WOOD WASTE PROCESSING

IN IOWA

Prepared for:

Iowa Department of Natural Resources
Waste Management Assistance Division
by:

Grant Crowell
Christopher Paar
Jennifer Ryan
Stuart Turner

May 8, 1996

Updated November 1996
by:

Bryan Schuster
Chris Diggins

Every effort has been made to verify the information provided in each entry. No warranty, expressed or implied, and no endorsement of any facility, business, organization or individual is suggested by inclusion or exclusion in this directory.

For those who cannot read the size of the print in this publication, a larger sized version of the text is available by contacting the Department of Natural Resources.

Telephone: 515/281-4367
TDD: 515/242-5967
Or write to:

Department of Natural Resources
Wallace State Office Building
Des Moines, Iowa 50319-0034

Under Title VI of the 1964 Civil Rights Act, Section 504 of the Rehabilitation Act of 1973, the Age of Discrimination Act of 1975 and Title IX of the Education Amendments of 1972, federal regulations prohibit discrimination on the basis of race, color, national origin, sex or handicap. If you believe that you have been discriminated against in any program, activity or facility as described above, or if you desire further information, please write to: Director, Iowa Department of Natural Resources, Wallace State Office Building, 900 East Grand Avenue, Des Moines, Iowa 50319-0034 or the Equal Employment Opportunity Commission, Washington, D. C. 20240.

Printed on recycled paper with soy ink.

WOOD WASTE PROCESSING IN IOWA

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF MAPS

EXECUTIVE SUMMARY

The objective of this report is to gain a better understanding of the wood waste market in Iowa through surveying the processors of wood waste. A main component of the report was to follow up a survey sent out by the Iowa Department of Natural Resources Waste Management Assistance Division to 147 public waste management organizations and private businesses, including some nearby businesses in Illinois. Of the 147 surveys sent out initially, there were 77 respondents. Of those 77 who returned surveys, 64 qualified as potential wood waste processors with 53 of those currently engaged in wood waste processing. The information that was obtained from the surveys was entered in a spreadsheet from which a database was created. From this database, maps were produced using the ArcView 2.1 software. The maps provided the basis for the analysis and recommendation sections of this report.

The survey that was sent out was a two page questionnaire which asked for details of any wood waste processing operation. The questions were an effort to gain insight into the types and amounts (tons per year) of wood waste used, and potential capacity of wood waste processors including any cases of excess or shortage in supply. It was also an effort to better understand the strengths and weaknesses of the emerging wood waste market.

The surveys elicited a lot of helpful information. Our findings show that **sixty-nine percent (53)** of the respondents presently use wood waste. Of these, many reported what they considered to be barriers to wood waste processing. Among these barriers, capital costs were cited as the principal obstacle to operating a wood waste processing facility. Machinery specific to wood processing, such as chippers and tub grinders, are priced out of reach of most processors and potential processors. Other costs were listed as well. These were mainly the high prices involved in transportation, receiving and processing of materials. Additionally, the immature nature of the market was cited as an impediment to starting such an operation. The most common market imperfections listed were the inconsistency of the wood waste supply and the relative lack of communication between producers and processors.

Findings

The findings of this report according to the survey results are as follows:

- Animal bedding, compost, and mulch were the end uses most frequently produced from wood waste.
- **Over 44,000** tons of wood are currently used for heat or electricity production.
- At least ten different wood waste uses were cited in Iowa.
- There is much that can be done to improve communication across the state simply by connecting the wood waste generators with the processors.
- Clean, untreated wood is preferred to other types of wood such as chemically tainted or pressure treated wood.
- **One third** of the respondents would accept any type of wood waste.
- **Pallets and sawdust comprise 62 percent** of the wood waste stream, used by respondents.
- There is twice as much wood waste being used now as there was in 1993 according to the figures presented in UNI study, *Closing the Loop on Wood Waste*, which analyzed only wood waste being used internally by generators.

Recommendations

The state of Iowa currently has an undeveloped market which handles wood waste. The lack of information, communication and market certainty all work to prevent this market from expanding. The technology is available as is the desire to divert wood waste from landfills. What is required at this stage is some intervention by state government organizations.

First, the predominant pallet recycling and mulch/ animal bedding producers in Iowa can be further expanded with the continued help of the Iowa Department of Natural Resources. Through continued use of the LAFAP grants, the state can assist its wood waste processors in the expansion of their facilities and operation. With this, the wood waste market can begin to be consistent, manageable and profitable while at the same time diverting valuable wood from the state's landfills.

Also, through greater use of wood waste by the Iowa Department of Transportation (IDOT) for roadways and landscaping, the State of Iowa can take the lead and move the wood waste market to the next level. This can be accomplished through a requirement that IDOT purchasers and their independent contractors be required to purchase their mulch and wood chips from Iowa's wood waste processors.

Lastly, there is the possibility of using wood chips as a boiler fuel in 30 industrial boilers located in Iowa's nine largest counties. This idea, which stems from a feasibility study done by M.L. Smith Environmentalists, can be profitable for the industry as well as Iowa's wood waste processors. In order for there to be the consistent supply of wood necessary for such a conversion, these nine counties should create a public outreach program which begins to collect wood waste from its citizens. Either through a permanent drop-off site or a bi-annual collection day, the wood waste processors would have another source of wood waste with which to supply industrial boilers. The conversion of such boilers can begin with the three state-owned boilers which are located at Iowa's three state universities in Ames, Iowa City and Cedar Falls. Using these three boilers as a case study, other industries can analyze the feasibility of the conversion and begin to do the same with their boilers.

INTRODUCTION

Wood waste is a valuable and recoverable resource that is currently being landfilled in growing quantities. Increased pressure on landfill space across the nation has raised interest in diverting this refuse from landfills. Yet, diversion of wood waste is made particularly difficult by the various categories which make up the wood waste market. These categories are:

1. Brush, tree trimmings, and stumps from various land clearing activities
2. Scrap wood, wood chips, and sawdust from sawmills, cabinetmakers, and furniture manufacturing processes
3. Construction and demolition waste which comes from construction cutoffs and pressure-treated lumber
4. Used pallets, crates, and other wood packaging.

The number and variety of wood waste types can cause problems for processors in sorting and collecting the appropriate material for their operation (See Figure 1). In a State as dispersed as Iowa, this variety makes it especially difficult to find the large quantities of various categories of wood waste required for most wood waste processing operations.

Over the last several decades, the generation of wood waste has been increasing nationwide. (See Table 1). According to the *Regional Planning User Guide: Rural Solid Waste Management*, the generation of wood waste has been projected to increase faster than the US population by the turn of the century. In its *Characterization of Municipal Solid Waste in the United States: 1994 Update*, the US Environmental Protection Agency reported that 13.7 million tons of wood waste was generated in 1993. This represents 6.6 percent of the total waste stream in the United States. (See Figure 2).

Figure 1. The structure of the wood waste stream

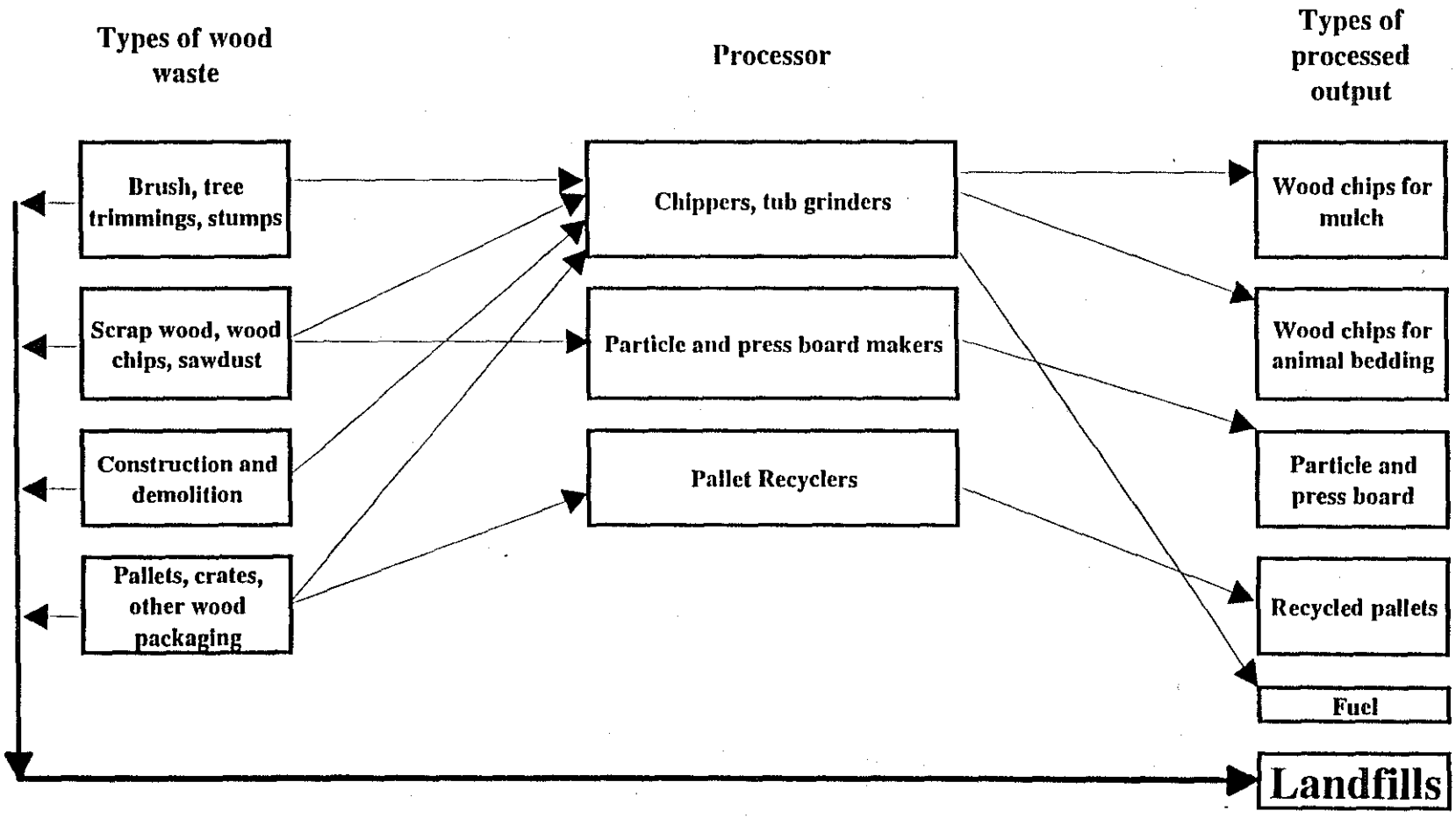


Table 1. Average annual rates of increase (or decrease) of generation of materials in municipal solid waste

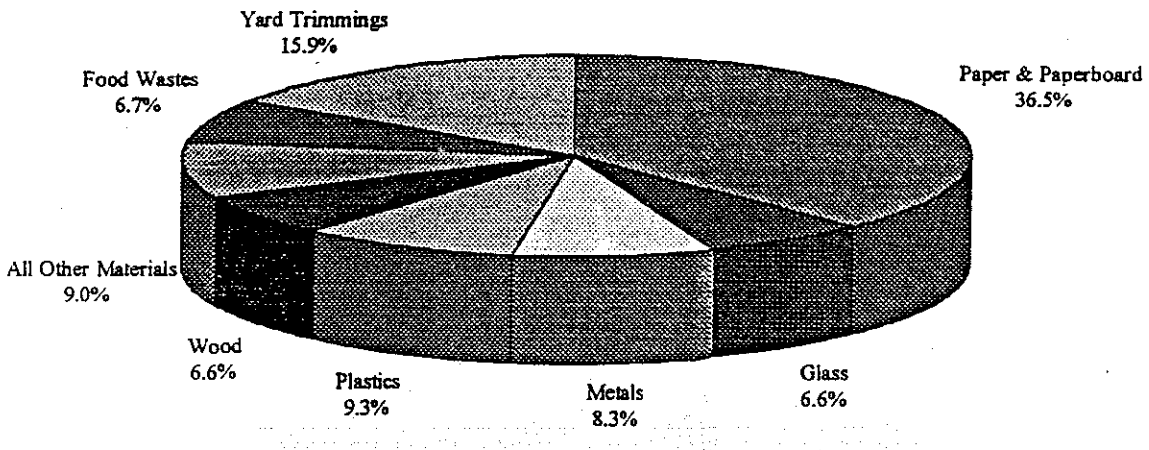
Types	1960-1970	1970-1980	1980-1990	1990-2000
Paper and paperboard	4.0	2.2	2.9	2.1
Glass	6.6	1.7	-1.2	0.6
Metals	3.0	0.2	1.3	1.5
Plastics	22.5	9.9	8.4	2.5
Wood	2.8	5.5	6.2	2.7
All other materials	4.3	4.3	3.9	1.9
Food wastes	0.5	0.3	0.0	0.6
Yard trimmings	1.5	1.7	2.4	-4.5
TOTAL MSW	3.3	2.2	2.7	1.0
Population growth	1.2	1.1	1.0	1.0

Source: Chapter 4: Solid Waste Characterization. Note: In annual percent by weight.

It should be noted, however, that wood waste generated by construction and demolition activities were not included in the EPA's analysis. A large portion of the 13.7 million tons of wood waste is made up of containers and packaging. According to the EPA report, 9.5 million tons of the total wood waste is used pallets, crates, and other wood packaging. The EPA report also found that 9.6 percent of the 13.7 million tons of wood waste material was recovered in 1993.

The ever increasing generation of municipal solid waste led to the creation of the Waste Reduction and Recycling Act of 1989 (HF753). Many states and municipalities are trying to meet waste reduction goals similar to Iowa's goal of 50 percent waste reduction by the year 2000. This has prompted the Iowa Department of Natural Resources to identify segments of the waste streams in order to target them for reduction or diversion.

