A profile of CCA-treated lumber removed from service in the southeastern United States decking market

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Abstract

This research developed a profile of used chromated copper arsenate (CCA) lumber removed from the demolition of residential decking. This was achieved by gathering and compiling information regarding the construction, demolition, deck remodeling, deck replacement factors, and factors affecting the recovery of spent CCA lumber. In addition, qualitative responses regarding programs and incentives to facilitate recovery, and the potential products that could be manufactured from spent CCA lumber were addressed. The study included a mail questionnaire that was sent to over 2,800 contractors in Georgia, North Carolina, and South Carolina. A mail questionnaire was used to collect both demographic data and assess the factors affecting the recovery oftreated lumber. Research findings indicate the average age of decks at removal was nearly 13 years, and that the average size of decks is increasing, from 198 to 272 ft.^{2}. Extrapolated results indicate that 67.5 million board feet oftreated lumber was removed from the sample states and 1 billion board feet ofdecking lumber was removed in 1999 from the demolition of decks. The majority ofparticipants built new decks. When decks were repaired, the primary components replaced were deck boards and railings. The primary reason for deck replacement was decayed wood, and the majority ofrespondents directed spent CCA lumber to municipal solid waste landfills. The two salient reasons for not recovering spent CCA lumber were a lack of recovery facilities and programs, respectively.

Recent research regarding the quantities of preservative-treated lumber taken out of service indicates that there is a pressing need to determine the factors affecting the recovery, recycling, and the subsequent utilization of used lumber treated with chromated copper arsenate (CCA). Recovery, as it pertains to this research, concerns diverting spent CCA lumber from landfills.

This research project focused on the removal of CCA-treated southern yellow pine products utilized in decking applications. Southern yellow pine is the primary species group that is preservatively treated in the United States. The Southern Forest Products Association (SFPA) (12) estimated production to average nearly 6 billion board feet (BF) a year during the time frame 1997 to 2004. The SFPA also estimates that over 2 billion BF was utilized in the fabrication of decking in 2000. Treated southern yellow pine is also used in many other applications, including framing, trusses, wood foundations, agriculture, industrial uses (e.g., marine, highway, and material handling), fences, landscaping, remodeling, and products for export. It should be noted that the largest

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share of treated lumber is estimated to be utilized in outdoor decking, nearly 38 percent (12).

Several investigators in the past decade have estimated the volume of CCA-treated lumber being removed from service. The estimates of CCA-treated lumber taken out of service range from 9 million m^3 in the year 2000 (4) to 19 million m^3 in 2020 (6). The largest share of treated lumber taken out of service is believed to be derived from the demolition of and remodeling of outdoor decks. McQueen and Stevens (9) projected that nearly 12 million m^3 of treated lumber will be removed from service in 2004.

There is growing concern over the disposal of spent CCA-treated lumber. An alternative to the disposal of used lumber directed to landfills is the recovery and subsequent recycling of spent lumber. However, many factors are not understood or known about the potential recovery of spent CCA-treated lumber. These factors include deck sizes, the number of deck removals, the quantities of CCA-treated lumber removed age of the treated lumber at removal, current fabrication and remodeling practices, deck removal factors, lumber disposal practices, and barriers toward the recovery and recycling of used lumber. These factors must be investigated in order to affect the recovery and recycling of CCA-treated lumber.

Estimating the quantities of treated lumber taken out of service is critical, as we need to develop accurate estimates or validate previous estimates. State, county, and other government officials need reliable estimates to develop recovery programs and the facilities to accommodate the used CCA lumber being taken out of service. Accurate data will provide researchers with information to recommend different applications and potential markets. Finally, current information will assist governmental officials and university researchers in directing future research in this area.

The objectives for this study were: 1) produce a profile of the decking construction industry that includes estimates of current decking fabrication, demolition, replacement practices, components, and disposal; 2) estimate the quantities of CCA-treated lumber being removed from service in the sample states and project decking lumber being removed from service nationally; and 3) identify the factors that affect the recovery of spent CCA-treated lumber.

Methodology

Population

Contractors associated with the fabrication, demolition, and deconstruction of residential decks were the population of interest for this study. The contractors sampled for this research were from Georgia, North Carolina, and South Carolina.

Sample frame and data collection

The sample frame was obtained from the American Business Disc 2000 (8), which listed a total of 5,902 contractors (with the capability to construct decks) in Georgia, North Carolina, and South Carolina (Harmonized System Codes (HS) 15 and 17). The sample included deck and patio builders, deck builders, homebuilders, carpenters, handymen, fence contractors, and general contractors. Potential respondents were selected by utilizing a simple random sampling method and the total number of questionnaires mailed was 2,833.

