THE ECONOMIC FEASIBILITY OF MANUFACTURING AND MARKETING SOLID WOOD PRODUCTS DERIVED FROM USED UTILITY POLES

By

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CHAPTER I

PROBLEM SETTING

Introduction

The disposal of used utility poles is becoming a major problem throughout the United States (Cooper and Balatinecz 1992, Electrical World 1992). In Oklahoma an estimated 140,000 utility poles, the equivalent to approximately 2.5 million cubic feet of treated wood, are removed from service each year (Huhnke et al. 1994). Huhnke et al. (1994) estimate that ninety to ninety-five percent of this volume is sound wood available for other uses, much of this volume ends up in landfills at a considerable expense to utility companies, their customers, and society.

Currently, utility poles identified for replacement are left for the nearby landowner or sold to the public for a nominal charge. This generates little, if any, revenue for utilities, and is a potential liability because of misuse. It is hoped that a significant number of these poles can be used as replacements, after testing and re-treatment, and/or the non-deteriorated portion of the poles used in other applications. This will decrease the need for new poles, reduce the potential liability, recover some of the remaining value in decommissioned poles, and reduce the waste stream of treated wood products.

Despite the fact that utility poles removed from service present a substantial source of material for solid wood products, very few utility companies, businesses, or individuals have pursued the opportunity of remanufacturing this material into solid wood products for a profit.

Wooden utility poles are treated with chemical preservatives to extend their service life. These chemical preservatives are retained in the used utility poles. Thus, the products manufactured from used utility poles will be classified as treated wood products.

This study addresses the feasibility of establishing a facility for the purpose of recycling used wood utility poles into solid wood products for profit. The analysis focuses on one major question: "Is it economically feasible to manufacture and market solid wood products derived from used utility poles removed from service?"

Objectives

The overall objective of this study is to determine whether it is economically feasible to reduce the number of utility poles entering the waste stream by establishing a facility to manufacture and market solid wood products derived from this raw material. The specific objectives are:

1. Estimate the average producer price and quantity of treated dimension lumber, landscape timbers, wood fence posts, and wood poles sold in Oklahoma during 1996.
2. Estimate the costs to establish and operate a facility for manufacturing treated dimension lumber, landscape timbers, fence posts, and poles derived from used wood utility poles.

Research Methods

Essentially two types of analytical tools are used to achieve the objectives of this study: descriptive and empirical.

The estimate of preservative treated wood product sales are based upon a descriptive survey of retail sales of treated wood in Oklahoma.

Potential treated wood products that could be manufactured from used utility poles are based upon estimates of the type and quantity of used utility poles removed from service. These estimates are based upon information from professionals in the electric utility industry in Oklahoma and previously conducted studies. The potential revenue generated from these products is based upon producer price information from secondary and primary sources.

Manufacturing facility configuration, productivity, and operation costs are based upon information from equipment manufactures and previously conducted trials.

Scope and Limitations

The scope of the study encompasses the state of Oklahoma and the disposal of utility poles in the state. It is limited to the recycling of wood utility poles, and the manufacturing and marketing of dimension lumber, landscape timbers, fence posts, and poles derived from used wood utility poles in the state of Oklahoma.

CHAPTER II

REVIEW OF LITERATURE

The purpose of chapter II is to review the literature relevant to this study. It is divided into two sections: (1) a review of literature pertaining to utility pole recycling and related issues, and (2) a review of economic feasibility analysis literature.

An Overview of Utility Pole Recycling Programs and Issues Related to Utility Pole Recycling

This section includes a review of disposal options for used utility poles removed from service, government regulation of preservative treated wood disposal, health and environmental concerns related to preservative treated wood, challenges facing solid wood recycling, current utility pole recycling programs, and uses for potential products manufactured from used utility poles.

Disposal Options for Decommissioned Utility Poles

This literature search has shown that there are many accepted disposal options (e.g. Cooper and Balatinecz 1992, Webb and Davis 1994). These include: (1) waste abatement or elimination; (2) waste rehabilitation and reuse; (3) waste refining for recycling; (4) reuse of spent treated wood material as fuel; and (5) waste disposal through landfilling. Disposal options for solid waste are often referred to as the disposal hierarchy, with waste abatement being the most desirable and landfilling being the least desirable (Cooper and Balatinecz 1992).

There are definite economic and environmental incentives for the owners of non-functional treated wood products to move up the disposal hierarchy. According to Cooper (1994) these incentives include:

1. The cost of wood products and especially treated wood products will continue to increase.
2. The cost of disposal of these materials in landfill sites is rapidly escalating.
3. Environmental legislation is becoming more restrictive with regard to disposal of products perceived to be hazardous.

Waste abatement or elimination

Waste abatement or elimination should be the most attractive option for utility companies. There are a number of approaches to reducing the amount and hazard of preservative in decommissioned treated wood. Cooper (1994) proposes various methods of extending the service life of treated wood through quality assurance programs to ensure adequate treatment quality and by in-situ treatments to control deterioration, and extending service life through design practices or technological innovations. Through extending the service life the frequency of decommissioned utility poles entering the waste stream would be reduced.

Waste rehabilitation and reuse

Rehabilitation and reuse of decommissioned utility poles provides many promising opportunities. Such opportunities may consist of using above ground portions of poles for residential lighting, low service lines, fence posts, building posts, landscape timbers, and parking lot bumpers. The decommissioned utility poles can also be transformed into sawn products. Kansas City Power and Light has been utilizing their decommissioned utility poles, by producing and marketing them into sawn products (Electrical World 1995). Consumer information sheets should always be given to the customer of the rehabilitated treated wood material/product (Webb and Davis 1994). As part of an agreement with the Environmental Protection Agency, the wood preserving industry agreed to develop a voluntary consumer awareness program (Webb and Davis 1994). This voluntary program distributes consumer information sheets used to convey the proper use, handling, and disposal of treated wood products (Webb and Davis 1994).

Waste refining for recycling

Louisiana State University's Institute for Environmental Studies has developed a recycling process for treated utility poles (Electrical World 1992). The utility poles are shredded, chipped, and washed, then inoculated with microbes. The microbes eat the residues, reducing the chemical to less than 1 parts per million (ppm) - far below the Environmental Protection Agency's toxicity limits of 100 ppm for pentachlorophenol and 200 ppm for creosote (Electrical World 1992). The reclaimed chemicals can be sold and reused, while the chips can be sold to paper mills and other pulp users.

Reuse of spent treated wood material as fuel

Using decommissioned utility poles as fuel for waste-to-energy plants is another option. In the 1980s the first large-scale waste-to-energy plant dedicated to incinerating treated wood was built by Koppers Industries in cooperation with Conrail and Pennsylvania Power & Light in Muncy, PA (Webb and Davis 1994). The facility has the capacity to burn 110,000 tons of used treated wood annually, producing steam for a wood treating operation and up to ten megawatts of power (Webb and Davis 1994). Koppers Industries has three plants, the Muncy plant is permitted to take creosote treated materials while facilities in Alabama and South Carolina are both permitted for creosote and penta treatments (Webb and Davis 1994).

Waste disposal through landfilling

According to Cooper (1994), landfilling should be the least desirable option, yet it is the recommended disposal method for disposing of chromated copper arsenate (CCA) and penta treated wood in some areas. Some landfills are banning the disposal of treated wood. This is not so much a hazardous waste concern, but a concern of the relative volume and noncompressibility of treated wood (Malecki 1994).

Government Regulation of Treated Wood Disposal

Creosote, pentachlorophenol-in-oil (penta), chromated copper arsenate (CCA), and ammoniacal copper arsenate (ACA) are the common "heavy duty" wood preservatives (Cooper 1994). The Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates the preservative chemicals (Webb and

Davis 1994). At the federal level, the regulatory control of wood pole disposal is under the Federal Hazardous Waste Program established by the Resource Conservation and Recovery Act (RCRA) (Malecki 1994). Each state is authorized by the federal government to implement the regulation of solid waste, including treated wood. They may develop their own rules and regulations, which can be more stringent than that established by the Environmental Protection Agency (Malecki 1994). Preservative treated wood is not regulated beyond the labeling and application requirements. However, when the treated wood has been designated as a spent waste material, it can be regulated under current environmental laws (Webb and Davis 1994).

Health and Environmental Concerns

In terms of public health and environmental protection, there is some concern about the appropriate uses, reuse, recycling, and disposal of treated wood products. If the decommissioned treated utility poles are resawn, there are problems with the disposal of unusable treated parts and the generation of contaminated sawdust (Cooper and Balatinecz 1992). Pentachlorophenol and creosote are common treatment applications for utility poles. Both pentachlorophenol and creosote are listed as hazardous waste by the Environmental Protection Agency (National Archives and Records Agency 1995). There are three ways a person can be exposed to these substances, breathing, ingesting, or skin contact. The federal government has set regulatory standards and guidelines to protect people from the possible health effect of both creosote and pentachlorophenol in air and water (U.S. Department of Health and Human Services 1995, U.S. Department of Health and Human Services 1994).

The Environmental Protection Agency has determined that coal tar creosote is a probable human carcinogen, and that coal tar pitch is a human carcinogen (U.S. Department of Health and Human Services 1995). The Environmental Protection Agency has assigned pentachlorophenol a weight-of-evidence classification of B2, which indicates that it is a probable human carcinogen (U.S. Department of Health and Human Services 1994).

The Environmental Protection Agency is now working to measure the levels of pentachlorophenol found at abandoned waste sites (U.S. Department of Health and Human Services 1994). Due to Resource Conservation and Recovery Act Land Disposal Restrictions, creosote can no longer be disposed in hazardous waste landfills unless it meets Environmental Protection Agency specified treatment standards (U.S. Department of Health and Human Services 1995). The State of Washington's Department of Ecology examined the status of treated wood and in consultation with the Environmental Protection Agency, ruled that reuse of treated wood is not regulated, provided such reuse is consistent with intended end use of the treated wood (Electrical World 1995).

Challenges of Recycling Solid Wood

The high cost of traditional disposal at municipal solid-waste areas, various government regulations and programs, the increasing demand for products utilizing recycled wood fiber, and increases in technology are helping to increase the recycling of solid wood. However, recycling of solid wood is not as common and lags far behind the paper recycling programs. Cooper and Balatinecz (1992) have noted that the recycling of treated wood has been less than successful. Recyclable paper use is projected to increase from less than 25 percent in the late 1980s to 40 percent by the year 2000 (Skog et al. 1995). Some of the reasons solid wood faces more extreme challenges for recycling include its bulkiness, lack of uniformity, distance from potential recycling industries, variable supply, and the lack of markets (Cooper and Balatinecz 1992).

Review of Current Recycling Programs

This literature search has identified two utility pole recycling programs, which are very different from each other. The first program is a portable sawmill and lumber marketing project being conducted by the Kansas City Power and Light Company (Electrical World 1995). The second project involves Public Service Electric and Gas of New Jersey, the recycling firm Microterra of Florida, and the Louisiana State University's Institute for Environmental Studies (Electrical World 1992). The Public Service Electric and Gas project transports utility poles from New Jersey to Microterra's Tallulah, Louisiana recycling plant. Microterra uses a process licensed by Louisiana State University's Institute for Environmental Studies to transform the utility poles into wood chips for use in newsprint, paper towels, particle board and other products. In addition the treatment chemicals in the used utility poles are reclaimed and sold. It appears that many utility companies nation-wide are concerned with the disposal of utility poles and would welcome some type of recycling program.

Potential Uses and Products

The most promising options for wood contaminated with preservatives are reuse in other applications and recycling as a component of composite products (Cooper and

Balatinecz 1992). Exterior rough-cut lumber applications appear to offer the easiest entry into the market and may be the least costly method of utilizing discarded utility poles. Two articles that addressed the market for treated wood suggest that the market for treated wood will remain strong for the near future. In the United States the southern region shows the greatest end use demand for treated wood (Gogolski 1988). The research has indicated that do-it-yourself projects, agricultural applications, and residential repair and remodeling end users offer the greatest potential demand for treated wood. One reuse opportunity being explored in Canada is the use of poles removed by utilities as guide rail posts for the Ontario Ministry of Transportation (Cooper and Balatinecz 1992).

The agricultural sector may prove to be one of the major market sectors for Oklahoma's products derived from discarded utility poles. Fence posts, fencing and gate rails, barn poles, hay-stack panels, landscaping timbers, bulk-heads, and similar products are potential products that could be manufactured from Oklahoma's used utility poles. The market for products derived from used utility poles should not be limited to just Oklahoma and its closest neighbors. The products from Montana's post and pole industry reach end users many miles away from Montana, about 30 percent of their market covers the area from the Dakotas to Texas (Jackson and Jackson 1989).

Conclusion and Summary

In conclusion, it is noted that in the United States the southern region consumes the largest percentage of treated wood (Gogolski 1988). According to Gogolski (1988), it is estimated that from 1990 to 2000 about 38 percent of the predicted 14 billion board feet of southern pine lumber production will be treated.

This literature search has identified two utility pole recycling programs. One in Kansas City that produces and sales lumber derived from used utility poles (Electrical World 1995). The second program processes used utility poles from New Jersey to reclaim the treatment chemicals and produce chips for paper and pulp mills (Electrical World 1992). The Koppers Industries waste-to-energy plants in Pennsylvania, Alabama, and South Carolina provide another example of current programs utilizing decommissioned utility poles as a source of energy (Webb and Davis 1994).

