
| <input type="checkbox"/> 2,000 - < 4,000 | <input type="checkbox"/> 26,000 - <30,000 |
| <input type="checkbox"/> 4,000 - < 6,000 | <input type="checkbox"/> 30,000 - <32,000 |
| <input type="checkbox"/> 6,000 - < 8,000 | <input type="checkbox"/> 32,000 - <34,000 |
| <input type="checkbox"/> 8,000 - <10,000 | <input type="checkbox"/> 34,000 - <36,000 |
| <input type="checkbox"/> 10,000 - <12,000 | <input type="checkbox"/> 36,000 - <38,000 |
| <input type="checkbox"/> 12,000 - <14,000 | <input type="checkbox"/> 38,000 - <40,000 |
| <input type="checkbox"/> 14,000 - <16,000 | <input type="checkbox"/> 42,000 - <44,000 |
| <input type="checkbox"/> 16,000 - <18,000 | <input type="checkbox"/> 44,000 - <46,000 |
| <input type="checkbox"/> 18,000 - <20,000 | <input type="checkbox"/> 46,000 - <48,000 |
| <input type="checkbox"/> 20,000 - <22,000 | <input type="checkbox"/> 48,000 - <50,000 |
| <input type="checkbox"/> 22,000 - <24,000 | |
- Over 50,000, number given _____ pounds
 - Total for 2005 (if only figure available)_____ pounds
 - DK. **Go to Q. 29.**
 - Refusal. **Go to Q. 29.**

29. Did your company pay to dispose of the debris, was it mainly removed at no cost to your company, or was your company paid for it? (If respondent indicates that two or three responses apply, ask about the most frequent practice.)

- Company paid for removal. **Go to Q. 29.A.**
- Removed at no cost to company. **Go to Q. 29.B**
- Company was paid for them. **Go to Q. 29.C.**
- DK. **Go to Q. 30.**
- Refusal. **Go to Q. 30.**

29.A For that typical month, about how much did your company pay for removal?

- | | |
|--|---|
| <input type="checkbox"/> >0 - 500 | <input type="checkbox"/> 5,000 - 5,500 |
| <input type="checkbox"/> 500 - 1,000 | <input type="checkbox"/> 5,500 - 6,000 |
| <input type="checkbox"/> 1,000 - 1,500 | <input type="checkbox"/> 6,500 - 7,000 |
| <input type="checkbox"/> 1,500 - 2,000 | <input type="checkbox"/> 7,000 - 7,500 |
| <input type="checkbox"/> 2,000 - 2,500 | <input type="checkbox"/> 7,500 - 8,000 |
| <input type="checkbox"/> 3,000 - 3,500 | <input type="checkbox"/> 8,000 - 8,500 |
| <input type="checkbox"/> 3,500 - 4,000 | <input type="checkbox"/> 8,500 - 9,000 |
| <input type="checkbox"/> 4,000 - 4,500 | <input type="checkbox"/> 9,000 - 9,500 |
| <input type="checkbox"/> 4,500 - 5,000 | <input type="checkbox"/> 9,500 - 10,000 |

Over \$10,000/month, amount given_____

DK. **Go to Q. 30.**

Refusal. **Go to Q. 30.**

29.A.1. Did your company use its own trucks to transport most of the debris to a disposal site or did another company provide trucks?

Our company provided the trucks

Another company provided the trucks

Other_____

29.A.2. Was most of the debris sent to a landfill or to another company?

Landfill

Another company

Other_____

29.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where most (over 50%) of your debris goes.

> 0 - 5

>50 - 55

> 5 - 10

>55 - 60

>10 - 15

>60 - 65

>15 - 20

>65 - 70

>20 - 25

>70 - 75

>25 - 30

>75 - 80

>30 - 35

>80 - 85

>35 - 40

>85 - 90

>40 - 45

>90 - 95

>45 - 50

>95 - 100

Over 100 miles, amount given_____

DK. **Go to Q. 30.**

Refusal. **Go to Q. 30.**

Go to Q. 30.

29.B. What was the primary way the debris was disposed of at no cost to your company?

- Given away to public and/or employees
- Given away to other private companies
- Other _____
- DK. **Go to Q. 30.**
- Refusal. **Go to Q. 30.**

Go to Q. 30.

29.C. For that typical month, about how much was your company paid?

\$ _____/typical month.

- DK. **Go to Q. 30.**
- Refusal. **Go to Q. 30.**

30. What percentage of the total amount of construction debris would you say your company was able to reuse?

- None. **Go to Q. 40 on Primary and 41/42 on Secondary**
- >0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100
- DK **Go to Q. 31.**
- Refusal. **Go to Q. 31.**

31. What was the primary use your company made of the debris?

- Mulch
- Livestock bedding
- Land cover or fill

- Heating fuel
- Other _____
- DK. **Go to Q. 40 on Primary and 41/42 on Secondary**
- Refusal. **Go to Q. 40 on Primary and 41/42 on Secondary**

Go to Q. 40 on Primary and 41/42 on Secondary

32. Does your company measure the amount of railroad ties it disposes of primarily by their total number, or by the volume hauled by truck or in containers, or by their weight?

- Primarily by number: **Go To Q. 32.A**
- Primarily by truck or container: **Go To Q. 32.B.**
- Primarily by weight: **Go to Q. 32.D.**
- DK. **Go to Q. 33.**
- Refusal. **Go to Q. 33.**

32.A. During a typical (average) month in 2005, in total, how many railroad ties did your company dispose of as wood waste?

- | | |
|--------------------------------------|--------------------------------------|
| <input type="checkbox"/> >0 - 200 | <input type="checkbox"/> 2000 - 2200 |
| <input type="checkbox"/> 200 - 400 | <input type="checkbox"/> 2200 - 2400 |
| <input type="checkbox"/> 400 - 600 | <input type="checkbox"/> 2400 - 2600 |
| <input type="checkbox"/> 600 - 800 | <input type="checkbox"/> 2600 - 2800 |
| <input type="checkbox"/> 800 - 1000 | <input type="checkbox"/> 2800 - 3000 |
| <input type="checkbox"/> 1000 - 1200 | <input type="checkbox"/> 3000 - 3200 |
| <input type="checkbox"/> 1200 - 1400 | <input type="checkbox"/> 3200 - 3400 |
| <input type="checkbox"/> 1400 - 1600 | <input type="checkbox"/> 3400 - 3600 |
| <input type="checkbox"/> 1600 - 1800 | <input type="checkbox"/> 3600 - 3800 |
| <input type="checkbox"/> 1800 - 2000 | <input type="checkbox"/> 3800 - 4000 |

- Over 4000, number given _____.
- Total for all of 2005 (if only figure offered by respondent)_____.
- DK. **Go to Q. 33.**
- Refusal. **Go to Q. 33.**

Go to Q. 33.

32.B. Thinking now of the trucks or containers used to haul the railroad ties away from your company, what would you say is the typical (average) volume in cubic yards they hold?

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> 0 - <10 | <input type="checkbox"/> 50 - <60 |
| <input type="checkbox"/> 10 - <20 | <input type="checkbox"/> 60 - <70 |
| <input type="checkbox"/> 20 - <30 | <input type="checkbox"/> 70 - <80 |
| <input type="checkbox"/> 30 - <40 | <input type="checkbox"/> 80 - <90 |
| <input type="checkbox"/> 40 - <50 | <input type="checkbox"/> 90 - <100 |

If over 100 cubic yards, ask for respondents' estimate of typical volume of truck or container_____

DK. **Go to Q. 33.**

Refusal. **Go to Q. 33.**

32.C. During a typical (average) month in 2005, about how many truckloads or containers of railroad ties would you say your company disposed of?

- | | |
|-------------------------------------|---------------------------------------|
| <input type="checkbox"/> >0 - < 20 | <input type="checkbox"/> 20220<-40240 |
| <input type="checkbox"/> 40 - < 60 | <input type="checkbox"/> 240 - <260 |
| <input type="checkbox"/> 60 - < 80 | <input type="checkbox"/> 260 - <280 |
| <input type="checkbox"/> 80 - <100 | <input type="checkbox"/> 280 - <300 |
| <input type="checkbox"/> 100 - <120 | <input type="checkbox"/> 300 - <320 |
| <input type="checkbox"/> 120 - <140 | <input type="checkbox"/> 320 - <340 |
| <input type="checkbox"/> 140 - <160 | <input type="checkbox"/> 340 - <360 |
| <input type="checkbox"/> 160 - <180 | <input type="checkbox"/> 360 - <380 |
| <input type="checkbox"/> 180 - <200 | <input type="checkbox"/> 380 - <400 |
| <input type="checkbox"/> 200 - <220 | |

Over 400, number given _____

Total for 2005 (if only figure available)_____

DK. **Go to Q. 33.**

Refusal. **Go to Q. 33.**

Go to Q. 33.

32.D. During a typical (average) month in 2005, about how many pounds of railroad ties to the nearest thousand, would you say your company disposed of?

- | | |
|---|---|
| <input type="checkbox"/> 0 - < 2,000 | <input type="checkbox"/> 24,000 - <26,000 |
| <input type="checkbox"/> 2,000 - < 4,000 | <input type="checkbox"/> 26,000 - <30,000 |
| <input type="checkbox"/> 4,000 - < 6,000 | <input type="checkbox"/> 30,000 - <32,000 |
| <input type="checkbox"/> 6,000 - < 8,000 | <input type="checkbox"/> 32,000 - <34,000 |
| <input type="checkbox"/> 8,000 - <10,000 | <input type="checkbox"/> 34,000 - <36,000 |
| <input type="checkbox"/> 10,000 - <12,000 | <input type="checkbox"/> 36,000 - <38,000 |
| <input type="checkbox"/> 12,000 - <14,000 | <input type="checkbox"/> 38,000 - <40,000 |
| <input type="checkbox"/> 14,000 - <16,000 | <input type="checkbox"/> 42,000 - <44,000 |
| <input type="checkbox"/> 16,000 - <18,000 | <input type="checkbox"/> 44,000 - <46,000 |
| <input type="checkbox"/> 18,000 - <20,000 | <input type="checkbox"/> 46,000 - <48,000 |
| <input type="checkbox"/> 20,000 - <22,000 | <input type="checkbox"/> 48,000 - <50,000 |
| <input type="checkbox"/> 22,000 - <24,000 | |

- Over 50,000, number given _____ pounds
- Total for 2005 (if only figure available)_____ pounds
- DK. **Go to Q. 33.**
- Refusal. **Go to Q. 33.**

33. Did your company pay to dispose of the ties, were they mainly removed at no cost to your company, or was your company paid for them? (If respondent indicates that two or three responses apply, ask about the most frequent practice.)