The primary data collection tool was a self-elicitation mail survey questionnaire. The mail survey and sequencing were modeled after Dillman's Total Design Method (5). A prenotification letter was mailed on July 25, 2000, 2 weeks before the questionnaires were mailed. This was followed by three additional mailings of the questionnaires. Reminder postcards were also mailed.

Survey questionnaire development

The questionnaire was designed to gather data regarding deck fabrication, demolition, deconstruction, disposal, and recovery factors regarding used CCA-treated lumber. Questions queried respondents on several facets of construction and recovery, and included the number of decks built and demolished the age of treated lumber at deck removal, deck replacement practices, and factors for removal or construction of new decks.

Prior to final questionnaire development, contractors were contacted through personal visits in the Commonwealth of Virginia and the State of Maryland and by phone to solicit their thoughts regarding the recovery of used CCA lumber. Critical issues regarding the recovery of treated lumber were identified. After this process, specific questions within the questionnaire were designed to meet research objectives. In addition, scholars from Virginia Tech and personnel from the USDA Forest Service Southern Research Station also assisted in the questionnaire development.

The questionnaire was pre-tested during the spring of 2000 via a mail and facsimile survey. Respondents were asked to identify questions that may be troublesome to answer and for their input regarding question wording. Eighteen contractors from the Commonwealth of Virginia responded to the pre-test. After the pre-test and minor modifications, the questionnaire was finalized for printing.

Results and discussion

In total, 580 questionnaires were completed, 681 were returned as undeliverable, and 13 refused to participate. The first question asked the respondent if their company fabricated decks; 180 respondents answered No, and 400 respondents checked Yes. The total adjusted response rate was calculated by subtracting the bad addresses and non-participation requests from the mailing total and dividing it into the usable responses. The total adjusted response rate was 27.1 percent (580/2,139).

Non-response bias

To ensure the validity of the research, non-response bias procedures were employed. Contractors that did not respond to the mail survey questionnaire were randomly selected and contacted by phone. These individuals were asked five pre-selected questions from the questionnaire. A total of 30 responses were collected for the non-response bias investigation.

An independent samples student t-test was executed to discern if there were statistical differences between respondents and non-respondents on the pre-selected questions. There were no significant differences detected on four of the questions. The question that resulted in a significant difference asked respondents, "In your opinion, what percentage of decks are repaired or built by the homeowner?' This statistical finding may be due to the wording of the question, as the question should have been two separate and distinct questions. Additionally, the Armstrong-Overton (3) wave analysis method was employed and

contrasted the first 30 respondents against the last 30 respondents. No statistical differences were discovered utilizing this method ($\alpha = 0.05$).

Deck fabrication and demolition

To develop the quantities of CCA-treated lumber removed from service, several questions regarding deck fabrication and demolition were necessary. Data were collected on the number of decks built in 1999, the average size (ft.') of decks built in 1999, decks demolished in 1999, the average size of decks demolished in 1999, the average age of the decks removed in 1999, the percentage of decks built or remodeled by the homeowner, and discards (i.e., scraps) from deck fabrication.

The mean number of decks built per respondent in 1999 was 31.2 and the average size of the decks was approximately 272 square feet. A recent article by Shook and Eastin (10) reported an average deck size of 239 square feet for spec homes and 398 square feet for custom homes in the southeastern United States. In addition to the survey data collected deck building permits were also analyzed in this study. This involved collecting deck sizes from permits issued in Charlotte, North Carolina; Greenville, South Carolina; and Decatur, Georgia. An independent samples t-test was executed to discern if differences existed between respondent data and deck permit data. There was no significant difference found between respondent and deck permit data regarding the size of decks built in 1999, with a p-value > 0.40 ($\alpha = 0.05$).

The average number of decks demolished in 1999 was 7.6 per respondent and the decks averaged about 198 ft.^{2} The average age of decks at removal was nearly 13 years. This was 4 years higher than reported by a previous study. McQueen and Stevens (9) estimated that the average age of a deck at removal was approximately 9 years. Truini (13) reported that decks are repaired, remodeled, or expanded after 10 to 12 years.

Respondents were also asked to estimate the percentage of decks built by homeowners. Analysis of respondent data indicates that over 35 percent of decks were either built or remodeled by the homeowner. This finding is in line with Truini (13), who reported that do-it yourself (DIY) homeowners fabricate 40 percent of all decks. Also, the Home Improvement Research Institute reported that homeowners build 46 percent of all decks (cf. 11). Finally, over 7 percent of the lumber purchased to construct a deck resulted in discards or scraps.

Estimation of CCA-treated southern yellow pine lumber removals

A primary focus of this research was to determine the quantities of CCA-treated lumber being removed from service. As mentioned previously, the disposal of spent CCA-treated lumber is a topic of concern among researchers, both in the treating and southern pine manufacturing industries. The quantity estimates of CCA-treated lumber coming out of service will allow us to gauge if removals are a pressing problem and provide information for industry and government personnel to develop recovery facilities and businesses.