There are public health and environmental protection concerns about the use, reuse, recycling and disposal of chemical preservative treated utility poles. Both pentachlorophenol and creosote, which are used as preservatives for utility poles, are listed as hazardous waste by the Environmental Protection Agency (National Archives and Records Agency 1995). The Federal Government has set regulatory standards and guidelines to protect people from the possible health effect of both creosote and pentachlorophenol in air and water (U.S. Department of Health and Human Services 1995, U.S. Department of Health and Human Services 1994). Although the treatment chemicals are regulated, the Federal Government does not regulate treated wood products (Webb and Davis 1994). However, once the material is designated as a spent waste material, it can be regulated (Webb and Davis 1994).

An Overview of Economic Feasibility Analyses

This section reviews literature pertaining to economic feasibility analyses in order to provide a background for the procedures used in this study.

From the review of various studies, it appears that there are three major components to an economic feasibility analysis (Blinn et al. 1986, Chiang and Koenigshof 1980, and Wright 1989). The three elements of an economic feasibility analysis are brought together to help form a basis for a sound decision of whether or not to adopt a project such as the proposed utility pole recycling facility. These three elements are:

1. an analysis of the raw material availability and requirements;
2. an analysis of the economic feasibility and profitability of the project; and
3. an analysis of the markets and marketing potential of the project's products.

Analysis of the Raw Material

Two key elements in the analysis of the raw material are the determination of the availability of the raw material and the amount of raw material required by the facility. Determination of the raw material availability and requirements was common throughout many of the studies which were reviewed (Blinn et al. 1986, Chiang and Koenigshof 1980, McCay and Wisdow 1984, and Wright 1989). For the utility pole recycling facility the issue of raw material availability is tied directly to the quantity of utility poles removed from service each year in Oklahoma.

Particular issues concerning raw material availability and requirements are the location, ownership, quality, specifications, quantity, and temporal aspects of the raw material. As part of the raw material analysis, Wright (1989) discusses the need for potential investors to consider how the quality, quantity, and timing of raw material availability may be managed or controlled. For the proposed utility pole recycling facility the issue of quality is very important. The number of defects, or non-recyclable portions, on an utility pole is an important factor on the level of waste and type of products that the facility produces.

Economic Feasibility and Profitability

Six feasibility studies on wood products manufacturing facilities were reviewed (Blinn et al. 1986, Chiang and Koenigshof 1980, Huber et al. 1989, Lin et al. 1995, McCay and Wisdom 1984, and Wright 1989). The majority of these studies used the term "financial analysis" when referring to the analysis of economic feasibility and profitability. The term economic feasibility was used to refer to the calculation of a discounted cash flow and the use of net present value (NPV) and internal rate of return (IRR) as measures of economic feasibility. The term profitability was used to refer to the calculation of an income statement and undiscounted measures of profitability such as return on sales (ROS).

Each of the six studies used the discounted cash flow method and calculated both or either the NPV and IRR to determine the feasibility of the proposed projects. The NPV is the present worth of the incremental net benefit or incremental cash flow stream (Schreiner 1989). The net present value model is expressed as:

Equation 1: Net Present Value

$$NPV = \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

where:

B_t = benefits or cash inflows in any year t;

C_t = costs or cash outflows in any year t; and

r = the discount rate or minimum acceptable rate of return.

If NPV is zero or greater the project is acceptable, and if NPV is less than zero the project is unacceptable. In other words, the present value of revenues must be greater than or equal to the present value of costs, both computed with the investor's minimum acceptable rate of return

The IRR, as given in equation 2, is the discount rate at which the present value of revenues minus the present value of costs equals zero or where NPV equals zero (Klemperer 1996).

Equation 2: Internal Rate of Return

$$\sum_{t=0}^{n} \frac{B_t}{(1+IRR)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+IRR)^t} = 0$$

where:

B_t = benefits or cash inflows in any year t;

C_t = costs or cash outflows in any year t; and

IRR = the discount rate at which the present value of revenues equals the present value of costs.

The IRR is the rate of return earned on funds invested in a project and it is unique (or internal) to a project. The minimum acceptable rate of return an investor wishes to earn is the best earning rate widely available elsewhere and is external to a project being evaluated. If IRR is equal to or greater than the minimum acceptable rate of return the project is acceptable (Klemperer 1996).

Three of the six studies calculated income statements and employed undiscounted measures to determine profitability of the proposed projects. The most common undiscounted measure of profitability was that of return on sales. The return on sales is simply the ratio of income to revenue for the project.

Equation 3: Return on Sales

$$ROS = \frac{Operating\ Income}{Sales\ \mathrm{Re}venue}$$

The ROS for the project is compared to similar ventures already in service. For example, in Lin et al. (1995) the ROS for the proposed mill they were evaluating was compared to the ROS for similar mills published in Dun and Bradstreet's annual report on key business ratios.

Another key component of the financial analysis section of a feasibility study is the sensitivity and/or break-even analysis. This type of analysis was conducted in many different forms in the six wood processing feasibility studies which were reviewed. Essentially the purpose of a sensitivity analysis is to determine the most important factors or variables affecting the economic feasibility and profitability of a new venture or project. The majority of the sensitivity analyses were conducted by adjusting one variable at a time (holding all other variables constant) a certain percentage above and below the base then calculating the change in the NPV, IRR, and ROS. Each of these movements were compared to one another to determine the variables posing the greatest affect on the economic feasibility and profitability of the project. In other cases variables were adjusted one at a time (while holding all other variables constant) until the NPV equals zero or the ROS equals one to determine how much a variable may change before the project would break-even both in terms of economic feasibility and profitability. Other break-even analyses determined the unit and dollar volume required to break-even on the project.

Markets and Marketing

Three of the six feasibility studies reviewed had specific sections addressing the markets and marketing potential of the products produced by the projects. Wright (1989) explains that a market analysis should consist of determining the size and availability of markets for the products produced by the plant, the channels of distribution, and the selling price of the products.

The size, growth, and availability of markets were addressed in each of the three mill feasibility studies in the marketing section. The channels of distribution in some cases were not directly addressed. The selling price of the products was addressed within the feasibility study, but not necessarily within the markets and marketing section.

An important aspect addressed in each of the three studies was market penetration. Blinn et al. (1986) define market penetration as the percentage of the market that the project's products must capture in order to sell all production.

Summary of Feasibility Analyses

The standard format for published feasibility studies on wood products manufacturing projects consists of three major elements: raw material analysis, financial analysis, and market analysis.

There are two key components of a raw material analysis. One is the estimation of the availability of raw materials to the facility. Second is the raw material requirements of the facility.

The financial analysis consists of three important components. First is the determination of economic feasibility using a discounted cash flow and the net present value and internal rate of return as measures of economic feasibility. Second is the calculation of an income statement and undiscounted measures of profitability such as the return on sales. The third important component is a sensitivity analysis and/or break-even analysis to determine the variables or factors that pose the greatest affect on the economic feasibility and profitability of the project.

The market analysis is mainly concerned with determining the size and availability of markets for the project's products. An important aspect of the market analysis is the market penetration or percentage of the market that the project's products must capture in order to sell all of its production.

These three elements of a feasibility analysis form the basis for making a sound decision on whether or not to adopt a project.

CHAPTER III

RESOURCE SUPPLY

The type and quantity of utility poles removed from service are crucial to determining the type and quantity of products that can be produced from used utility poles. Chapter III is an analysis of the type and quantity of utility poles being removed from service each year in Oklahoma.

Utility Pole Classification

Utility poles are divided into three groups: (1) transmission poles, (2) distribution poles, and (3) service poles. Transmission poles are generally 60 feet in length or longer. Distribution poles are generally 35 to 55 feet in length. Service poles are generally 30 feet in length or shorter. It must be noted that these are general groupings. Some electric utility providers will have service poles 35 feet in length and transmission poles as short as 45 feet in length.

It has been estimated by Huhnke et al. (1994) that there are an estimated 3.5 million utility poles in service in the state of Oklahoma. After discussion with various professionals in the electric utility industry and review of Huhnke et al. (1994), a more detailed estimate of the type and quantity of utility poles in service in Oklahoma was calculated. Table 1 summarizes the estimate of utility poles in service in Oklahoma by utility pole grouping.

Table 1: Estimated Number of Utility Poles in Service in Oklahoma

	Transmission Poles		Distribution Poles		Service Poles		Total	
Utility Firm(s)	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate
OAEC	16,170	18,480	1,600,830	1,829,520	49,000	98,000	1,666,000	1,946,000
OG&E	65,000	75,000	500,000	600,000	83,000	133,000	648,000	808,000
other	45,986	56,070	724,180	922,130	65,834	117,800	836,000	1,096,000
Totals	127,156	149,550	2,825,010	3,351,650	197,834	348,800	3,150,000	3,850,000

Note: OAEC = Oklahoma Association of Electric Cooperatives

Note: OG&E = Oklahoma Gas and Electric Company

Chemical Preservative and Wood Species of Utility Poles

There are five major types of chemical preservatives used to treat wood. These are chromated copper arsenate (CCA), ammoniacal copper arsenate (ACA), ammoniacal chromate zinc arsenate (ACZA), pentachlorophenol (penta), and creosote. Most utility poles being put into and taken out of service are treated with penta.

The two most common wood species used for utility poles are the southern yellow pines (*Pinus spp.*) and Douglas fir (*Pseudotsuga menziesii*). There may also be some western red cedar (*Thuja plicata*) poles still in service in Oklahoma, however these are usually replaced with either a southern yellow pine or Douglas fir pole.

The majority of utility poles 75 feet in length or shorter in service in Oklahoma are made of southern yellow pine and treated with penta. Most of the utility poles 80 feet in length or longer in service in Oklahoma are Douglas fir and either treated with penta or ACZA. There are still some creosote treated poles in service, however these are usually replaced with a penta or ACZA treated pole.

Utility Pole Replacement in Oklahoma

Each year an electric utility provider will on average inspect ten percent of the utility poles under their management (Joyce 1998). Thus, every ten years an electric utility provider will have inspected all the utility poles under their management.

It is generally accepted that utility poles have a service life of 20 to 60 years. Many estimates of the quantity of utility poles replaced each year are based upon this assumption. With an estimated 3.5 million utility poles in Oklahoma and an estimated 25 year life span for utility poles, the number of utility poles that would be replaced in Oklahoma each year would be 140,000. Based upon data provided by rural electric cooperatives and other electric utilities in Oklahoma, it is estimated that the number of utility poles replaced each year in Oklahoma is less than 140,000.

The most common reason stated for utility pole replacement is degradation due to decay in the near-groundline zone. This and other types of damage that result in utility pole replacement are referred to as "failure." During the annual inspection of ten percent of an electric utility firm's poles, many of the poles receive a remedial treatment to delay or correct near-groundline zone decay as well as other potential failures. On average two to four percent of inspected utility poles are removed from service each year due to failure (Joyce 1998). In drier regions of Oklahoma, such as northwestern Oklahoma, the failure rate is about two to three percent per year; whereas in the moister regions of Oklahoma, such as southeastern Oklahoma, the failure rate is about three to four percent per year (Joyce 1998).

Another common reason for utility pole replacement is the upgrading of utility lines. With an utility line upgrade. existing utility poles are usually replaced with taller and/or higher class poles. The number of utility poles removed from service due to utility line upgrades is less predictable. The majority of utility line upgrades are in areas experiencing urban growth. The poles being removed from service from utility line upgrades are usually of better quality than those removed from service due to failure. The number of poles removed from service as a result of utility line upgrades is usually less than the number removed from service due to failure.

Transmission Pole Replacement

It is estimated that about four percent of the electric utility poles in service in Oklahoma are transmission poles. The majority of transmission poles in service in Oklahoma are managed by the larger utility firms, such as Oklahoma Gas and Electric (OG&E). These regional and/or state-wide utility providers are in most cases the firms that supply electric power to rural and municipal utility firms.

Oklahoma Gas and Electric, the largest electric utility in the State of Oklahoma, manages a system of approximately 70,000 transmission poles (Voreis 1998). Slightly less than 50 percent of OG&E's transmission poles are 45 to 75 foot class-3 southern yellow pine penta treated poles (Voreis 1998). Another portion, slightly less than half, are 75 to 120 foot class-H2 Douglas fir ACZA poles (Voreis 1998). The remainder are 45 to 120 foot poles ranging from class-3 to class-H3. During the period of July 1996 to July 1997 approximately 7,000 of OG&E's transmission poles were inspected and approximately 350 transmission poles were replaced (Voreis 1998). This equates to about one-half percent of OG&E's transmission poles being replaced during the period of July 1996 to July 1997, which is equivalent to five percent of inspected poles. According to Voreis (1998) there are just a few large utility firms in Oklahoma that manage the majority of transmission poles, with OG&E managing the greatest quantity.

According to Joyce (1998) and Faulkenberry (1998), the rural electric utilities manage very few transmission poles. It is estimated that Oklahoma Association of Electric Cooperatives (OAEC) members manage approximately 1.7 to 1.9 million utility poles. If about one percent of the OAEC members' poles are transmission poles, this equates to an estimated 16,170 to 18,480 transmission poles. According to Joyce (1998) the majority of the rural electric utilities' transmission poles are 60 foot class-3 southern yellow pine penta poles. If ten percent are inspected each year and four percent of the ten percent fail inspection, this equates to an estimated 65 to 74 transmission poles being replaced by rural electric cooperatives each year.

With an estimated 3.1 to 3.8 million utility poles in Oklahoma and an estimated 1.7 to 1.9 million managed by OAEC members and an estimated 648,000 to 808,000 managed by OG&E, the remaining amount of poles managed by other utilities is an estimated 836,000 to 1,096,000. If about five percent of these poles are transmission poles, this equates to approximately 46,000 to 56,000 transmission poles managed by utilities other than OAEC members and OG&E. If 10 percent are inspected each year and the failure rate is four percent, this equates to an estimated 184 to 224 transmission poles being removed from service each year by utility firms other than OAEC members and OG&E.

