

BEFORE THE STATE CORPORATION COMMISSION
OF THE STATE OF KANSAS

DIRECT TESTIMONY

Received
on

OF

AUG 25 2011

VINCE MIKULANIS

ON BEHALF OF WESTAR ENERGY

by
State Corporation Commission
of Kansas

DOCKET NO. 12-WSEE-112-RTS

1 Q. PLEASE STATE YOUR NAME, TITLE, AND BUSINESS
2 ADDRESS.

3 A. My name is Vince Mikulanis. I am the Project Manager for accounts
4 for Davey Resource Group (DRG), 1500 North Mantua Street, Kent,
5 Ohio.

6 Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS
7 PROCEEDING?

8 A. Westar Energy, Inc. (Westar).

9 Q. WHAT IS YOUR EDUCATIONAL BACKGROUND AND
10 PROFESSIONAL EXPERIENCE?

11 A. I have a Bachelor of Science in Forest Conservation and a minor in
12 Environmental Ethics from Humboldt State University in Arcata,
13 California. I am a member of the International Society of

1 Arboriculture and the Utility Arborist Association and an ISA Certified
2 Arborist Utility and Municipal Specialist. I am currently the project
3 manager for accounts in the Central Southwestern United States,
4 including California, Texas, Kansas, Oklahoma, Arizona and New
5 Mexico. I began my career with DRG in July 2003 as a Consulting
6 Utility Forester working in DRG's San Diego office. I am now
7 responsible for several major market utility and municipal projects
8 within DRG's western region, leading a team of over 50 professional
9 arborists and foresters. Working with utilities, cities and other
10 municipal organizations has helped develop strong skills at
11 negotiating the urban forestry interests of multiple stakeholders to
12 achieve mutual agreements and build consensus. I am also
13 responsible for supporting training programs for DRG employees
14 throughout the Western Region.

15 **Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE KANSAS**
16 **CORPORATION COMMISSION?**

17 A. No.

18 **Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?**

19 A. The purpose of my testimony is to support the Vegetation
20 Management Program Review and Best Practices Recommendation
21 Report prepared by DRG for Westar in March 2010 (Vegetation
22 Management Report).

1 Q. CAN YOU IDENTIFY WHAT IS ATTACHED TO YOUR
2 TESTIMONY AS EXHIBIT VM-1?

3 A. Yes. Exhibit VM-1 is the Vegetation Management Report DRG
4 prepared for Westar.

5 Q. WAS THE VEGETATION MANAGEMENT REPORT PREPARED
6 BY YOU OR UNDER YOUR SUPERVISION?

7 A. Yes.

8 Q. THANK YOU.

REPORT

Vegetation Management
Program Review and
Best Practice Recommendations

WESTAR ENERGY, INC.

March 2010



REPORT

Vegetation Management Program Review and Best Practice Recommendations

Presented to

Westar Energy, Inc.
818 South Kansas Ave
Topeka, KS 66612

Presented by

Davey Resource Group
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March 2010

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Executive Summary

Westar Energy is the largest electric energy provider in the state of Kansas and is dedicated to providing safe and reliable power to its consumers. An important component of providing safe and reliable power is an effective vegetation management program. Trees contacting the power lines can, and do, cause service interruptions and can cause injury or even death. As part of ensuring the safety of the public and improving system reliability, Westar Energy contracted with Davey Resource Group (DRG) in 2009 to provide a system review, workload analysis and recommendation of best management practices for improving its vegetation management program.

The system review examined pruning practices, reliability data and utilized field consulting utility foresters from DRG who conducted a workload survey of over 486 miles of distribution line in Westar territory. This survey examined the number of trees currently requiring pruning or removal in order to achieve a best in class industry method.. This data was then extrapolated into total workload for Westar's service territory and a generalized cost was calculated to bring the system onto a four-year urban and five-year rural pruning cycle.

DRG concludes that the current focus on reliability pruning is having a positive short-term effect on overall system reliability but it may not be a sustainable long-term strategy. Currently, Westar's major reliability indexes are all in the first or second quartile when compared to its IEEE utility peers. Westar currently prunes its circuits on average once every 13 years. The miles of circuit that are pruned annually have decreased in the past three years reflecting the increased focus on reliability pruning. The assumption can be made that due to this decrease under the current program, cycle lengths may be further extended.

Utilizing peer reviewed research and industry knowledge, DRG developed the following recommendations for Westar's Vegetation Management Program:

- 1. Develop and Maintain a Cycle Schedule**
- 2. Conduct an In-Depth Analysis of Outage Data for Circuits Pruned in 2007 and 2008**
- 3. Utilize an Electronic System for Vegetation Management Preplanning and Post Auditing**
- 4. Alter Pruning Contracts for Westar Efficiency**
- 5. Set and Achieve Removal Goals**
- 6. Further Develop Customer Education**
- 7. Utilize ISA Best Management Practices Publication for Utility Pruning of Trees**
- 8. Work With Municipalities to Develop Tree Ordinances in Relation to Power Lines**
- 9. Increase Proactive Storm Management**
- 10. Include Tree Growth Regulators in Maintenance Activities**
- 11. Develop a Comprehensive Tree Failure Database**

Foreword

Throughout this report references are made to different pruning activities. For the purposes of this report the following definitions apply as utilized by Westar Energy Inc.:

Routine Circuit Pruning – Routine Circuit Pruning applies when vegetation along an entire circuit is scheduled to be pruned. Westar utilizes reliability data to prioritize which circuits are scheduled for routine circuit pruning during a given timeframe.

Reliability Pruning/Customers Experiencing Multiple Interruptions (CEMI) Work – Reliability Pruning and CEMI work are used interchangeably. Westar uses the Customers Experiencing Multiple Interruptions database to examine which portions of circuits are experiencing an unacceptable number of outages during the previous 12 months time frame. Those portions of the circuits are targeted for Reliability Pruning or CEMI work where the vegetation causing the reliability issues is targeted and cleared. The remainder of the circuit is not cleared.

Hot Spotting – Normally refers to pruning associated with construction and/or maintenance activities on existing rights-of-way where vegetation is cleared ahead of line work.

Introduction

As the largest electric energy provider in the state of Kansas, Westar Energy, Inc. (Westar) serves over 680,000 customers throughout Eastern Kansas covering an area of over 10,000 square miles. Westar maintains 19,165 miles of distribution line, in addition to over 15,000 miles of transmission line supplying power from its 16 energy centers located throughout the territory. Westar Energy provides safe, reliable, high quality electric service at a reasonable cost to all customers (Westar Mission Statement).



As part of providing safe and high quality electric service, Westar recognizes the need for an effective vegetation management program to help ensure reliable service to its customers and to protect those customers from tree related accidents in regards to the electric power lines. Much of Westar's service territory, especially in urbanized areas, has a high tree density. The impact of trees on service reliability in Westar's system is very high. Trees account for 18.9% (five-year average) of normalized outages in Westar's service territory. The highest percentage of outages caused by vegetation was 20.2% in 2008.

Currently, Westar is able to complete vegetation management pruning activities on its circuits on average, every 13 years. Westar follows the stated clearance zones outlined in the General Terms and Conditions, section 7.03.B filed with the KCC. The clearances required are species-specific, meaning trees that are fast-growing (such as elm or cottonwood) require greater clearances than trees that are slow-growing (such as spruce).