The southern yellow pine CCA-treated lumber production data used in this research was obtained from the Southern Forest Products Association (12), the American Wood-Preservers' Association (2), and the American Wood Preservers Institute (1). Additionally, to obtain treated lumber materials and quantities required to fabricate a deck, we utilized Lowe's™ Project Design System. The quantity of southern yellow pine CCA-treated lumber removed from service (in 1999) in the selected states and the lumber removed from the demolishing of decks in the United States was determined by using the average deck size, the estimated board footage contained in a deck, the average number of decks removed per respondent, the sample frame and national population estimates, and the percentage of decks built by the homeowner.

Deck size and treated lumber quantities

Drawing upon the analysis of respondent data, the average deck demolished in 1999 was approximately 198 square feet. A statistical method for indicating the reliability of an estimate is achieved by establishing confidence limits as estimate parameters. The confidence interval for the average square footage contained in a deck was 183 to 214 ft.^{2} This parameter was calculated by using a large sample size approximation (7).

In order to estimate the lumber required in a deck, we used the dimensions of 12 by 16 feet, which results in a deck that contains 6 ft.^{2} less than the average reported demolished deck. The treated lumber required for a 192-ft.^{2} deck was estimated to be 1,057 BF. The estimated board footage was strikingly similar to that found by George Carter and Affiliates (cf. 11), as they estimated 1,029 BF of treated lumber was contained in a deck built in 1987.

Extrapolation and assumptions

The extrapolation was based on several assumptions and they are as follows:

- The estimation was for 1999.
- The average deck size is 12 by 16 feet and contains 1,057 BF.
- Eight decks per builder were demolished.
- DIY homeowners demolish 35.3 percent of all treated-lumber decks.
- There are 5,902 builders in the three sample states and 88,579 in the entire United States.

The sample frame included 5,902 members from the states of Georgia, North Carolina, and South Carolina. Nationally, the study population contained 88,597 members. To calculate the average number of decks demolished per respondent, the reported number of decks were summed and divided by the number of respondents. The average number of decks reported demolished per respondent was 7.6. In order to provide a conservative estimate, the aforementioned average was expanded to eight decks per respondent.

To obtain the total number of decks demolished in the selected states, the decks demolished per respondent were multiplied by the sample frame population. This yielded 47,216 decks demolished in those states (in 1999). This total was multiplied by 1,057 BF (the estimated BF contained in a deck), yielding 49,907,312 BF (full sawn) removed in 1999. Using an alpha level of 0.05, the 95 percent confidence interval for this estimate is 38.1 million BF to 61.0 million BF.

The estimated board footage total was then adjusted by multiplying the percentage estimate of homeowner construction (35.3%) by the estimate of BF removed. The estimated CCA-treated

lumber removal was 67524,593 BF in the selected states. The 95 percent confidence interval for this estimate is 52.5 million BF to 82.5 million BF (α = 0.05).

The national estimate of decking lumber removals was executed in the same manner. The national population contained 88,597 members (HS Codes 15 and 17). The total number of decks demolished in 1999 was 708,776 and 749,176,232 BF of decking lumber was removed. Using an alpha level of 0.05, the 95 percent confidence interval for this estimate is 582.5 million BF to 915.8 million BF.

Adjusting for homeowner fabrication, the total board footage removed nationally was 1,013,635,442 in 1999 (full sawn). The 95 percent confidence interval for this estimate is 788.2 million BF to 1.2 billion BF (α = 0.05). Conversion of this total resulted in 84,469,620 $ft.^3$ or 2,392,180 m^3 of decking lumber removed in 1999.

Deck demolition and remodeling component practices

To gain insight into current demolition and remodeling practices, respondents were asked several questions regarding the building of decks and deck component replacement **(Fig. 1).** There were 323 respondents who reported building completely new decks in 1999. Of this total, 136 (42.1%) indicated that they fabricated new decks exclusively. Nearly 2 1 percent (39) reported building new decks more than 90 percent of the total project time.

Nearly 45 percent of the respondents indicated that they remodeled decks in 1999. Deck board replacement was the most common remodeling procedure, with 64.6 percent of respondents indicating this. The replacement of deck railings was the next most common procedure (45.5%). Stair tread replacement was reported by 27.5 percent, and 17.0 percent indicated that they replaced joists or stringers in decks. The replacement of deck lattice was reported by 16.5 percent of the respondents, and finally, 4.5 percent of the respondents indicated that other types of remodeling procedures were employed. This included the turning over of deck boards, replacing supports, replacing poplar posts, rebuilding a deck with concrete, and adding new hardware.