In summary it is estimated that about 500 to 600 transmission poles are removed from service each year in Oklahoma from annual inspections based upon a ten percent inspection rate and a four percent failure rate of inspected poles. Table 2 summarizes the estimated number of transmission poles replaced each year in Oklahoma. There are estimates for the ten percent inspection with an estimated four percent failure of the inspected. as well as estimates for a 25-year replacement cycle. From discussions with various professionals among the electric utility industry in Oklahoma, the true number of transmission poles being removed from service due to inspection failure is more likely to be near the 500 to 600 range per year.

Table 2: Estimated Annual Replacement of Transmission Poles in Oklahoma

	Estimated Number of Transmission Poles in Service		Estimated Number of Transmission Poles Inspected Each Year (10%)		Estimated Number of Transmission Poles Replaced if 4% of Inspected Fail		Estimated Number of Transmission Poles Replaced if on a 25 Year Cycle	
Utility Firm(s)	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate
OAEC	16,170	18,480	1,617	1,848	65	74	647	739
OG&E	65,000	75,000	6,500	7,500	260	300	2,600	3,000
other	45,986	56,070	4,599	5,607	184	224	1,839	2,243
Totals	127,156	149,550	12,716	14,955	509	598	5,086	5,982

Note: OAEC = Oklahoma Association of Electric Cooperatives

Note: OG&E = Oklahoma Gas and Electric Company

Distribution Pole Replacement

Distribution poles account for an estimated 87 to 90 percent of all the utility poles in service in Oklahoma. All of the various types of electric utility providers in the State of Oklahoma manage distribution poles.

According to Voreis (1998), Oklahoma Gas and Electric (OG&E) manages 500,000 to 600,000 distribution poles, and from July 1996 to July 1997 an estimated

10,000 to 13,000 distribution poles were replaced. This equates to about a two percent replacement of all distribution poles managed by OG&E. If this is the norm, the service life of a distribution pole is approximately 50 years. An estimated one-third of the distribution poles removed from service during the period were 30 foot class-9 poles; and an estimated two-thirds were 55 foot class-3 poles (Voreis 1998).

The Oklahoma Association of Electric Cooperative (OAEC) manages an estimated 1.6 to 1.8 million distribution poles. Most of the distribution poles managed by the OAEC are 35 foot southern yellow pine penta treated poles. Most of the distribution poles being removed from service are 35 foot class-6 poles and the poles being put in place of the old poles are 35 foot class-4 poles (Faulkenberry 1998). In some areas where increased clearance is desired a 40 foot class-4 pole is put in place of the old one (Faulkenberry 1998). In a recent annual pole inspection by Central Rural Electric approximately 5,000 poles were inspected and approximately 100 were replaced (Joyce 1998). This equates to a two percent failure rate among inspected poles.

Municipal electric utilities often use taller utility poles than rural electric utilities because of the need for greater clearance and to accommodate multiple lines. Many municipal distribution poles are 40 foot class-2 and -3, and 45 foot class-2. There are also a moderate amount of 50 and 60 foot class-2 distribution poles in service among the municipal electric utilities. The majority of these distribution poles are southern yellow pine penta treated.

Based upon a total quantity of approximately 2.8 to 3.4 million distribution poles, an annual inspection rate of ten percent, and a failure rate of four percent of inspected poles, it is estimated that about 11,300 to 13,400 distribution poles are removed from service in Oklahoma due to poles failing annual inspections. Table 3 summarizes the estimated number of transmission poles replaced each year in Oklahoma. There are estimates for the ten percent inspection with an estimated four percent failure of the inspected, as well as estimates for a 25-year replacement cycle. From replacement rate information provided by various professionals among the electric utility industry in Oklahoma, the true number of distribution poles removed from service each year is probably between 11,300 and 67,000. The 67,000 is based upon a 50-year service life for distribution poles.

Table 3: Estimated Annual Replacement of Distribution Poles in Oklahoma

	Number of Distribution Poles in Service		Number of Distribution Poles Inspected Each Year (10%)		Number of Distribution Poles Replaced if 4% of Inspected Fail		Number of Distribution Poles Replaced if on a 25 Year Cycle	
Utility Firm(s)	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate
OAEC	1,600,830	1,829,520	160,083	182,952	6,403	7,318	64,033	73,181
OG&E	500,000	600,000	50,000	60,000	2,000	2,400	20,000	24,000
other	724,180	922,130	72,418	92,213	2,897	3,689	28,967	36,885
Totals	2,825,010	3,351,650	282,501	335,165	11,300	13,407	113,000	134,066

Note: OAEC = Oklahoma Association of Electric Cooperatives

Note: OG&E = Oklahoma Gas and Electric Company

Service Pole Replacement

It is estimated that about six to nine percent of all utility poles in service in Oklahoma are service poles.

Service poles are most often 30 or 35 foot class-4 to -6 southern yellow pine penta treated. Service poles are most sparse among the lines managed by rural electric utilities, occurring about one pole every one to two miles. Among other electric utility providers service poles occur at about three to four poles per mile of electric line.

Service poles are estimated to be a small proportion of the utility poles removed from service each year. Virtually no information particular to service pole replacement rates was obtained. Based upon an approximate number of 198,000 to 349,000 service poles, a ten percent annual inspection, and a four percent failure rate of inspected poles, it is estimated that approximately 790 to 1,400 service poles are removed from service each year in Oklahoma due to failing annual inspection. Table 4 summarizes the estimates for annual service pole replacement in Oklahoma.

Table 4: Estimated Annual Replacement of Service Poles in Oklahoma

	Number of Service Poles in Service		Number of Service Poles Inspected Each Year (10%)		Number of Service Poles Replaced if 4% of Inspected Fail		Number of Service Poles Replaced if on a 25 Year Cycle	
Utility Firm(s)	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate
OAEC	49,000	98,000	4,900	9,800	196	392	1,960	3,920
OG&E	83,000	133,000	8,300	13,300	332	532	3,320	5,320
other	65,834	117,800	6,583	11,780	263	471	2,633	4,712
Totals	197,834	348,800	19,783	34,880	791	1,395	7,913	13,952

Note: OAEC = Oklahoma Association of Electric Cooperatives

Note: OG&E = Oklahoma Gas and Electric Company

Summary of Utility Pole Replacement in Oklahoma

In summary two types of estimates have been calculated for the number and type of utility poles being replaced in Oklahoma on an annual basis: (1) an estimate based upon a ten percent annual inspection and four percent failure rate of inspected poles; and (2) an estimate based upon a 25-year service life of utility poles.

Based upon an estimated 3.15 to 3.85 million utility poles, a ten percent annual inspection rate, and a four percent failure rate of the inspected poles, it is estimated that approximately 12,600 to 15,400 utility poles are removed from service each year in Oklahoma. Table 5 summarizes this estimate.

Table 5: Estimated Annual Number of Utility Poles Removed from Service, Based on a 10% Annual Inspection and 4% Failure Rate of Inspected Poles

	Transmission Poles	Distribution Poles	Service Poles	Total
Low Estimate	509	11,300	791	12,600
High Estimate	598	13,407	1,395	15,400

Based upon an average service life of 25 years for an utility pole, it is estimated that approximately 126,000 to 154,000 utility poles are removed from service each year in Oklahoma. Table 6 summarizes this estimate.

Table 6: Estimated Annual Number of Utility Poles Removed from Service, Based on a 25-Year Service Life for an Utility Pole

	Transmission Poles	Distribution Poles	Service Poles	Total
Low Estimate	5,086	113,000	7,913	126,000
High Estimate	5,982	134,066	13,952	154,000

CHAPTER IV

MARKET ANALYSIS

Chapter IV is an analysis of the preservative treated solid wood market in Oklahoma. It is organized into three major parts: (1) procedures, (2) data, and (3) results.

Procedures

A key component to the market analysis is the descriptive survey of the retail preservative treated wood products market in Oklahoma. The purpose of the survey is to aid in making estimations of the types and quantity of products that could be competitively manufactured and marketed by the utility pole recycling project.

Survey Population

The population of interest for the descriptive survey were retailers of preservative treated wood products in Oklahoma.

Sampling Procedure

The frame used for the survey was constructed from the Oklahoma Lumbermen's Association "1997 Directory and Buyers Guide," which provided a list of retail lumber and building material dealers in Oklahoma as of January 1, 1997 (Oklahoma Lumbermen's Association 1997). A supplemental list derived from telephone directories and the internet was used to address missing elements. With the supplemental list the total population of known retail lumber dealers numbered 335. Because of the small size of the survey population, a census was conducted.

Instrument Description

The survey was developed to provide a documentary analysis of the type and quantity of preservative treated solid wood products sold in Oklahoma. Both open and closed form questions were employed. See appendix-D for a copy of the survey questionnaire.

Data Gathering Procedures

The survey questionnaire was conducted via mail. A cover letter was included with the survey. The cover letter stated the purpose of the survey, the survey's sponsors, the importance of the survey, who should complete the questionnaire, an assurance of confidentiality, and when to return the questionnaire. This letter also provided a telephone number for respondents to call if they had questions about the legitimacy of the survey or had difficulty interpreting any of the questions. For non-respondents, reminder postcards, follow-up telephone calls, and second mailing of cover letters and survey questionnaires were conducted. See appendix for copies of cover letters and postcard to nonrespondents.

Data Analysis Techniques and Statistics

Descriptive statistics were employed to analyze the data and the results were tabulated into tables to describe the various types and quantity of preservative treated solid wood products sold in Oklahoma.

Data

Two major categories of data were obtained and analyzed. These are product price and sales quantity data. The product price data is from both primary and secondary data sources, while the sales quantity data is from the survey questionnaire.

Product Prices

The prices used for both the market analysis and feasibility analysis are producer prices. The prices for dimension lumber are from a secondary data source and prices for landscape timbers, fence posts, and poles are from primary data sources.

Treated dimension lumber

The producer prices for dimension lumber are from the Random Lengths "Weekly Report On North American Forest Products Markets" for 1996 (Random Lengths 1996). Each of the weekly producer prices for southern yellow pine pressure treated lumber were entered into a Microsoft Excel worksheet to determine the average price per item for 1996. The data is summarized in table 7.

Table 7: 1996 Producer Prices for Southern Yellow Pine Treated Lumber

Treated Dimension Lumber, Prices Per MBF, Prices in US $

Dimension (inches)	Length (feet) 8	10	12	14	16	Average Price
2x4	445	492	461	478	517	479
2x6	418	400	446	491	494	450
2x8	465	441	476	434	500	463
2x10	435	445	526	537	511	491
2x12	508	489	560	520	572	530
4x4	457	524	478	438	488	477
4x6	485	422	500	428	498	467
6x6	489	501	485	451	508	487

Source. Random Lenrths 1996 "Weekly Report On North American Forest Products Markets"

The sales quantity data for treated dimension lumber are in the form of aggregate board feet sold by retail lumber dealers in Oklahoma. Since the sales quantity data are in aggregate board feet, an overall average of $480.50 per thousand board feet (MBF) was used to determine the overall dollar volume of preservative treated dimension lumber sold in Oklahoma during 1996.

Treated landscape timbers, fence posts, and poles

The sales quantity data from the survey for landscape timbers, fence posts, and poles are in the form of the number of items sold. The data for treated wood poles is separated into two classes, poles 15 feet in length or less and poles greater than 15 feet in length. The producer prices for these products are derived from retail prices gathered from 14 retail lumber dealers in Oklahoma. Based on the difference between producer and retail prices for dimension lumber, it is estimated that the producer prices for these products are 65 percent of the retail price.

The producer price for treated landscape timbers was derived from ten retail prices for the standard size eight foot long landscape timber. The mean retail price was $2.95, multiplying this by 0.65 obtains the estimated producer price of $1.92 per unit for treated landscape timbers.

Thirty retail prices for various sizes of fence posts were obtained. The mean retail price was $7.05 per cubic foot, which results in an estimated producer price of $4.58 per cubic foot for treated fence posts.[1]

Derived from nine retail prices, the producer price for treated poles 15-feet in length or shorter is an estimated $6.49 per cubic foot. From seven retail prices, the producer price for treated poles greater than 15 feet is an estimated $6.80 per cubic foot.

To estimate the dollar volume of posts and poles sold by retail lumber dealers in Oklahoma, the following common sizes are used: an eight foot long, five inch top diameter fence post; a ten foot long, five inch top diameter pole; and a 20-foot long, four inch top diameter pole. Table 8 summarizes the estimated producer prices for these items.

Table 8: Estimated Producer Prices for Selected Treated Round Wood Products

Item	Cu. Ft.	$/Cu. Ft.	$/Item
8'-Length, 5"-Top	1.21	4.58	5.53
10'-Length, 5"-Top	1.60	6.49	10.37
20'-Length, 4"-Top	2.78	6.80	18.91

[1] See Appendix F for equations and procedures used for estimating solid cubic foot volumes. All cubic foot and board foot volume calculations were calculated using the methods of Avery and Burkhart (1994).

Results of the Market Analysis

The survey population numbered 335, 21 foreign elements were identified, and 160 valid questionnaires were returned. Thus, the adjusted response rate for the survey is 51 percent [160/(335-21) = 0.51]. Based on follow up telephone calls to non-respondents and the trend for identify foreign elements it is estimated that the true population of preservative treated lumber retailers in the state of Oklahoma numbers 305.

