

The Feasibility of Recycling CCA Treated Wood From Spent Residential Decks

By

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ABSTRACT

The amount of CCA treated wood being removed from spent residential decks is increasing at a tremendous rate. While most spent CCA treated wood is being disposed in landfills, further useful and environmentally beneficial alternatives have to be met. This research estimated the percentage of recoverable lumber from spent CCA decks that can be recycled into other usable products. Six residential decks were removed from service, by either demolition or deconstruction procedures. It was found that 86% of the CCA treated wood from the residential decks could be recovered as reusable CCA treated lumber. It was also found that deconstruction of a residential deck, rather than demolition, was not a factor in the volume of CCA treated wood recovered. Chemical and mechanical properties of the removed CCA treated wood were also analyzed. The chemical retention of the deck material proved that most of the spent CCA treated wood could be used in above ground applications. The stiffness of spent CCA treated wood from residential decks was approximately equal to that of recently treated CCA wood. The strength properties were slightly lower than recently treated CCA wood probably due mainly to physical and climatic degradation. Products were then produced that could be successfully utilized by recycling centers or community and government organizations. Products manufactured included, pallets, picnic tables, outdoor furniture, residential decks, and landscaping components. Waste management, recycling, and government organizations were interviewed to determine what markets and barriers exist for recycled CCA treated products. Most landfill and recycling facilities do not currently sort

or recycle CCA treated wood, citing the main reason as a lack of a viable market. Potential users were interested in the material but cited they did not know where to locate the material. A communication barrier exists between the waste management industry, recyclers, and users; which is preventing the successful recycling of CCA treated wood from spent residential decks.

DEDICATION

This work is dedicated to my wife, Amanda Hood Bailey, who I love and cherish dearly. She has sacrificed and endured much to help me succeed in life, and for that I will always be indebted. With her love, support, and absolute honesty I can never fail in whatever I pursue in the future. I am the luckiest man alive to spend the rest of my life with her.

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PREFACE

This thesis consists of five sections. Chapter One provides justification for this research, defines the objectives of this research, and reviews literature relevant to the recovery of CCA treated wood from exhausted residential decks. Chapter Two discusses the amount of recovered CCA treated wood from the residential deck obtained in this study, and the time and resources required to successfully recover CCA treated wood from residential decks. Chapter Three discusses the mechanical and chemical properties of the recovered CCA treated wood and how it compares to recently treated wood. Chapter four discusses the potential products that can be produced from recovered CCA treated wood in spent residential decks and the possible barriers associated with the reuse of the material from the landfillers, recyclers, and potential users perspective. Chapter Five consists of a summary of the results and conclusions, prescribes recommendations for future research, and describes the limitations to this study. In addition, some duplications of information between manuscripts, to allow them to stand alone, was unavoidable. The author apologizes for any inconvenience this may cause the reader.

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CHAPTER ONE. OVERVIEW OF CCA TREATED WOOD, RESIDENTIAL DECKS, AND THE RECYCLING INDUSTRY

INTRODUCTION

The United States is the world's leader in the consumption of wood products. According to the Food and Agriculture Organization (FAO), in 1998 the per capita consumption of wood products in the United States was 1.53 cubic meters, compared to the world consumption of .26 cubic meters. An immense burden is placed on our forests and that burden extends throughout the life of the wood even after disposal. As markets and demand for wood increase each year the disposal of wood products will also increase. This trend is also evident in the Chromated Copper Arsenate (CCA) treated wood industry.

The CCA treated wood industry has grown significantly over the past decades. In 1980 the amount of Southern Yellow Pine (SYP) treated with CCA was 2 billion board feet compared to almost 7 billion in 2001 (Southern Pine Council, 2002). The increase of CCA treated wood over the past decade is mirrored by the predictions of large volumes of CCA treated wood reaching the end of its useful life. Several researchers have predicted that the amount of CCA treated wood reaching the end of its useful life will increase dramatically over the next decades (Alderman, 2001, Cooper, 1993, McQueen and Stevens, 1998, and Felton and DeGroot, 1996).

The environmental impact of disposed CCA treated wood is also becoming a growing concern. Many local, state, and federal governments are investigating the potential hazards of spent CCA treated wood in landfills (Tom, 2001(a and b), Matus, 2002, and The Alachua County CCA Team, 2001). If stricter regulations on the disposal of CCA treated are enacted, then tipping fees will increase, the availability of adequate disposal sites will decrease, and the demand for non-wood alternative products will rise.

In order to reduce the negative effects the disposal of CCA treated wood will entail, the useful life of CCA treated wood must be extended. Which will involve the recovery and recycling of spent CCA treated wood products. New alternative markets and products will need to be evaluated and proper programs established by manufacturers, recyclers, and governments. If the reuse of CCA treated products is successful then the demand on landfills and the nations forests will be reduced.

The CCA treated wood industry is not the first to develop alternatives to landfilling. The wooden pallet industry faced many the same obstacles several years ago, and now approximately 40% of the pallets in the United States are made from recycled pallets (Bejune et.al., 2001). The pulp and paper industry has also faced the same problems. The United States currently recycles 45% of its paper mainly due to increased regulations and higher tipping fees (AF&PA, 2001). Recycling of wood products is not new, and with the increase of CCA treated wood reaching the end of its useful life, this industry must recognize the amount of spent CCA treated wood that can be recycled, products to manufacture from the recovered material, and potential markets for spent CCA treated wood.

PROBLEM STATEMENT AND OBJECTIVES

PROMBLEM STATEMENT

The amount of CCA treated wood being removed from service will be increasing at a dramatic rate of the next few decades. This rise will affect the way current disposal methods are being performed, and increase the environmental scrutiny and safety concerns that the treated product is already receiving. Approximately 40% of CCA treated wood produced is used in the residential deck market, whether for repair and remodeling or for new construction. Recent research approximated the amount of spent CCA treated wood being

removed from residential decks is one billion board feet a year (Alderman, 2001). This information is startling, and also solicits for further information regarding the amount of useful material, the performance of that material, potential recycled products, and barriers affecting the recovery of spent CCA treated wood.

Several important areas need to be researched to acquire information needed on the potential of recycling spent CCA treated wood. First, spent CCA treated residential decks, prior to demolition, need to be studied. Information including removal factors and history of decks being dismantled need be obtained. In order to make comparisons of different decks and volume of material following removal, the volume of a spent deck prior to removal needs to be obtained. The process of dismantling a deck needs to be researched to distinguish if certain methods will help the recovery of usable material. The amount and type of usable material needs to be obtained from a dismantled deck to understand the types and volume of recycled products that can be produced. The possible change in physical, chemical, and mechanical properties of any recovered raw material due to weathering or wear needs to be understood so suitable recycled products can be provided. Therefore to find appropriate applications for the recycled material the chemical retention and mechanical characteristic of spent CCA treated wood needs to be analyzed.

After information has been gathered about the material, markets for the material and entry barriers into those markets must be identified. Recycling centers that may recover this material and recycle it into new products, do not have much capital to invest in manufacturing equipment, so it is important to identify products that will require a small amount of capital investment. It is also important to identify products that can be produced by a work force that has limited experience and training in making products from CCA

treated wood. Once these products are identified and manufactured, barriers will have to be identified in recycling spent CCA treated wood. The feasibility to recycle CCA treated wood into usable products will depend on the participation of landfills all the way to the potential user of the recycled products. Factors that will effect the recycling of CCA treated wood need to be analyzed, and this will lead to better utilization of CCA treated wood as a recyclable material.

Successfully addressing the dilemmas mentioned previously could lead to less environmental impacts on disposal, a more efficient use of the material, lessen the need for increased harvesting of timber, and develop economically sustainable recycling enterprises in communities.

OBJECTIVES

The primary research goal is to identify the feasibility of recovering and recycling spent CCA treated wooden decks. In doing so the following objectives were established:

1. Determine the volume of CCA treated wood that can be recovered and the most feasible products that can be produced from discarded CCA treated wood.
2. Determine mechanical and chemical properties of used CCA treated residential decks.
3. Recognize barriers that exist for landfills, recycling centers, and organizations in reusing CCA treated wood.

LITERATURE REVIEW

CCA TREATED WOOD INDUSTRY

BACKGROUND OF THE WOOD TREATING INDUSTRY

With the high demand of wood in our society, the wood preserving industry has helped ease the need for a greater volume of timber harvested. Treated lumber can typically

retain its structural integrity 20 to 30 years longer than untreated lumber by resisting attack from fungi, rot, insects, and other forms of decay. Even with the history of positive influences the wood preserving industry has given the environment and society, it has received constant negative criticism. From the treating process to the disposal of the wood, the industry has been constantly criticized for the treating chemicals negative effect on the environment and human health.

The wood preserving industry can be broken down into four segments, wood treated with creosote solutions, oilborne preservatives, waterborne preservatives, and fire retardant treatments (Micklewright, 1998). In 1997, the industry in the United States treated 8.7 billion bdft of wood products, and this number has steadily risen from around 6.5 billion bdft in the mid-1980's (Micklewright, 1998). Wood treated with waterborne preservatives composes 80% of the industry, followed by creosote solutions (~13%), oilborne preservatives (~5%), and fire retardants (~2%) (Micklewright, 1998). Chromated Copper Arsenate (CCA) is the predominant treating chemical used in the industry composing approximately 98% of the waterborne treating chemical used (Micklewright, 1998). The major products treated, which accounted for 86% of the production in 1997, were lumber and timbers (~66%), crossties, switch and bridge ties (~11%), and poles (~9%) (Micklewright, 1998). Ninety-eight percent of the lumber and timbers were treated with waterborne preservatives, while crossties, switch and bridge ties were treated predominantly with creosote (~82%), and poles were treated with oil-borne solutions (~50%) (Micklewright, 1998).

Since the 1970's the production of CCA treated lumber has increased, from 1984 to 1997 the production of CCA treated products has risen 50% (Micklewright, 1998). The

Southern Pine Council (2002) reports that 5 billion bdft of CCA treated lumber and timbers were produced in 2000. Lumber and timber are the majority of the products treated with CCA, representing 65% of the total Southern Yellow Pine treated in 2000 (Southern Pine Council, 2002). Southern Yellow Pine (SYP) is the major species used in the CCA treating industry, which in 2000 represented 76% of all species treated with CCA (Southern Pine Council, 2002). The pressure treating industry also represents roughly 40% of the market for SYP produced in the United States. The Southeast and South Central regions of the United States produce 61% of the total amount of CCA treated wood in the United States (Micklewright, 1998).

CCA AND THE PRODUCTION PROCESS

Chromated Copper Arsenate is a combination of three chemicals: copper, arsenic, and chromium. The copper is used to kill mold and fungi that cause rot, the arsenic repels insects that can cause deterioration, and the chromium fixes the other chemicals to the wood fiber. There are various different combinations and compositions that make up CCA, but the most common is CCA-C, which a mixture of arsenic pentoxide (34%), chromic acid (47.5%) and cupric oxide (18.5%) (Cox, 1991). CCA-C was developed in 1968 and replaced other forms of CCA because the treated wood more tightly retains the chemicals than the previous types (Cox, 1991). CCA is applied to the wood by pressure treatment, where the wood is submerged in a cylinder with the CCA and pressurized to force the CCA into the cell walls. A chemical reaction occurs that combines the CCA and the wood to form an almost insoluble compound. After being removed from the cylinder the wood is allowed to dry, during which time the chemicals fix to the wood fiber. The fixation process can vary depending of the temperature and humidity of the surrounding environment. For example, fixation can occur

in a couple of hours at temperatures greater than 100°C or up to 2 to 6 weeks at 20°C.

Fixation is a chemical reaction that degrades the wood cell wall structure and thus the mechanical integrity of the wood.

Mechanical Properties of CCA Treated Wood

The treatment process of Chromated Cooper Arsenate with wood will generally reduce the strength properties. The AWPA (1994) has summed up the effects of waterborne preservative treatment on the mechanical properties of wood. The effects are as follows:

- Modulus of Elasticity (MOE) is usually unaffected
- Maximum crushing strength is usually unaffected
- Modulus of Rupture (MOR) is usually reduced from 0% to 20%
- Energy related properties are usually reduced from 10% to 15%

In general, these mechanical degrades will occur in treated lumber, but many other pre-, post, and treatment factors can cause dramatic results on the mechanical properties of wood.

According the Winandy (1995), the effects of waterborne treatments on mechanical properties of wood are directly related to many pre-treatment, treatment, and post-treatment factors. These factors are:

- Species
- Chemical type
- Retention
- Retreatment drying temperatures
- Size of material
- Grade of material
- Product type
- Initial kiln drying temperature
- Incising (Winandy, 1995)

Species

According to research (Burmeister and Becker, 1963; Burmeister, 1970; and Thompson, 1964) the effect of waterborne preservatives on mechanical properties does not vary significantly for different species. Most of the research found no differences related to

species in modulus of rupture (MOR), bending strength, and crushing strength parallel to the grain.

Chemical Type

The effect different preserving chemicals have on the mechanical properties of wood are minimal when compared to other treatment processing factors. The small effect it does have is based on the chemistry and the severity of the fixation reaction (Winandy, 1995). Bendtsen et.al. (1983) suggested that the loss in some strength properties is related to the chromium content, the higher the content of chromium the greater the loss in strength. The AWPA has classified many chemicals from most to least effective on strength properties. Ammoniacal copper arsenate (ACA), ammoniacal copper zinc arsenate (ACZA), and ammoniacal copper citrate (ACCit) have the least effect on strength, and CCA has the most effect on strength, but other factors such as retention, lumber grade, and species have a greater effect on strength than just preservative chemistry.

Retention

Much research has been performed to see if retention levels effect the mechanical properties of pressure treated lumber. The research concludes that retention levels of less than 1.00 lb/ft³ have little negative effect on strength (Winandy, 1995). Only treated lumber for salt water applications will be effected because of the high retention level (2.50 lb/ft³). According to research the MOR is often reduced and energy related properties are significantly reduced (Winandy, 1995). As of today the amount of retention is the only adjustment to standard design procedures. It involves a restriction on impact loading of marine treated (salt water treated) wood in the United States (Winandy, 1995).

Post-Treatment Drying Temperatures

This factor is a major contributor to the decrease in strength properties of waterborne treated lumber. Research has shown that kiln redrying with a high dry bulb temperature has caused greater strength loss than air-drying after pressure treatment. Research performed by Winandy et.al. (1985) concluded that, at a retention level of less than 1.00 lb/ft³ and a redrying temperature of 140°F, the loss of strength and stiffness from the treatment process was not significant, but at a redry dry-bulb temperature of 180°F the loss in bending strength is significant. With this information, in 1991 the AWWA imposed a limitation on post-treatment kiln drying temperatures to be lower than 165°F. If this were not performed an engineering design adjustment factor would have been needed for treated wood that had been redried at temperatures greater than 180°F.

Dimension of Material

The size of the wood is important to the mechanical properties during the treatment and post-treatment processing. Winandy and Boone (1988) found that generally larger sized material appear to have less strength reduction than the smaller sized material. This is probably due to the depth of penetration of the chemical, which is 0.25 to 2.0 inches. The thicker the wood is the less penetration, and therefore less degradation of the material.

Grade of Wood

Most research comparing the strength of treated wood to the grade concluded that the higher the grade (i.e., the strength) the more drastic the reduction in strength properties. Many studies have been performed that show #2 grade Southern Yellow Pine (SYP) does not reduce in strength compared to #1 grade SYP of the same dimensions. Winandy and Barnes (1991) proposed a theory based on this occurrence stating that, “the impact of CCA-treatment

can be thought of as a quality dependent phenomenon when comparing different grades or rank-order or percentile dependent within a single-grade distribution”, or in other words the higher the quality of the wood the greater the reduction in strength.

Product Type

Most research has been performed on solid wood material (dimension lumber), but some composite materials are also chemically treated. Research performed on plywood showed similar results to that of lumber (Lee, 1985). Research on other wood products such as fiberboards or MDF has shown that these products seem to be reduced in strength to a slightly greater degree than lumber (Adams et. al, 1981). Adams et. al. (1981) stated this could be a function of the internal bond damage caused by waterborne preservative treatment induced swelling, not by wood structure degradation of the cell wall by the chemicals.

Initial Kiln Drying Temperature

Typically SYP is kiln dried at approximately 212°F and if not dried for long periods of time (more than a few of days); will not effect the strength of the wood after chemical treatment. Winandy and Barnes (1991) found that if lumber is initially dried at 235°F the reduction in strength loss, after chemically treated, is much greater than drying at 196°F. The combinations of high initial kiln temperatures and high post drying temperatures have resulted in drastically lower strength values for treated lumber.

Incising

Incising is a pretreatment process in which small slits are punched in the surface of the wood to improve preservative penetration and distribution in difficult to treat species (Winandy, 1995). According to Perrin (1978) incising reduces strength but it is understood

that this strength loss is beneficial in the long run because the increase in treatability provides a substantial increase in biological performance.

Markets For CCA Treated Lumber

The Southern Forest Products Association (SFPA) estimates the usage of CCA treated SYP from 1997 to 2004 will remain constant around 5.5 billion bdft (1999). According to the SFPA (1999) the construction, repair and remodeling, and industrial uses are the major markets for the use of CCA treated SYP, each estimated to represent 19%, 50%, and 30% respectfully (shown in Table 1-1). The residential market, which is included in the construction and repair and remodeling market, is the largest of the CCA treating industry, which comprises 66% of the total CCA treating market of SYP. The construction and repair and remodeling of decks is the largest use of CCA treated SYP in the residential market, and represents 88% of the total residential and repair and remodeling market (SFPA, 1999). The SFPA estimated that in 2001 the construction of new residential decks would use 693.1 million board feet, and the repair and remodeling of residential decks would use 1.4 billion board feet. The total use of CCA treated SYP wood in residential decks in 2001 was 2.1 billion board feet, this represents 38% of the total market for the industry (SFPA, 1999). The SFPA estimates this will remain constant throughout the beginning of the 21st century.

Table 1 - 1. SFPA estimates of CCA treated SYP – 1999 (million board feet)

	Estimates by Year							
	1997	1998	1999	2000	2001	2002	2003	2004
Construction Markets								
Residential								
Flooring Framing	39.8	41.4	44.4	37.8	40.0	35.8	31.7	41.0
Wall Framing	68.4	73.2	79.4	67.7	72.4	66.2	60.1	76.9
Roof Framing	15.3	14.9	16.3	14.1	15.2	14.0	12.6	16.0
Trusses	19.9	19.0	20.4	17.9	19.2	17.6	15.9	20.4
New Decks	658.7	721.7	731.9	651.7	693.1	626.0	574.6	742.8
Wood Foundations	83.2	93.8	93.8	84.7	89.7	80.2	74.3	96.9
Sub-Total	885.3	964.0	986.2	873.9	929.6	839.8	769.2	994.0
Non-Residential								
Floor Framing	5.4	5.7	5.6	5.2	5.5	5.8	5.2	5.0
Wall Framing	3.4	3.8	3.8	3.5	3.7	4.1	3.8	3.6
Roof Framing	6.1	6.3	6.3	5.9	6.3	6.9	6.5	6.1
Trusses	16.4	16.3	16.1	15.3	16.3	17.8	16.6	15.7
Glulam	4.5	5.4	5.1	4.9	5.2	5.7	5.4	5.0
Sub-Total	35.8	37.5	36.9	34.8	37.0	40.3	37.5	35.4
Agricultural								
Posts	59.0	67.6	62.7	61.0	63.3	67.3	64.6	60.6
Misc. Framing	4.9	5.6	5.2	5.0	5.2	5.5	5.3	5.0
Sub-Total	63.9	73.2	67.9	66.0	68.5	72.8	69.9	65.6
All Construction Markets								
Sub-Total	985.0	1074.7	1091.0	974.7	1035.1	952.9	876.6	1095.0
Industrial Market								
Materials Handling	194.8	195.5	205.1	204.1	210.3	219.0	225.5	228.7
Marine	689.8	820.2	771.5	744.7	796.3	871.8	814.6	766.3
Highway	576.0	684.9	644.3	621.9	665.0	728.0	680.2	639.9
Furniture	4.4	4.2	4.4	4.4	4.4	4.5	4.4	4.4
Sub-Total	1465.0	1704.8	1625.3	1575.1	1676.0	1823.3	1724.7	1639.3
Repair & Remodeling Markets								
Repair and Remodeling								
Room Additions	30.6	28.5	28.7	28.5	30.2	30.8	28.5	28.4
Attached Garages	5.1	4.8	4.8	4.8	5.0	5.1	4.8	4.7
Finished Basements	4.5	4.3	4.3	4.3	4.5	4.6	4.3	4.3
Decks	1465.5	1338.3	1359.0	1339.7	1415.4	1445.3	1336.0	1332.3
Misc. home projects	1.2	1.1	1.1	1.1	1.2	1.2	1.1	1.1
Remodel Kitchen & Bath	4.2	4.0	4.0	4.0	4.2	4.3	4.0	4.0
Sub-Total	1511.1	1381.0	1401.9	1382.4	1460.5	1491.3	1378.7	1374.8
Additions/Alterations Separated From Structure								
Fences	562.9	484.0	435.2	407.6	430.6	439.8	406.8	405.6
Sheds	13.8	12.9	13.0	12.9	13.6	13.9	12.9	12.8
Landscaping	836.9	788.2	792.4	789.0	833.6	851.2	786.8	784.6
Detachd Garage	6.0	5.6	5.7	5.6	5.9	6.1	5.6	5.6
Misc. Home Projects	0.9	0.8	0.9	0.8	0.9	0.9	0.8	0.8
Sub-Total	1420.5	1291.5	1247.2	1215.9	1284.6	1311.9	1212.9	1209.4
Major Replacements								
Re-roof	1.6	1.5	1.5	1.5	1.6	1.6	1.5	1.5
Sub-Total	1.6	1.5	1.5	1.5	1.6	1.6	1.5	1.5
Maintenance & Repairs								
Misc. Home Projects	9.8	9.4	9.4	9.4	9.9	10.1	9.4	9.3
Sub-Total	9.8	9.4	9.4	9.4	9.9	10.1	9.4	9.3
All Repair and Remodeling Markets								
Sub-Total	2943.0	2683.4	2660.0	2609.2	2756.6	2814.9	2602.5	2595.0
Export Markets								
Sub-Total	94.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3

Source: Southern Forest Products Association (SFPA). 1999. Estimated Treated Southern Yellow Pine Lumber Demand. Kenner, LA

Other key markets for treated CCA SYP wood are in marine, highway, fences, and landscaping uses. The marine uses include docks, piers, and boardwalks used in and around fresh and salt water. This market is almost half (48% in 2001) of the industrial market for CCA treated SYP (SFPA, 1999). The highway market comprises approximately 40% of the industrial market for CCA treated SYP, with applications such as sign and guardrail posts, and in a smaller degree bridges. The fence and landscaping market are also major users of CCA treated SYP, which comprises approximately 46% of the repair and remodeling market in 2001 (SFPA, 1999). The major uses are in gardening areas in residential and public properties, and public park and recreational areas. As shown in Table 1-1, there is no market for CCA treated wood that is projected to grow in the near future, the market for CCA treated wood has reached its maturity and now other products are entering the market. Plastic lumber, wood-based composites, and steel have all taken some market share from the CCA treated wood industry.

Public Safety and Environmental Concerns

Environmental concerns over the use and disposal of CCA treated wood have escalated during the past couple of years. The public unpopularity with the use of arsenic is what has people concerned with the use of CCA treated wood. Arsenic is naturally found in the earth's crust, but is considered a human carcinogen (Gruder, 2001). Ten years ago the EPA and Consumer Safety Commission studied CCA and concluded it posed no unreasonable risks to ordinary consumers (Lyman, 2001), although advice and precautions were given to people who work with CCA treated wood. The EPA has banned most arsenical pesticides and designated CCA a restricted-use pesticide, but the EPA does not regulate CCA treated lumber because of the fixation of the chemicals during the treating

process (Gruder, 2001). Even though fixation does occur, some studies have shown that over time and certain climatic conditions leaching of chemicals take place, but many studies also have concluded that there has been no significant evidence showing CCA treated wood is harmful to the environment or to health and safety (e.g., Finch and Dainello, 1993 and AWPI (2), 2001).

On February 12, 2002 the EPA announced a voluntary decision by the wood treating industry to move consumer use of pressure treated lumber products away from that which contains arsenic by December 31, 2003 (EPA, 2002). The move calls for the use of different preservatives, which do not use arsenic as an ingredient. This will affect the residential markets only for the treated lumber industry, and will not affect the use of CCA treated wood products in commercial and industrial applications. The transition period will allow the industry to convert their existing treating equipment to allow for the production of non-arsenic containing treated wood products. According to the EPA (2002), the industry will expect a decline in the production of CCA products for the affected residential uses up to 25% during the current year. After December 31, 2003 new labeling will be required on all CCA products, specifying that no use of CCA will be allowed by the wood-treating industry for the affected residential uses (EPA, 2002). The major applications of CCA treated wood that will be affected are playground structures and equipment, decks, picnic tables, landscaping timbers, residential fencing, patios, and walkways (EPA, 2002). The Home Depot has already announced plans to phase out CCA treated wood products well before the stated deadline (PRNewswire, 2002). The Home Depot offers plastic decking and fencing in their stores as an alternative to CCA treated wood, but no store currently carries non-arsenic containing treated wood products in the store. Many branches of The Home Depot allow

consumers to special order non-arsenic containing treated wood products (PRNewswire, 2002).

These issues concerning the leaching of chemicals, especially arsenic, from the wood have gained national media attention. Articles, over the past year, have been written about the negative aspects of CCA treated wood. The use of CCA treated wood in playgrounds has had the most media criticism. Article entitles, “Poisonous Playgrounds” (Lyman, 2001), “Treated Lumber: A Consumer Arsenic Alert” (Gruder, 2001), “Children’s Playground Equipment Poses Arsenic Risk” (Natural Life Magazine, 2001), “The Poison In Your Backyard” (Hauderman, 2001), and “Toxic Playgrounds” (Kluger, 2001), have alerted the nation, this past year, over possible dangerous levels of arsenic in the soil around playgrounds from the CCA treated wood used to make the playground equipment. In response to this, many city, county, and school playgrounds have removed playgrounds with CCA treated wood. Public officials in Alachua County, Florida have recommended “replacement of CCA wood playgrounds, replacement or application of sealants to CCA treated picnic tables, soil and mulch removed from playgrounds areas, and discontinued purchases of CCA treated wood for county maintenance and construction projects” (Management Update, 2001). A state representative also recently filed a bill that would prohibit the use of CCA treated wood in new playground equipment, and prohibit state agencies from buying CCA treated lumber unless it can be shown that there are no non-arsenical alternatives exist for the application (Management Update, 2001). Several playground manufacturers have stopped producing equipment made from CCA treated wood. PlayNation, a leading producer of CCA treated playground sets, stopped using arsenic based treated wood in the production of playground equipment on June 27, 2001 (2001). All this is

in spite of the fact that there has been no significant evidence showing CCA treated lumber is harmful.

The use of CCA treated wood is not just getting attention in playgrounds but for all applications. An investigation by The Gainesville Sun (FL) found more than 40 incidents of consumers that blame illness or injuries on CCA treated wood, many which included sawing or burning the lumber (Natural Life Magazine, 2001). The PBS show “Health Week” aired a segment in January, 2002 about the health risks of CCA treated wood (2002). The Environmental Working Group and the Healthy Building Network has petitioned the Consumer Products Safety Commission to ban the use of CCA in wood treating (Roanoke Times, 2001), which is already banned or strictly regulated in Japan, Germany, Australia, and other countries (Chapin, 2001). Several individual law suites have been filed against major manufacturers and retailers of CCA treated lumber. The Center for Environmental Health has filed a legal notice to sue 11 U.S. manufacturers of arsenic treated wooden playgrounds (Natural Life Magazine, 2001). With the attention CCA treated wood is gaining the EPA is currently conducting a comprehensive assessment of CCA treated wood (Cummings, 2001), and is due to report the findings sometime in 2002. In a recent article in the USA Today (Eisler, 2002) the EPA and representatives of the wood preserving industry are expected to reach an agreement to phase out the production of CCA treated wood products over the next two to three years. The EPA now requires each piece of wood treated with CCA to be labeled alerting of the possible health risks if not handled or used properly. The EPA has also stated that CCA treated lumber is not a dangerous chemical if handled properly, and has issued a consumer information sheet about the use site and handling precautions of CCA treated lumber found at www.epa.gov.

Along with the increased human safety and health concerns, environmental hazards are also being scrutinized with the use of CCA treated wood. A major environmental concern with CCA treated wood is the use in aquatic environments. Many groups are concerned that the treated wood when wet will leach into the water and become detrimental to the well being of the environment. During the summer of 2001 a man near Rockport, Maine was prohibited from building a dock on his property by the local planning board because he was using pressure treated lumber. The planning board Chairman felt it was the board's duty to protect the environment and the water quality (Lumber & Building Materials Daily, 2001). This is becoming a more and more common occurrence as people become fearful of the chemicals used to treat the lumber. The USDA has issued a report titled, "Guide for Minimizing the Effect of Preservative-Treated Wood on Sensitive Environments" (Lebow and Tippie, 2001). In the guide the authors state that, "Recent research indicates that wood treated with these preservatives does release small amounts of chemical into the environment immediately adjacent to the treated structure, although no adverse biological impacts were observed" (Lebow and Tippie, 2001). Lebow and Tippie went on to write that several practices can be performed to minimize chemical releases from the wood (2001).

Estimated And Projected Amount of CCA Lumber Removed From Service

As previously stated CCA treated wood will last 20 to 30 years longer than untreated wood when exposed to environmental elements. Although this is true, the wood may eventually warp, decay, or discolor to the extent the owner needs to replace and dispose of the spent treated wood. Since the production of CCA wood has steadily increased since the 1970's, the amount of spent CCA treated wood will also increase. Numerous researchers have predicted tremendous growth in the quantities of spent CCA treated wood in the

upcoming years. McQueen and Stevens (1998) reported that by 2020 90% of treated wood being removed from service will be treated with CCA. Cooper (1993) estimated that in the year 2000 approximately 2 million cubic meters, in 2010 nearly 12 million cubic meters, and in 2020 18 million cubic meters will be removed from service. These estimates are based on an assumed life of 25 years, generations of 2.5% of the annual production as waste, and an assumed increase in production of 20% every 5 years (Cooper, 1993). Felton and DeGroot (1996) estimated that nearly 6 million cubic meters were removed from service in 1996 and 19 million cubic meters in 2020. This study assumed a thirty-year lifetime for all treated wood (Felton and DeGroot, 1996). Finally, McQueen and Stevens (1998) estimated that in 1997, 10.5 million cubic meters of CCA treated wood were removed, and in 2004, 12 million cubic meters of CCA treated wood will be removed from service. The numbers and assumptions may vary slightly, but the trends remain the same in all the studies, the amount of CCA treated wood being removed from service is increasing.

RESIDENTIAL DECK MARKET

Specifications of Residential Decks

As stated previously residential deck construction and remodeling account of the majority of CCA treated lumber used in the United States. In 1989 it was estimated that 8 of every 10 residential decks built in the United States used pressure treated lumber (Shook and Eastin, 2001). There have been numerous studies and reports of the materials and species used in the residential deck market, and the data varies greatly between each study. In 1987, George Carter and Affiliates examined three different deck materials in a survey study. The results stated that 82.5% of residential deck material was composed of pressure treated lumber, followed by redwood at 11.5% and western red cedar at 3.2% (Shook and Eastin,

2001). The National Association of Home Builders Research Center conducted a similar study in 1995 and concluded that the market share for pressure treated lumber was 54.7%, while all other untreated products represented 45.3% (Shook and Eastin, 2001). Truini, in 1996, stated that 80% of the residential deck market was composed of pressure treated lumber. Shook and Eastin surveyed homebuilders and requested the volume of materials used to build residential decks from November 1997 through October 1998. The survey found that homebuilders used 47.4% pressure treated lumber, 18.5% Western Red Cedar, 14.1% concrete, 11.1% Redwood, 4.0% wood fiber/plastic lumber, 2.6% untreated lumber, and 0.7% plastic lumber (Shook and Eastin, 2001). All this data varied greatly, from 47.4% to 82.5% market share of pressure treated lumber in the residential deck market, but the information emphasizes that the market is dominated by pressure treated lumber.

Shook and Eastin (2001) studied the material use pattern of homebuilders in constructing residential decks. The results showed that, from November 1996 to October 1998, 31.9% of the builders indicated that they increased their use of pressure treated lumber, 46.1% of the respondents remained the same, 12.4% decreased their use of pressure treated lumber, 9.6% never used pressure treated lumber (Shook and Eastin, 2001). The results showed that 90% of the respondents used pressure treated lumber, and the amount used increased more than it decreased from November 1996 to October 1998 (Shook and Eastin, 2001). Shook and Eastin (2001) also found the importance of the do-it-yourself (DIY) market in the use of deck material. Their study showed that 46% of all households have built a deck onto their home as a DIY project while living in the house.

The cost of materials is the most expensive component of constructing a deck, which represents 68% of the total cost (Smith, 1997). Most decks are composed of posts, joists,

decking, railing, steps, and spindles or balusters. A report by Shook and Eastin, in 1996, stated that the average deck uses 506 bdft of lumber, 251 bdft of joists, and 86 bdft of posts (Smith, 1997). Typically about 1/2 of the deck is the decking material. In the case of pressure treated SYP the material used for the decking is 5/4" x 6" or 6/4" x 6" radius edge boards or 2"x4" or 2"x6" dimension lumber. The joists range from dimensions of 2"x6" to 2"x12" lumber, and the posts are 4"x4" or 6"x6" timbers. Balusters, spindles, deck posts, step stringers, step treads, and railings are also used in the construction of residential decks (Smith, 1997). Of all the total lumber and timbers with CCA treatment, 88% were treated to the retention level of .40. Other items such as turnings, balusters, handrails, lattice, and stair stringers were also treated with a .40 retention level, comprising 68.4% of the total (Southern Pine Council, 2002). The other common retention level was .25 representing 31% of the total of deck material treated, excluding timbers and lumber.

Estimated Size of Decks Being Constructed and Replaced

Shook and Eastin (2001) found that 60% of spec homes and 68% of custom homes being built in the United States have decks attached. Alderman (2001) surveyed deck builders in several southern states and showed that the average deck being built in 1999 was 272 square feet. Alderman also found that the average deck being removed was 199 square feet, suggesting that the size of decks is increasing. Shook and Eastin also found the size of new decks being built for spec and custom homes to be 252 square feet and 407 square feet, respectively (2001). Shook and Eastin's (2001) data was recorded from builders of new homes where Alderman's (2001) data come from deck builder, not necessarily of new homes.

Geographical Locations Where CCA Treated Decks are Being Constructed and Removed

According to Shook and Eastin (2001), the Northwest region represented the highest percentage of new homes being constructed with a deck attached, at 73.2% for spec homes and 80.1% for custom homes. Surprisingly, of new homes in the Southeast region 55.0% of spec homes and 59.4% of custom homes were built with a deck (Shook and Eastin, 2001). This is surprising since the major building material used in residential deck is CCA treated lumber, and it is produced almost exclusively in the Southeast region of the United States. This data represents new homes, and may be different if accounting for existing homes adding a new deck. Smith (1997) also states that the South Atlantic region of the United States has decks that tend to be twice as large as those in the U.S. West and South Central states.

Estimated Amount of CCA Treated Lumber Used and Disposed

As stated previously, the major market for CCA treated wood is the residential deck market. According to the SFPA (1999), in 1997, 2.1 billion board feet were used in the construction of new decks and the repair or remodeling of existing decks. From 2001 to 2004, the SFPA has estimated the amount of CCA treated wood used in the deck market to be over 8 billion board feet. This information indicates that as more new material is being used, older material is being discarded. Alderman (2001) extrapolated, from his survey of deck contractors in Georgia, North Carolina and South Carolina, that one billion bdf (2.4 million cubic meters) of CCA treated lumber was removed from residential decks in the United States in 1999. The average age of the deck at removal was 12.8 years in Alderman's study (2001). As stated previously, McQueen and Stevens (1998) estimated that in 1999 almost 935 million bdf of CCA treated wood was removed from service, which was primarily from residential decks. They also concluded that the average age of a deck at

removal was 9 years. The studies by Alderman (2001) and McQueen and Stevens (1998) both showed many reasons for the removal of residential decks, but aesthetics was found to be an important factor in the homeowner's decision to remove the deck. This leads to question of whether the service life of the treated wood can be extended after removal. This shows that the amount of CCA treated lumber removed from service of residential decks is extremely high and increasing as more and larger decks are being constructed. Therefore as more CCA treated wood enters the waste stream the disposal and lifespan of treated wood becomes a major issue in the treating, construction, landfill, and recycling industries.

Disposal of CCA Treated Wood and Future Implications

“While there is little concern with the alteration of wood products with treatment chemicals, there is concern regarding the process of treating, the loss of chemicals in service, and perhaps of the greatest importance, the ultimate disposal of the treated products at the end of their service life” (Preston, 2000). CCA treated wood removed from service that has no other useful application is considered solid waste. Numerous studies have been conducted that estimate a huge amount of CCA treated wood being removed from service (e.g., Felton and DeGroot, 1996; Alderman 2001; McQueen and Stevens, 1998; and Cooper, 1993). As more CCA treated wood is entering the waste stream many questions have been asked of the proper methods of disposal. Current options are landfills, incinerating, and reuse or recycling. Currently, disposing in landfills is the most common option for disposing of CCA treated wood. McQueen and Stevens (1998), indicated that approximately 66% of CCA treated wood decks are being disposed of in landfills.

As more CCA treated wood is entering landfills stiffer regulations and higher costs are soon to follow. Currently, CCA treated wood is not a hazardous waste because under the

Federal Resource Conservation and Recovery Act (RCRA), “wood products treated with arsenical preservatives are exempt from hazardous waste regulations when disposed by the end user regardless of the Toxic Characteristics Leaching Procedure (TCLP) results for Waste Codes D004-D017” (AWPI (1), 2001). Most states follow the same regulations for disposal of treated wood, but some have regulations that are more stringent. California exempts treated wood that is managed for reuse from hazardous waste management requirements (Felton and DeGroot, 1996). As environmental regulations for landfills rise and the volume of spent CCA treated wood dramatically increases more states are exploring the impacts of the chemicals leaching from CCA treated lumber in Municipal Solid Waste (MSW) and Construction and Demolition (C&D) landfills. C&D landfills are currently the landfill of choice for disposing of CCA treated wood. The C&D landfills are not lined and thus the fees of disposal are cheaper, but stiffer regulations, such as classifying CCA treated wood as a solid hazardous waste, could increase the landfilling price and decrease the number of locations for disposal.

Research is currently being performed in Florida to evaluate the impacts of CCA treated wood in C&D landfills (Solo-Gabriele, 2001). The research group headed by Solo-Gabriele and Townsend has performed studies showing that there is a large reservoir of arsenic within the state associated with CCA treated wood. The group stated that since the 1960s, 29,000 tons of arsenic have been imported and 2,000 tons have been disposed of in Florida, leaving 27,000 tons of arsenic associated with CCA treated wood still in service in Florida (Solo-Gabriele, 2001). This group is currently investigating the impacts on the environment of arsenic leaching from spent CCA treated wood in C&D landfills in Florida (Solo-Gabriele, 2001). The results of the study are tentatively due towards the end of 2002;

frequently updated progress reports can be viewed on their web page, www.ccaresearch.com

Cooper (1993) reported that studies on CCA treated wood have suggested the total chemical losses is in the order of 10% to 30% with higher losses of arsenic and chromium. If studies show conclusive evidence that tremendous amounts of chemicals are leaching from landfilled CCA treated wood and is detrimental to the public health and the environment then many more regulations will be imposed making landfilling an expensive alternative in disposing of spent CCA treated wood.

CCA treated wood should never be burned except in specially designed incinerators. The metals in the CCA are not destroyed when burned, the copper and chromium become concentrated in the ash, and the arsenic becomes a vapor that will escape into the atmosphere or get trapped in pollution control equipment (Wilson, 1997). A study by Pasek (1994), suggests that under conditions of limited oxygen and high temperatures, arsenic is maintained in the ash along with the copper and chromium. This is useful for incinerators that have this technology, but the ash is left and the heavy metals in the ash are extremely toxic. Wilson (1997) stated that studies done indicated that ash of wood incinerated with 10.7% CCA treated wood, resulted in ash that exceeded the TCLP limits for arsenic by a factor of 26. This ultimately increases the disposal costs of the ash because it could be considered a hazardous waste. There have been numerous accounts of people burning CCA treated wood in residential fireplaces or open pits and suffering from permanent arsenic poisoning, and also cases of poisoning and killing of animals that ingest the highly toxic ash of burned CCA treated wood (Lavelle, 2002, Liptak, 2002, Shiffer, 2002).

With most of the spent CCA lumber being disposed of in landfills, questions have to be asked if any is being recycled. As reported earlier, McQueen and Stevens (1998)

estimated that in 1995, 66% of decks removed were landfilled, 14% were incinerated, and 17% were reused. Alderman (2001) indicated that contractors believe the potential amount of CCA treated lumber recovered from a deck was nearly 45%, but only roughly 4% is actually being reused. According to Alderman's study several factors arise when recycling CCA treated lumber is considered. These factors include time, a lack of recovery facilities, lack of recovery programs, the manpower to dismantle, and proper equipment to dismantle. This raises questions on how much of a residential deck composed of CCA treated lumber can possibly be recycled into usable products, and its economic feasibility.

RECYCLING AND DISPOSAL

MSW and C&D Landfill Facilities

Since most of the treated decks in the United States are disposed of in landfills it is important to know trends and factors affecting this area. Municipal Solid Waste (MSW) landfills and Construction and Demolition (C&D) landfills are the two landfills where CCA treated wood will be disposed. In most cases around the country CCA treated wood will be disposed of in C&D landfills because of the lower tipping fees charged, but when areas where disposal costs are low or when C&D landfills are not conveniently located, MSW landfills are a common disposal method.

MSW landfills consist of everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries (EPA, 2001). The EPA reported that in 1999 the United States generated 230 million tons of MSW, which is approximately 4.6 pounds of waste per day per person. This number was just 2.7 pounds per day per person in 1960. With this increased production of MSW, the number of sites to dispose of waste is decreasing. The EPA reports that in 1988 there were 8,000

landfills compared to only 2,300 in 1999. Wood waste only accounts for 5.8% of the material disposed on in MSW landfills, which is expected, since C&D landfills take spent wood at lower tipping fees (EPA, 2001).

Construction and Demolition (C&D) landfills are unlined and take material from the construction, renovation, or demolition of structures. Components of C&D debris typically include concrete, asphalt, wood, metal, gypsum wallboard, and roofing material (Franklin Associates, 1998). Several states vary in the definition of C&D debris, but most states also include land-clearing debris such as stumps, rocks, and dirt. Franklin Associates (1998) estimated that there was 136 million tons of building related debris generated in 1996, or 2.8 pounds per person per day. Forty-three percent of the C&D wastes were from residential sources, and 57% was from nonresidential sources. Demolition accounted for 48%, renovations 44%, and construction 8% of the C&D waste stream (Franklin, 1998). Of this debris only 35% to 40% was actually disposed of in C&D landfills, where the rest was managed on-site, at MSW landfills, or at unpermitted landfills. The number of licensed C&D landfills in 2000 was 1,825 (Goldstein and Madtes, 2001), but many more may exist. Unpermitted C&D landfills are common in many states, but not much data exists on the number or quantity of material received. Franklin Associates (1998) state that Georgia is the only state that tracks the number of unpermitted C&D landfills, which were 900 in 1994. Tipping fees will generally be lower in low populated areas of the United States. In the Midwest the average tipping fee for C&D landfills was \$19.70, compared to \$46 in the Northeast (Bush, Araman, and Reddy, 1996). As the options for disposal continue to decrease and become more expensive, a greater emphasis will be placed on reusing and recycling material.