- Company paid for removal. **Go to Q. 33.A.**
- Removed at no cost to company. **Go to Q. 33.B.**
- Company was paid for them. **Go to Q. 33.C.**
- DK. **Go to Q. 34.**
- Refusal. **Go to Q. 34.**

33.A For that typical month, about how much did your company pay for removal?

- | | |
|--|---|
| <input type="checkbox"/> >0 - 500 | <input type="checkbox"/> 5,000 - 5,500 |
| <input type="checkbox"/> 500 - 1,000 | <input type="checkbox"/> 5,500 - 6,000 |
| <input type="checkbox"/> 1,000 - 1,500 | <input type="checkbox"/> 6,500 - 7,000 |
| <input type="checkbox"/> 1,500 - 2,000 | <input type="checkbox"/> 7,000 - 7,500 |
| <input type="checkbox"/> 2,000 - 2,500 | <input type="checkbox"/> 7,500 - 8,000 |
| <input type="checkbox"/> 3,000 - 3,500 | <input type="checkbox"/> 8,000 - 8,500 |
| <input type="checkbox"/> 3,500 - 4,000 | <input type="checkbox"/> 8,500 - 9,000 |
| <input type="checkbox"/> 4,000 - 4,500 | <input type="checkbox"/> 9,000 - 9,500 |
| <input type="checkbox"/> 4,500 - 5,000 | <input type="checkbox"/> 9,500 - 10,000 |

- Over \$10,000/month, amount given_____
 - Total for 2005 (if only figure available)_____
 - DK. **Go to Q. 34.**
 - Refusal. **Go to Q. 34.**

33.A.1. Did your company use its own trucks to transport most of the ties to a disposal site or did another company provide trucks?

- Our company provided the trucks
- Another company provided the trucks
- Other_____

33.A.2. Were most of the ties sent to a landfill or to another company?

- Landfill
- Another company
- Other_____

33.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where most (over 50%) of your material goes.

- | | |
|-----------------------------------|-----------------------------------|
| <input type="checkbox"/> > 0 - 5 | <input type="checkbox"/> >50 - 55 |
| <input type="checkbox"/> > 5 - 10 | <input type="checkbox"/> >55 - 60 |
| <input type="checkbox"/> >10 - 15 | <input type="checkbox"/> >60 - 65 |
| <input type="checkbox"/> >15 - 20 | <input type="checkbox"/> >65 - 70 |
| <input type="checkbox"/> >20 - 25 | <input type="checkbox"/> >70 - 75 |
| <input type="checkbox"/> >25 - 30 | <input type="checkbox"/> >75 - 80 |
| <input type="checkbox"/> >30 - 35 | <input type="checkbox"/> >80 - 85 |
| <input type="checkbox"/> >35 - 40 | <input type="checkbox"/> >85 - 90 |
| <input type="checkbox"/> >40 - 45 | <input type="checkbox"/> >90 - 95 |
| <input type="checkbox"/> >45 - 50 | <input type="checkbox"/> >95 - 10 |
- Over 100 miles, amount given_____
- DK. **Go to Q. 34.**
- Refusal. **Go to Q. 34.**

Go to Q. 34.

33.B. What was the primary way the ties were disposed of at no cost to your company?

- Given away to public and/or employees
- Given away to other private companies
- Other_____
- DK. **Go to Q. 34.**
- Refusal. **Go to Q. 34.**

Go to Q. 34.

33.C. For that typical month, about how much was your company paid?

- \$_____/typical month.
- DK. **Go to Q. 34.**
 - Refusal. **Go to Q. 34.**

34. What percentage of the total amount of the ties would you say your company was able to reuse?

- None. **Go to Q. 40 on Primary and 41/42 on Secondary**
- >0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100

- DK **Go to Q. 35.**
- Refusal. **Go to Q. 35.**

35. What was the primary use your company made of the ties?

- Mulch
- Livestock bedding
- Land cover or fill
- Heating fuel
- Landscaping
- Other _____

- DK. **Go to Q. 40 on Primary and 41/42 on Secondary**
- Refusal. **Go to Q. 40 on Primary and 41/42 on Secondary**

Go to Q. 40 on Primary and 41/42 on Secondary

36. Does your company measure the amount of telephone poles it disposes of primarily by their total number, or by the volume hauled by truck or in containers, or by their weight?

- Primarily by number: **Go To Q. 36.A**
- Primarily by truck or container: **Go To Q. 36.B.**
- Primarily by weight: **Go to Q. 36.D.**
- DK. **Go to Q. 37.**
- Refusal. **Go to Q. 37.**

36.A. During a typical (average) month in 2005, in total, how many telephone poles did your company dispose of as wood waste?

- | | |
|--------------------------------------|--------------------------------------|
| <input type="checkbox"/> >0 - 200 | <input type="checkbox"/> 2000 - 2200 |
| <input type="checkbox"/> 200 - 400 | <input type="checkbox"/> 2200 - 2400 |
| <input type="checkbox"/> 400 - 600 | <input type="checkbox"/> 2400 - 2600 |
| <input type="checkbox"/> 600 - 800 | <input type="checkbox"/> 2600 - 2800 |
| <input type="checkbox"/> 800 - 1000 | <input type="checkbox"/> 2800 - 3000 |
| <input type="checkbox"/> 1000 - 1200 | <input type="checkbox"/> 3000 - 3200 |
| <input type="checkbox"/> 1200 - 1400 | <input type="checkbox"/> 3200 - 3400 |
| <input type="checkbox"/> 1400 - 1600 | <input type="checkbox"/> 3400 - 3600 |
| <input type="checkbox"/> 1600 - 1800 | <input type="checkbox"/> 3600 - 3800 |
| <input type="checkbox"/> 1800 - 2000 | <input type="checkbox"/> 3800 - 4000 |

- Over 4000, number given _____.
- Total for all of 2005 (if only figure offered by respondent)_____.
- DK. **Go to Q. 37.**
- Refusal. **Go to Q. 37.**

Go to Q. 37.

36.B. Thinking now of the trucks or containers used to haul the telephone poles away from your company, what would you say is the typical (average) volume in cubic yards they hold?

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> 0 - <10 | <input type="checkbox"/> 50 - <60 |
| <input type="checkbox"/> 10 - <20 | <input type="checkbox"/> 60 - <70 |
| <input type="checkbox"/> 20 - <30 | <input type="checkbox"/> 70 - <80 |
| <input type="checkbox"/> 30 - <40 | <input type="checkbox"/> 80 - <90 |
| <input type="checkbox"/> 40 - <50 | <input type="checkbox"/> 90 - <100 |

- If over 100 cubic yards, ask for respondents' estimate of typical volume of truck or container_____
- DK. **Go to Q. 37.**
- Refusal. **Go to Q. 37.**

36.C. During a typical (average) month in 2005, about how many truckloads or containers of telephone poles would you say your company disposed of?

- | | |
|-------------------------------------|-------------------------------------|
| <input type="checkbox"/> >0 - < 20 | <input type="checkbox"/> 120 - <140 |
| <input type="checkbox"/> 20 - < 40 | <input type="checkbox"/> 140 - <160 |
| <input type="checkbox"/> 40 - < 60 | <input type="checkbox"/> 160 - <180 |
| <input type="checkbox"/> 60 - < 80 | <input type="checkbox"/> 180 - <200 |
| <input type="checkbox"/> 80 - <100 | <input type="checkbox"/> 200 - <220 |
| <input type="checkbox"/> 100 - <120 | <input type="checkbox"/> 220 - <240 |

- | | |
|-------------------------------------|-------------------------------------|
| <input type="checkbox"/> 240 - <260 | <input type="checkbox"/> 320 - <340 |
| <input type="checkbox"/> 260 - <280 | <input type="checkbox"/> 340 - <360 |
| <input type="checkbox"/> 280 - <300 | <input type="checkbox"/> 360 - <380 |
| <input type="checkbox"/> 300 - <320 | <input type="checkbox"/> 380 - <400 |
- Over 400, number given _____
- Total for 2005 (if only figure available from respondent)_____
- DK. **Go to Q. 37.**
- Refusal. **Go to Q. 37.**

Go to Q. 37.

36.D. During a typical (average) month in 2005, about how many pounds of telephone poles to the nearest thousand, would you say your company disposed of?

- | | |
|---|---|
| <input type="checkbox"/> 0 - < 2,000 | <input type="checkbox"/> 24,000 - <26,000 |
| <input type="checkbox"/> 2,000 - < 4,000 | <input type="checkbox"/> 26,000 - <30,000 |
| <input type="checkbox"/> 4,000 - < 6,000 | <input type="checkbox"/> 30,000 - <32,000 |
| <input type="checkbox"/> 6,000 - < 8,000 | <input type="checkbox"/> 32,000 - <34,000 |
| <input type="checkbox"/> 8,000 - <10,000 | <input type="checkbox"/> 34,000 - <36,000 |
| <input type="checkbox"/> 10,000 - <12,000 | <input type="checkbox"/> 36,000 - <38,000 |
| <input type="checkbox"/> 12,000 - <14,000 | <input type="checkbox"/> 38,000 - <40,000 |
| <input type="checkbox"/> 14,000 - <16,000 | <input type="checkbox"/> 42,000 - <44,000 |
| <input type="checkbox"/> 16,000 - <18,000 | <input type="checkbox"/> 44,000 - <46,000 |
| <input type="checkbox"/> 18,000 - <20,000 | <input type="checkbox"/> 46,000 - <48,000 |
| <input type="checkbox"/> 20,000 - <22,000 | <input type="checkbox"/> 48,000 - <50,000 |
| <input type="checkbox"/> 22,000 - <24,000 | |
- Over 50,000, number given _____ pounds
- Total for 2005 (if only figure available)_____ pounds
- DK. **Go to Q. 37.**
- Refusal. **Go to Q. 37.**

37. Did your company pay to dispose of the poles, were they mainly removed at no cost to your company, or was your company paid for them? (If respondent indicates that two or three responses apply, ask about the most frequent practice.)

- Company paid for removal. **Go to Q. 37.A.**
- Removed at no cost to company. **Go to Q. 37.B.**
- Company was paid for them. **Go to Q. 37.C.**
- DK. **Go to Q. 38.**
- Refusal. **Go to Q. 38.**

37.A For that typical month, about how much did your company pay for removal?