Size and Location of Preservative Treated Lumber Retailers in Oklahoma

For the purposes of analysis, firms are characterized as being small, medium, and large. A small firm is characterized as having total annual solid wood sales of $1 million or less, a medium size firm $1-5 million, and a large size firm $5 million or more. It is estimated that there are 172 small size firms, 99 medium size firms, and 34 large size firms in the state.

Geographically the firms are divided into four regions within the state. The northeast region includes 18 counties located in north central and northeastern Oklahoma. The southeastern region includes 22 counties located in south central and southeastern Oklahoma. The northwestern region includes 20 counties located in north central and northwestern Oklahoma. The southeastern region includes 17 counties located in central, south central, and southwestern Oklahoma. See appendix-E for a state of Oklahoma map divided into the four regions. It is estimated that 86 firms are located in the northeast region, 70 in the southeast region, 61 in the northwest region, and 88 in the southwest region. Table 9 summarizes the distribution of preservative treated lumber retailers in the state of Oklahoma by firm size and location.

Table 9: Size and Location of Treated Wood Retailers in Oklahoma

Region	Firm Size	Number of Firms	Percentage of Firms in the Region	Percentage of Firms in the State
Northeast	Small	43	50.0	
	Medium	29	33.7	
	Large	14	16.3	
		86		28.2
Southeast	Small	39	55.7	
	Medium	29	41.4	
	Large	2	2.9	
		70		23.0
Northwest	Small	47	77.0	
	Medium	12	19.7	
	Large	2	3.3	
		61		20.0
Southwest	Small	43	48.9	
	Medium	29	33.0	
	Large	16	18.2	
		88		28.9
State Wide	Small	172	56.4	
	Medium	99	32.5	
	Large	34	11.1	
		305		100.0

<u>The Type and Quantity of Products Sold</u>

The survey questionnaire provided sales quantity data on four preservative treated wood product categories of interest: (1) dimension lumber, (2) landscape timbers, (3) fence posts, and (4) poles. All firm sizes within each region reported sales quantity data for these products except for the large firm respondent from the northwest region. The estimated sales for each particular type of treated wood product per large size firm in the northwest region was estimated using equation 4.

Equation 4: Estimation of Sales Quantity for Northwest Region Large Size Firms

$$\frac{NWSM}{SM} = \frac{NWLg}{NWLg + Lg}$$

where:

NWSM = the sum of the average sales for small and medium firms in the northwest region;

SM = the sum of the average sales for all small and medium firms in the state;

Lg = the sum of the average sales for all large firms in the state excluding the unknown average sales of large firms in the northwest region; and

NWLg = the estimated average sales for large firms in the northwest region.

Treated dimension lumber

Based on the survey results it is estimated that 55,240.9 MBF of treated dimension lumber were sold in Oklahoma during 1996, for a total producer price value of $26,543.066. Table 10 summarizes the estimated treated dimension lumber sales by firm size and location in Oklahoma during 1996.

Table 10: Estimated Retail Sales of Treated Dimension Lumber in Oklahoma During 1996

		Treated Dimension Lumber Sales							
						Total Value		Regional Value	
Region	Firm Size	Estimated Number of Firms	Estimated Sales Per Firm (MBF)	Estimated Total Sales (MBF)	Producer Price Per MBF ($)	By Firm Size and Region ($)	By Firm Size and Region (%)	($)	(%)
Northeast	Small	43	56.2	2,416.6	480.50	1,161,169	9.8		
	Medium	29	317 1	9,194 8	480.50	4,418,086	37.4		
	Large	14	925.3	12,953.7	480.50	6,224,231	52.7		
		86		24,565.2				11,803,486	44.5
Southeast	Small	39	130.6	5,094.7	480.50	2,447,981	37.8		
	Medium	29	256.1	7,426.1	480.50	3,568,199	55 1		
	Large	2	480.0	960.0	480.50	461,277	7 1		
		70		13,480.7				6,477,457	24 4
Northwest	Small	47	44.2	2,075.2	480.50	997,145	53.6		
	Medium	12	102.6	1,231.2	480.50	591,588	31.8		
	Large	2	283.7	567.3	480.50	272,599	14.6		
		61		3,873.8				1,861,333	7.0
Southwest	Small	43	37.0	1,591.2	480.50	764,574	11.9		
	Medium	29	145.8	4,227.3	480.50	2,031,205	31 7		
	Large	16	468.9	7,502.7	480.50	3,605,011	56.3		
		88		13,321.2				6,400,790	24.1
State Wide	Small	172	65.0	11,177 7	480.50	5,370,870	20.2		
	Medium	99	223.0	22,079.4	480.50	10,609,078	40.0		
	Large	34	646.6	21,983.7	480.50	10,563,118	39.8		
		305		55,240.9				26,543,066	100.0

Treated landscape timbers

An estimated 1,506,311 treated landscape timbers were sold in Oklahoma during 1996, valued in producer prices at $2,995,953. Table 11 summarizes the treated landscape timber sales in Oklahoma during 1996, by firm size and geographic location.

Table 11: Estimated Retail Sales of Treated Landscape Timbers in Oklahoma During 1996

		Treated Landscape Timber Sales							
						Total Value		Regional Value	
Region	Firm Size	Estimated Number of Firms	Estimated Sales Per Firm (number)	Estimated Total Sales (number)	Producer Price Per Unit ($)	By Firm Size and Region ($)	By Firm Size and Region (%)	($)	(%)
Northeast	Small	43	1,824	78,432	1.92	150,597	18.9		
	Medium	29	2,572	74,588	1.92	143,216	18.0		
	Large	14	18,700	261,800	1.92	502,682	63.1		
		86		414,820				796,496	26.6
Southeast	Small	39	4,436	173,004	1.92	332,185	53.0		
	Medium	29	4,564	132,356	1.92	254,137	40.6		
	Large	2	10,400	20,800	1.92	39,938	6.4		
		70		326,160				626,260	20.9
Northwest	Small	47	1,016	47,752	1.92	91,689	25.5		
	Medium	12	7,384	88,608	1.92	170,136	47.3		
	Large	2	25,467	50,934	1.92	97,798	27.2		
		61		187,294				359,623	12.0
Southwest	Small	43	829	35,647	1.92	68,446	5.6		
	Medium	29	4,798	139,142	1.92	267,167	22.0		
	Large	16	28,578	457,248	1.92	877,962	72.3		
		88		632,037				1,213,574	40.5
State Wide	Small	172	1,947	334,835	1.92	642,917	21.5		
	Medium	99	4,391	434,694	1.92	834,656	27.9		
	Large	34	23,258	790,782	1.92	1,518,381	50.7		
		305		1,560,311				2,995,953	100.0

Treated fence posts

An estimated 699,616 treated fence posts were sold in Oklahoma during 1996, for a producer price value of $3,866,261. Table 12 summarizes the estimated sales of treated fence post by firm size and location within Oklahoma during 1996.

Table 12: Estimated Retail Sales of Treated Fence Posts in Oklahoma During 1996

		Treated Fence Post Sales							
						Total Value		Regional Value	
Region	Firm Size	Estimated Number of Firms	Estimated Sales Per Firm (number)	Estimated Total Sales (number)	Producer Price Per Unit ($)	By Firm Size and Region ($)	By Firm Size and Region (%)	($)	(%)
Northeast	Small	43	489	21,027	5.53	116,201	12.2		
	Medium	29	655	18,995	5.53	104,971	11.1		
	Large	14	9,417	131,838	5.53	728,571	76.7		
		86		171,860				949,743	24.6
Southeast	Small	39	5,986	233,454	5.53	1,290,128	89.2		
	Medium	29	896	25,984	5.53	143,594	9.9		
	Large	2	1,150	2,300	5.53	12,710	0.9		
		70		261,738				1,446,433	37.4
Northwest	Small	47	1,987	93,389	5.53	516,092	81.2		
	Medium	12	1,083	12,996	5.53	71,819	11.3		
	Large	2	4,294	8,588	5.53	47,460	7.5		
		61		114,973				635,371	16.4
Southwest	Small	43	228	9,804	5.53	54,179	6.5		
	Medium	29	2,445	70,905	5.53	391,840	46.9		
	Large	16	4,396	70,336	5.53	388,695	46.6		
		88		151,045				834,714	21.6
State Wide	Small	172	2,080	357,674	5.53	1,976,600	51.1		
	Medium	99	1,302	128,880	5.53	712,225	18.4		
	Large	34	6,267	213,062	5.53	1,177,436	30.5		
		305		699,616				3,866,261	100.0

Treated poles

An estimated 30,860 poles greater than 15 feet in length were sold in Oklahoma during 1996, for a producer price value of $583,518. Table 13 summarizes, by firm size and location, the number and value of treated poles greater than 15 feet in length sold by retail lumber dealers in Oklahoma during 1996.

Table 13: Estimated Retail Sales of Treated Poles in Oklahoma During 1996, for Pole Sizes Greater Than 15 feet in Length

				Treated Poles (x>15') Sales					
						Total Value		Regional Value	
Region	Firm Size	Estimated Number of Firms	Estimated Sales Per Firm (number)	Estimated Total Sales (number)	Producer Price Per Unit ($)	By Firm Size and Region ($)	By Firm Size and Region (%)	($)	(%)
Northeast	Small	43	70	3,010	18.91	56,915	56.9		
	Medium	29	65	1,885	18.91	35,643	35.7		
	Large	14	28	392	18.91	7,412	7.4		
		86		5,287				99,970	17.1
Southeast	Small	39	129	5,031	18.91	95,129	51.8		
	Medium	29	158	4,582	18.91	86,639	47.2		
	Large	2	50	100	18.91	1,891	1.0		
		70		9,713				183,659	31.5
Northwest	Small	47	34	1,598	18.91	30,216	48.2		
	Medium	12	110	1,320	18.91	24,959	39.8		
	Large	2	200	400	18.91	7,563	12.1		
		61		3,318				62,739	10.8
Southwest	Small	43	14	602	18.91	11,383	4.8		
	Medium	29	68	1,972	18.91	37,288	15.7		
	Large	16	623	9,968	18.91	188,481	79.5		
		88		12,542				237,151	40.6
State Wide	Small	172	60	10,241	18.91	193,643	33.2		
	Medium	99	99	9,759	18.91	184,529	31.6		
	Large	34	319	10,860	18.91	205,347	35.2		
		305		30,860				583,518	100.0

An estimated 114,770 poles 15 feet in length or less were sold in Oklahoma during 1996 for a producer price value of $1,189,822. By firm size and location, table 14 summarizes the estimated number and value of poles 15 feet in length or less sold in Oklahoma by retail lumber dealers during 1996.

Table 14: Estimated Retail Sales of Treated Poles in Oklahoma During 1996, for Pole Sizes Less Than 15 Feet in Length

		Treated Poles (x<15') Sales							
						Total Value		Regional Value	
Region	Firm Size	Estimated Number of Firms	Estimated Sales Per Firm (number)	Estimated Total Sales (number)	Producer Price Per Unit ($)	By Firm Size and Region ($)	By Firm Size and Region (%)	($)	(%)
Northeast	Small	43	154	6,622	10.37	68,650	15.2		
	Medium	29	1,067	30,943	10.37	320,787	70.9		
	Large	14	433	6,062	10.37	62,845	13.9		
		86		43,627				452,282	38.0
Southeast	Small	39	217	8,463	10.37	87,736	36.7		
	Medium	29	491	14,239	10.37	147,616	61.8		
	Large	2	172	344	10.37	3,566	1.5		
		70		23,046				238,918	20.1
Northwest	Small	47	102	4,794	10.37	49,699	30.6		
	Medium	12	774	9,288	10.37	96,289	59.3		
	Large	2	785	1,570	10.37	16,276	10.0		
		61		15,652				162,265	13.6
Southwest	Small	43	102	4,386	10.37	45,470	13.5		
	Medium	29	199	5,771	10.37	59,828	17.8		
	Large	16	1,393	22,288	10.37	231,060	68.7		
		88		32,445				336,358	28.3
State Wide	Small	172	141	24,265	10.37	251,556	21.1		
	Medium	99	608	60,241	10.37	624,519	52.5		
	Large	34	890	30,264	10.37	313,747	26.4		
		305		114,770				1,189,822	100.0

Summary of Treated Wood Product Sales

The estimated total producer price value of treated dimension lumber, landscape timbers, fence posts and poles sold in Oklahoma by retail lumber dealers during 1996 is $35,178,620. Treated dimension lumber accounts for 75.5 percent of this dollar volume, fence posts account for 11 percent, landscape timbers account for 8.5 percent, and poles account for five percent.

Businesses in which lumber sales do not contribute a major or significant portion of the firm's overall sales revenue were not included in this study. Bias due to businesses not represented by the survey population may influence the estimates of retail sales for preservative treated solid wood products in this study. Thus, some department stores, lawn and garden centers, and farm supply stores were not included in this study. These particular types of businesses may provide for sale a moderate amount of treated solid wood products such as fence posts and landscape timbers. Therefore, the retail sales of treated wood fence posts and landscape timbers may be larger than the estimates reported.

CHAPTER V

FEASIBILITY ANALYSIS

Financial Analysis Model

Once the inputs and outputs of the project have been identified, valued, and priced, the model can be developed. The model consists of four components: (1) the total annual costs and benefits budget, (2) the annual cash flow budget, (3) the annual pro-forma income statement, and (4) the net present value.

Total Annual Costs and Benefits Budget

The expected costs of the utility pole recycling project are classified into two major components, the capital costs and production costs.

The capital costs include the cost of fixed investments and initial working capital. The working capital requirements are estimates of the resources necessary to fund the facility's startup and continued operation. The fixed investments include, land, site preparation, storage shed, equipment, freight costs for the equipment, and application and account fees.