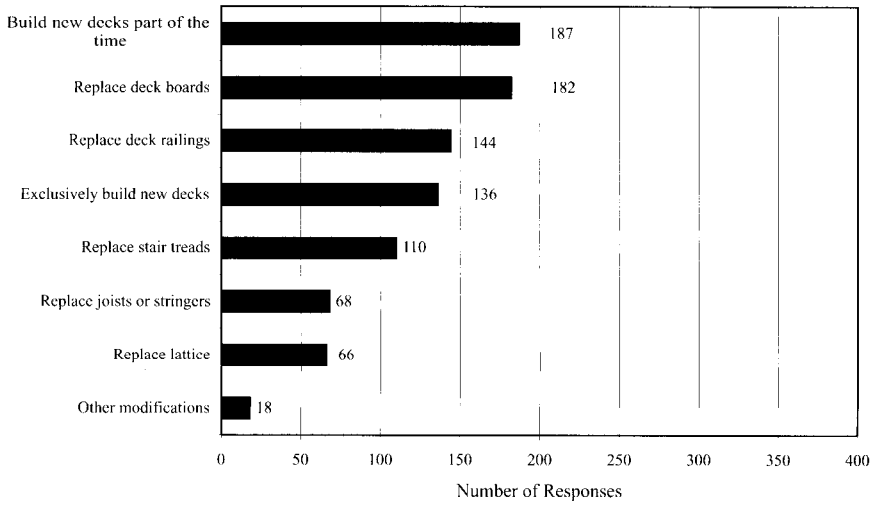

Figure 1. — Response distribution for current deck fabrication and remodeling practices.

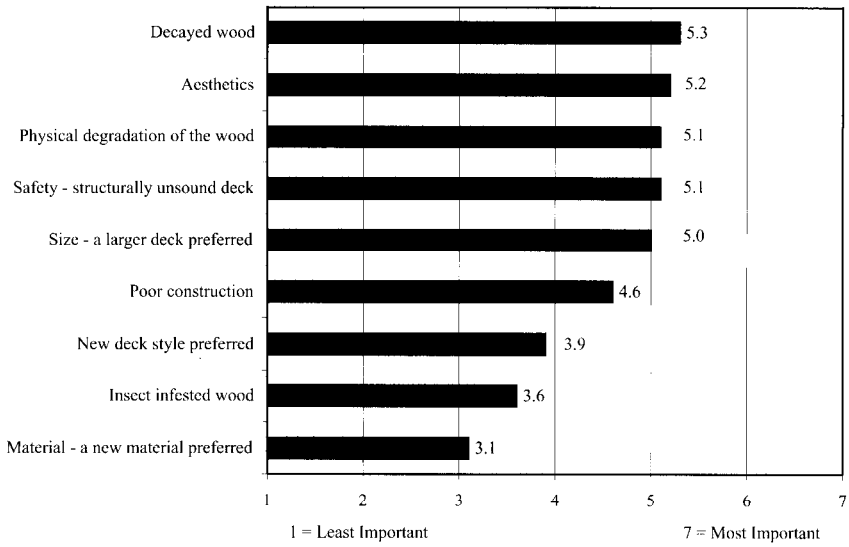

Figure 2. — Deck replacement importance factors.

Deck demolition and deconstruction costs

Respondents were asked questions concerning the costs associated with deck fabrication and deconstruction. The importance of these questions lies in the fact that financial incentives could be developed to encourage the recovery of used lumber. The average disposal cost (e.g., labor, tipping fees, and transportations costs) reported by the respondents was nearly $180 per deck.

Respondents were asked to estimate the cost for deconstructing a deck for recovery rather than demolishing the deck. The average cost for deck deconstruction was more than two times the estimated cost for demolishing a deck, nearly $371 per deck. Intuitively, this should indicate that financial incentives will have to be incorporated in conjunction with other programs, promotions, and facilities, for recovery to become a viable option.

Potential lumber recovery

Participants in the study were asked several questions regarding the percent-

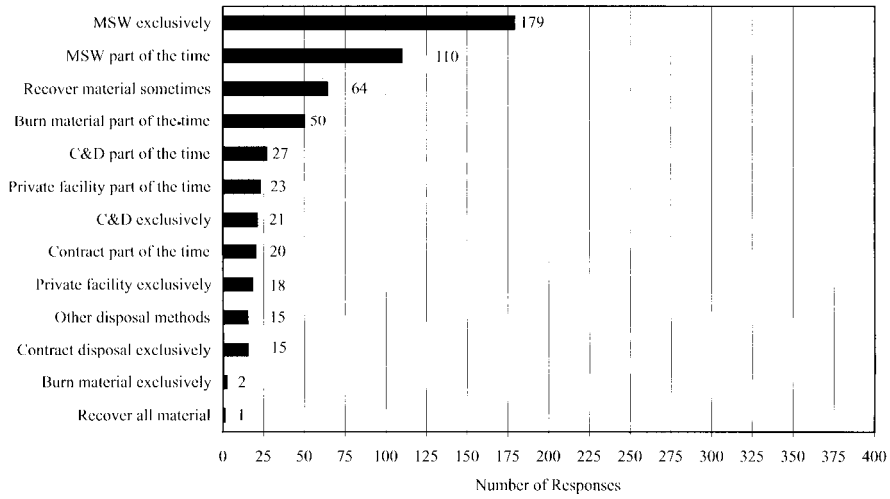

Figure 3. — Response distribution of current disposal facilities and disposal methods for spent CCA-treated lumber.