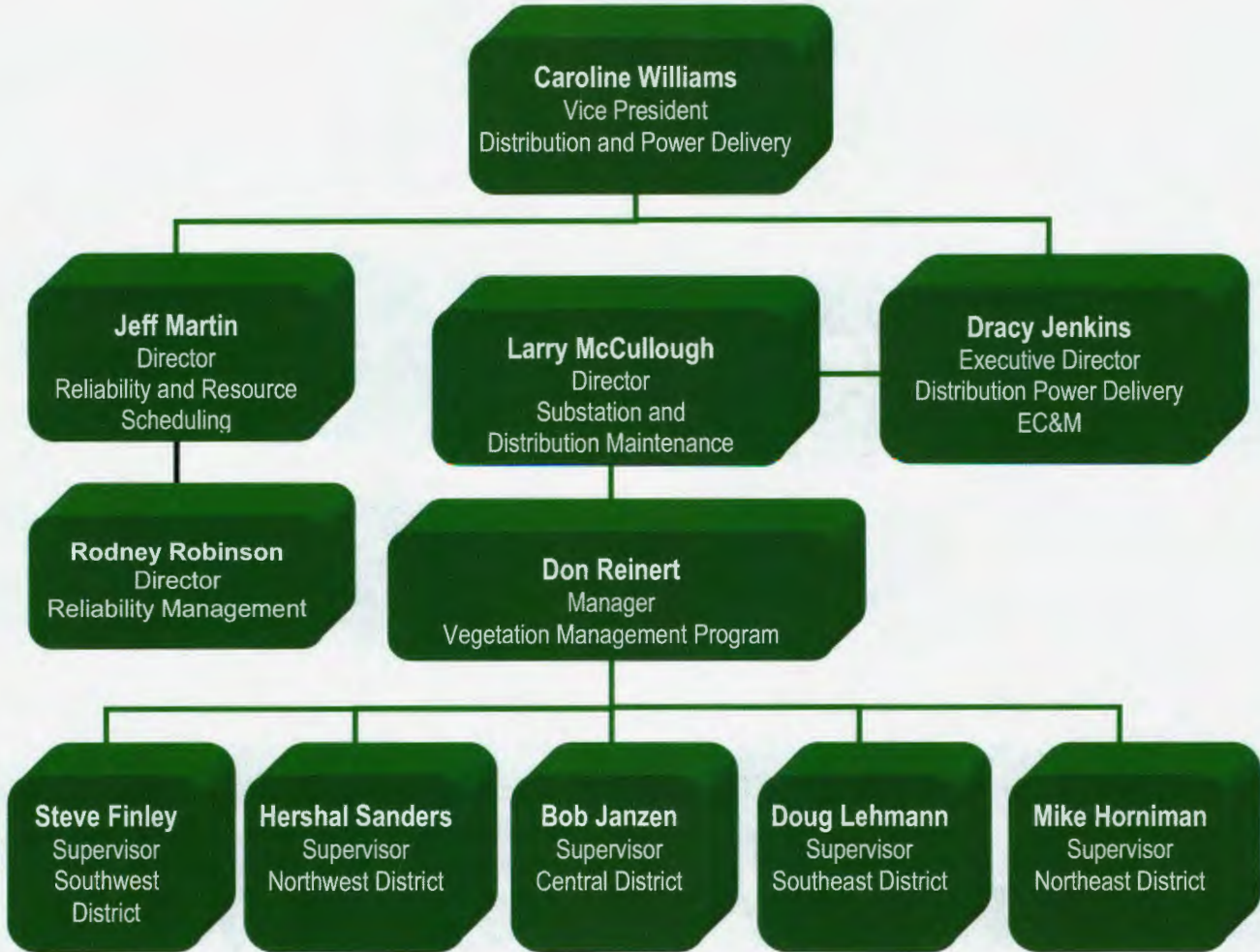
In the January 21, 2009 rate case order, Docket Number 08-WSEE-1041-RTS, the KCC determined that further research into the vegetation management program is necessary. Westar agreed to "fund a comprehensive study of its distribution vegetation management program, using an independent consultant with extensive experience in electric utility industry vegetation management practices". To complete this study, Westar issued a Request for Proposal for a Vegetation Management Program Review on May 22, 2009. Davey Resource Group (DRG) was awarded the contract for the study and report to Westar.

DRG began working on the program review in September, 2009, which consists of two main sections: 1) a review of Westar's current system, including reliability data, program manuals, budgets, interviews with key members of the program, and current vegetation management practices; and, 2) a comprehensive study of Westar's current workload requirements. This section of the study was conducted by performing a sample inventory and data analysis of Westar's current workload throughout its system. A statistical analysis of the data was conducted to give an expected range of required work per mile of Westar territory. The data represents overall workload in addition to a breakdown by district.

Review of Westar's Current System

Organization

Westar's vegetation management program is administered from within the Distribution Power Delivery department. The following is the management structure of the program:



History

Prior to 1997, Westar had a decentralized approach to maintenance with 17 separate areas conducting work as its budget allowed. In addition, the program was not consistent throughout the territory. The vegetation management program was centralized in 1997. Under this program contracted crews fluctuated from 50 to over 100 during the period of 2001 to 2003. With inflation and other factors increasing the costs of the program, Westar has, and will, continue to experience a continued decrease in the amount of crews available for the program, with projections for 2010 allowing for 60 crews. The most recent rate case did include a provision for this study of Westar's vegetation management program to assess its activities. This study examines current processes and outlines recommendations for maintaining an efficient vegetation management program.

Prior to 2007, the Westar vegetation management program focused on circuit pruning. Using this form of management, crews were directed to focus on ensuring that all trees in the vicinity of the power lines were pruned on the entire circuit before moving to new areas. In 2007, vegetation management began focusing more on enhancing reliability rather than circuit pruning. Routine circuit work is still performed, with priority given to poorer performing circuits.

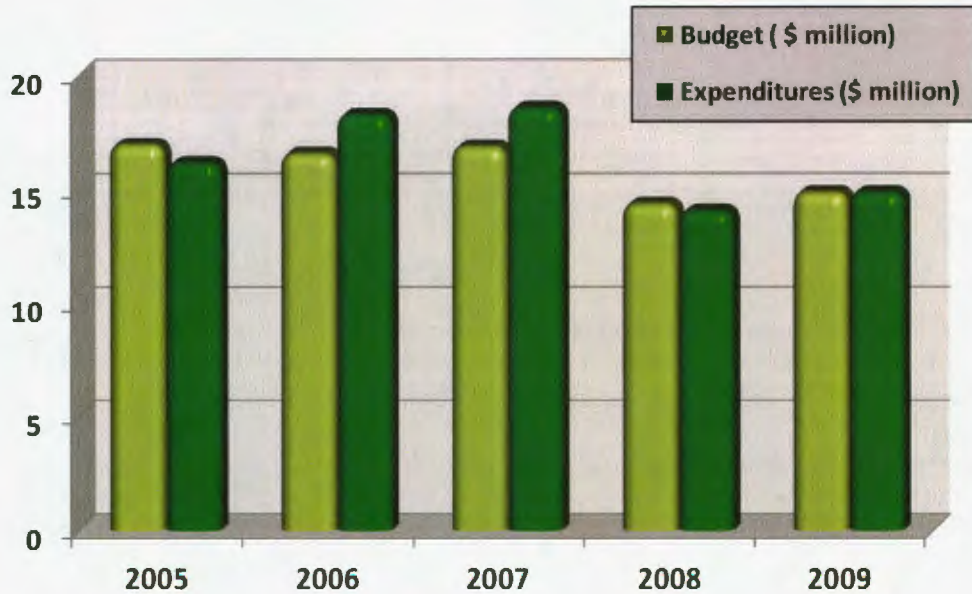
With a decreasing amount of funding and crew levels since 2007, vegetation continues to encroach upon Westar's power lines.

Budget Allocations

The vegetation management department budget is held within Westar's operation and maintenance budget. The budget for vegetation management is then allocated against other items such as O&M components of line construction, equipment maintenance, and other maintenance activities including personnel additions. Funds for vegetation management can, and have, been increased and decreased during the year, even after a certain amount is set aside during planning the previous year. The budget for 2010 is currently \$12.8 million.

Table 1. Budget allocations and actual expenditures by year (2005 through 2009).

| Item | 2005 | 2006 | 2007 | 2008 | 2009 |
|---------------------------|------|------|------|------|------|
| Budget (\$ million) | 17.0 | 16.6 | 16.9 | 14.4 | 14.9 |
| Expenditures (\$ million) | 16.2 | 18.3 | 18.6 | 14.1 | 14.9 |



Appropriation of Work

Westar's vegetation management program is divided into five districts—Central, Northeast, Northwest, Southeast, and Southwest. Each district has a Westar supervisor tasked with ensuring crews are performing work safely and to production expectations.

Table 2. Supervisors and total line miles by district.

| District | Supervisor | Total Line Miles |
|--------------|-----------------|------------------|
| Northeast | Mike Horniman | 5,217 |
| Northwest | Hershel Sanders | 3,238 |
| Central | Bob Janzen | 4,937 |
| Southwest | Steve Finley | 3,107 |
| Southeast | Doug Lehmann | 2,666 |
| TOTAL | | 19,165 |

Line Miles for each district can be further broken down by rural and urban classifications. By Westar definition, an urban circuit has greater than 35 customers per mile.

Table 3. Circuit miles by district and type.