Recycling

The concept of recycling, in a broad sense, can be defined as turning materials that would otherwise become waste into reusable resources (EPA, 1998). Solid waste, in the United States, has increased from 269 million tons a years, in 1990, to 409 million tons in 2001 (Goldstein and Madtes, 2001). As this is expected to increase into the future, more concern has risen over the disposal of waste residue. *Biocycle* publishes an annual article titled, “The State of Garbage in America”, and in the 2001 edition they surveyed waste management and recycling officials requesting data on their waste management practices. *Biocycle* concluded that in 2001 32% of waste was recycled in the Unites States, which is an increase from 1990 of 8%, but a decrease from 2000 of 33% (Goldstein and Madtes, 2001).

What materials are encompassed in the recycling rates varies from states to state. In 1997 the EPA issued a report, “Measuring Recycling: A Guide for State and Local Governments”. The standard recyclables defined in the guide are:

“Commercial and institutional food scraps, glass, lead acid batteries, metal, paper, plastic, textiles, automobile and truck tires, wood products, yard trimmings, and miscellaneous items in the MSW stream including household hazardous waste, oil filters, mattresses and consumer electronics” (Goldstein and Madtes, 2001).

Not included in the EPA’s standard recyclables are C&D debris, bio-solids, and agricultural and industrial waste. All states recycling rates include the EPA’s list of recyclable material, and many include other C&D material, which will make the recycling rates between each state not as consistent.

Since landfills are decreasing every year and the amount of waste is increasing recycling will continue to play an important role in American life. Still, recycling rates compared to many other countries are significantly lower. For example France, Sweden,

Switzerland, the Netherlands, Italy, and Japan all have higher recycling rates than the United States (Hershkowitz, 1998). Wilson (1996) states that one of the major reasons for not developing a better waste management system is cost. The countries that have high recycling rates are those who have found an economic incentive in recycling. The factors for this are reduced landfill space and tighter governmental regulations; recycling and managing waste better is deemed cheaper. Therefore as trends in the United States continue with tighter regulations and less landfill space available, recycling rates and better waste management systems will increase because the economic incentive, by consumer and manufacturer, is realized.

Recycling C&D residues is growing in this country as more and more see the incentives. All the major constituents of C&D debris has been recycled and marketed in some way in the United States. According to Franklin Associates (1998) the major C&D debris recycled is concrete, asphalt, metals, and wood, and to a lesser extent gypsum wallboard and asphalt shingles. There were 1,800 C&D recycling facilities in the United States in 1996, and the number continues to grow (Franklin Associates, 1998).

Reasons Recycling is Vital

Recycling is always seen as having an impact on the environment. It reduces the need for landfilling and other disposal methods. It also prevents pollution and saves energy caused by the manufacturing of virgin materials. Recycling has also been shown to decrease the emissions of greenhouse gases, and it also conserves natural resources.

Historically recycling is viewed as important to the environment, but it also has social and economic importance. The EPA reported that many municipalities have found financial incentives by increasing their recycling efforts. For example, Madison, WI increased it's

recycling rates to 49%, and decreased the net annual costs of solid waste service per household from \$158 to \$139 in eight years (EPA, 1998). Recycling also stimulates economic development for many areas. A study in the Northeast of the United States concluded that recycling added more than \$7 billion to the value of the material, and that recycling employed more than 103,000 people (EPA, 1998). The market value for recycled materials has also increased recycling because many materials are now considered valuable commodities in the marketplace. EPA (1998) stated that in 1997, aluminum cans had a market value of \$1 billion, and corrugated cardboard was valued at \$940 million. Recycling also has social impacts, along with environmental and financial importance. The EPA (1998) reported that the town of Brooks in Alberta, Canada added social impacts in evaluating their recycling program. Considerations such as noise and odor effects and illegal dumping potential were considered along with environmental, health, and economic impacts.

Successful Marketing Strategies for Recycling Material

Recycling is prevalent in many industries today. Metals, plastics, and many wood products have developed successful recycling programs that have helped decrease the potential of government regulations, negative public opinions towards the disposal of these products, and increased social acceptance of the material.

Paper and steel recycling are two of the most successfully recycled materials in the United States. Paper and paperboard recycling is the largest recycling industry in the United States employing 139,000 people and has \$49 million in annual receipts. The use of recycled paper fiber has grown faster than the use of virgin fiber. Denison and Ruston (1997) reported that in 1995, 34% of the fiber used by the U.S. papermakers was recycled, and that the industry plans to build or expand more than 50 recycled paper mills. Steel mills have found

that recycling steel has resulted in lower manufacturing costs, and the steel recycling industry employs 119,000 people with annual receipts around \$46 billion dollars. Steel construction recycling rates are greater than 90% from demolition sites (Power and Bodensteiner, 1999). Table 1-2 shows the increase recycling rates for several materials in 1997 and the projected increase in 2000 by the EPA.

Table 1 - 2. Recycling rates of material in the U.S. in 1997 and project rates for 2000.

Material	1997 Recycling Rates % Recycled	2000 Recycling Rates % Projected
Paper/Paperboard	41.7	44-46
Glass	24.3	29-33
Steel	38.4	41-46
Aluminum	31.2	37-39
Plastics	5.2	6-7
Yard Trimmings	41.4	52-54
Rubber & Leather	11.7	14.5-15.9
Wood	5.1	8.6-10
Clothing/Textiles	12.9	13-14.7
Total	28.0	30-32

Source: *Characterization of Municipal Solid Waste in the United States: 1998 Update.* The US Environmental Protection Agency, Washington

Wood waste recycling has become popular over the past decade, and will continue to increase in popularity. As shown in Table 1-2, wood recycling in 1997 was just 5%, but was projected to increase by 2000 to 9-10% (EPA. 1998). Many cite this reason as an increase

rise in virgin wood prices and an increased consumer demand for recycled products (Sherman-Huntoon, 2001). This number will increase as more regulations are implemented and fees are raised at landfills sites. For example, Orange County, North Carolina has drafted an ordinance that will divert wood (untreated, unpainted, and non-engineered), metal, and gypsum board from landfills to recycling centers (Sherman-Huntoon, 2001).

R. Marutzky (1996) stated the following preconditions for successful recycling of wood waste:

- The assortments are available continuously and in sufficient amounts
- The quality of the assortment is in accordance with the proposed recycling
- The recycled wood products have a market
- The recycling produces no new disposal problems

Many recycling centers, with some government support, have been successful in recycling wood waste. North Carolina recovered over 2 million tons of wood via recycling in 2000 (Goldstein and Madtes, 2001).

The reasons are numerous for North Carolina's success, but many local governments had set regulation for stricter landfill disposal of wood waste. Markets (boiler fuel, mulch, pallets, and wood flour) and a consistent wood waste supply (furniture manufacturers scraps, pallets, house demolition material) were also found for wood recyclers (Sherman-Huntoon, 2001). As with solid wood, all these conditions need to be met in order for a proper recycling program to be developed for CCA treated wood taken out of service. While meeting these criteria for successful recycling of CCA treated wood, the industry has other barriers to overcome before CCA treated wood becomes a viable option to disposal.

Possible Problems and Barriers Associated with Recycling CCA Treated Lumber

The mixing of treated and non-treated wood in C&D recycling facilities has a major effect on the recycling of wood. Wood waste is a significant component of C&D debris. Townsend and Solo-Gabriele (2000) reported that in Florida wood waste represents 44% of the mixed C&D debris by volume. Franklin Associates (1998) reported research by a couple of sources (NAHB Research Center and METRO Portland, Oregon) on the composition of debris from construction, renovation, and demolition of residential structures. In all the reports wood represented the largest amount of debris, ranging from 43% to 67%. Wood debris from demolition is harder to recycle because it is difficult and time consuming to separate the other building material from the wood (Townsend and Solo-Gabriele, 2000 and Franklin Associates, 1998). In addition the treated wood from demolition sites is usually mixed in with the untreated wood. Townsend and Solo-Gabriele (2000) found that approximately 6% of C&D debris wood is CCA treated. The two major markets for wood debris is wood mulch and boiler fuel. In the study by Townsend and Solo-Gabriele (2000) they found that as little as a 5% presence of CCA treated wood in boiler fuel will result in the ash classified as hazardous, and a 1% presence of CCA treated wood in mulch will not meet current groundwater standards. Separating of treated wood from wood C&D debris is currently not extensively performed, especially with demolition debris, and in order for recycling rates to increase for wood and treated wood this must occur. CCA treated lumber must be separated either at the job sites or the C&D recycling facility, but the process is time consuming and there is a lack of incentives for contractor's to separate at the job site.

Contractor beliefs regarding the recovery of spent CCA treated lumber are significant factors concerning the recovery of spent CCA lumber (Alderman, 2001). Alderman (2001)

suggests that a marketing campaign to address the key issues regarding recovery, and financial incentives should be used to facilitate the recovery of CCA treated lumber. Also, Alderman found that most contractors believe that no recycling facilities and lack of recycling programs are the two most important factors in lumber recovery (2001). If CCA treated wood can be sorted from non-treated wood and there is an incentive for contractors to recycle, then questions arise around the useful applications of spent CCA treated wood.

Current Research Performed on Products From Spent CCA Treated Lumber

Research has been performed on finding markets for spent CCA treated lumber. There has been a large amount of research in using spent CCA treated lumber in wood-based composite products (Vick et al., 1996; Mengeloglu and Gardner, 2000; Munson and Kamdem, 1998). This research has used 100% or a mixture of spent CCA treated wood chips or fiber with untreated wood. The researchers varied with their results, depending on the wood-based composite made and the amount of CCA treated lumber used, but in most of the research it would be a viable option for spent CCA treated lumber. Composite manufacturers have been evaluated to see if they are a viable option in using spent CCA treated wood, but most research has found that they are reluctant to consider spent CCA treated lumber as a possible raw material source (Smith and Shiau, 1996, Falk, 1997). The main reasons found were concerns with the health and safety of mill workers, residual chemicals that the material may still have, and products made from recycled treated wood may not have the same resistance to decay and insects as the original treated wood product. Therefore even though wood-based composite products could be produced from spent CCA treated lumber it does not seem to be a practical option for manufacturers in the near future. The most promising aspect is the use of treated wood in wood cement composites. Research

by Felton and DeGroot (1996) and Haung and Cooper (2000) has shown an improved performance using CCA treated wood compared to using untreated wood in wood cement composites.

Research has also been performed to remove the treating chemical from the spent CCA treated wood. If this process can be performed successfully then the CCA treated wood can be mixed with other wood waste for recycling. Clausen, Smith (Wilson, 1997), and Glasser (Alderman, 2001) have experimented with this method. Clausen's work has been successful in removing 92% of the copper and 42% of the arsenic, but there has been no success of removing the chromium because it is bound tightly to the lignin (Wilson, 1997). Shiau, Smith, and Avellaer (2000) were successful in extracting over 80% of CCA chemicals in the wood particles with citric acid. Another barrier associated with removing the treating chemical from the wood is that it is currently more expensive to do this than it is to dispose of the treated wood in a C&D landfill. Avellar and Glasser reported that the average cost of extraction of preservative from treated wood by a steam explosion process is \$35 to \$40 per ton plus an additional \$10 to \$20 when using organic acids (Avellar and Glasser, 1995). This is a base cost without adding in the raw material cost associated with the process. As stated earlier the average tipping fee for C&D landfills varies from \$20 to around \$50 so this process more than likely is not an economically viable option at the present time.

A program that has shown success is the recovering of scrap lumber at curbside by the town of Aberdeen, MD (Litke, 1996). The curbside program collected 3.47 tons of wood waste by residents and 35% (the largest contributor) was pressure treated lumber. The 768 pounds of treated wood was then donated to the Hartford Glen Nature Center for nature and wildlife trail construction. The nature center indicated that it could use more pressure treated

lumber, so the scrap lumber collection for 1997 emphasized the recovery of pressure treated wood. This indicates that if recycling incentives and programs are set then recovering CCA treated wood for the use in municipal recreational areas might have potential, but public safety concerns will have to be addressed.

DECONSTRUCTION AND DEMOLITION

Current Research Being Performed

Deconstruction is a relatively new term describing an old process. Deconstruction is the process of selective dismantling or removal of materials from buildings before or instead of demolition (Franklin Associates, 1998). This process will remove valuable material for recycle and reuse prior to and during demolition. Examples of material recycled or reused from the deconstruction process are: electrical and plumbing fixtures, steel, copper, lumber, wood flooring, doors, and windows (Franklin Associates, 1998).

There is numerous research in the feasibility of deconstruction rather than demolition. The National Association of Home Builders (NAHB) Research Center completed a study of a two story, four-unit apartment complex, and determined the diversion rate to be 76% by weight and 70% by volume. The Fort Ord Case study was a deconstruction project that included four buildings, and nearly 90% of the materials recovered were salvaged for reuse (Block, 1998). The Riverdale Case Study, by the NAHB in 1997, and the Presidio Case Study, by the California Integrated Waste Management Board in 1999, both found it economically feasible to deconstruct compared to demolition of the buildings.

Deconstruction can be separated into two types, nonstructural and structural. Nonstructural deconstruction salvages fixtures, appliances, and other components. This is a mature industry with markets nationwide, with high-end markets for the salvaged material

(HUD, 2001). Structural deconstruction is the removal of joists, beams, and other structural components; this is an emerging market and faces a number of factors to be successful. Factors include environmental contamination, code issues, project time constraints, and the value of the recovered material must offset the labor required to salvage them (HUD, 2001). In many areas of the United States, where there is not a large supply of structural deconstructed material, recycling or reusing this material is not currently economically feasible.

Deconstruction is also a tool that is being used by many communities in the United States to support economic development (HUD, 2001). Deconstruction creates new training and jobs, creates new businesses to handle the recycled material, and it benefits the environment by diverting the material away from landfills (HUD, 2001). Many advantages to deconstruction compared to demolition have been found through research, so could this be an advantage in reusing and recycling spent CCA treated wood from residential decks?

Implications on the Effective Recycling of CCA Treated Lumber from Residential Decks

One of the issues with recycling residential decks is that it is currently cheaper to demolish decks rather than deconstruct them. Alderman's research (2001) stated that the average disposal cost of a deck was \$179.56, compared to the cost of deconstruction, at \$370.57. This indicates that there is a lack of recycling incentives and programs that would motivate contractors in deconstructing decks, which increases the value to the removed lumber. King County, WA has implemented a program that has helped construction crews recycle up to 90% of the material (Koppang, 2001). King County combined technical information with extensive education and outreach to the construction industry. According to Koppang (2001), the success of construction recycling hinges on two factors: Recycling

must be voluntary rather than mandatory; and the marketplace must determine the economic viability of recycling without direct subsidies from the government. This information follows the same recommendations Alderman (2001) gave to increase the value of the spent CCA treated wood via deconstruction.

Other factors will effect the deconstruction of CCA treated decks including viable market for material, lack of lumber grade stamps on spent lumber, and job site safety and training (Alderman, 2001). The main factors in making deconstruction feasible for deck builder is that the time spent to deconstruct must be financially compensate, by recycling centers. But recycling centers must first have a market for recycled treated wood products and a steady raw material base to be successful.

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CHAPTER TWO. RECOVERY OF CCA TREATED WOOD FROM RESIDENTIAL DECKS

ABSTRACT

An enormous volume of CCA treated wood is currently being removed from spent residential decks, and is expected to increase over the next several years. Most of the removed CCA treated wood from residential decks is disposed of in landfills, but current disposal methods are becoming impractical due to the decreasing number of landfills and imposing environmental and safety regulations. Therefore, it is important to develop useful alternatives to the disposal CCA treated wood in landfills.

Six CCA treated wooden residential decks were removed from service and analyzed to determine the amount of usable material that could be recovered for further use. Four residential decks were demolished, and two decks were deconstructed to determine what process was most feasible for deck builders and recyclers. Most of the decks were removed because of the appearance, not because of the performance of the CCA treated wood. It was found that 86% of a treated deck could be recovered as reusable CCA treated lumber. 2x8s (primarily joists) and 2x6s (primarily decking) of the spent decks were the highest volume received and the most successful material recovered, at 95% and 93% respectively. Deconstruction procedures had no effect on the recovery of CCA treated wood from residential decks. It was found that other factors such as environmental conditions, construction methods, and material might have a larger influence on the recovery of CCA treated wood from spent residential decks.

This information will inform and aid landfill managers and recyclers with the amount of useful material that is available from dismantled CCA treated residential decks. It should help reduce the burden placed on landfills by diverting and extending the life of usable CCA treated wood from residential decks.

INTRODUCTION

The use of CCA treated wood in the United States has grown significantly since the 1970's, and the production of CCA treated wood has risen 50% since 1984 (Micklewright, 1998). The Southern Pine Council (2002) reports that 6.8 billion board feet of Southern Yellow Pine was treated with CCA in 2001. The construction and remodeling of residential decks is the largest market for CCA treated wood in the United States. The Southern Forest Products Association (SFPA) (1999) estimated that in 2001 the construction, repair and remodeling of residential decks comprised 40%, or used 2.1 billion board feet in 2001 of the total CCA treating market in the United States. Several investigators have indicated that approximately 80% of decks constructed in the United States used CCA treated wood (Shook and Eastin, 2001). The main components of decks are the deck boards, joists, steps, and spindles or balusters. Typically, approximately 50% of a deck is comprised of deck boards (Smith, 1997), which usually consist of 5/4" Radius Edge Decking (RED), 2"x4" lumber or 2"x6" lumber. With the recent safety related concerns with CCA chemicals, the EPA and the manufacturing industry have voluntarily discontinued the use of CCA treated wood in residential construction (EPA, 2002). The construction of new decks with CCA treated wood will end with the ban of CCA treated wood in residential markets, but the dismantling of old CCA treated decks will continue for several decades.

Along with the production of CCA treated wood, the disposal of spent CCA treated wood has risen in the past few years. Research has concluded that within the next several years the disposal of CCA treated wood will rise dramatically. Cooper (1993) estimated that from the year 2000 to the year 2020 the disposal of CCA treated wood will increase 9 fold (Cooper, 1993), and several other investigators have reported similar results (Felton and

DeGroot, 1996 and McQueen and Stevens, 1998). Recent reports have indicated that a large volume of CCA treated wood from residential decks is being removed from service each year. Alderman (2001) estimated that approximately 1 billion board feet a year of CCA treated wood is being removed a year from the dismantling of residential decks. McQueen and Stevens (1998) estimated that in 1999, 935 million board feet was removed from spent residential decks. This research suggests that every year, one-half of the new CCA treated wood used in the deck market is replacing discarded material.

The average age of a deck at removal from studies by McQueen and Stevens (1998) and Alderman (2001) was 9 and 12.8 years respectfully. Alderman (2001) estimated the average size of a removed deck was 198 square feet. There were many reasons for removal of the deck by the homeowner, but the research by Alderman (2001) and McQueen and Stevens (1998) both found aesthetics to be one of the most important factors. Other factors that lead to the replacement of a deck were the amount of decayed wood, physical degradation of the wood, and structural integrity of the deck (Alderman, 2001). The results raise questions as to the amount of usable lumber being discarded if aesthetics was the most important factor for the removal of a deck.

Most of the spent CCA treated wood removed from decks, by either demolition or remodeling, is disposed of in landfills. Alderman's research in 2001 indicated that over 50% of building contractors disposed of the spent CCA treated wood in landfills exclusively. Research performed by McQueen and Stevens (1998) stated that 66% of CCA treated wood decks are being disposed of in landfills. Due to the large volume of CCA treated wood being disposed of in landfills research has been conducted involving the potential environmental side affects of the chemical leachate in landfills contaminating groundwater. (Townsend and

Solo-Gabriele, 2001). If this research concludes that CCA is contaminating drinking water, then tighter regulations will most likely occur which will increase tipping fees at landfills, and reduce the number of landfills that have the capability to safely dispose of CCA treated wood.

As stated previously, the reason for the removal of a residential deck was not always because of physically or mechanically deteriorated CCA treated wood. Many factors such as aesthetic appeal of the deck or the homeowner's desire for a larger deck were also major factors in deck removal. Therefore, the spent deck material may be recoverable and used in similar applications. Research by McQueen and Stevens (1998) in 1995 stated that 17% of removed decks were reused, and Alderman's research in 2001 indicated that only 4% of a spent CCA treated deck is being reused. The building contractors in Alderman's research suggested that approximately 45% of a deck could be recovered (2001). Many factors were given by building contractors for the differences between the current and potential CCA treated wood being recovered. These factors included: no recycling facilities, lack of recycling programs, cost, time, and manpower (Alderman, 2001). A process that may increase the use of recovered CCA treated wood is the deconstruction instead of demolition of the spent deck. Deconstruction is a popular process in which material is recovered from a structure that may have added value as opposed to being landfilled. Deconstructing spent CCA treated decks may add value to the material and thus look more attractive for recycling centers to convert the material into a usable product. Deconstruction has been used in numerous projects around the country to add in economic development of communities (HUD, 2001). Some of the issues with deconstruction is that it is more expensive to deconstruct rather than to demolish a residential deck. Alderman found that the average

disposal cost of a deck was \$179.56 compared to the deconstruction cost of \$370.57 (2001). For deconstruction to be successful the building contractor or homeowner removing the residential deck must be financially compensated, therefore the recycling center or organization must have a viable market for recycled CCA treated wood.

For successful recovery and reuse of spent CCA treated wood, a great deal of information needs to be determined. Recyclers need to have an adequate supply of raw material in order to make a profit in recycling. This supply is true for any type of recycled material whether it is glass, metals, paper, or wood. To achieve a successful recycling program of discarded CCA treated decks the amount of recoverable CCA treated wood needs to be determined, and also if deconstructing a deck rather than dismantling the deck will be more cost effective for the homeowner, building contractor, and recycler.

OBJECTIVES

The objective of this study was to:

- Determine the percent of usable CCA treated wood that can be obtained from a spent CCA treated residential deck.
- Identify what economic benefits exist between deconstruction and demolition practices of spent CCA treated residential decks for building contractors and landfills or recycling companies in effectively recovering CCA treated wood.

METHODOLOGY

Building contractors were contacted in the area surrounding Blacksburg, VA to obtain spent CCA treated residential decks. The contractors that were contacted specialized in the construction and demolition of residential decks. The list of participating contractors is located in Appendix A. Once a CCA treated deck was located, prior to removal, an accurate

area and volumetric measurement and piece count of the deck was obtained. A questionnaire was given to the homeowner to gain an understanding of their satisfaction of the old deck, factors of the deck they found desirable, and what they plan to build after the spent deck is removed. A total of six decks were obtained, four that were demolished, following the typical building contractors techniques, and two decks were deconstructed. The deconstruction process is a “soft” removal alternative to demolition. Theoretically, deconstruction is the process of selectively and systematically disassembling the deck that would otherwise be demolished to generate a greater supply of materials suitable for reuse in the construction or rehabilitation of other structures. Deconstruction of the decks involved disassembling the decks while stressing the recovery of the material, not necessarily the most convenient process for the building contractor.

The discarded material was delivered to the Brooks Forest Products Laboratory’s log yard, where the hardware was removed from each deck and then similar dimensional lumber was stacked together, while keeping the deck separated. The unusable sections (such as damage caused by removal tools, splits, and excessive nail holes) of the salvaged CCA treated wood were removed and then the volume of material remaining was then calculated. The time, labor, and material costs were all calculated to recover the CCA treated wood from each residential deck.

DECKS PRIOR TO REMOVAL

The ages, type of material composing the deck, size, and the original retention of CCA chemical in the wood were gathered, prior to removal. All relevant information regarding each deck is described in the following sections.

DECK AGE

The average age of the decks prior to removal was 17.7 years. Deck No. 2 was in service the longest at 27 years and Deck No. 1 was in service the shortest time at 13 years. The average life span of the decks in this study was longer than the research performed by Alderman (2001) and McQueen and Stevens (1998), which concluded that the average life span of a CCA treated residential deck was 12.8 years and 9 years respectfully. The age of each deck prior to removal is located on Table 2-1.

Table 2- 1. Service time of each residential deck.

Deck No.	Age (years)
1	13
2	27
3	18
4	17
5	17
6	14
Average	17.7

DECK MATERIAL

The type of CCA treated wood composing the deck varied little. The wood from all decks received were grade stamped Southern Yellow Pine (SYP), excepted for Deck No. 5 which was grade stamped by the Southern Pine Inspection Bureau (SPIB) as Mixed Pine. Southern Yellow Pine group includes several pine species, which are: loblolly pine (*Pinus taeda*), shortleaf pine (*Pinus echinate*), longleaf pin (*Pinus palustris*), slash pine (*Pinus elliottii*), and pitch pine (*Pinus rigida*) (Hoadley, 1990). Mixed pine according to SPIB groups all SYP and adds virginia pine (*Pinus virginiana*) and pond pine (*Pinus serotina*). According to Hoadley (1990) Southern Yellow Pine, Virginia pine and pond pine are all considered hard pines, and very difficult to separate anatomically, therefore the species of the wood were not separated when comparisons were drawn.

The majority of the decking was 2x6 dimension lumber, which is not uncommon because 5/4" radius edge decking (RED) did not become popular in the residential decking market until the mid-1980's, before many of these decks were constructed. Deck No. 1 was the only deck that had RED, and it was also the youngest deck removed being built in the late 1980's. Future decks being removed from service will have a larger percent of RED, and that will have to be considered, by recyclers in the future, when determining feasible recycling alternatives for spent CCA treated decks.

The joists of the decks were composed of 2x6, 2x8, and 2x10 dimensional lumber. The railings were composed mainly of 2x2 and 1x6 lumber for the balusters and the rails were composed of 2x4 lumber. The posts of the decks were made from 4x4 lumber, with Deck No. 2 begin the exception having steel posts supporting the deck. A summary of the deck components is located on Table 2-2.

Table 2- 2. List of Components in Decks Prior to Removal.

Deck No.	Decking	Joists	Posts	Railing	Stairs
1	5/4 RED	2x10	4x4	2x2 & 2x4	2x10 & 5/4 RED
2	2x6	2x8 & 2x10	steel posts	2x4 & 1x6	N/A
3	2x6	2x8	4x4	2x6, 2x4 , & 1x6	2x12 & 2x6
4	2x6	2x8	4x4	2x6, 2x4 , & 1x6	N/A
5	2x6	2x6 & 2x8	4x4	1x6 & 2x4	2x6 & 2x10
6	2x6	2x6 & 2x8	4x4	2x2 & 2x6	2x6 & 2x10

RETENTION LEVELS

The retention levels of the deck material was stamped or tagged on the lumber as .40 lb/ft³ or .25 lb/ft³. The AWWA (Southern Pine Council, 1999) standards state that if the CCA treated wood is used above ground then the retention can be .25 lb/ft³, but if there is permanent ground contact the retention level must be .40 lb/ft³ for the CCA treated wood. The retention levels for the posts of the decks could not be found, but was assumed to be .40 lb/ft³, since the posts are in permanent contact with the ground. The decking and joists of

Decks No. 1, 2, 5, and 6 were treated entirely to a chemical retention level of .40 lb/ft³. For all other components, such as balusters, railing, and stair components, the original retention level could not be found on the material.

DECK SIZES

The average size prior to removal of all decks obtained for this study were 220 square feet. Table 2.3 displays the sizes of each deck prior to removal. The deck sizes in this study are similar to other studies (Alderman, 2001), which found the average size of a deck removed in the North Carolina, Georgia, and South Carolina, in 1999, was 199 square feet. A picture of each deck obtained for this research is located in Figures 2-1 through 2-6.

Table 2- 3. Deck size, in square feet.

Deck No.	Square Feet
1	239
2	150
3	200
4	210
5	160
6	360
Average	220



Figure 2- 1. Deck #1 while in-service.



Figure 2- 2. Deck #2 while in-service.



Figure 2- 3. Deck #3 while in-service.



Figure 2- 4. Deck #4 while in-service.



Figure 2- 5. Deck #5 while in-service.



Figure 2- 6. Deck #6 while in-service.

SURVEY OF DECK OWNERS

To gain an understanding of the reasons for the removal of the residential deck and attributes of the deck prior to demolition, a questionnaire was developed to address these questions, and is located in Appendix B. The first question asked the homeowner the age of the deck and this information has been reported in the previous section. The second question asked the deck owner why the residential deck was removed. The results of the question are located in Figure 2-7. The most frequently listed reasons for deck removal were aesthetics, safety, and physical degradation of the wood, each response was indicated by two thirds of the deck owners in the study. Decayed wood, inadequate size, and poor construction were listed by half of the deck owners as a reason for removal. Type of material the deck consisted of, insect damage, and style was not a factor in the removal of the deck by the owner.

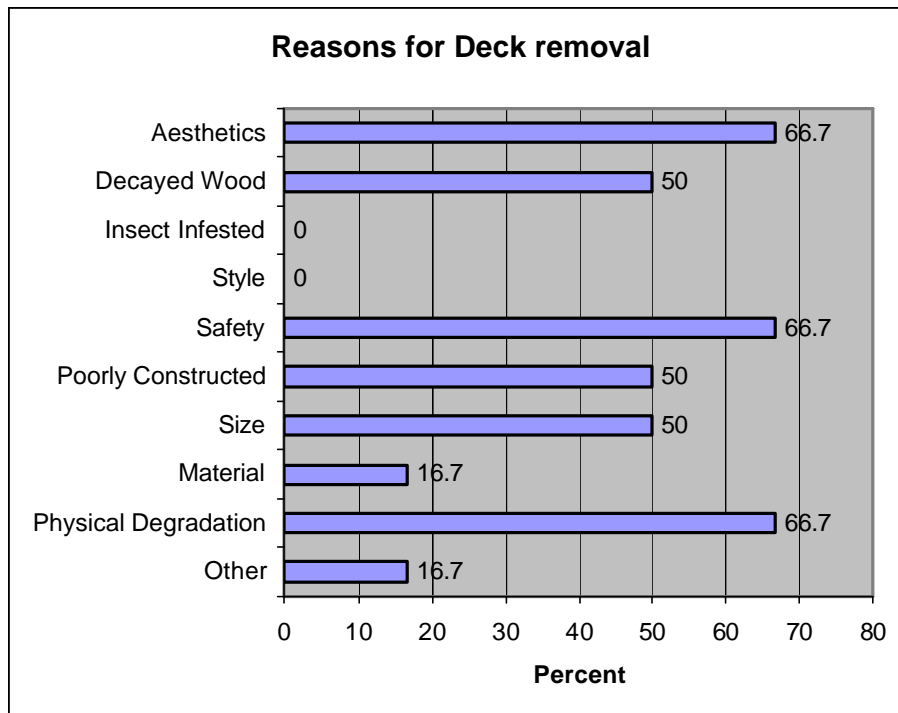


Figure 2- 7. Percent of Deck Owners Indicating Reasons for Deck Removal.

The next question asked the deck owner of their overall satisfaction of their residential deck. Overall, the satisfaction level of the deck from the owners was low. Of the six decks obtained four owners claimed to be unsatisfied with the deck while the other two were satisfied. It seems the low satisfaction level was not an indication of a low desirability of the deck, because each owners responded that they plan to build a new deck after removal of the existing deck. Also the survey pointed out that using CCA treated wood was not an issue because all but one owner planned to use this material to construct the new residential deck. The one deck owner that was the exception was using a wood based composite in the new deck, because this material, “ it seems to last longer and does not warp as bad as real wood”. When the deck owners were asked why they chose that material to construct the new deck, one-half of the sample said it was a cost issue, two owners claimed that CCA treated wood was more aesthetically pleasing, and two others responses were that they let the building contractor decide.

Another question asked the deck owner was who made the decision on the building material used to construct the new deck. Two-thirds of the owners indicated that the building contractor made the decision and the other third stated that they made the decision. The results of the questions were interesting because with all the negative press about the safety and environmental concerns with CCA treated wood, most owners and building contractors still chose this material. Therefore, the research suggests that the cost of material, and possibly the ease of fabrication, is still a bigger factor than the possible negative side affects that environmental groups and the media have portrayed CCA treated wood to be associated with.

The final question asked the deck owners to rate several attributes of the spent residential deck from a range of 1 (very satisfied) to 5 (very unsatisfied). The results of the question are displayed in Figure 2-8. The amount of insect damage, or lack there-of, was the highest rated attribute in terms of satisfaction. The deck owners rated overall deck construction and the lack of decay in the deck to be above average. Deck owners rated the aesthetics, amount of degradation, safety, and style of the deck as low in terms of their satisfaction. This indicated that the performance of the CCA chemical met the standards desired by the homeowners, but the quality of construction and the physical degradation of wood (i.e., warp, twist, bow, etc.) did not meet the homeowners desired level of expectation.

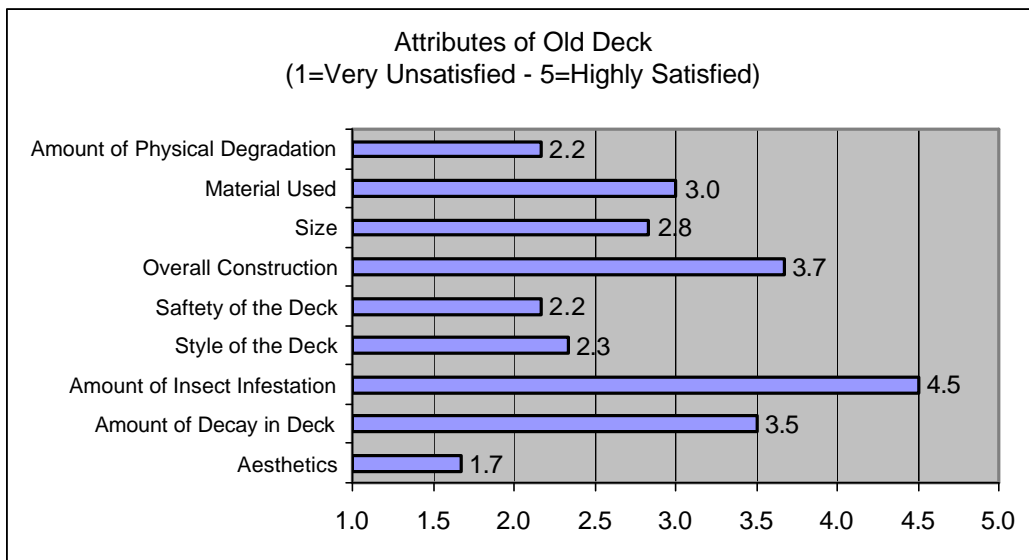


Figure 2- 8. Deck owner’s satisfaction level of several attributes of the removed decks.

COMPARISON OF CCA TREATED WOOD VOLUMES BEFORE AND AFTER REMOVAL OF RESIDENTIAL DECKS

Prior to removal by the building contractor, the size and volume of material in each deck was obtained. The type of material, such as 5/4” RED, 2”x2” balusters, 2”x8” joists, etc., and number of pieces the deck contained were documented. After delivery of the discarded material, the volume of CCA treated wood after hardware removal and man hours

required to complete task was documented. Claw hammers, nail pullers, crowbars, and clamps were the tools used to remove the hardware. To determine the amount of usable material from a demolished deck, the removed material was evaluated. Areas in the lumber where excessive nail holes, damaged material due to removal procedures, and decay existed were removed and discarded to obtain at least a No. 2 grade for the recovered lumber. The grading standards followed are found in SPIB's *Graders Manual for Boards and 2" Dimension* (1991). After removal of any degraded material, the amount of lumber that could be used again as construction material was calculated. A detailed account of the number of pieces and volumes of the CCA treated wood while in-service, after demolition, and recovered, for each deck, is located in Appendix D. The following section describes the volume of material recovered from each individual deck, and then combines the information together to obtain the aggregate amount of material that is salvageable from a recovered CCA treated residential deck.

DECK NO. 1

Deck No. 1 took approximately 9 worker-hours to demolish by the employees of the building contractor, and then an additional 13-3/4 worker-hours to remove the hardware and stack the material according to dimension. The hardware consisted of 3-1/2" and 2-1/2" spiral shank nails and joists hangers, and the total weight of the hardware remove from the deck was 24.4 lbs. It was assumed that this was not the total amount of hardware in the deck, because during demolition hardware could have been removed and not remained with the rest of the removed material. The removal of unusable parts of the lumber took 1-1/2 worker-hours. The total amount of time needed to recover the CCA treated wood from Deck No. 1 was 24.25 worker-hours. The composition of Deck No. 1, while in-service, is located in

Figure 2-9. As expected the decking (5/4" RED) and the joists (2"x8" and 2"x10") comprise the majority of the deck volume, over 60%. The volume of lumber after demolition and that is reusable was then obtained. A picture of the CCA treated wood recovered in Deck No. 1 after the hardware and unsuitable portions were removed is located in Appendix C. Table 2-4 displays the volume of material in-service, after demolition, and finally the volume of the deck that can be reused from each type of material and the percent of material usable after demolition.

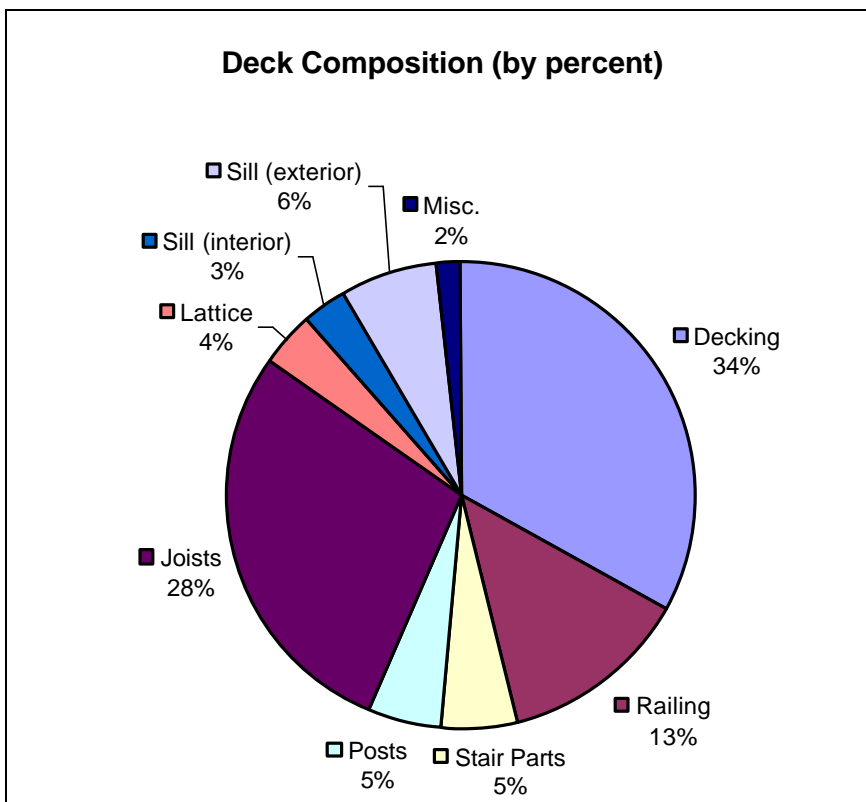


Figure 2- 9. Deck No. 1 composition by percent while in-service.

Table 2- 4. Volume and percent of CCA treated wood in-service, after demolition, and volume and percent recovered from Deck No. 1.

Material	In-Service		After Demolition	Recovered	
	Volume (bdft)	% of Total	Volume (bdft)	Volume (bdft)	% Recovered
5/4x6 (R.E.D)	263	33%	231	208	79%
2x4	83	10%	81	89	108%
5/4x4.5 (R.E.D)	9	1%	7	6	65%
4x4 (Posts)	49	6%	37	36	73%
2x2 (Balusters)	50	6%	48	39	78%
2x10 (Joists)	309	39%	329	299	97%
Lattice	32	4%	17	0	0%
Total	796	100%	751	677	85%

Eighty-five percent of the CCA treated wood in-service from Deck No. 1 was recovered. As displayed in Table 2-4, the percent of recovered 2x4s increased above what was original in the deck by 8%. This is due to other material such as in-service 2x10 joist that are ripped into 2x4 boards. Also, there could have been some small error in calculating the amount of CCA treated wood in-service, but the overall affect it had on the volume recovered was negligible, since the difference was only six board feet between the volume of CCA treated wood in-service and recovered for the 2x4s. Following the 2x4s, the 2x10s, or joists in the deck, were recovered the most effectively. This was expected since the joists of the deck are covered by the decking and therefore are not exposed to the climatic and physical weathering other components of the deck receive. More CCA treated wood from Deck No. 1 was lost during the trimming of unusable portions of the deck material, rather than the deck demolition. A difference of 45 board feet, or 5.6%, was lost during the demolition and hardware removal, and 74 board feet, or 9.9%, was lost during the trimming of unusable areas of the recovered wood.

DECK NO. 2

Deck No. 2 was different from the other removed decks that were used in this study. As shown in Figure 2-2, metal posts supported the deck, which is unusual for many residential decks; therefore, the posts were not used in the study. Also, as shown in the earlier section, Deck No. 2 was 27 years old, the oldest deck in the study.

The homeowner demolished Deck No. 2 in approximately six hours. The hardware in the deck was straight shank 3-1/2" nails, and the total weight of hardware removed was 18 lbs. To remove the hardware from the CCA treated wood it took 12 worker-hours, and then an additional 2 worker-hours to remove the unusable portions from the deck material, such as excess nail holes, damage from demolition tools, and insect damage. The total amount of time to convert Deck No. 2 into recovered lumber was 20 worker-hours. Appendix C displays the recovered material from Deck No. 2.

The composition of Deck No. 2, while in-service, is located in Figure 2-10. As expected, the decking and joists were the majority of the deck, especially since the posts were not used. The volume of CCA treated wood composing the deck while in-service, after demolition, and recovered is located on Table 2-5. From a total of 531 board feet of CCA treated wood from Deck No. 2, 94%, or 501, board feet were recovered. The 2x4s and 1x6s increased in volume between being in-service and then recovered. This increase is due to the 1x6s and 2x6s that were ripped during the recovery process into narrower boards. Also, the percentages are misleading because this material represents a small percent of the total deck volume. The joists and the deck were recovered the best, resulting in 94% of the material retained from the deck while in-service. The 1x6s, used mainly in the railing, were the least recovered material, since only 77% of that material could be recovered. More unusable CCA

treated wood was removed for recovery during the demolition of the deck (22 bd.ft. or 4.1%), than the trimming of unusable portions of the wood (8 bd.ft. or 1.6%).

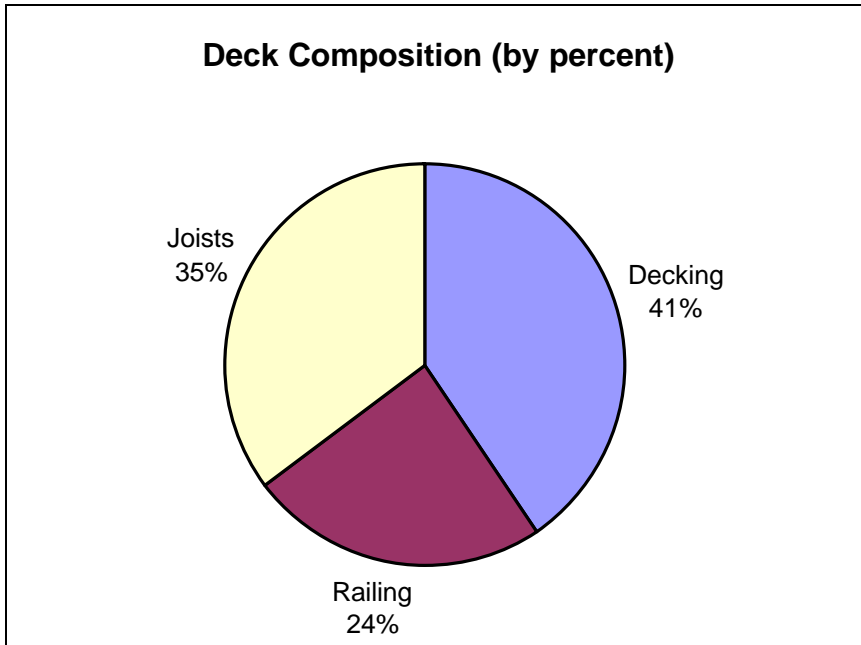


Figure 2- 10. Deck No. 2 Composition by percent while in-service.