- | | |
|--|---|
| <input type="checkbox"/> >0 - 500 | <input type="checkbox"/> 5,000 - 5,500 |
| <input type="checkbox"/> 500 - 1,000 | <input type="checkbox"/> 5,500 - 6,000 |
| <input type="checkbox"/> 1,000 - 1,500 | <input type="checkbox"/> 6,500 - 7,000 |
| <input type="checkbox"/> 1,500 - 2,000 | <input type="checkbox"/> 7,000 - 7,500 |
| <input type="checkbox"/> 2,000 - 2,500 | <input type="checkbox"/> 7,500 - 8,000 |
| <input type="checkbox"/> 3,000 - 3,500 | <input type="checkbox"/> 8,000 - 8,500 |
| <input type="checkbox"/> 3,500 - 4,000 | <input type="checkbox"/> 8,500 - 9,000 |
| <input type="checkbox"/> 4,000 - 4,500 | <input type="checkbox"/> 9,000 - 9,500 |
| <input type="checkbox"/> 4,500 - 5,000 | <input type="checkbox"/> 9,500 - 10,000 |
- Over \$10,000/month, amount given_____
- Total for 2005 (if only figure available from respondent)_____
- DK. **Go to Q. 38.**
- Refusal. **Go to Q. 38.**

37.A.1. Did your company use its own trucks to transport most of the poles to a disposal site or did another company provide trucks?

- Our company provided the trucks
- Another company provided the trucks
- Other_____

37.A.2. Was most of the poles sent to a landfill or to another company?

- Landfill
- Another company
- Other_____

37.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where most (over 50%) of the poles go.

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> > 0 - 5 | <input type="checkbox"/> >50 - 55 |
| <input type="checkbox"/> > 5 - 10 | <input type="checkbox"/> >55 - 60 |
| <input type="checkbox"/> >10 - 15 | <input type="checkbox"/> >60 - 65 |
| <input type="checkbox"/> >15 - 20 | <input type="checkbox"/> >65 - 70 |
| <input type="checkbox"/> >20 - 25 | <input type="checkbox"/> >70 - 75 |
| <input type="checkbox"/> >25 - 30 | <input type="checkbox"/> >75 - 80 |
| <input type="checkbox"/> >30 - 35 | <input type="checkbox"/> >80 - 85 |
| <input type="checkbox"/> >35 - 40 | <input type="checkbox"/> >85 - 90 |
| <input type="checkbox"/> >40 - 45 | <input type="checkbox"/> >90 - 95 |
| <input type="checkbox"/> >45 - 50 | <input type="checkbox"/> >95 - 100 |
- Over 100 miles, amount given_____

DK. **Go to Q. 38.**

Refusal. **Go to Q. 38.**

Go to Q. 38.

37.B. What was the primary way the poles were disposed of at no cost to your company?

Given away to public and/or employees

Given away to other private companies

Other _____

DK. **Go to Q. 38.**

Refusal. **Go to Q. 38.**

Go to Q. 38.

37.C. For that typical month, about how much was your company paid?

\$_____/typical month.

DK. **Go to Q. 38.**

Refusal. **Go to Q. 38.**

38. What percentage of the total amount of the poles would you say your company was able to reuse?

None. **Go to Q. 40 on Primary and 41/42 on Secondary**

>0 - 10

10 - 20

20 - 30

30 - 40

40 - 50

50 - 60

60 - 70

70 - 80

80 - 90

90 - 100

DK **Go to Q. 39.**

Refusal. **Go to Q. 39.**

39. What was the primary use your company made of the poles?

Mulch

Livestock bedding

- Land cover or fill
- Heating fuel
- Landscaping
- Building construction
- Other _____
- DK. **Go to Q. 40 on Primary and 41/42 on Secondary**
- Refusal. **Go to Q. 40 on Primary and 41/42 on Secondary**

40. I've asked about the primary wood waste your company disposes of. Does your company also dispose of significant quantities of other kind's wood waste as well? By significant I mean more than 10 percent of the total wood waste your company disposed of in 2005.

- Yes, company disposes of other wood wastes. **Go to Q. 40.A.**
- No, none or 10 percent or less. **Go to Q. 41.**
- DK. **Go to Q. 41.**
- Refusal. **Go to Q. 41.**

40.A. I'm interested only in the second largest amount of wood waste your company disposed of in 2005. What type of wood waste was it?
 [Interviewer can read list again. There will be a provision in the questionnaire software that prevents the same type from being selected twice and upon completion of questions for the second type will send the interviewer to Q. 41, not Q. 40.]

- Pallets, skids, and shipping crates. **Go to Q. 6.**
- Dunnage. **Go to Q. 10.**
- Edgings and cutoffs. **Go to Q. 14.**
- Chips, shavings, and sawdust. **Go to Q. 18.**
- Tree trunks, limbs, and stumps. **Go to Q. 22.**
- Construction debris. **Go to Q. 28.**
- Railroad ties. **Go to Q. 32.**
- Telephone poles. **Go to Q. 36.**
- DK. **Go to Q. 41**
- Refusal. **Go to Q. 41**

Now, I would like to ask just a few final questions about the market for wood waste.

41. From your company's experience in 2005, in your judgment is there no market for the kind of waste wood your company accepts or generates, a developing market, or a fully developed market for that wood? By market, we mean that there are buyers for the wood waste and ongoing amounts available from suppliers.

- No market. **Go to Q. 41.A.**
- A developing market. **Go to Q. 41.B.**
- A fully developed market. **Go to Q. 41.C.**
- DK. **Go to Q. 42.**
- Refusal. **Go to Q. 42.**

41.A. What is the single most important reason, in your judgment, that there is no market for the kind of wood waste your firm accepts or generates?

- Can't use wood containing preservatives
- Can't use wood coated with paint
- Can't use wood containing glue
- Can't use wood is attached to metal, shingles, or other non-wood material
- Can't use wood containing metal or other foreign material that cannot be easily removed
- No cost effective way to sort wood waste from non-wood waste
- Wood waste too expensive to transport (relative to value)
- Other_____
- DK. **Go to Q. 42.**
- Refusal. **Go to Q. 42.**

Go to Q. 42.

41.B. In your judgment, what is the single most important part of the market that is as yet not fully developed?

- Difficult to identify/contact buyers
- Difficult to identify/contact sellers
- Difficult to get prevailing market prices
- Transportation costs too high

- Waste wood more expensive to use than alternative materials
- Governmental regulations (write in regulation if mentioned by respondent) _____
- DK. **Go to Q. 42.**
- Refusal. **Go to Q. 42.**

Go to Q.42

41.C. From month to month since the beginning of 2005, are the prices for wood waste accepted or generated by your company relatively stable or do the prices vary widely? As a standard of comparison, use gasoline prices at the pump.

- Prices vary less than gasoline prices. **Go to Q. 41.D.**
- Prices vary about as much as gasoline prices. **Go to Q. 41.C.1.**
- Prices vary more than gasoline prices. **Go to Q. 41.C.1.**
- DK. **Go to Q. 41.D.**
- Refusal. **Go to Q. 41.D.**

41.C.1. What do you think is the primary cause of price fluctuations?

- Unpredictable swings in the supply of waste wood
- Unpredictable swings in the demand for waste wood
- Inadequate information about supply available
- Inadequate information about quantity demanded
- Other _____
- DK. **Go to Q. 41.D.**
- Refusal. **Go to Q. 41.D.**

41.D. As a participant in the waste wood market, do you feel that your company is getting as much market information as it needs to operate efficiently?

- Yes. **Go to Q. 42.**
- No. **Go to Q. 41.D.1.**
- DK. **Go to Q. 42.**
- Refusal. **Go to Q. 42.**

41.D.1. What is the single most important kind of additional information could your company use?

- Market prices
- Identity of users/buyers
- Identity of sources/sellers
- Transportation costs
- Explanation of governmental regulations
- New uses for wood waste
- New technology/machinery for processing wood waste at lower cost
- Other _____
- DK. **Go to Q. 42.**
- Refusal. **Go to Q. 42.**

41.D.2 Do you think if your company had the additional information you just identified, it would be more likely to recycle its wood waste, about as likely to recycle as it is now, or less likely to recycle its waste?

- More likely to recycle. **Got to Q. 42.**
- About as likely to recycle as now. **Go to Q. 41.D.3.**
- Less likely to recycle. **Go to Q. 41.D.3.**

41.D.3. Why do you think your company would recycle no more than it does now or even less than it does now even with the additional information?

42. Now, my last question: is there anything you would like to add to your answers? Or, do you have any suggestions or comments you would like to make about the subject of our interview today?

- Yes. **Go to Q. 42.A.**
- No. **Thank you for your time. Goodbye.**

42.A. Additions, comments, or suggestions:

APPENDIX B

SURVEY COVER LETTER



7203 Jackson Road Ann Arbor MI 48103-9506
Phone: (734) 761-6722 X 105 Fax: (734) 662-1686
Web Site: www.semircd.org

*Serving Lenawee, Macomb, Monroe, Oakland,
St. Clair, Washtenaw and Wayne Counties*

January 12, 2006

Dear Michigan Business Owner or Manager:

Some Michigan businesses have found ways to economically dispose of their wood waste while others have not. Local and state government agencies are frequently asked what Michigan businesses can do to lower disposal costs and to make the best use of their wood waste. The problem is all the more pressing and answers more important since the Emerald Ash Borer infestation was discovered several years ago here in southern Michigan.

With support from the USDA Forest Service, the Southeast Michigan Resource Conservation and Development Council is conducting a survey among businesses in fourteen of Michigan counties. We will be asking about the amount of wood waste being generated and identifying how it is used and disposed of. Our interest is in pallets, dunnage (packing material), chips and shavings, edgings and cutoffs, tree debris, construction debris, railroad ties, and telephone poles. Your answers will help us determine what we can do together to reduce costs and make the best use of this wood.

The survey will be conducted by professional telephone interviewers and will take only a few minutes of your time. Your company was specifically selected to participate and your answers are very important to the success of this survey. So when our interviewer calls please take a few minutes to answer our questions. Your answers will remain completely confidential. In advance, please accept our appreciation for your participation.

Please contact me if you have any questions about the survey. You may call Cooper Research at 1-800-743-3003 (study number 2903) to answer our questions at your convenience.

If you have questions about the Southeast Michigan Resource Conservation and Development Council, or about wood waste, please call Jessica Simons at 1-734-761-6722, ext. 105. You can also go to the Council's website at www.semircd.org. For information about making the best use of urban trees, go to www.harvestingurbantimber.com.