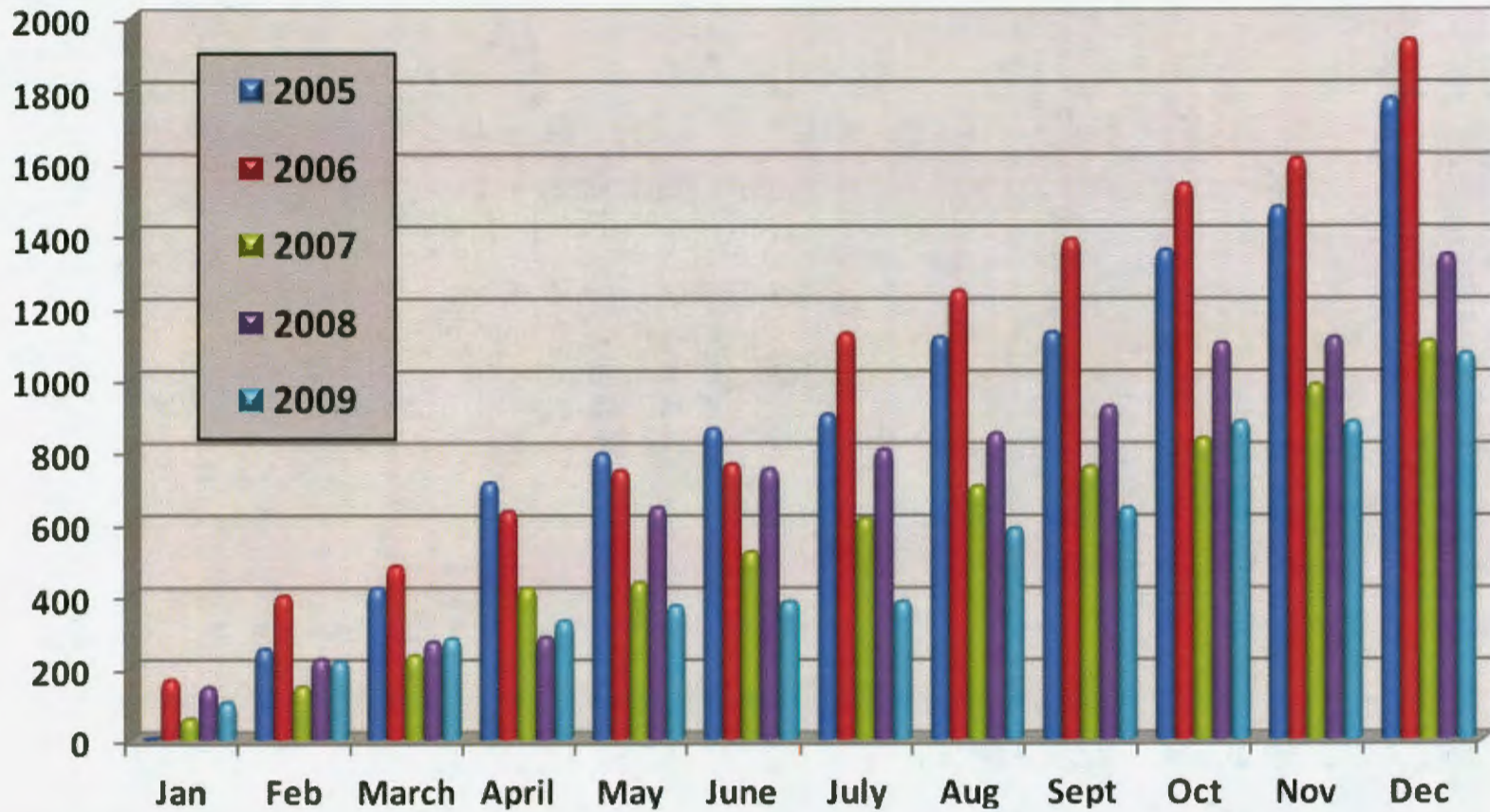
| District | Rural | Urban | Total Line Miles |
|--------------|---------------|--------------|------------------|
| Northeast | 3,408 | 1,809 | 5,217 |
| Northwest | 2,388 | 850 | 3,238 |
| Central | 4,077 | 860 | 4,937 |
| Southwest | 1,372 | 1,735 | 3,107 |
| Southeast | 2,023 | 643 | 2,666 |
| TOTAL | 13,268 | 5,897 | 19,165 |

Circuit Miles Completed

In 2005 and 2006, Westar pruned an average of 1,852 circuit miles per year. The most recent years of 2007 through 2009, saw a decreased amount of miles cleared (1,170 on average). The year with the lowest miles of circuit completed was 2009, with 1,067 miles. The decrease in 2007 through 2009 is due in part to reduced budget allocations, but more importantly to the increased focus on CEMI and hot spot work.

Table 4. Total first time circuit miles completed the first time YTD by month.

| Year | Jan | Feb | March | April | May | June | July | Aug | Sept | Oct | Nov | Dec |
|-------------|-----|-----|-------|-------|-----|------|-------|-------|-------|-------|-------|-------|
| 2005 | 0 | 250 | 419 | 710 | 791 | 860 | 899 | 1,113 | 1,127 | 1,354 | 1,472 | 1,772 |
| 2006 | 164 | 397 | 480 | 631 | 744 | 762 | 1,123 | 1,241 | 1,383 | 1,536 | 1,607 | 1,933 |
| 2007 | 56 | 145 | 232 | 418 | 434 | 518 | 612 | 700 | 754 | 833 | 981 | 1,102 |
| 2008 | 143 | 221 | 270 | 283 | 642 | 748 | 802 | 846 | 921 | 1,097 | 1,112 | 1,340 |
| 2009 | 102 | 215 | 279 | 328 | 370 | 381 | 381 | 583 | 640 | 878 | 878 | 1,067 |

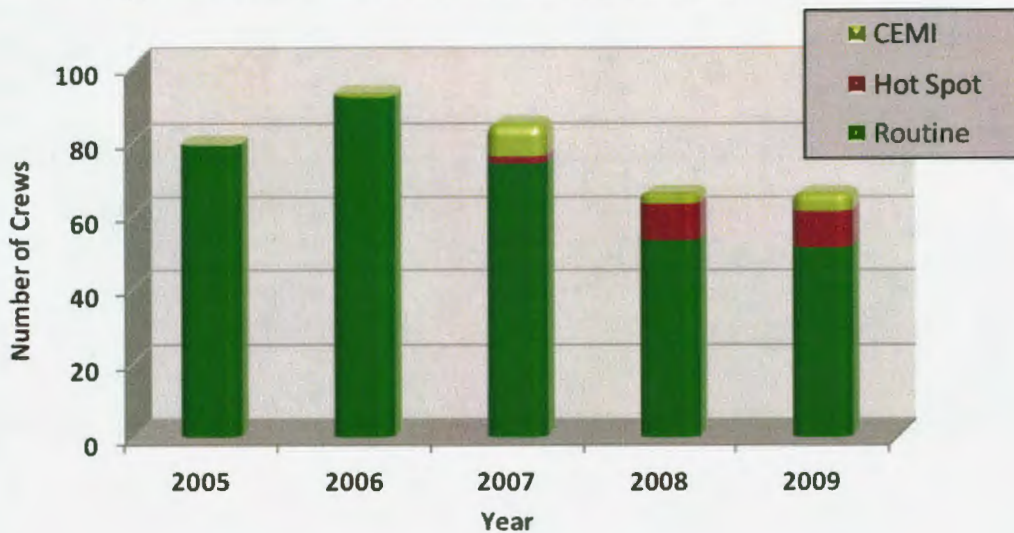


Crew levels vary throughout the year depending on available budget and work scheduling. The average number of crews working on Westar's routine line clearance program annually is presented below.

Table 5. Average number of line clearance crews by work assignment

| | 2005 | 2006 | 2007 | 2008 | 2009 |
|--------------------------|-----------|-----------|-----------|-----------|-----------|
| Routine Circuit Clearing | 79 | 92 | 74 | 53 | 51 |
| Hot Spot | 0 | 0 | 2 | 10 | 10 |
| CEMI | 0 | 1 | 9 | 3 | 5 |
| Total Crews | 79 | 93 | 96 | 66 | 66 |

Average Number of Line Clearance Crews by Year



Billing Rate Comparisons

A comparison of contractor Time and Material rates with three Midwest utilities shows Westar's contract line clearance rates are lower than all three other comparable utilities. Comparisons were made for a three-person lift crew using an average 2009 rate from Westar's four primary contractors, Asplundh, Royer, Salina, and Wright Tree Services. Rates from the other utilities were obtained by polling contractors for their current billable rates to the utility. The exact utility was asked to be kept confidential by the contractor; however, Utility 1 and 2 were in Missouri, and Utility 3 is in Illinois. All three comparing utilities reflect union wages through the International Brotherhood of Electrical Workers (IBEW), as does Westar.