The production costs include purchase and freight cost for raw material, direct labor, supervisor salary, worker's compensation and employer's liability tax, energy, sales expense, general administrative expense, insurance, and property tax.

Raw Material Analysis

Lack of Uniformity

The used utility poles available to the processing plant will arrive in a multitude of sizes and conditions. The size and condition of the used utility pole is a major consideration in the type of solid wood products that could be manufactured from the used utility poles. The major aspects that make up the lack of uniformity of the used utility poles are:

1. length,
2. size class, and
3. number and location of defects.

The used utility poles arriving to the plant may be of many different lengths ranging from 30 feet to 120 feet in five foot increments. The poles may also be one of approximately 16 different size classes. The size class is based on the top diameter and the circumference six feet from the butt of the pole. The standard classification numbers range from one to ten, with a class-1 having a larger diameter than a class-10 (Hawes 1947). The largest diameter poles are "H-class" poles, with a class-H6 having a larger diameter than a class-H1 (Voreis 1998). The length and size classes are important in determining the number of board feet of dimension lumber or landscape timbers, or length and diameter of poles or posts that could be manufactured from the used utility pole.

The third major aspect concerning the lack of uniformity of used utility poles entering the processing plant is the number and location of defects. The major defects are:

1. near-groundline zone decay,
2. pole top decay,
3. splitting of pole tops,
4. number and location of bolt holes or connection points,
5. decay at connection points,
6. seasoning checks,
7. woodpecker damage, and
8. abrasions.

The number and location of these defects will have a significant impact on the type and quantity of products that could be manufactured from the used utility pole. There are literally hundreds of combinations of connection points or bolt hole locations used. At a minimum for most poles the top 18 to 24 inches of the pole will be rendered near useless for the manufacturing of solid wood products because of the number of bolt holes. Below this area bolt holes may also be common, however they may be spaced about four or more feet apart and would thus limit the length of the solid wood product that could be manufactured. If a pole is removed from service due to failing inspection, the near-groundline zone decay could render the section from 24 inches below and 18 inches above groundline near useless for manufacturing solid wood products. Furthermore, the greater the quantity of defects in a pole the greater the disposal costs for the utility pole recycling facility.

Transmission Poles as Raw Material Input

For the purpose of this analysis all transmission poles will be utilized to produce dimension lumber. The 60-foot class-3, 80-foot class-1, and 100-foot class-H2 transmission poles are used as base length and class sizes to determine the potential board foot and cubic foot volume that could be produced from transmission poles. For the base case scenario, 50 percent of the transmission poles entering the recycling facility will be 60-foot class-3, 25 percent 80-foot class-1, and 25 percent 100-foot class-H2. Table 15 summarizes the board foot (international 1/4 rule) and solid cubic foot volumes per pole excluding waste.

Table 15: Board Foot and Cubic Foot Content of Selected Transmission Poles

Length (feet)	Class Size	Board Foot Content Per Pole (international 1/4 rule)	Cubic Foot Content Per Pole
100	H2	3,125.2	390.0
80	1	533.1	77.1
60	3	214.2	34.0

Distribution Poles as Raw Material Input

The distribution poles have potential to produce dimension lumber, as well as landscape timbers, poles, and posts. It is most likely that the smaller distribution poles will not be suitable for the manufacture of dimension lumber. The 35-foot class-6, 40-foot class-4, and 45-foot class-2 are used as base length and class sizes to determine the potential board foot and cubic foot volume that could be produced from distribution poles. For the base case scenario, 50 percent of the distribution poles entering the recycling facility will be 35-foot class-6, 25 percent 40-foot class-4, and 25 percent 45-

foot class-2. Table 16 summarizes the board foot (international 1/4 rule) and solid cubic foot volumes per pole excluding waste.

Table 16: Board Foot and Cubic Foot Content of Selected Distribution Poles

Length (feet)	Class Size	Board Foot Content Per Pole (international 1/4 rule)	Cubic Foot Content Per Pole
45	2	122.8	20.2
40	4	84.8	15.0
35	6	43.7	8.9

Service Poles as Raw Material Input

Service poles will be used for the manufacture of poles and posts. The 35-foot class-6, and 30-foot class-6 are used as base length and class sizes to determine the potential board foot and cubic foot volume that could be produced from service poles. In the base case, each of these type of poles will contribute 50 percent to the number of service poles entering the recycling facility. Table 17 summarizes the board foot (international 1/4 rule) and solid cubic foot content per pole excluding waste.

Table 17: Board Foot and Cubic Foot Content of Selected Service Poles

Length (feet)	Class Size	Board Foot Content Per Pole (international 1/4 rule)	Cubic Foot Content Per Pole
35	6	43.7	8.9
30	6	32.3	6.9

Total Estimated Raw Material Input

Based on the preceding estimates for board foot and cubic foot volumes for transmission, distribution, and service poles and the estimated removals of utility poles each year, two estimates of the total quantity of raw material available as input for the sawmill have been calculated. These estimates are: (1) a conservative estimate predicted on an annual ten percent inspection and four percent failure rate of inspected poles, and (2) a liberal estimate predicted on a 25-year service life.

Under the conservative estimate, the board foot volume available is approximately 1.4 to 1.7 million, estimated by the international one-quarter log rule. The conservative estimate for solid cubic foot volume is between 224,000 and 269,000 cubic feet. Under the liberal estimate, the board foot volume available is 13.8 to 16.5 million, and the solid cubic foot volume is 2.2 to 2.7 million. These estimates are for the total volume available without an adjustment for the non-recyclable portions of the poles. Table 18 summarizes these estimates.

Table 18: Estimated Total Raw Material Input Available Under Two Scenarios

	Estimated Volume of Used Utility Poles Removed Annually							
	10% inspection, 4% failure				25-year replacement cycle			
	Low Estimate		High Estimate		Low Estimate		High Estimate	
Type of Pole	Board Feet	Cubic Feet	Board Feet	Cubic Feet	Board Feet	Cubic Feet	Board Feet	Cubic Feet
Transmission	519,658	68,029	611,179	80,010	5,196,582	680,290	6,111,786	800,100
Distribution	833,259	150,131	988,596	178,119	8,332,593	1,501,310	9,885,959	1,781,185
Service	30,058	6,272	52,995	11,058	300,579	62,719	529,949	110,580
TOTAL	1,382,975	224,432	1,652,769	269,187	13,829,754	2,244,320	16,527,694	2,691,866

Sawmill Facility Layout

The proposed sawmill facility will require two acres of land. The plant will produce sawn (e.g., dimension lumber) and round wood (e.g., posts, poles) products. The used utility poles will arrive at the facility through a sorting yard, where they will be sorted based upon their suitability for the production of either sawn or round wood products. Waste sections of the poles will be removed and placed in a waste disposal receptacle. Used poles suitable for the production of sawn products will be transferred to the sawmill for processing then to the finished products yard. Slabs and other by-products of the production process will be transferred to the waste disposal receptacle. Used poles not suitable for sawn products will be cut to length for fence posts and poles then transferred to the finished products yard.

The plant will have a base level of output per hour of 300 board feet of sawn products and 38 cubic feet of round wood products, and operate eight hours per day 250 days per year. The annual production will be 600,000 board feet of sawn products and 76.000 cubic feet of round wood products. The amount of waste per pole will be important in determining the number and characteristics of poles required for the input. Table 19 provides estimates of the raw material required to produce the annual output depending upon the amount of waste per pole.

Table 19: Annual Raw Material Requirements of the Utility Pole Recycling Facility

	Number of Poles Required Per Year, Based Upon Amount of Waste					
	Amount of Waste Per Pole (%)					
	0	10	20	30	40	50
Pole Length and Class	Number of Poles Required Per Year					
100-foot, Class-H2	102	114	128	146	171	205
80-foot, Class-1	131	146	164	188	219	263
60-foot, Class-3	233	259	292	333	389	467
45-foot, Class-2	1,303	1,448	1,629	1,861	2,172	2,606
40-foot, Class-4	2,000	2,222	2,500	2,857	3,333	4,000
35-foot, Class-6	4,857	5,397	6,071	6,939	8,095	9,714
30-foot, Class-6	333	370	417	476	556	667

A waste level of 20 percent will be used for the base case scenario. A 20 percent waste level means that 80 percent of the board foot volume available from an used utility pole can be reclaimed, and that 20 percent must be disposed of at cost to the utility pole recycling facility. The number of poles required to produce the annual output at 20 percent waste is slightly less than the estimated annual utility pole replacement at the ten percent inspection rate and four percent failure rate of inspected poles. The proportionate number of transmission, distribution, and service poles required as input are roughly equivalent to the estimated proportionate number being removed from service each year.

Costs and Benefits Budget

Capital Costs

The capital costs are classified into four categories: (1) land and building, (2) equipment, (3) account and application fees, and (4) working capital.

Land and building

The facility will require two acres of land at an estimated $5,000 per acre with an estimated expense of $20,000 for site preparation. A 1,296 square foot metal building will be required for use as an equipment storage shed and site office at an estimated cost of $15,000.

Equipment

The facility will require a portable sawmill, forklift, and chain-saw. The estimated expenses for the equipment are $26,000, $24,000, and $500 respectively. The estimated useable life spans are ten years for the portable sawmill and forklift and five years for the chain-saw. Also included in the capital costs are the freight costs of delivering the equipment to the sawmill facility. It is estimated that the freight costs will be five percent of the value of the equipment purchased.

Account and application fees

Various accounts must be established. Two major accounts are (1) worker's compensation and employer's liability, and (2) waste disposal.

The worker's compensation and employer's liability account classification code for sawmills in the State of Oklahoma is number 2710 (Durban 1998). This account is established with the State of Oklahoma Insurance Fund. In order to write a worker's compensation and employer's liability policy, the State Insurance Fund requires an one time application fee of $140. A deposit is also required, the amount of the deposit is 25 percent of the projected annual worker's compensation and employer's liability tax payments, which is estimated to be $3,871.

The sawmill facility will produce some by-product that must be disposed. Each area within the State of Oklahoma will offer various solid waste disposal services. For this analysis a 40-yard dumpster will be required. For establishing waste disposal services it is common that the business must establish an account. It is estimated that there will be an one time fee of $250 to establish the account and another one time fee of $60 to initially deliver the 40-yard dumpster to the sawmill facility.

Working capital

Included in the capital cost is three months of working capital. The amount of working capital required is based upon the costs of operating the facility for three months. The amount of working capital required is $120,111.

Summary of capital costs

The entire capital cost for the operation is an estimated $222,457 in the first year and $525 in the sixth year. Table 20 summarizes the capital costs.

Table 20: Capital Costs For Base Case Scenario ($/Year)

Item	Year 1	Year 6
Land (2 acres)	10,000	
Site Preparation	20,000	
Storage Shed (36' x 36' metal)	15,000	
Equipment		
Portable Sawmill	26,000	
Chainsaw	500	500
Forklift	24,000	
Freight Costs	2,525	25
Worker's Comp. Application	140	
Worker's Comp. Deposit	3,871	
Waste Disposal Application Fee	250	
Dumpster Delivery Fee	60	
Working Capital	120,111	
Total	222,457	525

Production Costs

The production costs are: raw material input; labor and labor related expenses; energy, maintenance, and waste disposal expenses; and sales, general administrative, and property expenses.

Cost of raw material

Various electric utilities throughout Oklahoma sell used utility poles on either a per foot or per pole basis. Used utility poles sold on a per foot basis are priced at $0.30 to $0.50 per foot. Used utility poles sold on a per pole basis are priced at $15 to $30 per pole. For the purpose of this analysis a per linear foot rate of $0.40 is used as the base. The estimated annual expense for the raw material input is $176,691.

In addition to the actual cost of the used utility pole, there will be an added cost of transporting the utility pole to the recycling facility. The rate for transporting poles is an estimated \$1.85 per mile, with a maximum load of 42,000 pounds. At an estimated 56 pounds per cubic foot of raw material and an estimated 200 miles per load, the estimated annual expense for freighting the raw material is \$98,744.

Labor and labor related expenses

It is expected that two laborers and one supervisor will be required. The labor wage rate is \$15 per hour and the supervisor wage rate is \$20 per hour. Total annual wages are estimated to cost \$60,000 for the direct labor and \$40,000 for the supervisor.

The sawmill facility will be required to pay worker's compensation and employer's liability tax to the State of Oklahoma Insurance Fund. The worker's compensation and employer's liability code for sawmill facilities is number 2710. Code 2710 has a base rate of \$17.32 per \$100 of payroll. If the total annual tax paid to the State of Oklahoma Insurance Fund is greater than \$5,000 there is a 10.6 percent discount on the worker's compensation and employer's liability tax rate. The estimated annual worker's compensation and employer's liability tax payments are \$15,484.

Worker's safety apparel and equipment will also be required. These items will include hard-hats, ear and eye protective wear, chaps, and so forth. It is estimated that these items will cost \$0.50 per thousand board feet (MBF) of production. At an estimated production level of 600 MBF per year, the estimated annual expense for worker's safety apparel and equipment is \$300.

Energy, maintenance, and waste disposal expenses

The major consumption of energy will be diesel-oil and gasoline for the portable sawmill, forklift, and chain-saw. Because the fuel will be used for off-road industrial purposes the sawmill facility is expected to qualify for tax-exemption status on the fuel purchases. The estimated average price of fuel is $0.715 per gallon, which includes the tax exemption. The aggregate average fuel consumption for the facility is an estimated 1.65 gallons per hour. With the facility operating 2,000 hours per year, the estimated annual fuel expense is $2,360.