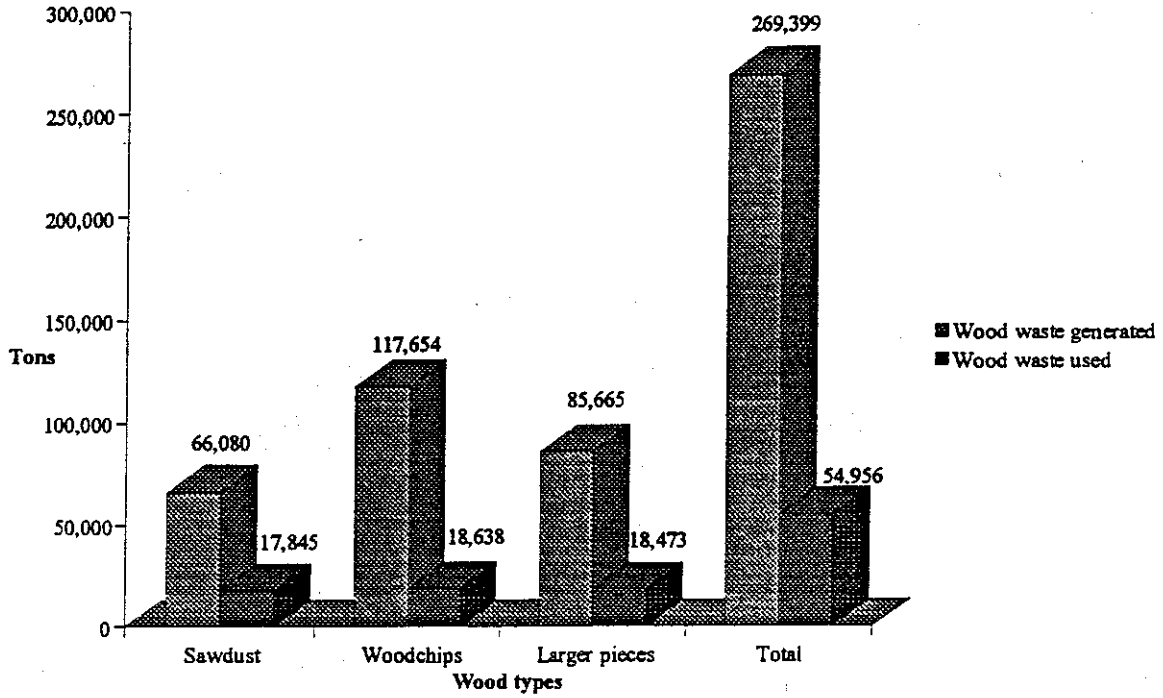
Figure 2. Materials generated in MSW, 1993



Source: Characterization of Municipal Solid Waste in the United States: 1994 Update

In 1993, the University of Northern Iowa (UNI) conducted a study of wood waste in Iowa called *Closing the Loop on Wood Wastes*. This study identified and surveyed wood waste generators and users across eastern Iowa to determine the appropriate applications for wood wastes generated in the state. The report estimated that there are about 270,000 tons of wood waste produced in Iowa per year, which is low by national standards. The report also estimates that only one-fifth (55,000 tons) of the wood waste is utilized by the producers in their day-to-day operations (See Figure 3). This illustrates the significant wood waste problem with 80 percent being landfilled across the nation.

Figure 3. Waste generated vs. Waste used



Source: Closing the Loop: UNI Study, 1993

According to the study, the market for the use of wood waste in Iowa is not well established, partly due to the fact that there are many small producers who are geographically dispersed across eastern Iowa. (Closing the Loop, 1993). The wood waste market is also disorganized and lacks formal communication between generators and processors. (Closing the Loop, 1993).

The purpose of this study is to survey these dispersed processors and to identify the key obstacles they face in their daily operations. This paper will begin by discussing a survey which was sent out by the Iowa Department of Natural Resources (IDNR) Waste Management Assistance Division (WMAD). In effect, the analysis of this data will enable

us to better understand the nature of this fledgling market. Next, the paper will offer case studies of successful wood waste processing operations nationally and locally. The paper will conclude with recommendations for making this young market more efficient and profitable, to reduce barriers to potential wood waste processors, and most importantly to reduce the amount of wood waste being landfilled.

METHODOLOGY

The foundation of our research into wood waste in Iowa is a survey, which was drafted by WMAD officials, and edited by the Field Problems members. This survey was then either faxed or mailed to 147 places statewide as well as in neighboring states. The recipients, identified by WMAD officials, were potential wood waste processors. They were a varied group consisting of both public and private organizations. The majority of the public sector groups were city and county landfills. The surveys sent out to the private sector covered a broad range of operations, from large pallet recyclers like Riverside Pallets, to such eclectic enterprises as the New Melleray Abbey, near Dubuque.

The return rate of 52 percent (77) was lower than we had hoped for, but was acceptable with our IDNR clients. However, of the surveys we received, **69 percent (53) were active in wood waste processing**. It is important to note that the IDNR had sent out another survey approximately two weeks prior to the Wood Waste survey. This survey, which gathered data for a recycling directory, most likely contributed to our lower than expected response rate.

The Wood Waste survey consists of three pages, the first of which is a letter from Teresa Hay, the WMAD Administrator. This page outlines the two main purposes of the survey: to help wood waste processors improve their supplies of wood waste and to enhance and expand the markets for recycled wood products. The actual survey (included in Appendix A) has 18 questions, eight of which are not relevant to our study. Those questions, 8-15, were included by the IDNR for another purpose. The information provided by the survey helped to narrow our particular work to focusing on the following conditions of the market for recycled wood products. The information provided by the Wood Waste survey was:

1. Where current processors of wood waste are in Iowa.
2. If good, stable markets exist for the processed and manufactured wood products.
3. If there is enough capacity to process all of the wood waste that is currently generated.

Our next task was to follow up on all of the non-responses to the survey. This was quite time consuming, given the high amount of non-responses. Follow-up phone calls were made, and the survey was either conducted over the phone, or another copy of the survey was sent. At least two attempts were made to follow-up on each non-response.

Near the end of the follow-up process, the Field Problems group began entering the data into a spreadsheet that contained a list of all of the survey recipients. After that, time was spent "tightening up" the spreadsheet. We looked at the information provided by each respondent, and standardized it in the spreadsheet. For example, some respondents provided answers to questions in measurements of cubic yards, while others gave numbers using tons as a unit of measurement.

A consistent database is very important for the GIS component of the project. The maps all require a database as the starting point for creating a map. In order to show anything significant, all data must be standardized. The database and maps were created at the IDNR's Geologic Survey Bureau. We used their facilities and software programs (Dbase IV, ArcView 2.1) to create the maps included in this report. The purpose of using GIS was to provide a detailed visual analysis of the data, by interpreting survey results in various graphical forms.

There was a total of 77 responses to the survey. The ensuing table lists the organizations that, according to the survey, are currently active in the recycled wood waste market. These 53 firms form the basis of our GIS analysis.

Table 2. Respondents engaged in wood waste recycling

Aubrey Altena	Jeld-Wen Fiber Products of Iowa
AMF Pallets	John Company
Addoco, Inc.	Kinze Manufacturing
B & B Bedding	Koster Grain
Bee Line Prod. Corp.	Landfill of Des Moines
Big Timber Inc.	Langenbach Wood Products, Inc.
Big D Lumber	M & N Pallet
Bob Lewis Pallets	Metro Waste Authority
Bluestem Composting Facility	Midland Paper
Buttermore Lumber	Midwest Faswall
Buy-Rite Pallets	Midwest Walnut
By-Product Technologies Inc.	Ottumwa-Wapello County Sanitary Landfill
Carroll County Solid Waste Mgmt. Comm.	Pak-A-Way Container Service
Chase Manufacturing	Paltech Enterprises
City of Grinnell Composting Facility	Pallet Industries, Inc.
City of Marshalltown	Pierce Lumber Inc.
City of Davenport	R&D Recycling
City of Des Moines	Riverside Pallets
City of DeWitt	Sanborn P & L
Estherville Pallet Co.	Sho-Dust Bedding
Fayette County Recycling	Simonsen Rendering
Four Oaks Farm & Stable	Still's Lawn Ornaments
Great River Regional Waste Authority	Stuhr Enterprises, Inc.
Home Recycling Exchange	Top Notch Ent., Inc.
J & B Pallet Company	Trailer Transfer Service Inc.
J & M Woodshaving's	Woodbury County Area S. W. Agency
Jacobs Energy Corp.	

DATA ANALYSIS

General results

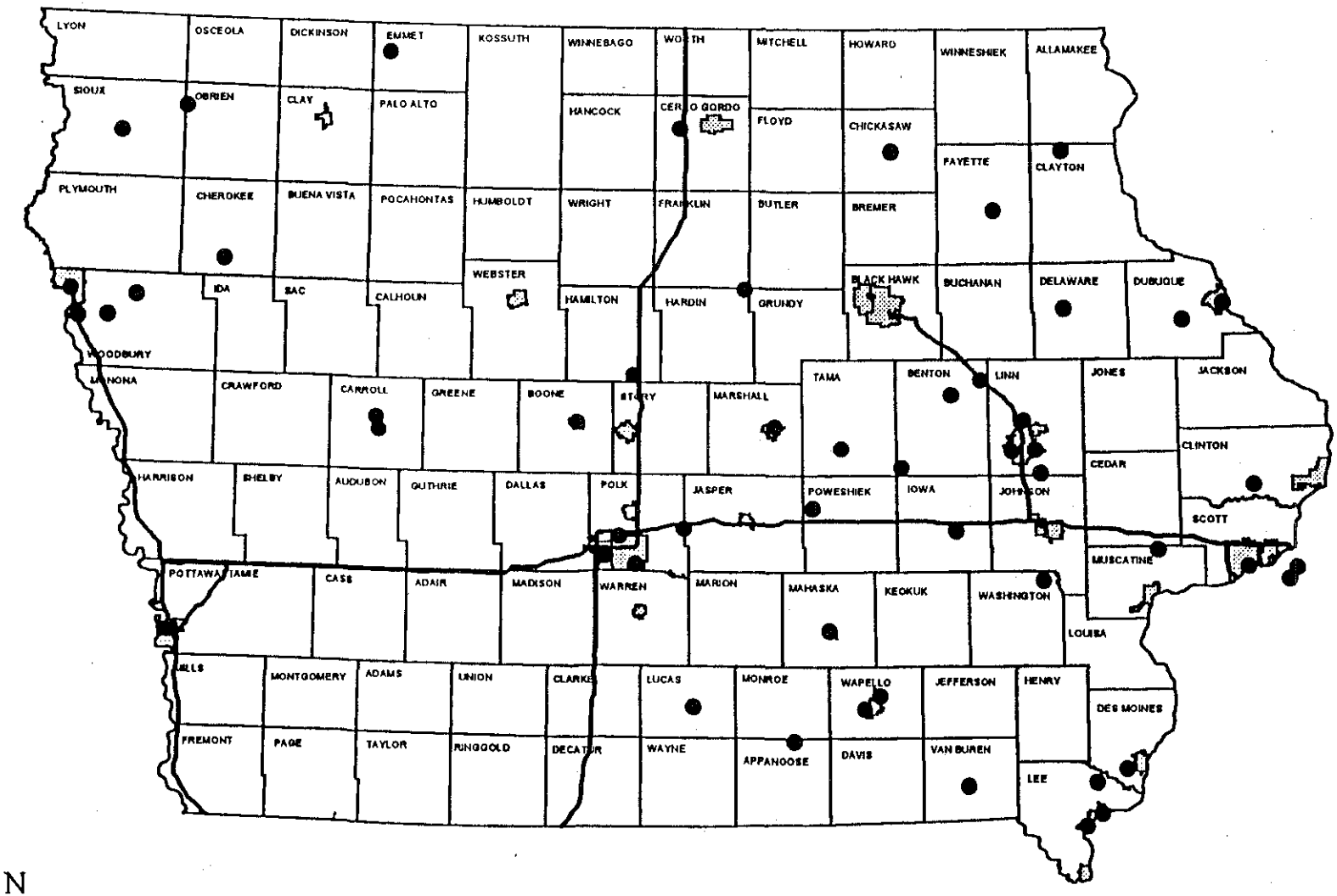
As mentioned in the methodology section of this report, 147 recycling businesses were identified by the IDNR and selected for inclusion in the wood waste processing

database. Selected businesses were first asked if they currently use wood waste in their operations. Of the 77 respondents to the wood waste survey, 13 (17 percent) were immediately eliminated from the data analysis. These 13 respondents stated that they did not currently use wood waste and that they had not considered it as a possibility for their operation. Because of these negative responses, they were not considered legitimate processors of wood waste and were removed from the analysis.