Sincerely,

Sam Sherrill, Ph.D.
Survey Director
(513) 248-0509
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APPENDIX C

FREQUENCY DISTRIBUTIONS BY QUESTION

- 1. Over the entire year of 2005, did your company here in southern Michigan either generate or accept any wood waste in the form of pallets, dunnage, edging and cutoffs, chips and shavings, tree trunks and limbs, construction debris, railroad ties, or telephone poles?**

Code/Response		Frequency	Percent
1	Yes	420	28.0
2	No	1,080	72.0
Total		1,500	100.0

- 2. Does your company primarily accept wood waste in some form from other companies, organizations, or governmental agencies?**

Code/Response		Frequency	Percent
1	Yes	47	11.2
2	No	373	88.8
Total		420	100.0

- 3. What does your firm primarily accept?**

Code/Response		Frequency	Percent
1	Chips, shavings, and sawdust	1	0.2
2	Construction debris	5	1.2
3	Dunnage	1	0.2
4	Edgings and cutoffs	1	0.2
5	Pallets, skid, and containers	35	8.3
6	Railroad ties	1	0.2
7	Telephone poles	3	0.7
8	Tree trunks, limbs, and stumps	0	0.0
Subtotal		47	11.2
Primarily generate wood waste		373	88.8
Total		420	100.0

- 4. Does your company measure the quantity of wood waste it accepts primarily by volume hauled in by truck or in containers, or by its weight, or by the counted number (e.g., 1000 pallets, skids, and containers or 500 railroad ties or 800 telephone poles)?**

Code/Response		Frequency	Percent
1	Truck/container	16	3.8
2	Weight	5	1.2
3	Number	26	6.2
	Subtotal	47	11.2
	Primarily generate wood waste	373	88.8
Total		420	100.0

- 4.A. Thinking now of the trucks or containers that bring wood waste to your company, what would you say is the typical (average) volume in cubic yards they hold?

Code/Response		Frequency	Percent
1	0 - <10	10	2.4
2	10 - <20	2	0.5
3	20 - <30	1	0.2
4	30 - <40	1	0.2
11	100 or more (DK exact amount)	2	0.5
	Subtotal	16	3.8
	Other measures + generate wood waste	404	96.2
Total		420	100.0

- 4.A.1 During a typical (average) month in 2005, about how many truckloads or containers of wood waste would you say your company accepted?

Code/Response		Frequency	Percent
1	0 - < 20	9	2.1
2	20 - <40	2	0.5
3	40 - < 60	1	0.2
21	More than 400	1	0.2
34	DK	3	0.7
	Subtotal	16	3.8
	Other measures + generate wood waste	404	96.2
Total		420	100.0

- 4.B. During a typical (average) month in 2005, about how many pounds of wood waste, to the nearest thousand, would you say your company accepted?

Code/Response		Frequency	Percent
1	0 - <2,000	2	0.5
3	4,000 - <6,000	1	0.2
34	DK	1	0.2
35	Refusal	1	0.2
	Subtotal	5	1.2
	Other measures +	415	98.8

	generate wood waste		
Total		420	100.0

4.C. During a typical (average) month in 2005, in total, about how many of these did your company accept?

Code/Response		Frequency	Percent
1	0 - <200	22	5.2
2	200 - <400	1	0.2
8	1,400 - <1,600	1	0.2
34	DK	2	0.5
	Subtotal	26	6.2
	Other measures + generate wood waste	394	93.8
Total		420	100.0

4.D. What one source provided most of the wood waste your company accepted in 2005? We are interested in business and government sources in and outside of the State of Michigan as well as outside the U.S.

Code/Response		Frequency	Percent
1	Michigan businesses	20	4.8
2	Businesses in other states	15	3.6
3	Canadian businesses	1	0.2
4	Michigan governments	2	0.5
5	Other state governments	1	0.2
6	Governments in Canada	0	0.0
21	Other	7	1.7
23	DK	1	
	Subtotal	47	10.9
	Other measures + generate wood waste	373	89.1
Total		420	100.0

4.E. Does your company use most of the wood waste it accepts to make products or does your company permanently hold most of the wood as waste? By products we mean fuel for heat, electric power generation, mulch, compost, firewood, pallets, skids, containers, or dunnage, wood products such as lumber and plywood, or building material such as joists.

Code/Response		Frequency	Percent
1	Used to make products	13	3.1
2	Permanently holds as waste	18	4.3
11	DK	14	3.3
12	Refusal	2	0.5
	Subtotal	47	11.2
	Other measures + generate wood waste	373	88.8
Total		420	100.0

4.E.1 What is the primary product your company makes from the wood waste it accepts?

Code/Response		Frequency	Percent
1	Building materials	4	1.0
2	Composite wood products	0	0.0
3	Compost	0	0.0
4	Firewood	2	0.5
5	Fuel for electric power	0	0.0
6	Fuel for heat	0	0.0
7	Lumber	1	0.2
8	Mulch	3	0.7
9	Pallets, skid, containers	3	0.7
	Subtotal	13	3.1
	Other measures + generate wood waste	407	96.9
Total		420	100.0

4.E.2. In terms of expense, what is the single most important reason that the rest of the wood waste is not being re-used or recycled?

Code/Response		Frequency	Percent
22	No reason, use all	2	0.5
1	Regulations make recycling too difficult	2	0.5
2	Too difficult to separate wood into different categories	1	0.2
7	Too expensive to haul to recycler	2	0.5
21	Other	5	1.2
23	DK	1	0.2
	Subtotal	13	3.1
	Other measures + generate wood waste	407	96.9
Total		420	100.0

4.E.3. In your judgment, what is the single most important action, if there is one, that state or local governments could take to promote the greater use of wood waste?

Code/Response		Frequency	Percent
1	Provide more information	5	1.2
2	Reduce regulations	2	0.5
21	Other	2	0.5
22	None	2	0.5
23	DK	2	0.5
	Subtotal	13	3.1
	Other measures + generate wood waste	407	96.9
Total		420	100.0

- 4.F. From what you and others in your company have observed, how much of the wood waste your company accepts and holds do you think could be re-used or recycled?

Code/Response		Frequency	Percent
1	Little or none	15	3.6
2	About one-third	4	1.0
3	About one-half	5	1.2
4	About two-thirds	3	0.7
5	All or nearly all	15	3.6
11	DK	4	1.0
12	Refusal	1	0.2
	Subtotal	47	11.2
	Generate wood waste	373	88.8
Total		420	100.0

- 4.G. In terms of expense, in your judgment, what is the single most important reason that more wood waste is not being re-used or recycled?

Code/Response		Frequency	Percent
1	Regulations make recycling too difficult	1	0.2
2	Too difficult to separate wood into different categories	6	1.4
3	Wood contains preservatives	1	0.2
4	Wood is glued product	2	0.5
5	Wood is attached to metal, etc.	3	0.7
6	Wood is coated with paint	0	0.0
7	Too expensive to haul to recycler	4	1.0
21	Other	10	2.4
34	DK	4	1.0
35	Refusal	1	0.2
	Subtotal	32	7.6
	Other measures + generate wood waste	388	92.4
Total		420	100.0

- 4.H. What single most important way, if any, could more of the wood be re-used or recycled (examples, if needed, are to make wood products, fuel, mulch, lumber or re-use in existing form)?

Code/Response		Frequency	Percent
1	Find way to remove chemicals	0	0.0
2	Find cost-effective way to sort wood waste from non-wood waste	2	0.5
3	Find way to remove wood from non-wood waste	3	0.7
4	Help finding recycler	1	0.2
5	Lower cost of transporting to/from where generated	2	0.5
6	Find new use for wood waste	12	2.9

21	Other	2	0.5
22	None, more cannot be re-used	1	0.2
	Subtotal	23	5.5
	Other measures + generate wood waste	397	94.5
Total		420	100.0

- 4.I. In your judgment, what is the single most important action, if there is one, that Michigan state or local governments could take to promote the greater use of wood waste?

Code/Response		Frequency	Percent
1	Provide more information on wood waste market	20	4.8
2	Reduce regulations	1	0.2
21	Other	3	0.7
22	None: nothing else to do	4	1.0
34	DK	18	4.3
	Subtotal	46	11.2
	Other measures + generate wood waste	374	88.8
Total		420	100.0

5. As wood waste, what does your company primarily dispose of? By primary I mean what your company disposes of the most.

Code/Response		Frequency	Percent
1	Chips, shavings, sawdust	62	14.8
2	Construction debris	136	32.4
3	Dunnage	4	1.0
4	Edgings, cutoffs	74	17.6
5	Pallets, skids, crates	83	19.8
6	Railroad ties	0	0.0
7	Telephone poles	0	0.0
8	Tree trunks, limbs,, stumps	14	3.3
	Subtotal	373	88.8
	Accept wood waste	47	11.2
Total		420	100.0

NOTE: In the following tables for wood wastes disposals, the Subtotals are slightly greater than the totals by type of wood waste in the table for Question 5 above. The reason for the difference is that 32 of the responding firms also disposed of other types of wood waste in addition to their primary type. For example, pallets, skids, and crates were primarily disposed of by 83 firms, as shown in the table above, and secondarily by 2 other firms, bringing the total to 85, as shown in the table immediately below. The distribution by type for secondary disposal is in the table for Question 40.A.

6. Does your company measure the amount of pallets, skids, and shipping crates it disposes of primarily by their total number, or by the volume hauled by truck or in containers, or by their weight?

Code/Response		Frequency	Percent
1	Number	31	7.4
2	Truck/container	15	3.6
3	Weight	1	0.2
34	DK	36	8.6
35	Refusal	2	0.5
	Subtotal	85	20.2
	Not pallets, skids, crates	335	79.8
Total		420	100.0

- 6.A. During a typical (average) month in 2005, in total, how many pallets, skids, and shipping crates did your company dispose of as wood waste?

Code/Response		Frequency	Percent
1	0 - <200	26	6.2
2	200 - <400	1	.2
3	400 - <600	1	.2
33	Total for 2005 (sum of 3 = 44)	3	.7
	Subtotal	31	7.4
	Truckload, weight	389	92.6
Total		420	100.0

- 6.B. Thinking now of the trucks or containers used to haul pallets, skids, and shipping crates away from your company, what would you say is the typical (average) volume in cubic yards they hold?

Code/Response		Frequency	Percent
1	0 - <10	9	2.1
3	20 - <30	1	.2
4	30 - <40	1	.2
23	DK	3	.7
24	Refusal	1	.2
	Subtotal	15	3.6
	Number or weight	405	96.4
Total		420	100.0

- 6.C. During a typical (average) month in 2005, about how many truckloads or containers of pallets, skids, and shipping crates would you say your company disposed of?

Code/Response		Frequency	Percent
1	0 - <20	10	2.4
2	20 - <40	1	.2
	Subtotal	11	2.6
	Number or weight	409	97.4
Total		420	100.0

- 6.D. During a typical (average) month in 2005, about how many pounds of pallets, skids, and shipping crates to the nearest thousand, would you say your company disposed of?

Code/Response		Frequency	Percent
1	0 - <2,000	1	.2
	Number or truckload	419	99.8
Total		420	100.0

7. **Did your company pay to dispose of the pallets, skids, and crates, were they mainly removed at no cost to your company, or was your company paid for them.**

Code/Response		Frequency	Percent
1	Company paid for removal	30	7.1
2	Removed at no cost to company	39	9.3
3	Another company paid	4	1.0
34	DK	10	2.4
35	Refusal	2	.5
	Subtotal	85	20.2
	Not pallets, skids, crates	335	79.8
Total		420	100.0

- 7.A For that typical month, about how much did your company pay for removal (in dollars)?