All equipment will need regular maintenance, and sawmill blades and chain-saw chains will need to be replaced frequently. These and other maintenance expenses are estimated to cost $5.00 per MBF of production. At an annual production level of 600 MBF, the annual maintenance expense is $3,000.

A 40-yard dumpster will be used to store waste for disposal. The major waste will be sawdust and non-recyclable portions of the utility poles. The amount of waste generated will depend upon the quality of the utility poles recycled. The disposal of 40-yards of waste is estimated to cost $300, plus an estimated cost of $4.00 per day to rent the 40-yard dumpster. Based on a 20 percent waste level the estimated annual cost for waste disposal is $61,507.

Sales, general administrative, and property expenses

Expenses associated with sales and sales promotions are estimated to cost 2.5 percent of the total dollar volume of sales. The estimated annual sales expense is $12,968.

General administrative expenses involved in operating the sawmill facility are estimated to cost 1.5 percent of the total dollar volume of sales. The estimated annual general administrative expense is $7,781.

Property insurance is estimated to cost one percent of the value of the building and equipment, for an annual expense of $655. The property tax is estimated to cost one percent of the value of the land, site preparation, equipment, and building, for an annual expense of $955.

Summary of production costs

The production costs are based upon an annual output of 600 MBF of sawn products and 76,000 ft^3 of round wood products. The facility will operate eight hours per day 250 days per year with two laborers and one supervisor. There is an expected 20 percent level of waste, or 80 percent recyclability, of the used utility poles. Under this base case scenario, the estimated total annual production costs are $480,444. Table 21 summarizes the annual production costs.

Table 21: Annual Production Costs For Base Case Scenario

Item	$/Year
Cost of Used Utility Poles (raw material)	176,691
Freight Expense for Used Utility Poles	98,744
Direct Labor	60,000
Supervisor Salary	40,000
Worker's Comp & Employer's Liability Tax	15,484
Worker's Safety Apparel & Equipment	300
Energy	2,360
Maintenance	3,000
Waste Disposal	61,507
Sales Expense	12,968
General Administrative Expense	7,781
Insurance	655
Property Tax	955
Total	480,444

Preservative Retreatment

Preservative retreatment is not considered in the base case scenario. If retreating the recycled wood products is desired, it will add production expenses. Preservative retreatment will most likely be done at one of the preservative retreating facilities within Oklahoma. This will also add additional freight expenses.

There are three major wood preserving plants in Oklahoma (AWPI 1996). These facilities are in Antlers, Idabel, and Broken Bow. The Idabel plant uses creosote treatment, the Antlers plant uses creosote and waterborne treatment (e.g., CCA, ACZA, ACA, et al.), and the Broken Bow plant uses creosote and pentachlorophenol (AWPI 1996). In every case, the chemicals used to retreat the sawn and round wood products manufactured from the used utility pole must be the same chemical preservative that was used to treat the original utility pole.

The estimated expense for preservative treatment is $3.00 per cubic foot. The estimated annual expense for retreatment of all output is $377,324. The cost of transporting the products is $1.85 per mile, with a maximum load of 42,000 pounds. At an estimated 200 miles per load and 56 pounds per cubic foot the total annual freight cost for retreating is $62,049.

Depreciation

For the purpose of this analysis the straight-line method of depreciation is used, with no salvage value. The annual depreciation amounts are $2,600 for the sawmill, $100 for the chain-saw, and $2,400 for the forklift, for a total annual depreciation of $5,100.

Sales Revenue

The sales revenue per item is estimated to be 70 percent of the producer price for the recycled wood products not retreated, which is the base case scenario. The estimated sales prices for the base case scenario are $336.35 per MBF for sawn products and $4.17 per ft^3 for round wood products.

If the recycled products are retreated the sales revenue per item is estimated to be 85 percent of the producer price. For the preservative retreatment option, the sales prices for the products are $408.43 per MBF for sawn products and $5.07 per ft^3 for round wood products.

The price of sawn products is based on the average producer price of southern pine treated lumber from the Random Lengths 1996 "Weekly Report On North American Forest Products Market" (Random Length 1996). The price of round wood products is derived for a sample of retail prices for preservative treated round wood products sold by retail lumber dealers in Oklahoma. Table 22 summarizes the estimated per unit and total annual sales revenue.

Table 22: Sales Revenue for the Project

					100% of market value		85% of market value		70% of market value	
Products	Producer price per unit ($)	Retail price per unit ($)	Units	Number of units	in producer prices ($)	in retail prices ($)	in producer prices ($)	in retail prices ($)	in producer prices ($)	in retail prices ($)
sawn	480.50	739.23	MBF	600	288,300	443,538	245,055	377,008	201,810	310,477
round	5.96	9.16	cubic ft.	76,000	452,743	696,527	384,831	592,048	316,920	487,569
Total					741,043	1,140,066	629,886	969,056	518,730	798,046

Analysis of Base Case Scenario

To determine the financial feasibility of the base case the operating income before income taxes is calculated. The net present value of the cash flow is calculated using a ten year planning period and an 11.25 percent discount rate. The discount rate is based on the Prime Rate for corporate loans posted by at least 75 percent of the nation's 30 largest banks (Wall Street Journal 1998) plus 2.75 percent for local bank expenses. A sensitivity analysis is also conducted to determine the effects of the various variables on the profitability of the venture.

The following assumptions were used in the analysis of the base case scenario:

1. The proposed utility pole recycling facility will be fully equity financed.
2. The minimum attractive rate of return for investment will be 11.25 percent.
3. The planning period, or period of analysis, is ten years.
4. The proposed facility will operate 250 days per year and one eight hour shift per day, with a production capacity of 300 board feet of sawn products per hour and 38 cubic feet of round wood products per hour.

5. All final products produced by the proposed facility will be sold.
6. The average selling price for the products will be 70 percent of the producer price for equivalent virgin treated wood products, or an estimated $336.35 per MBF for sawn products and $4.17 per ft^3 for round wood products.
7. The average purchase price for raw material input (used utility poles) will be $0.40 per linear foot.
8. The raw material input must be transported to the facility on average 200 miles per load at a cost of $1.85 per mile, with a maximum load of 42,000 pounds or 750 ft^3.
9. The average waste level of the raw material input is 20 percent.
10. Waste disposal service will on average cost the facility $300 per 200 ft^3 of waste generated.
11. The proposed facility will require two full-time laborers at $15 per hour each, and one full-time supervisor at $20 per hour.
12. The straight-line method of depreciation is employed with no salvage value, for an estimated $5,100 of depreciation per year.

An analysis of the optimal location for the facility is beyond the scope of this study and was therefore not included in this analysis.

Operating Income of the Base Case Scenario

Under the base case scenario the project yields, before income tax, an annual income of $33,186, a return on sales of 6.56 percent, and a return on investment of 14.92 percent.

Table 23: Pro-Forma Annual Income Statement for Base Case Scenario ($)

Sales Revenue:		
Sawn Products		201,810
Round Wood Products		316,920
Total Sales Revenue		518,730
Less: Sales Expense		12,968
Net Sales Revenue		505,762
Cost of Goods Manufactured:		
Direct Materials	176,691	
Freight Cost for Direct Materials	98,744	
Direct Labor	60,000	
Supervisor Salary	40,000	
Worker's Comp. & Emp. Liab. Tax	15,484	
Worker's Safety Apparel & Equip.	300	
Energy	2,360	
Maintenance	3,000	
Waste Disposal	61,507	
Cost of Goods Manufactured		458,085
Gross Margin		47,677
Operating Costs:		
General Administrative Expense	7,781	
Insurance	655	
Property Tax	955	
Depreciation	5,100	
Operating Cost		14,491
Operating Income Before Income Tax		33,186
Return on Sales (%) =	6.56	
Return on Investment (%) =	14.92	

Discounted Cash Flow Analysis of the Base Case Scenario

The discounted cash flow analysis for the base case scenario indicates a net present value of $128,706 at an 11.25 percent discount rate over a ten year period. The internal rate of return is 56.5 percent. The results indicate that the project is an attractive investment.

Table 24: Discounted Cash Flow for Base Case Scenario

Year	Annual Benefits ($)	Annual Costs ($)	Annual Net Benefit (Cash Flow) ($)	Discount Factor (11.25%)	Present Value of Cash Flow 11.25% ($)
1	486,309	552,762	(66,453)	0.8989	(59,733)
2	518,730	480,444	38,286	0.8080	30,934
3	518,730	480,444	38,286	0.7263	27,806
4	518,730	480,444	38,286	0.6528	24,994
5	518,730	480,444	38,286	0.5868	22,467
6	518,730	480,969	37,761	0.5275	19,918
7	518,730	480,444	38,286	0.4741	18,153
8	518,730	480,444	38,286	0.4262	16,317
9	518,730	480,444	38,286	0.3831	14,667
10	518,730	480,444	38,286	0.3443	13,184
Total	5,154,879	4,877,284	277,596		128,706

Net present value at 11.25 percent = $ 128,706
Internal Rate of Return = 56.5%

Sensitivity Analysis of the Base Case Scenario

A sensitivity analysis was performed on each of the variables to determine their effects on the profitability of the venture. The most important variables are: sales prices of the finished products, purchase price of the raw material, the overall waste level of the raw material, freighting mileage and rate, laborer number and wage rate, waste disposal rate, and supervisor salary. All other variables could be double or more the base level without having a great impact on the profitability of the venture.

The sensitivity analysis was conducted in a manner to determine the level of the variable, holding all other variables constant, that would cause a break-even or zero-profit in the annual pro-forma income statement.

Price of finished goods, price of raw material input, and level of waste variables

The sales price of the round wood products has the greatest impact on the profitability of the utility pole recycling venture. The price could decrease by 10.79 percent, or from $4.17 to $3.72 per cubic foot, before a zero profit before income taxes is reached. The price of sawn products was the second most sensitive variable. The price of sawn products could decrease by 17.13 percent, or from $336.35 to $278.74 per thousand board feet, before a zero-profit before income taxes is reached.

The price of the raw material input was the third most sensitive variable. The price of the raw-material could increase by 20 percent, or from $0.40 to $0.48 per linear foot, before an annual zero-profit before income taxes is reached.

The level of waste of the raw-material is the fourth most sensitive variable. The waste level could increase by 21.8 percent, or from the base of 20 to 24.36 percent, before an annual zero-profit before income taxes is reached.

Freight, labor, waste disposal, and supervisor expense variables

The freighting variables could increase by 33.61 percent from the base before an annual zero-profit before income taxes is reached. The average distance for freighting used utility poles from their source to the recycling facility could increase from 200 to 267.22 miles. The cost of freighting could increase from $1.85 to $2.47 per mile.

The labor variables could increase by 47.89 percent from the base before an annual zero-profit before income taxes could be reached. The number of laborers could increase from two to 2.96, or a total of 4,000 to 5,916 labor hours per year. The labor wage rate could increase from $15 to $22.18 per hour, or an annual wage bill increase from $60,000 to $88,720.

The cost of disposing waste could increase by 55.27 percent, or from $300 to $465.80 per load, before an annual zero-profit is reached.

The supervisor salary could increase by 71.84 percent before an annual zero-profit is reached. The wage rate per hour for the supervisor could increase from $20 to $34.37, or the total supervisory annual wage bill could increase from $40,000 to $68,740.

Table 25 summarizes the variables with the greatest impact on the profitability of the utility pole recycling venture. Each variable was adjusted, while holding all other variables constant, to determine the point of zero-profit before income taxes.

Table 25: Results of Sensitivity Analysis for Base Case Scenario

	Amount of Increase or Decrease Before Zero-Profit is Reached		
Variable	(%)	From:	To.
Sales Price of Round Wood ($/cu. ft.)	-10.79	4.17	3.72
Sales Price of Sawn Products ($/MBF)	-17.13	336.35	278.74
Price of Raw-Material ($/LF)	20.00	0.40	0.48
Waste Level of Raw-Material (%)	21.80	20.00	24.36
Freighting Distance (miles/load)	33.61	200.00	267.22
Freighting Charge ($/mile)	33.61	1.85	2.47
Number of Laborers (1=2,000 hrs/yr)	47.89	2.00	2.96
Labor Wage Rate ($/hour)	47.89	15.00	22.18
Waste Disposal Charge ($/load)	55.27	300.00	465.80
Supervisor Wage Rate ($/hour)	71.84	20.00	34.37

Conclusion of Base Case Financial Analysis

The base case scenario results in an annual profit before income taxes of $33,186, a pre-tax return on sales of 6.56 percent, and a pre-tax return on investment of 14.92

percent. The net present value of the project, using a 10 year planning period and an 11.25 percent discount rate, is $128,706. The internal rate of return is 56.5 percent. These results indicate that the project is economically feasible.

The sensitivity analysis indicates the variables posing the greatest effect on the profitability of the venture are: sales price of the finished products, purchase price of raw material, and overall waste level of the raw material input.

Analysis of Preservative Retreatment Option

The preservative retreatment option adds additional production expenses with the expectation of gaining a positive return on the value of retreating the recycled solid wood products.

The analysis of the preservative retreatment option maintains the variables and/or assumptions of the base case scenario except for the following:

1. It is expected that all of the output will be retreated with chemical preservative.
2. The capital costs for the preservative retreatment scenario in the first year of operation are $333,417, which $102,346 is for fixed investment and $231,071 is for working capital.
3. The annual production expenses for the preservative retreatment scenario are $924,282.
4. The sales price of the finished products is estimated to be 85 percent of the producer price rather than 70 percent. The sawn products are expected to be sold for $408.43 per MBF and $5.07 per ft^3 for round wood products.