Table 6. Hourly rate comparison with Westar and three Midwest utilities

| Job Title | Westar | Utility 1 | Utility 2 | Utility 3 |
|------------------------------|--------|-----------|-----------|-----------|
| Foreman | 33.06 | 40.00 | 35.07 | 35.24 |
| Trimmer/Climber | 28.52 | 35.00 | 33.22 | 31.26 |
| Apprentice | 22.20 | 32.00 | 27.27 | 31.71 |
| Aerial Lift Dump Truck | 10.97 | 10.00 | 11.50 | 13.00 |
| Disc Chipper | 3.95 | 2.50 | 2.95 | 3.00 |
| Total for 3-person Lift Crew | 98.70 | 119.50 | 110.01 | 114.21 |

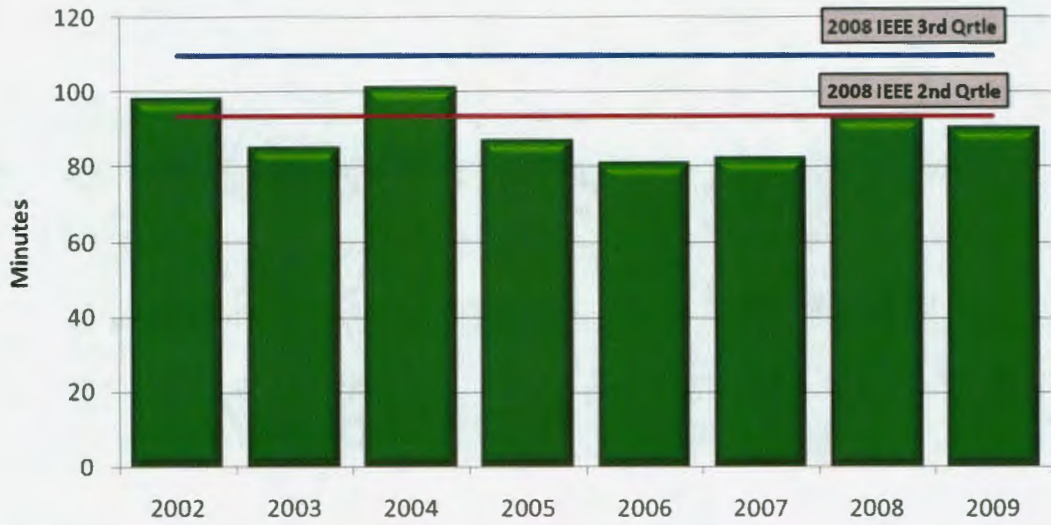
Reliability Statistics

When measuring reliability, there are several factors to consider:

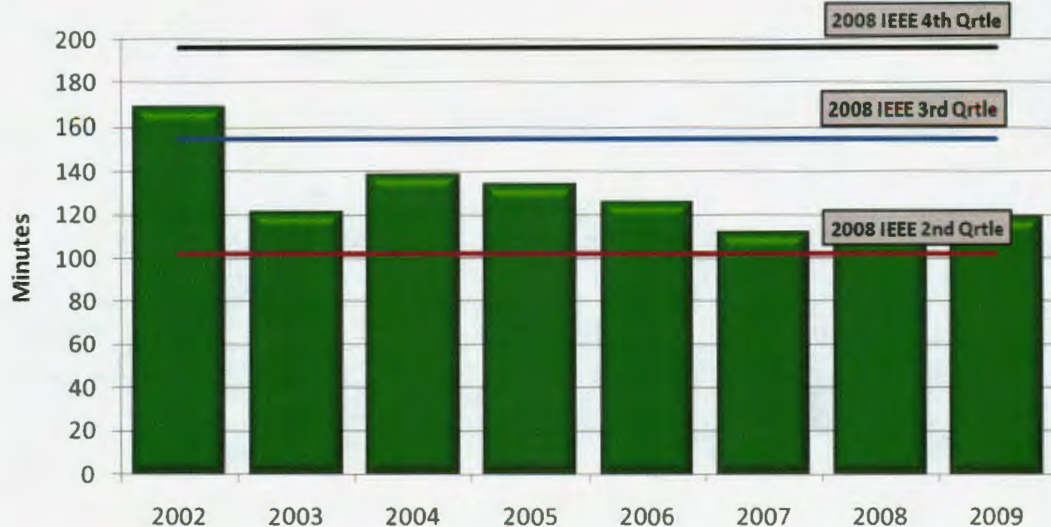
1. **Number of Outages** – this is the total number of outages a utility experiences on its system.
2. **Customer Interruptions** – reflects the industry standard System Average Interruption Frequency Index (SAIFI). This illustrates the number of customers that are affected by the number of outages.
3. **Customer Minutes** – reflects the industry standard System Average Interruption Duration Index (SAIDI). This illustrates the period of time customers were without power.
4. **Customer Minutes per Interruption** – reflects the Customer Average Interruption Duration Index (CAIDI). This illustrates the average time needed to restore service to the average customer per sustained interruption.

This report will examine both normalized and non-normalized outages. Normalized outages do not take factors such as major storms into consideration. The following charts represent Westar Energy's 2002–2009 Normalized reliability indices and its respective quartiles compared to the IEEE peer utility companies.

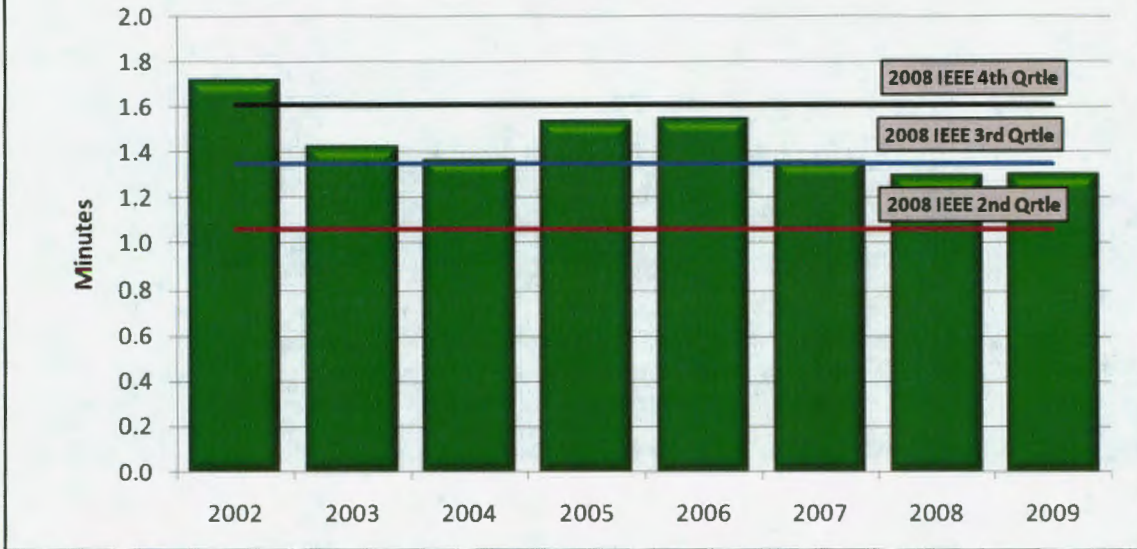
Westar Energy Annual Normalized CAIDI



Westar Energy Annual Normalized SAIDI



Westar Energy Annual Normalized SAIFI



Non-Normalized Number of Outages

The year 2005 saw the highest total number of tree caused outages in recent years. However, as this data is non-normalized, the ice storm of 2005 must be considered a major contributor to these figures. Westar saw a reduction in total tree caused outages in 2006, but that decrease was short lived, as indicated by the rise in 2007 and 2008. Although lower than the previous two years, 2009 also had a higher number of total tree caused outages than 2006.

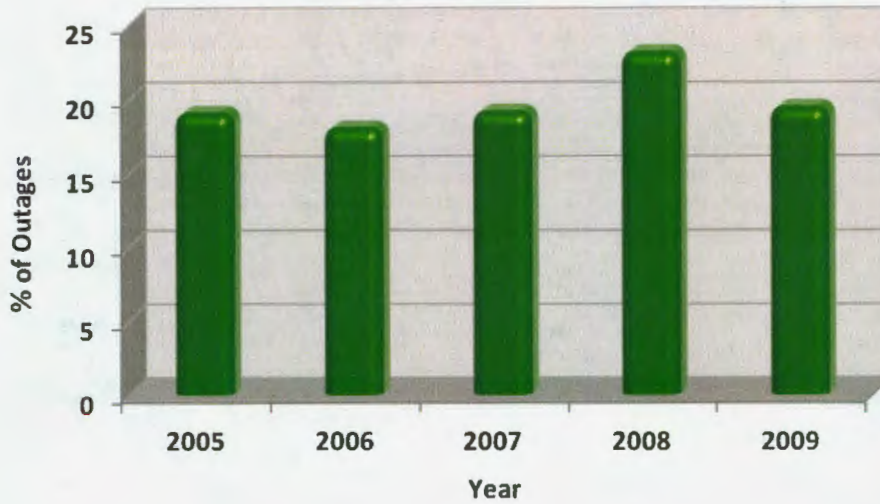
It is also important to examine the overall percentage of tree caused outages in relation to the total number of outages (caused by all factors including, lightning, switching errors, equipment failures etc.). Tree caused outages as a percent of total outages in Westar territory remain fairly significant. The highest percentage of tree caused outages was in 2008 (23.2%), with the second highest year being 2009 (19.5%).