Table 2- 5. Volume and percent of CCA treated wood in-service, after demolition, and volume and percent recovered from Deck No. 2.

Material	In-Service		After Demolition	Recovered	
	Volume (bdft)	% of Total	Volume (bdft)	Volume (bdft)	% Recovered
2x6 (decking & railing)	240	45%	235	225	94%
2x4 (railing)	46	9%	42	54	117%
2x8 (joists)	98	19%	95	94	95%
1x4 (railing)	2	0%	4	4	144%
1x6 (railing)	60	11%	52	46	77%
2x10 (joists)	84	16%	81	79	94%
Total	531	100%	509	501	94%

DECK NO.3

Deck No. 3 was deconstructed rather than demolished as the previous decks were removed. Deck No. 3 and Deck No. 4 were attached to the same home, but since the building contractor kept them separated and did not consider them the same structure the decks were separated as Deck No. 3 and Deck No. 4. It took the building contractor

approximately four hours to deconstruct Deck No. 3. The removal of hardware took 14 worker-hours to remove, and weighed a total of 32.6 lbs. The hardware consisted of 3-1/4" straight shank nails, 2" spiral shank nails, and joist hangers. It took 2-1/2 worker-hours to remove the unrecoverable areas of the lumber. The total amount of time to convert Deck No. 3 into recovered lumber was 20.5 worker-hours. Appendix C displays the material recovered from Deck No. 3. Figure 2-11 shows the composition of the deck while in-service. The composition of Deck No. 3 is similar to the other decks collected. The decking and joists components compose the majority of the deck, but the stairs comprise 26% of the deck, mainly because Deck No.3 had two stairways.

As seen in Table 2-6 the total amount of CCA treated wood recovered from Deck No. 3 was only 76%, much lower than the other decks. The least recoverable material was the 1x6s and the 2x12s. The 1x6s were the balusters in the railings and during the deconstruction process the hardware could not be feasibly removed to recover that material. The nails were 2" spiral shank nails and could not be removed with the tools that were available in a timely manner. The heads of the 2" spiral shank nails during hardware removal broke and the shank of the nail could not be removed without destroying the wood around the nail. This nail issue was the main reason the 1x6s and some of the 2x4s could not be recovered. The recovery of the 2x12s in Deck No. 3 was also low. The 2x12s composed the stair treads and stringers. The 2x12s were ripped into 2x8s, because of notches located in the corners made to fabricate the treads for the stairs. Much of the 2x12 material was lost during the recovery process not the deconstruction process, like the railing components (1x6s and 2x4s).

The material lost during the deconstruction of the deck and the removal of unusable material was similar, as shown in Table 2-6. The material lost during deconstruction was 106 board feet, and 117 board feet was lost during the removal of unusable material. As shown on Table 2-6, the volume of 2x8 and 4x4 lumber was higher after deconstruction, likely caused by a miscalculation of the volume while in-service. The joists (mainly 2x8s), the posts (mainly 4x4s), and the deck (mainly 2x6s) had the highest percent recovered. This follows the trend of the previous decks removed.

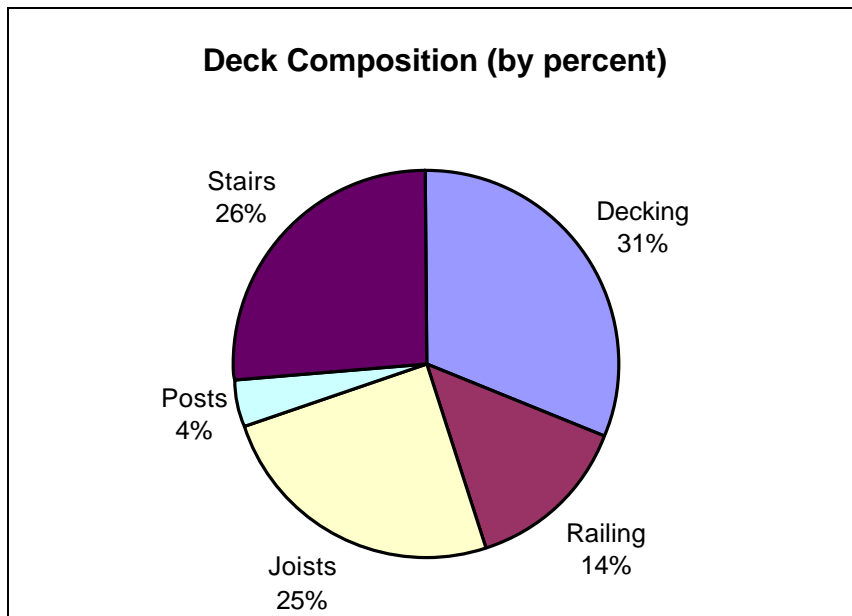


Figure 2- 11. Deck No. 3 composition by percent while in-service.

Table 2- 6. Volume and percent of CCA treated wood in-service, after deconstruction, and volume and percent recovered from Deck No. 3.

Material	In-Service		After Deconstruction	Recovered	
	Volume (bdft)	% of Total	Volume (bdft)	Volume (bdft)	% Recovered
2x6	365	39%	328	309	85%
2x4	68	7%	59	49	72%
1x6	42	4%	11	9	22%
2x12	154	17%	114	49	32%
2x8	230	25%	234	220	95%
4x4	73	8%	80	73	100%
Total	932	100%	826	709	76%

DECK NO. 4

Deck No. 4 was similar to Deck No. 3, because it was connected to the same house. Therefore, the percent of recovered CCA treated wood should be similar. This deck was deconstructed instead of demolished by the building contractor. It took the contractor approximately 5-1/2 hours to deconstruct the deck, and another 15 worker-hours were required to remove the nails and other hardware. The hardware in the deck consisted of 3-1/2" straight shank nails, 2" spiral shank nails, and joist hangers. The total weight of the hardware incorporated in the deck was 27.8 lbs. It took 3 worker-hours to remove the unusable sections of Deck No. 4. In total, 23.5 worker-hours were needed to turn Deck No. 4 into reusable lumber. Appendix C displays the recovered wood from Deck No. 4.

The composition of Deck No. 4 is similar to Deck No. 3, except that Deck No. 4 has no stair components. Figure 2-12 shows that the joists and the decking are the major components of the deck, by volume. Table 2-7 shows that the 2x6s (decking) and 2x8s (joists) were the most successfully recovered material. As expected the 1x6s from the railing were not recovered because of the hardware, the same in Deck No. 3, used in construction could not be removed without destroying the wood. Overall, 78% of the deck material was recoverable, mainly due to the successful recovery of the 2x6s and the 2x8s. As shown on Table 2-7, the volume of 2x6 and 2x8 material after deconstruction was higher than while in service, which likely was caused by miscalculating the volume while in-service.

Similar volumes of CCA treated wood were not recovered between the deconstruction process and from the removal of unusable material. From a total volume of 778 board feet 89 board feet or 11.4% of the original deck material was unrecoverable after

deconstruction. During the removal of unusable sections of the CCA treated wood 11.3% or 78 board feet were discarded as not usable in further applications.

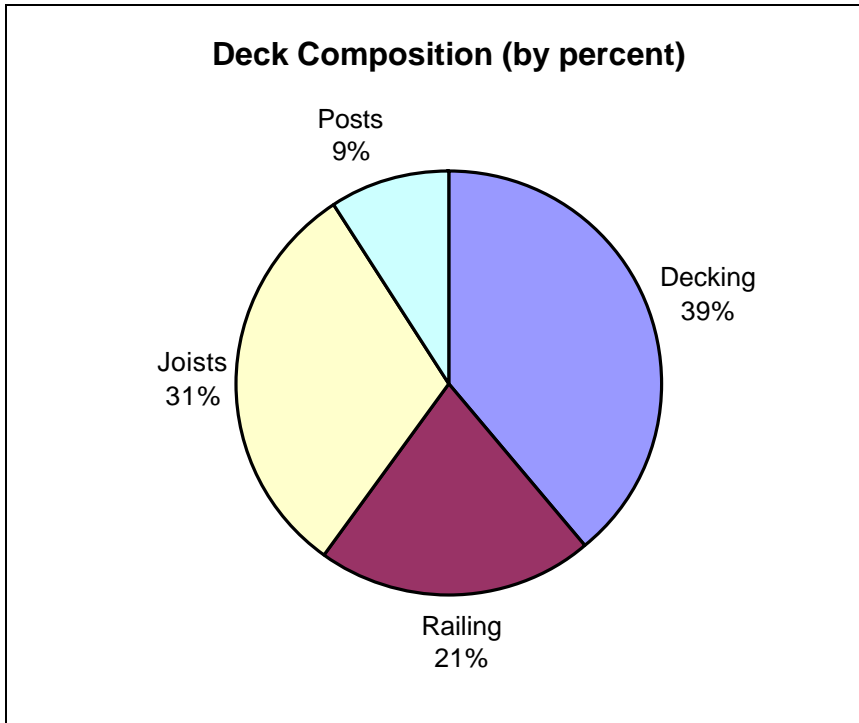


Figure 2- 12. Deck No. 4 composition by percent of component volume, while in-service.

Table 2- 7. Volume and percent of CCA treated wood in-service, after deconstruction, and volume and percent recovered from Deck No. 4.

Material	In-Service		After Deconstruction	Recovered	
	Volume (bdft)	% of Total	Volume (bdft)	Volume (bdft)	% Recovered
2x6	321	41%	323	298	93%
2x4	42	5%	45	18	42%
1x6	63	8%	0	0	0%
2x10	19	2%	0	0	0%
2x8	222	29%	236	234	105%
4x4	102	13%	85	61	60%
2x9	10	1%	0	0	0%
Total	778	100%	689	611	78%

DECK NO.5

Deck No. 5 was demolished similar to the style used for Decks No. 1 and 2. Deck No. 5 took approximately 3 worker-hours for the employees of the building contractor to

demolish. After being removed from service 12-1/2 worker-hours were needed to remove the hardware from Deck No. 5. The total weight of the hardware removed from Deck No. 5 was 18 lbs. The hardware consisted of 3” spiral shank nails and 4” horizontal shank nails. Three and a quarter worker-hours were needed to remove the unusable sections of the CCA treated wood recovered from the residential deck. In total, 24-3/4 worker-hours were needed to turn Deck No. 5 into reusable CCA treated lumber. Appendix C displays the recovered CCA treated wood from Deck No. 5.

The composition of Deck No. 5 while in-service follows the trend of the other decks removed in the study, as shown in Figure 2-13. The decking, as expected, contains the highest volume of CCA treated wood, but Deck No. 5 had a lower proportion of joists in the deck compared to the other decks. The reason is that the joists of Deck No. 5 consisted of 2x6s instead of the usual 2x8s or 2x10s, the predominate material used to construct deck joists; therefore a small dimensional material means lower volumes.

Overall, 92% of the CCA treated wood from Deck No. 5 was recovered. The largest volume and percent of material recovered was the 2x6s, which composed the decking and the joists. The 2x4s and the 5/4x6s, both used predominantly in the railing of the deck were also successfully recovered. Nothing was recovered from the 1x3s or the 2x10s in the deck, but they represented only a small proportion of the deck, comprising only 3% of the total volume. The 1x6s, used as balusters in the railings, were not recovered well compared to the rest of the deck. The main reason was because of the extreme weathering the balusters received while in-service, and when hardware was removed the 1x6s split and crack leaving many boards unpractical to be reused in other applications.

The amount of CCA treated wood that could not be recovered was similar between the two stages. During the demolition process approximately 22 board feet or 4% of the in-service volume of the deck was lost. After the demolition process, 22 board feet or 4.2% of the demolished volume was lost. Deck No. 5 was a highly recovered deck, recovering 92% of the total in-service volume. The amount of CCA treated wood recovered was higher than Decks No. 3 or 4, but the deck was structurally unsound while in-service and was not originally well constructed. The low quality of the construction (i.e., improperly or inadequately fastened and improper material used for certain applications) could be a factor in the amount of CCA treated wood recovered.

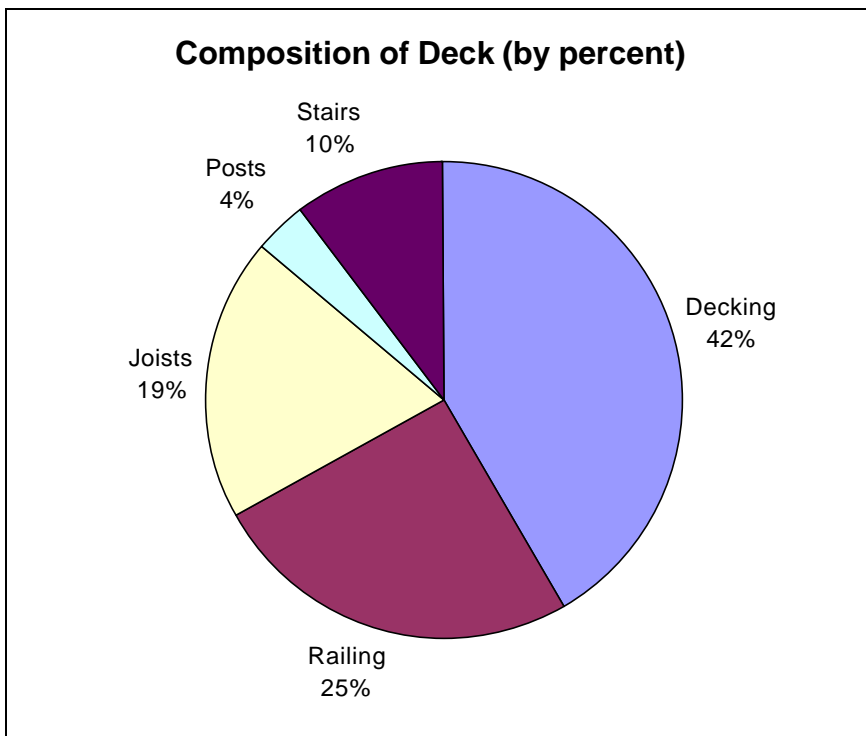


Figure 2- 13. Deck No. 5 composition by percent of component volume, while in-service.

Table 2- 8. Volume and percent of CCA treated wood in-service, after demolition, and volume and percent recovered from Deck No. 5.

Material	In-Service		After Demolition	Recovered	
	Volume (bdft)	% of Total	Volume (bdft)	Volume (bdft)	% Recovered
2x6 (decking & joists)	285	53%	279	286	100%
2x4 (railing)	69	13%	59	68	99%
5/4x6 (railing)	18	3%	18	17	94%
1x3 (boulsters)	1	0%	4	0	0%
1x6 (boulsters)	78	15%	73	62	79%
2x10 (joists)	16	3%	14	0	0%
2x2 (joists)	6	1%	6	5	82%
2x8 (joists)	46	9%	45	41	89%
4x4 (posts)	19	4%	19	17	90%
Total	539	100%	518	496	92%

DECK NO. 6

The building contractor demolished Deck No. 6, the final deck obtained in the study. Six hours were need for one man to remove the deck from service. Once demolished it required another 9-3/4 worker-hours to remove the hardware from the deck. The hardware consisted of 3-1/2” and 2-1/2” straight shank nails, and the total weight of the hardware removed was 36.6 lbs. An additional 2-3/4 worker-hours were needed to remove the unusable portions of the CCA treated wood. In total, 18-1/2 worker-hours were needed to transform Deck No. 6 into reusable CCA treated lumber. The reusable lumber from Deck No. 6 is displayed in Appendix C.

As with the other decks, the decking and joists comprised most of the deck as shown in Figure 2-14. In terms of volume this deck was the largest, and as shown in Table 2-3 was the largest in square feet. Overall, 92% of the CCA treated wood in the deck was recovered, displayed on Table 2-9. Some of the data is deceiving, such as 210% recovery of the 2x4s in the deck. The reason for the increase, just as the increase in some material in the other decks, is that some of the 2x6s and 2x8s in the deck could be ripped into narrower widths. In

general, all the material was recovered successfully. The only material that was not recovered effectively was the 2x10s, which composed the stringer in the stairs. Therefore, the 2x10s were notched and had to be ripped to make a 2x4 board, thus the increase of 2x4s between in-service and recovery. The entire lattice was recovered because it was not attached well to the railing and was easily removed without damaging the material.

The removal of unusable material had a larger affect than the demolition of the deck. After demolition 2.5% of the original material could not be recovered, and 5.6% of the CCA treated wood was unusable after unfeasible parts of the recovered wood was removed for future reuse. Decay of the wood was a large factor in the difference in loss of reusable CCA treated wood. As shown in Figure 2-15 the areas of the CCA treated wood that were in ground contact were decay severely, causing larger areas to be trimmed off of the CCA treated wood, in order for reuse.

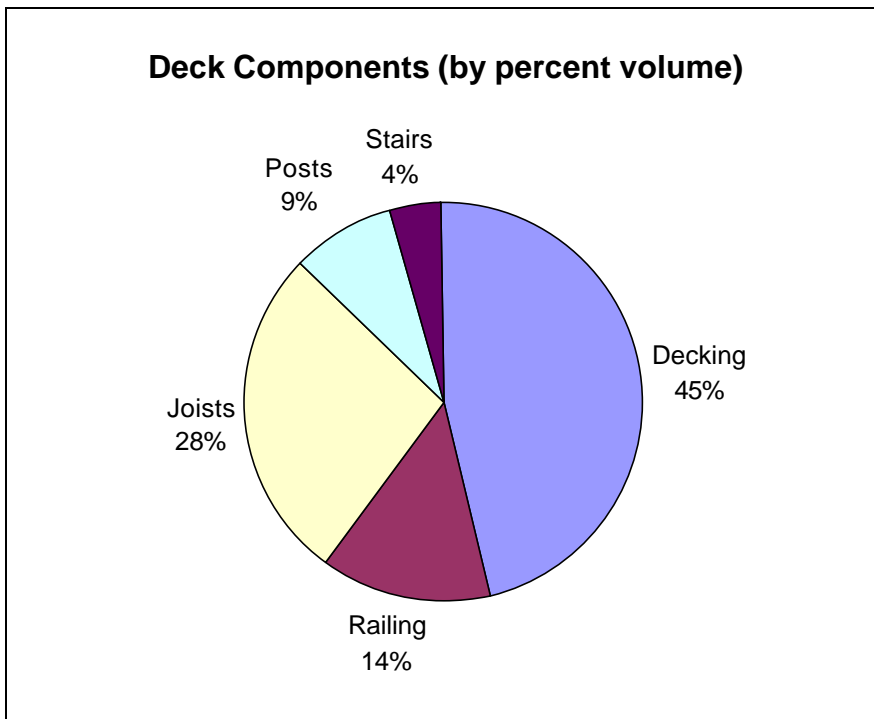


Figure 2- 14. Deck No. 6 composition by percent of component volume, while in-service.

Table 2- 9. Volume and percent of CCA treated wood in-service, after demolition, and volume and percent recovered from Deck No. 6.

Material	In-Service		After Demolition	Recovered	
	Volume (bdft)	% of Total	Volume (bdft)	Volume (bdft)	% Recovered
2x6	554	51%	546	515	93%
2x4	13	1%	12	26	210%
2x8	256	24%	228	221	87%
2x5	17	2%	20	15	87%
2x10	35	3%	41	18	52%
2x2	91	8%	91	88	97%
4x4	93	9%	92	87	94%
Lattice	21	2%	21	21	102%
Total	1078	100%	1051	992	92%



Figure 2- 15. Decayed portion of 4x4 posts of Deck No. 6 that were in ground contact while in-service.

RECOVERY DATA FROM ALL DECKS COMBINED

The information from the previous sections is combined to obtain an overall perspective on the recovery of CCA treated wood decks. On average, it took 22 worker-hours to fully recover the lumber from a spent CCA treated wood deck, as shown on Table 2-10. Removal of the hardware took the longest time in the recovery process averaging almost 13 worker-hours per deck. Deck No. 6 was the largest deck in terms of volume (Table 2-12)

and size (Table 2-3), but took the shortest amount of time to recover the lumber from the deck. This suggests that other factors, such as type of fasteners, location of the deck while in-service, and type of CCA treated wood composing the deck, have a greater impact on the amount of CCA treated wood recovered.

Table 2- 10. Time, in hours, needed to recover reusable wood from all six spent decks.

Deck No.	Demolition/ Deconstrcuton	Hardware Removal	Trimming of Unusable Areas	Total Recovery Time
1	9.00	13.75	1.50	24.25
2	6.00	12.00	2.00	20.00
3	4.00	14.00	2.50	20.50
4	5.50	15.00	3.00	23.50
5	9.00	12.50	3.25	24.75
6	6.00	9.75	2.75	18.50
Average	6.58	12.83	2.50	21.92

There was 4,654 board feet received from all the spent CCA treated wood decks, as shown on Table 2-11. Decking comprised approximately 38% and the joist 29% of the total volume of the deck while in-service. From Table 2-3 the average deck size was 220 square feet, and from Table 2-12 the average volume, while in-service, from each deck obtained was 774 board feet. Therefore, according to this research this is approximately 3.5 board feet per square feet of deck. This information might be important to building contractors and recyclers to determine an approximate amount of wood in a deck prior to demolition.

Table 2- 11. Component volume and percent of total volume from all decks.

Volume of Components in all Decks		
Component	Volume (Bd.Ft.)	% of Total
Decking	1789	38.4
Railing	810	17.4
Stairs	387	8.3
Joists	1359	29.2
Posts	261	5.6
Lattice	32	0.7
Misc.	15	0.3
Total	4654	100.0

The average percent of material recovered from all the spent residential decks received in this study was 85.8%, as shown on Table 2-12. The percent recovered ranged from a high of 94% (Deck No. 2) to a low of 76% (Deck No. 3). Deck No. 2 had the highest amount of CCA treated wood recovered, but was also the oldest deck in-service (27 years). Deck No. 1 was the youngest deck in the study (13 years) and the amount of CCA treated wood recovered was average compared to the percent of recovered CCA treated wood from the other decks. Therefore, the age of the deck while in-service does not appear to have an affect on the amount of CCA treated wood that can be recovered after removal. Other factors such as the severity of the physical and climatic environments might be a larger factor in the success of recovery CCA treated wood from residential decks.

Table 2- 12. CCA treated wood recovered from each residential deck.

CCA Treated Wood In-Service and Recovered from Residential Decks (Bdft)				
	In-service	Recovered	Difference	% Recovered
Deck #1	788	677	111	85.9
Deck #2	531	501	30	94.4
Deck #3	932	709	223	76.1
Deck #4	778	611	167	78.5
Deck #5	539	496	43	92.0
Deck #6	1078	992	86	92.0
Average	774	664	110	85.8

The material obtained from the decks is listed in Table 2-13. Since it is impossible to identify the function of each type of wood used in the deck (i.e., decking, joists, posts, etc.) after removal the application of the material, while in-service, is not listed in Table 2-13. From the composition of the deck, while in-service, assumptions can be made that the 5/4"x6" RED and the 2"x6" is decking, the 2"x8" and 2"x10" are joists and the 4"x4" are posts. According to Table 2-13, the 2"x6" material was the highest volume of material

received from decks and recovered. This is expected since the decks in this study consisted of 40% decking. The most successful materials recovered were the 2x8s and the 2x4s. The success of recovering the 2x8s, which were predominantly joists, is due to the lack of exposure to weathering and physical wear. The fact that the 2x4s were recovered effectively is due to the ripping of wider material into 2x4s. It must be acknowledged that the volume of 2x4s was low and this might not be an accurate representation of the recovery success of this material. Only after obtaining a higher volume of 2x4s from a deck can that conclusion be stated. The information from Table 2-13 and Figure 2-16 indicate that the 2x6s, and 2x8s were highest volume of material received from the spent CCA treated residential deck and they also were the best material to recover.

Table 2- 13. Volume (bd.ft.) of CCA treated wood from deck, while in-service and after recovery.

	In-Service		Recovered		
	Volume	% of Total	Volume	% of Total	% Recovered
5/4x6 (RED)	281	6.1	225	5.7	80.1
2x2	147	3.2	132	3.3	89.8
2x4	321	6.9	304	7.6	94.7
2x5	17	0.4	15	0.4	88.2
2x6	1765	38.1	1633	41.1	92.5
2x8	852	18.4	810	20.4	95.1
2x10	463	10.0	396	10.0	85.5
2x12	154	3.3	49	1.2	31.8
1x6	243	5.2	117	2.9	48.1
4x4	336	7.3	274	6.9	81.5
lattice	53	1.1	21	0.5	39.6
Total	4632	100.0	3976	100.0	85.8

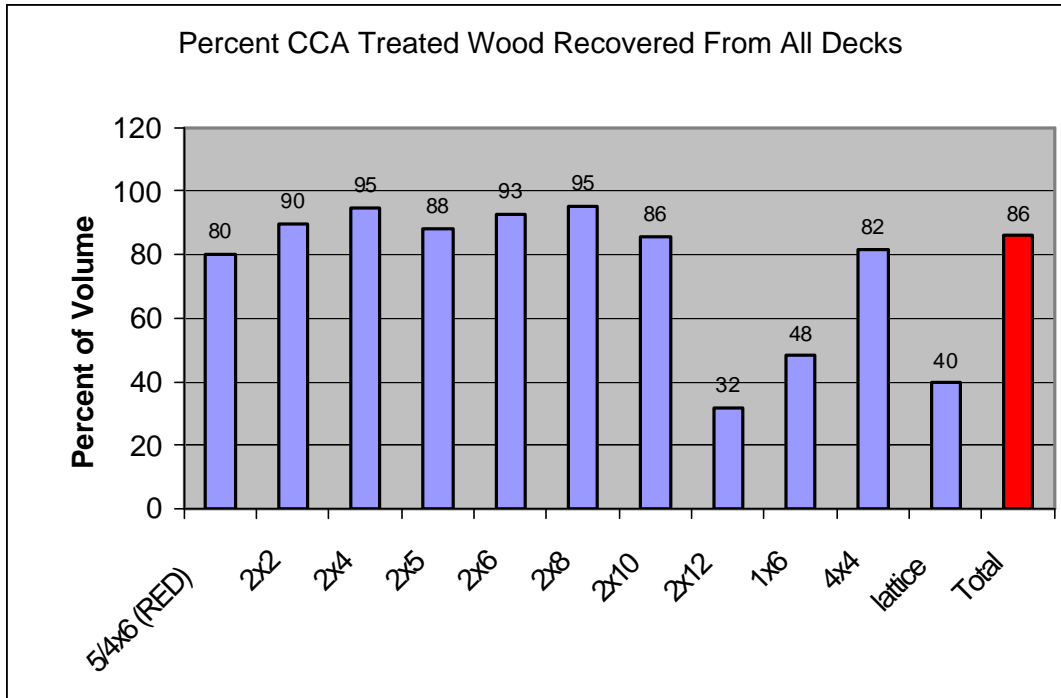


Figure 2- 16. Percent recovery of various CCA treated wood products from residential decks.

DECONSTRUCTION VERSUS DEMOLITION

Decks No. 3 and No. 4 were both deconstructed to determine if it would be beneficial in the recovery and recycling of CCA treated wood from residential decks. Tools used to deconstruct the decks were similar. The only tool that was not used in the deconstruction process of Decks No. 3 and No. 4 was a reciprocating saw, which is usually used to remove the joists from the side of the attached house. For the deconstruction process to be successful, a higher amount of CCA treated wood needs to be recovered from the spent residential decks. This increase in usable material will theoretically offset the increased time to deconstruct the deck. However, this research concluded otherwise. As shown in Table 2-12, the volume and percent of CCA treated wood recovered from Decks No. 3 and No. 4 are much lower than the average. In fact, the average percent of recovered lumber from decks No. 3 and No. 4 was 77.2% and from the remaining decks was 90.8%, the opposite of what

was expected. Also, from Table 2-10, the time to deconstruct Decks No. 3 and No. 4 were less than the time to demolish the other 4 decks in the study.

There were many factors that influenced the success of deconstruction process of Decks No. 3 and No. 4. First, Deck No. 3 and No. 4 had 33 lbs and 28 lbs of hardware in them, respectively, a higher weight than the average deck, but what is more important is the type of hardware used. Most of the unrecoverable CCA treated wood from Deck No. 3 and No. 4, as seen in Tables 2-6 and 2-7, was from the railing components. Those components were fastened together using spiral shank nails. When the removal of hardware was attempted the nail heads snapped and the shank of the nail was imbedded into the wood, making it unfeasible to remove. Therefore, the use of hardware had a large impact on the recovery of Decks No. 3 and No. 4.

Second, deconstruction of a residential deck compared to a residential home is quite different, and obtaining the same results should not be expected. Residential homes are a more complex and intricate structure compared to the standard residential deck. Therefore, following the same deconstruction procedure for a home is not necessarily the most cost effective or practical process in removing a deck. The easiest and more effective procedure to remove many residential decks for a building contractor are to remove the deck boards from the joists then to detach the joists from the post and then remove the posts from the ground. This procedure, used by all contactors in this study, to remove a spent residential deck is similar to deconstruction. Therefore, the current removal procedures are the most effective for the building contractor and also for the recovery of CCA treated wood.

CONCLUSION

The aesthetics, safety, and physical degradation of the wood were the main reasons for decks removed in the study. All but one homeowner planned to use CCA treated wood as the construction material for their new deck. The main reason for using CCA treated wood in their new deck was the low cost compared to alternative materials. Many homeowners were satisfied with the performance of the CCA chemicals, but were not with the physical degradation of the wood. However these decks were built before water repellents were put in the solutions.

Of the decks obtained, 40% of the deck was decking material, either 5/4x6 RED or 2x6. The joists comprised 30% of the deck volume, which were either 2x8s or 2x10s. Overall it was found that 86% of the deck could be recovered as reusable lumber. The highest volume of material recovered from the dismantled decks was 2x6s, 41% of the total (predominately from the decking), followed by 2x8s, 20% of the total (almost exclusively from the joists), and then 2x10s (10% of the total). The most successful material recovered was the 2x8 and 2x4 (both approximately 95% recovered), followed by the 2x6s (93% recovered). Therefore the most feasible parts of the deck to recover is also the most dominant, the decking (2x6s) and the joist (2x8s).

From the research deconstruction does not increase the volume recovered from a CCA treated residential deck. The two decks deconstructed had less treated wood recovered than the demolished decks. Other factors play a more significant role in the recovery of CCA treated wood from decks. The hardware used to construct the deck not necessarily the amount of hardware used plays an important factor in the recovery of CCA treated wood. The exposure to climatic conditions, such as sunlight, precipitation, and wind play a larger

role in the recovery of CCA treated wood from decks. The height of the deck, the location on the ground, the quality of the original construction, all could have roles in the recovery of CCA treated wood from residential decks.

Research by Alderman (2001) suggested that, according to the building contractors, approximately 45% of a CCA treated deck can be recovered. This research concludes that the amount of CCA treated wood that can be recovered is much higher than previously believed. Also, the traditional deconstruction process does not increase the recovery of CCA treated wood. The amount of recoverable CCA treated wood from a deck is known, but practical uses for this material need to be found. In order to achieve this the physical and mechanical properties of CCA treated wood need to be analyzed.

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**CHAPTER THREE. CHEMICAL AND MECHANICAL
PROPERTIES OF RECOVERED CCA TREATED WOOD
FROM RESIDENTIAL DECKS.**

ABSTRACT

CCA treated wood has been the preferred building material in the construction of residential decks for several decades. Billions of board feet, per year, of CCA treated wood is used to build new residential decks, but each year a large volume is also coming out of service. Most of the removed CCA treated wood from residential decks is disposed of in landfills, but due to tighter disposal regulations and the reducing amount of landfill space, environmentally conscious alternatives will soon be required. Recycling CCA treated wood from the decks could be a feasible alternative, but there is a lack of knowledge regarding the physical and mechanical properties of the removed material. This research addressed the chemical and mechanical properties of spent CCA treated wood from residential decks in order to increase the recovery and reuse of the material.

The joists and decking of six residential decks were analyzed for chemical retention and compared to the original retention after treatment and to recently treated wood. Several of the joists and the decks were found to be below the originally stated retention level. This does not indicate that the CCA leached from the wood, because some of the recently treated material was below specified retention levels. The joists had higher retention levels, from chemical assay, which could be assumed since it was not exposed to as much physical and environmental degradation compared to the decking. Length of service was not a factor in lower retention of chemicals in the decking or joists. Even though the material had lower than expected results from chemical assay, much of the material can be reused in applications with limited ground contact.

The decking of the six residential decks removed from service was tested to determine its strength and stiffness properties. That data was compared to recently CCA

treated wood, to determine if statistically equivalent properties existed between new and old material. It was found that the spent decking had similar stiffness properties, but the bending strength was lower than recently treated material. As with the chemical properties, the mechanical properties were not affected by the amount of time the deck was in service.

It was found that the chemical properties were lower than expected, the stiffness was equal to and the strength was lower than recently CCA treated wood. This does not indicate that the material is unusable, but will dictate the suitable applications where recycled CCA wood can be used.

INTRODUCTION

Chromated Copper Arsenate (CCA) treated wood is the predominate material used for the construction of residential decks in the United States. Research has shown that nearly 80% of all residential decks built used CCA treated wood (Shook and Eastin, 2001 and Truini, 1996). Further research has found that the average age of a deck being removed from service was 13 years by Alderman (2001) and 9 years by McQueen and Stevens (1998). The investigators also found that a large volume of CCA treated wood is currently being removed from service and disposed of primarily in landfills. The research also concluded that aesthetics was the highest rated factor in residential deck removal, and the quality of the CCA treated wood was not rated as an important factor in the removal of the deck. Therefore, high volumes of CCA treated wood should be reusable in other applications. In order to reuse the CCA treated wood, the physical and mechanical properties of the spent CCA treated wood have to perform to the same standards of new CCA treated wood.

CCA treated wood has retention levels ranging from a low of .25 lbs/ft³ to a high of 2.5 lbs/ft³ (Southern Pine Council, 1999). Most residential decks use CCA treated wood that has a retention level of .25 lbs/ft³ or .40 lbs/ft³ for above ground contact and .40 lbs/ft³ exclusively if the wood will be in ground contact (Southern Pine Council, 1999). Research has been performed on the amount of arsenic around and on the surface of structures composed of CCA treated wood (Kluger, 2001, Finch and Dainelle, 1993, Ginsberg and Stilwell, 2001, Hauserman, 2001, and Pianin, 2002). The research concluded that arsenic levels were high around and on the structures made of CCA treated wood, but the retention level of the wood was not given. Research by Hoffoman and Morrel at the University of Florida are currently examining the retention levels of CCA treated wood that has been in-

service for several years, as of now the results have not been published (The Forestry Source, 2002). Extensive research has been performed on the disposal practices and the leaching of CCA treated wood in landfills (Townsend and Solo-Gabriele, 2002). Some of the research performed simulated the effect of spent CCA treated wood in unlined landfills and concluded that in simulated environments the arsenic from spent CCA treated wood does leach into the ground water. While this research has been useful in studying the potential hazards associated with the use and disposal of CCA treated wood, little research has been performed to analyze the current retention levels of CCA treated wood in residential decks. Research studying the retention level of spent CCA treated wood from residential decks could aid in the reuse of the material.

Several mechanical properties of wood reduce after pressure treated with CCA chemicals. The AWWA (1994) has summed up the affects of waterborne preservatives on the mechanical properties of wood. The affects are as follows:

- Modulus of Elasticity (MOE) is usually unaffected
- Maximum crushing strength is usually unaffected
- Modulus of Rupture (MOR) is usually reduced from 0% to 20%
- Energy related properties are usually reduced from 10% to 15%

These degrades will usually occur in CCA treated wood, but many other pre-, post, and treatment factors can have a larger influence on the mechanical properties of wood.

According to Winandy (1995), several treatment factors influence the mechanical properties of CCA treated wood. These factors are:

- Species
- Chemical Type
- Retention
- Post-treatment drying temperatures
- Dimension of material
- Grade of material
- Product type

- Initial kiln drying temperature
- Incising (Winandy, 1995)

Of these factors the major contributor to the decrease in strength properties of CCA treated wood is post-treatment drying temperature. Winandy et. al. (1985) concluded that, at a retention level of 1.00lb/ft³ and a redry dry-bulb temperature of 180°F the loss in bending strength is significant. In light of this information, in 1991, the AWPA imposed a limitation on post-treatment kiln drying temperatures to be lower than 165°F.

There has been numerous research performed on the mechanical properties of new CCA treated wood, but little research has been performed on the mechanical properties of CCA treated wood that has been in-service for several years. Some mechanical tests have been performed on wood from deconstructed buildings (Falk et. al., 1999). The research found that the deconstructed wood had similar stiffness properties of recently manufactured wood, but the strength properties were less than the new wood. If spent CCA treated wood is to be recycled from spent residential decks, then information is needed regarding the strength and stiffness of the removed material.

OBJECTIVES

The research objectives were:

- Compare chemical retention levels of CCA treated wood from removed residential decks and recently treated wood.
- Compare strength and stiffness properties of recently treated CCA treated wood with CCA treated wood removed from six residential decks.

CHEMICAL RETENTION TESTS

METHODOLOGY

The AWPA Book of Standards (1984) was followed to obtain samples for chemical assay. The joists and decking of the six removed decks were tested along with recently

treated 5/4x6 RED and 2x6 wood. In total, fourteen samples were tested, which include the six decking samples and six joists samples from each deck, and the two samples from the recently treated 2x6 and 5/4x6 lumber. An increment borer with a diameter of 3/16" was used to obtain the samples. The samples were obtained in a defect clear area of the board with no obvious amount of slope of grain. The sample was extracted from the edge and at least two feet from the end of the lumber. The core samples obtained were approximately 0.6" in length. Ten cores were extracted from each sample set, and were mailed in plastic bags to Chemical Specialists, Inc, located in Charlotte, NC, for the chemical assay tests. The samples were dried to approximately 0% moisture content and then the wood was ground. The ground treated wood was then analyzed for Arsenic (As₂O₅), Copper (CuO) and Hexavalent chromium (CrO₃) content using an Asoma x-ray fluorescence analyzer. Three replications were performed on each test to account for any errors during the test. There were enough samples to perform two separate tests from each fourteen samples, therefore a total of 28 chemical assays were completed.

CHEMICAL ASSAY RESULTS

The minimum retention of chemicals (lbs/ft³) for the individual components, according to the AWWA Book of Standards (1984), is located in Table 3-1. This information will be used to compare the recently treated CCA wood with the spent CCA treated wood from the six residential decks. As previously stated 28 chemical assays were performed, two for each sample. The data from the chemical assays displayed in the following sections as the average of the two tests performed on the samples. The raw data from each retention test can be located in Appendix E.

Table 3- 1. Minimum retention of individual components in CCA type C.

Minimum Retention of Individual Components (lb/ft ³)				
Retention (lb/ft ³)	Copper	Chromium	Arsenic	Minimum sum of Components
0.25	0.042	0.107	0.075	0.25
0.4	0.067	0.171	0.122	0.4

As stated previously, the joists and decking of six residential decks treated with CCA was tested for retention. Table 3-2 shows the original retention level indicated that was stamped or tagged on the wood, and the number of years in-service for each deck tested. The original retention level of the lumber was assumed to be that of the stamp or tag, but it cannot be a 100% guarantee that the retention level stated on the stamp or tag was equal to that of the original treatment. All deck material was Southern Yellow Pine, except Deck No. 5, which had a SPIB grade stamp “Mixed Pine” on the wood indicating that some of the wood could be virginia or pond pine.

Table 3- 2. Age and retention level stamped of each deck tested.

Deck No.	Years In-service	Retention level (lb/ft ³)
1	13	0.4
2	27	0.4
3	18	0.25
4	18	0.25
5	17	0.4
6	14	0.4

Copper Retention

The copper retention levels of the decking and joists of the six decks removed and the recently treated 5/4x6 and 2x6 lumber is located in Figure 3-1. As shown, the recently treated 2x6 was above the minimum requirements, but the 5/4x6 was slightly below. The joists and decking of Deck No. 3 and No. 4 along with the joists of Deck No. 1 were above

the required minimum levels set by the AWWA. Both the joists and decking for Deck No. 5 were well below the minimum standards for recently treated wood, but Deck No. 5 was grade stamped mixed pine. Therefore, other species, such as Virginia or pond pine, could have an affect on the treatability and thus the retention levels. The decking of Deck No. 1 was extremely lower than the joists of the same deck, as shown in Figure 3-1. No explanation is known why this occurred, and further analysis will determine if this trend is true for all CCA chemicals. Overall, the joists and decking for just two of the decks retained or originally contained the required minimum level of copper. There seems to be no relationship of the age of the deck, shown in Table 3-2, to the retention of copper in the decks. Deck No. 2 was the deck that was in-service the longest and had similar or better copper retention compared to the other decks.

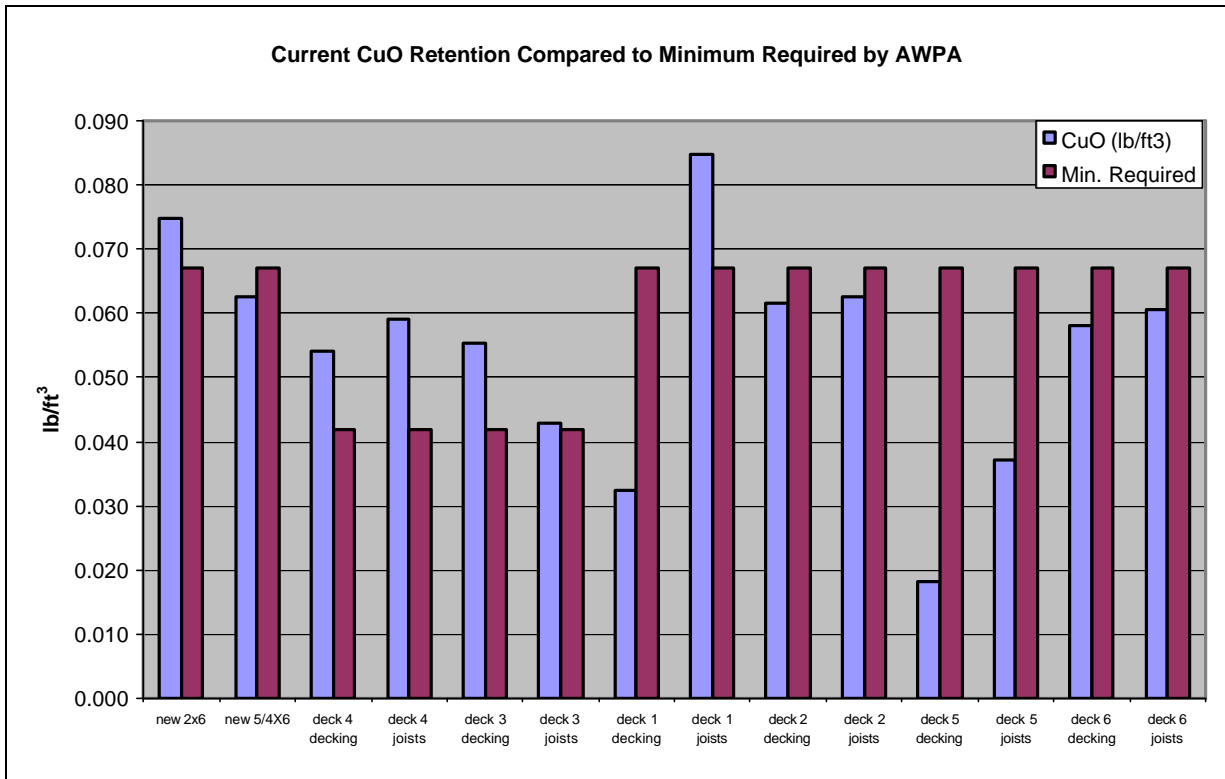


Figure 3- 1. Copper retention in all samples from chemical assay.