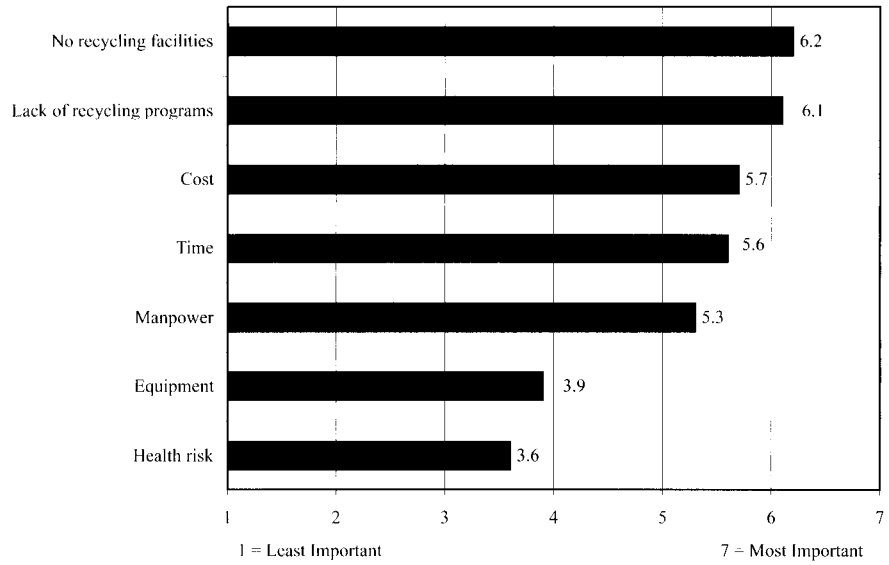

Figure 4. — Lumber recovery importance factors.

age of lumber that could be potentially recovered from a deck, and used lumber currently being recovered from decks. This information can be utilized to recommend new applications for used lumber, and the building of the requisite recovery facilities.

It was found that over 44 percent of treated lumber could be potentially recovered. The mean percentage of lumber reported being recovered from dismantling a deck was over 51 percent.

Deck replacement factors

These questions were designed to gain an understanding of the factors concerning deck replacement. This information can be used by the producers of southern yellow pine for product offerings and promotions, and it may also be used to encourage the restoration and/or expansion of a deck rather than demolishing the old deck. Respondents were asked to rate the deck replacement factors on a 7-point rating scale: 1 = least important and 7 = most important.

The highest-rated factor for deck replacement was decayed wood at 5.3. This was followed by aesthetics (5.2). The physical degradation of the wood components was rated at 5.1. Safety, or a structurally unsound deck was the next highest factor, followed by homeowner preferance for a larger deck. Other reasons for deck replacement, in order of importance, were poor construction, a new deck style preferred insect-infested wood and finally, a new material was preferred **(Fig. 2).**

Primary disposal facilities and methods

Data were collected on the primary disposal methods and the facilities where contractors directed their used lumber **(Fig. 3)** Concerning the primary method of disposal a contractor used 72.3 percent reported they disposed of used lumber in municipal solid waste (MSW) landfills. Of this total, 44.7 percent of the respondents used MSW facilities exclusively. Additionally, 8.0 percent directed disposals to MSW landfills more than 90 percent of the time. Construction and demolition facilities (C&D) were used by 12.0 percent of the respondents and 5.3 percent of the respondents directed their used lumber to C&D facilities exclusively. Over 10 percent replied that they disposed of spent CCA lumber at private facilities, either exclusively or part of the time.

Spent lumber was recovered for reuse by 16.0 percent of the respondents, and of this total, 1.5 percent reused the material more than 90 percent of the time. Less than 1 percent of the respondents indicated that they recovered all of their spent lumber for reuse. Contract disposal was utilized by 8.7 percent of the respondents, and 3.7 percent of the respondents used other disposal methods. Other disposal methods included using the recovered lumber to build deer stands, reusing it in the home, disposing of it in a dumpster, homeowner giving it away, and contractors burying it or giving it away. Thirteen percent of the respondents reported burning used lumber as their primary or alternative disposal method. Of this total, 11.3 percent burned the used material less than 50 percent of the time. The burning of treated lumber is legally prohibited and is detailed on the consumer information sheet that is given to buyers at the time of purchase.