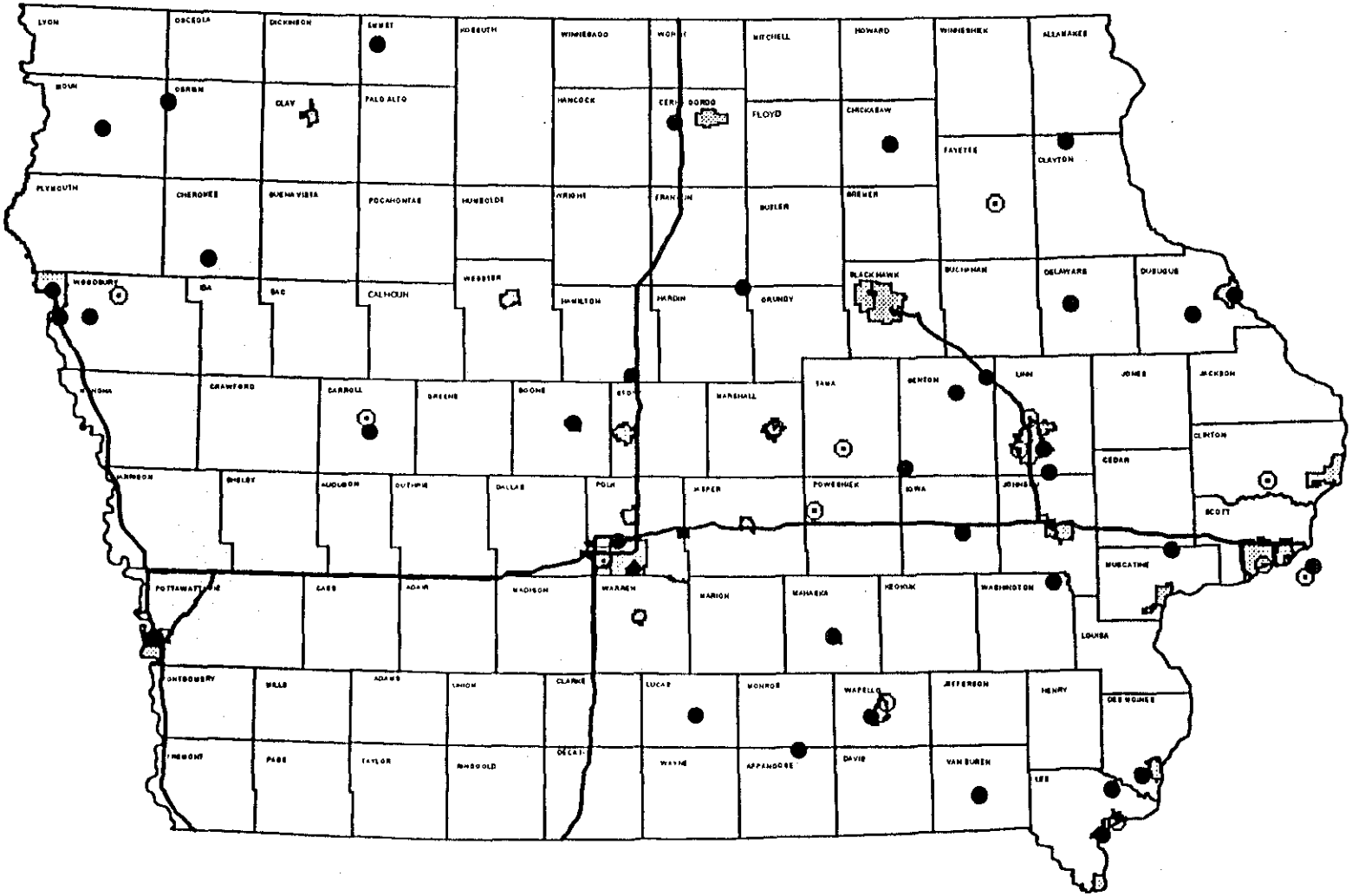
Eleven (14 percent) respondents stated that they would at least consider using wood waste. Businesses that are presently using wood waste comprised 69 percent (53) of the responses (see Map 1). Of these analyzed businesses, **37 were private organizations, 14 were public operations, one claimed non-profit status, and one listed their organizational type as public non-profit** (see Map 2).

Map 1 shows the basic geographical distribution of all processors who currently use wood waste. Wood waste processing businesses in one form or another are distributed throughout the state. However, the concentration of processors is greater in the eastern half of the state.

Map 1. Responding wood waste processors



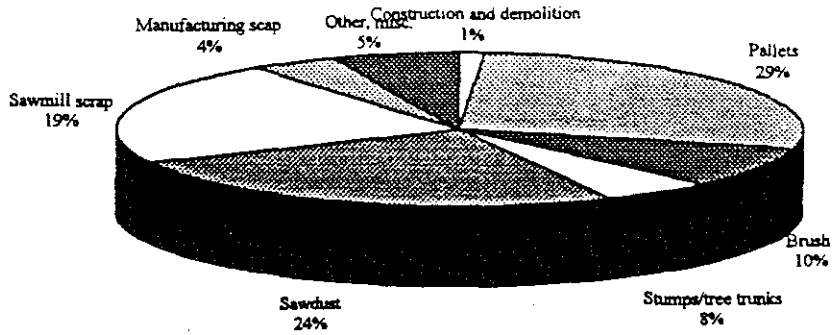
Map 2. Wood waste processors by organizational structure



Twenty respondents offered what they perceived as barriers to processing wood waste. The most frequently cited obstacle to wood waste processing was the need to acquire wood waste processing machinery. Small chippers cost between $6,000 and $20,000, while large chippers cost between $100,000 and $250,000. Other businesses replied that there was a lack of a consistent supply of wood waste; that the processing and receiving costs were too high; and that the market for wood chips and animal bedding has declined.

After these preliminary questions, the processors were asked to solicit some figures regarding the composition of the waste stream and the products produced from wood waste. Wood waste was categorized into seven possible sources for data collection: construction and demolition (C & D), pallets, brush, stumps and tree trunks, sawdust, saw mill scrap, and manufacturing (i.e. furniture). First, the total tons of each wood waste type used per year by each of the industries responding was determined (see Figure 4).

Figure 4. Composition of wood waste stream



Source: 1996 Wood Waste Survey.

Assumptions

Due to the inconsistency of the data received, an effort was made to present the data in similar units. Many responses to the survey presented wood waste figures in both cubic yards and tons. Professionals listed as contact people for some of the processors were contacted in an effort to make some gross conversions of cubic yards to tons. A source at Sho-Dust Bedding estimated animal bedding to weigh 375 pounds per cubic yard and 444 pounds per cubic yard of mulch. Koster Grain, who presented their data by semi load, estimated a semi load of animal bedding weighs between 12 and 25 tons. We assumed that one semi load of animal bedding equals 18 tons of material.

For compost, Bluestem Solid Waste Agency offered the estimate of 1,215 pounds per cubic yard for finished compost. According to a spokesperson for Riverside Pallet, pallets range from 30 to 150 pounds with an across the board average of 55 pounds per pallet. The *On-Farm Composting Handbook* edited by Robert Rynk, provided the figure of 1,296 pounds per cubic yard of tree trimmings. After discussion with Garth Frable of the WMAD, we assumed that this figure applied to the brush category. Stumps and tree trunks, wood for heat recovery, and pressboard were assumed to weigh twice as much as brush per cubic yard.

It must be stressed that these assumptions only apply to this particular analysis. Conversions used to standardize the units of measure reported in the survey are just estimates arrived at after conversations with responding wood waste processors (see Table 3). Weights per cubic yard and by semi load vary substantially with the moisture

content of the material, the size of the mulch or compost particles, and the type of wood used.

Table 3. Assumptions converting survey measurement units to pounds

Wood waste product	Conversion
Animal bedding	375 lbs./cubic yard
Animal bedding	18 tons/semi load
Compost	1,215 lbs./cubic yard
Mulch	444 lbs./cubic yard
Stumps/tree trunks	2,592 lbs./cubic yard
Wood for heat recovery	2,592 lbs./cubic yard
Pressboard	2,592 lbs./cubic yard
Brush (tree trimmings)	1,296 lbs./cubic yard
Pallets	55 lbs./pallet

Source: See text.

Explanation of terms

Without some explanation of the terms used in the survey, this section may be confusing to some. Please refer to the original survey in Appendix A for an illustrated example of the survey questions referred to. Question 2 asked the survey respondents to indicate the types and amounts of wood waste used, and their potential capacity for processing additional waste. Those responding were also asked to disclose if there were any cases of excess supply or lack of supply (excess demand) of a particular material. Tables presented in this section use this survey language for description.

These figures have been aggregated from all of the survey respondents. There were 35 possible response categories for this question and no firm provided a response in every category. In fact, many firms filled out only one or two categories. Therefore, there were many blank entries in the database that made the aggregation of this data necessary.

The aggregation should, however, provide an accurate depiction of the trends in wood waste processing in Iowa.

Some firms produced wood waste within their own operation. These industries indicated this by stating the total tons of wood waste generated on site. Some industries, for example, may produce sawmill scrap and use it for heat recovery. Another example could be that landfills produce a certain amount of brush waste due to their own landscaping operations. This is by no means the sole component of their brush stream, but is included to show that wood waste processors are also generators. However, only **25 percent (40,564 tons)** of the total wood waste used was produced on site by the responding businesses. Ideally, firms would be able to generate and process equal amounts of wood waste. However, this is not the case and by analyzing on site wood waste generation and processing, we can better understand the characteristics of this emerging market.

Survey responses

Overall, there are **162,055.5 tons of wood waste used in Iowa each year** by the 77 survey respondents. This is approximately triple the numbers reported in the UNI study, *Closing the Loop on Wood Waste, 1993.*

Construction and demolition. **Only three firms reported using construction and demolition waste. Together they used 1,420 tons of C & D annually. None of these businesses claimed to generate any C & D waste on site.** In fact, one of the three firms reported an excess supply of 550 tons of C & D waste per year. C & D wood waste

comprised only one percent of the total wood waste used annually according to the survey (see Figure 3).

Pallets. Wooden pallets proved to be a more actively sought out wood waste product. The data we collected showed that **25 companies used 46,460.5** tons of pallets per year. That figure averages out to over **1,800** tons per firm per year; the largest pallet consumer uses 9,625 tons per year, while the smallest uses only 28 tons. Figure 3 shows that pallets comprise **29** percent of the total wood waste stream reported by the 77 responders to the survey. Of the pallet processors, **seven** industries generated **11,820** tons of pallet waste on site.

Seven firms claimed that they had the potential to utilize over **19,500** additional tons total of pallets per year. Pallets seem to be a versatile wood waste product. Improving lines of communication could eventually divert all pallet waste from landfills.

Map 3 displays pallet processors in Iowa. Again, the distribution shows that this industry is being operated throughout the state. The largest pallet processor responding to the survey is located in northwest Iowa. Another large pallet processor is located in north central Iowa. The market for pallets in Iowa has much potential for expansion as Map 4 illustrates. Map 4 shows the firms responding to the survey that have unused capacity for processing pallets. The largest cited additional pallet processing potential was located in the center of the state.

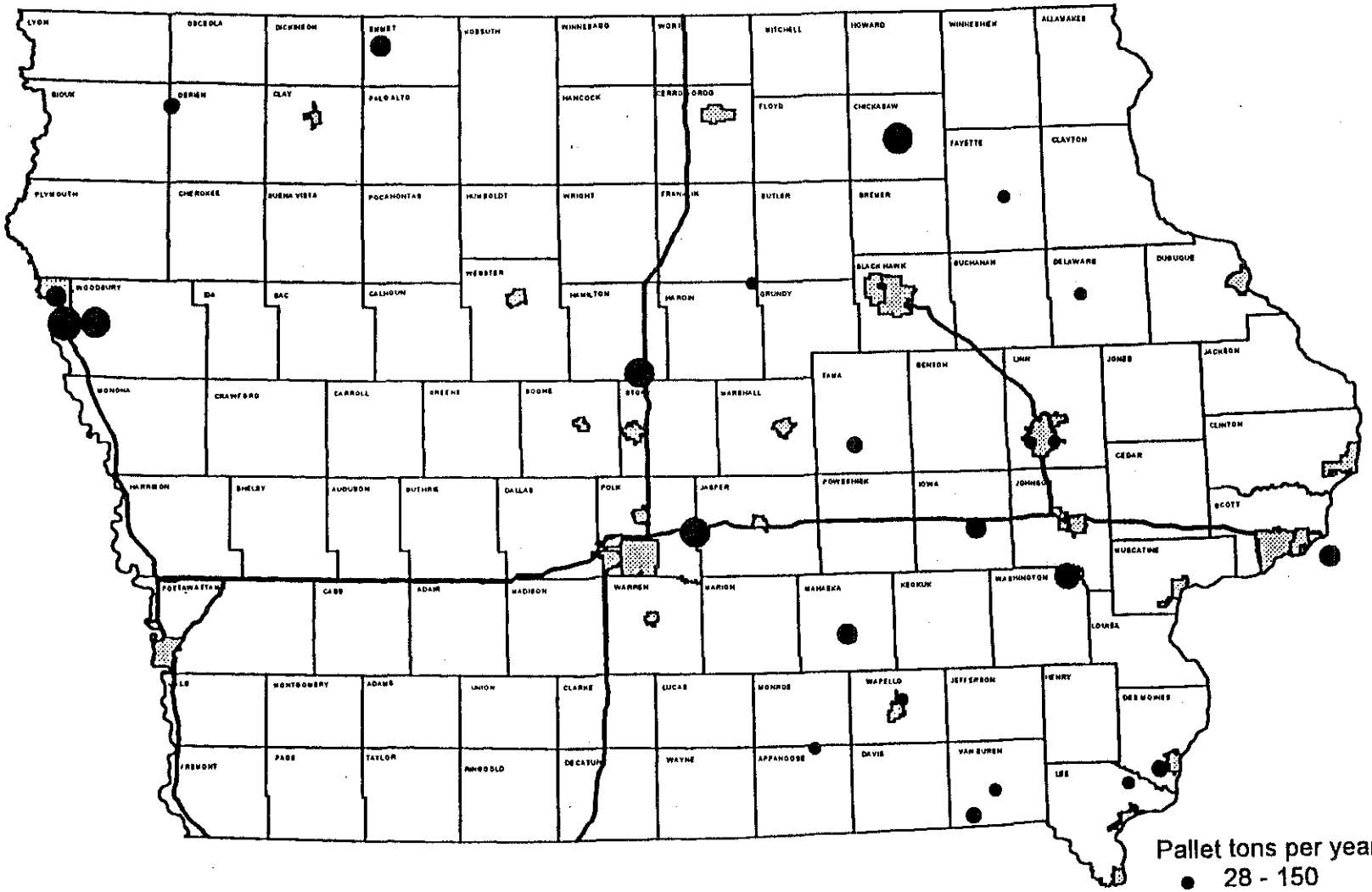
Brush. The amount of brush or tree trimmings used per year by the survey respondents was **17,164** tons (**ten percent** of all wood waste processed). **Seven** firms claimed that they used brush in their operations, two of which generated a total of 4,324

tons of brush on site. Four of the brush processing firms are able to process up to 10,994 additional tons of brush annually (see Map 5). Only one processor claimed an excess supply of brush of 500 tons.