Chromium Retention

The results of chromium retention follow a similar trend to that of the copper retention of the same samples. As shown in Figure 3-2, the recently treated 2x6 samples had a higher than required chromium content, in lb/ft^3 , and the 5/4x6 samples had lower than required retention level. As with the copper retention, the chromium retention for the decking and joists of Deck No. 4 were above the minimum requirements. The decking for Deck No. 3 was above the minimum required but the joists were below required retention levels. As with the copper retention the joists of Deck No. 1 were well above the minimum standards for chromium. The samples from Deck No. 5 have extremely low levels of chromium, as with copper, and may be due to the potential amount of mixed pine that was in the sample that influenced the retention when the wood was treated years ago. The retention of chromium in the samples from the deck material does not appear to be influenced by the age of the deck. Deck No. 2 had the longest service time and the retention of the samples from the deck performed similar or better than most of the other chemical assay samples from the other decks.

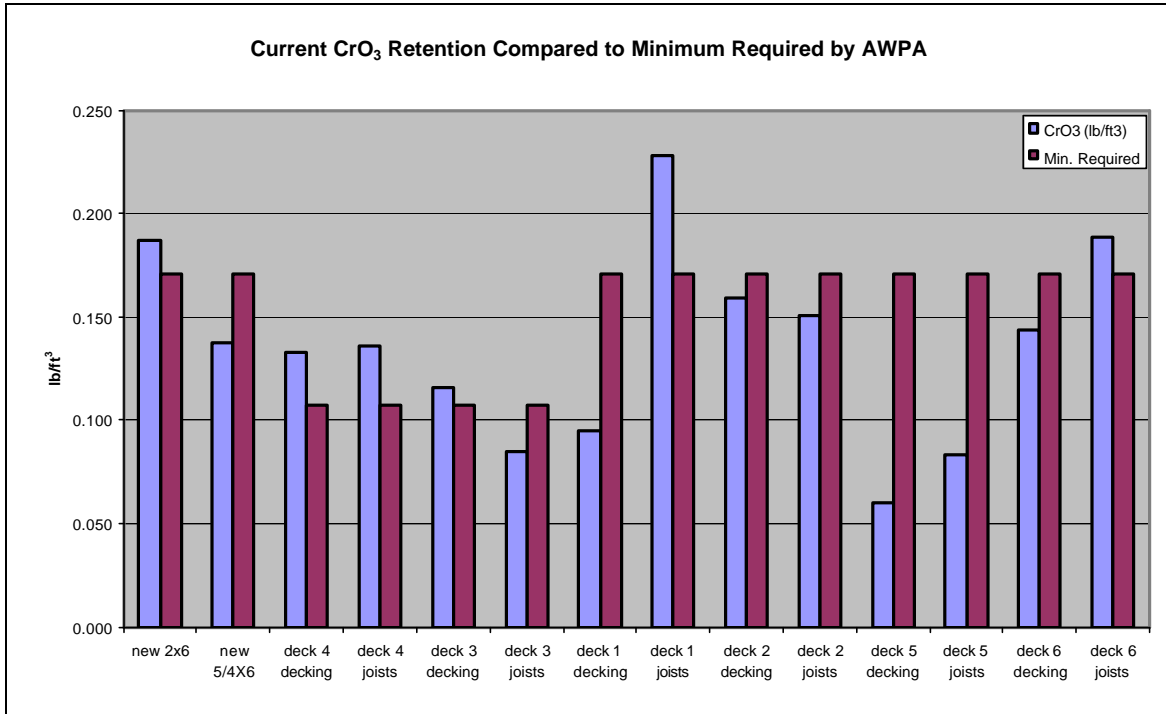


Figure 3- 2. Chromium retention in all samples from chemical assay.

Arsenic Content

As with the retention of the copper and chromium, the arsenic retention of the samples from recently treated wood and CCA treated wood from residential decks followed a similar trend. The recently treated 2x6 samples were well above the minimum requirements, but like the copper and chromium levels, the retention for the 5/4x6 were slightly below required standards as shown in Figure 3-3. Deck No. 4 samples from both the decking and joists were above minimum requirements. The samples tested from the joists of Deck No. 1 were well above the required lb/ft³ of arsenic, similar to the data obtained on the copper and chromium levels. Again, Deck No. 5 was well below the minimum standard obtained by chemical assay. A majority of the arsenic retention levels are below the requirements by AWPA for all the six decks samples tested, but the recently treated 5/4x6 samples were also below the minimum required. Therefore, the low retention of arsenic in the deck samples

might not be an indication of chemicals leaching, but rather low initial retention from the original pressure treating process.

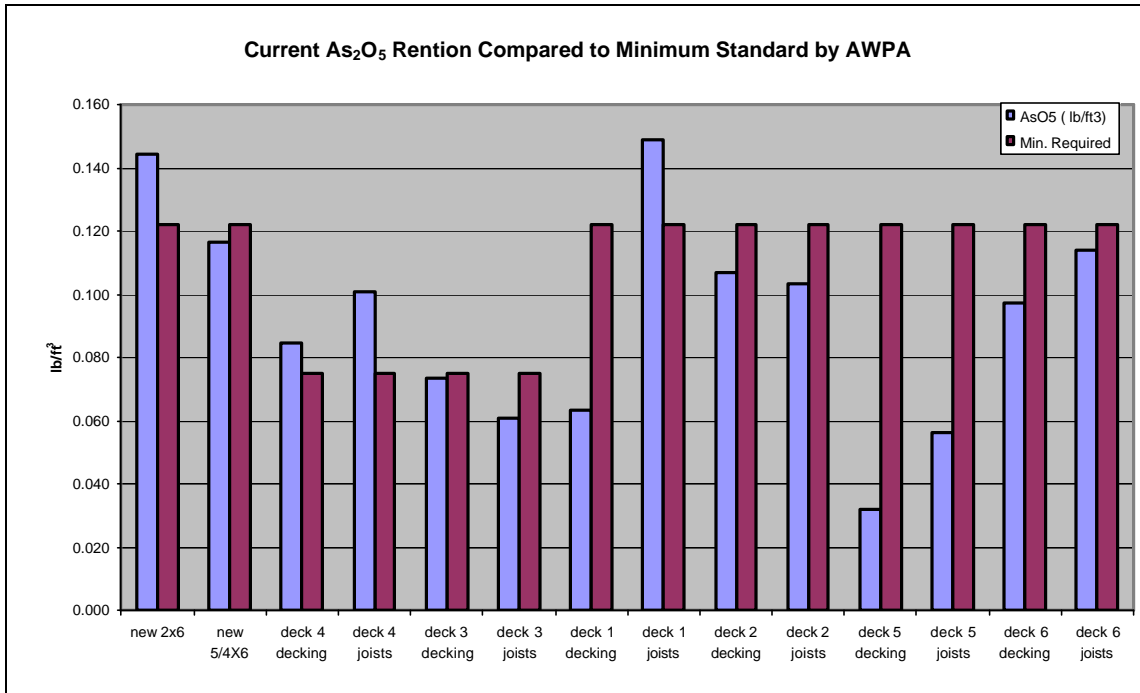


Figure 3- 3. Arsenic retention in all samples from chemical assay.

Overall Chemical Retention

A majority of the total retention levels from the chemical assay samples taken from the decking and joists of the residential decks were lower than the minimum standard required for recently treated wood, as shown in Figure 3.4. The chemical assay samples from the joist and decking from Deck No. 4 used were above the minimum standards required by AWPA, as shown in Figure 3-5. Other than Deck No. 4, the decking samples used for chemical assay from Deck No. 1 were the only samples above the minimum retention in lb/ft^3 . Deck No. 5 had the lowest retention levels, and the low data could be a result of pressure treating mixed pine species with southern pine species, treating both species at the same time might have altered the original retention in the wood. The decking of Deck No. 1 was also low compared to the stamped level it was treated to. It is plausible that the decking

was not original treated to $.40 \text{ lb/ft}^3$, but rather to $.25 \text{ lb/ft}^3$ and mistakenly stamped to be $.40 \text{ lb/ft}^3$.

The recently treated 2x6 samples had a chemical retention that was above the required limit, but the 5/4x6 samples were 20% below required minimum standards. The average retention of the eight chemical assay samples from the removed decks that were reported to be pressure treated at a minimum of $.40 \text{ lb/ft}^3$ was $.281 \text{ lb/ft}^3$, approximately 30% below the level required retention after pressure treatment. The average of the four chemical assay samples tested that was originally pressure treated at a minimum chemical retention of $.25 \text{ lb/ft}^3$ was found to be exactly equal.

The service time of the decks in this sample did not have an effect on the retention level. As seen in Figure 3-4 there appears to be no correlation between amount of time in service and retention levels lower than the minimum required. Other factors, such as lower than required retentions during the pressure treatment process and environmental conditions while the decks were in-service, could have been larger influences on the retention of preservative treating chemicals.

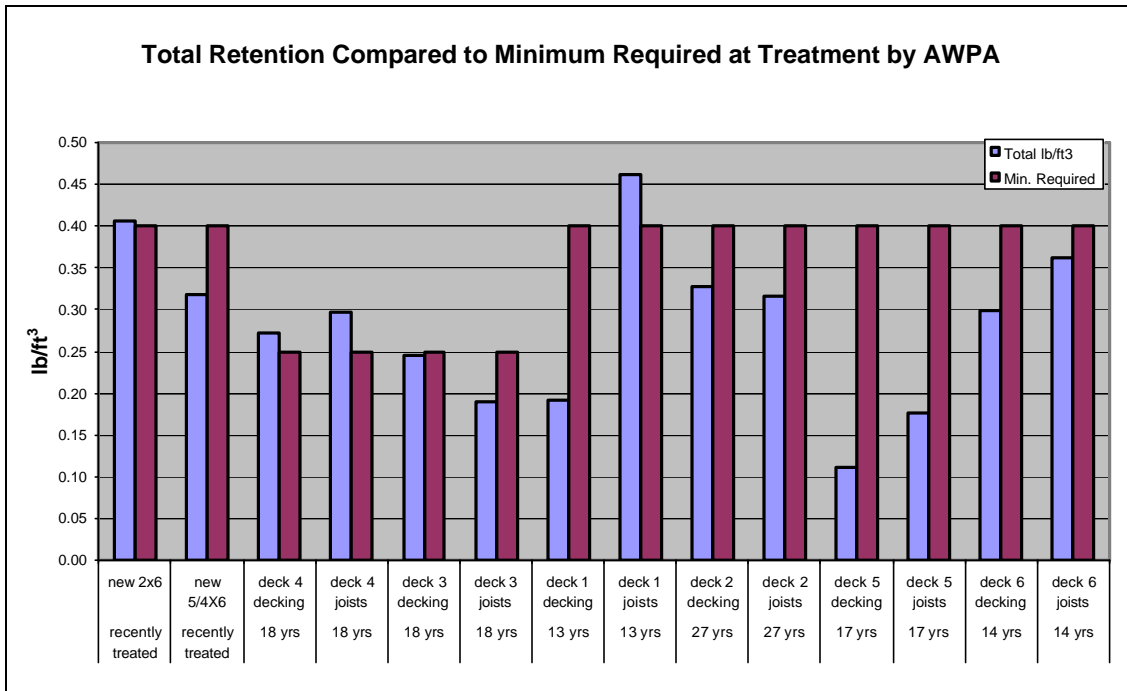


Figure 3- 4. Chemical assay of chemicals in the CCA treated wood samples taken from removed decks.

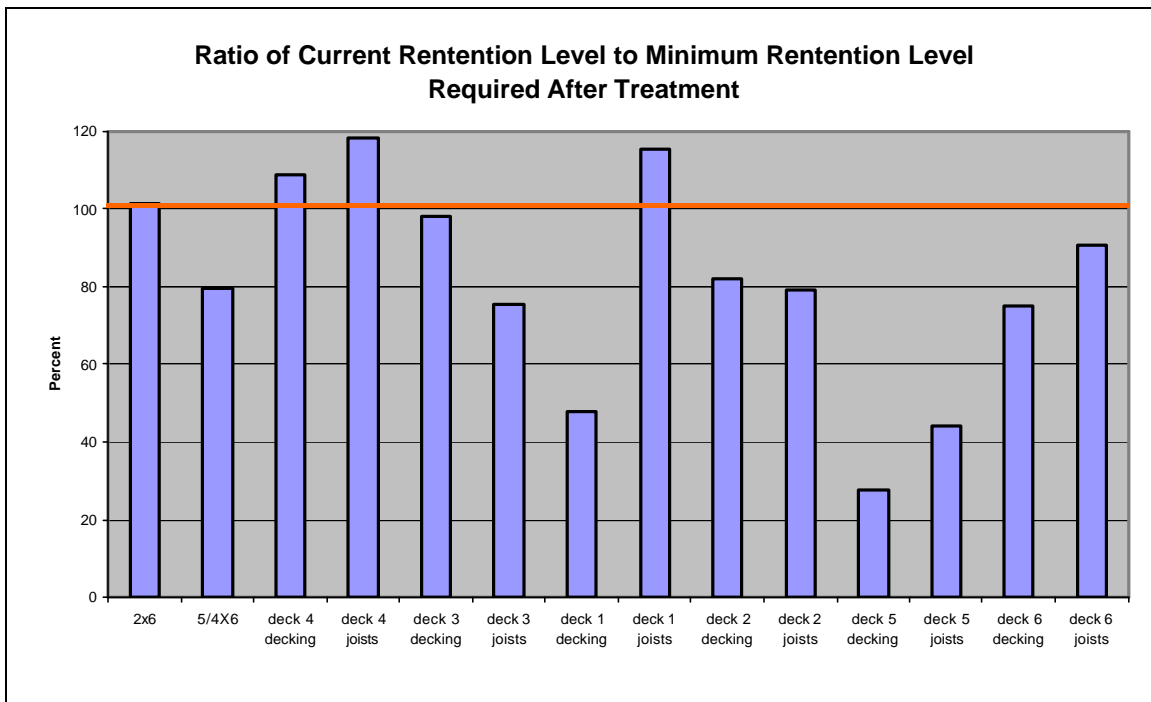


Figure 3- 5. Ratio of actual chemical retention to required chemical retention of chemical assay samples.

From chemical analysis, the samples from the joists had, on average, a higher chemical retention compared to the samples from the decking of the six removed residential decks. The average retention of the chemical assay samples from the decking was .26 lb/ft³, and was .301 lb/ft³ from the joist samples. As seen in Figure 3-6, the joists chemical assay samples, on average, were approximately 15% below the minimum required chemical retention after preservative treatment. The decking samples, on average, were approximately 30% below the minimum required chemical retention after preservative treatment. Lack of physical and environmental exposure of the joists compared to the decking could be factors affecting the difference in preservative chemical retention, or there could have been a large amount of random variation due to a small sample size.

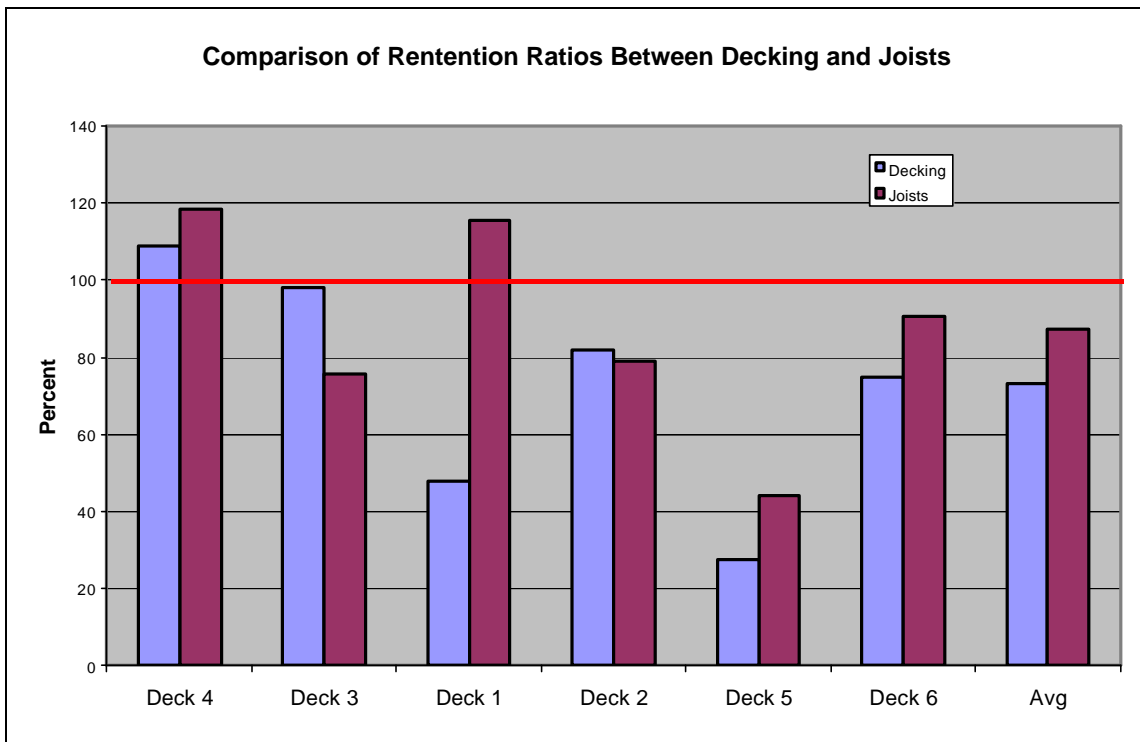


Figure 3- 6. Comparison of chemical assay samples from decking and joists of the removed decks.

MECHANICAL PROPERTY TESTS

METHODOLOGY

Decking samples were collected from the six spent CCA treated residential decks. Thirty random samples from the decking of each deck and recently treated 2x6 and 5/4x6 radius edge decking (RED) were obtained, therefore there were 8 different sets, each containing thirty samples. Recently treated SYP 2x6 and 5/4 RED were tested because existing data regarding the strength values of the CCA treated wood could not be found for comparison. Also, since no early data existed, an appropriate sample size to obtain normality could not be efficiently determined; therefore the Central Limit Theorem (Ott and Longnecker, 2001) was followed and a sample size of thirty from each set was used.

The samples were cut to a length of 30 inches and labeled, and were conditioned approximately 60 days to reach equilibrium moisture content of 12%. Prior to testing the width and thickness of each sample was recorded. A testline Mechanical Testing System (MTS) was used to test the strength properties, and a test span of 24 inches was selected to match the maximum joist spacing allowed for Southern Yellow Pine 5/4 RED (SPIB, 1986). Pieces were tested in flatwise bending, to simulate the performance of the decking material in-service. Pictures of the MTS machine and test samples are located in Appendix F.

The samples were tested in a third point loading system for two main reasons. First, to reduce the effect of span-to-depth ratio on the ratio of apparent to true modulus of elasticity (MOE) (Bodig and Jayne, 1982). Second, the middle third load, where the majority of the failures occur, will have maximum force equally distributed and no shear force is present.

The testing method followed was ASTM designation: D 198-99, *Standard Test Methods of Static Tests of Lumber in Structural Sizes* (ASTM, 2000a). If possible, the largest defect of the test samples were intentionally placed in the middle third of the load span to create the most conservative MOE and MOR values possible. Load-deflection data was obtained from LabTech Control software, which then exported the data into Microsoft Excel, and the MOE and modulus of rupture (MOR) was calculated for each piece. The equations used to calculate MOE and MOR are as follows:

$$\text{MOR} = (P \cdot L) / (b \cdot h^2)$$

Where: P = Maximum load on beam (lb)

L = Span of beam (in)

b = Width of beam (in)

h = Depth of beam (in)

$$\text{MOE} = [(P' / \Delta) \cdot L^3] / (4.7 \cdot b \cdot h^3)$$

Where: P'/Δ = Slope of load deflection curve under proportional limit (lb/in)

L = Span of beam (in)

b = Width of beam (in)

h = Depth of beam (in)

(Free Body Diagram of test specimens is located in Appendix G)

After testing of the samples a failure description, if known, was recorded. The moisture content of the samples was determined, after mechanical testing, by determining the oven dry weight according to ASTM Designation: D 4442-92 (ASTM, 200b). This method is deemed more accurate than using a hand held moisture meter when determining moisture content of treated wood. The moisture content of the samples were found to vary from 10% to 14%. In order not to make differing moisture contents a factor in comparing strength properties, ASTM designation: D 1990-00, *Moisture Adjustment Procedure For Development of Characteristic Values For Mechanical Properties of Lumber* (ASTM, 2000c), was used to adjust all properties of the test data to a 15% moisture content (this adjustment can only be performed for moisture content values between 10 and 23%). Also,

the density of the samples in each set were assumed to be a normal representation of Southern Yellow Pine, and therefore the specific gravity of the samples was not determined.

The raw data from the eight samples sets is located in Appendix H.

Statistical Analysis

Differences in the average MOE and MOR values between spent decking material and recently treated material were evaluated. The mechanical properties of the spent 2x6 decking material was compared to the recently treated 2x6 material, and the spent 5/4x6 RED decking material was compared to recently treated 5/4x6 RED material.

The distribution of each sample set was checked for normality, by performing the Shapiro-Wilk test of normality at an alpha level of 0.10, where:

- Null hypothesis was data was normal
- Alternative hypothesis was data was not normally distributed.

An independent t-test for equality of means was performed to determine if differences existed between MOR and MOE values of the spent 5/4x6 RED and recently treated 5/4x6 decking, at an alpha level of 0.05, where:

- Null hypothesis was: property of new decking = property of spent decking
- Alternative hypothesis was: property of new decking \neq property of spent decking

An Analysis of Variance (ANOVA) was performed to see if differences existed between the MOR and MOE values of the five sample sets of 2x6 decking material, at an alpha level of 0.05, where:

- Null hypothesis was that the mean mechanical property distributions are equal
- Alternative hypothesis was that the distributions were not equal

If differences in MOE and MOR values were determined to exist, then a Tukey Highly Significant Difference (HSD) multiple comparison test was performed to determine what set of spent 2x6 decking material had mechanical properties that were significantly different from the recently treated 2x6 decking, at an alpha level of .05.

RESULTS

Table 3-3 displays the average and standard deviation from the mechanical strength tests of the decking samples from recently treated material and spent decking. The significance level for the Shapiro-Wilk normality tests, the t-tests for the 5/4x6 decking material and multiple comparison tests for the 2x6 decking are also shown in Table 3-3.

Table 3- 3. MOR and MOE data and statistical significance of strength tests

MOE Test Data				
	average (PSI)	Standard Deviation (PSI)	Significance Level from Normality Test	Significance level from t-test or multiple comparison
deck 1	1238272	299578	0.236	0.394
new 5/4x6	1306645	317426	0.317	0.317
deck 2	1096692	318098	0.141	0.229
deck 3	917034	257320	0.436	0.999
deck 4	813425	278345	0.455	0.448
deck 5	932898	240950	0.365	1.000
deck 6	1192649	211506	0.577	0.005
new 2x6	941178	299418	0.465	0.465
MOR Test Data				
	average (PSI)	Standard Deviation (PSI)	Significance Level from Normality Test	Significance level from t-test or multiple comparison
deck 1	5903	1701	0.508	0.000
new 5/4x6	7877	1874	0.236	0.236
deck 2	5675	1602	0.265	0.802
deck 3	4887	1579	0.098	0.024
deck 4	3682	1356	0.325	0.000
deck 5	4592	1282	0.153	0.002
deck 6	5762	1487	0.688	0.900
new 2x6	6170	2222	0.759	0.759

MOE data from 2x6 decking

The Shapiro-Wilk normality test was performed and concluded all the MOE data from the 2x6 decking samples sets were normally distributed at an alpha level of 0.10. Figure 3.7 represents the average MOE of each 2x6 sample set, with error bars representing a range of twice the standard deviation. This type of error bar was used because it represents 95% of the cases from the mean of a normal distribution (SPSS, 2001). Analysis of Variance indicated that there are significant differences between the sample sets. Therefore, Tukey's HSD multiple comparison was performed and found that the MOE data from Deck No. 2, 3, 4, and 5 were statistically equal to the recently treated 2x6 samples. The MOE data from Deck No. 6 was found to be statistically greater than the recently treated material.

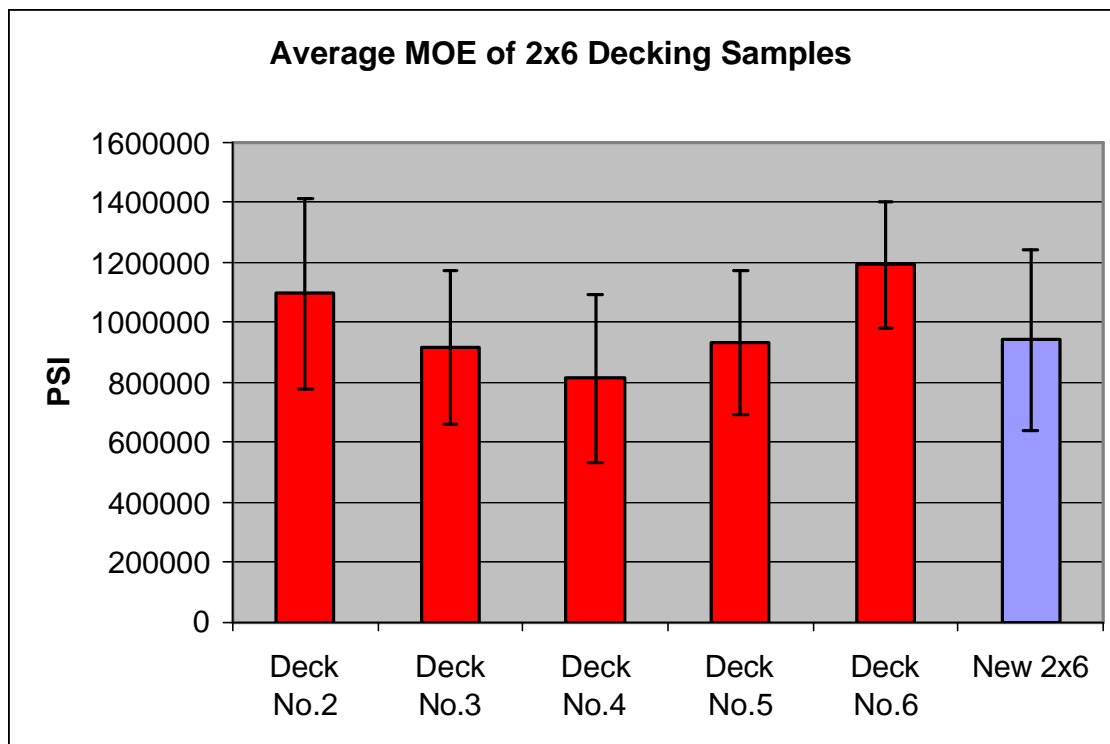


Figure 3- 7. Average and range of the MOE data from the 2x6 decking and recently treated sets.

* Darker bars represent samples that are statistically equal or greater than the new 2x6 data.

MOR data from 2x6 decking

The Shapiro-Wilk test for normality was performed on each data set and the hypothesis of normal distribution of data was not rejected for the recently treated samples and Decks No. 4, 5, and 6. However, the hypothesis was rejected for Deck No. 2 and 3 at an alpha level of 0.10. The test statistic of Deck No. 2 and 3 were .088 and .098 respectively. SPSS statistical analysis indicated that the data from Deck No. 2 had three statistical outliers; therefore those outliers were disregarded from the data set. After those outliers were disregarded the data was tested for normality. The new test statistic was .265; therefore the null hypothesis of normality was not rejected. Deck No. 3 had no statistical outliers but the test statistic was rounded to .10 an assumed normal.

Figure 3-8 displays the average MOR from each set and the range of the values from the mean. Analysis of Variance was conducted on the six sets and concluded that statistical differences exist between the MOR values at an alpha level of 0.05. Tukey's HSD multiple comparison was performed and the MOR values from Deck No. 6 and 2 were statically equal to the recently treated deck material. The multiple comparison test also found that the samples from Deck No. 3, 4 and 5 had statistically lower MOR values than the recently treated 2x6 decking.

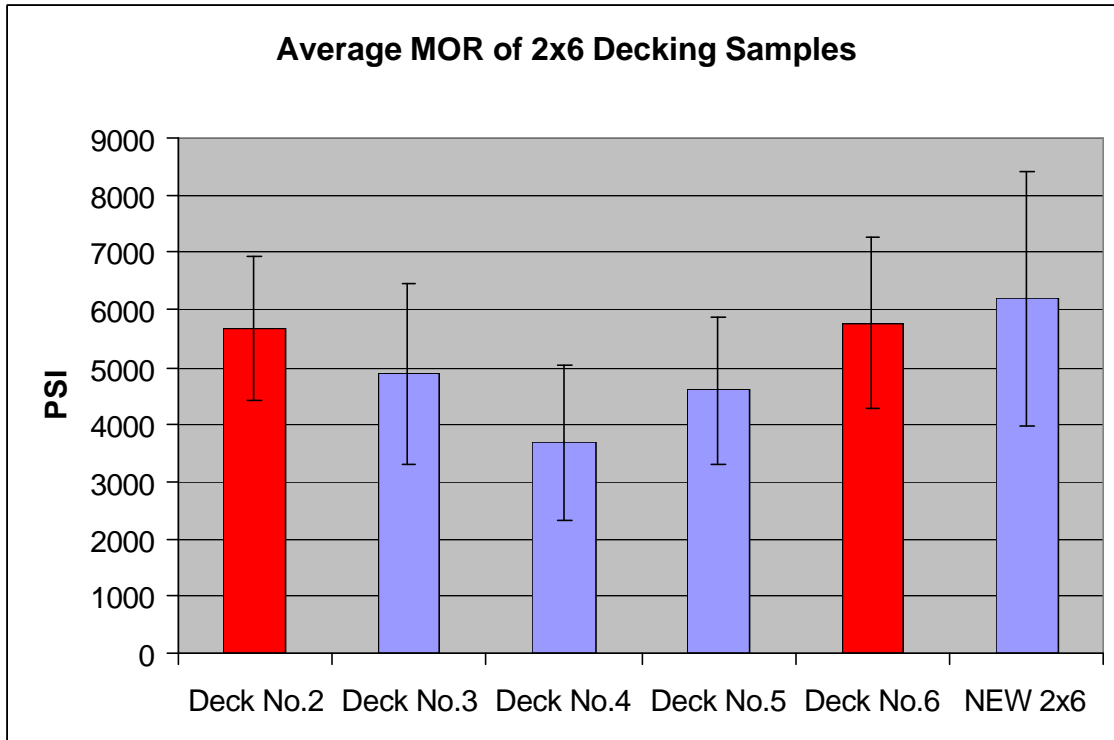


Figure 3- 8. Average and range of the MOR data from the 2x6 decking and recently treated sets.

* Darker bars represent samples that are statistically equal to the new 2x6 data.

MOE data from 5/4x6 RED

A Shapiro-Wilk test of normality was performed on the two samples sets and both were normally distributed at an alpha of 0.10. Figure 3-9 displays the average and a range of both sample sets. After an independent t-test was performed, the samples were found to be statistically equal at an alpha level of .05.

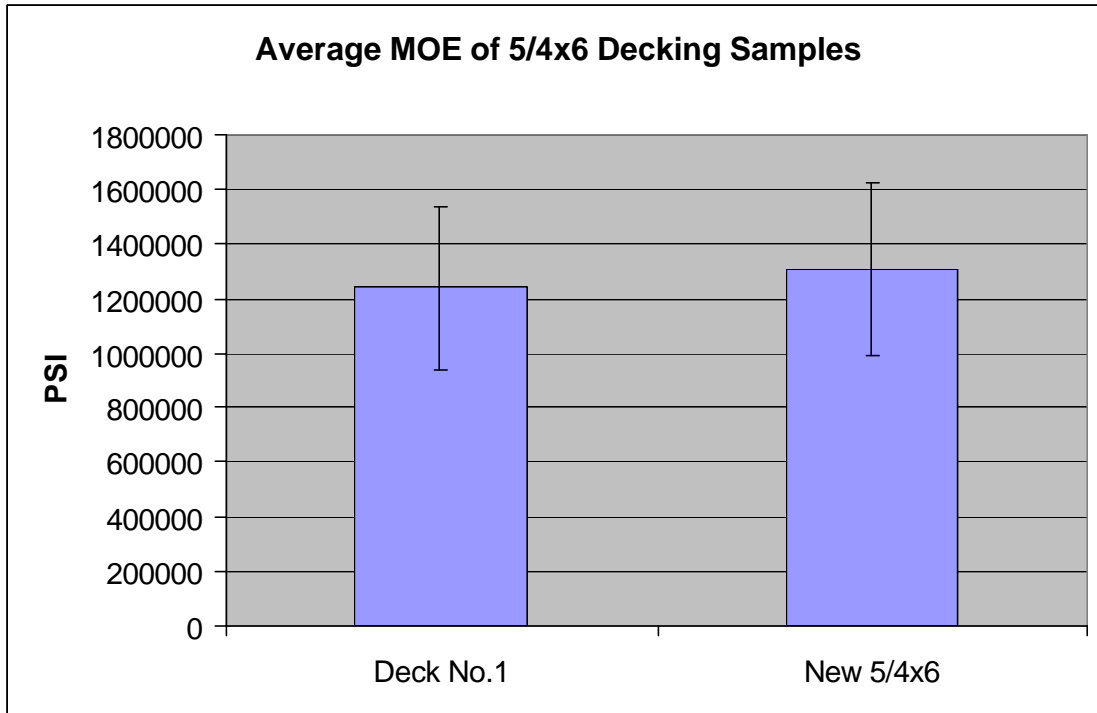


Figure 3- 9. Average and range of the MOE data from the 5/4x6 decking and recently treated sets.

MOR data from the 5/4x6 decking

The Shapiro-Wilk test for normality concluded that both sample sets were normally distributed at an alpha level of 0.10. The average and range of both sample sets are located in Figure 3-10. The independent t-test concluded that the MOR values from both sets were not statistically equal at an alpha level of 0.05.

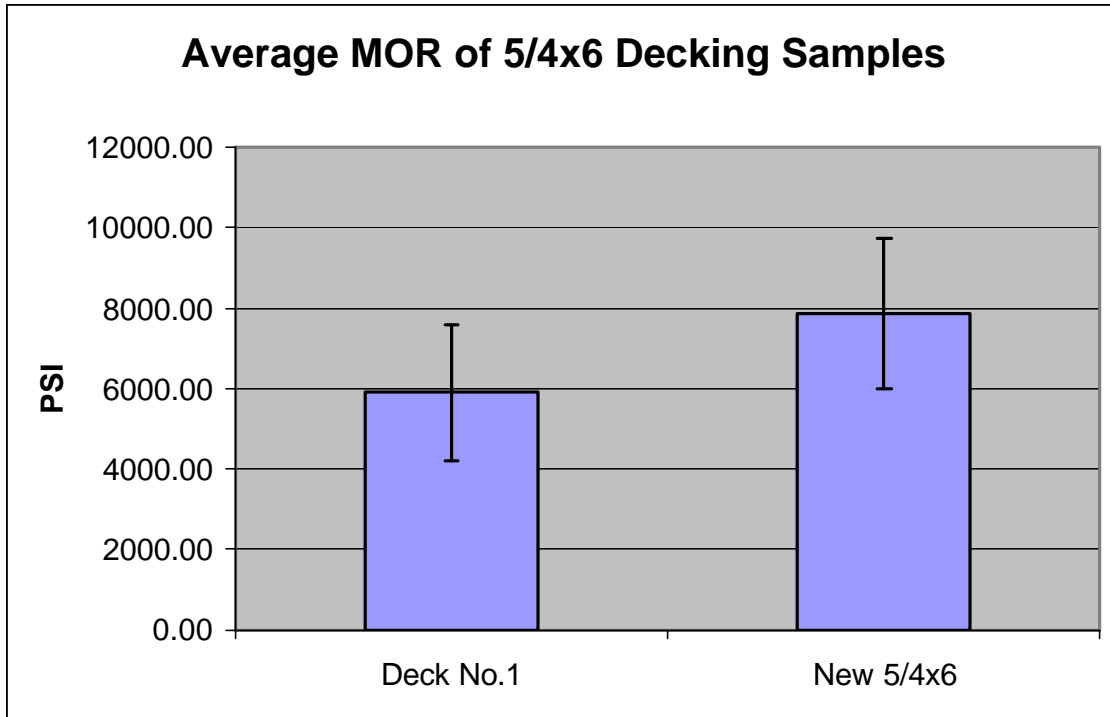


Figure 3- 10. Average and range of the MOR data from the 5/4x6 decking and recently treated sets.

CONCLUSIONS

CHEMICAL RETENTION LEVELS

Most of the chemical assay samples from the decking and joists resulted in lower than anticipated results. It should be noted that the low chemical retention of the assay samples does not mean that the treated wood is not reusable. Most of the samples used for chemical assay were above $.25 \text{ lb/ft}^3$ which is the minimum required for above ground contact applications for CCA treated wood. The majority of residential decks today are treated to a level of $.40 \text{ lb/ft}^3$. Therefore, much of the CCA treated wood coming out of service in residential decks will at least have a chemical retention level equal to or greater than $.25 \text{ lb/ft}^3$, and can be used in applications where minimum ground soil contact is required.

There appears to be no great difference in percent of chemicals present in the samples. Each chemical (arsenic, chromium, and copper) contained approximately the same

percent of chemical required by AWWA. In other words, if the arsenic retention level of the sample was 20% below the AWWA standard for volume then the chromium and copper retention levels were found to be at the same level. Therefore, no chemical in CCA can be responsible for the lower than anticipated retention levels.

The objective of the chemical analysis of the deck components were to determine the feasibility of reusing spent CCA treated wood from residential decks, not the exposure of the CCA chemicals to the environment. Conclusions cannot be drawn from the data that any preservatives chemicals have leached. The scope of this research was not to analyze the location or reasons for lower than expected chemical retention levels, therefore conclusions cannot be drawn that chemicals are leaching from CCA treated residential decks.

MECHANICAL PROPERTY TESTS

Although this information is from only six removed decks and two sets of new material, the analysis indicated the there is potential reuse of removed CCA treated SYP decking from residential decks. The stiffness of the decking material was found to be statistically equal to that of recently treated wood; however the bending strength of the removed decking was overall lower than the recently treated wood. A valid theory for this phenomenon is that physical and climatic degradation or nail holes could have induced flaws that recently treated wood do not have. Therefore, crack propagation could occur in several more locations on the samples of spent decking and cause the ultimate failure of the specimen.

Age was seen as a non-factor for lower mechanical strength properties. Deck No. 2 was the oldest deck in-service at 27 years and had the same bending strength and stiffness as recently treated material. Conversely, Deck No. 4, which was in-service for 18 years, had

MOE values statistically equal recently treated samples, but MOR values statistically less than the recently treated specimens.

The mechanical property tests concluded that the recovered CCA treated wood could be used in many applications. The MOE properties are similar to that of recently treated wood, but the strength properties are lower, indicating that this material can be used in applications where bending strength is not as important as elasticity. Products where light load are applied and released, such as outdoor furniture, decking components such as railings, decking, and stairs, and pallets, could use spent CCA treated wood as successfully as recently treated material.

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**CHAPTER FOUR. PRODUCT AND MARKET ANALYSIS
OF RECYCLED CCA TREATED WOOD.**

ABSTRACT

The volume of CCA treated wood being disposed of in landfills is growing at an alarming rating. In order to reduce the demand on landfills and timber harvests, more environmentally responsible alternatives for spent CCA treated wood have to be addressed. The objective of this study was to determine feasible products that can be produced from CCA treated wood and understand the barriers associated with recycling CCA treated wood.

Several products were produced from CCA treated wood recovered from dismantled residential decks. The products chosen were practical to make and use in residential and public applications. The products made were a picnic table, trellis, trash container, pallets, patio chair and table, sawhorses, a deck, deck components, planter boxes, and a porch swing. All products made required little training or carpentry skills, low monetary investment in tools and hardware, and required a low amount of time to complete. Therefore, the spent CCA treated wood is feasible to be recycled by most landfills and recycling organizations. Pallets produced from recycled CCA treated wood were tested and their performance found to be similar to pallets using untreated virgin wood.

From interviews with MSW and C&D landfills, recycling centers, and potential users, there appears to be a communication barrier between the groups. Many landfills managers and recyclers do not know of a market for the recycled CCA treated wood and do not feel they receive a large volume to make CCA wood recycling profitable. The potential users were found to be willing to use the recycled CCA treated wood, but did not know where to get the material. Local government programs that help build awareness and partnerships between the groups could help immensely in recycling of CCA treated wood from residential decks.

INTRODUCTION

The volume of disposed CCA treated wood from spent residential decks is enormous, and many investigators have predicted the rate of disposal to increase of the next several years (Alderman, 2001 and McQueen and Stevens, 1998). The heavy burden of disposal is placed primarily on municipal solid waste (MSW) and construction and demolition (C&D) landfills (Alderman, 2001 and McQueen and Stevens, 1998). The large volume of spent CCA treated wood reaching landfills has instigated several studies on the environmental and safety impacts of this material in landfills (Townsend and Solo-Gabriele, 2000 and Cooper, 1993). Most research has suggested that alternative disposal practices need to be initiated in order to mitigate the possible detrimental impact that spent CCA treated wood disposed in landfills, especially unlined, will have on human health and environmental safety. If stricter disposal regulations are enacted then higher tipping fees will mostly likely follow. In order to reduce the demand on landfills and extend the useful life of CCA treated wood recycling practices need to be developed for this material.

Recycling is defined by the EPA (1998), as turning materials that would otherwise become waste into reusable resources. In 2001, the United States recycled approximately 32% of the waste generated. Still, recycling rates in the United States compared to many other countries is significantly lower. France, Sweden, Switzerland, the Netherlands, Italy, and Japan all have higher recycling rates than the United States (Hershkowitz, 1998). Wilson (1996) states that one of the major reasons for not developing a better waste management system is cost. Those who have a high recycling rate have found an economic incentive in recycling (Wilson, 1996), which has developed primarily from reduced landfill space and tighter governmental regulations. This situation is occurring in the disposal of CCA treated

wood with foreseeable tighter regulations and a reduction in landfill space. Therefore, developing products and markets for recycled CCA treated wood is vital in increasing the recycling rate of this material.

Recycling is prevalent and successful in many industries. Metals, plastics, and several wood products have developed recycling programs that have helped decrease the potential of government regulations, negative public opinions towards the disposal, and increase social acceptance of the material. Wood recycling was 5% in 1997, but was projected to increase to 10% by 2000 (EPA, 1998). An increase in virgin wood prices and an increased consumer demand for recycled materials are main reasons for the increase (Sherman-Huntoon, 2001). The recycling rate will increase as more regulations are implemented and tipping fees are raised at landfills.

R. Marutzky (1996) stated the following preconditions for successful recycling of wood waste:

- The assortments are available continuously and in sufficient amounts
- The quality of the assortment is in accordance with the proposed recycling
- The recycled wood products have a market
- The recycling produces no new disposal problems

Meeting these criteria is important for successful recycling of CCA treated wood waste, and the industry has several barriers associated with these conditions to overcome. Research has suggested that the building contractors are important factors in recyclers receiving sufficient amounts of spent CCA treated wood from residential decks. Alderman (2001) suggested that in order to receive an adequate supply of spent CCA treated wood for recyclers, marketing campaigns and financial incentives need to be used to entice building contractors to bring in

the material to be recycled. Also, the CCA treated debris must be separated from other wood debris. Townsend and Solo-Gabriele (2000) found that approximately 6% of C&D landfill wood debris is CCA treated. If CCA treated wood is not separated from untreated wood, than the quality of the material will not meet the needs of the proposed recycling.