Operating Income of the Preservative Retreatment Option

The pro-forma annual income statement indicates, before income tax, a net loss of $299,004, return on sales of negative 48.65 percent, and return on investment of negative 89.68 percent.

Table 26: Pro-Forma Income Statement for the Preservative Retreatment Option

Sales Revenue:		
Sawn Products		245,058
Round Products		385,320
Total Sales Revenue		630,378
Less: Sales Expense		15,759
Net Sales Revenue		614,619
Cost of Goods Manufactured:		
Direct Materials	176,691	
Freight Cost for Direct Materials	98,744	
Preservative Retreatment Expense	377,324	
Freight for Preservative Retreatment	62,049	
Direct Labor	60,000	
Supervisor Salary	40,000	
Worker's Comp. & Employer's Liability Tax	15,484	
Worker's Safety Apparel & Equip.	300	
Energy	2,360	
Maintenance	3,000	
Waste Disposal	61,507	
Cost of Goods Manufactured		897,457
Gross Margin		(282,839)
Operating Costs:		
General Administrative Expense	9,456	
Insurance	655	
Property Tax	955	
Depreciation	5,100	
Operating Cost		16,166
Operating Income Before Income Tax		(299,004)
Return on Sales (%) =	-48.65	
Retrun on Investment (%) =	-89.68	

Discounted Cash Flow Analysis of Preservative Retreatment Option

With the initial investment costs and the estimated annual operating income loss, the net present value of the investment is a negative $1,788,636 for the preservative retreatment option. Table 27 is the discounted cash flow analysis for the preservative retreatment option.

Table 27: Discounted Cash Flow For Preservative Retreatment Option

Year	Annual Benefits ($)	Annual Costs ($)	Annual Net Benefit (Cash Flow) ($)	Discount Factor (11.25%)	Present Value of Cash Flow 11.25% ($)
1	590,979	968,861	(377,881)	0.8989	(339,668)
2	630,378	924,282	(293,904)	0.8080	(237,468)
3	630,378	924,282	(293,904)	0.7263	(213,455)
4	630,378	924,282	(293,904)	0.6528	(191,869)
5	630,378	924,282	(293,904)	0.5868	(172,467)
6	630,378	924,807	(294,429)	0.5275	(155,303)
7	630,378	924,282	(293,904)	0.4741	(139,350)
8	630,378	924,282	(293,904)	0.4262	(125,258)
9	630,378	924,282	(293,904)	0.3831	(112,592)
10	630,378	924,282	(293,904)	0.3443	(101,206)
Total	6,264,381	9,287,925	(3,023,544)		(1,788,636)

Net present value at 11.25 percent = $ (1,788,636)

Sensitivity Analysis of the Preservative Retreatment Option

The sensitivity analysis for the preservative retreatment option did not reveal any single variable that would allow the venture to break-even. Adjusting a single variable, while holding all other variables constant, would not yield a feasible solution.

Conclusion of Preservative Retreatment Financial Analysis

Using the base case variables and a finished goods sales price of 85 percent of the producer price results in an annual net loss of $299,004. The net present value of the preservative retreatment option is a negative $1,788,636. The results indicate that the preservative retreatment option is not an attractive investment.

The sensitivity analysis of increasing or decreasing a single variable, while holding all other variables constant, did not result in a feasible break-even point for the preservative retreatment option.

Finished Goods Market Analysis

The products manufactured by the proposed utility pole recycling facility will most likely be sold throughout Oklahoma via retail outlets or directly to the final consumer. The base case feasibility analysis of the utility pole recycling facility used prices of 70 percent of the producer market value, which is equivalent to 45.5 percent of retail market value. To sell all 600,000 board feet of sawn products, the project's products must penetrate about one percent of the treated sawn products retail market in Oklahoma. To sell all 76,000 cubic feet of round wood products, the project must penetrate about seven percent of the treated round wood retail market in Oklahoma. Table 28 summarizes the project's production as a percentage of the estimated annual treated wood retail sales in Oklahoma.

Table 28: The Project's Output as a Percent of Total Annual Treated Wood Sales in Oklahoma

Item	Estimated Production for the Project	Estimated Total Market Sales	Estimated Production as a Percent of Total Market Sales
Sawn Products (MBF)	600	63,042	0.95
Roundwood Products (Cu.Ft.)	76,000	1,112,514	6.83

Summary of Feasibility Analysis

The proposed utility pole recycling facility will require an annual raw material input roughly equivalent to the conservative estimate for the number of utility poles removed from service each year in Oklahoma.

Under the base case scenario the utility pole facility is economically feasible. It provides an estimated annual operating income before income taxes of $33,186, a pre-tax return on sales of 6.56 percent, and a pre-tax return on investment of 14.92 percent. At a discount rate of 11.25 percent over a ten year period, the net present value of the base case scenario is $128,706. The internal rate of return for the base case scenario is 56.5 percent.

The analysis of the preservative retreatment option indicates that preservative retreatment of the recycled solid wood products is not an attractive investment. The preservative retreatment option has an estimated annual operating loss of $299,004, and a negative net present value of $1,788,636.

To sell all of the products produced by the proposed utility pole recycling facility, the products must penetrate about one percent of the total treated sawn products and about seven percent of the treated round wood products retail market in Oklahoma.

CHAPTER VI

CONCLUSIONS AND DISCUSSION

The accumulation of used utility poles is an increasing problem throughout the United States (Cooper and Balatinecz 1992, Electrical World 1992). Manufacturing sawn products (e.g., dimension lumber, landscape timbers) and round wood products (e.g., posts, poles) from this material is an opportunity to reduce the waste of used utility poles. This study examined the economic feasibility of establishing a facility for manufacturing and marketing sawn and round wood products derived from used utility poles.

Many estimates of the number of utility poles removed from service are based on a 20 to 60 year service life for utility poles. From discussions with professionals in the electric utility industry and review of Huhnke et al. (1994), two estimates of the number of used utility poles being removed from service each year in Oklahoma were calculated. A conservative estimate based on a ten percent annual inspection of utility poles and a four percent failure rate of inspected utility poles predicts an annual replacement of 12,600 to 15,400 utility poles. A liberal estimate based on a 25-year service life for utility poles predicts an annual replacement of 126,000 to 154,000 utility poles. The purpose of these estimates is to provide lower and upper bound numbers for annual utility pole replacement in Oklahoma. Further research should be conducted to more precisely estimate the number of utility poles removed from service each year in Oklahoma. Based on discussions with electric utility professionals, little evidence supports utility pole replacement rates based on a service life of less than 50 years. Thus, the conservative estimate is used as the available raw material input for the utility pole recycling facility.

Under the production level proposed in this study, an utility pole recycling facility could potentially prevent approximately 126,000 cubic feet or 3,500 tons per year of used utility poles from entering landfills in Oklahoma. This equates to an approximate savings of $123,500 or more per year in waste disposal fees for Oklahoma's utility industry.

The analysis of the utility pole recycling facility is based on an estimated annual production level of 600 thousand board feet (MBF) of sawn products and 76,000 cubic feet (ft^3) of round wood products. The proposed facility is expected to be located within Oklahoma. Determining the optimal location for the facility within the state is beyond the scope of this study. It is therefore recommended that further research be conducted to determine the optimal location within the state for the utility pole recycling facility.

The base case scenario does not consider retreating the recycled wood products with chemical preservatives. The results indicate that the base case scenario is economically feasible. The net present value is $128,706 at an 11.25 percent discount rate over a ten year period. The internal rate of return is 56.6 percent. The estimated annual operating income before income taxes is $33,186 with a return on sales of 6.56 percent and return on investment of 14.92 percent. The variables posing the greatest affect on the profitability of the venture are the prices of finished products and raw material input, and the overall waste level of the raw material input. If a pilot project is established, it is recommended that accurate records be maintained in order to determine the actual impact that these variables have on the profitability of the project.

An analysis considering chemical preservative retreatment of the recycled wood products was also conducted. This analysis maintained the base case variables, plus additional production expenses for retreating, and finished product sales prices at 85 percent of the producer price value rather than 70 percent. The results indicate that preservative retreating is not an attractive investment for the utility pole recycling facility. The estimated annual operating income is negative $299,004 and the net present value is negative $1,788,636 at an 11.25 percent discount rate over a ten year period for the preservative retreating option. The sensitivity analysis did not reveal any single variable that would allow the preservative retreatment option to break-even.

The results of the market analysis indicate an estimated producer price value of $35,178,620 of preservative treated sawn and round wood products sold by retail lumber dealers in Oklahoma during 1996. This is an estimated 63,042 MBF of sawn products and 1,112,514 ft^3 of round wood products. To sell all production, the utility pole recycling facility must capture approximately one percent of the treated sawn retail products market and approximately seven percent of the treated round wood retail products market in Oklahoma.

The results of this study indicate that the manufacturing and marketing of non-retreated solid wood products derived from used utility poles is an economically feasible and profitable method of reducing the amount of used utility poles entering the waste stream in Oklahoma.

Based upon the results of this study, it is recommended that a pilot project be established to manufacture and market non-retreated solid wood products derived from used utility poles.

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APPENDIXES

Appendix A

Cover Letter for Initial Mailing of Survey Questionnaire

OKLAHOMA STATE UNIVERSITY

OSU

Department of Forestry
008 Agriculture Hall, Room C
Stillwater, Oklahoma 74078-6013
405-744-5437, FAX 405-744-9693
Office 405-744-6723
E-Mail dklewis@okway.okstate.edu

August 4, 1997

«Sal» «FirstName» «LastName»
«Company»
«Address1»
«Address2»
«City», «State» «PostalCode»

Dear «Sal» «LastName»:

The Oklahoma State University Department of Forestry, in cooperation with the Oklahoma Lumberman's Association, Oklahoma Association of Electric Cooperatives, and Oklahoma Gas and Electric Company, is conducting research to examine the opportunities to recycle utility poles. In Oklahoma 140,000 utility poles are taken out of service each year. The replacement and disposal of these poles are a significant expense that is reflected in our monthly electric bills. The disposal of these utility poles contributes to our national problem of waste disposal and limited landfill capacity.

We need your **HELP** to conduct a survey of the size and nature of the market for treated wood products. These market parameters are an important consideration in any effort to reduce the waste associated with the disposal of used utility poles. Your response to the survey questions in the enclosed questionnaire will contribute to our understanding of the potential to market products recycled from utility poles, and help reduce the volume of wood entering Oklahoma's landfills.

Please support us in this study by having the person in your firm who has the greatest knowledge about preservative treated wood products and their sales complete the attached questionnaire. It is important that we receive an accurate response to each question and your responses are important to our study.

If you have any questions regarding this survey or the questionnaire, please contact us at 405-744-6723. We assure you that your questions and responses will be kept strictly confidential.

We appreciate your time and effort in making this survey meaningful. Please return the completed questionnaire **by August 22, 1997**. You can return the survey by dropping it in the nearest mailbox. No postage is required.

Thank you for your assistance.

STEPHEN A. KING
Graduate Student

DAVID K. LEWIS, D.Phil.
Associate Professor, Forestry and
Adjunct Professor Agricultural Economics

DKL/mac

enclosure: "Survey of the Preservative Treated Wood Market in Oklahoma"

Appendix B

Cover Letter for Second Mailing of Survey Questionnaire

OKLAHOMA STATE UNIVERSITY

OSU

Department of Forestry
008 Agriculture Hall, Room C
Stillwater, Oklahoma 74078-6013
405-744-5437, FAX 405-744-9693
Office 405-744-6723
E-Mail dklewis@okway.okstate.edu

September 16, 1997

«FirstName» «LastName»
«Company»
«Address1»
«Address2»
«City», «State» «PostalCode»

Dear «FirstName» «LastName»:

The Oklahoma State University Department of Forestry, in cooperation with the Oklahoma Lumbermen's Association, Oklahoma Association of Electric Cooperatives, and Oklahoma Gas and Electric Company, is conducting research to examine the opportunities to recycle utility poles. In Oklahoma 140,000 utility poles are taken out of service each year. The replacement and disposal of these poles are a significant expense that is reflected in our monthly electric bills. The disposal of these utility poles contributes to our national problem of waste disposal and limited landfill capacity.

We need your **HELP** to conduct a survey of the size and nature of the market for treated wood products. These market parameters are an important consideration in any effort to reduce the waste associated with the disposal of used utility poles. Your response to the survey questions in the enclosed questionnaire will contribute to our understanding of the potential to market products recycled from utility poles, and help reduce the volume of wood entering Oklahoma's landfills.

Please support us in this study by having the person in your firm who has the greatest knowledge about preservative treated wood products and their sales complete the attached questionnaire. It is important that we receive an accurate response to each question and your responses are important to our study.

If you have any questions regarding this survey or the questionnaire, please contact us at 405-744-6723. We assure you that your questions and responses will be kept strictly confidential.

We appreciate your time and effort in making this survey meaningful. Please note that this is a **second mailing**. This survey is also part of a graduate study thesis and an appropriate response rate is required. Please **return the completed questionnaire**. You can return the survey by dropping it in the nearest mailbox. No postage is required. If you have already returned the questionnaire, disregard this second mailing.

Thank you for your assistance.

STEPHEN A. KING
Graduate Student

DAVID K. LEWIS, D.Phil.
Associate Professor, Forestry and
Adjunct Professor Agricultural Economics

DKL/mac

enclosure: "Survey of the Preservative Treated Wood Market in Oklahoma"

Appendix C

Post Card for Non-Respondents of the Survey Questionnaire

Dear «FirstName» «LastName»:«Next Record»

About two weeks ago you received a survey questionnaire from the Department of Forestry at Oklahoma State University concerning the "preservative treated wood market in Oklahoma." If you have not responded to the questionnaire, please do so. Your response is very important. You can return the completed survey by dropping it in the nearest mailbox. No postage is required. If you have misplaced the questionnaire and need a new one please contact us at 405/744-6723.