Code/Response		Frequency	Percent
1	0 - <500	19	4.5
2	1,000 - <1,500	1	.2
4	1,500 - <2,000	1	.2
34	DK	9	2.1
	Subtotal	30	7.1
	Not pallets, skids, crates + removed at no cost + another company paid for them	390	92.9
Total		420	100.0

- 7.A.1. Did your company use its own trucks to transport most of the material to a disposal site or did another company provide trucks?

Code/Response		Frequency	Percent
1	Our company provide truck	4	1.0
2	Another company provided trucks	17	4.0
	Subtotal	21	5.0
	Not pallets, skids, crates +	399	95.0
Total		420	100.0

- 7.A.2. Was most of the material sent to a landfill or to another company?

Code/Response		Frequency	Percent
1	Landfill	16	3.8
2	Another company	1	.2
21	Other	1	.2
23	DK	3	.7
	Subtotal	21	5.0
	Not pallets, skids, crates	399	95.0
Total		420	100.0

7.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where most (over 50%) of your material goes (one-way)?

Code/Response		Frequency	Percent
1	0 - < 5	4	1.0
2	5 - <10	3	.7
3	10 - <15	4	1.0
4	15 - <20	2	.5
6	25 - <30	1	.2
34	DK	7	1.7
	Subtotal	21	5.0
	Not pallets, skids, crates	399	95.0
Total		420	100.0

7.B. What was the primary way the pallets, skids, and crates were disposed of at no cost to your company?

Code/Response		Frequency	Percent
1	Given away to public/employees	23	5.5
2	Given away to other companies	6	1.4
3	Burned	5	1.2
4	Trashed/dumped/thrown away	2	.5
5	Recycled/reused	2	.5
34	DK	1	.2
	Subtotal	39	9.3
	Not pallets, skids, crates	381	90.7
Total		420	100.0

7.C. For that typical month, about how much was your company paid (in dollars)?

Code/Response		Frequency	Percent
1	0 - <500	3	.7
34	DK	1	.2
	Subtotal	4	1.0
	No cost /company paid for removal	416	99.0
Total		420	100.0

8. For a typical (average) month, what percentage of the total number of pallets, skids, and shipping crates would you say your company was able to re-use?

Code/Response		Frequency	Percent
1	None	23	5.5
2	0 - 10	20	4.8
3	11 - 20	4	1.0
4	21 - 30	3	0.7
5	31 - 40	0	0.0
6	41 - 50	3	0.7
7	51 - 60	2	0.5
8	61 - 70	1	0.2
9	71 - 80	6	1.4
10	81 - 90	5	1.2
11	91 - 100	15	3.6
34	DK	3	.7
Subtotal		85	20.2
Not pallets, skids, crates		335	79.8
Total		420	100.0

9. Did your company re-use most of the pallets, skids, and shipping crates for shipping and storage or did your company reduce most of them to parts or wood fiber and use that material for something other than shipping and storage?

Code/Response		Frequency	Percent
1	Re-used in original form	47	11.2
2	Reduced to parts/fiber for other uses	8	1.9
11	DK	6	1.4
12	Refusal	1	0.2
Subtotal		62	14.8
Did not re-use		23	5.5
Not pallets, skids, crates		335	79.8
Total		420	100.1

- 9.A. What was the primary use your company made of the parts and fiber?

Code/Response		Frequency	Percent
1	Heating fuel	3	0.7
2	Land cover/fill	3	0.7
21	Other	1	0.2
34	DK	1	0.2
Subtotal		8	1.9
Not pallets, skids, crates + not re-use parts/fiber		412	98.1
Total		420	100.0

10. Does your company measure the amount of dunnage it disposes of primarily by volume hauled away in trucks or containers or does your company primarily measure the

wood waste it disposes of by weight?

Code/Response		Frequency	Percent
1	Truck/container	3	0.7
2	Weight	0	0.0
34	DK	4	1.0
	Subtotal	7	1.7
	Not dunnage	416	98.3
Total		420	100.0

NOTE: frequency distributions for questions 10 through 13 on dunnage are omitted owing to an inadequate number of responses.

14. Does your company measure the amount of edgings and cutoffs it disposes of primarily by volume hauled away in trucks or containers or does your company primarily measure the wood waste it disposes of by weight?

Code/Response		Frequency	Percent
1	Truck/container	54	12.9
2	Weight	3	.7
34	DK	25	6.0
	Subtotal	82	19.5
	Not edgings/ cutoffs	338	80.5
Total		420	100.0

14.A. Thinking now of the trucks or containers used to haul edgings and cutoffs away from your company, what would you say is the typical (average) volume in cubic yards they hold?

Code/Response		Frequency	Percent
1	0 - <10	22	5.2
2	10 - <20	10	2.4
3	20 - <30	11	2.6
4	30 - <40	3	0.7
11	100 or more	2	0.5
23	DK	6	1.4
	Subtotal	54	12.9
	Not edgings/ cutoffs + weight	366	87.1
Total		420	100.0

14.B. During a typical (average) month in 2005, about how many truckloads or containers of edgings and cutoffs would you say your company disposed of?

Code/Response		Frequency	Percent
1	>0 - <20	37	8.8
2	20 - <40	4	1.0

3	40 - <60	2	.5
5	80 - <100	2	.5
12	220 - <240	1	.2
15	280 - <300	1	.2
34	DK	1	.2
	Subtotal	48	11.4
	Not edging/ cutoffs + weight	372	88.6
Total		420	100.0

14.C. During a typical (average) month in 2005, about how many pounds of edgings and cutoffs to the nearest thousand, would you say your company disposed of?

Code/Response		Frequency	Percent
1	0 - <2,000	1	.2
24	50,000 or more	1	.2
34	DK	1	.2
	Subtotal	3	.7
	Not edging/ cutoffs + volume	417	99.3
Total		420	100.0

15. **Did your company pay to dispose of edgings and cutoffs, was it mainly removed at no cost to your company, or was your company paid for it?**

Code/Response		Frequency	Percent
1	Company paid for removal	53	12.6
2	Removed at no cost to company	27	6.4
3	Another company paid	1	0.2
34	DK	1	0.2
	Subtotal	82	19.5
	Not edging/ cutoffs	338	80.5
Total		420	100.0

15.A For that typical month, about how much did your company pay for removal?

Code/Response		Frequency	Percent
1	>0 - <500	43	10.2
2	500 - <1,000	2	.5
3	1,000 - <1,500	1	.2
34	DK	7	1.7
	Subtotal	53	12.6
	Not edging/cutoffs + removed at no company cost + another company paid for them	367	87.4
Total		420	100.0

15.A.1. Did your company use its own trucks to transport most of the edgings and cutoffs to a disposal site or did another company provide trucks?

Code/Response		Frequency	Percent
1	Our company provided trucks	17	4.0
2	Another company provided trucks	27	6.4
21	Other	2	0.5
	Subtotal	46	11.0
	Not edging/cutoffs + removed at no company cost + another company paid for them	374	89.0
Total		420	100.0

15.A.2. Were most of the edgings and cutoffs sent to a landfill or to another company?

Code/Response		Frequency	Percent
1	Landfill	34	8.1
2	Another company	3	0.7
21	Other	1	0.2
23	DK	8	1.9
	Subtotal	46	11.0
	Not edging/cutoffs + removed at no company cost + another company paid for them	374	89.0
Total		420	100.0

15.A.3. How far (to the nearest mile) would you say the disposal site is where most (over 50%) of your material goes.

Code/Response		Frequency	Percent
1	0 - <5	9	2.1
2	5 - >10	8	1.9
3	10 - <15	2	0.5
4	15 - <20	6	1.4
5	20 - <25	5	1.2
6	25 - <30	3	0.7
34	DK	12	2.9
35	Refusal	1	0.2
	Subtotal	46	11.0
	Not edging/cutoffs + removed at no company cost + company paid for them	374	89.0
Total		420	100.0

15.B. What was the primary way the edgings and cutoffs were disposed of at no cost to your company?

Code/Response		Frequency	Percent
1	Given away to public/employees	11	2.6

2	Given away to other companies	1	0.2
3	Burned	9	2.1
4	Trashed/dumped/discarded	5	1.2
34	DK	1	.2
	Subtotal	27	6.4
	Not edgings/cutoffs + company paid for removal + company paid for edgings/cutoffs	393	93.6
Total		420	100.0

15.C. For that typical month, about how much was your company paid?

Code/Response		Frequency	Percent
34	DK	1	.2
	All other	419	99.8
Total		420	100.0

16. What percentage of the total amount of edgings and cutoffs would you say your company was able to reuse?

Code/Response		Frequency	Percent
1	None	28	6.7
2	0 - 10	16	3.8
3	11 - 20	4	1.0
4	21 - 30	5	1.2
5	31 - 40	2	0.5
6	41 - 50	5	1.2
7	51 - 60	2	0.5
8	61 - 70	1	0.2
9	71 - 80	3	0.7
10	81 - 90	2	0.5
11	91 - 100	6	1.4
34	DK	8	1.9
	Subtotal	82	19.5
	Not edgings/cutoffs	338	80.5
Total		420	100.0

17. What was the primary use your company made of the edgings and cutoffs?

Code/Response		Frequency	Percent
1	Heating fuel	15	3.6
2	Land cover/fill	4	1.0
3	Livestock bedding	0	0.0
4	Mulch	1	0.2
5	Building materials	16	3.8
6	Re-use	10	2.4
21	Other	3	0.7
34	DK	5	1.2

	Subtotal	54	12.9
	Not edgings/cutoffs + company did not use edgings/cutoffs	366	87.1
Total		420	100.0

18. Does your company measure the amount of chips and shavings it disposes of primarily by volume hauled away in trucks or containers or does your company primarily measure the chips and shavings it disposes of by weight?

Code/Response		Frequency	Percent
1	Truck/container	33	7.9
2	Weight	10	2.4
34	DK	24	5.7
35	Refusal	1	0.2
	Subtotal	68	16.2
		352	83.8
Total		420	100.0

- 18.A. Thinking now of the trucks or containers used to haul chips and shavings away from your company, what would you say is the typical (average) volume in cubic yards they hold?

Code/Response		Frequency	Percent
1	0 - <10	23	5.5
2	10 - <20	3	0.7
3	20 - <30	1	0.2
4	30 - <40	1	0.2
11	100 or more	2	0.5
23	DK	3	0.7
	Subtotal	33	7.9
	Not chips/shavings + weight	387	92.1
Total		420	100.0

- 18.B. During a typical (average) month in 2005, about how many truckloads or containers of chips and shavings would you say your company disposed of?

Code/Response		Frequency	Percent
1	>0 - <20	26	6.2
2	20 - <40	1	0.2
3	40 - <60	1	0.2
7	120 - <140	1	0.2
12	220 - <240	1	0.2
	Subtotal	30	7.1
	Not chips/shavings + volume	390	92.9
Total		420	100.0

- 18.C. During a typical (average) month in 2005, about how many pounds of chips and shavings to the nearest thousand, would you say your company disposed of?