Research has been performed on finding markets for spent CCA treated lumber. There has been a large amount of research in using spent CCA treated lumber in wood-based composite products (Vick et al., 1996; Mengeloglu and Gardner, 2000; Munson and Kamdem, 1998). The researchers varied with their results, depending on the wood based composite made and the amount of CCA treated lumber used, but in most of the research it would be a viable option for spent CCA treated lumber. Composite manufacturers have been evaluated to see if they are a viable option in using spent CCA treated wood, but most research has found that they are reluctant to consider spent CCA treated lumber as a possible raw material source (Smith and Shiau, 1996 and Falk, 1997). The main reasons found were concerns with the health and safety of mill workers, residual chemicals that the material may still have, and products made from recycled treated wood may not have the same resistance to decay and insects as the original treated wood product. Therefore even though wood-based composite products could be produced from spent CCA treated lumber it does not seem to be a practical option for manufacturers in the near future.

Research has also been performed to remove the treating chemical from the spent CCA treated wood. If this process can be performed successfully then the CCA treated wood can be mixed with other wood waste for recycling. Clausen and Smith (Wilson, 1997) and Glasser (Alderman, 2001) have experimented with this method. Clausen's work has been successful in removing 92% of the copper and 42% of the arsenic, but there has been no

success of removing the chromium because it is bond tightly to the lignin (Wilson, 1997). Shiau, Smith, and Avellaer (2000) were successful in extracting over 80% of CCA chemicals in the wood particles with citric acid. Another barrier associated with removing the treating chemical from the wood is that it is currently more expensive to do this than it is to dispose of the treated wood in a C&D landfill (Avellar and Glasser, 1995).

A program that has shown success is the recovering of scrap lumber at curbside by the town of Aberdeen, MD (Litke, 1996). The curbside program collected 3.47 tons of wood waste by residents and 35% (the largest contributor) was pressure treated lumber. Seven hundred sixty-eight pounds of treated wood was then donated to the Hartford Glen Nature Center for nature and wildlife trail construction. The nature center indicated that it could use more pressure treated lumber, so the scrap lumber collection for 1997 emphasized the recovery of pressure treated wood. This indicates that if recycling incentives and programs are set then recovering CCA treated wood for the use in municipal recreational areas might have potential, but public safety concerns will have to be addressed.

As stated previously, incentives need to be developed for building contractors to bring spent CCA treated wood to recyclers. This will only happen if recyclers find economic viable products and markets for the recovered CCA treated wood. The following research examines potential products and market barriers associated with the successful recycling of spent CCA treated wood from residential decks.

OBJECTIVES

- Determine feasible products that can be produced from recovered CCA treated wood.
- Recognize barriers that exist for landfills, recycling centers, and organizations in reusing CCA treated wood from residential decks.

PRODUCTS FROM RECOVERED CCA TREATED WOOD FROM RESIDENTIAL DECKS

METHODOLOGY

The products manufactured were chosen because they were practical, easily fabricated, required little carpentry training or skill, a small number of inexpensive tools, and effectively utilized the recovered CCA treated wood from the residential decks. This will aid recycling centers in hiring and training qualified employees, and also easily produced products can be performed by people or organizations that acquire the recycled wood for do-it-yourself (DIY) outdoor projects. The designs of the products made for this research were from DIY outdoor wood furnishings designs, taken from published books or over the Internet. The tools used to produce the products was a 12” compound miter saw, a 12” table saw, a 10” circular saw, cordless drill (with several different drill bits), a reciprocating saw, and other miscellaneous tools such as hammers, tape measure, and wrenches. The hardware used were different sizes of galvanized decking screws, galvanized lag bolts and screws, and galvanized nails. It should be noted that strict safety procedures were followed when handling and machining the CCA treated wood. Proper dust masks, clothing, safety gloves, glasses, or goggles, and hearing protection was worn by at all times while working with the CCA treated material, and all exposed areas were thoroughly washed after work was completed. For each product, the worker-hours required, amount of hardware and cost, and type and volume of material were documented.

After feasible products were made, interviews, either by phone or in person, were conducted with landfill managers, recycling companies, and potential users of recycled material. The purpose was to identify barriers that exist for the waste management and recycling industries in the successful recovery and recycling of CCA treated wood. The

interviews were conducted with companies located in Virginia and North Carolina. In total, 22 people were interviewed, which included 6 C&D landfill managers (3 from Virginia and 3 from North Carolina), 6 MSW landfill managers (3 from Virginia and 3 from North Carolina), 6 recycling centers (3 from Virginia and 3 from North Carolina), and 4 potential users of recycled CCA treated wood (all from Virginia). The landfills and recyclers were found on recycling center and government Internet databases. The following are the questions asked to interviewee.

Questions for C&D and MSW landfill managers

- 1) Are you currently receiving CCA treated wood waste?
- 2) What approximate percent of total annual wood waste is CCA treated wood?
- 3) Do you require any special handling or disposal procedures for CCA treated wood waste?
- 4) Do you separate wood waste from other waste?
- 5) If so, do you separate CCA treated wood waste from untreated wood waste?
- 6) If not, then what are the barriers?
- 7) If spent CCA treated wood waste is being separated then what are you currently doing with it?

Questions for recycling companies

- 1) Do you currently recycle wood waste?
- 2) Do you recycle CCA treated wood waste? If not, why not?
- 3) Would it be financially feasible for you to produce products similar to those made at Virginia Tech? If not why? If so, who would purchase the products?
- 4) What is the single most limiting aspect of CCA treated wood waste recycling to your operation?

Questions for Park Services and Habitat for Humanity

- 1) Do you use CCA treated wood in your organization?
- 2) Does your organization have a policy regarding the use of recycled material? (Does your company set higher priority on purchasing recycled material?)
- 3) Could recovered CCA treated wood be used by your organization?
- 4) Could similar products that were made at Virginia Tech from used CCA treated wood be produced or used by your organization?

PRODUCTS MANUFACTURED

Several products were made that fit the criteria of being practical to use and make, cost feasible, and required little previous experience and training in wood carpentry. Table

4-1 displays the products made from recycled CCA treated lumber, along with the type of CCA treated wood used, volume, type of hardware, cost of hardware, and the worker-hours needed to create the product.

Table 4- 1. Products manufactured, material and volume used of CCA treated wood, type and cost of hardware, and worker-hours need to complete.

Product	Material (bd.ft.)	Total Board Feet	Hardware	Cost of Hardware	Worker-Hours
Porch Swing	2x4 (8.4), 5/4x6 (14.8)	23.2	3-1/2" & 2" screws, 3-1/2" lag screws, 3-1/2" lag bolts	\$8.68	2.5
Chair	2x4 (6.7), 1x4 (4.4)	11.1	2-1/2" screws, 3-1/2" lag bolts, 3-1/2" lag screws	\$8.71	3
Trash Container	1x4 (5.1), 2x2 (1.8), Lattice (14 ft ²)	6.9	1-3/4" screws, 1-1/4" nails	\$2.00	4
Trellis	2x6 (22), 2x4 (7), 4x4 (81.7), 2x8 (15.4), 2x2 (7.5)	133.6	corner bracket, 5-1/2" lag screws, 3-1/2 lag bolts, 3" & 2-1/2" screws	\$28.70	27
Planter Box	5/4x6 (4.5)	4.5	1-3/4" screws, 1-1/4" nails	\$1.20	1.5
Planters	2x4 (12)	12	3-1/2" & 2-1/2" nails	\$0.60	2
Patio Table	4x4 (18.4), 2x2 (3.8), 5/4x6 (12.4), 1x6 (5)	39.6	2" & 3" screws, 6" lag screws	\$18.00	8
Picnic Table	2x6 (65), 2x4 (6.2)	71.2	2-1/2" & 3" screws, 3-1/2" lag bolts	\$18.31	8.5
Porch Railing	2x2 (10), 2x4 (8.1), 4x4 (8.2)	26.3	all tread, 2-1/2" nails	\$6.75	8.5
Deck	2x8 (108.8), 5/4x6 (100.8), 4x4 (36.8)	246.4	joist hangers, 2-1/2" screws, 1-1/2" nails	\$26.18	22
Saw Horse	2x6(10.3), 1x6 (2.2)	12.5	3-1/2" & 2-1/2" nails	\$0.35	1.25
Block Pallets	1x4 (3.8), 1x6 (5), 5/4x6 (9.7), 4x4 (4.8)	23.3	2-1/4" and 1-5/8" spiral shank nails	\$4.83	2.25
Stringer Pallets	2x4 (5.3), 1x4 (5.1), 1x6 (4)	14.4	2-1/4" spiral shank nails	\$2.52	1.75

Pictures of the products made are located in Figures 4-1 through Figure 4-12. It should be noted that the worker-hours needed to complete each product will be much lower

than the ones shown in Table 4-1 if they are mass produced, because the learning curve and time to produce each product will reduce after several of the same product is produced. The only products that required unused CCA treated wood was the deck that used new 5/4x6 decking, and the trash container that required treated plywood for the lid. Table 4-2 shows the volume of material used to make the 13 products shown in Table 4-1. The 2x8,4x4, and 2x6 material was the most utilized dimensional material. In Chapter 2 it was found that 2x6 and 2x8 were the most successfully recovered material and the highest volume from spent CCA treated residential decks. Therefore, it is beneficial that 2x6 and 2x8 lumber was utilized in the manufacturing of the products. All products were uncomplicated to make, and required a small investment in hardware (from Table 4-1 only the deck, trellis, patio table, and picnic table required hardware that cost \$10.00). Other material used in the making of the products included: latex stain (\$18.99/gallon), white latex paint (\$10.99/quart), white sealer primer (6.99/quart), deck stain (17.99/gallon), sandpaper (\$0.40/sheet), and paint brushes (\$3.99/brush).

Table 4- 2. Volume and percent of recovered CCA treated wood used to manufacturer products.

Material	Volume (bd.ft.)	Percent Volume
2x6	97.3	18.6
2x4	53.6	10.2
2x8	124.2	23.7
2x2	23.1	4.4
5/4x6	41.4	7.9
1x4	18.4	3.5
1x6	16.3	3.1
4x4	149.9	28.6
Total	524.1	100



Figure 4- 1. Porch Swing.



Figure 4- 2. Outdoor Chair.



Figure 4- 3. Trash can container.



Figure 4- 4. Trellis.

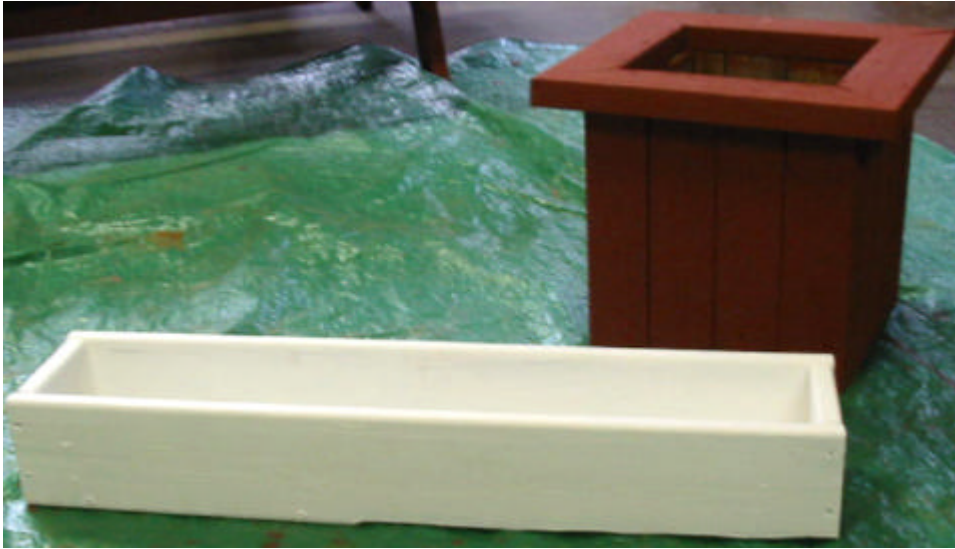


Figure 4- 5. Planter boxes.



Figure 4- 6. Patio Table



Figure 4- 7. Picnic Table



Figure 4- 8. Porch railing.



Figure 4- 9. Residential deck.



Figure 4- 10. Sawhorses.



Figure 4- 11. Block pallets



Figure 4- 12. Stringer pallet.

PALLET PERFORMANCE

Six pallets were made to determine if the pallet industry would be a feasible market to utilize recycled CCA treated wood from residential decks. The two most popular pallet designs, the stringer and block, were used to make the pallets. Typical pallets are 40"x48", but the material needed to make the pallets that size was not available from the recovered CCA treated wood from the residential decks, therefore the pallets made were 35"x48". Figure 4-11 and Figure 4-12 show the block and stringer pallets that were manufactured. The type of hardware and CCA treated wood used and the approximate cost of the hardware is listed in Table 4-1.

The pallets were tested to determine how they would perform compared to pallets made with untreated virgin wood of the same specifications. The William H. Sardo Jr. Pallet and Container Research Laboratory at Virginia Tech tested the six pallets. Table 4-3 displays the pallets and how they were tested. Two of the three stringer pallets were tested to failure in rack across the width (stringer pallets No. 2 and 3), and the other pallet was tested to failure at rack across the length (stringer pallet No 1). Figure 4-13 displays a stringer pallet racked across the length, and Figure 4-14 shows a stringer pallet racked across the width. Two of the three block pallets were tested to failure in rack across the width (block pallets No. 1 and 2), and the other block pallet was tested to failure in rack across the width (block pallet No. 3). Figure 4-15 displays a block pallet racked across the length, and Figure 4-16 shows a block pallet racked across the width. The load was ramped at 500 lbs./min to a maximum of 10,500 lbs. for all pallets tested.

Table 4- 3. Maximum load of pallets made from recycled CCA treated wood, and comparisons with PDS recommended safe maximum load.

	Max load in lbs. (Racked Across Length)	Max. Load in lbs. (Racked Across Width)	Safe Max. Load (lbs.)	PDS recommended Safe Max. load (lbs.)	% difference in PDS safe max. load and actual safe max load
Stringer Pallet No.1	8366.5		2935.6	3287	-10.7
Stringer Pallet No. 2		8194.5	2875.3	2349	22.4
Stringer Pallet No.3		9127	3202.5	2349	36.3
Block Pallet No.1	8010.1		2810.6	2619	7.3
Block Pallet No.2	8825.70		3096.7	2619	18.2
Block Pallet No.3		10274.6	3605.1	3883	-7.2

After testing, the maximum load to failure was recorded as shown on Table 4-3. The Pallet Design System (PDS) software, version 3.2, was used to compare the strength values obtained from testing to predicted strength values of pallets with the same material, components and specie (Southern Yellow Pine), but with untreated virgin wood. As shown in Table 4-3 the PDS software uses a safe maximum load, which is calculated by reducing the maximum load by a factor of 2.85. For comparison reasons the maximum rack across the length or width was reduced by a factor of 2.85. As seen in Table 4-3, the safe maximum loads of the six pallets compared favorably to the load specified by the PDS software. For the stringer pallets the safe maximum load across the width was 22% and 36% greater than the PDS analysis. Although the PDS software safe maximum load across the width was 11% greater than the safe maximum load across the length. For stringer pallets the critical member in the rack across the length is the center stringer, and it is the bottom deck board for rack across the width. Therefore the center stringer, which was a 2x4, could have had lower than anticipated bending strength and caused the pallet to perform worse than a simulated pallet using untreated unused wood. The opposite could be assumed for the pallets racked across the width were the bottom deck board is the critical member.

The block pallets performed better than the PDS software analysis in rack across the length, but worse in rack across the width, as shown in Table 4-3. The critical member, which was the top stringer board in the rack across the length, performed worse than what would be anticipated for untreated and unused Southern Yellow Pine boards. The outer board is the critical member in rack across the width, and this board performed up to the level of the PDS pallet design. It should be noted that concrete conclusions cannot be drawn until several more tests are run, but the recycled CCA treated wooden pallets tested had similar structural values as designed pallets using virgin untreated Southern Yellow Pine.

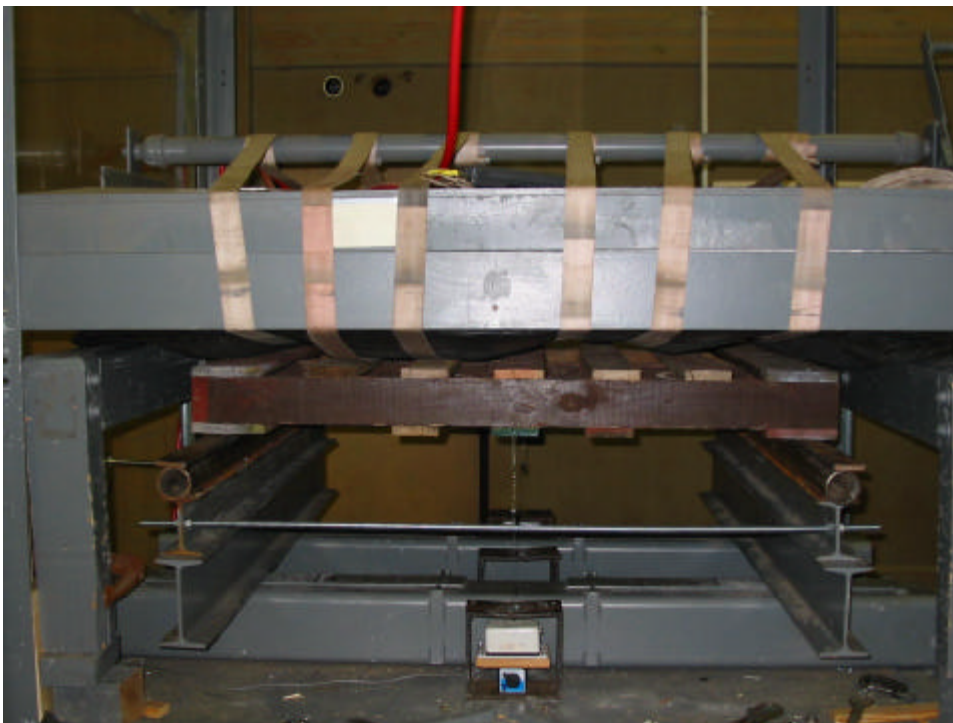


Figure 4- 13. Stringer pallet racked across the length, before load was applied.



Figure 4- 14. Stringer pallet racked across the width, after failure.



Figure 4- 15. Block pallet racked across the length, before load was applied.



Figure 4- 16. Block pallet racked across the width after failure.

MARKET ASSESSMENT

Six C&D and six MSW landfill managers, six recycling companies, and four potential users of the recovered CCA treated wood were interviewed. The questions asked are located in the methodology section of this chapter. The results of the interviews of each segment are summarized in the following sections.

C&D LANDFILL MANAGERS

Of the six C&D landfills interviewed one manger stated they do not received CCA treated wood waste at their facility. They claimed that the wood waste they receive is all from pallets and land clearing debris. The five C&D landfills that receive CCA treated wood waste stated that approximately 10% to 20% of their wood waste was CCA treated. The percent of CCA wood waste was higher for landfills with close proximity to the oceanfront,

which is expected. None of the C&D landfill managers stated that they require any special handling procedures for the CCA material.

All six of the landfills separated wood waste from other waste, in one form or another. Several indicated that they only keep landing clearing debris separate, while two facilities stated they keep wood waste separate only if a load arrives at the landfill as just wood waste. Most ground the wood waste into either mulch or boiler fuel. Only one of the C&D landfills stated that they separate CCA treated wood waste. Two other landfills stated they separated “clean” wood waste but did not separate the CCA treated wood from the unclean wood waste.

Most facilities did not recover CCA treated wood waste, because there was no market and therefore it was not cost effective to hire employees to separate the material. One landfill manager stated that they have seen a significant rise in the amount of CCA treated wood entering the landfill, citing a 2% increase a year over the past 10 years. They also believed that it is important to recycle CCA treated wood, but it was currently too expensive to recycle the material because they do not have the financial resources to hire additional labor. Several managers did not know there were safety and environmental issues with the use and disposal of CCA treated wood. One facility did have employees on site that separate CCA treated wood, pull the nails and cut bad ends off the lumber. The wood is then stacked and sold at cost to local citizens; although this material was mostly from new home construction, not demolished decks. The manager claimed it was very popular, and people used the material to repair decks, build outdoor furniture, and residential landscaping.

MSW LANDFILL MANAGERS

The MSW landfill managers answers were very similar to that of the C&D landfill managers. All stated that they receive CCA treated wood waste, except one who had a private company intercept the wood waste entering the facility and separated the wood waste that could be recycled and then sent the rest to the landfill. The facilities that received CCA treated wood waste gave a range from 1% to 20% of the wood waste received as CCA treated. None of the facilities required any special handling procedures for CCA treated wood waste. None of the facilities separated the CCA wood waste, but most charged less expensive tipping fees if the material received at the site was completely “clean” wood waste which was ground into mulch or boiler fuel or sold to companies that did so. One MSW landfill separated some CCA treated wood out of new construction waste and set that material aside for The Humane Society, which used the material in fencing and shelters for abandoned pets. They currently do not do this because they collected a large inventory and The Humane Society never picked the material up on a routine basis.

They all concluded that the process to separate and recover CCA treated wood was too labor intensive and cannot be profitable because they could not sell the material to justify the costs. The MSW landfill managers interviewed believed the biggest barrier associated with the recycling of CCA treated wood is there is no customer demand and not an adequate supply of raw material to make it cost effective for them to recover and store the material. One manger said that, “You can recycle toothpicks and cigarette butts if you have enough volume and a demand for it.”

RECYCLING COMPANIES

Three of the six recycling companies that were contacted recycled wood waste, but none recycle CCA treated wood waste. Most claimed they could easily produce similar products made in this study, but it would not be feasible. Many believed that they would not receive an adequate supply of raw material, and furthermore they were not aware of a potential market for the finished product that would purchase the material on a regular basis. Many recycling centers were uncertain if they would receive an ample supply of the recovered material, one manager stated. “How will we inform landfills and building contractors that we want the material, and will they bring it to us on a consistent basis, not just during the summer months.” Also one recycling manager stated that they were more worried about “state regulators telling them what they can and cannot do with the material”.

POTENTIAL USERS

Several county and city park and recreation departments were contacted to determine if they could use recycled CCA treated wood in their facilities. All the park managers claimed that they do not have a policy regarding the purchase of recycled material; rather they purchase the lowest priced material that will meet their specifications. They indicated they could use the material, but did not know how to get recovered CCA treated wood. They did not want to make the process of receiving CCA treated wood, as one manager stated, “a logistical nightmare”, where they exhausted more time and money getting the material than it would to buy new CCA treated wood. Most park managers said the potential use could be in trail guides, landscape timbers, bridges, benches, and shelves. The National Forest service stated that they could not use the material because they specify that the CCA treated wood used in their parks be treated to .60 lb/ft³, which few residential decks have wood treated to

that level. Habitat for Humanity was also contacted, they claimed to be interested in using the material, and would also supply the labor in pulling nails and trimming the unusable ends. Most of the material would be used in decks, railings, and porches of habitat homes. As with the other potential users, Habitat for Humanity was unaware of a method to receive recycled CCA treated wood on a routine basis.

CONCLUSIONS

The two objectives of this research were to make products that could feasibly utilize recycled CCA treated wood from residential decks, and to determine barriers that may exist in the reuse of spent CCA treated wood. Several products were made from recovered CCA treated wood. The products produced, in this study, included outdoor home furnishings, landscaping products, pallets, and residential decks and components. Those produced were uncomplicated designs that allowed researchers with limited knowledge or skill in wood carpentry to complete successfully. The products were also inexpensive to produce, requiring a small amount of monetary investment in tools and hardware. The products also utilized the highest volume of CCA treated wood coming from spent residential decks, which are 2x6s and 2x8s. This study made only a few products that could be made from recovered CCA treated wood, several other items can be made, including but not limited to, benches, raised walkways, walking bridges, trail guides and paths, and in residential and commercial landscaping. Pallets made from the recovered CCA treated wood were found to perform similar to that of untreated wooden pallets, of the same species and similar quality. Recycled CCA treated wood can be used in several different applications as effectively as new CCA treated wood.

Several barriers exist in the reuse of recycled CCA treated wood. Landfills stated that they receive little CCA treated wood, and believed that separating it from other waste would not be cost effective because there are no markets. Recycling centers also claimed it would not be possible to recover the material, most citing that there are no markets and not a consistent supply of spent CCA treated wood. Several potential users stated that they could use the material, but did not know where to get it. From the personal interviews it appears that the biggest barrier in the recycling of CCA treated wood waste is lack of communication between all interested parties.

Several groups will influence the success of recycling CCA treated wood from residential decks. These groups include manufacturers of CCA treated wood, building contractors, or other “waste” producers, government organizations, and landfills/recyclers. Many manufacturers have not evaluated the effect their product has on their profitability after it has been sold. This has already occurred with the ban of CCA treated wood in residential applications at the end of 2003. The environmental groups and media attack on the use of CCA treated wood, though questionable, has forced the industry to spend millions of dollars on new chemical development and treatment processes, and also a loss of market share which might have been avoided if the issue was confronted earlier. The industry is currently facing another negative attack on its products with the possible adverse safety and environmental side effects on the disposal of spent CCA treated wood. Therefore the industry must be proactive and support the development of recycling programs and markets, through financial incentives or other forms of support in order to keep CCA wood markets sustainable.

Building contractors currently dispose of CCA treated wood in landfills because it is less expensive than to recycle and there are no other alternatives. Therefore, the

development of recovery programs for landfill and recycling centers are needed, and also required is support by the local government. Incentives need to be giving to CCA waste producers that bring separated CCA treated wood waste into the facility. This can be achieved by lowering tipping fees for sorted CCA treated wood waste, or by raising the fees to accept unsorted C&D wood waste. The CCA treated wood waste producers will only make an effort to recover the waste if there are no cheaper alternatives.

To make CCA treated wood recycling successful, local governments need to support and initiate programs that foster communication and awareness of the amount of CCA treated wood reaching landfills and the potential reuse of the material. Landfills, recyclers, and potential users (individual citizens, parks and recreation, non-profit organizations) need to be informed how each sector can benefit from the recovery of CCA treated wood. Government officials should help develop markets for the material, and aid recyclers in developing business opportunities in making recycled CCA wood profitable. Government officials and recyclers should develop easy drop off and purchase sites for CCA treated wood.

In summary, the recycling of CCA treated wood from residential decks can be achieved if all affected parties are aware of the issues and potential reuse of the material. If the industry, builders, governments, recyclers, and users associated with the use, disposal, and recycling of CCA treated wood understand the needs of each party, and response accordingly, then the barriers in the reuse of spent CCA treated residential decks can be diminished.

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**CHAPTER FIVE. RESEARCH SUMMARY, IMPLICATIONS,
LIMITATIONS, AND FUTURE STUDIES.**

RESEARCH SUMMARY

The CCA treating industry is one of the largest markets for Southern Yellow Pine (SYP). In 2001, approximately 7 billion board feet, or 40% of the total production, of SYP was treated with CCA (Southern Pine Council, 2002). One of the largest markets for CCA treated SYP is in residential decks. Forty percent of CCA treated wood is used in the repair, remodeling and construction of residential decks in the United States (SFPA, 1999). While the residential deck market increased the production of CCA treated wood, it has also increased the disposal of CCA treated wood. Research has suggested that approximately 1 billion board feet a year is being removed from service in residential decks a year, mainly disposal of in landfills, and this is expected to increase (Alderman, 2001 and McQueen and Stevens, 1999). Along with this research, several other scientists have investigated the potential safety and environmental hazards associated with the disposal of CCA treated wood in landfills (Tom, 2001(a and b), and Townsend and Solo-Gabrielle, 2000). Better and more responsible alternatives other than disposal need to be addressed to reduce the burden on landfills and to extend the useful life of CCA treated wood.

In light of this information, research was conducted to analyze the feasibility in recycling spent CCA treated wood residential decks. The objectives of the research were:

1. Determine the amount of CCA treated wood that can be recovered and the most feasible products that can be produced from discarded CCA treated wood.
2. Determine mechanical and chemical properties of the CCA treated wood recovered from spent residential decks.
3. Recognize barriers that exist for landfills, recycling centers, and organizations in recycling and reusing recovered CCA treated wood from residential decks.

Six residential decks constructed with CCA treated wood were found before they were dismantled. The deck owners were interviewed to understand their opinion of the deck performance, and what was replacing the deck. Four of the decks were dismantled following the building contractors typical procedure, and two were deconstructed. The hardware was removed and unusable areas of the material were discarded. Samples of the decking and joists of each deck and recently treated wood were collected for chemical analysis. Samples of the decking from each deck was also from recently treated wood was also collected. Products were made that emphasized simple designs, inexpensive tools and hardware, and were quickly made, so recovered CCA treated wood could be used without much capital investment. Interviews were conducted with municipal solid waste (MSW) and construction and demolition (C&D) landfills, recycling companies, and potential users to understand barriers that may exist in the reuse of CCA treated wood from spent residential decks.

The first objective of this research was to determine the amount of CCA treated wood that can be recovered from CCA treated residential decks and products that could be produced from the material. The survey of deck owners indicated that aesthetics, safety, and physical degradation of the CCA treated wood were the main reasons for deck removal. All but one of the homeowners planned to use CCA treated wood as the construction material for the new deck; many owners citing that the cost of the construction material was the biggest factor in choosing the construction material. It was found that 86% of the deck material was recovered as reusable lumber. The largest volume recovered was the 2x6s at 41% of the total, and 2x8s at 20% of the total volume recovered. The most successful material recovered was the 2x8s and 2x4, both approximately 95% recovered from the volume while

in-service, followed by the 2x6s, approximately 93% recovered. The most feasible components of the deck to recover were the decking and joists.

Deconstruction of the two decks did not result in an increase of recoverable CCA treated wood. In fact, the two decks deconstructed had less recoverable wood than the other demolished decks. Other factors such as type of hardware in the deck and different exposures to environmental conditions may have a larger impact in the amount of CCA treated wood recovered than the removal procedure.

Several products were manufactured from the recovered CCA treated wood. The products produced included: pallets, residential decks, railings, outdoor furniture, such as picnic and patio tables, chairs, and swings, and outdoor landscaping items, such as a trellis, and planter boxes. The products were made from simple designs, required little initial training and skill, and inexpensive hardware and tools. The products made also utilized the highest volume of CCA wood recovered the spent residential decks, which were the 2x6s and the 2x8s. Pallets had similar strength values to that of predicated strength values of untreated wood pallets of the same specie and wood grade.

The second objective of this research was to determine the mechanical and chemical properties of the recovered CCA treated wood from spent residential decks. Several of the joists and decking samples were found to be below the retention level that was stamped or tagged on the lumber. As a whole the joists had a higher retention level than the decking samples, which was expected since the joists were not exposed to as much physical and environmental degradation when compared to the decking. Length of service was not a factor in the chemical retention levels in the decking and joists of the decks used in this

study. Though the material had lower than expected chemical retention, it still can be reused in applications with limited ground contact.

The MOE and MOR values of recently CCA treated wood samples were compared to samples of the six decks obtained in this research. The MOE values of the decking samples were found to be statically equal or greater than recently treated wood. Although the MOR values were found be statically lower for most of the decking samples compared to the recently treated wood. As with the chemical properties, the strength properties tested did not decrease as service life increased. The results of the chemical and mechanical tests indicated that the material could be reused in many applications where new CCA treated wood is typically used.

The third objective of this research was to recognize barriers that exist for landfills, recycling centers, and organizations in recycling and reusing recovered CCA treated wood from residential decks. Interviews with MSW and C&D landfills, recycling centers, and potential users indicated that a communication barrier exists between the three groups. The MSW and C&D landfills indicated that they could not recover the material because it is not financially feasible for them to do so without a reliable market that purchases the recovered material. Also the recycling companies had the same feeling, that a stable market cannot be found to make the recovering of the material economically viable. The potential user stated that they could use the material or products made from the material, but did not know where to get the material. All affected parties, manufacturers, waste producers, recyclers, and governments, need to take a proactive approach in developing spent CCA treated wood into a feasible recyclable material. Several local government organizations need to promote the potential uses of the material, and also get interested parties communicating in ways they can

help each other better utilize the material. Incentives need to be developed that attract building contractors that demolish and build new decks to separate or take used CCA treated wood to recycling facilities.

IMPLICATIONS IN RECYCLING

“Recycling is a good policy only if environmental discharges and the resources used to collect, sort, and recycle a material are less than the environmental discharges and resources needed to provide an equivalent virgin material plus the resources needed to dispose of the material safely” (Lave et.al., 1999). Therefore according to Lave et.al.(1999), for recycling of CCA treated wood to be a sensible environmental policy, the energy, equipment, and labor associated with collection, separation, and recycling of treated wood should be smaller than the energy, equipment, and labor associated with producing new CCA treated wood. If the resources associated with collecting, separating, and recycling of CCA treated wood are larger than the resources associated with making new treated wood and with landfilling the used wood, recycling does not help with environmental quality or sustainability.

In the case of CCA treated wood, the wood and chemical supply are sufficient and relatively inexpensive, and currently the disposal of CCA treated wood does not have environmental safety regulations, which has not created a demand for recycled CCA treated wood. Ongoing research on the impacts of CCA treated wood disposal could cause stricter disposal regulations, and thus higher tipping fees making recycling a more attractive option. From this research it was found that the energy, equipment, and labor associated with collection, recycling, and separation is currently cheaper than that associated with production of treated wood. Therefore, the recycling of CCA treated wood does help environmental

quality and sustainability. This broad view has explained why CCA treated wood should be recycled, but what will make recycling viable is that the cost of collection and separation should be less than the cost of collection and disposal for the waste producer, which is not currently the situation for CCA treated wood.

Several programs need to be initiated by local governments and recycling organizations. These organizations need to network with construction firms and recyclers to encourage the reuse of CCA wood waste. This can be achieved through programs such as the reduction of tipping fees for building contractors that have separated loads of CCA treated wood waste. Also, programs need to be developed that show the advantages of separating the CCA treated wood waste, and the markets that are available for recycled CCA treated wood. The government and recycling organizations need to publicize recovery processes of CCA treated wood from residential decks, and distribute them by mailings, fact sheets, and case studies to consumers of the recovered material, building contractors, and landfills.

The lack of identifiable markets for recyclers of CCA treated wood is currently a major barrier in recovering the material. Programs need to help develop markets for the material, emphasizing that the material is 100% recycled, has similar properties of recently treated wood, is cheaper than new CCA treated wood, and display different products that can be made from recycled CCA treated wood. If markets are developed then many landfills may see the economic advantage of receiving separated wood waste and will reduce tipping fees for separated CCA treated wood waste or raise the fees for unsorted wood waste.

LIMITATIONS OF RESEARCH

As with most research every aspect cannot be controlled or anticipated. Due to monetary and time constraints the number of decks received were relatively low (six), and the location of the decks were centralized around one region of the country. Therefore, the compositions of decks in regions of the country near the oceanfront or other large bodies of water may differ and could alter the results. Also, decks in areas of the country where the terrain was drastically different than the New River Valley region of Virginia might alter the results. Although as a whole, the New River Valley region of Virginia is demographically and geographically similar to many regions of the country. Also, the differences in physical or environmental wear of each deck removed for this study was not obtained, which might have been a factor in the amount recovered. Therefore conclusions cannot be drawn that physical or environmental degradation of a residential deck plays a role in the recovery of CCA treated wood.

Another limitation of this study was the landfills, recyclers, and potential users of the material were confined to Virginia and North Carolina, and the interviewed sample size was small. An increased sample size and a different geographical segment of the country could obtain different results.

The objectives of this study were derived to understand the feasibility of recycling CCA treated wood from spent residential decks. These conclusions were reached in the research and cannot be assumed as valid regarding the feasibility to recycle other products produced from CCA treated wood. The research objectives were also not focused on determining the safety and environmental aspects of CCA treated wood, that is prevalent in

today's media, therefore no conclusions based on the safety or environmental hazards can be drawn.

AREAS OF FUTURE RESEARCH

This research has shown that CCA treated wood can be recycled from residential decks. The physical and chemical properties of the recovered wood were found suitable to use in several applications. Also a large majority of the CCA treated deck was recoverable, but questions arise if this number could be increased by designing decks that the CCA wood composing them is easily recovered, without sacrificing the performance of the deck. Reverse engineering concepts could be studied in the construction of new decks to analyze how the style, location, hardware, component design (railing, steps, decking, etc.), and deck finishes affect the recoverability of a deck, and how to design and engineer decks accordingly. This would help building contractors and recyclers easily convert the spent CCA treated wood into reusable material.

This research was based on CCA treated wood being recycled, which will no longer be used in residential applications by the end of 2003. Therefore, research could be performed to determine the feasibility of recycling residential decks treated with other chemicals, such as ACQ (Alkaline Copper Quat), CC (Copper Citrate), CBA (Copper Boron Azole), and CDDC (Copper Dimethyldithiocarbamate), or another wood preserving chemical currently or soon to be used in treated wood used in residential decks.

This research also showed that barriers do exist between the landfills, recyclers, and potential user, or markets. A more in-depth survey of different MSW and C&D landfills, recyclers, and potential users, in different regions in the country to understand the barriers and attitudes that are prevalent in recovering CCA treated wood from residential decks. The

results of this survey and research will give recyclers a foundation in developing strategies in finding markets for recovered CCA treated wood.

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APPENDIX

APPENDIX A. PARTICIPATING BUILDING CONTRACTORS

Blue Ridge Home Improvement, Inc.
Rick Waller
P.O. Box 903
Blacksburg, VA 24063
(540) 951-3505

Ewing Building and Remodeling, Inc.
Paul Ewing
Blacksburg, VA 24060
(540) 951-0544

Creative Carpentry
Greg Lester
Christiansburg, VA
(540) 382-4170

O'Reily Contracting
Pat O'Riely
Steve Hall (Foreman)
Blacksburg, VA
(540) 951-1280

APPENDIX B. QUESTIONNAIRE FOR DECK OWNERS

Deck # _____

Date _____

Questions For Homeowners Removing a CCA-Treated Wood Deck

1) How many years was the deck in service?

2) What was the reason for deck removal? (Circle all that apply)

Aesthetics (wood appearance)

Decayed Wood

Insect Infested Wood

Style (a new style of deck preferred)

Safety (structurally unsound deck)

Poorly constructed Deck

Size (a larger deck preferred)

Material (a new material preferred)

Physical Degradation (warp, twist, splits, or bow of the wood)

Other Reasons

3) What is, or was, your satisfaction level of your pressure treated deck? (Circle One)

Unsatisfied

Satisfied

Very satisfied

4) Are you building a new deck?

5) If building a new deck, is it larger or smaller than the existing deck?

6) If you are building a new deck, what building material are you using?

7) Why did you decide to use this building material for your new deck?

8) Who made the decision on the building material used to construct your new deck?

You, the homeowner Building Contractor
 Home Improvement Center (Lowe's, Home Depot, and others)
 Other _____

9) If you are not building a new deck, what was the reason not to construct a deck?

10) Rate these following attributes of your old deck from 1 to 5 as far as satisfaction.
 (1 being very unsatisfied and 5 being very satisfied.)

	Very Unsatisfied				Very Satisfied
Aesthetics (wood appearance)	1	2	3	4	5
Amount of Decayed Wood	1	2	3	4	5
Amount of Insect Infestation	1	2	3	4	5
Style of Your Deck	1	2	3	4	5
Safety (Was your deck structurally stable?)	1	2	3	4	5
Overall Construction of deck	1	2	3	4	5
Size (Was deck an adequate size?)	1	2	3	4	5
Material (Was wood a good material?)	1	2	3	4	5
Amount of Physical Degradation (Warp, Twist, Bow, Splits, etc.)	1	2	3	4	5
Other attributes of deck – please list	_____				

APPENDIX C. PHOTOS OF STACKED RECOVERED CCA TREATED WOOD FROM RESIDENTIAL DECKS.



Figure A- 1. Recovered CCA treated wood from Deck #1.



Figure A- 2. Recovered CCA treated wood from Deck #2.



Figure A- 3. Recovered CCA treated wood from Deck #3.



Figure A- 4. Recovered CCA treated wood from Deck #4.



Figure A- 5. Recovered CCA treated wood from Deck #5.



Figure A- 6. Recovered CCA treated wood from Deck #6.

APPENDIX D. TABLES OF CCA TREATED WOOD WHILE IN-SERVICE, AFTER REMOVAL, AND RECOVERED FROM ALL DECKS.

Table A- 1. CCA treated wood composing Deck No.1 while in-service.

<u>Deck #1 In-service</u>							Overall Deck Size Square Feet	
							12' x 20'9"	239.10
Deck Part	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.	
Decking								
decking	5/4 X 6	1x5.5	260	20	1430	9.93	198.61	
decking	5/4 X 4.5	1x4.5	260	1	1170	8.13	8.13	
decking	5/4 X 6	1x5.5	93.5	5	514.25	3.57	17.86	
decking	5/4 X 6	1x5.5	93.5	5	514.25	3.57	17.86	
decking	5/4 X 2.5	1x2.5	64	1	160	1.11	1.11	
decking	5/4 X 6	1x5.5	103	5	566.5	3.93	19.67	
sub-total				37			263.23	
Railing								
railing	2 X 4	1.5x3.5	131	2	687.75	4.78	9.55	
railing	2 X 4	1.5x3.5	143	1	750.75	5.21	5.21	
railing	2 X 4	1.5x3.5	139.5	1	732.375	5.09	5.09	
railing	2 X 4	1.5x3.5	63.5	1	333.375	2.32	2.32	
railing	2 X 4	1.5x3.5	32.5	2	170.625	1.18	2.37	
railing	2 X 4	1.5x3.5	25	2	131.25	0.91	1.82	
railing	2 X 4	1.5x3.5	68	2	357	2.48	4.96	
railing	2 X 4	1.5x3.5	58.5	2	307.125	2.13	4.27	
railing	2 X 4	1.5x3.5	59	2	309.75	2.15	4.30	
railing	2 X 4	1.5x3.5	60	2	315	2.19	4.38	
railing	2 X 4	1.5x3.5	65.5	2	343.875	2.39	4.78	
railing	2 X 4	1.5x3.5	68.5	2	359.625	2.50	4.99	
railing	2 X 4	1.5x3.5	39	2	204.75	1.42	2.84	
railing	2 X 4	1.5x3.5	35	2	183.75	1.28	2.55	
railing balusters	2 X 2	1.5x1.5	35	82	78.75	0.55	44.84	
sub-total				107			104.27	
Stair Parts								
stair treads	5/4 X 6	1x5.5	37.5	6	206.25	1.43	8.59	
stair railing	2 X 4	1.5x3.5	46	2	241.5	1.68	3.35	
stair railing	2 X 4	1.5x3.5	38.5	4	202.125	1.40	5.61	
stair balusters	2 X 2	1.5x1.5	35	10	78.75	0.55	5.47	
stair posts	4 X 4	3.5x3.5	46	2	563.5	3.91	7.83	
stringers	2 X 10	1.5x9.25	45	3	468.28125	3.25	9.76	
sub-total				27			40.61	
Posts								
posts	4 X 4	3.5x3.5	74	4	906.5	6.30	25.18	
posts	4 X 4	3.5x3.5	48	4	588	4.08	16.33	
sub-total				8			41.51	
Sill Exterior								
sill	2 X 10	1.5x9.25	139	2	1928.625	13.39	26.79	
sill	2 X 10	1.5x9.25	252	1	3496.5	24.28	24.28	
sub-total				3			51.07	
Lattice Material								
Lattice	22.5 X .5	22.5x.5	139	2	1172.8125	8.14	16.29	
Lattice	22.5 X .5	22.5x.5	252	1	2126.25	14.77	14.77	
connecting lattices	1 X 2	.5x1.5	22.5	9	16.875	0.12	1.05	
sub-total				12			32.11	
Joists								
joists	2 X 10	1.5x9.25	141	14	1956.375	13.59	190.20	
joists	2 X 10	1.5x9.25	116	3	1609.5	11.18	33.53	
sub-total				17			223.73	
Sill Interior								
sill	2 X 10	1.5x9.25	90	1	1248.75	8.67	8.67	
sill	2 X 10	1.5x9.25	64	1	888	6.17	6.17	
sill	2 X 10	1.5x9.25	103	1	1429.125	9.92	9.92	
sub-total				3			24.76	

Misc. 2X4's							
Contact w/							
Ground							
	2 X 4	1.5x3.5	139	1	729.75	5.07	5.07
	2 X 4	1.5x3.5	252	1	1323	9.19	9.19
sub-total				2			14.26

Grand Total				216			795.56
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** Note: Weight of Hardware in Deck = 24.4 lb.