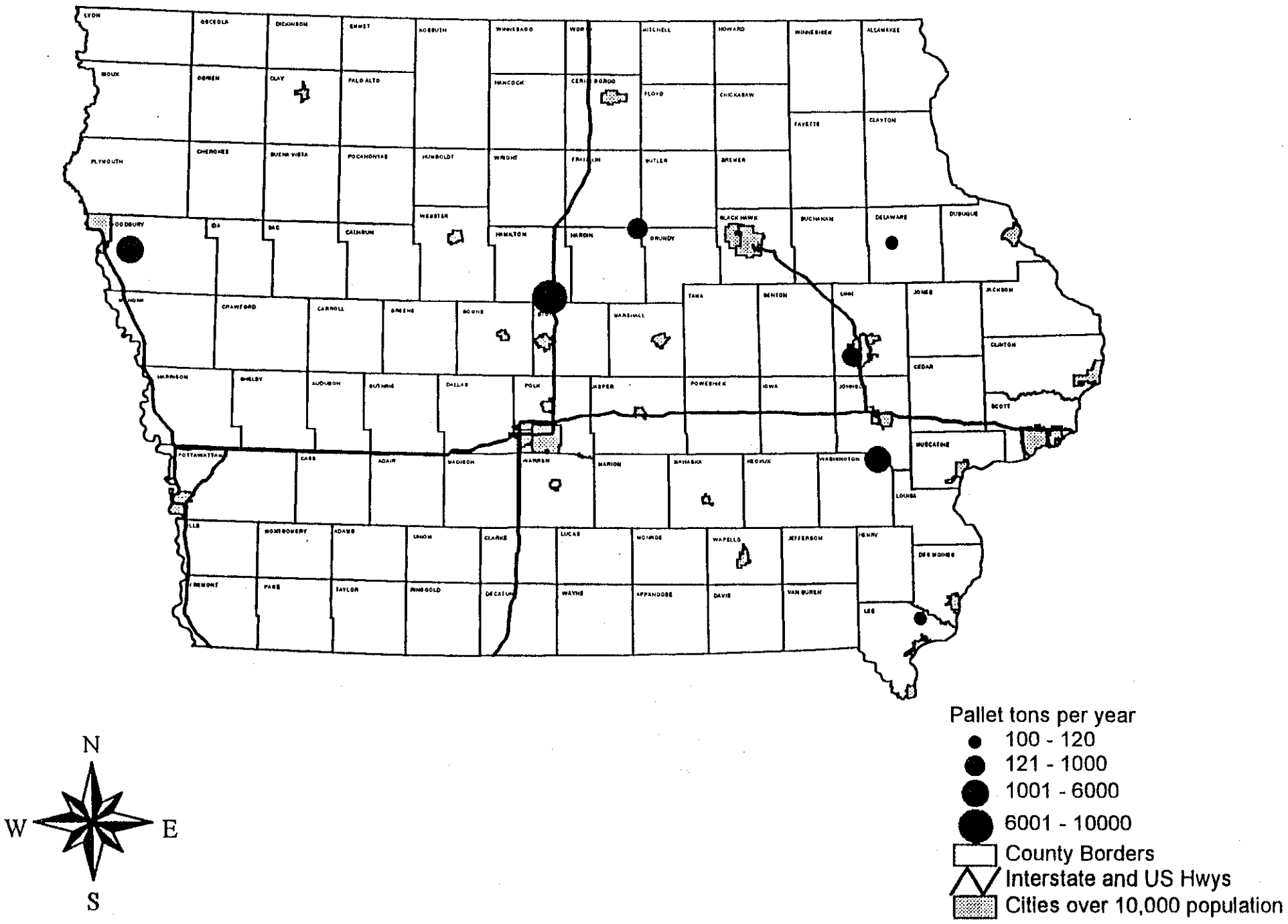
Stumps and large tree limbs are another commonly used wood waste resource. According to the survey results, five companies process 12,400 tons of stumps and tree trunks per year. Only one firm generated five tons of stump and/or tree limb waste on site. The potential additional capacity to process stumps and tree trunks was 9,037 tons. Contrary to that, however, are 11,664 tons of stumps that were listed as excess supply.

Sawdust. Approximately **39,465** tons of sawdust were processed annually by **eight** firms (see Map 6). This significant wood waste product comprises **24** percent of the total cited wood waste stream. Only **7,800** tons of sawdust were produced on site by **four** companies. The potential to process additional sawdust was calculated to be **25,005** tons with three operations having additional capacity. For comparison, only **2,002** tons of excess sawdust supply existed, while **three** firms claimed a total of **14,800** tons of excess

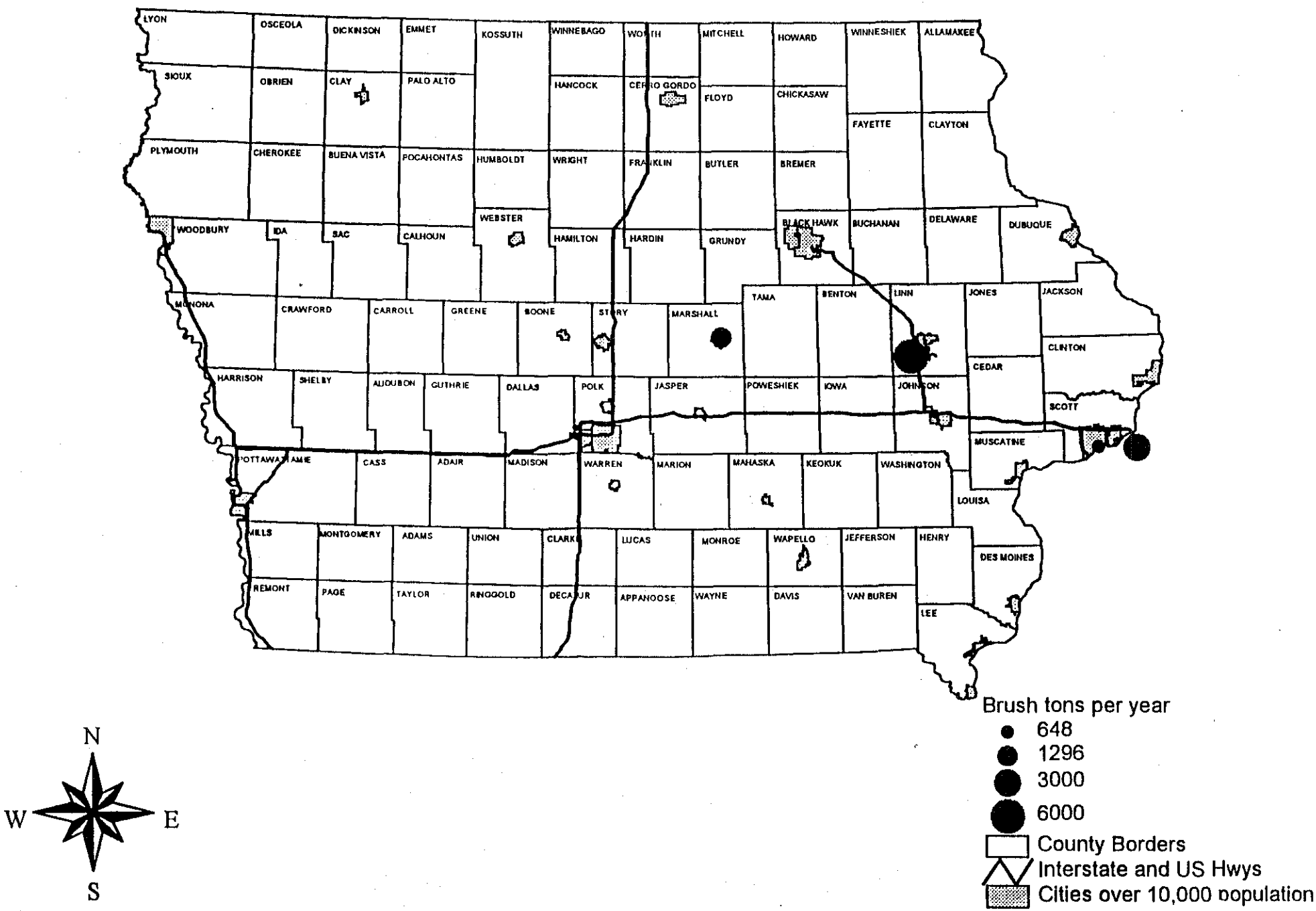
Map 3. Pallet processors



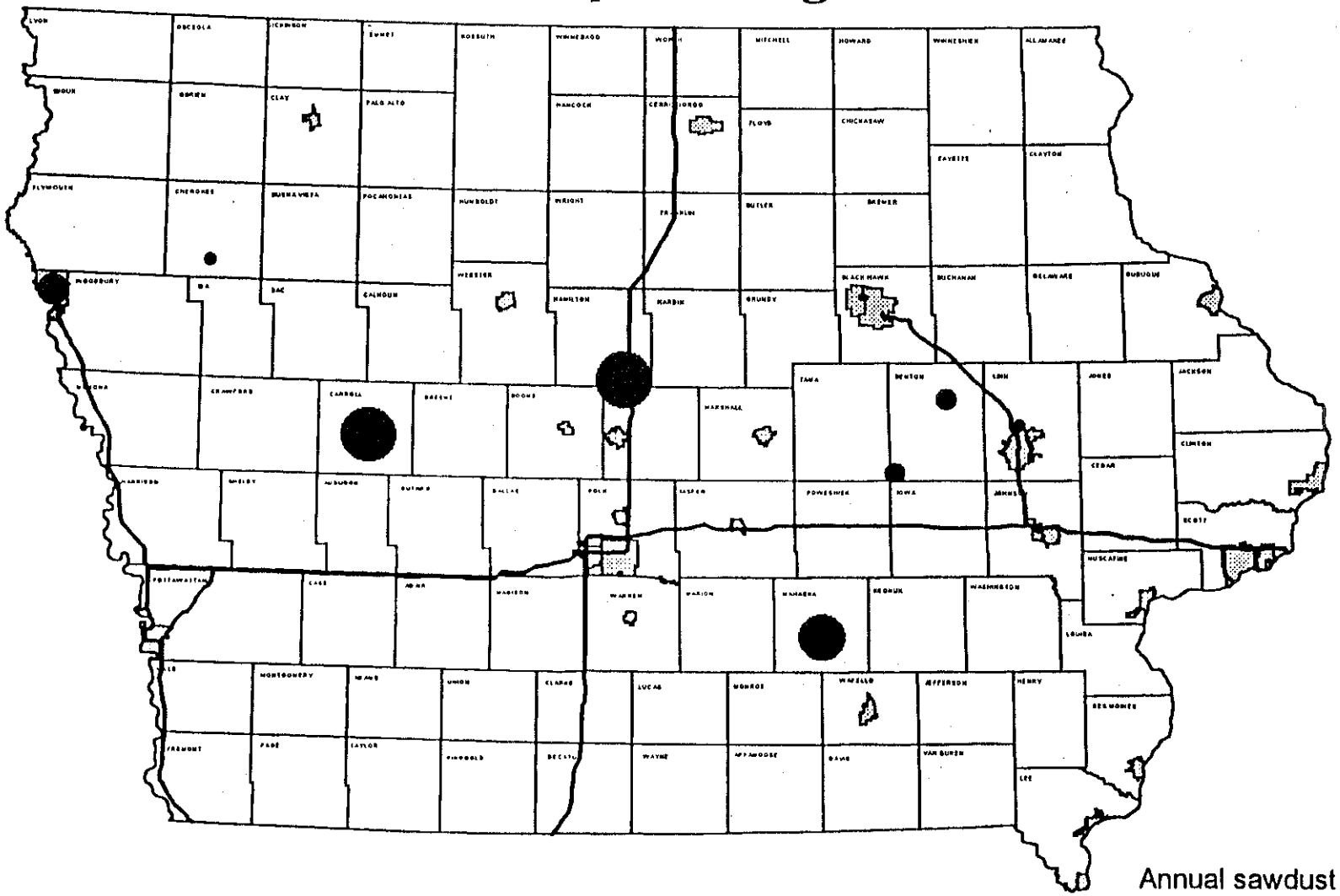
Map 4. Potential annual processing capacity for pallets

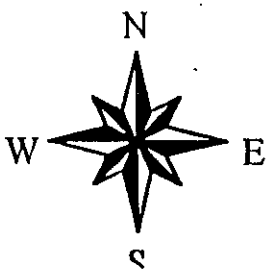


Map 5. Potential annual processing capacity for brush



Map 6. Sawdust processing in Iowa





Annual sawdust processing (tons)

- 500 - 2083
- 2084 - 3666
- 3667 - 5250
- 5251 - 6833
- 6834 - 8416
- 8417 - 10000
- County Borders
- Interstate and US Hwys
- Cities over 10,000 population

demand (lack of supply) for sawdust. This shows that through better communication among the processors, all of the excess supply could be diverted from landfilling.