Code/Response		Frequency	Percent
1	0 - <2,000	8	1.9
2	2,000 - <4,000	1	0.2
34	DK	1	0.2
	Subtotal	10	2.4
		410	97.6
Total		420	100.0

19. Did your company pay to dispose of the chips and shavings, were they mainly removed at no cost to your company, or was your company paid for them?

Code/Response		Frequency	Percent
1	Company paid for removal	28	6.7
2	Removed at no cost to company	34	8.1
3	Another company paid	6	1.4
	Subtotal	68	16.2
	Not chips/shavings	352	83.8
Total		420	100.0

19.A For that typical month, about how much did your company pay for removal?

Code/Response		Frequency	Percent
1	>0 - <500	24	5.7
2	500 - <1,000	1	0.2
3	1,000 - <1,500	1	0.2
34	DK	2	0.5
	Subtotal	28	6.7
	Not chips/shavings + removed at no company cost + another company paid for them	392	93.3
Total		420	100.0

19.A.1. Did your company use its own trucks to transport most of the chips and shavings to a disposal site or did another company provide trucks?

Code/Response		Frequency	Percent
1	Our company provided trucks	6	1.4
2	Another company provided trucks	20	4.8
	Subtotal	26	6.2
	Not chips/shavings + removed at no company cost + another company paid for them	394	93.8
Total		420	100.0

19.A.2. Were most of the chips and shavings sent to a landfill or to another company?

Code/Response		Frequency	Percent
1	Landfill	20	4.8
2	Another company	2	0.5
21	Other	1	0.2
23	DK	3	0.7
	Subtotal	26	6.2
	Not chips/shavings + removed at no company cost + another company paid for them	394	93.8
Total		420	100.0

19.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where most (over 50%) of your material goes.

Code/Response		Frequency	Percent
1	0 - <5	3	0.7
2	5 - >10	2	0.5
3	10 - <15	3	0.7
4	15 - <20	4	1.0
5	20 - <25	2	0.5
6	25 - <30	2	0.5
13	60 - <65	1	0.2
34	DK	9	2.1
	Subtotal	26	6.2
	Not chips/shavings + removed at no company cost + another company paid for them	394	93.8
Total		420	100.0

19.B. What was the primary way the chips and shavings were disposed of at no cost to your company?

Code/Response		Frequency	Percent
1	Given away to public/employees	13	3.1
2	Given away to other companies	1	0.2
3	Burned	6	1.4
4	Trashed/dumped/discarded	5	1.2
5	Recycled/re-used	9	2.1
	Subtotal	34	8.1
	Not chips/shavings + paid for removal + another company paid	386	91.9
Total		420	100.0

19.C. For that typical month, about how much was your company paid?

Code/Response		Frequency	Percent
1	>0 - <500	3	0.6
6	3,000 - <3,500	1	0.2
15	8,000 - <8,500	1	0.2

	DK	1	0.2
	Subtotal	6	1.2
	Not chips/shavings + paid for removal + removed at no cost	414	98.6
	Total	420	100.0

20. What percentage of the total amount of chips and shavings would you say your company was able to reuse?

Code/Response		Frequency	Percent
1	None	46	11.0
2	>0 - 10	5	1.2
3	11 - 20	3	0.7
4	21 - 30	1	0.2
6	41 - 50	2	0.5
9	71 - 80	2	0.5
10	81 - 90	1	0.2
11	91 - 100	8	1.9
	Subtotal	68	16.2
	Not chips/shavings	352	83.8
	Total	420	100.0

21. What was the primary use your company made of the chips and shavings?

Code/Response		Frequency	Percent
1	Heating fuel	5	1.2
2	Land cover/fill	2	0.5
3	Livestock bedding	1	0.2
4	Mulch	12	2.9
5	Building materials	1	0.2
34	DK	1	0.2
	Subtotal	22	5.2
		398	94.8
	Total	420	100.0

22. Does your company measure the amount of trunks, limbs, and stumps, it disposes of primarily by volume hauled away in trucks or containers or does your company primarily measure the trunks, limbs, and stumps it disposes of by weight?

Code/Response		Frequency	Percent
1	Truck/container	10	2.4
2	Weight	1	0.2
34	DK	9	2.1
	Subtotal	20	4.8
	Not trunks, limbs, stumps	400	95.2
	Total	420	100.0

- 22.A. Thinking now of the trucks or containers used to haul trunks, limbs, and stumps away from your company, what would you say is the typical (average) volume in cubic yards they hold?

Code/Response		Frequency	Percent
1	0 > - <10	6	1.4
2	10 - <20	1	0.2
3	20 - <30	1	0.2
23	DK	2	0.5
Subtotal		10	2.4
Not trunks, limbs, stumps + weight		410	97.6
Total		420	100.0

- 22.B. During a typical (average) month in 2005, about how many truckloads or containers of trunks, limbs, and stumps would you say your company disposed of?

Code/Response		Frequency	Percent
1	>0 - <20	8	1.9
Not trunks, limbs, stumps + weight		412	98.1
Total		420	100.0

- 22.C. During a typical (average) month in 2005, about how many pounds of trunks, limbs, and stumps to the nearest thousand, would you say your company disposed of?

Code/Response		Frequency	Percent
4	6,000 - <8,000	1	0.2
Not trunks, limbs, stumps + trucks		419	99.8
Total		420	100.0

23. **Did your company pay to dispose of the trunks, limbs, and stumps, were they mainly disposed of at no cost to your company, or did another company buy them?**

Code/Response		Frequency	Percent
1	Company paid for removal	7	1.7
2	Removed at no cost to company	8	1.9
3	Another company paid	1	0.2
34	DK	4	1.0
Subtotal		20	4.8
Not trunks, limbs, stumps		400	95.2
Total		420	100.0

23.A For that typical month, about how much did your company pay for disposal of the trunks, limbs, and stumps?

Code/Response		Frequency	Percent
1	<0 - <500	5	1.2
6	3,000 - <3,500	1	.2
10	5,000 - <5,500	1	.2
	Subtotal	7	1.7
	Not trunks, limbs, stumps + paid for removal + another company paid	413	98.3
Total		420	100.0

23.A.1. Did your company use its own trucks to transport most of them to a disposal site or did another company provide trucks?

Code/Response		Frequency	Percent
1	Our company provided trucks	4	1.0
2	Another company provided trucks	3	0.7
	Subtotal	7	1.7
	Not trunks, limbs, stumps + removed at no company cost + another company paid	413	98.3
Total		420	100.0

23.A.2. Were most of them sent to a landfill or to another company?

Code/Response		Frequency	Percent
1	Landfill	2	0.5
2	Another company	4	1.0
23	DK	1	0.2
	Subtotal	7	1.7
	Not trunks, limbs, stumps + removed at no company cost + another company paid	413	98.3
Total		420	100.0

23.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where most (over 50%) of your material goes.

Code/Response		Frequency	Percent
1	>0 - <5	1	0.2
2	5 - <10	2	0.5
3	10 - <15	1	0.2
5	20 - >25	1	0.2
34	DK	2	0.5
	Total	7	1.7
	Not trunks, limbs, stumps + removed at no company cost + another company paid	413	98.3
Total		420	100.0

23.B. What was the primary way the trunks, limbs, and stumps were disposed of at no cost to your company?

Code/Response		Frequency	Percent
1	Given away to public/employees	1	0.2
3	Burned	4	1.0
4	Trashed/dumped/discarded	1	0.2
5	Recycled/re-used	1	0.2
35	Refusal	1	0.2
	Subtotal	8	1.9
	Not trunks, limbs, stumps + paid for removal + another company paid	412	98.1
Total		420	100.0

23.C. For that typical month, about how much was your company paid?

Code/Response		Frequency	Percent
6	3,000 – <3,500	1	.2
	Not trunks, limbs, stumps + paid for removal + another company paid	419	99.8
Total		420	100.0

24. What percentage of the total amount of the trunks, limbs, and stumps would you say your company was able to reuse?

Code/Response		Frequency	Percent
1	None	11	2.6
9	71 - 80	3	0.7
10	81 – 90	1	0.2
11	91 - 100	4	1.0
35	Refusal	1	0.2
	Subtotal	20	4.8
	Not trunks, limbs, stumps	400	95.2
Total		420	100.0

25. For that typical month in 2005, what did your company do with most of the trunks, limbs, and stumps? Were they cut up for firewood to sell? Ground into mulch to sell? Were they sawed into lumber to sell?

Code/Response		Frequency	Percent
1	Cut up for firewood sales	4	1.0
2	Ground for mulch sales	1	0.2
3	Sawed into lumber sales	0	0.0
4	Sold for other uses	0	0.0
5	Given away to other companies	0	0.0
6	Given away to public	2	0.5
7	Used by company/employees	1	0.2
35	Refusal	1	0.2

	Subtotal	9	2.1
	Not trunks, limbs, stumps + none reused	411	97.9
Total		420	100.0

26. **Compared to this time last year, is your company getting more ash trees, about the same number as last year, or less?**

Code/Response		Frequency	Percent
1	More than last year	3	0.7
2	About the same	4	1.0
3	Less than last year	2	0.5
34	DK	10	2.4
35	Refusal	1	0.2
Subtotal		20	4.8
Not trunks, limbs, stumps		400	95.2
Total		420	100.0

27. **For that typical month in 2005, what did your company do with over half the ash tree trunks, limbs, and stumps? Was this material cut up for firewood to sell? Ground up for mulch to sell? Or were they sawed into lumber to sell?**

Code/Response		Frequency	Percent
1	Cut up for firewood sales	5	1.2
2	Ground for mulch sales	1	0.2
3	Sawed into lumber sales	0	0.0
4	Sold for other uses	1	0.2
5	Given away to other companies	0	0.0
6	Given away to public	1	0.2
7	Used by company/employees	1	0.2
34	DK	9	2.1
35	Refusal	2	0.5
Subtotal		20	4.8
Not trunks, limbs, stumps		400	95.2
Total		420	100.0

28. **Does your company measure the amount of construction debris it disposes of primarily by volume hauled away in trucks or containers or does your company primarily measure the debris it disposes of by weight?**

Code/Response		Frequency	Percent
1	Truck/container	88	21.0
2	Weight	11	2.6
34	DK	41	9.8
35	Refusal	1	0.2
Subtotal		141	33.6
Not construction debris		279	66.4
Total		420	100.0

28.A. Thinking now of the trucks or containers used to haul construction debris away from your company, what would you say is the typical (average) volume in cubic yards they hold?