Table A- 2. CCA treated wood from demolished Deck No.1.

Deck #1 Demolished Material

Overall	
Deck Size	Square Feet
12' x 20'9"	239.10

Deck Material	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.
5/4 X 6	5/4 X 6	1x5.5	65.5	1	360.25	2.50	2.50
	5/4 X 6	1x5.5	86.5	2	475.75	3.30	6.61
	5/4 X 6	1x5.5	110.5	3	607.75	4.22	12.66
	5/4 X 6	1x5.5	103	1	566.5	3.93	3.93
	5/4 X 6	1x5.5	143.5	3	789.25	5.48	16.44
	5/4 X 6	1x5.5	142.25	1	782.375	5.43	5.43
	5/4 X 6	1x5.5	128	1	704	4.89	4.89
	5/4 X 6	1x5.5	142	1	781	5.42	5.42
	5/4 X 6	1x5.5	48	1	264	1.83	1.83
	5/4 X 6	1x5.5	94	2	517	3.59	7.18
	5/4 X 6	1x5.5	118	2	649	4.51	9.01
	5/4 X 6	1x5.5	142	1	781	5.42	5.42
	5/4 X 6	1x5.5	60	1	330	2.29	2.29
	5/4 X 6	1x5.5	62	1	341	2.37	2.37
	5/4 X 6	1x5.5	86	1	473	3.28	3.28
	5/4 X 6	1x5.5	91	1	500.5	3.48	3.48
	5/4 X 6	1x5.5	118	1	649	4.51	4.51
	5/4 X 6	1x5.5	86	1	473	3.28	3.28
	5/4 X 6	1x5.5	103	1	566.5	3.93	3.93
	5/4 X 6	1x5.5	110	2	605	4.20	8.40
	5/4 X 6	1x5.5	54	1	297	2.06	2.06
	5/4 X 6	1x5.5	80	1	440	3.06	3.06
	5/4 X 6	1x5.5	78	1	429	2.98	2.98
	5/4 X 6	1x5.5	103	1	566.5	3.93	3.93
	5/4 X 6	1x5.5	96	1	528	3.67	3.67
	5/4 X 6	1x5.5	128	1	704	4.89	4.89
	5/4 X 6	1x5.5	52	1	286	1.99	1.99
	5/4 X 6	1x5.5	55	1	302.5	2.10	2.10
	5/4 X 6	1x5.5	67	1	368.5	2.56	2.56
	5/4 X 6	1x5.5	93.5	1	514.25	3.57	3.57
	5/4 X 6	1x5.5	86	1	473	3.28	3.28
	5/4 X 6	1x5.5	64	1	352	2.44	2.44
	5/4 X 6	1x5.5	118	1	649	4.51	4.51
	5/4 X 6	1x5.5	142.25	1	782.375	5.43	5.43
	5/4 X 6	1x5.5	86.5	1	475.75	3.30	3.30
	5/4 X 6	1x5.5	82	1	451	3.13	3.13
	5/4 X 6	1x5.5	142.25	1	782.375	5.43	5.43
	5/4 X 6	1x5.5	95.5	1	525.25	3.65	3.65
	5/4 X 6	1x5.5	37.5	1	206.25	1.43	1.43
	5/4 X 6	1x5.5	42	1	231	1.60	1.60
	5/4 X 6	1x5.5	148	1	814	5.65	5.65
	5/4 X 6	1x5.5	127.5	2	701.25	4.87	9.74
	5/4 X 6	1x5.5	118.25	1	650.375	4.52	4.52
	5/4 X 6	1x5.5	62	1	341	2.37	2.37
	5/4 X 6	1x5.5	66	1	363	2.52	2.52
	5/4 X 6	1x5.5	96	1	528	3.67	3.67
	5/4 X 6	1x5.5	89	1	489.5	3.40	3.40
	5/4 X 6	1x5.5	103	1	566.5	3.93	3.93
	5/4 X 6	1x5.5	16	1	88	0.61	0.61
	5/4 X 6	1x5.5	22	2	121	0.84	1.68
	5/4 X 6	1x5.5	30	1	165	1.15	1.15
	5/4 X 6	1x5.5	30.5	1	167.75	1.16	1.16
	5/4 X 6	1x5.5	26	1	143	0.99	0.99
	5/4 X 6	1x5.5	22	1	121	0.84	0.84
	5/4 X 6	1x5.5	30.5	1	167.75	1.16	1.16
	5/4 X 6	1x5.5	29	1	159.5	1.11	1.11
	5/4 X 6	1x5.5	37	1	203.5	1.41	1.41
	5/4 X 6	1x5.5	31	1	170.5	1.18	1.18
	5/4 X 6	1x5.5	22.5	1	123.75	0.86	0.86
	5/4 X 6	1x5.5	30	1	165	1.15	1.15
	5/4 X 6	1x5.5	31	1	170.5	1.18	1.18
	5/4 X 6	1x5.5	24	2	132	0.92	1.83
	5/4 X 6	1x5.5	31	1	170.5	1.18	1.18
sub-total				74			231.23

2 X 4							
	2 X 4	1.5x3.5	135.25	1	710.06	4.93	4.93
	2 X 4	1.5x3.5	142.5	1	748.13	5.20	5.20
	2 X 4	1.5x3.5	128.5	3	674.63	4.68	14.05
	2 X 4	1.5x3.5	162.5	1	853.13	5.92	5.92
	2 X 4	1.5x3.5	101	1	530.25	3.68	3.68
	2 X 4	1.5x3.5	96	4	504.00	3.50	14.00
	2 X 4	1.5x3.5	65	4	341.25	2.37	9.48
	2 X 4	1.5x3.5	60	4	315.00	2.19	8.75
	2 X 4	1.5x3.5	59	4	309.75	2.15	8.60
	2 X 4	1.5x3.5	41	1	215.25	1.49	1.49
	2 X 4	1.5x3.5	25.5	1	133.88	0.93	4.93
sub-total				25			81.05

5/4 X 4.5							
	5/4 X 4.5	1x4.5	67	1	301.5	2.09	2.09
	5/4 X 4.5	1x4.5	73	1	328.5	2.28	2.28
	5/4 X 4.5	1x4.5	16	1	72	0.50	0.50
	5/4 X 4.5	1x4.5	35	1	157.5	1.09	1.09
	5/4 X 4.5	1x4.5	30.5	1	137.25	0.95	0.95
sub-total				5			6.92

4 X 4							
	4 X 4	3.5x3.5	74	4	906.5	6.30	25.18
	4 X 4	3.5x3.5	48	3	588	4.08	12.25
sub-total				7			37.43

Balusters							
	2 X 2	1.5x1.5	35	70	81.375	0.57	39.56
	2 X 2	1.5x1.6	24	1	55.8	0.39	0.39
	2 X 2	1.5x1.7	25	1	58.125	0.40	0.40
	2 X 2	1.5x1.8	15	1	34.875	0.24	0.24
	2 X 2	1.5x1.9	27	2	62.775	0.44	0.87
	2 X 2	1.5x1.10	21	2	48.825	0.34	0.68
	2 X 2	1.5x1.11	23	1	53.475	0.37	0.37
	2 X 2	1.5x1.12	28	1	65.1	0.45	0.45
	2 X 2	1.5x1.13	5.25	1	12.20625	0.08	0.08
	2 X 2	1.5x1.14	29	1	67.425	0.47	0.47
	2 X 2	1.5x1.15	10	1	23.25	0.16	0.16
	2 X 2	1.5x1.16	30	1	69.75	0.48	0.48
sub-total				83			44.16

2 X 10							
	2 X 10	1.5x9.25	36	1	499.5	3.47	3.47
	2 X 10	1.5x9.25	101.5	1	1408.3125	9.78	9.78
	2 X 10	1.5x9.25	141	14	1956.375	13.59	190.20
	2 X 10	1.5x9.25	129	1	1789.875	12.43	12.43
	2 X 10	1.5x9.25	143	1	1984.125	13.78	13.78
	2 X 10	1.5x9.25	128.25	1	1779.4688	12.36	12.36
	2 X 10	1.5x9.25	127.25	1	1765.5938	12.26	12.26
	2 X 10	1.5x9.25	143.75	1	1994.5313	13.85	13.85
	2 X 10	1.5x9.25	116	3	1609.5	11.18	33.53
	2 X 10	1.5x9.25	91	1	1262.625	8.77	8.77
	2 X 10	1.5x9.25	64	1	888	6.17	6.17
	2 X 10	1.5x9.25	129.5	1	1796.8125	12.48	12.48
sub-total				27			329.07

Lattice Material	weight (lb.)	Bd. Ft.		
	50.8	16.75		16.75
sub-total				16.75

misc scrap	weight (lb.)	Bd. Ft.		
	57.6	19		19.00
sub-total				19.00

Grand Total		221		765.61
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Table A- 3. Recovered CCA treated wood from Deck No.1.

**Deck #1 Fully
Recovered**

Overall Deck Size	Square Feet
12' x 20'9"	239.10

Deck Material	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.
5/4 X 6	5/4 x 6	1x5.5	16	2	88	0.61	1.22
	5/4 x 6	1x5.5	17.5	1	96.25	0.67	0.67
	5/4 x 6	1x5.5	17	2	93.5	0.65	1.30
	5/4 x 6	1x5.5	34	1	187	1.30	1.30
	5/4 x 6	1x5.5	36	1	198	1.38	1.38
	5/4 x 6	1x5.5	47.5	1	261.25	1.81	1.81
	5/4 x 6	1x5.5	51	1	280.5	1.95	1.95
	5/4 x 6	1x5.5	59	1	324.5	2.25	2.25
	5/4 x 6	1x5.5	75	1	412.5	2.86	2.86
	5/4 x 6	1x5.5	75.5	1	415.25	2.88	2.88
	5/4 x 6	1x5.5	78	1	429	2.98	2.98
	5/4 x 6	1x5.5	93.5	1	514.25	3.57	3.57
	5/4 x 6	1x5.5	94	1	517	3.59	3.59
	5/4 x 6	1x5.5	111	1	610.5	4.24	4.24
	5/4 x 6	1x5.5	96	1	528	3.67	3.67
	5/4 x 6	1x5.5	116	1	638	4.43	4.43
	5/4 x 6	1x5.5	15	1	82.5	0.57	0.57
	5/4 x 6	1x5.5	27	1	148.5	1.03	1.03
	5/4 x 6	1x5.5	30.5	1	167.75	1.16	1.16
	5/4 x 6	1x5.5	33.5	1	184.25	1.28	1.28
	5/4 x 6	1x5.5	46.5	1	255.75	1.78	1.78
	5/4 x 6	1x5.5	46	1	253	1.76	1.76
	5/4 x 6	1x5.5	51	1	280.5	1.95	1.95
	5/4 x 6	1x5.5	63.5	1	349.25	2.43	2.43
	5/4 x 6	1x5.5	66.5	1	365.75	2.54	2.54
	5/4 x 6	1x5.5	84	1	462	3.21	3.21
	5/4 x 6	1x5.5	86.5	1	475.75	3.30	3.30
	5/4 x 6	1x5.5	112	1	616	4.28	4.28
	5/4 x 6	1x5.5	93.5	2	514.25	3.57	7.14
	5/4 x 6	1x5.5	142.5	1	783.75	5.44	5.44
	5/4 x 6	1x5.5	24	1	132	0.92	0.92
	5/4 x 6	1x5.5	26	1	143	0.99	0.99
	5/4 x 6	1x5.5	20.5	1	112.75	0.78	0.78
	5/4 x 6	1x5.5	22.5	1	123.75	0.86	0.86
	5/4 x 6	1x5.5	21	1	115.5	0.80	0.80
	5/4 x 6	1x5.5	29	1	159.5	1.11	1.11
	5/4 x 6	1x5.5	30	1	165	1.15	1.15
	5/4 x 6	1x5.5	43.5	1	239.25	1.66	1.66
	5/4 x 6	1x5.5	50	1	275	1.91	1.91
	5/4 x 6	1x5.5	65.5	2	360.25	2.50	5.00
	5/4 x 6	1x5.5	62	1	341	2.37	2.37
	5/4 x 6	1x5.5	82.5	1	453.75	3.15	3.15
	5/4 x 6	1x5.5	79	1	434.5	3.02	3.02
	5/4 x 6	1x5.5	92	2	506	3.51	7.03
	5/4 x 6	1x5.5	86	1	473	3.28	3.28
	5/4 x 6	1x5.5	125	1	687.5	4.77	4.77
	5/4 x 6	1x5.5	28.5	1	156.75	1.09	1.09
	5/4 x 6	1x5.5	30.5	1	167.75	1.16	1.16
	5/4 x 6	1x5.5	37.5	1	206.25	1.43	1.43
	5/4 x 6	1x5.5	25.5	1	140.25	0.97	0.97
	5/4 x 6	1x5.5	30.5	1	167.75	1.16	1.16
	5/4 x 6	1x5.5	39.5	1	217.25	1.51	1.51
	5/4 x 6	1x5.5	52	1	286	1.99	1.99
	5/4 x 6	1x5.5	57.5	1	316.25	2.20	2.20
	5/4 x 6	1x5.5	63.5	1	349.25	2.43	2.43
	5/4 x 6	1x5.5	62	1	341	2.37	2.37
	5/4 x 6	1x5.5	61.5	1	338.25	2.35	2.35
	5/4 x 6	1x5.5	76	1	418	2.90	2.90
	5/4 x 6	1x5.5	72	1	396	2.75	2.75
	5/4 x 6	1x5.5	65	1	357.5	2.48	2.48
	5/4 x 6	1x5.5	110.5	1	607.75	4.22	4.22
	5/4 x 6	1x5.5	99.5	1	547.25	3.80	3.80
	5/4 x 6	1x5.5	143.5	1	789.25	5.48	5.48
	5/4 x 6	1x5.5	28.5	1	156.75	1.09	1.09

	5/4 x 6	1x5.5	118	2	649	4.51	9.01
	5/4 x 6	1x5.5	142	1	781	5.42	5.42
	5/4 x 6	1x5.5	115	1	632.5	4.39	4.39
	5/4 x 6	1x5.5	104	1	572	3.97	3.97
	5/4 x 6	1x5.5	142	1	781	5.42	5.42
	5/4 x 6	1x5.5	86.5	1	475.75	3.30	3.30
	5/4 x 6	1x5.5	127	1	698.5	4.85	4.85
	5/4 x 6	1x5.5	128	1	704	4.89	4.89
	5/4 x 6	1x5.5	115.5	1	635.25	4.41	4.41
* if ripped	5/4 x 6	1x5.5	33	1	181.5	1.26	1.26
* if ripped	5/4 x 6	1x5.5	36	1	198	1.38	1.38
* if ripped	5/4 x 6	1x5.5	31	1	170.5	1.18	1.18
sub-total				82			207.66

2 X 4							
	2 X 4	1.5x3.5	25.5	2	133.875	0.93	1.86
	2 X 4	1.5x3.5	36	1	189	1.31	1.31
	2 X 4	1.5x3.5	50	2	262.5	1.82	3.65
	2 X 4	1.5x3.5	65	1	341.25	2.37	2.37
	2 X 4	1.5x3.5	58.5	1	307.125	2.13	2.13
	2 X 4	1.5x3.5	95	1	498.75	3.46	3.46
	2 X 4	1.5x3.5	102.5	1	538.125	3.74	3.74
	2 X 4	1.5x3.5	127.5	1	669.375	4.65	4.65
	2 X 4	1.5x3.5	35	2	183.75	1.28	2.55
	2 X 4	1.5x3.5	59	4	309.75	2.15	8.60
	2 X 4	1.5x3.5	59.5	3	312.375	2.17	6.51
	2 X 4	1.5x3.5	65.5	1	343.875	2.39	2.39
	2 X 4	1.5x3.5	128.5	1	674.625	4.68	4.68
	2 X 4	1.5x3.5	123.5	1	648.375	4.50	4.50
	2 X 4	1.5x3.5	28.5	1	149.625	1.04	1.04
	2 X 4	1.5x3.5	38.5	1	202.125	1.40	1.40
	2 X 4	1.5x3.5	44	1	231	1.60	1.60
	2 X 4	1.5x3.5	135.5	1	711.375	4.94	4.94
	2 X 4	1.5x3.5	20	1	105	0.73	0.73
	2 X 4	1.5x3.5	38	1	199.5	1.39	1.39
	2 X 4	1.5x3.5	36.5	1	191.625	1.33	1.33
	2 X 4	1.5x3.5	40.5	1	212.625	1.48	1.48
	2 X 4	1.5x3.5	139	1	729.75	5.07	5.07
	2 X 4	1.5x3.5	68	1	357	2.48	2.48
	2 X 4	1.5x3.5	60.5	1	317.625	2.21	2.21
2 X 4	2 X 4	1.5x3.5	67	1	351.75	2.44	2.44
	2 X 4	1.5x3.5	68.5	1	359.625	2.50	2.50
* if ripped	2 X 4	1.5x3.5	41	1	215.25	1.49	1.49
* if ripped	2 X 4	1.5x3.5	67	1	351.75	2.44	2.44
* if ripped	2 X 4	1.5x3.5	33	1	173.25	1.20	1.20
* if ripped	2 X 4	1.5x3.5	62	1	325.5	2.26	2.26
* if ripped	2 X 4	1.5x3.5	25	1	131.25	0.91	0.91
sub-total				33			89.32

Balusters							
	2 X 2	1.5x1.5	34	66	76.5	0.53	35.06
	2 X 2	1.5x1.5	16.5	1	37.125	0.26	0.26
	2 X 2	1.5x1.5	19	2	42.75	0.30	0.59
	2 X 2	1.5x1.5	21.5	1	48.375	0.34	0.34
	2 X 2	1.5x1.5	22.5	1	50.625	0.35	0.35
	2 X 2	1.5x1.5	25.5	2	57.375	0.40	0.80
	2 X 2	1.5x1.5	27.5	1	61.875	0.43	0.43
	2 X 2	1.5x1.5	23	1	51.75	0.36	0.36
	2 X 2	1.5x1.5	28	1	63	0.44	0.44
	2 X 2	1.5x1.5	26	1	58.5	0.41	0.41
	2 X 2	1.5x1.5	21	1	47.25	0.33	0.33
sub-total				78			39.36

4 X 4							
	4 X 4	3.5x3.5	34	1	416.5	2.89	2.89
	4 X 4	3.5x3.5	70.5	1	863.625	6.00	6.00
	4 X 4	3.5x3.5	48	1	588	4.08	4.08
	4 X 4	3.5x3.5	45.5	1	557.375	3.87	3.87
	4 X 4	3.5x3.5	74	2	906.5	6.30	12.59
	4 X 4	3.5x3.5	75	1	918.75	6.38	6.38
sub-total				7			35.81

5/4 X 4.5							
	5/4 X 4.5	1x4.5	57	1	256.5	1.78	1.78
	5/4 X 4.5	1x4.5	54	1	243	1.69	1.69
	5/4 X 4.5	1x4.5	46.5	1	209.25	1.45	1.45
	5/4 X 4.5	1x4.5	34	1	153	1.06	1.06
sub-total				4			5.98

2 X 10							
	2 X 10	1.5x9.25	61	1	846.375	5.88	5.88
	2 X 10	1.5x9.25	72	1	999	6.94	6.94
	2 X 10	1.5x9.25	106	1	1470.75	10.21	10.21
	2 X 10	1.5x9.25	141	13	1956.375	13.59	176.62
	2 X 10	1.5x9.25	116	3	1609.5	11.18	33.53
	2 X 10	1.5x9.25	100	2	1387.5	9.64	19.27
	2 X 10	1.5x9.25	36	1	499.5	3.47	3.47
	2 X 10	1.5x9.25	64	1	888	6.17	6.17
	2 X 10	1.5x9.25	144	1	1998	13.88	13.88
	2 X 10	1.5x9.25	111	1	1540.125	10.70	10.70
	2 X 10	1.5x9.25	130	1	1803.75	12.53	12.53
sub-total				26			299.18

Grand Total				230			677.32
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Table A- 4. CCA treated wood from Deck No.2 while in-service.

Deck #2 In-Service Component							Overall Deck Size Square Feet	
							12'5" x 12'	150.03
Deck Part	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.	
Decking								
decking	2x6	1.5x5.5	144	26	1188	8.25	214.50	
sub-total				26			214.50	
Railing								
railing	2x6	1.5x5.5	149	2	1229.25	8.54	17.07	
railing	2x6	1.5x5.5	145	1	1196.25	8.31	8.31	
railing	2x4	1.5x3.5	149	2	782.25	5.43	10.86	
railing	2x4	1.5x3.5	145	1	761.25	5.29	5.29	
railing	2x4	1.5x3.5	147	2	771.75	5.36	10.72	
railing	2x4	1.5x3.5	135	1	708.75	4.92	4.92	
railing	2x4	1.5x3.5	33	12	173.25	1.20	14.44	
railing balusters	1x6	.75x5.5	36	54	148.5	1.03	55.69	
railing balusters	1x4	.75x3.5	36	2	94.5	0.66	1.31	
sub-total				77			128.61	
Joists								
joists	2x8	1.5x7.25	145.5	8	1582.3125	10.99	87.91	
joists	2x10	1.5x9.25	145.5	2	2018.8125	14.02	28.04	
joists	2x10	1.5x9.25	147	2	2039.625	14.16	28.33	
joists	2x8	1.5x7.25	138	1	1500.75	10.42	10.42	
joists	2x10	1.5x9.25	145	1	2011.875	13.97	13.97	
joists	2x10	1.5x9.25	141	1	1956.375	13.59	13.59	
filler around joists	1x6	.75x5.5	144	1	594	4.13	4.13	
sub-total				16			186.38	
Misc.								
filler around door	1x4	.75x3.5	64	1	168	1.17	1.17	
sub-total				1			1.17	
Grand Total				120			530.65	

**Note: Weight of hardware in Deck = 18 lb.

Table A- 5. Demolished CCA treated wood from Deck No.2.

Deck #2 Demolished Material

Overall Deck Size	Square Feet
12'5" x 12'	150.03

Deck Material	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.
2 X 6							
	2x6	1.5x5.5	143.25	24	1181.8125	8.21	196.97
	2x6	1.5x5.5	146.5	2	1208.625	8.39	16.79
	2x6	1.5x5.5	137	1	1130.25	7.85	7.85
	2x6	1.5x5.5	48	1	396	2.75	2.75
	2x6	1.5x5.5	94	1	775.5	5.39	5.39
	2x6	1.5x5.5	100	1	825	5.73	5.73
sub-total				30			235.47
2 X 4							
	2x4	1.5x3.5	71	1	372.75	2.59	2.59
	2x4	1.5x3.5	105.5	1	553.88	3.85	3.85
	2x4	1.5x3.5	106.5	1	559.13	3.88	3.88
	2x4	1.5x3.5	147.5	1	774.38	5.38	5.38
	2x4	1.5x3.5	141	1	740.25	5.14	5.14
	2x4	1.5x3.5	134.5	1	706.13	4.90	4.90
	2x4	1.5x3.5	33	12	173.25	1.20	14.44
	2x4	1.5x3.5	23	1	120.75	0.84	0.84
	2x4	1.5x3.5	39	1	204.75	1.42	1.42
sub-total				20			42.44
2 X 8							
	2x8	1.5x7.25	141.5	1	1538.8125	10.69	10.69
	2x8	1.5x7.25	97.25	8	1057.59375	7.34	58.76
	2x8	1.5x7.25	41.75	8	454.03125	3.15	25.22
sub-total				17			94.67
1 X 4							
	1x4	.75x3.5	44	3	115.5	0.80	2.41
	1x4	.75x3.5	36	2	94.5	0.66	1.31
sub-total				5			3.72
1 X 6							
	1x6	.75x5.5	36	48	148.5	1.03	49.50
	1x6	.75x5.5	21	1	86.625	0.60	0.60
	1x6	.75x5.5	25	1	103.125	0.72	0.72
	1x6	.75x5.5	27	1	111.375	0.77	0.77
sub-total				51			51.59
2 X 10							
	2 X 10	1.5x9.25	96.5	4	1338.9375	9.30	37.19
	2 X 10	1.5x9.25	141.5	1	1963.3125	13.63	13.63
	2 X 10	1.5x9.25	144.5	1	2004.9375	13.92	13.92
	2 X 10	1.5x9.25	41.75	4	579.28125	4.02	16.09
sub-total				10			80.84
misc scrap							
	weight (lb.)					Bd. Ft.	
	32.4					11.40	11.40
sub-total							11.40
Grand Total				133			520.12

Table A- 6. Recovered CCA treated wood from Deck No.2.

Deck #2 Recovered							Overall Deck Size	Square Feet
							12'5" x 12'	150.03
Deck Material	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.	
2 X 6								
	2x6	1.5x5.5	41	1	338.25	2.35	2.35	
	2x6	1.5x5.5	46.5	1	383.625	2.66	2.66	
	2x6	1.5x5.5	47	1	387.75	2.69	2.69	
	2x6	1.5x5.5	45	1	371.25	2.58	2.58	
	2x6	1.5x5.5	32	2	264	1.83	3.67	
	2x6	1.5x5.5	86	1	709.5	4.93	4.93	
	2x6	1.5x5.5	144	8	1188	8.25	66.00	
	2x6	1.5x5.5	143.5	5	1183.875	8.22	41.11	
	2x6	1.5x5.5	46	1	379.5	2.64	2.64	
	2x6	1.5x5.5	50	1	412.5	2.86	2.86	
	2x6	1.5x5.5	58	1	478.5	3.32	3.32	
	2x6	1.5x5.5	134	2	1105.5	7.68	15.35	
	2x6	1.5x5.5	26.5	1	218.625	1.52	1.52	
	2x6	1.5x5.5	37	1	305.25	2.12	2.12	
	2x6	1.5x5.5	49.5	1	408.375	2.84	2.84	
	2x6	1.5x5.5	43.5	1	358.875	2.49	2.49	
	2x6	1.5x5.5	120	1	990	6.88	6.88	
	2x6	1.5x5.5	90	10	742.5	5.16	51.56	
	2x6	1.5x5.5	128	1	1056	7.33	7.33	
	sub-total			41			224.90	
2 X 4								
	2x4	1.5x3.5	33	5	173.25	1.20	6.02	
	2x4	1.5x3.5	34.5	2	181.13	1.26	2.52	
	2x4	1.5x3.5	32	4	168.00	1.17	4.67	
	2x4	1.5x3.5	18	1	94.50	0.66	0.66	
	2x4	1.5x3.5	27.5	1	144.38	1.00	1.00	
	2x4	1.5x3.5	35	1	183.75	1.28	1.28	
	2x4	1.5x3.5	25	1	131.25	0.91	0.91	
	2x4	1.5x3.5	37	1	194.25	1.35	1.35	
	2x4	1.5x3.5	27	1	141.75	0.98	0.98	
	2x4	1.5x3.5	38	1	199.50	1.39	1.39	
	2x4	1.5x3.5	69	1	362.25	2.52	2.52	
	2x4	1.5x3.5	143	1	750.75	5.21	5.21	
	2x4	1.5x3.5	144	1	756.00	5.25	5.25	
	2x4	1.5x3.5	100	1	525.00	3.65	3.65	
	2x4	1.5x3.5	148	1	777.00	5.40	5.40	
	2x4	1.5x3.5	66.5	1	349.13	2.42	2.42	
	2x4	1.5x3.5	106	1	556.50	3.86	3.86	
	2x4	1.5x3.5	135	1	708.75	4.92	4.92	
	sub-total			26			53.99	
2 X 8								
	2x8	1.5x7.25	41	7	445.875	3.10	21.67	
	2x8	1.5x7.25	41.5	1	451.3125	3.13	3.13	
	2x8	1.5x7.25	98	1	1065.75	7.40	7.40	
	2x8	1.5x7.25	97	3	1054.875	7.33	21.98	
	2x8	1.5x7.25	97.5	1	1060.3125	7.36	7.36	
	2x8	1.5x7.25	95	1	1033.125	7.17	7.17	
	2x8	1.5x7.25	98.5	1	1071.1875	7.44	7.44	
	2x8	1.5x7.25	91	1	989.625	6.87	6.87	
	2x8	1.5x7.25	141	1	1533.375	10.65	10.65	
	sub-total			17			93.68	
1 X 4								
	1x4	.75x3.5	15.5	1	40.6875	0.28	0.28	
	1x4	.75x3.5	17	1	44.625	0.31	0.31	
	1x4	.75x3.5	32	1	84	0.58	0.58	
	1x4	.75x3.5	44	3	115.5	0.80	2.41	
	sub-total			6			3.58	

1 X 6							
1x6	.75x5.5	35.5	32	146.4375	1.02	32.54	
1x6	.75x5.5	33	1	136.125	0.95	0.95	
1x6	.75x5.5	30.5	2	125.8125	0.87	1.75	
1x6	.75x5.5	31	1	127.875	0.89	0.89	
1x6	.75x5.5	31.5	1	129.9375	0.90	0.90	
1x6	.75x5.5	30	1	123.75	0.86	0.86	
1x6	.75x5.5	22.5	1	92.8125	0.64	0.64	
1x6	.75x5.5	22	1	90.75	0.63	0.63	
1x6	.75x5.5	18.5	1	76.3125	0.53	0.53	
1x6	.75x5.5	27.5	1	113.4375	0.79	0.79	
1x6	.75x5.5	27	1	111.375	0.77	0.77	
1x6	.75x5.5	28	2	115.5	0.80	1.60	
1x6	.75x5.5	26	1	107.25	0.74	0.74	
1x6	.75x5.5	20	1	82.5	0.57	0.57	
1x6	.75x5.5	21.5	1	88.6875	0.62	0.62	
1x6	.75x5.5	23	1	94.875	0.66	0.66	
1x6	.75x5.5	29	1	119.625	0.83	0.83	
sub-total			50			46.28	
2 X 10							
2 X 10	1.5x9.25	32	1	444	3.08	3.08	
2 X 10	1.5x9.25	37	1	513.375	3.57	3.57	
2 X 10	1.5x9.25	40.5	2	561.9375	3.90	7.80	
2 X 10	1.5x9.25	141	1	1956.375	13.59	13.59	
2 X 10	1.5x9.25	97	1	1345.875	9.35	9.35	
2 X 10	1.5x9.25	96	2	1332	9.25	18.50	
2 X 10	1.5x9.25	96.5	1	1338.9375	9.30	9.30	
2 X 10	1.5x9.25	143	1	1984.125	13.78	13.78	
sub-total			10			78.96	
Grand Total			150			501.40	

Table A- 7. CCA treated wood from Deck No.3 while in-service.

Deck #3 In-Service Component								Overall Deck Size Square Feet	
								10' x 20'	200.00
Deck Part	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.		
Decking									
decking	2x6	1.5x5.5	120	42	990	6.88	288.75		
sub-total				42			288.75		
Railing									
railing	2x6	1.5x5.5	36	1	297	2.06	2.06		
railing	2x6	1.5x5.5	30	1	247.5	1.72	1.72		
railing	2x6	1.5x5.5	122	1	1006.5	6.99	6.99		
railing	2x6	1.5x5.5	125	1	1031.25	7.16	7.16		
railing	2x6	1.5x5.5	34	1	280.5	1.95	1.95		
railing	2x6	1.5x5.5	40	1	330	2.29	2.29		
railing	2x4	1.5x3.5	29	3	152.25	1.06	3.17		
railing	2x4	1.5x3.5	27	3	141.75	0.98	2.95		
railing	2x4	1.5x3.5	55.5	6	291.375	2.02	12.14		
railing	2x4	1.5x3.5	57.5	6	301.875	2.10	12.58		
railing	2x4	1.5x3.5	30.5	3	160.125	1.11	3.34		
railing	2x4	1.5x3.5	32	4	168	1.17	4.67		
railing	4x4	3.5x3.5	36	9	441	3.06	27.56		
railing balusters	1x6	.75x5.5	36	54	111.375	0.77	41.77		
sub-total				94			130.35		
Joists									
joists	2x8	1.5x7.25	59.5	1	647.0625	4.49	4.49		
joists	2x8	1.5x7.25	62.5	1	679.6875	4.72	4.72		
joists	2x8	1.5x7.25	112	9	1218	8.46	76.13		
joists	2x8	1.5x7.25	120	16	1305	9.06	145.00		
sub-total				27			230.34		
Posts									
posts	4x4	3.5x3.5	70	6	857.5	5.95	35.73		
sub-total				6			35.73		
Stairs (two)									
railing	2x4	1.5x3.5	59	6	309.75	2.15	12.91		
railing	2x6	1.5x5.5	60	2	495	3.44	6.88		
railing	4x4	3.5x3.5	28.5	2	349.125	2.42	4.85		
treads	2x12	1.5x11.25	47	15	793.125	5.51	82.62		
risers	2x6	1.5x5.5	47	14	387.75	2.69	37.70		
stringers	2x12	1.5x11.25	84	4	1063.125	7.38	29.53		
railing	2x4	1.5x3.5	72	6	378	2.63	15.75		
railing	2x6	1.5x5.5	82	2	676.5	4.70	9.40		
railing	4x4	3.5x3.5	29	2	355.25	2.47	4.93		
stringers	2x12	1.5x11.25	120	4	1518.75	10.55	42.19		
sub-total				57			246.74		
Grand Total				226			931.91		

Table A- 8. CCA treated wood after deconstruction of Deck No.3.

Deck #3 Material After Deconstruction							Overall Deck Size Square Feet	
							10' x 20'	200.00
Deck Material	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.	
2 X 6								
	2x6	1.5x5.5	68.75	1	567.1875	3.94	3.94	
	2x6	1.5x5.5	51	3	420.75	2.92	8.77	
	2x6	1.5x5.5	43	2	354.75	2.46	4.93	
	2x6	1.5x5.5	62	2	511.5	3.55	7.10	
	2x6	1.5x5.5	36	1	297	2.06	2.06	
	2x6	1.5x5.5	39.75	1	327.9375	2.28	2.28	
	2x6	1.5x5.5	69	1	569.25	3.95	3.95	
	2x6	1.5x5.5	34	1	280.5	1.95	1.95	
	2x6	1.5x5.5	82	1	676.5	4.70	4.70	
	2x6	1.5x5.5	85	1	701.25	4.87	4.87	
	2x6	1.5x5.5	120	9	990	6.88	61.88	
	2x6	1.5x5.5	120.5	12	994.125	6.90	82.84	
	2x6	1.5x5.5	121.5	1	1002.375	6.96	6.96	
	2x6	1.5x5.5	119.75	1	987.9375	6.86	6.86	
	2x6	1.5x5.5	116.5	1	961.125	6.67	6.67	
	2x6	1.5x5.5	47.5	1	391.875	2.72	2.72	
	2x6	1.5x5.5	120.25	16	992.0625	6.89	110.23	
	2x6	1.5x5.5	84.5	1	697.125	4.84	4.84	
	sub-total			56			327.55	
2 X 8								
	2x8	1.5x7.25	118	4	1283.25	8.91	35.65	
	2x8	1.5x7.25	112	11	1218	8.46	93.04	
	2x8	1.5x7.25	120	8	1305	9.06	72.50	
	2x8	1.5x7.25	44	1	478.5	3.32	3.32	
	2x8	1.5x7.25	47.5	2	516.5625	3.59	7.17	
	2x8	1.5x7.25	59.5	1	647.0625	4.49	4.49	
	2x8	1.5x7.25	119.5	2	1299.5625	9.02	18.05	
	sub-total			29			234.23	
2 X 4								
	2x4	1.5x3.5	27	2	141.75	0.98	1.97	
	2x4	1.5x3.5	30.5	2	160.13	1.11	2.22	
	2x4	1.5x3.5	32	3	168.00	1.17	3.50	
	2x4	1.5x3.5	29	1	152.25	1.06	1.06	
	2x4	1.5x3.5	57	3	299.25	2.08	6.23	
	2x4	1.5x3.5	57.25	3	300.56	2.09	6.26	
	2x4	1.5x3.5	55.5	2	291.38	2.02	4.05	
	2x4	1.5x3.5	55	3	288.75	2.01	6.02	
	2x4	1.5x3.5	30.5	1	160.13	1.11	1.11	
	2x4	1.5x3.5	29	2	152.25	1.06	2.11	
	2x4	1.5x3.5	27	1	141.75	0.98	0.98	
	2x4	1.5x3.5	37.5	1	196.88	1.37	1.37	
	2x4	1.5x3.5	61	1	320.25	2.22	2.22	
	2x4	1.5x3.5	71	1	372.75	2.59	2.59	
	2x4	1.5x3.5	59	1	309.75	2.15	2.15	
	2x4	1.5x3.5	56	1	294.00	2.04	2.04	
	2 X 4	1.5x3.5	50	1	262.50	1.82	1.82	
	2x4	1.5x3.5	60	4	315.00	2.19	8.75	
	2x4	1.5x3.5	70	1	367.50	2.55	2.55	
	sub-total			34			59.02	
1 X 6								
	1x6	.75x5.5	47.25	8	194.90625	1.35	10.83	
	1x6	.75x5.5	36	4	74.25	0.52	2.06	
	sub-total			12			10.83	

2 X 12							
	2x12	1.5x11.25	47.5	14	801.5625	5.57	77.93
	2x12	1.5x11.25	88.5	1	1120.07813	7.78	7.78
	2x12	1.5x11.25	88	1	1113.75	7.73	7.73
	2x12	1.5x11.25	90	1	759.375	5.27	5.27
	2x12	1.5x11.25	87.5	1	738.28125	5.13	5.13
	2x12	1.5x11.25	86	1	725.625	5.04	5.04
	2x12	1.5x11.25	91	1	767.8125	5.33	5.33
sub-total				20			114.21
4 X 4							
	4x4	3.5x3.5	70.75	1	866.6875	6.02	6.02
	4x4	3.5x3.5	74	1	906.5	6.30	6.30
	4x4	3.5x3.5	73	1	894.25	6.21	6.21
	4x4	3.5x3.5	70.5	1	863.625	6.00	6.00
	4x4	3.5x3.5	69.5	2	851.375	5.91	11.82
	4x4	3.5x3.5	30	4	367.5	2.55	10.21
	4x4	3.5x3.5	36	11	441	3.06	33.69
sub-total				21			80.24
misc scrap							
	weight (lb.)		Bd. Ft.				
	229.8		87.86				87.86
sub-total							87.86
Grand Total				172			913.94

Table A- 9. Recovered CCA treated wood from Deck No.3.

Deck #3 Recovered Material							Overall Deck Size Square Feet	
							10' x 20'	200.00
Deck Material	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.	
2 X 6								
	2x6	1.5x5.5	120	14	990	6.88	96.25	
	2x6	1.5x5.5	101.5	1	837.375	5.82	5.82	
	2x6	1.5x5.5	98	1	808.5	5.61	5.61	
	2x6	1.5x5.5	120.5	14	994.125	6.90	96.65	
	2x6	1.5x5.5	106	1	874.5	6.07	6.07	
	2x6	1.5x5.5	100	1	825	5.73	5.73	
	2x6	1.5x5.5	116.5	1	961.125	6.67	6.67	
	2x6	1.5x5.5	91	1	750.75	5.21	5.21	
	2x6	1.5x5.5	97.5	1	804.375	5.59	5.59	
	2x6	1.5x5.5	95	1	783.75	5.44	5.44	
	2x6	1.5x5.5	80	1	660	4.58	4.58	
	2x6	1.5x5.5	115.5	1	952.875	6.62	6.62	
	2x6	1.5x5.5	36.5	1	301.125	2.09	2.09	
	2x6	1.5x5.5	39	1	321.75	2.23	2.23	
	2x6	1.5x5.5	81.5	1	672.375	4.67	4.67	
	2x6	1.5x5.5	61	1	503.25	3.49	3.49	
	2x6	1.5x5.5	66	1	544.5	3.78	3.78	
	2x6	1.5x5.5	58	1	478.5	3.32	3.32	
	2x6	1.5x5.5	31	1	255.75	1.78	1.78	
	2x6	1.5x5.5	41	1	338.25	2.35	2.35	
	2x6	1.5x5.5	45.5	1	375.375	2.61	2.61	
	2x6	1.5x5.5	63	2	519.75	3.61	7.22	
	2x6	1.5x5.5	53	1	437.25	3.04	3.04	
	2x6	1.5x5.5	24	1	198	1.38	1.38	
	2x6	1.5x5.5	36	1	297	2.06	2.06	
	2x6	1.5x5.5	60.5	1	499.125	3.47	3.47	
	2x6	1.5x5.5	51.5	1	424.875	2.95	2.95	
	2x6	1.5x5.5	64.5	1	532.125	3.70	3.70	
	2x6	1.5x5.5	64	1	528	3.67	3.67	
	* if ripped 2x6	1.5x5.5	47.5	2	391.875	2.72	5.44	
	sub-total			58			309.49	
2 X 8								
	2x8	1.5x7.25	52.5	1	570.9375	3.96	3.96	
	2x8	1.5x7.25	84.5	1	918.9375	6.38	6.38	
	2x8	1.5x7.25	91	1	989.625	6.87	6.87	
	2x8	1.5x7.25	112	7	1218	8.46	59.21	
	2x8	1.5x7.25	120	6	1305	9.06	54.38	
	2x8	1.5x7.25	112.5	1	1223.4375	8.50	8.50	
	2x8	1.5x7.25	118	3	1283.25	8.91	26.73	
	2x8	1.5x7.25	89.5	1	973.3125	6.76	6.76	
	2x8	1.5x7.25	90	1	978.75	6.80	6.80	
	2x8	1.5x7.25	105	2	1141.875	7.93	15.86	
	2x8	1.5x7.25	119.5	1	1299.5625	9.02	9.02	
	2x8	1.5x7.25	105.5	1	1147.3125	7.97	7.97	
	* if ripped 2x8	1.5x7.25	47.5	2	516.5625	3.59	7.17	
	sub-total			28			219.61	
2 X 4								
	2x4	1.5x3.5	56	2	294.00	2.04	4.08	
	2x4	1.5x3.5	29	2	152.25	1.06	2.11	
	2x4	1.5x3.5	27	1	141.75	0.98	0.98	
	2x4	1.5x3.5	41.5	1	217.88	1.51	1.51	
	2x4	1.5x3.5	56.5	2	296.63	2.06	4.12	
	2x4	1.5x3.5	57	1	299.25	2.08	2.08	
	2x4	1.5x3.5	52	1	273.00	1.90	1.90	
	2x4	1.5x3.5	51.5	1	270.38	1.88	1.88	
	2x4	1.5x3.5	68.5	1	359.63	2.50	2.50	
	2x4	1.5x3.5	53.5	1	280.88	1.95	1.95	
	* if ripped 2x4	1.5x3.5	47.5	1	249.38	1.73	1.73	
	* if ripped 2x4	1.5x3.5	82	8	430.50	2.99	23.92	
	sub-total			22			48.76	

1 X 6							
	1x6	.75x5.5	36	2	148.5	1.03	2.06
	1x6	.75x5.5	22	1	90.75	0.63	0.63
	1x6	.75x5.5	42	1	173.25	1.20	1.20
	1x6	.75x5.5	35.5	1	146.4375	1.02	1.02
	1x6	.75x5.5	32	1	132	0.92	0.92
	1x6	.75x5.5	39.5	1	162.9375	1.13	1.13
			35	1	144.375	1.00	1.00
			41	1	169.125	1.17	1.17
sub-total				9			9.14
2 X 12							
	2x12	1.5x11.25	36	1	607.5	4.22	4.22
	2x12	1.5x11.25	47.5	8	801.5625	5.57	44.53
sub-total				9			48.75
4 X 4							
	4x4	3.5x3.5	27	4	330.75	2.30	9.19
	4x4	3.5x3.5	36	11	441	3.06	33.69
	4x4	3.5x3.5	70	3	857.5	5.95	17.86
	4x4	3.5x3.5	72.5	2	888.125	6.17	12.34
sub-total				20			73.07
Grand Total				146			708.83

Table A- 10. CCA treated wood in Deck No. 4 while in-service.