Thank you for making this survey meaningful.

Stephen A. King	David K. Lewis, D. Phil.
Graduate Student	Associate Professor, Forestry
	Adjunct Assoc. Prof., Ag Econ

Appendix D

Survey Questionnaire

Survey of the Preservative Treated Wood Market in Oklahoma

We appreciate your response to the following questions on the nature of preservative treated wood sales by your company. Once the questionnaire is completed, please drop in a mailbox, the postage is prepaid. Thank you

Q-1. Did your firm sell preservative treated lumber in 1996? (e.g., creosote, CCA, ACA, ACZA, or PENTA treated lumber)

a. Yes

b. No

If you answered "No" to Q-1, please stop and return the questionnaire by dropping it in the nearest mailbox. No postage is required. If you answered "Yes" to Q-1 please continue.

Q-2. Please indicate whether your firm offers for sale the following *preservative treated wood products:* (circle all that apply)

a. dimension lumber

b. landscape timbers

c. fence posts

d. poles over 15 ft in length

e. poles less than 15 ft in length

f. plywood panels

Please indicate the relative importance of the following attributes for preservative treated wood products:

		unimportant	important	very important
Q-3.	Preservative Type	1	2	3
Q-4.	Preservative Retention Level	1	2	3
Q-5.	Species	1	2	3
Q-6.	Strength	1	2	3
Q-7.	Moisture Content	1	2	3
Q-8.	General Appearance	1	2	3
Q-9.	Straightness	1	2	3
Q-10.	Low Price	1	2	3
Q-11.	Brand Name	1	2	3
Q-12.	Grade	1	2	3

Please indicate your level of agreement with the following product service attributes for preservative treated wood products:

		strongly disagree	disagree	indifferent	agree	strongly agree
Q-13.	Future demand will increase	1	2	3	4	5
Q-14.	Preservative type is less important than appearance	1	2	3	4	5
Q-15.	Preservative type is less important than straightness	1	2	3	4	5
Q-16.	Preservative type is less important than low price	1	2	3	4	5
Q-17.	Brand name treated wood is superior	1	2	3	4	5
Q-18.	Preservative wood emits a strong odor	1	2	3	4	5
Q-19.	Eastern and Western red cedar are substitutes for treated wood products	1	2	3	4	5
Q-20.	Cypress is a substitute for treated wood products	1	2	3	4	5

Please indicate the importance of preservative treated wood to each type of customer:

		unimportant	important	very important
Q-21.	Do-it-yourself (non-farm/ranch)	1	2	3
Q-22.	Residential Repair & Remodeling	1	2	3
Q-23.	Commercial Contractor	1	2	3
Q-24.	Residential Contractor	1	2	3
Q-25.	Farm & Ranch	1	2	3

Please indicate your level of agreement with the following attributes of customers:

		strongly disagree	disagree	indifferent	agree	strongly agree
Q-26.	Do-it-yourself or walk-in type customers purchase treated wood almost totally on the basis of general appearance	1	2	3	4	5
Q-27.	Do-it-yourself or walk-in type customers purchase treated wood almost totally on the basis of straightness	1	2	3	4	5
Q-28.	Do-it-yourself or walk-in type customers purchase treated wood almost totally on the basis of low price	1	2	3	4	5
Q-29.	Customers are satisfied with the current quality of treated wood products	1	2	3	4	5
Q-30.	Customers are willing to pay more for preservative treated wood than non-treated wood	1	2	3	4	5

Q-31. Please indicate the change you expect for sales of preservative treated wood products in the next three years:

a. increase 10% or more per year;
b. increase 5% to 10% per year;
c. increase 1% to 5% per year;
d. 0.0%;
e. decrease 1% to 5% per year;
f. decrease 5% or more per year.

Q-32. Please indicate the change you expect to see in the market price of preservative treated wood products in the next three years:

a. increase 20% or more;
b. increase 15% to 20%;
c. increase 10% to 15%;
d. increase 5% to 10%;
e. increase 1% to 5%;
f. 0.0%;
g. decrease 1% to 5%;
h. decrease 5% or more.

Q-33. Does your firm sell any solid wood products labeled as *recycled or used* ? Please circle the appropriate response.

a. yes
b. no

If you answered "no" to Q-33 please move to Q-35, otherwise continue with Q-34.

Q-34 Compared to normal wood products, recycled and used wood products are priced:

a. at a lower price
b. at an equivalent price
c. at a higher price

To successfully determine the feasibility of marketing recycled preservative treated wood products IT IS VERY IMPORTANT to obtain data on the types and quantity of the preservative treated wood products currently being sold.

Please estimate the quantity your firm sold for each of the following *preservative treated wood* products during 1996:

	PRODUCT CATEGORY	QUANTITY OF UNITS SOLD
Q-35.	Dimension lumber	______board feet
Q-36.	Landscape timbers	______number
Q-37.	Fence posts	______number
Q-38.	Poles over 15 ft in length	______number
Q-39.	Poles less than 15 ft in length	______number
Q-40.	Plywood panels	______square feet
Q-41.	Other treated wood products	

PRODUCT	QUANTITY SOLD	UNIT OR SIZE
______	______	______
______	______	______
______	______	______

Q-42. What percentage of your firm's total preservative treated wood sales in 1996 was southern yellow pine (SYP)?

a. ____% (SYP sale as a percentage of total treated wood sales).

Q-43. What percentage of your firm's total preservative treated wood sales in 1996 was CCA (cromated copper arsenate)?

a. ____% (CCA sales as a percentage of total treated wood sales).

Q-44. What percentage of your firm's total *lumber* sales in 1996 was preservative treated wood?

a. _____% (treated wood sales as a percentage of total lumber sales)

Q-45. Please circle the size category that applies to your firm:

1. Small (total annual solid-wood sales less than $1 million)
2. Medium (total annual solid-wood sales between $1-5 million)
3. Large (total annual solid-wood sales more than $5 million)

Q-46. Within which county is your firm located: ______________________.

Q-47. General Comments: (feel free to provide any comments conceming recycled solid wood products or treated solid wood products, thank you.)

____

____

____

____

____

____

____

____

____

Please Note:

Information about retail prices, quantity and types of preservative treated solid wood prôducts sold is crucial for this research. If your firm would be willing to provide a price list of all the preservative treated solid wood products sold by your firm, as well as data on sales volume for 1996, it would be greatly appreciated. The information pertaining to your firm will be handled with care and confidentiality. Please indicate whether your firm will be willing to do so.

______ Yes, we are willing to provide a price list.

______ No, we are not willing to provide a price list.

______ Yes, we are willing to provide sales quantity data.

______ No, we are not willing to provide sales quantity data.

______ Check here if you wish to receive a copy of the report resulting from this study.

Person to be contacted if necessary regarding the report, or the request for a price list or sales quantity data.

Name: ______________________ Title: ____________________

Firm: ____

Street or Postal Address: ______________________________

City: ______________________ Zip Code: _________________

Telephone: ( ) ____________________

Thank you! **for completing this questionnaire.**

Please return the questionnaire by dropping it in the nearest mailbox. No postage is required.

OKLAHOMA STATE UNIVERSITY
DEPARTMENT OF FORESTRY
008 Agriculture Hall, Room C
Stillwater, Oklahoma 74078-6013
Phone: 405/744-5437
Fax: 405/744-9693
E-mail for David K. Lewis [dklewis@okway.okstate.edu]
E-mail for Stephen A. King [kingsa@okstate.edu]

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UNIVERSITY PRINTING BLDG EAST
STILLWATER OK 74075-9987

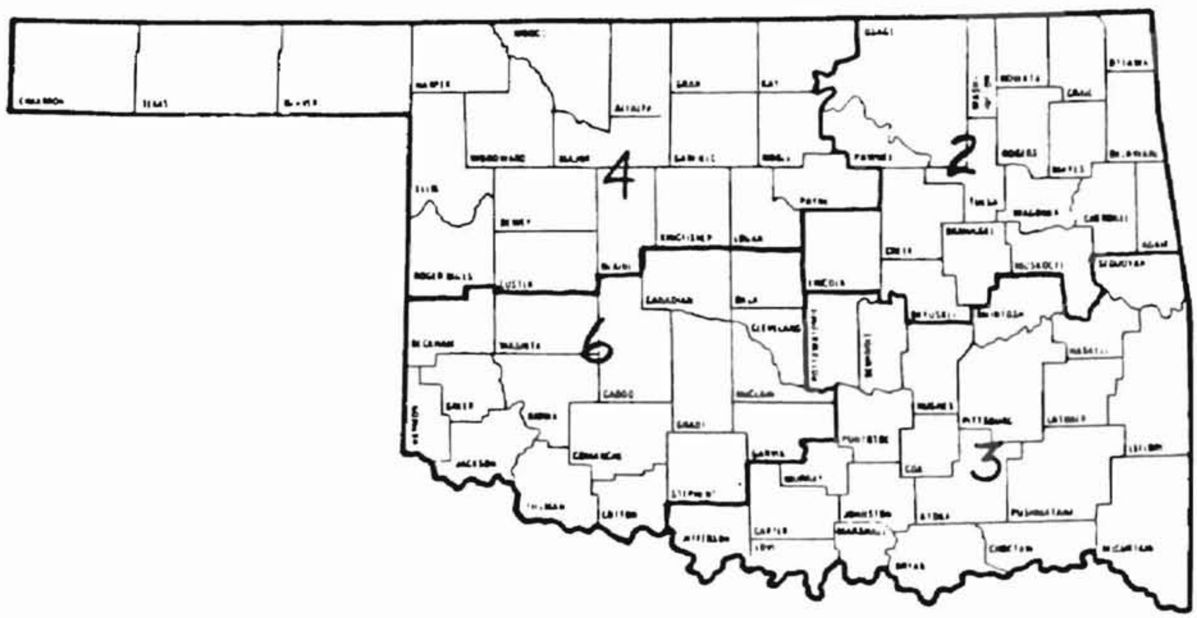
2-1-12329

Appendix E

Map of Oklahoma: Regional Distribution Areas For Lumber Retailers

(Based on the Oklahoma Lumbermen's Association - OLA - Districts)

OLA District 2 = Northeast Region
OLA District 3 = Southeast Region
OLA District 4 = Northwest Region
OLA District 6 = Southwest Region



Appendix F

Board Foot and Solid Cubic Foot Estimation Equations

The International One-Quarter Rule is a method for estimating board foot (BF) content in a log. It includes a fixed taper allowance of one-half inch per four foot of log length, one-fourth inch saw kerf, and one-sixteenth inch for shrinkage (Avery and Burkhart 1994).

Equation 5: International One-Quarter Rule

$$(0.905(0.22D^2 - 0.71D))L$$

where: D = top diameter in inches, and
L = length in feet.

Calculations were made in four foot increments using one-half inch fixed taper allowance to estimate top diameter of each four foot pole section. Top diameters for standard-class poles were obtained from Hawes (1947) and for H-class poles from Voreis (1998). A bark ratio of 0.885 was used to estimate diameter inside bark (Hawes 1947).

Table 29: Pole Top Diameters

Pole Class					
H2	1	2	3	4	6
Pole Top Diameters Inside Bark (inches)					
19.7	7.6	7.1	6.5	5.9	4.8

The following equation was used to estimate cubic foot (ft^3) content of round wood (Avery and Burkhart 1994)

Equation 6: Cubic Foot Volume

$$\frac{3.1416D^2}{4(144)}L$$

where: D = top diameter in inches, and
L = length in feet.

Cubic foot volume calculations were also made in four foot increments using one-half inch fixed taper allowance to estimate top diameter of each four foot section.

Appendix G

Institutional Review Board (IRB) Form

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 07-28-97 **IRB#:** AG-98-001

Proposal Title: SURVEY OF TREATED WOOD MARKET IN OKLAHOMA

Principal Investigator(s): David K. Lewis, Stephen A. King

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING, AS WELL AS ARE SUBJECT TO MONITORING AT ANY TIME DURING THE APPROVAL PERIOD.
APPROVAL STATUS PERIOD VALID FOR DATA COLLECTION FOR A ONE CALENDAR YEAR PERIOD AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Disapproval are as follows:

Signature: John H. Wyckoff
Chair of Institutional Review Board

Date: July 28, 1997

cc: Stephen A. King

VITA

Stephen A. King

Candidate for the Degree of

Master of Science

Thesis: THE ECONOMIC FEASIBILITY OF MANUFACTURING AND MARKETING SOLID WOOD PRODUCTS DERIVED FROM USED UTILITY POLES

Major Field: Forest Resources

Area of Specialization: Economics

Biographical:

Personal Data: Born in Chehalis, Washington, On April 22, 1967, the son of James and Suzanne King.

Education: Graduated from Centralia High School, Centralia, Washington in June 1985; received Bachelor of Arts degree in Business Administration from Washington State University, Pullman, Washington in May 1990. Completed the requirements for the Master of Science degree with a major in Forest Resources at Oklahoma State University in May 1998.

Experience: U.S. Peace Corps Volunteer, Small Enterprise Development, Ghana, 1990-1993; Forest Fire Fighter and Natural Resources Worker - Engine Crew Leader, Washington State Department of Natural Resources, 1994-1995; Forest Technician, Forest Resources Department, University of Idaho, 1995; Graduate Research Assistant, Oklahoma State University, Stillwater, Oklahoma, 1996-1998.

Professional Membership: Xi Sigma Pi, Society of American Foresters.