Scrapwood. Sawmill scrap also comprised a significant portion of the wood waste stream. **Ten** firms processed **30,650** tons of this material. **Five** processors generated **16,095** tons on site. Sawmill scrap makes up **19** percent of the total waste stream. According to the respondents, the potential to process more scrap only adds up to an additional 2,500 tons per year. Participating firms also identified that they had **5,518** tons of excess sawmill scrap supply; only one firm claimed an excess demand for sawmill scrap of 3,000 tons. This shows that most, if not all, of this material has the potential to be processed somewhere within the state of Iowa.

Seven of the survey respondents reported that manufacturing scrap, particularly from furniture manufacturing, accounted for 5,872 tons of the wood waste processed per year. Manufacturing scrap made up **less than one** percent of the total utilized wood waste stream reported by the 77 survey respondents. Only one survey respondent produced any of this type of material within their own operation - 520 tons. There was no listed excess supply of manufacturing scrap, although three operations combined for a total of 5,500 tons of excess demand for manufacturing scrap.

Table 4 presents some detailed figures regarding the wood waste stream in Iowa. Potential additional capacity is the phrase utilized in the survey and we presume this simply is another term for existing unused capacity.

Table 4. Composition of wood waste stream of survey respondents

Wood waste type	Total tons used/yr	Tons generated on site/yr	Potential additional capacity (tons/yr)	Amount of excess supply (tons)	Amount of excess demand (tons)
Construction and demolition	1,420	0	50	550	0
Pallets	46,460.5	11,820	19,520	12,465	6,400
Brush	17,164	4,324	10,944	500	0
Stumps/tree trunks	12,400	5	9,036.8	11,664	0
Sawdust	39,465	7,800	25,005	2,002	14,800
Sawmill scrap	30,650	16,095	2,500	5,518	3,000
Manufacturing scrap (i.e. furniture)	5,872	520	150	0	5500
Any type material	8,624	3,000	Not provided	NA	NA
Totals	162,055.5	43,564	67,205.8	32,699	29,700

Source: 1996 IDNR Wood Waste Recycling Survey.

Types of wood accepted. Two of the surveys received stated that they processed any type of wood waste material. These two processors used a total of 8,624 tons and one claimed an unlimited potential for additional processing of any wood waste type.

The responding companies were asked to indicate the species of wood accepted. The survey choices were as follows: hardwood with no walnut, hardwood (all types), softwood, or other. Of the 77 respondents, 47 responded to this question. All types of wood are accepted by 29 of the processors; 8 take all wood with the exception of walnut; three accept only pallets; three accept only hardwood; the rest may take only softwood, or particle board, **along with two that take unfinished C &D wood and bundled brush.**

Service area of processors. Wood waste recyclers were asked what areas of the state they accepted wood waste from. Many of the processors are municipal governments or regional solid waste agencies that accept waste only from within their own service area. However, of the 41 who responded to this question, 18 would accept waste from

anywhere in the state. When asked how far they would travel to pick up a wood waste product, 23 recyclers were willing to travel to pick up wood waste. The distance they would travel to pick up wood waste ranged from 50 miles to 500 miles. Most companies would only travel great distances for a premium product such as pallets or used lumber. The amount of wood waste accepted from outside the state of Iowa was figured to be 25,103 tons according to the survey. A few industries are located near the state borders or in nearby states. Most firms, especially public operations, will accept wood waste only from within their particular region of the state.

Forms accepted. The various forms of wood waste accepted by the processors varied greatly. Below is a list of various forms of wood waste accepted:

- Pallets
- Pallets and boards
- Sawdust and wood chips
- Stumps, tree sections, yard trimmings and brush
- Wood scraps
- Unprocessed clean wood
- Clean and dry hardwood bark
- Hog wood

Of the inputs listed above, pallets, usable lumber, and wood chips were the most widely accepted wood waste forms. Usable lumber is referred to as waste because in many cases, even usable lumber scraps will reach the landfills of Iowa. Many processors added the additional requirement of accepting only clean wood waste, containing no foreign materials or chemicals.

Table 5 below denotes the total tons of wood waste used annually to produce various products. The greatest amount of wood waste was used for mulch production. Since pallets were not included in the original survey questions, we feel that the figure

listed below for pallets may be underestimating the actual figure. On the original survey, processors of pallets had to write the pallet figures in the category *other*. No wood waste was reportedly used for charcoal, presslog, or fuel pellet production.

Table 5. Uses of wood waste in Iowa

Product	Tons of wood waste used for product
Animal bedding	34,339
Mulch	42,945
Composting	17,692
Incineration for heat recovery	32,579
Incineration for electricity generation	11,664
Paper	5,671
Pressboard	6,888
Pallets	20,725
Play ground underlayment	375
Remanufactured doors	2,187
Building forms	300
Total	175,365

Source: 1996 Iowa DNR Wood Waste Survey.

End uses. The final products or end uses of wood waste are as varied as the wood waste material that is used to produce these marketable products. The figures here may not match exactly with table 4 due to the fact that wood waste changes forms during processing. For example, table 4 shows that **46,460.5** tons of pallets were accepted annually. However, table 5 shows that there were 20,725 tons of wood waste used annually to produce pallets. In this case, much of the pallet waste not satisfactory for reuse as pallets ends up in the form of mulch, animal bedding, or sawdust.

Most of the total amount of wood waste material was used for a secondary usable product, although over **44,000** tons were being processed for incinerated generate heat or electricity (see Map 8). Table 6 below lists various wood waste products that are sold or given away by operations around the state.

Animal bedding production comprises the most frequently distributed wood waste product (see Map 7). Due to the large number of livestock operations throughout the state, the production of animal bedding should remain a viable market for wood waste products. Also, over 37,000 tons of compost are distributed annually by the responding companies; mulch production tops the rest of the list (see Table 6). Most of these materials are not sold by the ton, but in much smaller units (refer to Table 4). The large range in prices for animal bedding and mulch seen in table 6 are due to two companies with very specialized products. The range of prices charged for mulch and animal bedding without the two specialized companies is about $0 to $15 per cubic yard or ton.

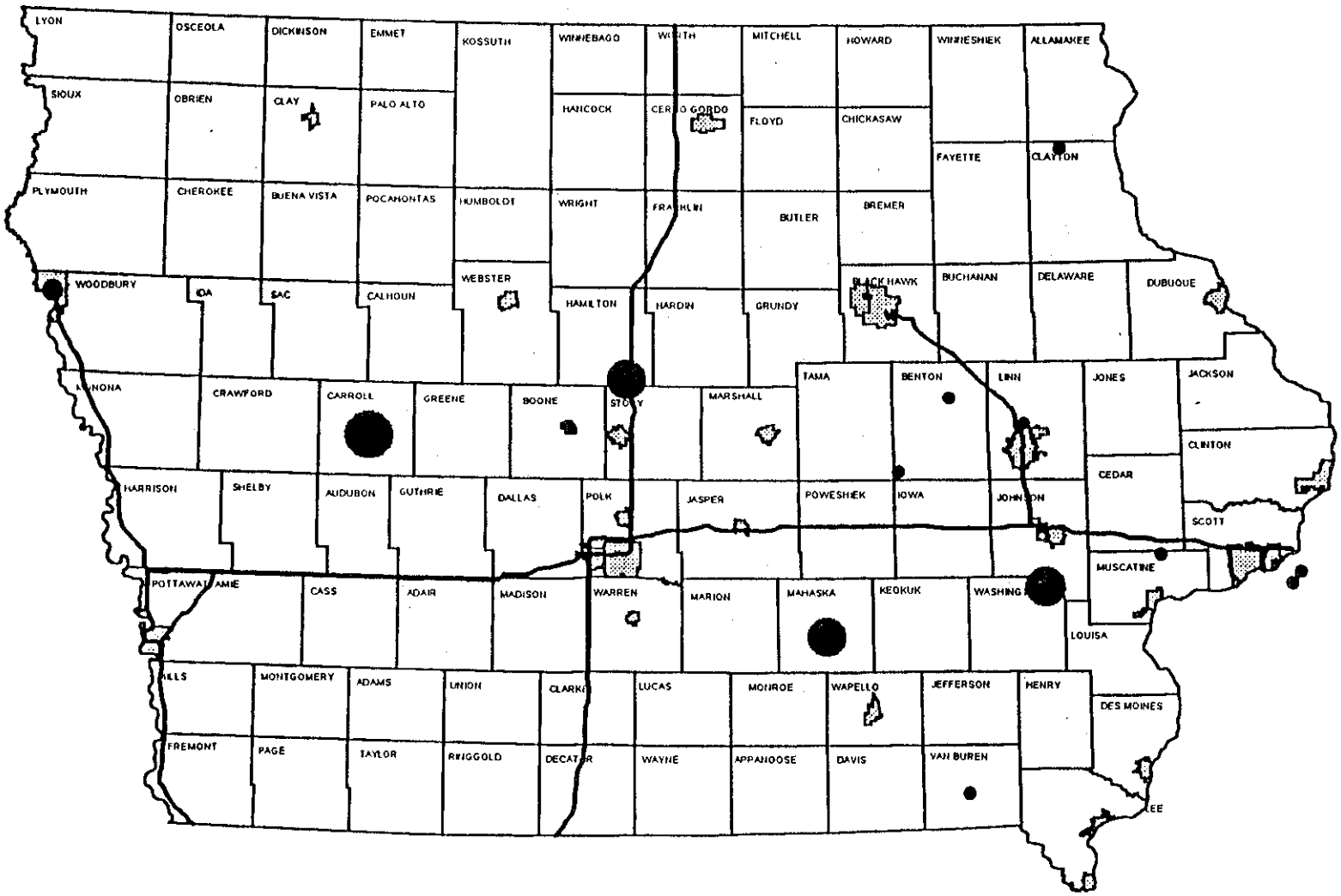
Table 6. Amount of wood waste products sold annually

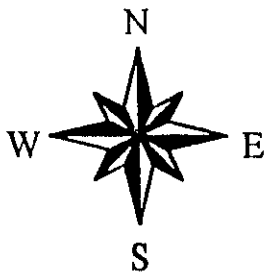
Product	Tons sold annually	Prices of product listed	Avg. Price\Ton
Animal bedding	39,482	free-$11/CY; $5-$100/ton	$18.24
Compost	37,410	$5-$19/ton; $7-$10/CY	$11.85
Mulch	24,086	free-$15/CY; $10-$200/ton	$20.65
Pallets	9,538	$1.25-6.50/pallet	
Biomass fuel	5,000	$21.50/ton	
Wood chips	2,600	$17.75/ton	
Paper	2,000	$11/CY	
Building forms	94,000 SQ FT	$2.70/SQ FT	

Source: 1996 Iowa DNR Wood Waste Survey. Prices based on 19 of the 77 responses.

An important reason for some of the discrepancies between tables 5 and 6 derives from the respondents not replying to the survey in full. More specifically, some of the private firms did not provide figures in regard to annual sales. In addition, the question on the survey asked for the amount of product sold, therefore, the respondents that do not charge for the wood waste products they process may not have responded to this question.

Map 7. Animal bedding production in Iowa

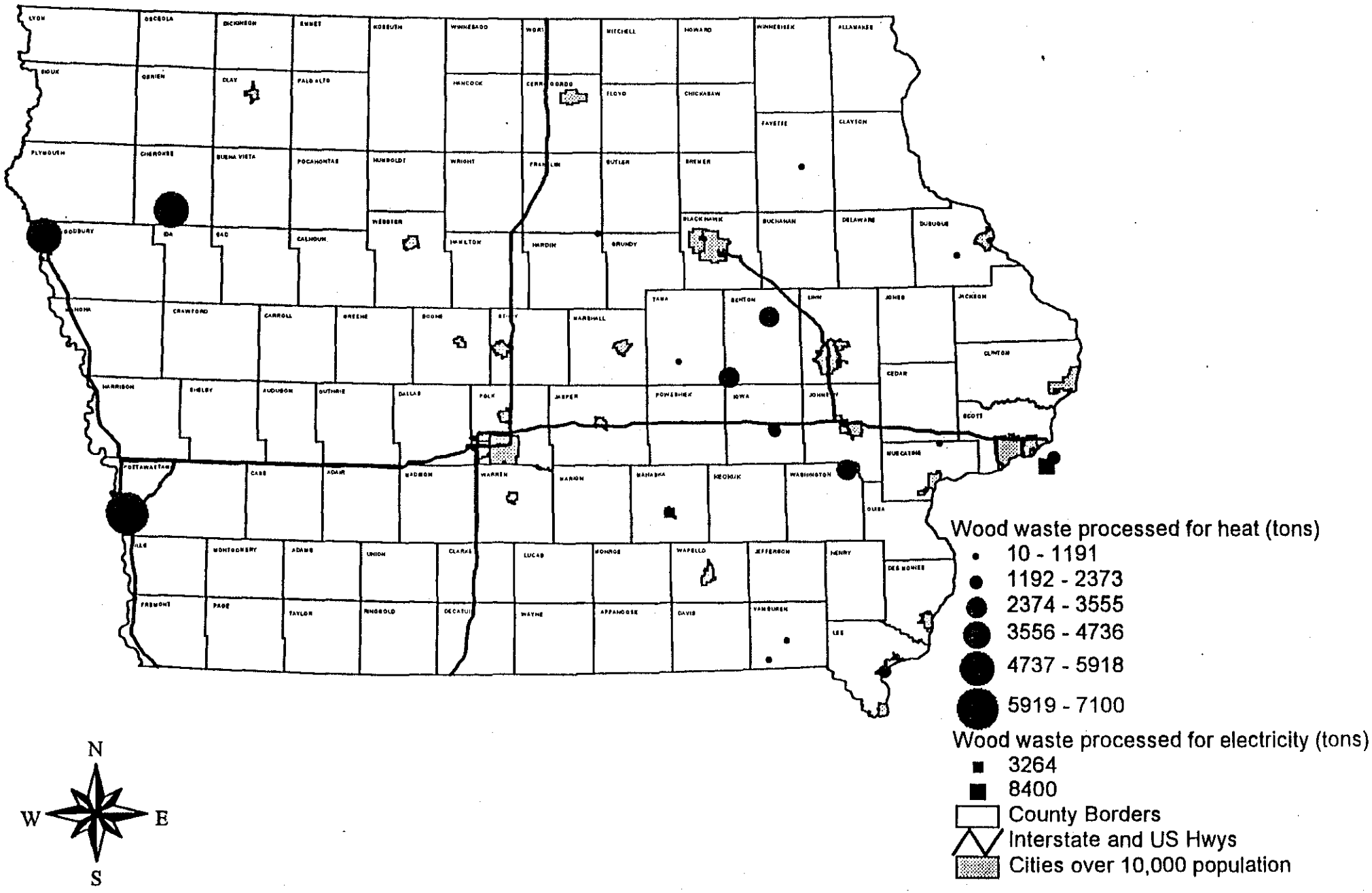




Animal bedding production (tons)

- 1 - 1800
- 1801 - 3600
- 3601 - 5400
- 5401 - 7200
- 7201 - 9000
- County
- Interstate and US Hwys
- Cities over 10,000 population

Map 8. Wood waste processed annually for heat or electricity generation.