Deck #4 In-Service Components								Overall Deck Size Square Feet 10' x 21' 210.00	
Deck Part	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.		
Decking									
decking	2x6	1.5x5.5	120	44	990	6.88	302.50		
sub-total				44			302.50		
Railing									
railing	2x6	1.5x5.5	40	1	330	2.29	2.29		
railing	2x6	1.5x5.5	34	1	280.5	1.95	1.95		
railing	2x6	1.5x5.5	126	1	1039.5	7.22	7.22		
railing	2x6	1.5x5.5	128	1	1056	7.33	7.33		
railing	2x4	1.5x3.5	32	3	168	1.17	3.50		
railing	2x4	1.5x3.5	30	3	157.5	1.09	3.28		
railing	2x4	1.5x3.5	58	11	304.5	2.11	23.26		
railing	2x4	1.5x3.5	52	3	273	1.90	5.69		
railing	2x4	1.5x3.5	53	3	278.25	1.93	5.80		
railing	4x4	3.5x3.5	36	10	441	3.06	30.63		
railing	2x9	1.5x8.25	114	1	1410.75	9.80	9.80		
railing balusters	1x6	.75x5.5	36	61	148.5	1.03	62.91		
sub-total				99			163.65		
Joists									
joists	2x8	1.5x7.25	120	24	1305	9.06	217.50		
joists	2x8	1.5x7.25	62	1	674.25	4.68	4.68		
joists	2x10	1.5x9.25	72	1	999	6.94	6.94		
joists	2x10	1.5x9.25	120	1	1665	11.56	11.56		
sub-total				27			240.68		
Posts									
posts	4x4	3.5x3.5	140	6	1715	11.91	71.46		
sub-total				6			71.46		
Grand Total				176			778.29		

Table A- 11. CCA treated wood from Deck No. 4 after deconstruction.

Deck #4 Material After Deconstruction							Overall Deck Size Square Feet	
							10' x 21'	210.00
Deck Material	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In. Bd. Ft.	Total Bd. Ft.		
2 X 6								
	2x6	1.5x5.5	77	2	635.25	4.41	8.82	
	2x6	1.5x5.5	50	1	412.5	2.86	2.86	
	2x6	1.5x5.5	52	2	429	2.98	5.96	
	2x6	1.5x5.5	89.5	1	738.375	5.13	5.13	
	2x6	1.5x5.5	67	2	552.75	3.84	7.68	
	2x6	1.5x5.5	60	1	495	3.44	3.44	
	2x6	1.5x5.5	84	1	693	4.81	4.81	
	2x6	1.5x5.5	57	1	470.25	3.27	3.27	
	2x6	1.5x5.5	62	1	511.5	3.55	3.55	
	2x6	1.5x5.5	44	2	363	2.52	5.04	
	2x6	1.5x5.5	75	1	618.75	4.30	4.30	
	2x6	1.5x5.5	70	1	577.5	4.01	4.01	
	2x6	1.5x5.5	33.5	1	276.375	1.92	1.92	
	2x6	1.5x5.5	32	1	264	1.83	1.83	
	2x6	1.5x5.5	36	1	297	2.06	2.06	
	2x6	1.5x5.5	43	1	354.75	2.46	2.46	
	2x6	1.5x5.5	40	1	330	2.29	2.29	
	2x6	1.5x5.5	46	1	379.5	2.64	2.64	
	2x6	1.5x5.5	30	3	247.5	1.72	5.16	
	2x6	1.5x5.5	32.5	2	268.125	1.86	3.72	
	2x6	1.5x5.5	24	1	198	1.38	1.38	
	2x6	1.5x5.5	128	1	1056	7.33	7.33	
	2x6	1.5x5.5	127	1	1047.75	7.28	7.28	
	2x6	1.5x5.5	113	1	932.25	6.47	6.47	
	2x6	1.5x5.5	120	29	990	6.88	199.38	
	2x6	1.5x5.5	119	3	981.75	6.82	20.45	
	sub-total			63			323.24	
2 X 8								
	2x8	1.5x7.25	120	25	1305	9.06	226.56	
	2x8	1.5x7.25	60	1	652.5	4.53	4.53	
	2x8	1.5x7.25	69	1	750.375	5.21	5.21	
	sub-total			27			236.30	
2 X 4								
	2x4	1.5x3.5	72	4	378.00	2.63	10.50	
	2x4	1.5x3.5	41	1	215.25	1.49	1.49	
	2x4	1.5x3.5	58	10	304.50	2.11	21.15	
	2x4	1.5x3.5	53	5	278.25	1.93	9.66	
	2x4	1.5x3.5	57	1	299.25	2.08	2.08	
	sub-total			21			44.88	
4 X 4								
	4x4	3.5x3.5	36	10	441	3.06	30.63	
	4x4	3.5x3.5	132	1	1617	11.23	11.23	
	4x4	3.5x3.5	68.5	2	839.125	5.83	11.65	
	4x4	3.5x3.5	122.5	1	1500.625	10.42	10.42	
	4x4	3.5x3.5	125.5	1	1537.375	10.68	10.68	
	4x4	3.5x3.5	120.5	1	1476.125	10.25	10.25	
	sub-total			16			84.86	
misc scrap								
	weight (lb.)		Bd. Ft.					
	218		85.88		85.88			
	sub-total						85.88	
Grand Total				127			775.16	

Table A- 12. CCA treated wood recovered from Deck No.4.

Deck #4 Material Recovered							Overall Deck Size Square Feet	
							10' x 21'	210.00
Deck Material	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.	
2 X 6								
	2x6	1.5x5.5	120	25	990	6.88	171.88	
	2x6	1.5x5.5	28	1	231	1.60	1.60	
	2x6	1.5x5.5	36	1	297	2.06	2.06	
	2x6	1.5x5.5	41	1	338.25	2.35	2.35	
	2x6	1.5x5.5	43.5	1	358.875	2.49	2.49	
	2x6	1.5x5.5	50	1	412.5	2.86	2.86	
	2x6	1.5x5.5	66	1	544.5	3.78	3.78	
	2x6	1.5x5.5	74	1	610.5	4.24	4.24	
	2x6	1.5x5.5	68.5	1	565.125	3.92	3.92	
	2x6	1.5x5.5	114.5	1	944.625	6.56	6.56	
	2x6	1.5x5.5	97.5	1	804.375	5.59	5.59	
	2x6	1.5x5.5	119.5	2	985.875	6.85	13.69	
	2x6	1.5x5.5	98.5	1	812.625	5.64	5.64	
	2x6	1.5x5.5	126	1	1039.5	7.22	7.22	
	2x6	1.5x5.5	32	1	264	1.83	1.83	
	2x6	1.5x5.5	49	1	404.25	2.81	2.81	
	2x6	1.5x5.5	59	1	486.75	3.38	3.38	
	2x6	1.5x5.5	50.5	1	416.625	2.89	2.89	
	2x6	1.5x5.5	71	1	585.75	4.07	4.07	
	2x6	1.5x5.5	67	1	552.75	3.84	3.84	
	2x6	1.5x5.5	73	1	602.25	4.18	4.18	
	2x6	1.5x5.5	84.5	1	697.125	4.84	4.84	
	2x6	1.5x5.5	113.5	1	936.375	6.50	6.50	
	2x6	1.5x5.5	25	1	206.25	1.43	1.43	
	2x6	1.5x5.5	34	1	280.5	1.95	1.95	
	2x6	1.5x5.5	43	1	354.75	2.46	2.46	
	2x6	1.5x5.5	38.5	1	317.625	2.21	2.21	
	2x6	1.5x5.5	54	1	445.5	3.09	3.09	
	2x6	1.5x5.5	77.5	1	639.375	4.44	4.44	
	2x6	1.5x5.5	65	1	536.25	3.72	3.72	
	2x6	1.5x5.5	71.5	1	589.875	4.10	4.10	
	2x6	1.5x5.5	107	1	882.75	6.13	6.13	
sub-total				57			297.77	
2 X 8								
	2x8	1.5x7.25	60.5	1	657.9375	4.57	4.57	
	2x8	1.5x7.25	116.5	1	1266.9375	8.80	8.80	
	2x8	1.5x7.25	120	11	1305	9.06	99.69	
	2x8	1.5x7.25	117	1	1272.375	8.84	8.84	
	2x8	1.5x7.25	101.5	1	1103.8125	7.67	7.67	
	2x8	1.5x7.25	119	2	1294.125	8.99	17.97	
	2x8	1.5x7.25	112.5	1	1223.4375	8.50	8.50	
	2x8	1.5x7.25	69	1	750.375	5.21	5.21	
	2x8	1.5x7.25	113	1	1228.875	8.53	8.53	
	2x8	1.5x7.25	115.5	2	1256.0625	8.72	17.45	
	2x8	1.5x7.25	54.5	1	592.6875	4.12	4.12	
2 X 8								
	2x8	1.5x7.25	109	1	1185.375	8.23	8.23	
	2x8	1.5x7.25	107.5	1	1169.0625	8.12	8.12	
	2x8	1.5x7.25	114.5	1	1245.1875	8.65	8.65	
	2x8	1.5x7.25	117.5	1	1277.8125	8.87	8.87	
	2x8	1.5x7.25	116	1	1261.5	8.76	8.76	
sub-total				28			233.96	
2 X 4								
	2x4	1.5x3.5	68.5	1	359.63	2.50	2.50	
	2x4	1.5x3.5	53	1	278.25	1.93	1.93	
	2x4	1.5x3.5	60.5	1	317.63	2.21	2.21	
	2x4	1.5x3.5	68	1	357.00	2.48	2.48	
	2x4	1.5x3.5	55.5	1	291.38	2.02	2.02	
	2x4	1.5x3.5	61.5	1	322.88	2.24	2.24	
	2x4	1.5x3.5	58.5	1	307.13	2.13	2.13	
	2x4	1.5x3.5	55	1	288.75	2.01	2.01	
sub-total				8			17.52	

4 X 4							
4x4	3.5x3.5	36	3	441	3.06	9.19	
4x4	3.5x3.5	68.5	2	839.125	5.83	11.65	
4x4	3.5x3.5	122	1	1494.5	10.38	10.38	
4x4	3.5x3.5	115	1	1408.75	9.78	9.78	
4x4	3.5x3.5	117	1	1433.25	9.95	9.95	
4x4	3.5x3.5	123	1	1506.75	10.46	10.46	
sub-total			9			61.42	
Grand Total			102			610.68	

Material with Nails (not recovered)

2 X 4							
2x4	1.5x3.5	23	1	120.75	0.84	0.84	
2x4	1.5x3.5	32	1	168.00	1.17	1.17	
2x4	1.5x3.5	30	3	157.50	1.09	3.28	
2x4	1.5x3.5	32.5	1	170.63	1.18	1.18	
2x4	1.5x3.5	53	1	278.25	1.93	1.93	
2x4	1.5x3.5	58	2	304.50	2.11	4.23	
2x4	1.5x3.5	41	1	215.25	1.49	1.49	
2x4	1.5x3.5	57	2	299.25	2.08	4.16	
2x4	1.5x3.5	57.5	1	301.88	2.10	2.10	
2x4	1.5x3.5	58	2	304.50	2.11	4.23	
2x4	1.5x3.5	50	1	262.50	1.82	1.82	
2x4	1.5x3.5	52	2	273.00	1.90	3.79	
2x4	1.5x3.5	52.5	1	275.63	1.91	1.91	
sub-total			19			32.14	

4 X 4							
4x4	3.5x3.5	35.5	1	434.875	3.02	3.02	
4x4	3.5x3.5	36	8	441	3.06	24.50	
sub-total			9			27.52	

Grand Total			28			59.66	
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Table A- 13. CCA treated wood from Deck No.5 while in-service.

Deck #5 In-Service Components

Overall Deck Size	Square Feet
15'10" x 10'	159.65

Deck Part	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.
Decking							
decking	2x6	1.5x5.5	70	7	577.5	4.01	28.07
decking	2x6	1.5x5.5	119	1	981.75	6.82	6.82
decking	2x6	1.5x5.5	73	3	602.25	4.18	12.55
decking	2x6	1.5x5.5	117	3	965.25	6.70	20.11
decking	2x6	1.5x5.5	120	16	990	6.88	110.00
decking	2x6	1.5x5.5	25	4	206.25	1.43	5.73
decking	2x6	1.5x5.5	45	4	371.25	2.58	10.31
decking	2x6	1.5x5.5	21	6	173.25	1.20	7.22
decking	2x6	1.5x5.5	48	6	396	2.75	16.50
decking	2x4	1.5x3.5	43	1	225.75	1.57	1.57
decking	2x4	1.5x3.5	21.5	1	112.875	0.78	0.78
decking	2x4	1.5x3.5	57	1	299.25	2.08	2.08
decking	2x4	1.5x3.5	62	1	325.5	2.26	2.26
sub-total				54			224.00
Railing							
railing	5/4x6	1.25x5.5	119	1	818.125	5.68	5.68
railing	5/4x6	1.25x5.5	19	1	130.625	0.91	0.91
railing	5/4x6	1.25x3.5	122	1	838.75	5.82	5.82
railing	5/4x6	1.25x3.5	117	1	804.375	5.59	5.59
railing	2x4	1.5x3.5	30	5	157.5	1.09	5.47
railing	2x4	1.5x3.5	54	3	283.5	1.97	5.91
railing	2x4	1.5x3.5	41	1	215.25	1.49	1.49
railing	2x4	1.5x3.5	115	1	603.75	4.19	4.19
railing	2x4	1.5x3.5	58	1	304.5	2.11	2.11
railing	2x4	1.5x3.5	56	1	294	2.04	2.04
railing	2x4	1.5x3.5	118	1	619.5	4.30	4.30
railing	2x4	1.5x3.5	42	3	220.5	1.53	4.59
railing	2x4	1.5x3.5	59	1	309.75	2.15	2.15
railing	2x4	1.5x3.5	16	1	84	0.58	0.58
railing	2x4	1.5x3.5	57	1	299.25	2.08	2.08
railing	2x4	1.5x3.5	119	1	624.75	4.34	4.34
railing balusters	1x6	.75x5.5	35	78	144.375	1.00	78.20
railing balusters	1x3	.75x3	35	2	78.75	0.55	1.09
sub-total				104			136.56
Joists							
joists	2x6	1.5x5.5	113	8	932.25	6.47	51.79
joists	2x8	1.5x7.25	96	1	1044	7.25	7.25
joists	2x8	1.5x7.25	88	1	957	6.65	6.65
joists	2x8	1.5x7.25	90	1	978.75	6.80	6.80
joists	2x8	1.5x7.25	97	1	1054.875	7.33	7.33
joists	2x8	1.5x7.25	119	2	1294.125	8.99	17.97
filler around joists	2x2	1.5x1.5	39	1	87.75	0.61	0.61
filler around joists	2x2	1.5x1.5	145	2	326.25	2.27	4.53
filler around joists	2x2	1.5x1.5	5.5	7	12.375	0.09	0.60
filler around joists	2x2	1.5x1.5	40	1	90	0.63	0.63
sub-total				25			104.15

Post								
	Post	4x4	3.5x3.5	60	1	735	5.10	5.10
	Post	4x4	3.5x3.5	60	1	735	5.10	5.10
	Post	4x4	3.5x3.5	60	1	735	5.10	5.10
	Post	4x4	3.5x3.5	45	1	551.25	3.83	3.83
sub-total					4			19.14

Stairs								
	railing	2x4	1.5x3.5	74	2	388.5	2.70	5.40
	railing	2x4	1.5x3.5	67	2	351.75	2.44	4.89
	railing	2x4	1.5x3.5	37	2	194.25	1.35	2.70
	treads	2x4	1.5x3.5	47	6	246.75	1.71	10.28
	treads	2x6	1.5x5.5	47	6	387.75	2.69	16.16
	stringers	2x10	1.5x9.25	74	3	1026.75	7.13	16.04
sub-total					21			55.46

Grand Total					208			539.31
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Table A- 14. CCA treated wood demolished from Deck No.4.

Deck #5 Material After Demolition							Overall Deck Size Square Feet	
							15'10" x 10'	159.65
Deck Material	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.	
2 X 6								
	2x6	1.5x5.5	70	7	577.5	4.01	28.07	
	2x6	1.5x5.5	72.5	3	598.125	4.15	12.46	
	2x6	1.5x5.5	120	15	990	6.88	103.13	
	2x6	1.5x5.5	116	8	957	6.65	53.17	
	2x6	1.5x5.5	119.5	1	985.875	6.85	6.85	
	2x6	1.5x5.5	117.5	1	969.375	6.73	6.73	
	2x6	1.5x5.5	117	1	965.25	6.70	6.70	
	2x6	1.5x5.5	84	1	693	4.81	4.81	
	2x6	1.5x5.5	92	1	759	5.27	5.27	
	2x6	1.5x5.5	47	4	387.75	2.69	10.77	
	2x6	1.5x5.5	48.5	1	400.125	2.78	2.78	
	2x6	1.5x5.5	45	3	371.25	2.58	7.73	
	2x6	1.5x5.5	36	2	297	2.06	4.13	
	2x6	1.5x5.5	21.5	6	177.375	1.23	7.39	
	2x6	1.5x5.5	48.25	3	398.0625	2.76	8.29	
	2x6	1.5x5.5	48	1	396	2.75	2.75	
	2x6	1.5x5.5	46.75	1	385.6875	2.68	2.68	
	2x6	1.5x5.5	24.75	4	204.1875	1.42	5.67	
	sub-total			63			279.38	
2 X 4								
	2x4	1.5x3.5	19	1	99.75	0.69	0.69	
	2x4	1.5x3.5	22	1	115.50	0.80	0.80	
	2x4	1.5x3.5	17.5	1	91.88	0.64	0.64	
	2x4	1.5x3.5	34.75	3	182.44	1.27	3.80	
	2x4	1.5x3.5	30	2	157.50	1.09	2.19	
	2x4	1.5x3.5	34.25	3	179.81	1.25	3.75	
	2x4	1.5x3.5	35	6	183.75	1.28	7.66	
	2x4	1.5x3.5	37	1	194.25	1.35	1.35	
	2x4	1.5x3.5	39	1	204.75	1.42	1.42	
	2x4	1.5x3.5	47	3	246.75	1.71	5.14	
	2x4	1.5x3.5	58	1	304.50	2.11	2.11	
	2x4	1.5x3.5	45	1	236.25	1.64	1.64	
	2x4	1.5x3.5	48.5	1	254.63	1.77	1.77	
	2x4	1.5x3.5	51	1	267.75	1.86	1.86	
	2x4	1.5x3.5	57.5	1	301.88	2.10	2.10	
	2x4	1.5x3.5	65	1	341.25	2.37	2.37	
	2x4	1.5x3.5	66	2	346.50	2.41	4.81	
	2x4	1.5x3.5	73	1	383.25	2.66	2.66	
	2x4	1.5x3.5	61	1	320.25	2.22	2.22	
	2x4	1.5x3.5	56	1	294.00	2.04	2.04	
	2x4	1.5x3.5	44	1	231.00	1.60	1.60	
	2x4	1.5x3.5	67	1	351.75	2.44	2.44	
	2x4	1.5x3.5	58	1	304.50	2.11	2.11	
	2x4	1.5x3.5	62	1	325.50	2.26	2.26	
	sub-total			37			59.45	
5/4 X 6								
	5/4x6	1.25x5.5	18.5	1	127.1875	0.88	0.88	
	5/4x6	1.25x5.5	48	1	330	2.29	2.29	
	5/4x6	1.25x5.5	49	1	336.875	2.34	2.34	
	5/4x6	1.25x5.5	62	1	426.25	2.96	2.96	
	5/4x6	1.25x5.5	65	1	446.875	3.10	3.10	
	5/4x6	1.25x5.5	66	1	453.75	3.15	3.15	
	5/4x6	1.25x5.5	61	1	419.375	2.91	2.91	
	sub-total			7			17.64	
1 X 4								
	1x4	.75x3.5	35	6	91.875	0.64	3.83	
	sub-total			6			3.83	

1 X 6							
	1X6	.75X5.5	35	71	144.375	1.00	71.18
	1x6	.75x5.5	37	2	152.625	1.06	2.12
sub-total				73			73.30
2 X 10							
	2x10	1.5x9.25	25	9	346.875	2.41	14.45
sub-total				9			14.45
2 X 2							
	2x2	1.5x1.5	40	2	90	0.63	1.25
	2x2	1.5x1.5	52.25	1	117.5625	0.82	0.82
	2x2	1.5x1.5	56.5	1	127.125	0.88	0.88
	2x2	1.5x1.5	94	1	211.5	1.47	1.47
	2x2	1.5x1.5	89	1	200.25	1.39	1.39
sub-total				6			5.81
4 X 4							
	4x4	3.5x3.5	45	1	551.25	3.83	3.83
	4x4	3.5x3.5	60	3	735	5.10	15.31
sub-total				4			19.14
2 X 8							
	2x8	1.5x7.25	92	1	1000.5	6.95	6.95
	2x8	1.5x7.25	89	1	967.875	6.72	6.72
	2x8	1.5x7.25	87.75	1	954.28125	6.63	6.63
	2x8	1.5x7.25	97	1	1054.875	7.33	7.33
	2x8	1.5x7.25	115.25	1	1253.34375	8.70	8.70
	2x8	1.5x7.25	113	1	1228.875	8.53	8.53
sub-total				6			44.86
misc scrap							
	weight (lb.)	volume	Bd. Ft.				
	27.2		10.33				10.33
sub-total							10.33
Grand Total				211			528.19

Table A- 15. CCA treated wood recovered from Deck No.5.

							Overall Deck Size Square Feet
							15'10" x 10' 159.65
							Deck #5 Recovered Material
Deck Material	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.
2 X 6							
	2x6	1.5x5.5	13	1	107.25	0.74	0.74
	2x6	1.5x5.5	23	1	189.75	1.32	1.32
	2x6	1.5x5.5	20	1	165	1.15	1.15
	2x6	1.5x5.5	21	1	173.25	1.20	1.20
	2x6	1.5x5.5	27.5	1	226.875	1.58	1.58
	2x6	1.5x5.5	21	1	173.25	1.20	1.20
	2x6	1.5x5.5	25	4	206.25	1.43	5.73
	2x6	1.5x5.5	29	1	239.25	1.66	1.66
	2x6	1.5x5.5	24.5	1	202.125	1.40	1.40
	2x6	1.5x5.5	22	1	181.5	1.26	1.26
	2x6	1.5x5.5	23	1	189.75	1.32	1.32
	2x6	1.5x5.5	16	1	132	0.92	0.92
	2x6	1.5x5.5	22	1	181.5	1.26	1.26
	2x6	1.5x5.5	18	1	148.5	1.03	1.03
	2x6	1.5x5.5	16.5	1	136.125	0.95	0.95
	2x6	1.5x5.5	21.5	2	177.375	1.23	2.46
	2x6	1.5x5.5	26	1	214.5	1.49	1.49
	2x6	1.5x5.5	39	1	321.75	2.23	2.23
	2x6	1.5x5.5	47	6	387.75	2.69	16.16
	2x6	1.5x5.5	45	4	371.25	2.58	10.31
	2x6	1.5x5.5	67	1	552.75	3.84	3.84
	2x6	1.5x5.5	55	1	453.75	3.15	3.15
	2x6	1.5x5.5	73	3	602.25	4.18	12.55
	2x6	1.5x5.5	120	3	990	6.88	20.63
	2x6	1.5x5.5	116	18	957	6.65	119.63
	2x6	1.5x5.5	115	1	948.75	6.59	6.59
	2x6	1.5x5.5	44	1	363	2.52	2.52
	2x6	1.5x5.5	49	1	404.25	2.81	2.81
	2x6	1.5x5.5	48	2	396	2.75	5.50
	2x6	1.5x5.5	60.5	1	499.125	3.47	3.47
	2x6	1.5x5.5	75	1	618.75	4.30	4.30
	2x6	1.5x5.5	70.5	1	581.625	4.04	4.04
	2x6	1.5x5.5	114	1	940.5	6.53	6.53
	2x6	1.5x5.5	98	1	808.5	5.61	5.61
	2x6	1.5x5.5	110	1	907.5	6.30	6.30
	2x6	1.5x5.5	48.5	1	400.125	2.78	2.78
	2x6	1.5x5.5	43	1	354.75	2.46	2.46
	2x6	1.5x5.5	65	1	536.25	3.72	3.72
	2x6	1.5x5.5	70	2	577.5	4.01	8.02
	2x6	1.5x5.5	78.5	1	647.625	4.50	4.50
	2x6	1.5x5.5	27	1	222.75	1.55	1.55
sub-total				76			285.86

2 X 4							
2x4	1.5x3.5	17	1	89.25	0.62	0.62	
2x4	1.5x3.5	32.5	1	170.63	1.18	1.18	
2x4	1.5x3.5	30	2	157.50	1.09	2.19	
2x4	1.5x3.5	39	1	204.75	1.42	1.42	
2x4	1.5x3.5	33	1	173.25	1.20	1.20	
2x4	1.5x3.5	34	5	178.50	1.24	6.20	
2x4	1.5x3.5	30.5	1	160.13	1.11	1.11	
2x4	1.5x3.5	43	1	225.75	1.57	1.57	
2x4	1.5x3.5	52	1	273.00	1.90	1.90	
2x4	1.5x3.5	45	1	236.25	1.64	1.64	
2x4	1.5x3.5	63	1	330.75	2.30	2.30	
2x4	1.5x3.5	19	1	99.75	0.69	0.69	
2x4	1.5x3.5	42	1	220.50	1.53	1.53	
2x4	1.5x3.5	32	1	168.00	1.17	1.17	
2x4	1.5x3.5	48	1	252.00	1.75	1.75	
2x4	1.5x3.5	58	3	304.50	2.11	6.34	
2x4	1.5x3.5	57	1	299.25	2.08	2.08	
2x4	1.5x3.5	47	2	246.75	1.71	3.43	
2x4	1.5x3.5	14	1	73.50	0.51	0.51	
2x4	1.5x3.5	32	1	168.00	1.17	1.17	
2x4	1.5x3.5	44	1	231.00	1.60	1.60	
2x4	1.5x3.5	51	1	267.75	1.86	1.86	
2x4	1.5x3.5	64	1	336.00	2.33	2.33	
2x4	1.5x3.5	54	1	283.50	1.97	1.97	
2x4	1.5x3.5	56.5	1	296.63	2.06	2.06	
2x4	1.5x3.5	60.5	1	317.63	2.21	2.21	
2x4	1.5x3.5	35	4	183.75	1.28	5.10	
2x4	1.5x3.5	35.5	1	186.38	1.29	1.29	
2x4	1.5x3.5	40	1	210.00	1.46	1.46	
2x4	1.5x3.5	53	1	278.25	1.93	1.93	
2x4	1.5x3.5	60	1	315.00	2.19	2.19	
2x4	1.5x3.5	63.5	1	333.38	2.32	2.32	
2x4	1.5x3.5	54	1	283.50	1.97	1.97	
sub-total			44			68.29	

5/4 X 6							
5/4x6	1.25x5.5	18.5	1	127.1875	0.88	0.88	
5/4x6	1.25x5.5	43.5	1	299.0625	2.08	2.08	
5/4x6	1.25x5.5	49.5	1	340.3125	2.36	2.36	
5/4x6	1.25x5.5	64	1	440	3.06	3.06	
5/4x6	1.25x5.5	56	1	385	2.67	2.67	
5/4x6	1.25x5.5	62	1	426.25	2.96	2.96	
5/4x6	1.25x5.5	60	1	412.5	2.86	2.86	
sub-total			7			16.88	

1 X 5							
1x5	.75x4.5	35	1	118.125	0.82	0.82	
sub-total			1			0.82	

1 X 6							
1X6	.75X5.5	35	38	144.375	1.00	38.10	
1X6	.75X5.5	17.5	2	72.1875	0.50	1.00	
1X6	.75X5.5	21.5	1	88.6875	0.62	0.62	
1X6	.75X5.5	25.5	2	105.1875	0.73	1.46	
1X6	.75X5.5	24	1	99	0.69	0.69	
1X6	.75X5.5	24.5	2	101.0625	0.70	1.40	
1X6	.75X5.5	22	1	90.75	0.63	0.63	
1X6	.75X5.5	23.5	2	96.9375	0.67	1.35	
1X6	.75X5.5	24	1	99	0.69	0.69	
1X6	.75X5.5	26	2	107.25	0.74	1.49	
1X6	.75X5.5	28	2	115.5	0.80	1.60	
1X6	.75X5.5	29	2	119.625	0.83	1.66	
1X6	.75X5.5	15	1	61.875	0.43	0.43	
1X6	.75x5.5	20	2	82.5	0.57	1.15	
1X6	.75X5.5	33	1	136.125	0.95	0.95	
1X6	.75X5.5	31	2	127.875	0.89	1.78	
1X6	.75X5.5	30	1	123.75	0.86	0.86	
1X6	.75X5.5	14	1	57.75	0.40	0.40	
1X6	.75X5.5	16	2	66	0.46	0.92	
1X6	.75X5.5	19	1	78.375	0.54	0.54	
1X6	.75X5.5	23	1	94.875	0.66	0.66	
1X6	.75X5.5	25	1	103.125	0.72	0.72	
1X6	.75X5.5	31	1	127.875	0.89	0.89	
1x6	.75x5.5	31.5	1	129.9375	0.90	0.90	
sub-total			71			60.87	
2 X 2							
2x2	1.5x1.5	28.5	1	64.125	0.45	0.45	
2x2	1.5x1.5	40	1	90	0.63	0.63	
2x2	1.5x1.5	56.5	1	127.125	0.88	0.88	
2x2	1.5x1.5	41	1	92.25	0.64	0.64	
2x2	1.5x1.5	43	1	96.75	0.67	0.67	
2x2	1.5x1.5	39.5	1	88.875	0.62	0.62	
2x2	1.5x1.5	44	1	99	0.69	0.69	
2x2	1.5x1.5	41.5	1	93.375	0.65	0.65	
sub-total			8			5.22	
4 X 4							
4x4	3.5x3.5	44	2	539	3.74	7.49	
4x4	3.5x3.5	55.5	1	679.875	4.72	4.72	
4x4	3.5x3.5	60	1	735	5.10	5.10	
sub-total			4			17.31	
2 X 8							
2x8	1.5x7.25	41	1	445.875	3.10	3.10	
2x8	1.5x7.25	112.5	1	1223.4375	8.50	8.50	
2x8	1.5x7.25	89	1	967.875	6.72	6.72	
2x8	1.5x7.25	97	1	1054.875	7.33	7.33	
2x8	1.5x7.25	88	1	957	6.65	6.65	
2x8	1.5x7.25	115.5	1	1256.0625	8.72	8.72	
sub-total			6			41.01	
Grand Total			217			496.25	

Table A- 16. CCA treated wood from Deck No.6 while in-service.

Deck #6 In-Service Components													
<table border="1" style="float: right; margin-left: auto;"> <tr> <td>Overall Deck Size</td> <td>Walkway Size</td> <td>Total Square Feet</td> </tr> <tr> <td>30' x 10'</td> <td>3' x 20'</td> <td>360</td> </tr> </table>								Overall Deck Size	Walkway Size	Total Square Feet	30' x 10'	3' x 20'	360
Overall Deck Size	Walkway Size	Total Square Feet											
30' x 10'	3' x 20'	360											
Deck Part	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.						
Decking													
decking	2x6	1.5x5.5	37	41	305.25	2.12	86.91						
decking	2x6	1.5x5.5	360	19	2970	20.63	391.88						
decking	2x5	1.5x4.5	72	1	486	3.38	3.38						
decking	2x5	1.5x4.5	144	2	972	6.75	13.50						
sub-total				63			495.66						
Railing													
railing	2x6	1.5x5.5	166	1	1369.5	9.51	9.51						
railing	2x6	1.5x5.5	192	1	1584	11.00	11.00						
railing	2x6	1.5x5.5	121	1	998.25	6.93	6.93						
railing	2x6	1.5x5.5	193	1	1592.25	11.06	11.06						
railing	2x6	1.5x5.5	164	1	1353	9.40	9.40						
railing	2x2	1.5x1.5	43	33	96.75	0.67	22.17						
railing	2x2	1.5x1.5	43	84	96.75	0.67	56.44						
lattice	24x.25	24x.25	149	1	670.5	4.66	4.66						
lattice	24x.25	24x.25	116	1	522	3.63	3.63						
lattice	24x.25	24x.25	38	1	171	1.19	1.19						
lattice	24x.25	24x.25	353	1	1588.5	11.03	11.03						
sub-total				126			147.01						
Joists													
joists	2x6	1.5x5.5	35	1	288.75	2.01	2.01						
joists	2x8	1.5x7.25	67	4	728.625	5.06	20.24						
joists	2x8	1.5x7.25	35	2	380.625	2.64	5.29						
joists	2x8	1.5x7.25	358	1	3893.25	27.04	27.04						
joists	2x8	1.5x7.25	144	7	1566	10.88	76.13						
joists	2x8	1.5x7.25	30	1	326.25	2.27	2.27						
joists	2x8	1.5x7.25	118	14	1283.25	8.91	124.76						
Joists	2x6	1.5x6.25	358	1	2953.5	20.51	20.51						
filler around joists	2x2	1.5x1.5	358	1	805.5	5.59	5.59						
filler around joists	2x2	1.5x1.5	110	1	247.5	1.72	1.72						
bracing	2x4	1.5x3.5	172	2	903	6.27	12.54						
sub-total				35			298.08						
Post													
Post	4x4	3.5x3.5	84	1	1029	7.15	7.15						
Post	4x4	3.5x3.5	110	1	1347.5	9.36	9.36						
Post	4x4	3.5x3.5	113	1	1384.25	9.61	9.61						
Post	4x4	3.5x3.5	130	3	1592.5	11.06	33.18						
Post	4x4	3.5x3.5	133	1	1629.25	11.31	11.31						
Post	4x4	3.5x3.5	132	2	1617	11.23	22.46						
sub-total				9			93.07						
Stairs													
railing	2x6	1.5x5.5	78	1	643.5	4.47	4.47						
railing	2x2	1.5x1.5	43	7	96.75	0.67	4.70						
treads	2x10	1.5x9.25	35	7	485.625	3.37	23.61						
stringers	2x10	1.5x9.25	80	2	832.5	5.78	11.56						
sub-total				17			44.34						
Grand Total				250			1078.16						

Table A- 17. CCA treated wood demolished from Deck No.6.

Deck #6 Material After Demolition

Overall Deck Size	Walkway Size	Total Square Feet
30' x 10'	3' x 20'	360

Deck Material	Nominal Dimensions	Actual Dimensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.
2 X 6							
	2x6	1.5x5.5	144	34	1188	8.25	280.50
	2x6	1.5x5.5	120	2	990	6.88	13.75
	2x6	1.5x5.5	143	1	1179.75	8.19	8.19
	2x6	1.5x5.5	72	10	594	4.13	41.25
	2x6	1.5x5.5	71	3	585.75	4.07	12.20
	2x6	1.5x5.5	88	1	726	5.04	5.04
	2x6	1.5x5.5	57	1	470.25	3.27	3.27
	2x6	1.5x5.5	48	2	396	2.75	5.50
	2x6	1.5x5.5	96	2	792	5.50	11.00
	2x6	1.5x5.5	82	1	676.5	4.70	4.70
	2x6	1.5x5.5	143	2	1179.75	8.19	16.39
	2x6	1.5x5.5	89	1	734.25	5.10	5.10
	2x6	1.5x5.5	76	1	627	4.35	4.35
	2x6	1.5x5.5	68	1	561	3.90	3.90
	2x6	1.5x5.5	83	1	684.75	4.76	4.76
	2x6	1.5x5.5	125	1	1031.25	7.16	7.16
	2x6	1.5x5.5	59	1	486.75	3.38	3.38
	2x6	1.5x5.5	64	1	528	3.67	3.67
	2x6	1.5x5.5	69	1	569.25	3.95	3.95
	2x6	1.5x5.5	121	1	998.25	6.93	6.93
	2x6	1.5x5.5	38	12	313.5	2.18	26.13
	2x6	1.5x5.5	36	24	297	2.06	49.50
	2x6	1.5x5.5	33	1	272.25	1.89	1.89
	2x6	1.5x5.5	37	4	305.25	2.12	8.48
	2x6	1.5x5.5	48	1	396	2.75	2.75
	2x6	1.5x5.5	47	1	387.75	2.69	2.69
	2x6	1.5x5.5	24	4	198	1.38	5.50
	2x6	1.5x5.5	78	1	643.5	4.47	4.47
	sub-total			116			546.39
2 X 4							
	2x4	1.5x3.5	167	1	876.75	6.09	6.09
	2x4	1.5x3.5	81	1	425.25	2.95	2.95
	2x4	1.5x3.5	87	1	456.75	3.17	3.17
	sub-total			3			12.21
2 X 8							
	2x8	1.5x7.25	116	3	1261.5	8.76	26.28
	2x8	1.5x7.25	103	1	1120.125	7.78	7.78
	2x8	1.5x7.25	117	5	1272.375	8.84	44.18
	2x8	1.5x7.25	110	1	1196.25	8.31	8.31
	2x8	1.5x7.25	107	1	1163.625	8.08	8.08
	2x8	1.5x7.25	115	1	1250.625	8.68	8.68
	2x8	1.5x7.25	82	1	891.75	6.19	6.19
	2x8	1.5x7.25	83	1	902.625	6.27	6.27
	2x8	1.5x7.25	63	1	685.125	4.76	4.76
2 X 8							
	2x8	1.5x7.25	143	1	1555.125	10.80	10.80
	2x8	1.5x7.25	26	1	282.75	1.96	1.96
	2x8	1.5x7.25	33	1	358.875	2.49	2.49
	2x8	1.5x7.25	113	2	1228.875	8.53	17.07
	2x8	1.5x7.25	118	3	1283.25	8.91	26.73
	2x8	1.5x7.25	144	3	1566	10.88	32.63
	2x8	1.5x7.25	119	1	1294.125	8.99	8.99
	2x8	1.5x7.25	14	1	152.25	1.06	1.06
	2x8	1.5x7.25	72	1	783	5.44	5.44
	sub-total			29			227.70
2 X 5							
	2x5	1.5x4.5	36	1	243	1.69	1.69
	2x5	1.5x4.5	72	1	486	3.38	3.38
	2x5	1.5x4.5	144	2	972	6.75	13.50
	2x5	1.5x4.5	32	1	216	1.50	1.50
	sub-total			5			20.06

2 X 10							
	2x10	1.5x9.25	85	2	1179.375	8.19	10.92
	2x10	1.5x9.25	40	1	555	3.85	3.85
	2x10	1.5x9.25	34	8	471.75	3.28	26.21
	sub-total			11			40.98
2 X 2							
	2x2	1.5x1.5	145	2	326.25	2.27	4.53
	2x2	1.5x1.5	66	1	148.5	1.03	1.03
	2x2	1.5x1.5	60	1	135	0.94	0.94
	2x2	1.5x1.5	43	108	96.75	0.67	72.56
	2x2	1.5x1.5	41	7	92.25	0.64	4.48
	2x2	1.5x1.5	33	1	74.25	0.52	0.52
	2x2	1.5x1.5	35	1	78.75	0.55	0.55
	2x2	1.5x1.5	37	1	83.25	0.58	0.58
	2x2	1.5x1.5	42	1	94.5	0.66	0.66
	2x2	1.5x1.5	35	1	78.75	0.55	0.55
	2x2	1.5x1.5	67	2	150.75	1.05	2.09
	2x2	1.5x1.5	144	1	324	2.25	2.25
	sub-total			127			90.73
4 X 4							
	4x4	3.5x3.5	138	2	1690.5	11.74	23.48
	4x4	3.5x3.5	110	1	1347.5	9.36	9.36
	4x4	3.5x3.5	139	2	1702.75	11.82	23.65
	4x4	3.5x3.5	140	1	1715	11.91	11.91
	4x4	3.5x3.5	58	1	710.5	4.93	4.93
	4x4	3.5x3.5	82	1	1004.5	6.98	6.98
	4x4	3.5x3.5	135	1	1653.75	11.48	11.48
	sub-total			9			91.79
Lattice							
	24x.25	24x.25	38	1	171	1.19	1.19
	24x.25	24x.25	96	5	432	3.00	15.00
	24x.25	24x.25	57	1	256.5	1.78	1.78
	24x.25	24x.25	24	1	108	0.75	0.75
	24x.25	24x.25	72	1	324	2.25	2.25
	sub-total			9			20.97
misc scrap							
	weight (lb.)						
	36.4						9.22
	sub-total						9.22
Grand Total				309			1060.06

Table A- 18. CCA treated wood from Deck No.6 while in-service.