This evidence presents the case that Westar should continue to improve the efficiencies of its vegetation management program. It demonstrates that the focus on reliability pruning is not significantly reducing overall non-normalized outages.

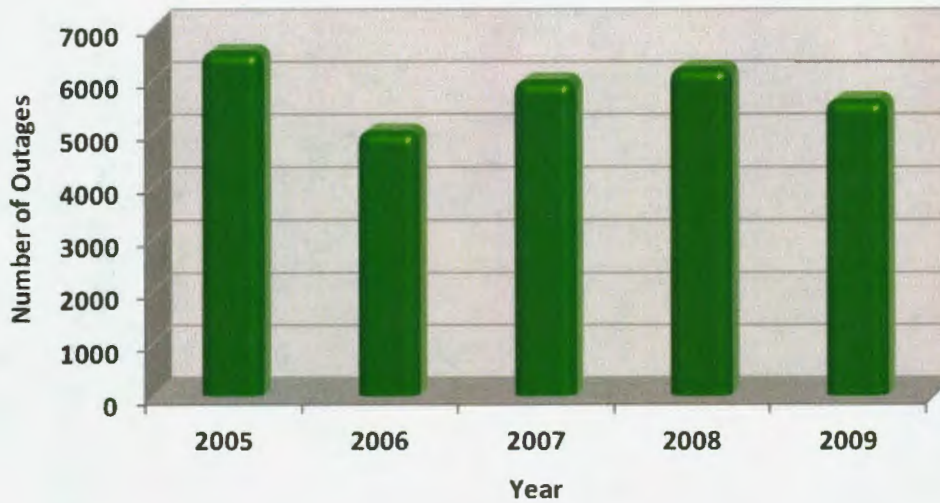
Table 7. Number and percent of total tree caused outages – non-normalized

| 2005 | % total | 2006 | % total | 2007 | % total | 2008 | % total | 2009 | % total |
|-------|---------|-------|---------|-------|---------|-------|---------|-------|---------|
| 6,544 | 19.1 | 5,032 | 18.1 | 5,984 | 19.2 | 6,228 | 23.2 | 5,622 | 19.5 |

Percent of Tree Caused Outages - Non Normalized



Total Tree Caused Outages - Non Normalized



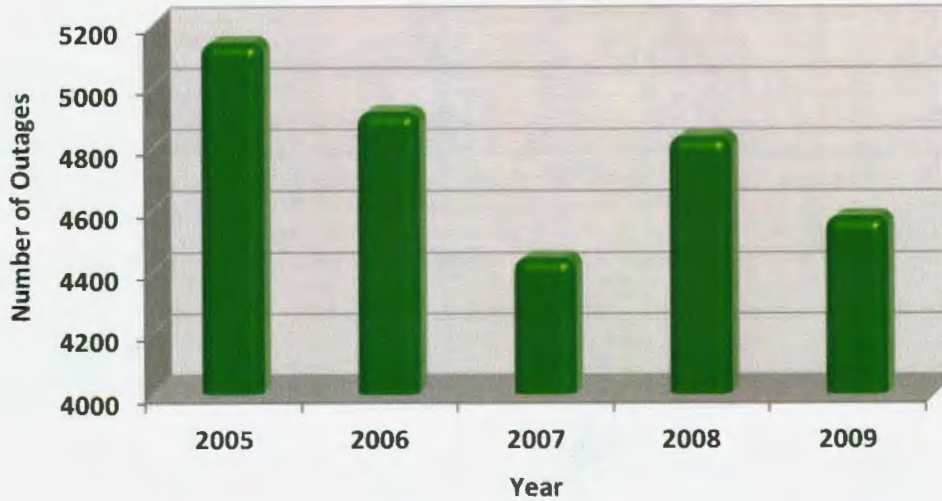
Number of Outages – Normalized

Normalized outages do not take items such as severe storms into account. Examining normalized outages gives a clearer picture of what customers can experience during a routine year, and do not skew data due to major weather events. As such we will examine normalized outages closer than non-normalized outages, looking at other data than just the number of tree caused outages. For the study period of 2005 through 2009, Westar experienced the highest number of tree caused outages in 2005. The year 2007 saw a significant decrease in normalized tree caused outages, however, 2008 saw a significant increase. There does not appear to be a pattern for the number of normalized tree caused outages. There are years that are high, and then the next year is low, but there does not appear to be a long term trend toward reducing the number of normalized tree caused outages. Focusing on reliability pruning rather than routine circuit based pruning can result in a short-term decrease in outages (improving reliability). However, this increase in reliability is typically not long-term, as evidence by the up and down swing of Westar's normalized tree caused outages. Long range planning, focusing on quality, and proper scheduling of circuit pruning is essential to improving reliability. In research published in 1983, Johnstone states "unless (pruning) is performed circuit by circuit instead of tree by tree, the reliability of the system will never improve and, in fact, it may deteriorate". This tendency is still applicable to utilities in 2009.

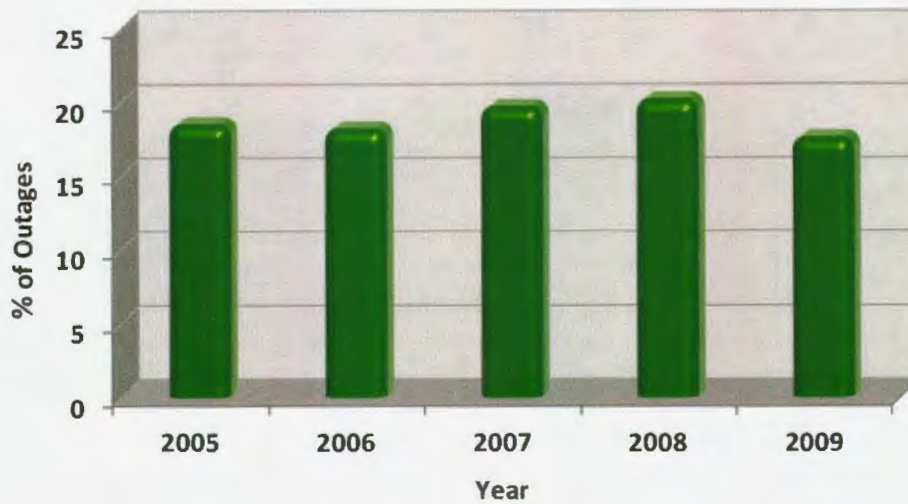
Table 8. Number and percent of tree caused outages - normalized.

| 2005 | % Total | 2006 | % Total | 2007 | % Total | 2008 | % Total | 2009 | % Total |
|-------|---------|-------|---------|-------|---------|-------|---------|-------|---------|
| 5,141 | 18.5 | 4,913 | 18.2 | 4,440 | 19.7 | 4,832 | 20.2 | 4,573 | 17.6 |

Number of Tree Caused Outages - Normalized



Percent of Tree Caused Outages - Normalized



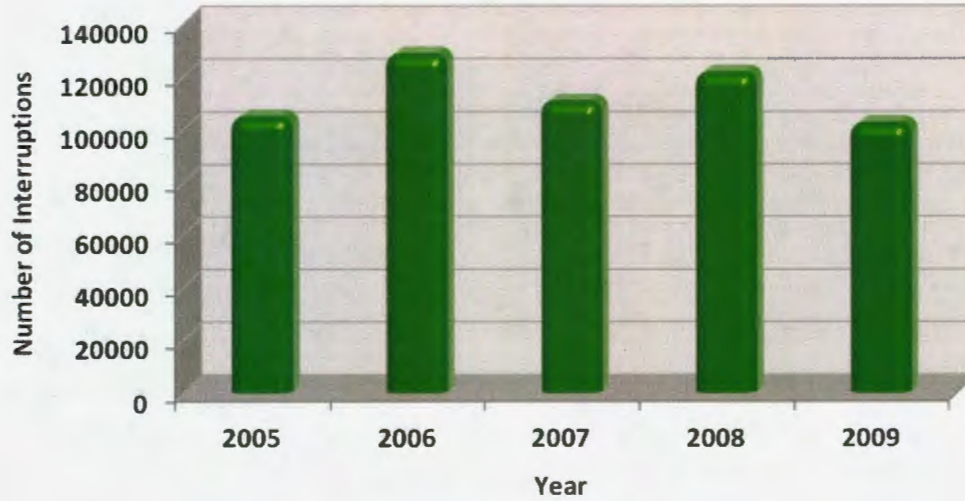
Customer Interruptions – Normalized

The number of customers affected by tree caused outages over the past five years peaked in 2006, with 128,666 individual customer locations receiving a power outage. The second highest year was 2008, with nearly the same number of total customer interruptions as the peak. There was a significant reduction in customer interruptions in 2009, representing the lowest total customer interruptions of the study period. However, this data is skewed by significant storm activity during 2009. Westar experienced seven major storms within three months of each other. By having so many storms in quick succession, normalizing the outage data (removing those events) actually gives the perception that significant gains in reliability performance were achieved. When major storms occur, all outages that happen during the storm, including the time it takes to restore power, are attributed to that event (not normalized outage data). For instance, if restoration takes three days, that three day time period is attributed to the storm event, providing the outage first occurred during the storm time period. By prioritizing work based on circuits that have the most customer interruptions, and by performing hot spotting work to clear certain areas of problem circuits, Westar may be somewhat successful in influencing the total number of customer interruptions. Based on industry averages this may not be sustainable. As work is focused on areas that have a large proportion of the overall outages, other areas of the system are not receiving necessary maintenance. Those areas not receiving maintenance will, in time, present a larger problem for the utility through an increased amount and density of vegetation encroaching on the overhead conductors. Again, Johnstone and Goodfellow are among those who state that reliability pruning or hot spotting does not have a long-term positive effect on overall system reliability performance.