Findings

- Animal bedding, compost, and mulch were the end uses most frequently produced from wood waste.
- **Over 39,000** tons of wood are currently used for heat or electricity production.
- At least ten different wood waste uses were cited.
- There is much that can be done to improve communication across the state simply by connecting the wood waste generators with the processors.
- Clean, untreated wood is preferred to other types of wood such as chemically tainted or pressure treated wood.
- **Over one-third** of the respondents would accept any type of wood waste.
- Pallets and sawdust comprise **53 percent** of the wood waste stream, having an excess demand of almost 20,000 tons or one-seventh of the total wood waste currently processed. (Figure 4, Table 4)
- There is twice as much wood waste being used now as there was being in used in 1993 according to the figures presented in UNI study, *Closing the Loop on Wood Waste*, which analyzed only wood used internally by generators.

NATIONAL WOOD WASTE RECYCLING MARKET

The national market for recycling wood waste is fairly young and scattered across the nation. The *National Wood Recycling Directory* produced by the American Forest Service & Paper Association surveyed 600 processors of wood waste nationwide and found that wood waste processors were geographically dispersed. North Carolina reported the most processors with 15 percent of the total, while California, Maryland, and Oregon accounted for another 25 percent of the total processors (Darrow, 1996). This study also concluded that wood recycling activity appears to be on the threshold of a major expansion (Darrow, 1996).

Wood waste processors accept a variety of material and produce a variety of end products. The American Forest Service & Paper Association report also discussed the types of material accepted by wood waste processors nationwide. The table below summarizes the percentage of wood waste processors that accept and handle each type of

material. The report found that pallets were the most widely accepted and handled wood waste material, with more than two-thirds of all the processors accepting them.

Table 7. Percent of national processors handling wood waste material by type

Type of Material	Percent of Total Processors
Wood Pallets	66
Brush Trimmings	55
Construction Cutoffs	49
Tree Residue	42
Demolition Scrap	31
Engineered Wood	23
Preservative-treated Wood	8

Source: *National Wood Recycling Directory:* Darrow, 1996.

The most common wood waste end use product is wood chips and mulch for various applications. The wood chips are used in landscaping, trail building, playground underlayment, and even as flavor chips for use in barbecues. Another popular use for wood chips is animal bedding because it is a cleaner, more absorbent material. Composting operators have also found wood chips to be a good additive to their compost to improve the product and composting process.

There are many processors reusing wood waste in various ways to make new value added products. As discussed previously, wooden pallets are the most widely processed in this way. The pallets are refurbished for reuse as pallets or dismantled to provide wood for products such as furniture, toys, or firewood. Some processors are also recovering wood fiber for use in medium density fiberboard or particleboard. Another end use product for wood waste is in producing wood pellets or pressed cubes for use as a fuel source.

CASE STUDIES

Wood waste operations nationwide

There are many different and innovative wood waste diversion operations that have been implemented by the public and private sectors. The literature provides some examples of these wood waste operations from across the nation. Two examples worth noting are a pilot curbside collection program in Aberdeen, Maryland and a city-wide drop-off site in Anniston, Alabama. The pilot project was both a service to the residents of the City of Aberdeen and a research opportunity to quantify the types and amounts of wood waste set out on the curb. The city also intended the project to recover a portion of the lumber and fabricate it into usable products such as birdhouses, bat houses, and compost bins.

The one-time curbside collection was advertised to encourage participation, but also as an attempt to control the quantity of setouts. The participants were counted and the wood waste piles were estimated during the collection. The collection crews directed the 'usable' wood into a separate truck that could be used to fabricate the birdhouses and compost bins. Clean wood was favored in the separation of 'usable' wood, although good pieces of pressure treated lumber were also salvaged.

Roughly one out of eight households (12.6 percent) participated in the pilot curbside collection project with an average setout of 174 pounds (Litke, 1996). Of the wood collected, pressure treated lumber was the largest contributor at 35 percent, while the quantity of clean wood totaled 16 percent (Litke, 1996). The Aberdeen pilot project collected a total of 39 tons of scrap wood and claimed 3.47 tons of that for refabrication

(Litke, 1996). As a result of the curbside collection pilot project, the City of Aberdeen implemented an annual scrap lumber collection program to recover more usable wood (Litke, 1996).

City of Anniston case study. The City of Anniston in eastern Alabama has developed a successful program to recycle wood waste. A waste audit in 1992 revealed that approximately 20 percent of Anniston's waste stream consisted of wood (*BioCycle* 1995). The city targeted wood waste as a material to be diverted from the landfill and developed a program to address it. The City of Anniston developed a site where all wood and yard trimmings collected by the city or dropped off by residents would be accepted. This operation chips the wood waste to produce wood chips, mixed chips, and compost. Wood chips consist of tree residue while mixed chips include both tree residue and processed wood. In 1993, the operation produced 949 tons of wood chips, 590 tons of mixed chips, and 258 tons of compost (*BioCycle* 1995). Most of the chips are sold to individuals or local landscaping companies. The local golf courses and the city Park and Recreation Department have also been major users of the chips. The operators of the wood waste recycling program in Anniston cite their competitive pricing as a key to their success. They charge a tipping fee of $12.50 compared to $22 at the landfill. This has allowed them to divert large amounts of material without enacting any new ordinances or regulations. To date, the program in Anniston has avoided expenditures on landfill tipping fees of over $120,000 and has generated over $50,000 in revenue.

Wood waste operations statewide

There are also several examples of wood waste recycling programs in Iowa that are working to divert wood from landfills. For example, Carroll County, Iowa implemented a wood waste grinding program to help them meet the state's 25 percent waste reduction goal. Carroll County received a Landfill Alternatives Financial Assistance Program (LAFAP) grant from the IDNR and purchased the equipment needed to grind wood waste into mulch. They accept clean and separated loads of wood at $20 per ton compared to the $34.75 per ton tipping fee charged at the local landfill (Steuteville, 1996). The recycling operation separates the wood waste into tree residuals or pallets and dimensional lumber to produce two kinds of mulch. The tree residuals are ground and mixed with leaves to produce a compostable mix mulch, while the lumber is ground to produce a more stable mulch. The county sells both kinds of mulch for $20 per ton and has found that they have difficulty producing enough to satisfy demand (Steuteville, 1996).

Another example of wood waste recycling programs in Iowa comes from Oskaloosa, Iowa. B&B Bedding of Oskaloosa is a business processing wood waste from cabinet and window manufacturers and from used pallet processors. They receive about 50,000 tons per year of wood waste and grind it to produce animal bedding. The company received a LAFAP grant from the IDNR to expand their processing and bagging operations. The company continues to expand due to growing markets (Steuteville, 1996).

A third example of wood waste recycling in the state comes from Riverside, Iowa. Riverside Pallets of Riverside is a used pallet processing company. They collect and rebuild wood pallets for reuse and grind the remaining wood waste for mulch and animal bedding. A grant from the IDNR Landfill Alternatives Grant Program helped the company to purchase the tub grinder that is essential to their operation (Ryan, 1994). About nine million pallets are collected, dismantled, and rebuilt to be sold as used pallets. Riverside Pallets sells used pallets for considerably less then the price charged for new pallets. The wood that is damaged beyond reuse is ground in the tub grinder to produce wood chips used for mulch or animal bedding. Riverside Pallets currently sells the wood chips for $15 per truck load and often have far more demand than supply.

RECOMMENDATIONS - POTENTIAL WAYS TO UTILIZE WOOD WASTE IN IOWA

Introduction

As part of the creation of this project, the IDNR requested that they be given some recommendations for the use and disposal of wood waste in Iowa. These recommendations are partially based on the survey results and the case studies produced in the first two sections of this paper. The recommendations are also partially based on creative thinking and the literature review of the wood waste field. For this reason, many of the ideas in this section lack the necessary economic analysis that any prudent program would require before initiation. The ideas, therefore, are intended to give the IDNR a place to start as it begins to develop the wood waste utilization market in Iowa.

With recent increases in technological capabilities and the desire to divert wood waste from landfills, there are many potential methods of wood waste utilization. Iowa, being a sparsely populated state, lacks the concentrated wood waste supply needed to make most existing disposal methods feasible. The capital costs and the lack of consistent supply of wood waste make many potential projects very difficult.

The current uses of wood waste in Iowa are generally limited to basic pallet recycling and wood chipping facilities that provide mulch, animal bedding and other wood products. There is potential for an expansion of the current wood waste utilization techniques and the creation of new methods of disposal. This section of the paper will discuss the possibilities for expansion of current wood waste utilization techniques and creation of new methods of utilization.

Expansion of current technologies

Pallet Industry. Currently in Iowa, there are 15 wood waste processors who are processing old pallets to construct and sell new ones. (See Map 3). This type of business is very labor intensive and requires a lot of hard work to be successful. Some of the larger operations, such as Riverside Pallets in Riverside, Iowa, have slowly expanded their business through gradually building markets and business connections. Riverside Pallets recently began receiving orders for pallets from California and New York because of the low price at which they can sell their pallets. The owners of Riverside Pallets say that they have a difficult time filling all of the orders they receive for pallets each year. They also commented that the pallet recycling market has great potential in Iowa and that there is

room for expansion into the business for those people who are willing to invest the time and great labor involved. (John Hahn, Riverside Pallets, Inc.)

Essential to the success of a large pallet recycling business is an on-site wood chipper because it allows for a diversification of the business. Such a wood chipper allows for diverting the wood that would otherwise be waste destined for the landfill, yet the capital costs can be exorbitantly high with good tub grinders ranging in price from $100,000-$250,000 (Dave Hogan, Bluestem Waste Management Facility).[1] Riverside Pallets, with the help of a $150,000 Landfill Alternatives Financial Assistance Program (LAFAP) grant from the Iowa Department of Natural Resources, was able to purchase their wood chipper for use on-site to grind excess wood. (Ryan, 1995). Andrew Pallet Co. was able to do the same with a $100,000 LAFAP grant which allows them to produce 5,000 tons of usable mulch and animal bedding from the wood waste each year instead of landfilling it. This allows the company to sell or give away their unwanted wood and avoid the high tipping fees (ranging from $27-40/ton) associated with landfill disposal.[2] Therefore, the first recommendation is the expansion of the LAFAP grant program to allow other pallet recycling firms to get established in this growing market.

Also, if there were a readily available market nearby to purchase the wood chips for boiler fuel or mulch, the pallet recycler would not be forced to give away such a large

[1]The price for a smaller chipper, such as the ones used by many municipalities for their park maintenance projects, range in price from $6,000 - $20,000. These smaller chippers are best used for smaller logs and may not have the grinding capabilities required for a larger wood waste processor.

[2] Though there may already exist a market for mulch and bedding, that demand is usually satisfied by the bags which can be purchased at Kmart. The same people who buy it by the bag are not the same people who buy it directly by the truckload from the wood waste processor. There is not enough consistent demand for mulch or animal bedding from the processor to finance the purchase of a bagger to bag the mulch and bedding. This most likely can be attributed to the lack of communication between the wood waste processor and the wood waste market.

portion of their shredded wood and could profit from the excess chips. If there was a consistent demand for the shredded wood, the pallet recycler would be able to charge a more appropriate price for the waste (currently ranging from $0-15 per ton) and begin to see a profit which might pay for the cost of their equipment. Later proposals will demonstrate how effective communication and restructuring of current technologies could lead to the creation of such a consistent demand for wood chips.

Wood Waste as a Boiler Fuel. In January 1995, M.L. Smith Environmental, Inc. published a Study of Processing and Utilizing Urban Wood Waste and Pallets for Fuel in the State of Iowa (hereinafter MLSE study). This 150 page study outlines the possibilities for using Iowa's wood waste as an industrial fuel in the nine largest counties in Iowa. The MLSE study concluded that it would be very feasible, and in fact profitable, to convert existing industrial boilers to partial burners of wood waste.

The MLSE study begins by outlining the four major categories of wood waste and their potential for use as a fuel. The four categories of such waste are:

Category 1: Brush and tree trimmings and urban tree removal
Category 2: Mixed municipal solid waste
Category 3: Manufacturing solid waste
Category 4: Construction and demolition debris (C&D waste)

These categories of wood waste generate approximately 12,600 tons per 100,000 people per year in Iowa which amounts to 157,098 tons of wood waste generated in the nine largest counties (MLSE, 1995). The energy content for Iowa's wood waste is expected to average about 7,100 BTU/lb for non-forestry and 4,500 BTU/lb for forestry wood and is projected to be 4.5 trillion BTU/year for all of Iowa (MLSE, 1995). This

translates into approximately 1.3 percent of the energy produced by coal in Iowa (MLSE, 1995).