<u>Deck #6 Recovred Material</u>				Overall Deck Size			Walkway Size	Total Square Feet
				30' x 10'	3' x 20'	360		
Deck Material	Nominal Demensions	Actual Demensions	Length (in.)	Number of Pieces	Cubic In.	Bd. Ft.	Total Bd. Ft.	
2 X 6	2x6	1.5x5.5	17	1	140.25	0.97	0.97	
	2x6	1.5x5.5	20	2	165	1.15	2.29	
	2x6	1.5x5.5	23	1	189.75	1.32	1.32	
	2x6	1.5x5.5	24	5	198	1.38	6.88	
	2x6	1.5x5.5	29.5	1	243.375	1.69	1.69	
	2x6	1.5x5.5	28	2	231	1.60	3.21	
	2x6	1.5x5.5	37	4	305.25	2.12	8.48	
	2x6	1.5x5.5	36	11	297	2.06	22.69	
	2x6	1.5x5.5	38	7	313.5	2.18	15.24	
	2x6	1.5x5.5	36.5	2	301.125	2.09	4.18	
	2x6	1.5x5.5	45	1	371.25	2.58	2.58	
	2x6	1.5x5.5	19	1	156.75	1.09	1.09	
	2x6	1.5x5.5	23	2	189.75	1.32	2.64	
	2x6	1.5x5.5	29	1	239.25	1.66	1.66	
	2x6	1.5x5.5	26	1	214.5	1.49	1.49	
	2x6	1.5x5.5	35.5	1	292.875	2.03	2.03	
	2x6	1.5x5.5	37.5	1	309.375	2.15	2.15	
	2x6	1.5x5.5	47.5	1	391.875	2.72	2.72	
	2x6	1.5x5.5	33	1	272.25	1.89	1.89	
	2x6	1.5x5.5	48	2	396	2.75	5.50	
	2x6	1.5x5.5	39.5	1	325.875	2.26	2.26	
	2x6	1.5x5.5	39	1	321.75	2.23	2.23	
	2x6	1.5x5.5	57	2	470.25	3.27	6.53	
	2x6	1.5x5.5	52	1	429	2.98	2.98	
	2x6	1.5x5.5	72	5	594	4.13	20.63	
	2x6	1.5x5.5	64	3	528	3.67	11.00	
	2x6	1.5x5.5	66	1	544.5	3.78	3.78	
	2x6	1.5x5.5	143.5	9	1183.875	8.22	73.99	
	2x6	1.5x5.5	144.5	3	1192.125	8.28	24.84	
	2x6	1.5x5.5	133	1	1097.25	7.62	7.62	
	2x6	1.5x5.5	120	2	990	6.88	13.75	
	2x6	1.5x5.5	145	1	1196.25	8.31	8.31	
2x6	1.5x5.5	144	16	1188	8.25	132.00		
2x6	1.5x5.5	130	1	1072.5	7.45	7.45		
2x6	1.5x5.5	143	1	1179.75	8.19	8.19		
2x6	1.5x5.5	134	1	1105.5	7.68	7.68		
2x6	1.5x5.5	53	1	437.25	3.04	3.04		
2x6	1.5x5.5	68	2	561	3.90	7.79		
2x6	1.5x5.5	76	1	627	4.35	4.35		
2x6	1.5x5.5	62	2	511.5	3.55	7.10		
2x6	1.5x5.5	123	1	1014.75	7.05	7.05		
2x6	1.5x5.5	67	1	552.75	3.84	3.84		
2x6	1.5x5.5	58.5	1	482.625	3.35	3.35		
2x6	1.5x5.5	60	1	495	3.44	3.44		
2x6	1.5x5.5	77.5	1	639.375	4.44	4.44		
2x6	1.5x5.5	65	1	536.25	3.72	3.72		
2x6	1.5x5.5	57.5	1	474.375	3.29	3.29		
2x6	1.5x5.5	69	1	569.25	3.95	3.95		
2x6	1.5x5.5	75.5	1	622.875	4.33	4.33		
2x6	1.5x5.5	73	2	602.25	4.18	8.36		
2x6	1.5x5.5	89	1	734.25	5.10	5.10		
2x6	1.5x5.5	115.5	1	952.875	6.62	6.62		
2x6	1.5x5.5	96	1	792	5.50	5.50		
2x6	1.5x5.5	109	1	899.25	6.24	6.24		
sub-total				118			515.45	

2 X 4							
	2x4	1.5x3.5	77.5	1	406.88	2.83	2.83
	2x4	1.5x3.5	86	1	451.50	3.14	3.14
	2x4	1.5x3.5	150.5	1	790.13	5.49	5.49
	* if ripped	2x4	1.5x3.5	24	1	126.00	0.88
	* if ripped	2x4	1.5x3.5	36	2	189.00	1.31
	* if ripped	2x4	1.5x3.5	35	1	183.75	1.28
	* if ripped	2x4	1.5x3.5	33	1	173.25	1.20
	* if ripped	2x4	1.5x3.5	30	1	157.50	1.09
	* if ripped	2x4	1.5x3.5	32	1	168.00	1.17
	* if ripped	2x4	1.5x3.5	31.5	1	165.38	1.15
	* if ripped	2x4	1.5x3.5	77	1	404.25	2.81
	* if ripped	2x4	1.5x3.5	75	1	393.75	2.73
sub-total				13			26.38

2 X 8							
	2x8	1.5x7.25	32.5	1	353.4375	2.45	2.45
	2x8	1.5x7.25	33	1	358.875	2.49	2.49
	2x8	1.5x7.25	25	1	271.875	1.89	1.89
	2x8	1.5x7.25	35.5	1	386.0625	2.68	2.68
	2x8	1.5x7.25	113	2	1228.875	8.53	17.07
	2x8	1.5x7.25	144.5	1	1571.4375	10.91	10.91
	2x8	1.5x7.25	106.5	1	1158.1875	8.04	8.04
	2x8	1.5x7.25	110.5	1	1201.6875	8.35	8.35
	2x8	1.5x7.25	94.5	1	1027.6875	7.14	7.14
	2x8	1.5x7.25	103	1	1120.125	7.78	7.78
	2x8	1.5x7.25	111.5	1	1212.5625	8.42	8.42
	2x8	1.5x7.25	117	1	1272.375	8.84	8.84
	2x8	1.5x7.25	144	3	1566	10.88	32.63
	2x8	1.5x7.25	61.5	1	668.8125	4.64	4.64
	2x8	1.5x7.25	84	1	913.5	6.34	6.34
	2x8	1.5x7.25	82.5	1	897.1875	6.23	6.23
	2x8	1.5x7.25	72	1	783	5.44	5.44
	2x8	1.5x7.25	118.5	1	1288.6875	8.95	8.95
	2x8	1.5x7.25	95	1	1033.125	7.17	7.17
	2x8	1.5x7.25	94	1	1022.25	7.10	7.10
	2x8	1.5x7.25	100.5	1	1092.9375	7.59	7.59
	2x8	1.5x7.25	105	1	1141.875	7.93	7.93
	2x8	1.5x7.25	104.5	2	1136.4375	7.89	15.78
	2x8	1.5x7.25	110	1	1196.25	8.31	8.31
	2x8	1.5x7.25	115	1	1250.625	8.68	8.68
	2x8	1.5x7.25	113.5	1	1234.3125	8.57	8.57
sub-total				30			221.43

2 X 5							
	2x5	1.5x4.5	144	1	972	6.75	6.75
	2x5	1.5x4.5	119	1	803.25	5.58	5.58
	2x5	1.5x4.5	49	1	330.75	2.30	2.30
sub-total				3			14.63

2 X 10							
	2x10	1.5x9.25	28.5	1	395.4375	2.75	2.75
	2x10	1.5x9.25	30	1	416.25	2.89	2.89
	2x10	1.5x9.25	33	3	457.875	3.18	9.54
	2x10	1.5x9.25	32.5	1	450.9375	3.13	3.13
sub-total				6			18.31

2 X 2							
	2x2	1.5x1.5	43	106	96.75	0.67	71.22
	2x2	1.5x1.5	30	1	67.5	0.47	0.47
	2x2	1.5x1.5	32.5	1	73.125	0.51	0.51
	2x2	1.5x1.5	33.5	1	75.375	0.52	0.52
	2x2	1.5x1.5	38.5	1	86.625	0.60	0.60
	2x2	1.5x1.5	40	7	90	0.63	4.38
	2x2	1.5x1.5	16	1	36	0.25	0.25
	2x2	1.5x1.5	67	2	150.75	1.05	2.09
	2x2	1.5x1.5	60.5	1	136.125	0.95	0.95
	2x2	1.5x1.5	66.5	1	149.625	1.04	1.04
	2x2	1.5x1.5	104	1	234	1.63	1.63
	2x2	1.5x1.5	145.5	1	327.375	2.27	2.27
	2x2	1.5x1.5	144	1	324	2.25	2.25
sub-total				125			88.17

4 X 4							
	4x4	3.5x3.5	87	1	1065.75	7.40	7.40
	4x4	3.5x3.5	122.5	1	1500.625	10.42	10.42
	4x4	3.5x3.5	127.5	1	1561.875	10.85	10.85
	4x4	3.5x3.5	125.5	1	1537.375	10.68	10.68
	4x4	3.5x3.5	43	1	526.75	3.66	3.66
	4x4	3.5x3.5	53	1	649.25	4.51	4.51
	4x4	3.5x3.5	96	1	1176	8.17	8.17
	4x4	3.5x3.5	123.5	1	1512.875	10.51	10.51
	4x4	3.5x3.5	123	2	1506.75	10.46	20.93
sub-total				10			87.11

Lattice							
	24x.25	24x.25	38	1	171	1.19	1.19
	24x.25	24x.25	96	5	432	3.00	15.00
	24x.25	24x.25	57	1	256.5	1.78	1.78
	24x.25	24x.25	24	1	108	0.75	0.75
	24x.25	24x.25	72	1	324	2.25	2.25
sub-total				9			20.97

Grand Total				314			992.44
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APPENDIX E. CHEMICAL RETENTION DATA.

Table A- 19. Raw data from chemical assay performed on decking and joists.

#	sample	CrO3 (1)	CrO3 (2)	CrO3 (avg)	CuO(1)	CuO (2)	CuO(avg)	As2O5	As2O5 (2)	As2O5(avg)	Total %	kg/m3	pcf
1	2x6	0.597	0.570	0.584	0.234	0.233	0.234	0.451	0.452	0.452	1.269	6.49	0.41
2	5/4X6	0.429	0.433	0.431	0.199	0.193	0.196	0.366	0.363	0.365	0.992	5.08	0.32
3	deck 4 decking	0.414	0.419	0.417	0.169	0.170	0.170	0.264	0.264	0.264	0.850	4.35	0.27
4	deck 4 joists	0.424	0.426	0.425	0.186	0.184	0.185	0.316	0.315	0.316	0.926	4.74	0.30
5	deck 3 decking	0.363	0.363	0.363	0.173	0.173	0.173	0.227	0.231	0.229	0.765	3.92	0.24
6	deck 3 joists	0.273	0.259	0.266	0.135	0.133	0.134	0.190	0.191	0.191	0.591	3.02	0.19
7	deck 1 joists	0.714	0.709	0.712	0.264	0.266	0.265	0.465	0.464	0.465	1.441	7.38	0.46
8	deck 1 decking	0.319	0.274	0.297	0.107	0.096	0.102	0.202	0.194	0.198	0.596	3.05	0.19
9	deck 2 decking	0.494	0.503	0.499	0.191	0.194	0.193	0.331	0.336	0.334	1.025	5.25	0.33
10	deck 2 joists	0.472	0.470	0.471	0.195	0.196	0.196	0.319	0.327	0.323	0.990	5.07	0.32
11	deck 5 joists	0.267	0.254	0.261	0.116	0.116	0.116	0.178	0.175	0.177	0.553	2.83	0.18
12	deck 5 decking	0.181	0.196	0.189	0.055	0.058	0.057	0.099	0.102	0.101	0.346	1.77	0.11
13	deck 6 decking	0.454	0.446	0.450	0.173	0.190	0.182	0.300	0.309	0.305	0.936	4.79	0.30
14	deck 6 joists	0.591	0.588	0.590	0.191	0.188	0.190	0.352	0.360	0.356	1.135	5.81	0.36

APPENDIX F. PICTURES OF MECHANICAL TESTS.



Figure A- 7. Mechanical test samples in conditioning chamber.



Figure A- 8. MTS used to test mechanical properties.

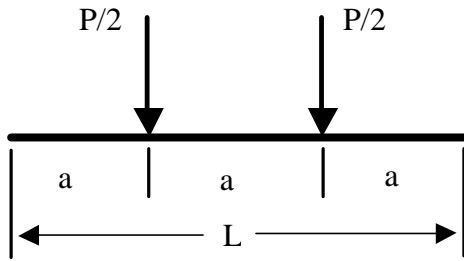


Figure A- 9. Loading of samples in MTS machine.



Figure A- 10. Typical failure of test samples under load.

APPENDIX G. FREE BODY DIAGRAM OF MECHANICAL TESTS.



$$L = 3a$$
$$a = L/3$$

APPENDIX H. MECHANICAL TEST DATA.

Table A- 20. Raw data from Deck No. 1 mechanical test samples.

Board #	Width (b)	Thickness (h)	MC (%)	P	MOR (PSI)	Adj MOR	P/Δ	MOE (PSI)	Adj MOE
D1-1	5.365	0.944	12.44	1713.637	8602	8027	2441.6	1591200	1529306
D1-2	5.355	0.944	12.17	1759.741	8850	8196	2503.1	1634326	1564438
D1-3	5.355	0.944	12.67	1690.285	8501	7983	2688.2	1755181	1692973
D1-4	5.363	0.963	12.90	1836.98	8865	8365	2883	1770492	1713742
D1-5	5.363	0.963	13.14	1367.556	6599	6309	2346.1	1440774	1399608
D1-6	5.363	0.963	12.47	1354.982	6539	6160	2287.2	1404602	1350766
D1-7	5.465	0.966	13.15	1085.543	5109	4923	1726.5	1030815	1001545
D1-8	5.465	0.966	12.43	1095.123	5154	4899	1844.4	1101208	1058322
D1-9	5.465	0.966	12.35	1160.387	5461	5169	1996	1191722	1143953
D1-10	5.385	0.945	11.88	906.5149	4524	4290	1162.5	752398	717079
D1-11	5.385	0.945	12.60	779.5789	3891	3761	1358.6	879319	847211
D1-12	5.385	0.945	12.86	916.6937	4575	4405	1508.6	976402	944473
D1-13	5.435	0.961	12.44	495.1703	2368	2372	1144.9	698126	670962
D1-14	5.435	0.961	12.87	659.8279	3155	3097	1164.4	710016	686926
D1-15	5.435	0.961	12.85	731.0797	3496	3410	1301.1	793372	767313
D1-16	5.471	0.947	12.13	1720.822	8417	7800	2729.9	1728088	1653274
D1-17	5.471	0.947	12.05	1499.282	7334	6815	2492.4	1577746	1507586
D1-18	5.471	0.947	12.10	1392.105	6810	6353	2130.4	1348591	1289631
D1-19	5.395	0.961	12.88	1859.134	8955	8444	1940.5	1192032	1153414
D1-20	5.395	0.961	12.40	1510.659	7277	6818	2120.6	1302666	1251259
D1-21	5.395	0.961	12.11	1277.743	6155	5768	1991.5	1223361	1170055
D1-22	5.411	0.957	11.52	1444.796	6997	6437	2108.1	1307416	1239274
D1-23	5.411	0.957	11.65	1362.766	6600	6105	2207.4	1369000	1300191
D1-24	5.411	0.957	12.27	1140.628	5524	5218	2122.3	1316222	1261880
D1-25	5.424	0.961	12.03	837.6581	4013	3844	1989.8	1215781	1161369
D1-26	5.424	0.961	12.11	1345.402	6446	6028	2477.1	1513525	1447443
D1-27	5.424	0.961	11.33	1321.452	6331	5830	2238.1	1367494	1292553
D1-28	5.366	0.951	13.01	1197.51	5922	5664	2332.1	1486246	1440989
D1-29	5.366	0.951	13.05	1862.726	9212	8721	2569.1	1637286	1588457
D1-30	5.366	0.951	12.60	1253.793	6200	5868	2120.8	1351585	1302179
Avg	5.407	0.956	12.42	1285.99	6263	5903	2064.21	1288900	1238272
Std Dev	0.040	0.008	0.48	374.39	1865	1701	482.97	311735	299578

Table A- 21. Raw data from Deck No.2 mechanical test samples.

Board #	Width (b)	Thickness (h)	MC (%)	P	MOR (PSI)	Adj MOR	P/Δ	MOE (PSI)	Adj MOE
D2-1	5.330	1.484	12.54	3067.4214	6272	5927	7376.8	1245590	1199100
D2-2	5.330	1.484	13.43	3270.3992	6687	6434	7270.2	1227590	1197891
D2-3	5.330	1.484	13.43	3507.5061	7172	6890	7784.5	1314431	1282549
D2-4	5.366	1.511	11.87	2570.4546	5035	4744	3587.2	569964	543166
D2-5	5.366	1.511	12.81	2450.105	4800	4608	5097.3	809901	782873
D2-6	5.366	1.511	12.76	2107.0186	4128	3987	5563.6	883991	853856
D2-7	5.245	1.469	11.70	1794.4684	3805	3643	2736.5	484084	460087
D2-8	5.245	1.469	13.02	3273.3931	6941	6608	6389.8	1130348	1096028
D2-9	5.245	1.469	12.91	4404.4409	9339	8804	9431.3	1668386	1614997
D2-10	5.354	1.465	11.80	2999.762	6265	5829	5909.3	1032478	982860
D2-11	5.354	1.465	13.16	2587.2197	5404	5199	5469.3	955601	928631
D2-12	5.354	1.465	13.27	2926.7139	6113	5873	6465.6	1129675	1099633
D2-13	5.288	1.475	12.04	4849.9146	10117	9302	10146	1758584	1680073
D2-14	5.288	1.475	12.81	4514.6118	9418	8853	10017	1736225	1678101
D2-15	5.288	1.475	12.63	4842.1309	10101	9435	10081	1747318	1684283
D2-16	5.406	1.473	12.98	3743.4155	7659	7268	6806.2	1158661	1122918
D2-17	5.406	1.473	12.62	2865.042	5862	5562	6578.5	1119898	1079334
D2-18	5.406	1.473	13.18	2617.1577	5355	5155	5725	974602	947353
D2-19	5.290	1.488	12.77	3169.2095	6494	6160	7521.5	1269334	1226242
D2-20	5.290	1.488	13.09	3484.1548	7139	6804	9599.7	1620052	1572593
D2-21	5.290	1.488	13.11	3317.1021	6797	6490	8379.1	1414063	1373188
D2-22	5.379	1.491	14.22	2013.6127	4041	3992	5196.3	857227	846814
D2-23	5.379	1.491	13.52	1768.7219	3550	3487	5253.3	866630	846887
D2-24	5.379	1.491	13.61	1843.5663	3700	3633	5452.1	899426	880144
D2-25	5.449	1.482	12.32	2699.187	5413	5122	5683.9	942586	904284
D2-26	5.449	1.482	12.67	3378.7739	6776	6403	6541.2	1084756	1046213
D2-27	5.449	1.482	12.24	3464.3958	6947	6496	6628.6	1099249	1053299
D2-28	5.400	1.494	11.84	3263.813	6499	6040	5046.4	824275	785058
D2-29	5.400	1.494	12.36	3306.9233	6585	6186	6140.1	1002919	962780
D2-30	5.400	1.494	11.68	3185.9746	6344	5884	7535.1	1230777	1169533
Avg	5.351	1.483	12.75	3109.55	6359	6027	6713.75	1135287	1096692
Std Dev	0.061	0.013	0.63	822.13	1759	1602	1846.44	329238	318098

Table A- 22. Raw data from Deck No.3 mechanical test samples.

Board #	Width (b)	Thickness (h)	MC (%)	P	MOR (PSI)	Adj MOR	P ¹ /Δ	MOE (PSI)	Adj MOE
D3-1	5.47	1.486	13.45	1599.2743	3178	3133	3099.7	507939	495819
D3-2	5.47	1.486	13.60	1703.4576	3385	3333	3192.3	523113	511791
D3-3	5.47	1.486	13.37	1469.3445	2920	2889	3216.9	527144	513883
D3-4	5.45	1.494	13.31	3109.334	6135	5899	7415.8	1200178	1169040
D3-5	5.45	1.494	13.15	3210.5237	6334	6065	7262.1	1175303	1142028
D3-6	5.45	1.494	14.05	3399.1313	6706	6550	7870	1273686	1254948
D3-7	5.44	1.517	13.26	1570.5341	3011	2972	5349.4	828486	806382
D3-8	5.44	1.517	13.76	1587.2992	3043	3013	4856.7	752180	737700
D3-9	5.44	1.517	13.85	2193.2393	4205	4126	5117.9	792633	778471
D3-10	5.448	1.489	13.44	3357.2188	6671	6420	3780.4	618233	603352
D3-11	5.448	1.489	13.64	2677.0332	5319	5169	4232.6	692185	677634
D3-12	5.448	1.489	13.38	2726.1309	5417	5234	5604.8	916589	893676
D3-13	5.405	1.505	13.30	3970.3438	7783	7441	9128.5	1457237	1419093
D3-14	5.405	1.505	13.60	2783.6113	5457	5296	7633.4	1218565	1192261
D3-15	5.405	1.505	13.58	2468.0676	4838	4708	7901	1261284	1233608
D3-16	5.443	1.49	13.67	2064.5068	4100	4015	5827	951883	932285
D3-17	5.443	1.49	13.43	2469.8638	4905	4758	6950.4	1135399	1107910
D3-18	5.443	1.49	13.46	3146.457	6249	6026	7499.9	1225164	1196033
D3-19	5.412	1.477	14.35	3114.124	6330	6232	3820.2	644351	637845
D3-20	5.412	1.477	14.36	3414.1003	6940	6827	4911.9	828488	820163
D3-21	5.412	1.477	14.34	3602.708	7324	7197	6047.6	1020046	1009506
D3-22	5.428	1.525	14.25	3060.2363	5818	5719	7306.4	1116323	1103212
D3-23	5.428	1.525	14.10	1969.3048	3744	3698	5582.9	852995	841085
D3-24	5.428	1.525	14.22	2311.7925	4395	4335	6630.4	1013039	1000685
D3-25	5.423	1.499	13.57	3050.6563	6008	5814	6488.9	1044870	1021767
D3-26	5.423	1.499	13.56	4181.1055	8235	7917	8435.2	1358272	1328034
D3-27	5.423	1.499	13.46	1559.7565	3072	3034	5232.5	842560	822526
D3-28	5.425	1.491	13.82	1572.9291	3130	3098	4924.9	805565	790885
D3-29	5.425	1.491	13.58	1258.5828	2505	2500	4133.5	676116	661322
D3-30	5.425	1.491	13.82	1615.4407	3215	3179	5031.9	823067	808065
Avg	5.434	1.497	13.69	2540.54	5012	4887	5816.17	936096	917034
Std Dev	0.019	0.014	0.35	827.53	1658	1580	1667.53	263587	257320

Table A- 23. Raw data from Deck No.4 mechanical test samples.

Board #	Width (b)	Thickness (h)	MC (%)	P	MOR (PSI)	Adj MOR	P/Δ	MOE (PSI)	Adj MOE
D4-1	5.422	1.509	13.54	1909.429	3712	3640	5577	880459	860630
D4-2	5.422	1.509	13.81	2829.716	5501	5361	7827.8	1235800	1213084
D4-3	5.422	1.509	13.67	2477.648	4816	4695	7038.2	1111144	1088342
D4-4	5.434	1.57	12.81	1210.084	2168	2188	4959.3	693646	670493
D4-5	5.434	1.57	12.50	1058.599	1897	1944	3694.2	516699	497121
D4-6	5.434	1.57	13.74	2648.293	4745	4634	8069.2	1128620	1106648
D4-7	5.436	1.481	13.89	2228.566	4486	4398	4719.1	786050	772569
D4-8	5.436	1.481	13.77	3091.372	6223	6044	5985.6	997009	978031
D4-9	5.436	1.481	14.20	2682.422	5399	5307	7376.6	1228705	1213424
D4-10	5.461	1.507	13.90	1520.239	2942	2920	4271.3	672178	660662
D4-11	5.461	1.507	14.34	831.6705	1609	1630	2363.4	371930	368088
D4-12	5.461	1.507	14.58	1819.017	3520	3502	4711.7	741484	736632
D4-13	5.332	1.486	13.32	915.4962	1866	1901	3411.6	573518	558712
D4-14	5.332	1.486	13.37	1467.548	2991	2956	5259	884082	861911
D4-15	5.332	1.486	14.37	1445.993	2947	2934	5676.3	954233	944836
D4-16	5.409	1.487	13.03	1756.148	3524	3443	4932.1	815676	791093
D4-17	5.409	1.487	13.13	2405.797	4828	4660	8266.5	1367123	1327963
D4-18	5.409	1.487	14.21	3481.76	6987	6846	8426.5	1393584	1376390
D4-19	5.459	1.485	14.27	2576.442	5136	5059	5616.2	924030	913496
D4-20	5.459	1.485	13.74	2836.901	5656	5500	6888.5	1133361	1111255
D4-21	5.459	1.485	13.91	2211.801	4410	4326	6292.2	1035252	1017729
D4-22	5.474	1.48	14.92	1513.054	3029	3027	3897.5	645999	645176
D4-23	5.474	1.48	13.86	1651.965	3307	3268	4970	823763	809153
D4-24	5.474	1.48	13.49	1172.961	2348	2352	3513.2	582303	568721
D4-25	5.432	1.491	14.34	1002.914	1993	2004	3135.8	512261	506972
D4-26	5.432	1.491	14.36	1639.99	3259	3238	3551	580088	574287
D4-27	5.432	1.491	13.18	1068.179	2123	2143	2659.7	434486	422331
D4-28	5.45	1.482	14.36	1770.518	3550	3521	3830.1	635046	628658
D4-29	5.45	1.482	14.23	2135.759	4282	4227	4584.3	760095	751009
D4-30	5.45	1.482	13.27	1401.086	2809	2784	2647.9	439032	427333
Avg	5.431	1.498	13.80	1892.05	3735	3682	5138.39	828589	813425
Std Dev	0.038	0.026	0.56	708.83	1415	1356	1760.99	283318	278345

Table A- 24. Raw data from Deck No.5 mechanical test samples.

Board #	Width (b)	Thickness (h)	MC (%)	P	MOR (PSI)	Adj MOR	P'/Δ	MOE (PSI)	Adj MOE
D5-1	5.164	1.45	11.90	1674.119	3701	3559	4341.6	811139	773320
D5-2	5.164	1.45	11.99	1321.452	2921	2867	3697	690709	659367
D5-3	5.164	1.45	11.37	1899.849	4200	3973	4220.1	788439	745698
D5-4	5.31	1.425	14.66	3166.216	7047	6985	7360	1408882	1401280
D5-5	5.31	1.425	12.68	2575.844	5733	5451	6838.3	1309016	1262698
D5-6	5.31	1.425	12.60	2123.185	4726	4524	5219.8	999196	962779
D5-7	5.232	1.451	12.59	3039.28	6622	6252	6293.4	1158114	1115634
D5-8	5.232	1.451	12.34	2205.813	4806	4576	5945.4	1094075	1049937
D5-9	5.232	1.451	12.70	2277.065	4961	4747	6048	1112955	1073993
D5-10	5.326	1.46	12.46	2145.938	4537	4341	5014.9	889894	855573
D5-11	5.326	1.46	12.34	1923.799	4067	3908	4902.7	869984	834958
D5-12	5.326	1.46	12.46	2544.109	5378	5105	5128.7	910088	875030
D5-13	5.301	1.472	12.78	1501.079	3136	3078	3526.8	613530	592802
D5-14	5.301	1.472	12.17	1227.448	2565	2550	3374.2	586983	561917
D5-15	5.301	1.472	12.04	1229.843	2570	2553	3334.4	580059	554177
D5-16	5.432	1.474	12.34	1986.07	4039	3883	4724.1	798735	766567
D5-17	5.432	1.474	12.68	1863.325	3789	3672	4341.4	734029	708102
D5-18	5.432	1.474	11.73	2899.77	5897	5494	6098.4	1031097	980437
D5-19	5.281	1.448	12.36	2206.412	4782	4557	5903	1082896	1039651
D5-20	5.281	1.448	12.41	3441.044	7458	6986	7279.2	1335358	1282996
D5-21	5.281	1.448	12.74	3240.461	7024	6642	7757.2	1423046	1374099
D5-22	5.328	1.446	12.68	2858.456	6158	5840	6552.2	1196338	1154104
D5-23	5.328	1.446	12.72	2590.214	5580	5316	7017.4	1281277	1236853
D5-24	5.328	1.446	12.36	1646.576	3547	3439	4171.3	761620	731205
D5-25	5.371	1.459	13.03	1767.524	3710	3616	4608	812507	787954
D5-26	5.371	1.459	12.71	2011.218	4222	4070	4157.8	733126	707579
D5-27	5.371	1.459	12.53	2060.315	4325	4153	5139.1	906154	872175
D5-28	5.347	1.483	12.40	2369.872	4837	4608	5968.2	1006574	966854
D5-29	5.347	1.483	12.29	2089.655	4265	4084	5385.6	908315	871115
D5-30	5.347	1.483	11.84	3672.763	7496	6926	7395.5	1247297	1188091
Avg	5.309	1.457	12.46	2251.96	4803	4592	5391.46	969381	932898
Std Dev	0.071	0.016	0.55	644.28	1392	1283	1294.82	246384	240950

Table A- 25. Raw data from Deck No.6 mechanical test samples.

Board #	Width (b)	Thickness (h)	MC (%)	P	MOR (PSI)	Adj MOR	P/Δ	MOE (PSI)	Adj MOE
D6-1	5.484	1.505	13.85	1346.5997	2602	2594	4472.4	703671	691155
D6-2	5.484	1.505	13.77	4322.4116	8352	8074	9045.5	1423185	1396118
D6-3	5.484	1.505	13.91	2229.7632	4308	4229	7049.3	1109111	1090339
D6-4	5.541	1.539	14.12	4143.9824	7578	7402	8759	1275517	1258027
D6-5	5.541	1.539	12.63	2455.4937	4490	4311	7166.3	1043583	1006004
D6-6	5.541	1.539	12.63	2946.4727	5388	5131	7421.4	1080731	1041806
D6-7	5.453	1.485	12.12	3478.167	6942	6474	8136.8	1340216	1281969
D6-8	5.453	1.485	13.17	3746.4092	7477	7133	7595.1	1250992	1215939
D6-9	5.453	1.485	15.04	3280.5781	6547	6554	7461.9	1229052	1229798
D6-10	5.418	1.477	14.97	3452.4207	7010	7005	8609	1450468	1449823
D6-11	5.418	1.477	14.43	3302.1333	6705	6609	8860	1492757	1479407
D6-12	5.418	1.477	12.66	4166.7354	8461	7944	9421.9	1587427	1530962
D6-13	5.469	1.492	13.04	4546.3457	8962	8487	9416	1524712	1479048
D6-14	5.469	1.492	13.15	3653.6023	7203	6872	9309.6	1507483	1464658
D6-15	5.469	1.492	12.98	3527.8638	6955	6615	8870.8	1436429	1392030
D6-16	5.468	1.497	14.31	2546.5044	4988	4919	6137.6	984103	973561
D6-17	5.468	1.497	13.78	2111.2097	4135	4055	7229	1159098	1137247
D6-18	5.468	1.497	14.13	2429.1484	4758	4679	6680.1	1071087	1056642
D6-19	5.551	1.537	14.25	1957.9285	3583	3549	6165.6	899743	889162
D6-20	5.551	1.537	13.11	2511.7769	4597	4444	7161	1045001	1014760
D6-21	5.551	1.537	14.01	3527.2651	6456	6302	9039.6	1319144	1298842
D6-22	5.449	1.499	13.33	2559.6772	5017	4855	6879.6	1102497	1074248
D6-23	5.449	1.499	13.34	3353.626	6574	6315	6580.1	1054500	1027639
D6-24	5.449	1.499	14.83	3053.6499	5986	5961	7532.6	1207144	1203827
D6-25	5.456	1.515	14.67	3586.5417	6874	6815	9137.8	1416659	1409276
D6-26	5.456	1.515	13.32	3139.8706	6018	5790	7461.2	1156731	1126807
D6-27	5.456	1.515	13.99	3347.0398	6415	6260	8828.8	1368754	1347346
D6-28	5.43	1.464	14.17	1644.1809	3391	3359	4810.6	830447	819670
D6-29	5.43	1.464	14.18	2181.8628	4499	4433	6783.7	1171061	1156085
D6-30	5.43	1.464	14.68	2772.834	5718	5677	7203.1	1243461	1237285
Avg	5.472	1.501	13.75	3044.07	5933	5762	7640.85	1216159	1192649
Std Dev	0.042	0.023	0.76	799.42	1581	1487	1303.35	216484	211507

Table A- 26. Raw data from recently treated 5/4x6 mechanical test samples.

Board #	Width (b)	Thickness (h)	MC (%)	P	MOR (PSI)	Adj MOR	P'/Δ	MOE (PSI)	Adj MOE
5/4-1	5.479	1.006	12.68	1760.339	7619	7177	2711.5	1429718	1379235
5/4-2	5.479	1.006	12.69	1551.374	6715	6351	2168.5	1143405	1103131
5/4-3	5.479	1.006	13.09	1645.977	7124	6789	1864.3	983007	954178
5/4-4	5.411	1.005	13.09	1490.301	6544	6252	2353.6	1260355	1223526
5/4-5	5.411	1.005	13.09	1957.929	8598	8159	2440.2	1306729	1268446
5/4-6	5.411	1.005	13.27	2016.606	8856	8438	2522.6	1350854	1314888
5/4-7	5.421	1.011	13.16	2114.802	9160	8697	3038.1	1595163	1550056
5/4-8	5.421	1.011	13.07	2333.348	10107	9556	3016.8	1583979	1537241
5/4-9	5.421	1.011	13.25	2586.023	11201	10626	3331.7	1749318	1702274
5/4-10	5.465	1.007	12.91	1750.161	7579	7181	2643.7	1393380	1348894
5/4-11	5.465	1.007	13.19	1375.34	5956	5717	2267.9	1195312	1162069
5/4-12	5.465	1.007	13.22	1372.346	5943	5708	2495.3	1315164	1279152
5/4-13	5.432	0.994	13.05	1199.306	5363	5150	1585.5	874144	848088
5/4-14	5.432	0.994	12.92	1469.345	6571	6251	1695.8	934957	905210
5/4-15	5.432	0.994	13.08	1569.337	7018	6689	1735.6	956900	928725
5/4-16	5.465	1.016	12.95	1623.823	6908	6567	1581	811328	785866
5/4-17	5.465	1.016	12.84	1675.915	7130	6754	1988.8	1020600	986879
5/4-18	5.465	1.016	13.23	1502.276	6391	6128	1557.6	799320	777598
5/4-19	5.521	0.991	13.08	2314.188	10243	9685	2967	1624107	1576360
5/4-20	5.521	0.991	13.03	2468.068	10925	10302	2856.2	1563456	1516251
5/4-21	5.521	0.991	13.16	2326.762	10299	9758	2838.9	1553987	1510118
5/4-22	5.428	0.968	13.52	1048.42	4947	4806	1621.1	968456	946359
5/4-23	5.428	0.968	13.15	1833.388	8651	8222	2233.2	1334128	1296364
5/4-24	5.428	0.968	13.02	1805.246	8518	8071	2291	1368658	1327217
5/4-25	5.536	0.988	12.92	2271.676	10089	9500	3125.5	1721823	1667131
5/4-26	5.536	0.988	12.88	2302.212	10225	9614	3281.2	1807597	1749070
5/4-27	5.536	0.988	12.97	2642.904	11738	11036	3496.8	1926370	1866452
5/4-28	5.425	0.973	13.08	1435.216	6707	6400	2228.2	1311450	1272867
5/4-29	5.425	0.973	13.26	2017.804	9429	8972	2760.3	1624628	1581157
5/4-30	5.425	0.973	13.00	2677.632	12512	11763	3215.5	1892545	1834551
Avg	5.458	0.996	13.06	1871.27	8302	7877	2463.78	1346695	1306645
Std Dev	0.042	0.016	0.17	447.91	2020	1874	585.01	327444	317426

Table A- 27. Raw data from recently treated 2x6 mechanical test samples.

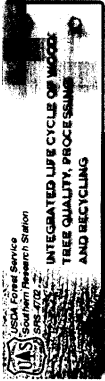
Board #	Width (b)	Thickness (h)	MC	P	MOR (PSI)	Adj MOR	P/Δ	MOE (PSI)	Adj MOE
6-1	5.42	1.488	12.59	3329.077	6658	6285	6758.1	1113147	1072432
6-2	5.42	1.488	12.38	2343.527	4687	4471	4068.3	670102	643492
6-3	5.42	1.488	13.00	2753.674	5507	5278	4061.7	669015	648499
6-4	5.428	1.493	12.80	3569.178	7080	6702	5472.2	891002	861052
6-5	5.428	1.493	12.91	3859.574	7656	7251	5875	956587	925990
6-6	5.428	1.493	13.34	2936.294	5824	5613	5268.9	857900	836043
6-7	5.458	1.501	13.12	3266.208	6375	6098	5629.2	897030	871154
6-8	5.458	1.501	13.10	1741.778	3399	3330	4679.5	745692	723929
6-9	5.458	1.501	13.09	1371.747	2677	2659	5407.1	861638	836484
6-10	5.401	1.489	12.99	3989.504	7996	7581	7577.6	1249998	1211573
6-11	5.401	1.489	13.43	4230.802	8480	8120	7333.7	1209764	1180443
6-12	5.401	1.489	13.60	2110.012	4229	4133	2757.7	454909	445093
6-13	5.412	1.475	13.43	3523.672	7182	6901	5553.3	940488	917738
6-14	5.412	1.475	13.10	2582.43	5264	5062	4202.7	711755	691019
6-15	5.412	1.475	13.14	2392.026	4876	4706	6178.5	1046369	1016568
6-16	5.425	1.492	13.19	1783.691	3545	3468	5244.4	856102	832290
6-17	5.425	1.492	13.00	4442.163	8828	8353	7315.8	1194240	1157708
6-18	5.425	1.492	13.01	3288.362	6535	6231	6629	1082126	1049120
6-19	5.41	1.488	13.26	4178.71	8372	7985	7203.7	1188736	1157011
6-20	5.41	1.488	13.10	1397.494	2800	2773	4832.6	797463	774237
6-21	5.41	1.488	12.97	4145.18	8305	7863	7117.5	1174512	1138101
6-22	5.412	1.458	12.78	1962.12	4093	3956	3318.2	581846	562142
6-23	5.412	1.458	12.85	1508.264	3146	3089	3055.1	535711	518134
6-24	5.412	1.458	13.20	2684.817	5601	5387	2858.7	501273	487412
6-25	5.413	1.492	13.01	3353.626	6680	6365	7936.2	1298386	1258765
6-26	5.413	1.492	13.03	6124.664	12199	11483	11160	1825810	1770661
6-27	5.413	1.492	13.13	5039.121	10037	9506	7367.1	1205280	1170725
6-28	5.422	1.513	13.21	5199.587	10054	9543	9071.2	1420772	1381640
6-29	5.422	1.513	13.34	4822.372	9325	8894	8415.5	1318073	1284359
6-30	5.422	1.513	13.33	3732.039	7216	6916	5317.9	832913	811535
Avg	5.420	1.489	13.08	3255.39	6488	6200	5922.21	969621	941178
Std Dev	0.015	0.014	0.25	1220.15	2387	2222	1944.50	308219	299418

APPENDIX I: BROCHURES MADE TO PROMOTE RECYCLED CCA TREATED WOOD


FACTS

- In 2001, approximately 6.5 billion board feet of CCA treated wood products were produced.
- Forty percent, or 2.6 billion board feet, of the total CCA treated wood produced in 2001 was used in the construction, repair, and remodeling of residential decks.
- Recent research estimated the total amount of spent CCA treated wood removed from residential decks in 1999 was 1 billion board feet, roughly 40 percent of annual treated wood consumption by this market.
- Further research concluded that only 5 percent of a demolished CCA treated deck is currently recovered and reused.
- Current research suggests that as much as 85 percent of the treated wood volume in a demolished residential deck is reusable.
- Current research also revealed no significant changes in mechanical properties when comparing recycled CCA treated deck components to unused treated components.
- Potential products produced from recovered CCA treated wood included: pallets, deck components, outdoor furniture, and exterior architectural wood products.

ACKNOWLEDGEMENTS



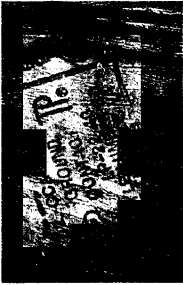
Center for Forest Products Marketing and Management




Department of Wood Science and Forest Products

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Recycling CCA Treated Wood from Spent Residential Decks




Figure A- 11. Half of brochure made to promote the recovery and reuse of CCA treated wood from residential decks (brochure was folded in thirds).

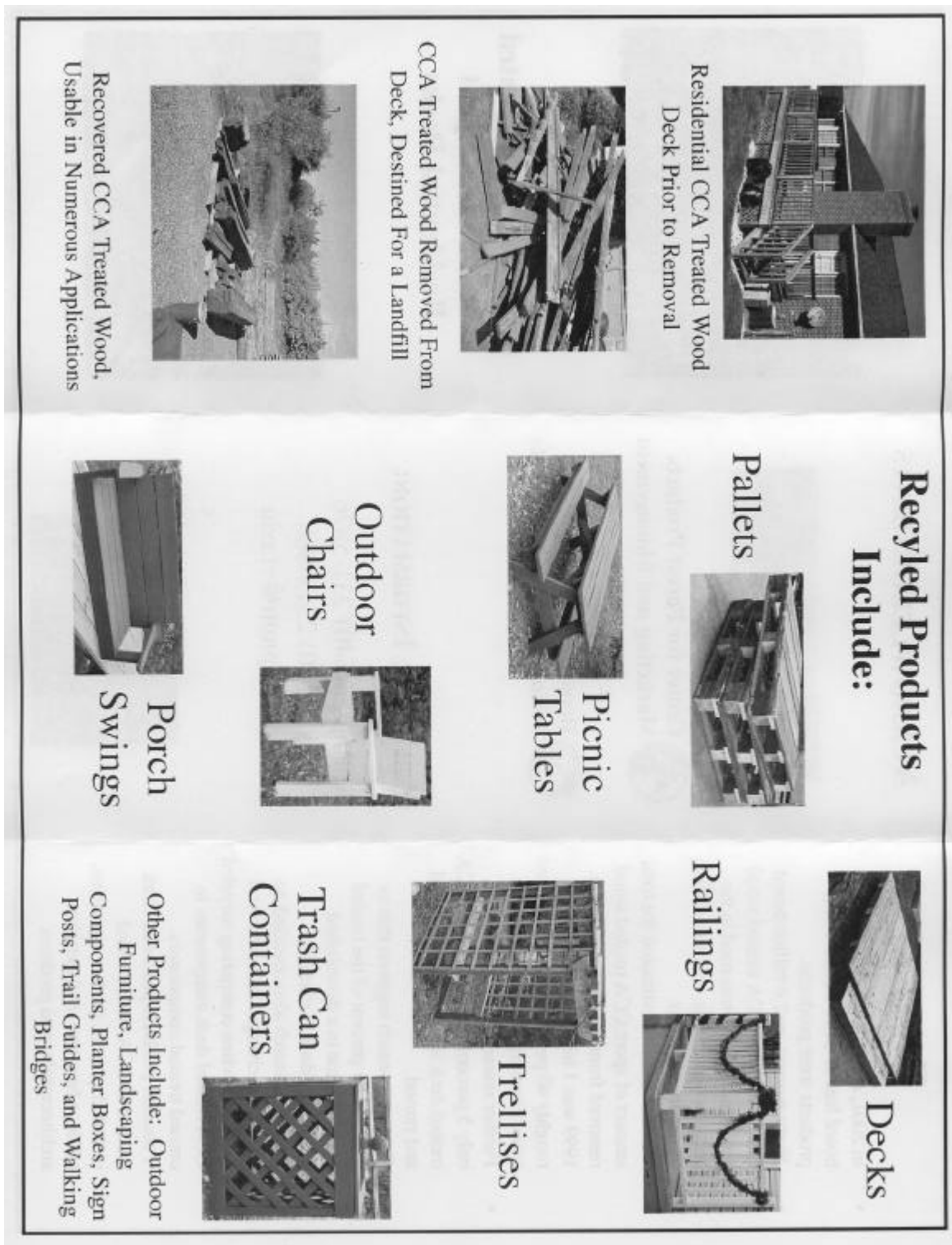


Figure A- 12. Half of brochure made to promote the recover and reuse of CCA treated wood from residential decks (brochure was folded into thirds).

VITA

David S. Bailey, son of Samuel W. Bailey and Maria L. Bailey, was born in Richmond, VA on June 15, 1976. After graduating from Sussex Central High School, as Salutatorian in 1994, Mr. Bailey attended Virginia Polytechnic Institute and State University (Virginia Tech). He received his Bachelor of Science degree in Wood Science and Forest Products at Virginia Tech in 1998 from the College of Natural Resources. After graduation Mr. Bailey accepted a position as Management Trainee with Champion International Corporation at Citronelle, AL. After eight months in this position Mr. Bailey accepted the position of Production Supervisor for Champion International Corporation in a softwood lumber production facility located at Whitehouse, FL. In May of 2001, Mr. Bailey accepted the position of Graduate Research Assistant in the Department of Wood Science at Virginia Tech, to pursue a Master of Science degree. In March of 2003, Mr. Bailey earned a Master of Science degree in Wood Science and Forest Products from Virginia Tech. Mr. Bailey will continue his career in the forest products industry.