Lumber recovery factors

When contemplating the recovery of used CCA lumber, there are several factors that a contractor must consider.

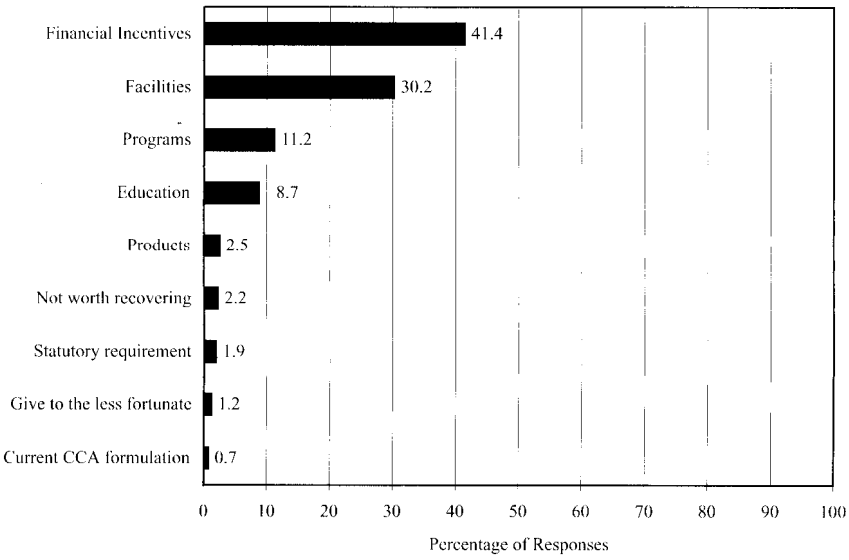

Figure 5. — Suggested incentives or programs for the recovery of CCA-treated lumber.

These factors include time, costs, a lack of recycling facilities, recycling programs in place to assist a contractor, the manpower to dismantle, and equipment. Respondents were asked to rate each of these factors utilizing a 7-point rating scale: 1 = least important and 7 = most important **(Fig. 4).**

Not surprisingly, a lack of recycling facilities was rated the highest at 6.2. This was followed closely by a lack of recycling programs, which had a mean rating of 6.1. The costs associated for dismantling a deck was the third highest rated factor at 5.7. The next highest rated factor was time, followed by manpower and equipment. Health risk was the lowest rated factor. Most salient are the lack of recycling facilities and lack of recycling programs, which indicate that recovery programs and centers will have to be developed and built in order to facilitate the recovery and recycling of used CCA-treated lumber.

Qualitative question results

The respondents were asked two open-ended questions. The first queried the respondents for their opinion on what incentives or programs could be instituted or developed to initiate the recovery and recycling of spent CCA-treated lumber.

Respondents offered 321 ideas or opinions on possible initiatives; 129 respondents mentioned financial incentives **(Fig. 5).** Contractor responses indicated that some type of financial incentive needed to be offered to facilitate recovery (41.4%). Thirty-one percent of that 41 percent indicated that some type of monetary inducement should be offered. Nearly 29 percent indicated that there should not be any tipping fees or a reduction in tipping fees. Fourteen percent indicated that the incentive should be based by the pound or by the ton. Next, 11.6 percent of the respondents reported that they should be paid to recover the material. Nearly 8 percent indicated that some type of tax break should be instituted. Other incentives included retailer discounts (2.3%) and penalties or fines (2.3%). Less than 2 percent (1.5%) indicated that they should receive a discounted price at the time of purchase, and less than 1 percent (0.3%) indicated that a fund should be established for demolition.

The establishment of recovery facilities was the next most frequently reported response (30.2%). Nearly 70 percent of these responses simply indicated that recovery centers needed to be developed and easy access to those facilities should be available to contractors. Some respondents got more specific. Over 17 percent of the 30.2 percent indicated that separate areas should be developed at the landfill site. Participants also reported that business establishments such as Home Depot or Lowe's should establish the recovery centers (5.4%). The respondents also stated that dumpsters or containers should be made available at the jobsite (3.2%) the recovery facilities should also receive spent lumber that contains nails (3.2%) and treated lumber manufacturers should provide recovery centers and accept used treated lumber (1.1%).

The establishment of recovery programs was the next highest rated response category at 11.2 percent. The most frequently reported option was the development of a buyback program (36.1%). This was followed by the establishment of industry or government pickup programs at the jobsite (27.7%). Recommended equally (13.9%) were the development of a county government recovery program or a program by building associations in conjunction with a government agency. The next three response categories each were mentioned equally (2.8%): local governments contracting with builders, the establishment of a community recycler, and that any program developed should not include any government agency participation.