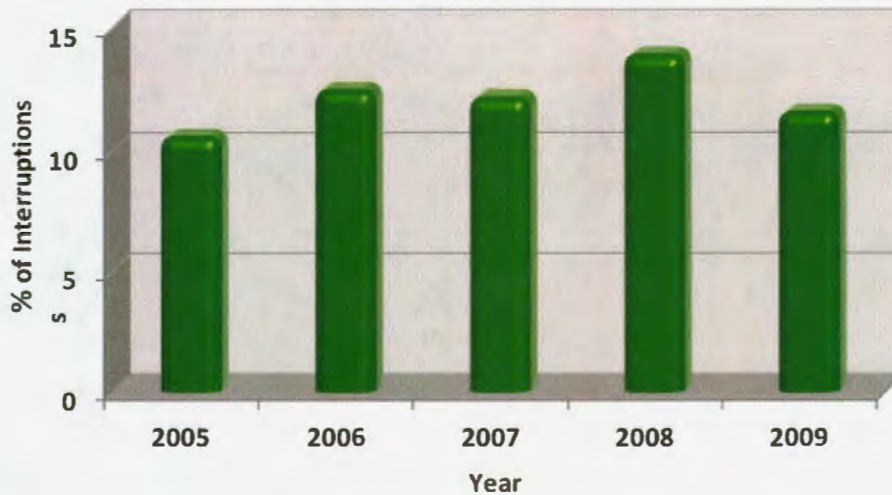
Table 9. Number and percent total of tree caused customer interruptions - normalized

| 2005 | % Total | 2006 | % Total | 2007 | % Total | 2008 | % Total | 2009 | % Total |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 104,943 | 10.6 | 128,666 | 12.5 | 110,741 | 12.2 | 121,684 | 13.9 | 102,331 | 11.6 |

Total Tree Caused Customer Interruptions - Normalized



Percentage of Tree Caused Customer Interruptions - Normalized



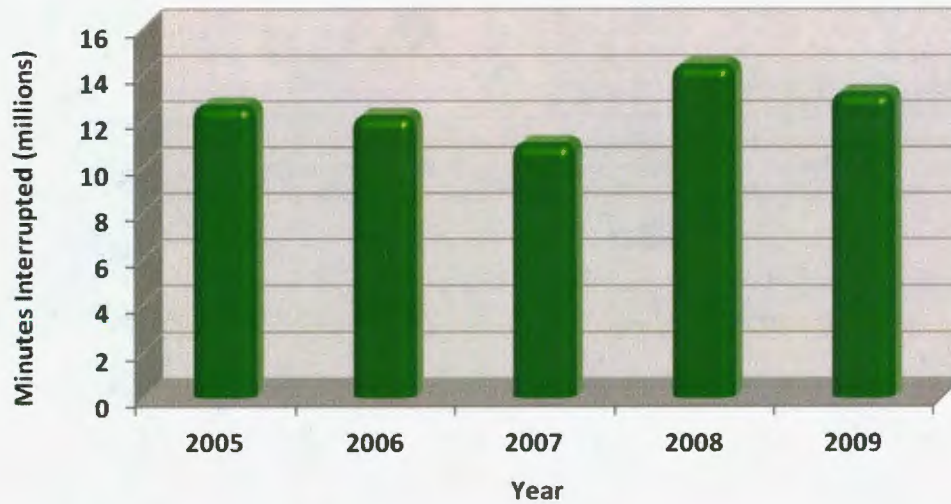
Customer Minutes Interrupted – Normalized

An analysis of total customer minutes interrupted looks at the length of time customers are without power during a service interruption. The delay in service restoration for vegetation caused outages is highest in 2008 (14.41 million minutes), with 2009 being the second highest (13.19 million minutes) in the study period. A contributing factor to this is an increased amount and density of vegetation that must be cleared away from the power lines in order to restore service. This increase in vegetation is caused by irregular maintenance of vegetation throughout the system. As more time goes by between clearing activities, the amount and density of vegetation increases, thus increasing the amount that must be cleared in order to restore service after an outage. If Westar can improve the frequency of vegetation management activities throughout its system, they can more effectively manage the duration of vegetation caused outages.

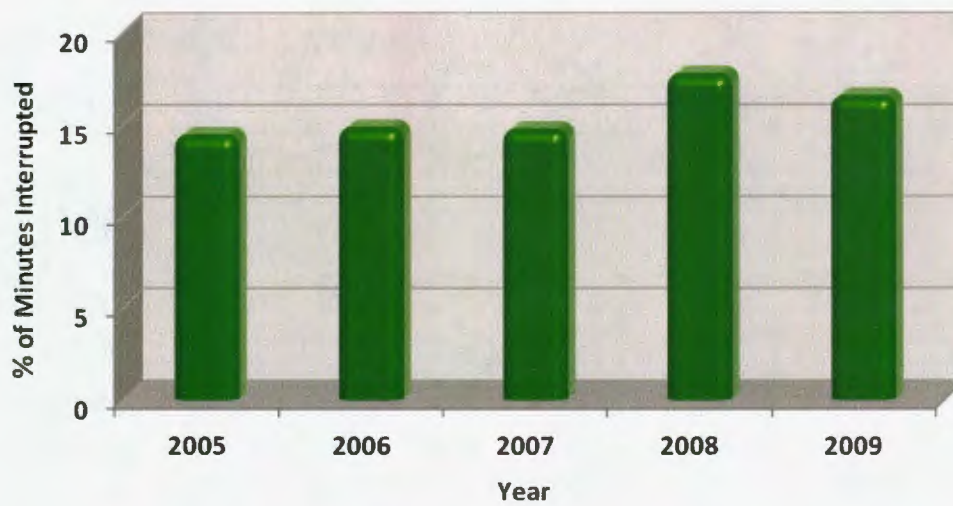
Table 10. Total duration of tree caused outages (in million minutes) - normalized.

| | 2005 | % | 2006 | % | 2007 | % | 2008 | % | 2009 | % |
|------------|-------|------|-------|------|-------|------|-------|------|-------|------|
| Vegetation | 12.64 | 14.4 | 12.18 | 14.8 | 10.98 | 14.7 | 14.41 | 17.7 | 13.19 | 16.5 |

Total Tree Caused Customer Minutes Interrupted - Normalized



Percent of Tree Caused Customer Minutes Interrupted - Normalized



Vegetation Management Manual

Westar currently has a document in place to direct the pruning activities of its in-house staff and contractors who work on Westar property. This manual, updated effective June 12, 2007, provides “instructions to facilitate the orderly, uniform, safe, and efficient furtherance of Westar Energy, Inc.’s objectives relative to vegetation management activities”, (Westar 2007). This manual reflects an increased focus on performance and quality over the manual in place prior to 2007. This increased focus on performance and quality can help to explain the difference in system reliability over previous years that had larger budgets, but not necessarily better reliability performance.

The manual is divided into the following four sections:

Section A – Regulations affecting tree work. Section A illustrates the legal aspects relating to trees in the planning and performance of associated vegetation management work. It describes the obligations and rights Westar has to the public in performing line clearance operations, rights of landowners, relationships with customers and local authorities, notification, refusals, tree removals, claims, and general contractor guidelines with respect to safety, adherence to the manual, crew configurations, and work practices.