These numbers indicate that a lot of money could be saved by industries that burn coal in their boilers to heat their facilities while at the same time saving the wood from being landfilled. Please refer to Appendix B for a complete detailing of the cost analysis of using wood waste as a boiler fuel. There are, however, barriers to the recovery of wood waste which inhibit its full utilization as an industrial fuel. The MLSE study lists ten reasons for the relatively small amounts of recovery:

1. Mixing of wood waste with other wastes
2. Lack of facilities and programs to process and remove C&D waste
3. Lack of markets and/or presence of wood waste contaminants
4. Lack of availability of urban wood in large supplies and in a form which will encourage market development and use
5. Costs of finely sizing or processing wood into useful end products
6. Lack of firm wood fuel markets and industry policies favoring other fuels
7. Present low cost of other fuels such as coal
8. Relatively low landfill tipping fees of about $25/ton in Iowa
9. Costs of gathering and transporting urban wood to the processor
10. Costs of transporting wood fuel to wood markets - the combination of light payloads and low heat value limits the economical haul distance to market

One of the major concerns when considering the use of wood as a fuel is its relatively low BTU value mentioned as number ten on the list above. This BTU value, demonstrated in Table 9, shows that wood can be comparable to coal in BTU value per pound.

Table 8. Range of heat values for different industrial fuels

Fuel Type	Fuel Heat Value Range
Wood	3,900 - 8,500 Btu/lb
Oil	140,000-150,000 Btu/gal
Natural Gas	900-1300 Btu/cubic foot
Coal	7,000 -14,000 Btu/lb

Source: MLSE Report, p.59, Jan. 1995

One thing that must also be considered when examining the table of heat value is the cost of each fuel type. One factor in the profitability of wood waste is the avoided tipping associated with landfilling the waste. This avoided cost may partially reduce the cost of obtaining the necessary quantities of wood waste. The MLSE report assumes that there is no cost for the wood fuel at the point of use including transportation costs (MLSE, 1995). The tables in Appendix B detail the proximity of possible boilers to the nine largest counties. The MLSE report concludes that wood waste fuel can be a profitable endeavor even with the lower BTU value of wood. (See Appendix B tables of costs and revenues).

The MLSE study indicates that there is a good potential for the use of wood waste as a fuel in industrial boilers in Iowa. The study proposes use of such wood in an existing 150,000 lb/hour coal fired combuster which could be retrofitted to accommodate the co-firing of wood. This proposal was the most cost efficient and effective way to convert wood waste to fuel because there are fewer capital costs involved in mixing the wood with coal than if a stand-alone wood waste combuster were created. In Appendix B attached to the end of this report are copies of the entire costs and revenue projected by the MLSE study. The study anticipates the use of 18,400 tons of wood waste per year per facility. This means one such facility would increase use of wood waste by 15 percent and three facilities would increase use by 45 percent. The cost savings projected for the retrofitted boiler is approximately $8.87/ton. This projected cost savings stems from the $2.00 per million BTU avoided cost of not using coal as the boiler fuel. (MLSE, 1995) This

assumes that the wood fuel is available at the F.O.B. point of use at no cost (MLSE, 1995). The study makes the point that:

> To insure continued availability of wood residue for wood energy projects and tip fee income (if this is agreed upon) the wood must be clearly a part of the waste disposal stream and the business arrangement must be a win, win condition for all parties participating. (MLSE, 1995, p.115).

This type of win/win solution is possible if the wood waste generators are willing to pay a portion of the avoided tipping fee to the wood waste processor, and the wood waste processor is able to sell the fuel chips to the owners of the boilers at a market price cheaper per BTU than coal. It must also be remembered at this point that much of the current chipped wood which is used for bedding or mulch is sold at a very cheap rate such as $15 per truck load at Riverside Pallets.

In order to begin this process in the most efficient manner, it is best to target the nine largest counties as was done in the MLSE report. By targeting these areas, it is possible to create some type of organization between the wood waste processors in order to guarantee a consistent supply of wood waste to the boiler owners. A community drop-off or annual collection of wood waste in each of these nine counties would be ideal for using wood waste as a fuel. The processors could either share the supply of the wood waste collected with the wood with the boiler operators or sell it to them at a reduced rate. This could lead to a much larger public outreach program for the diversion of wood waste.

Tables 4.11-1, 4.11-2 and 4.11-3 from the MLSE report (listed in Appendix B) name all of the industries in Iowa which have coal-fired boilers that have the potential to

be converted to partial wood waste users. This list of industries gives the State a starting point to target businesses and encourage the use of wood waste as an industrial fuel. Notably, there are three state-owned facilities, Iowa State University in Ames, the University of Iowa in Iowa City, and the University of Northern Iowa in Cedar Falls which are on this list and represent a good starting place for conversion to wood waste as a fuel. These three facilities alone could increase the use of wood waste 45 percent per year using the 18,400 tons per year figure.

In 1980, the Environmental Protection Agency released a study titled, Environmental and Technological Analysis of the Use of Surplus Wood as an Industrial Fuel. This study listed five non-technical barriers to the use of wood waste as an industrial fuel. They include:

1. lack of an established supply/market infrastructure
2. competition among alternative users of wood waste (limits total supply)
3. uncertainty concerning the future supply of wood
4. inconvenience of wood as a fuel compared with gas or oil
5. capital investment required for conversion of facilities to use of wood as a fuel

The non-economic barriers, which exist in Iowa as well as the rest of the country, can be corrected with the creation of proper communication channels. There are 53 wood waste processors in Iowa who responded to our survey. These processors are sufficiently spread throughout the state so that they could pick up wood or supply wood to just about any region. (See Map 1). If industries with the capability to use wood waste as a fuel were aware of its availability or its cheap price, they would be more likely to consider the conversion.

With the creation of the database that was started with this study, the information will be more readily available to the industrial sector. It is the responsibility of the Department of Natural Resources and the State of Iowa to complete the process of information gathering and begin the dissemination of this information. Once completed, there would be a database that showed all wood waste processors, all wood waste generators as well as possible markets or industries which consume wood waste. With this increased availability of information, industry owners will have a chance to see first-hand the convenience and feasibility of conversion of industrial boilers to partial wood waste burners.

The availability of this information will not be sufficient to initiate industry conversion to partial use of wood waste as a fuel. There must be some case study examples available for examination which these industries can look to for feasibility analysis. In order to initiate the use of wood waste as a fuel, the state government should look to its state-owned facilities to lead the way. As was mentioned in the discussion of the MLSE report, the state owns at least three facilities which have the potential to partially convert their boilers to use of wood waste as a fuel. Either through some administrative mandate or a state law similar to the one which requires state-owned vehicles to use ethanol gasoline, the State of Iowa should strongly encourage its three universities which have boiler capabilities to begin the switch to partial wood waste use. By leading the conversion to use of wood waste as a fuel, the State of Iowa not only gives its wood waste processors the beginning of a consistent demand for wood waste, but it also demonstrates the ease and success which can be experienced by a conversion to wood

waste. This type of mandate has the potential to create a state-wide conversion to use of wood waste as a fuel to supplement use of coal. Industries would be more likely to convert to wood waste if they were to see a profitable demonstration of the possibilities.

Use of wood waste for road creation and landscaping. The State of Iowa has the opportunity in another manner to take the lead in use of wood waste. The Iowa Department of Transportation (IDOT) has an entire road system throughout the state which needs constant repair and landscaping using various mulch products. The IDOT uses mulch for roadside development projects such as ditch landscaping and other road building activities (Kermit Wilson, Iowa Department of Transportation). The purchase of this mulch is not regulated by the IDOT for any of its roadside projects. When the IDOT purchases mulch, it does so from the lowest bidder, whether or not that company resides in Iowa. For projects done by independent contractors, the purchase of the mulch is left solely to the discretion of the contractor.

If the IDOT were to make it a provision in its independent contracts and require from its own purchasers that the mulch that is purchased for projects is wood waste mulch which was generated in Iowa, then the government could go a long way towards creating a consistent demand for wood waste. The use of recycled wood chips as bedding around trees or on state park trails and roadways is a good way for the State to demonstrate its commitment to the use of recycled wood. With a few road signs or radio advertisements, the citizens of Iowa can take notice of the State's efforts every time they use Iowa's roads. Also, this would encourage the citizens of Iowa to seek out and purchase recycled wood for their own projects.

In addition, there is one final method of disposal of wood waste which the State of Iowa can begin to examine for feasibility. This method involves using a chunker to create chunkwood to surface low volume roads such as Level B Service roads. This process, which was invented by the Houghton Michigan Forest Service and tested by the USDA Forest Service, has proven to be a good alternative surface for low volume roads (Public Works, 1988). The major advantage that chunkwood has over other surfacing materials is its unit weight which is 100 lb/cu.ft lower than either sand or gravel. This is especially important for roads in terrain possessing weak roadbed soils such as uniform sands, saturated silts and clays. The idea was initially created as a way to surface remote roads in national parks where gravel surfacing was not readily available (Jim Madsen, Project Coordinator, Houghton Forest Services). Yet this idea seems just as feasible in rural Iowa where low volume roads exist, as does the desire to utilize Iowa's wood waste.

In 1988, the Forest Service built 2.5 miles of roads in Chequamegon National Forest out of chunkwood material for testing purposes. The road surface withstood tests by a 50,000 pound vehicle examining its lateral shoving, stiffness, roadrutting and general settlement (Forest Service Report, Department of Agriculture, 1991). The wood used and processed by the woodchunker can be any type of wood, hard or soft and costs about $2.35 per cubic yard to process and use on-site. It is processed from a woodchunker which can take whole trees and reduce them to pieces ranging from 1/4 inches to 6 inches (Public Works, 1988). This range of sizes allows the chunkwood to be interwoven which provides a high-frictional strength. If the IDOT were to invest in such a chunker,

currently in the developmental stages[3], the processed wood could be a likely candidate for low volume roads.

Though an actual woodchunker would be required to utilize wood as a road surfacing material, it would not be required to line trails and paths in Iowa's state parks. The same mulch or surfacing materials that are placed along trees for landscaping, may make a valuable resource for creating trails in Iowa's parks. This, like the other proposals involving state agencies, would create a consistent demand which processors could rely on in order to begin charging a profitable rate for disposal of their processed wood.

As was mentioned at the beginning of this section, such new uses of wood waste have not been completely developed and the economic feasibility has not yet been computed. These remain simple recommendations to the IDNR as potential methods the State may use to begin diverting larger portions of its wood waste from landfills.

[3]The Canadian firm Cazes & Heppner Forest Services Limited is currently looking into the commercial marketing of a woodchunker. As this is a relatively new idea, only prototype chunkers, such as the one created in Houghton, Michigan, can be relied on for feasibility data. The contact person at that company in Canada for questions regarding the wood chunker is Lyle Cazes at (604) 855-0678. For questions about the process of using chunkwood as a road surface material, the contact person is Jim Madsen, Project Coordinator, at (906) 482-6303.

CONCLUSIONS

The state of Iowa currently has an undeveloped market for handling wood waste. The lack of information, communication and market certainty all work to prevent this market from expanding. The technology is available as is the desire to divert wood waste from landfills. What is required at this stage is some intervention by state government organizations. Through greater control over the types of wood waste used by the IDOT for roadways and landscaping as well as use of wood chips as a boiler fuel, the State of Iowa can take the lead and move the wood waste market to the next level. The wood waste market can begin to be consistent, manageable and profitable while at the same time diverting valuable wood from the state's landfills.

SOURCES CITED

Arola, Roger A., et al., "Forest Roads Built With Chunkwood," Chunkwood: Production, Characterization and Utilization, Department of Agriculture, 1991.

BioCycle. "Wood Recycling at Municipal Centers." October 1995. p.38-39.

Badger, Phillip C., "End User Requirements: Marketing Wood Waste For Fuel," *BioCycle*, January 1995, vol. 36, no.1, p.71-74.

Clayson, Dr. Dennis E., et al., "Closing the Loop on Wood Waste: Reuse Applications and Market Potential," report prepared for Project Consultants from the Iowa Waste Reduction Center, June 30, 1993.

Coastal Georgia Regional Development Center. *Regional Planning User Guide: Rural Solid Waste Management*, Chapter 4.

Darrow, Carl. "Counting on Wood Recovery." *Resource Recycling*. February. 1996. Vol. 15, No. 2, pp. 69-70.

Hall, E.H., et al, "Environmental and Technological Analysis of the Use of Surplus Wood as an Industrial Fuel," Interagency Energy/ Environment R&D Program Report, June 1980.

Litke, Jim. "Recovering Scrap Lumber at Curbside." *BioCycle*. March 1996. pp. 33-34.

MLSE & Associates, "Study of Processing and Utilizing Urban Wood Waste and Pallets For Fuel in the State of Iowa," prepared for: Council of Great Lakes Governors, January 1995.

Ryan, Jennifer. "Pallet Waste Grinds to a Halt." *Iowa Conservationist*. May/June 1994. pp. 44-46.

Shook, Larry, "Using Chunkwood to Build Low Volume Roads," *Public Works*, Vol, 119, no. 10, September 1988, p.105-106.

Steuteville, Robert. "Wood Diversion Strategies." *BioCycle*. January 1996. pp. 37-39.

Urban Waste Wood Utilization, Proceedings of a Conference on Alternatives to Urban Waste Wood Disposal, March 26-28, Charleston, South Carolina.

APPENDIX A

WOOD WASTE SURVEY

Please fax the completed survey to (319) 335-3330 ATTN: Stu Turner or mail to Wood Waste Study, Attn: Stu Turner, Graduate Program in Urban and Regional Planning, 347 Jesup Hall, Iowa City, IA 52242-1316.