Several respondents indicated that public education programs needed to be developed, nearly 9 percent. Respondents reported that the public education program should include methods for demolition, material on why the recovery of spent CCA-treated lumber was necessary, and literature on the potential health risks associated with the building and demolition of CCA-treated structures.

The next highest rated response category involved products and processing equipment (2.5%). The respondents indicated that the development of a viable product line was necessary (71.4%). Next, the development of processing equipment and processing techniques should be incorporated (13.3% each). Finally, respondents reported that a listing of alternative products to CCA-treated lumber should be made available to them (2%).

Over 2 percent of the respondents indicated that used CCA-treated products were not worth recovering. Nearly 2 percent of the respondents reported that statutes should be instituted to initiate the recovery of spent CCA-treated products. Over 1 percent of the participants reported that the used CCA-treated materials should be given to the less fortunate in local communities.

The final category involved the constituents of CCA-treated lumber products currently being manufactured (less

than 1%). Responses indicated that the retention level of CCA-treated products should be increased or improved, or that the arsenic contained in CCA products should be removed.

Participants were next asked to offer their opinion on the types of products that could be produced from recovered CCA-treated lumber **(Fig. 6).** It should be noted that the following results are actual responses of the study participants and are not the opinions of the researchers. Neither Virginia Tech, the Department of Wood Science and Forest Products at Virginia Tech, nor the USDA Forest Service endorse or recommend any of the following uses, recommendations, or products for spent CCA lumber.

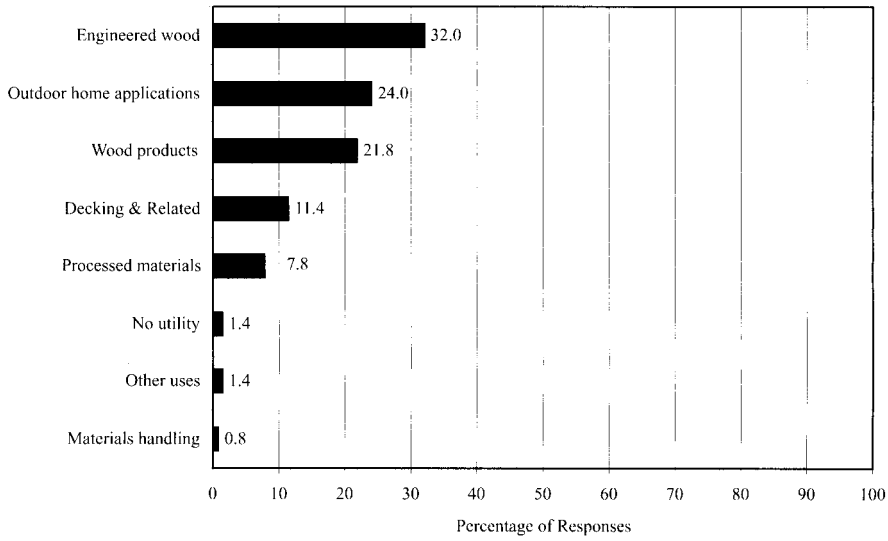

Figure 6. — Suggested uses for recovered CCA-treated lumber.

For this question, the largest response was utilizing the CCA-treated lumber to manufacture some type of engineered wood product(s) (32.0%). Many products were listed including microlam, parallam, laminated veneer lumber, and medium density fiberboard (46.1%, combined). The production of treated oriented strandboard was mentioned by 42.6 percent. Other potential products included composite decking material (6.1%), miscellaneous composite products (2.6%), treated finger jointing (1.7%), and fillers for composite products (0.9%).

The use of CCA-treated lumber for outdoor home applications was the next highest product category (24%). The most frequently mentioned response was to apply the recovered lumber as landscape borders (31.4%). This was followed by the manufacture of lawn furniture (19.7%) and the building of playground structures (12.7%). Both fencing materials (8.1%) and flower planters (4.6%) were also mentioned. The manufacture of lattice (7.0%) and pickets (4.7%) followed. Other uses included the manufacture of birdhouses and feeders (3.5% each) and tree houses, screen doors, gables and vents, or the repair of porches (1.2% each).

The manufacture of miscellaneous wood products from spent CCA-treated lumber was the next product category (21.8%). Stakes (31.9%) were the most frequently mentioned product. This was followed by using recovered lumber as forming materials (15.8%), the manufacture of other lumber products and firewood logs (7.9% each), and using the material for posts (6.6%). Use as non-visible support structures, reusing the larger pieces in other applications, and the manufacture of small wood products were also mentioned (3.9% each). The use of treated lumber for the construction of mudsills, baller boards, and artwork were also equal (2.6%). The following products were mentioned and each comprised 1.3 percent of the wood products category: spindles, parking stops, signs, crawl space lumber, deer stands, mats, and sub-flooring.