Section A outlines that Westar is obligated and has the right to perform line clearance operations on private land in accordance with policies and procedures in place and authorized by the State Corporation Commission of the State of Kansas. In turn, landowners have the obligation to allow Westar to conduct necessary pruning activities on their land, and Westar is obligated to provide adequate notification of pending work on its property. Section A also recognizes that Westar shall use reasonable efforts to cooperate with landowners and city/county officials in the area of work. Refusals of work by landowners are to be handled first by crew foremen and then increasing in responsibility to the Westar manager of Vegetation Management. It outlines that no trees that can reasonably affect public safety or reliability of the electrical system shall be left unpruned. Removal guidelines are described for trees that are hazardous or are incompatible with their location in respect to power line clearance requirements. This section also outlines that safety is a very high priority for Westar Energy. In accordance with safety, proper work planning and efficiency measures for contractors are described.

Section B – Tree Clearance Specifications. Section B describes the intent to prune trees for a minimum of four-year (urban) and five-year (rural) clearances. Clearances are based upon voltage of the power line and species of the tree in question. Section B also describes emergency procedures for storm work.

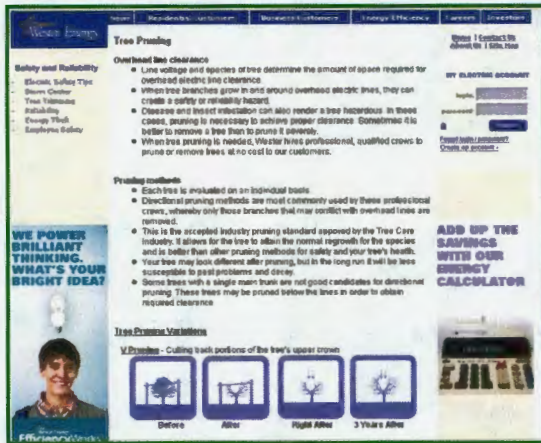
Section C – Tree Pruning Methods. Section C mandates that all work complies with the most recent version of the established ANSI Standard Z133.1 American National Standard for Arboricultural Operations-Safety Requirement. The ANSI standard Z133.1 provides for safe work practices. In addition to safety standards, the manual dictates that all pruning work conform to ANSI A300 (Part 1) American National Standard for Tree Care Operations-Tree, Shrub, and Other Woody Plant Maintenance-Standard Practices. The ANSI A300 details proper pruning methods and include items such as using direction pruning and minimum size of laterals to be left. In addition to proper pruning methods, guidelines for pursuing removals on incompatible private trees are discussed. Work methods such as use of climbing spurs, stumps, tree felling, procedures for working around fence lines, site cleanup, and herbicide use are also described.

Section D – Productivity and work Management. Section D describes the use of productivity monitoring systems in place. Each crew is responsible for filling out a Weekly Contract Crew Forestry/Time Report and submitting to their local Westar supervisor. These reports describe equipment, man-hours, and production rates the crew experienced for the week. Those reports are checked by management, and variances are discussed with the contractor.

Appendices. The appendices section contains the clearance guide, instructions for the Weekly Contract Crew Forestry/Time Report, and an example of a Vegetation Work Order.

Westar's Vegetation Management Manual is a comprehensive guide for contractors and Westar supervisors to use while conducting line clearance operations. This manual provides the fundamentals for the vegetation management program. It is the directive of the Vegetation Management Program, that each crew is in full compliance with the manual at all times and that it is present on all work vehicles.

Customer Education



As part of its customer service program, Westar provides customer education materials related to tree pruning. Information regarding tree pruning and safety is available to customers on the Westar web site. Additionally, pruning contractors leave door hangers with packets of information regarding why trees require pruning away from power lines, along with notices that tree pruning is scheduled on a customer's property. This packet also includes information for planting the right tree in the right place with respect to overhead power lines.

Additionally, when entering a new area, Westar personnel will speak and work with organizations such as city or town councils, and homeowner associations to explain the program and educate them on the reasons and benefits behind tree pruning. This has been shown to be effective, especially in areas where tree pruning activities have not occurred for several years.

Westar is also a Tree Line USA accredited utility. The Arbor Day Foundation, in cooperation with the National Association of State Foresters, recognizes "public and private utilities that demonstrate practices that protect and enhance America's urban forests. The goal of the program is to promote the dual goals of safe, reliable electric service and abundant, healthy trees across utility service areas", (Arbor Day).

Requirements of achieving Tree Line USA accreditation include:

- **Quality Tree Care** – Formal work practices in compliance with ANSI A300 standards.
- **Annual Worker Training** – Documented annual training for all employees and contractors.
- **Tree Planting and Public Education** – Utility must sponsor an ongoing tree planting program. Customer education is also mailed at least annually regarding items such as appropriate tree planting, pruning trees safely, and creating energy efficient landscapes.

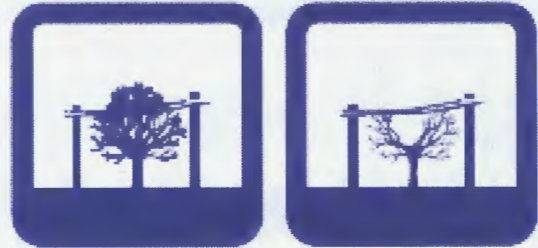
As part of its community tree planting efforts, Westar has a "Green Team" that is tasked, not only with items such as tree plantings, but also with improving culverts, building bridges, and other environmental projects throughout Westar's service territory.



Pruning Practices

As outlined in Westar's "Vegetation Management Manual", tree pruning contractors shall prune trees in accordance with ANSI A300 (Part 1) pruning standards. Proper arboricultural standards are important to abide by, as they take the health of the tree and the continued safety of the contractors and general public into account. The ANSI Standards provide clear direction to pruning contractors with respect to:

- Tree inspection
- Tools and equipment
- Pruning cuts
- Wound treatment
- Pruning objectives
- Pruning methods
- Utility pruning



With respect to Utility Pruning, the ANSI standards require that directional pruning be utilized. Directional pruning reduces branches to laterals that direct growth away from the power lines. Although directional pruning may initially take more time than non-industry accepted practices such as shearing, in the long run directional pruning is more effective. As trees are trained to

grow away from power lines, subsequent pruning activities require less material to be removed, fewer pruning cuts, and thus increase efficiency (Johnstone, 1983).



Westar's pruning contractors prune for clearance from the power lines for four years in urban areas and five years in rural areas. The specific clearance that needs to be achieved is dependent on species and the expected growth rate. Given current budget and production estimates, Westar can only clear a circuit every 13 years (Williams, 2008). That is problematic in that a tree may be expected to remain clear

three times longer than the last clearance obtained was designed to do. This leads to trees growing into the power lines (as observed during the sample inventory), and an increased number of outages.

ANSI standards also recommend that certain trees growing directly under the power lines should be removed. Westar also provides its contractors with guidelines for when to remove trees under the power lines rather than prune them. Generally, the following conditions would warrant a removal:

- Trees that will not be able to fully develop within the height restrictions.
- Trees which have been previously topped under low level primary and distribution circuits with no future chance of reasonable natural development.
- Trees with dangerously weakened crotches and/or a considerable amount of dead wood.
- Trees that, in general, removal will require less than twice the amount of time than pruning should be targets for removal.

With the extended time between pruning activities on Westar's system, removal may be the best option for many trees. Westar's removal program is a high priority. However, observations made during the sampling survey (table 12) note that there are many candidates for removal currently in the field. This is most likely due to extended cycle lengths as removal rates on recently pruned circuits are reflective of the requirements of the vegetation management manual. Focus on removals should continue as the field sampling for this project did identify existing removal candidates in recently pruned circuits.

In rural areas, Westar is able to increase its efficiency by utilizing mowing machines and herbicide treatments. Significant portions of rural circuits can be classified as "cross country" meaning the main feeder lines were constructed as the shortest distance between two points, and do not necessarily follow roads. Pruning individual trees along these cross country lines would require significant climbing (not using a bucket truck), lowering production rates. To increase efficiency Westar utilizes tractors outfitted with SEPPi mowing attachments capable of removing whole trees up to 12 inches in diameter. All vegetation capable of growing into the power lines is removed. Using these mowers is estimated to be five times more efficient than using arborists to prune trees. Herbicide treatment of the mowed area follows within three years. This method is highly productive and efficient; however, it must be repeated on a regular basis.

Westar also utilizes herbicide treatment in rural areas without mowing. Depending on size of the vegetation and clearance to roadways, some vegetation may be treated with herbicide instead of being pruned and removed. Both herbicide treatments and mechanized mowing are identified as best management practices by the International Society of Arboriculture (ISA).

Safety

Paramount to line clearance operations is the safety of the public, employees, property, and facilities of Westar. This is evidenced by Westar's exemplary safety record, having only one OSHA recordable accident on its property during 2009. Compared to other utilities in the mid-west and other parts of the nation this is a highly admirable accomplishment. Regular reinforcement of safety policies is a definite contributor to this success. Safety of the general public is also of great concern.