Code/Response		Frequency	Percent
1	0 - <10	30	7.1
2	10 - <20	10	2.4
3	20 - <30	23	5.5
4	30 - <40	12	2.9
5	40 - <50	3	.7
8	70 - <80	1	.2
9	80 - <90	1	.2
11	100 or more	3	.7
23	DK	4	1.0
24	Refusal	1	.2
	Subtotal	88	21.0
	Not construction debris + by weight	332	79.0
Total		420	100.0

More than 100 cubic yards

Response		Frequency	Percent
	140	1	0.2
	1,800	1	0.2
	4,800	1	0.2
	Subtotal	3	0.7
	Not construction debris + more than 100 + by weight	417	99.3
Total		420	100.0

28.B. During a typical (average) month in 2005, about how many truckloads or containers of construction debris would you say your company disposed of?

Code/Response		Frequency	Percent
1	0 - <20	67	16.0
2	20 - <40	5	1.2
3	40 - <60	2	.5
5	80 - <100	1	.2
6	100 - <120	1	.2
33	Total for 2005	2	.5
34	DK	5	1.2
	Subtotal	83	19.8
	Not construction debris + by weight	332	80.2
	Non-Response for Question 28.A.	5	
Total		420	100.0

Totals for 2005

Response	Frequency	Percent
1 truckload for 2005	1	0.2
3 truckloads for 2005	1	0.2
Subtotal	2	0.5
Not construction debris + monthly averages	418	99.5
Total	420	100.0

28.C. During a typical (average) month in 2005, about how many pounds of construction debris to the nearest thousand, would you say your company disposed of?

Code/Response	Frequency	Percent
1 0 - <2,000	4	1.0
2 2,000 - <4,000	2	0.5
3 4,000 - <6,000	1	0.2
5 8,000 - <10,000	1	0.2
8 14,000 - <16,000	1	0.2
34 DK	2	0.5
Subtotal	11	2.6
Not construction debris + by truckload	409	97.4
Total	420	100.0

29. Did your company pay to dispose of the debris, was it mainly removed at no cost to your company, or was your company paid for it?

Code/Response	Frequency	Percent
1 Company paid for removal	117	27.9
2 Removed at no cost to company	19	4.5
3 Another company paid	2	0.5
34 DK	2	0.5
35 Refusal	1	0.2
Subtotal	141	33.6
Not construction debris	279	66.4
Total	420	100.0

29.A For that typical month, about how much did your company pay for removal?

Code/Response	Frequency	Percent
1 >0 - <500	82	19.5
2 500 - <1,000	15	3.6
3 1,000 - <1,500	4	1.0
4 1,500 - <2,000	2	.5
7 3,500 - <4,000	2	.5
8 4,000 - <4,500	1	.2
12 6,500 - <7,000	1	.2
34 DK	10	2.4
Subtotal	117	27.9

	Not construction debris + removed at no cost + another company paid	303	72.1
Total		420	100.0

29.A.1. Did your company use its own trucks to transport most of the debris to a disposal site or did another company provide trucks?

Code/Response		Frequency	Percent
1	Our company provided trucks	34	8.1
2	Another company provided trucks	72	17.1
21	Other	1	0.2
Subtotal		107	25.5
Not construction debris + removed at no cost + another company paid		313	74.5
Total		420	100.0

29.A.2. Was most of the debris sent to a landfill or to another company?

Code/Response		Frequency	Percent
1	Landfill	73	17.4
2	Another company	9	2.1
21	Other	5	1.2
23	DK	20	4.8
Subtotal		107	25.5
Not construction debris + removed at no cost + another company paid		313	74.5
Total		420	100.0

29.A.3. How far (to the nearest mile, if asked) would you say the disposal site is where most (over 50%) of your debris goes.

Code/Response		Frequency	Percent
1	>0 - <5	8	1.9
2	5 - <10	17	4.0
3	10 - <15	16	3.8
4	15 - <20	12	2.9
5	20 - <25	9	2.1
6	25 - <30	6	1.4
7	30 - <35	2	0.5
8	35 - <40	4	1.0
9	40 - <45	2	0.5
10	45 - <50	2	0.5
12	55 - <60	2	0.5
34	DK	27	6.4
Subtotal		107	25.5
Not construction debris + Another company + Other		313	74.5
Total		420	100.0

29.B. What was the primary way the debris was disposed of at no cost to your company?

Code/Response		Frequency	Percent
1	Given away to public/employees	4	1.0
2	Given away to other companies	3	0.7
3	Burned	4	1.0
4	Trashed/dumped/ discarded	8	1.9
	Subtotal	19	4.5
	Not debris + paid for removal + another company paid	401	95.5
Total		420	100.0

29.C. For that typical month, about how much was your company paid?

Response		Frequency	Percent
	100	1	0.2
	6,400	1	0.2
	Subtotal	2	0.5
	Not debris + paid for removal + removed at no cost	418	99.5
Total		420	100.0

30. What percentage of the total amount of construction debris would you say your company was able to reuse?

Code/Response		Frequency	Percent
1	None	71	16.9
2	>0 - 10	33	7.9
3	11 - 20	9	2.1
4	21 - 30	6	1.4
5	31 - 40	1	0.2
6	41 - 50	5	1.2
7	51 - 60	1	0.2
9	71 - 80	2	0.5
10	81 - 90	5	1.2
11	91 - 100	2	0.5
34	DK	5	1.2
35	Refusal	1	0.2
	Subtotal	141	33.6
	Not debris	279	66.4
Total		420	100.0

31. What was the primary use your company made of the debris?

Code/Response		Frequency	Percent
1	Heating fuel	11	2.6

2	Land cover/fill	7	1.7
3	Livestock bedding	0	0.0
4	Mulch	3	0.7
5	Building materials	28	6.7
6	Re-use	12	2.9
21	Other	5	1.2
34	DK	3	0.7
35	Refusal	1	.2
	Subtotal	70	16.7
	Not debris + company did not use	350	83.3
Total		420	100.0

NOTE: None of the responding companies disposed of either railroad ties (questions 32 through 35) or telephone poles (questions 36 through 39).

- 40. I've asked about the primary wood waste your company disposes of. Does your company also dispose of significant quantities of other kind's wood waste as well? By significant I mean more than 10 percent of the total wood waste your company disposed of in 2005.**

Code/Response		Frequency	Percent
1	Yes	32	7.6
2	No	323	76.9
11	DK	14	3.3
12	Refusal	4	1.0
	Subtotal	373	88.8
		47	11.2
Total		420	100.0

- 40.A. I'm interested only in the second largest amount of wood waste your company disposed of in 2005. What type of wood waste was it?**

Code/Response		Frequency	Percent
1	Chips, shavings, sawdust	6	1.4
2	Construction debris	5	1.2
3	Dunnage	3	0.7
4	Edgings, cutoffs	8	1.9
5	Pallets, skids, containers	2	0.5
6	Railroad ties	0	0.0
7	Telephone poles	0	0.0
8	Tree trunks, limbs, stumps	6	1.4
34	DK	2	0.5
	Subtotal	32	7.6
	No second wood waste	388	92.4
Total		420	100.0

- 41. From your company's experience in 2005 and through this year, in your judgment is there no market for the kind of waste wood your company accepts or generates, a developing market, or a fully developed market for that wood? By market, we mean**

that there are buyers for the wood waste and ongoing amounts available from s suppliers.

Code/Response		Frequency	Percent
1	No market	262	62.4
2	Developing market	61	14.5
3	Fully developed market	27	6.4
11	DK	61	14.5
12	Refusal	9	2.1
	Total	420	100.0

41.A. What is the single most important reason, in your judgment, that there is no market for the kind of wood waste your firm accepts or generates?

Code/Response		Frequency	Percent
1	Contains preservative	4	1.0
2	Coated with paint	3	0.7
3	Contains glue	2	0.5
4	Attached to metal, shingles, non-wood material	5	1.2
5	Contains metal & non-wood material	16	3.8
6	No cost-effective way to sort wood from non-wood waste	44	10.5
7	Wood waste too expensive to transport	12	2.9
8	Other: low volume	40	9.5
9	Other: no good end product	47	11.2
10	Other: poor quality (rotten)	13	3.1
11	Other: not profitable	11	2.6
12	Other: pieces too small	14	3.3
13	Other: never considered & not aware of options	10	2.4
21	Other: miscellaneous	12	2.9
34	DK	26	6.2
35	Refusal	3	0.7
	Total	262	62.4
	There is developed/developing market/DK/Refusal	158	37.6
Total		420	100.0

41.B. In your judgment, what is the single most important part of the market that is as yet not fully developed?

Code/Response		Frequency	Percent
1	Difficult to identify/contact buyers	21	5.0
2	Difficult to identify/contact sellers	2	0.5
3	Difficult to get prevailing prices	2	0.5
4	High transportation costs	6	1.4
5	Wood waste more expensive to use than alternatives	3	0.7
6	Governmental regulations	3	0.7

21	Miscellaneous other	11	2.6
34	DK	13	3.1
	Subtotal	61	14.5
		359	85.5
Total		420	100.0

- 41.C. From month to month since the beginning of 2005, are the prices for wood waste accepted or generated by your company relatively stable or do the prices vary widely? As a standard of comparison, use gasoline prices at the pump.

Code/Response		Frequency	Percent
1	Prices vary less	47	11.2
2	Prices vary about as much	14	3.3
3	Prices vary more	2	0.5
11	DK	25	6.0
	Subtotal	88	21.0
	No market + developing market	332	79.0
Total		420	100.0

- 41.C.1. What do you think is causing price fluctuations?

Code/Response		Frequency	Percent
1	Unpredictable swings in supply	4	1.0
2	Unpredictable swings in demand	2	0.5
3	Inadequate information on available supply	1	0.2
4	Inadequate information about quantity demanded	1	0.2
21	Other	6	1.4
34	DK	2	0.5
	Total	16	3.8
		404	96.2
Total		420	100.0

- 41.D. As a participant in the waste wood market, do you feel that your company is getting as much market information as it needs to operate efficiently?

Code/Response		Frequency	Percent
1	Yes	54	12.9
2	No	24	5.7
11	DK	10	2.4
	Subtotal	88	21.0
	Not wood waste market participant	332	79.0
Total		420	100.0

- 41.D.1. What is the single most important kind of additional information could your company use?

Code/Response		Frequency	Percent
1	Market prices	1	0.2
2	Identity of users/buyers	13	3.1
3	Identity of sources/sellers	1	0.2
5	Explanation of governmental regulations	1	0.2
6	New uses for wood waste	4	1.0
7	New technology/ techniques for processing wood waste	1	0.2
21	Other	2	0.5
34	DK	1	0.2
	Subtotal	24	5.7
		396	94.3
Total		420	100.0

41.D.2 Do you think if your company had the additional information you just identified, it would be more likely to recycle its wood waste.