The manufacture of decking and decking related materials were mentioned in 11.4 percent of the responses. In this category, the fabrication of small decks from used CCA-treated lumber was the most frequently mentioned response at 6 1.6 percent; followed by the construction of walkways (22.6%) and the manufacture of stair treads (12.9%). Finally, these products were followed by the fabrication of docks (2.9%).

The next product category was processed materials (7.8%). Respondents indicated that used treated materials should be processed for further application. The manufacture of mulch was the most frequently mentioned product (61.9%), followed by chips and paper products (10.7% each). Next, respondents mentioned the processing of spent CCA material for fuel fiber (7.1%). This was followed by the manufacture of sawdust, the processing of recovered lumber for absorption material, and the production of pet pen mulch (3.2% each).

The next categories included utilizing the spent material for other uses and no utility (1.4% each). Participants indicated that used material could be given to the less fortunate and that the opportunities for using spent CCA-treated material were endless.

Materials handling is the next application category recommended for utilizing spent CCA-treated lumber (0.8%). In this category, crates and pallets were the primary product mentioned (66.7%) followed by the manufacture of dunnage (33.3%).

Conclusion

This research sought to develop a profile of used CCA-treated lumber resulting from fabrication and demolition of residential decking. This was achieved by gathering and compiling information regarding the construction, demolition, deck replacement components and factors, and recovery factors. In addition, qualitative responses regarding programs and incentives to facilitate recovery, and the potential products that could be manufactured from spent CCA lumber were elicited.

Analysis of respondent data indicated that the average size of decks is increasing, as the average size of a demolished deck was nearly 198 ft.^{2} and a new deck contained approximately 280 ft.^{2} The estimated age of decks was nearly 13 years at removal; this is notably higher

than found in previous research. From extrapolation, we estimate that over 47,000 decks were demolished in the sample states and nearly 709,000 decks were demolished nationally. Our estimates indicate that about 67.5 million BF of CCA-treated lumber were removed from service in the sample states. The national estimate of decking lumber removed from service was over 1 billion BF, or nearly 84.5 million ft.^{3} removed in 1999.

Regarding deck replacement factors, the primary factor for replacing a deck was decayed wood. Aesthetics, the physical degradation of wood, and safety followed closely. Surprisingly, a new deck style preferred and a new material preferred were among the lower rated factors. This may signal the opportunity for increased component replacement rather than demolishing and fabricating a completely new deck.

When observing the results for importance factors concerning the recovery of spent deck lumber, the most striking results are "lack of recycling programs" and a "lack of recycling facilities." Responses from the qualitative question regarding initiatives or programs to facilitate recovery supported the findings of the recovery importance factors. The largest percentage of qualitative responses indicated that financial incentives should be instituted to facilitate the recovery of CCA-treated lumber. Additionally, respondents overwhelming indicated that recovery centers needed to be built in order to facilitate recovery. It should be self-evident that programs and facilities will have to be developed to make the recovery of treated lumber a viable option.

One of the more salient findings was the lack of knowledge regarding the disposal of CCA lumber and potential products that could be manufactured from spent CCA lumber. Obviously, certain respondents are not cognizant of the regulations and ramifications regarding the disposal of CCA lumber and of burning spent lumber. This finding was also illustrated in the potential products responses, as certain respondents suggested the manufacture of fire logs. This finding not only has strategic implications regarding the recovery of CCA lumber but also relates to marketing in general. The primary implications are that the industry should strive to understand the knowledge level of the customers and develop marketing campaigns to address the specific knowledge level of the customer.

The results of this research indicate that the cost of dismantling a deck, financial incentives, and recovery programs and facilities are important factors with contractors. For the recovery of treated lumber to become a viable alternative to landfill disposal, it is vitally important that these issues be addressed to assist in the recovery of discarded CCA-treated lumber. Addressing these needs will benefit the producers of southern yellow pine, the treating industry, consumers, municipalities, and our forests.

Study limitations and future research

Each geographic region of the United States was not sampled and the study was limited to the states of Georgia, North Carolina, and South Carolina. Replication of this study to other geographic areas of the United States would expand the external validity of the results.

This study focused on the factors affecting recovery and not on the manufacturing of products from recovered materials. Contractors apparently do not have viable options for recovered CCA-treated lumber. This suggests that a practical product line should be developed, as well as a distribution model for those products.

Finally, future research should also address the issue of financial cost to the contractor. An additional project relating to cost would contrast the price of a deck fabricated with new materials to the cost of a deck built with remanufactured materials. The results would enable investigators to determine if remanufacturing spent CCA lumber is an economically viable alternative.

Literature cited

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