Your Name: _____ Company Name: _____
Wood Waste Contact Person: _____ Title: _____
Address: _____
City: _____ County: _____ Zip Code: _____
Phone: _____ Fax: _____ E-mail Address: _____

Do you represent a ☐ public ☐ private ☐ nonprofit organization?

1. Does your operation currently use wood waste? ☐ Yes (go to question 2) ☐ No

a. If No, have you considered doing so? ☐ Yes ☐ No

b. What do you perceive as the barriers to your operation using wood waste? (check all that apply)
☐ Lack of consistent supply ☐ Contamination ☐ Machinery to process wood waste
☐ Transportation ☐ Your manufacturing process ☐ Price of receiving/processing waste
☐ Other _____
Suggested recommendations for reducing barriers _____
PLEASE GO TO QUESTION #10

2. If Yes, please indicate the types, amounts (tons per year), and potential capacity of wood waste used and any cases of excess supply or shortage of supply (indicate all that apply). Please provide unit of measurement if not in tons.

Type	Total Tons Used/Year	Tons Generated on Site/Year	Potential Additional Capacity (Tons/Year)	Amount of Excess Supply	Amount of Excess Demand
construction and demolition					
pallets					
brush					
stumps/tree trunks					
sawdust					
saw mill scrap					
manufacturing scrap(i.e. furniture)					

3. Please indicate the species of wood you accept
☐ hardwood (no walnut) ☐ hardwood (all types) ☐ softwood
☐ other _____

4. What area(s) of the state will you accept wood waste from? _____
a. How many miles are you willing to travel to collect wood waste?
_____ miles (Put 0 if materials must be delivered)

5. Please indicate the form in which you accept the wood wastes
☐ sawdust ☐ wood chips - please indicate required size _____
☐ other _____

6. Does your company have any other requirements for accepting wood wastes (species type, contamination level, etc)? Please describe in detail: _____

7. How much wood waste are you currently using for the following applications? Indicate annual quantities and unit of measurement (i.e. cubic yards, tons, lbs, etc.) for each applicable activity.

☐ animal bedding production _____ amount _____ unit measurement
☐ mulch production _____ amount _____ unit measurement
☐ composting _____ amount _____ unit measurement
☐ incineration for heat recovery _____ amount _____ unit measurement
☐ incineration for electricity generation _____ amount _____ unit measurement
☐ fuel pellet production _____ amount _____ unit measurement
☐ press log production _____ amount _____ unit measurement
☐ charcoal _____ amount _____ unit measurement
☐ paper production _____ amount _____ unit measurement
☐ pressboard production _____ amount _____ unit measurement
☐ other _____ amount _____ unit measurement

THE FOLLOWING INFORMATION WILL BE KEPT CONFIDENTIAL

8. Do you pay for the wood waste you receive?
   - ☐ Yes, we pay $_____ amount per _____ (unit of measurement).
   - ☐ No, we charge $_____ amount per _____ (unit of measurement).
   - ☐ We do not pay or charge for wood waste.

9. Please identify by company name your two biggest sources of wood waste.
   1. _____
   2. _____

10. What is the amount of wood waste you receive from sources outside of Iowa?
    _____ amount _____ unit of measurement

11. How many employees do you have?
    Full-time _____
    Part-time _____ Average hours worked per week by part-time employees_____

12. What is the average hourly rate for your hourly employees?
    Full-time_____ Part-time_____

13. Do you have any salaried employees?
    ☐ Yes If yes, how many?_____ ☐ No

14. What is the salary range for salaried employees?
    $_____ to _____ /year

15. What is your annual gross sales?
    $_____/year

16. How much do you sell annually of the following products? Please indicate amount and unit of measurement.

☐ animal bedding	_____ amount	_____ unit of measurement (i.e. cubic yards, tons, pounds, etc.)
☐ mulch	_____ amount	_____ unit of measurement
☐ compost	_____ amount	_____ unit of measurement
☐ fuel pellets	_____ amount	_____ unit of measurement
☐ press logs	_____ amount	_____ unit of measurement
☐ charcoal	_____ amount	_____ unit of measurement
☐ paper	_____ amount	_____ unit of measurement
☐ pressboard	_____ amount	_____ unit of measurement
☐ other wood waste products	_____	
_____	_____ amount	_____ unit of measurement

17. What is the price per unit of the products you sell?

☐ animal bedding	$_____ price per unit	_____ unit of measurement (i.e. cubic yards, tons, pounds, etc.)
☐ mulch	$_____ price per unit	_____ unit of measurement
☐ compost	$_____ price per unit	_____ unit of measurement
☐ fuel pellets	$_____ price per unit	_____ unit of measurement
☐ press logs	$_____ price per unit	_____ unit of measurement
☐ charcoal	$_____ price per unit	_____ unit of measurement
☐ paper	$_____ price per unit	_____ unit of measurement
☐ pressboard	$_____ price per unit	_____ unit of measurement
☐ other wood waste products	_____	
_____	$_____ price per unit	_____ unit of measurement

18. What is the percentage of recycled materials in each unit?

☐ animal bedding	_____ % of wood waste in each unit	_____ unit of measurement
☐ mulch	_____ % of wood waste in each unit	_____ unit of measurement
☐ compost	_____ % of wood waste in each unit	_____ unit of measurement
☐ fuel pellets	_____ % of wood waste in each unit	_____ unit of measurement
☐ press logs	_____ % of wood waste in each unit	_____ unit of measurement
☐ charcoal	_____ % of wood waste in each unit	_____ unit of measurement
☐ paper	_____ % of wood waste in each unit	_____ unit of measurement
☐ pressboard	_____ % of wood waste in each unit	_____ unit of measurement
☐ other wood waste products	_____	
_____	_____ % of wood waste in each unit	_____ unit of measurement

APPENDIX B

TABLE 4.8-1

Wood Fuel Combustion Facility
Capital Cost

Capital Cost Estimate

Facility Option	**Case 1**	**Case 2**
Product (Air Heating, Steam or Electricity)	**Elect./Stoker**	**Coal-Retrofit**
Facility Boiler Steaming Rate	**50,000 Lb/Hr**	**150,000 Lb/Hr**
Site Development Utilities, Grading, Surge Bin and Feeders	500,000	100,000
Boiler Wood Fuel Storage, Surge Bin and Feeder	500,000	400,000
Boiler Island Boiler System Fuel Feeders/Stoker or Bed Emission Control System, CEM and Stack Ash System as Required Structural Steel/Siding/Foundations	4,000,000	450,000
Turbine Generator Island Turbine Generator Cooling Tower	2,000,000	0
Balance of Plant (As Required) Feedwater System Instrumentation and Controls Electrical/Interconnect	1,500,000	100,000
Construction/Erection		
Boiler Island	1,800,000	100,000
Turbine Generator Island	1,000,000	0
Balance of Plant	1,000,000	75,000
Misc. (Offices, Etc.)	250,000	75,000
Steam Line (1/2 Mile)	0	0
Equipment & Construction Total	**12,550,000**	**1,300,000**

TABLE 4.8-2

Wood Fuel Combustion Facility

Annual Operating Cost

Summary

Facility Option Product (Air Heating, Steam or Electric) Facility Boiler Steaming Rate	Case 1 Elect./Stoker 50,000 Lb/Hr	Case 2 Coal-Retrofit 150,000 Lb/Hr
Summary		
A. Annual Labor Cost	865,400	80.960
B. Annual Materials Costs	219,000	46.000
C. Annual Contract Services and Rental Cost	159,134	6.000
D. Miscellaneous Costs	26,000	0
E. Fuel		
1. Natural Gas	31,536	0
2. Fuel	1,000	0
F. Insurance	57,100	2.350
G. Annual Ash Disposal	44,668	25,428
H. Utilities		
1. Electricity	31,397	4.524
2. Water	8.604	0
Total Annual Operating Expenses	1,443,839	**165,262**

TABLE 4.8-3 (cont.)
Wood Fuel Combustion Facility

Annual Operating Cost

Facility Option Product (Air Heating, Steam or Electricity) Facility Boiler Steaming Rate	Case 1 Elect./Stoker 50,000 Lb/Hr	Case 2 Coal-Retrofit 150,000 Lb/Hr
B. Annual Materials Cost		
Spare Parts:		
Boiler	30,000	10,000
Electrical	30,000	6,000
Balance of Power Plant	50,000	8,000
Rolling Stock Spares	5,000	0
Replacement Reserve		
Boiler	20,000	16,000
Turbine Generator	20,000	0
Miscellaneous		
Bldg Clean and Maintenance Service	6,000	0
Office Supplies & Reproduction	5,000	0
Invoicing & Mailing	3,000	0
Uniforms	10,000	0
Misc. Supplies (Rags, etc.)	10,000	6,000
Feedwater Treatment	10,000	0
Cooling Tower Treatment	10,000	0
De-Nox Urea	10,000	0
	219,000	**46,000**
C. Annual Contract Services and Rental Costs		
T-G Annual Maintenance & Service	20,000	0
Annual Boiler Inspect & Overhaul	25,000	0
Emission Testing	45,000	0
Fuel Testing	5,000	6,000
Miscellaneous	30,000	0
Boiler Cleaning	15,000	0
Elevator Maintenance & Inspect	0	0
Rolling Stock Lease	19,134	0
	159,134	**6,000**

TABLE 4.8-3 (cont.)

Wood Fuel Combustion Facility

Annual Operating Cost

Facility Option Product (Air Heating, Steam or Electricity) Facility Boiler Steaming Rate		Case 1 Elect./Stoker 50,000 Lb/Hr		Case 2 Coal-Retrofit 150,000 Lb/Hr
G. Annual Disposal Cost				
Ash 2,899 Tons/Yr	$52 Per Ton	44,668	489	25,428
H. Utilities				
Electrical				
Demand:		23,113		0
Use:		8,284		4,524
Total Electrical Cost		31,397		4,524
Water				
Annual Cost		8,605		0

TABLE 4.8-5
Wood Fuel Combustion Facility

Calculation of Wood Energy Value

Case 1

Annual Tons Wood Fired:	32,300 Tons
Wood HHV	7133 BTU/Lb
Wood HHV	14.27 MMBTU/Ton
Electricity Price	$0.05 Per KWH
Net Electrical Generation Rate @ MCR	4,028 KW/Hr
Wood Firing Rate @ MCR	72.28 MMBTU/Hr
Wood Firing Rate @ MCR	5.07 Ton/Hr

$$\text{Wood Energy Value} = \text{Annual Tons Wood} \times \text{Elect Price} \times \frac{\text{Net Electrical Gen Rate @ MCR (KW/Hr)}}{\text{Wood Firing Rate @ MCR (Tons/Hr)}}$$

$$\text{Wood Energy Value} = 32{,}300 \text{ Tons} \times \$0.05/\text{KWH} \times \frac{4{,}028 \text{ KW/Hr}}{5.07 \text{ Tons/Hr}}$$

Wood Energy Value = $1,283,080 = $39.72/Ton

Case 2

Annual Tons Wood Fired	18,400 Tons
Wood HHV	7133 BTU/Lb
Wood HHV	14.27 MMBTU/Ton
Coal Energy Price	$2.00 Per MMBTU
Wood Fired Boiler Efficiency	77%
Coal Fired Boiler Efficiency	80%
Coal Displacement Rate	17.12%

$$\text{Wood Energy Value} = \text{Annual Tons Wood} \times \text{Wood HHV (MMBTU/Ton)} \times \text{Coal Price} \times \frac{\text{Wood Boiler Efficiency}}{\text{Coal Fired Boiler Eff.}}$$

Wood Energy Value = 18,400 Tons X 14.27 MMBTU/Ton X 2.00/MMBTU X 77% / 80%

Wood Energy Value = $505,443 = $27.47/Ton for Coal Displaced at $2.00/Million BTU

TABLE 4.11-1 (34)

Utility, Institutional And Industrial Coal Fired Boilers Within Approximately 75 Miles Of The Bettendorf/Davenport Iowa Region

	Company/Organization	Location	Approximate Distance From Davenport Area
1.	J.I. Case	Davenport/Bettendorf	-
2.	Linwood Stone	Davenport/Bettendorf	-
3.	Oscar Mayer	Davenport/Bettendorf	-
4.	Ralston Purina	Davenport/Bettendorf	-
5.	Davenport Cement	Davenport/Bettendorf	-
6.	Iowa/Illinois Gas & Electric Company	Davenport/Bettendorf	-
7.	Grain Processing	Muscatine	30 Miles
8.	Monsanto	Muscatine	30 Miles
9.	Muscatine Power & Light	Muscatine	30 Miles
10.	Interstate Power	Clinton	40 Miles
11.	ADM Company	Clinton	40 Miles
12.	John Deere	Dubuque	70 Miles
13.	Interstate Power	Dubuque	70 Miles
14.	University Of Iowa	Iowa City	70 Miles
15.	Cargill	Cedar Rapids	70 Miles
16.	Cedar Rapids Meats	Cedar Rapids	70 Miles
17.	Iowa Electric Light & Power	Cedar Rapids	70 Miles
18.	Iowa Army Amunition Plant	Burlington	75 Miles
19.	Iowa Southern Utility	Burlington	75 Miles

TABLE 4.11-2 (34)

Utility, Institutional, Municipal & Industrial Coal Fired Boilers Within Approximatly 75 Miles Of Des Moines

	Company/Organization	Location	Approximate Distance From Des Moines
1.	ADM	Des Moines	-
2.	Monarch Cement	Des Moines	-
3.	Firestone	Des Moines	-
4.	Iowa Electric	Marshall Town	50 Miles
5.	Ames Municipal	Ames	30 Miles
6.	Iowa State University	Ames	30 Miles
7.	Cargill	Eddyville	75 Miles