Code/Response		Frequency	Percent
1	More likely to recycle	21	5.0
2	About as likely as now to recycle	1	0.2
3	Less likely to recycle	1	0.2
	Subtotal	23	5.5
		397	94.5
Total		420	100.0

NOTE: there were no responses to question 41.D.3.

42. Now, my last question: is there anything you would like to add to your answers? Or, do you have any suggestions or comments you would like to make about the subject of our interview today?

Code/Response		Frequency	Percent
1	Yes	80	19.0
2	No	340	81.0
	Total	420	100.0

APPENDIX D

Study Species and FIA Species-Product Class Assignments

FIA species-product group	Common name	Latin name
ash	ash, European ash, green ash, white	<i>Fraxinus excelsior</i> <i>Fraxinus pennsylvanica</i> <i>Fraxinus americana</i>
basswood	basswood, American linden, littleleaf	<i>Tilia americana</i> <i>Tilia cordata</i>
birch	birch, river birch, paper	<i>Betula nigra</i> <i>Betula papyrifera</i>
Douglas-fir	Douglas-fir	<i>Pseudotsuga menziesii</i>
hard maple	maple, black maple, hedge maple, sugar	<i>Acer nigrum</i> <i>Acer campestre</i> <i>Acer saccharum</i>
hickory	hickory, bitternut hickory, pignut hickory, shagbark hickory, shellbark	<i>Carya cordiformis</i> <i>Carya glabra</i> <i>Carya ovata</i> <i>Carya laciniosa</i>
non-commercial	apple ornamental cherry / plum gingko hawthorn mountain ash, American pear, callery olive-tree, Russian Tree-of-heaven willow willow, black	<i>Malus spp.</i> <i>Prunus spp.</i> <i>Ginkgo biloba</i> <i>Crataegus spp.</i> <i>Sorbus americana</i> <i>Pyrus calleryana</i> <i>Elaeagnus angustifolia</i> <i>Ailanthus altissima</i> <i>Salix spp.</i> <i>Salix amygdaloides</i>
other hard hardwoods	chestnut honeylocust locust, black	<i>Castanea spp.</i> <i>Gleditsia triacanthos</i> <i>Robinia pseudoacacia</i>
other pine	pine, Austrian pine, Scotch	<i>Pinus nigra</i> <i>Pinus sylvestris</i>
other soft	baldcypress red cedar, eastern white-cedar, northern	<i>Taxodium distichum</i> <i>Juniperus virginiana</i> <i>Thuja occidentalis</i>
other soft hardwoods	buckeye catalpa, Northern cherry, black elm, American elm, Siberian hackberry horse chestnut plane tree, London mulberry, red sassafras sweetgum	<i>Aesculus spp.</i> <i>Catalpa speciosa</i> <i>Prunus serotina</i> <i>Ulmus americana</i> <i>Ulmus pumila</i> <i>Celtis occidentalis</i> <i>Aesculus hippocastanum</i> <i>Platanus acerifolia</i> <i>Morus rubra</i> <i>Sassafras albidum</i> <i>Liquidambar styraciflua</i>

	sycamore	<i>Platanus occidentalis</i>
poplar	aspen, bigtooth	<i>Populus grandidentata</i>
	aspen, quaking	<i>Populus tremuloides</i>
	cottonwood, eastern	<i>Populus deltoides</i>
red oak	oak, black	<i>Quercus velutina</i>
	oak, northern red	<i>Quercus rubra</i>
	oak, pin	<i>Quercus palustris</i>
	oak, shingle	<i>Quercus imbricaria</i>
soft maple	box elder	<i>Acer negundo</i>
	maple, Norway	<i>Acer platanoides</i>
	maple, red	<i>Acer rubrum</i>
	maple, silver	<i>Acer saccharinum</i>
spruce fir	fir, white	<i>Abies concolor</i>
	spruce, Colorado blue	<i>Picea pungens</i>
	spruce, Norway	<i>Picea abies</i>
	spruce, white	<i>Picea glauca</i>
walnut	walnut, black	<i>Juglans nigra</i>
white oak	oak, bur	<i>Quercus macrocarpa</i>
	oak, English	<i>Quercus robur</i>
	oak, swamp white	<i>Quercus bicolor</i>
	oak, white	<i>Quercus alba</i>
white-red pine	pine, eastern white	<i>Pinus strobus</i>
	pine, red	<i>Pinus resinosa</i>
yellow poplar	yellow-poplar	<i>Liriodendron tulipifera</i>

APPENDIX E

REFERENCES

PART ONE: WOOD RESIDUE SURVEY

Bush, Robert J., Vijay S. Reddy, and Philip A. Araman. September, 1996. *Pallets: A Growing Source of Recycled Wood*, paper presented at The Use of Recycled Wood and Paper in Building Applications Conference, Madison, WI.

Everson, Vern A. and Nicholas R. Hubing. October, 1993. *Wisconsin Wood Residue Study*, Bureau of Forestry, Wisconsin Department of Natural Resources, Publ-FR-075-93.

Falk, Robert H., David B. McKeever. April 22-24, 2004. "Recovering Wood for Reuse and Recycling: A United States Perspective", Proceedings, European COST E31 Conference, *Management of Recovered Wood*, Christos Th. Gallis (ed.), Thessaloniki, Greece.

Petroni, Rita, Richard Sigman, Diane Willimack, Steve Cohen, Clyde Tucker. December 14, 2004. *Response Rates and Nonresponse in Establishment Surveys -- BLS and Census Bureau*, paper presented to the Federal Statistics Advisory Committee (FESAC).

Siegel, Sidney and N. John Castellan, Jr. 1988. *Nonparametric Statistics for the Behavioral Sciences*, 2nd edition, McGraw-Hill, Boston.

The American Association for Public Opinion Research. 2004. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*. 3rd edition. Lenexa, Kansas: APPOR.

PART TWO: URBAN TREE SURVEY

- Avery, T.E., Burkhardt, H.E. 1994. Forest Measurements, 4th edition. McGraw_Hill, Inc., New York, 408 pgs.
- Bratkovich, S. M. 2001. Utilizing municipal trees: Ideas from across the country. NA-TP-06-01, St. Paul, MNI: USDA, Forest Service, Northeastern Area, State and Private Forestry. 50 pgs.
- DeBell, J.D., Tappener, J.C., and Kramer, R.L. 1994. Branch diameter of western hemlock: effects of precommercial thinning and implications for log grades. West J. Appl. For. 9(3): 88-90.
- Falk, B. 2002. Wood-framed building deconstruction: A source of lumber for construction? Forest Products Journal, 52(3): 8-15.
- Fang, S., Gertner, G., Wang, G. and Anderson, A. 2006. The impact of misclassification in land use maps in the prediction of landscape dynamics. Landscape Ecology, 21: 233-242.
- Freese, F. 1973. A collection of log rules. Gen. Tech. Rep. FPL-01. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 65 p. U.S. Government Printing Office, 754-546/28.
- Johnson, A.D. and Gerhold, H.D. 2001. Carbon Storage by utility-compatible trees. J. Arboriculture, 27(2): 57-68.
- Jurek, J. and Wihs, U. 1998. Norway Maple in the city forest of Northeim. Site requirements and growth. Forst-und-Holz, 53(1): 15-18.
- LeVan-Green, S.L. and Livingston, J. 2001. Exploring the use for small-diameter trees. Forest Products Journal, 51(9): 10-21.
- Mackes, K., Sheppard, W. and Jennings, C. 2005. Evaluating the bending properties of clear wood specimens produced from small-diameter ponderosa pine trees. Forest Products Journal; 55(10): 72-80.
- Matheny, N.P. and Clark, J.R. 1994. A photographic guide to the evaluation of hazard trees in urban areas. 2nd ed. International Society of Arboriculture, Urbana, Illinois, USA. 85 pgs.
- Michigan Department of Natural Resources Forest Mineral and Fire Management Division. 2003. IFMAP/GAP Lower Peninsula Land Cover. Michigan Department of Natural Resources, Ann Arbor, MI. http://www.dnr.dstate.mi.us/spatialdatalibrary/sdl2/land_use_cover/2001/IFMAP_lp_landcover.htm.
- Miles, P.D., Brand, G.J., Alerich, C.L., Bednar, L.F., Woudenberg, S.W., Glover, J.F., and Ezzell, E.N. 2001. The forest inventory and analysis database: Database Description and users manual, Version 1. U.S.D.A. Forest Service, North Central Forest Experiment Station, GTR NC-218.
- NOAA CSCC-CAP. "Late-Date Classification of the Lower Peninsula of Michigan". National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center (CSC)/Coastal Change Analysis Products(C-CAP), Charleston, SC, 2003.

- Nowak, D.J., Pasek, J.E., Sequeira, R.A., Crane, D.E., and Mastro, V.C. 2001. Potential Effect of *Anoplophora glabripennis* (Coleoptera: Cerambycidae) on urban trees in the United States. *J. Econ. Entomol.*, 94(1): 116-122.
- Nowak, D.J. and Crane, D.E. 2002. Carbon storage and sequestration by urban trees in the USA. *Environmental Pollution*, 166: 381-389.
- Nowak, D.J., Kuroda, M., and Crane, D.E. 2004. Tree mortality rates and tree population projections in Baltimore, Maryland, USA. *Urban For. Urban Green*, 2: 139-147.
- Nowak, D.J., Walton, J.T., Dwyer, J.F., Kaya, L.G. and Meyong, S. 2006. The increasing influence of urban environments on U.S. forest management. *J. Forestry*, 103(8): 377-382.
- Pillsbury, N.H., and Gill, S.J. 2003. A user guide for CUFIM, the Community and Urban Forest Inventory and Management Program. Tech. Report No. 11, Urban Forest Ecosystems Institute, California Polytechnic State University, San Luis Obispo, CA. 37 pgs.
- Poland, T.M. and McCullough, D.G. 2006. Emerald Ash Borer: Invasion of the urban forest and the threat to North America's ash resource. *J. For.*, 104(3): 188-124.
- Scott, J.L. and Betters, D.R. 2000. Economic analysis of urban tree replacement decisions. *J. Arboriculture*, 26(2) 69-77.
- Sherrill, S.B. 2003. *Harvesting Urban Timber: A guide to making better use of urban trees.* Linden Publishing Inc., Fresno, CA. 200 pgs.
- Shiver, B.D. and Borders, B.E. 1996. *Sampling Techniques for Forest Resource Inventory.* John Wiley and Sons, Inc., New York. 356 pgs.
- Solid Waste Association of North America. 2002. Successful approaches to recycling urban wood wastes. Gen. Tech. Rep. FPL-GTR-133, Madison, WI: USDA, Forest Service, Forest Products Laboratory. 20 pgs.
- Uusitalo, J., and Isotalo, J. 2005. Predicting knottiness of *Pinus sylvestris* for use in tree bucking procedures. *Scandinavian J. For. Res.*, 20: 521-533.