Cycle Maintenance

Currently, Westar is not on a specific cycle maintenance program which allows trees to grow into close proximity, and often come into contact or grow through, the power lines.

As the distance between a tree and power lines decreases, the time required to prune the tree increases. Browning and Wiant demonstrate that as the period of growth (cycle length) is lengthened, the amount of time required for maintenance increases. The average worker minutes required to prune a tree that was last pruned two years prior has been demonstrated to be less than 20 minutes. For a tree that has had five years since its last pruning, that time has been shown to be over 80 minutes. This is due to the hazards of working around the electrical facilities and additional tree material (branches) that must be removed and treated. Trees that are clear of the power lines and are receiving cycle maintenance may require less than 20 minutes of worker time. A tree in contact with the power lines can require over an hour of time to be safely and effectively pruned (Browning, 1997). A published study evaluating the length of time required to prune trees that are ten years or more past their last pruning could not be located; however, it is not uncommon for individual trees in Westar territory to have grown so far into the power lines that it requires two hours or more to prune and clear the line.



Increasing the length of time between pruning cycles will allow trees to grow into the power lines. This, in turn, increases the time it takes to prune trees and decreases the efficiency of pruning contractors. However, as Browning and Wiant demonstrate, deferring tree maintenance actually costs more in the long run. As time required for pruning a tree increases, so does the expense. This is substantiated by information from Westar management indicating that Westar is experiencing decreased production rates compared to rates in the past. Historical production rates were approximately one unit to one-man-hour. Current production rates are one unit per two man-hours. Browning and Wiant conclude that for each dollar saved if maintenance on a tree on a five-year cycle is deferred one year, it costs \$1.21 to prune it the following year. If the tree is left two years past its targeted cycle, it costs \$1.39 for every dollar that would have been spent if the tree had been pruned on cycle. No data exists for trees left for extended periods past a 4/5 year cycle, as is the case for many trees in Westar's territory.

Review of Workload Requirements

Sampling Methodology

For the purpose of this study, a sample survey of Westar's approximately 20,000 miles of distribution lines provides the most cost-effective method for determining existing workload on the system. Prior to beginning the analysis, it was estimated that between 2% and 5% of the system would need to be surveyed to provide a statistically accurate data set with a confidence level of 95%. As data was collected and analyzed, both Westar and DRG agreed that the final sampling percentage of 2.37% returned data statistically valid for assessing the entire system.

DRG utilized proprietary Work Planning Software (WPS) loaded onto pen-based Panasonic Toughbook® CF-19 computers equipped with GPS receivers for data collection. An experienced four-person crew of Certified Arborists worked together, starting in the Southwest district in the City of Wichita, sampling half mile segments of Westar overhead distribution line. The crew worked together for the first three days of data collection to assure consistent collection of attributes throughout the entire system. DRG staff also met with Westar staff in the field to ensure that data collection was consistent with the goals they had for the study.

DRG collected detailed information on 973 half-mile samples of Westar Energy's distribution system during the fall of 2009. All samples were randomly located throughout the system and patrolled according to Westar Energy's Vegetation Management Distribution and Sub-Transmission manual. The sampling procedure is summarized below in Table 11. A full data listing from the plot samples is included in Appendix C.

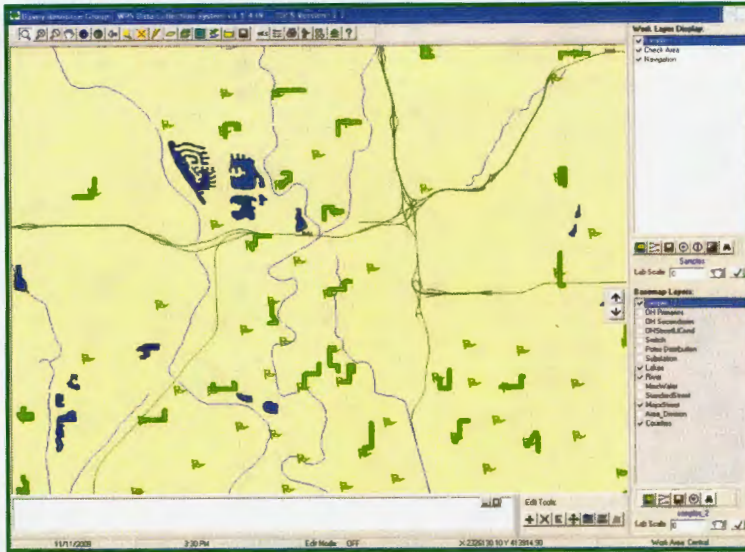
Table 11. Summary of sampling methodology for the workload survey.

| | |
|--------|--|
| Step 1 | All samples were located on system maps via GIS before fieldwork began using a random sample generator based on the location of individual distribution overhead poles. This ensured random location of all samples. A surplus of samples (totaling 5%) was identified in case any sample needed to be replaced or the sample locations needed to be rejected due to proximity, access, or other issues. |
| Step 2 | The sample began at the start pole identified on the map and continued along the given circuit. In the event that a starting point did not exist, the sample was begun at the closest distribution pole. |
| Step 3 | If a line ended before 2,640 feet was measured, the arborist returned to the starting point and measured in the opposite direction to complete the distance. |
| Step 4 | When the data collector encountered a tap on the line, the sampling direction generally alternated with every tap, (i.e., the data collector will go right one time, straight the next time, and then left the next time). This method also applied when multiple taps were encountered at one location. |
| Step 5 | When collecting data in the field, individual trees were counted that were within four to five years' growth of facilities. |
| Step 6 | Danger trees off the right-of-way that may interfere with the lines were counted. Trees that should be removed for long-term cost savings (i.e., fast-growing trees directly under the wires) were also counted. |
| Step 7 | Brush was estimated by spans, including estimated density of the span, and the most likely treatment was recorded. |

Data attributes collected during the workload survey is summarized in Table 11. Data was tallied in a data collection sheet (included in Appendix A). Totals were then entered into a Geographic Information System (GIS) over Westar Energy's base maps using DRG's ROWKeeper Work Planning Software (WPS).

The arborists identified the following categories of information:

- **Dominant Species** – the three most prevalent species of trees in each sample.
- **Pruning Required** – trees requiring pruning for a four-year urban/five-year rural maintenance cycle were recorded using the following categories:
 - **Clearance Zone Fast** – fast-growing trees as defined by Westar's vegetation management manual that are within the clearance zone (typically the majority of the tree is directly under the power lines).
 - **Clearance Zone Slow** – slow-growing trees within the clearance zone.
 - **Outside Fast** – fast-growing trees growing to the side of the clearance zone.
 - **Outside Slow** – slow-growing trees to the side of the clearance zone.
- **Brush** – the density of brush throughout the sample was recorded in addition to the average type of treatment (mechanical versus herbicide).
- **Removals** – the number of trees that are existing removal candidates based on Westar's vegetation management manual.
- **Hazard Trees** – the number of dead, dying, or diseased trees that are in danger of falling into the power lines.
- **Lift and Climb Access** – the percentage of the sample accessible to lift trucks or only accessible by climbing.
- **Minimum Clearance** – the minimum clearance of trees observed throughout the sample was recorded.



An Excel™ spreadsheet developed by DRG was utilized to track the accuracy of data returned by the arborists. This spreadsheet analyzed the mean and margin of error of each category of data collected using the following formulas. The margin of error gives the statistical range of each data category that Westar can expect to occur on each mile of its distribution line. For example, throughout the territory, Westar can expect there to be between 27.44 and 31.76 fast-growing trees per mile outside the clearance zone that require pruning for a

four-year cycle. For this study, a 95% degree of confidence was used, meaning that 95% of the time, the actual number should fall within the confidence interval defined by the margin of error. The data presented in the spreadsheet can be found in Appendix B by system wide and by district.

The formulas used for the statistical analysis are as follows:

Mean

$$\mu = \frac{\sum X}{N}$$

Where

μ is the mean (average)

ΣX is the sum of the category (i.e., sum of the number of fast prunes in the Clearance Zone)

N – is the total number of sample locations

Standard Deviation

The standard deviation was calculated using the excel formula =STDEV. The formula calculates standard deviation according to the following:

$$s = \frac{\sqrt{\sum (x - \mu)^2}}{n - 1}$$

Where

S is the standard deviation

μ is the mean (average)

x represents each number returned from the survey

n is the number of samples

Standard Error

The standard error of the mean was calculated using the following formula:

$$\sigma_m = \frac{s}{\sqrt{n}}$$

Where

σ_m is the standard error of the mean

s is the standard deviation

n is the sample size

Margin of Error

The margin of error was calculated using the following formula:

$$\text{Standard error} = Z \times \sigma_m$$

Where

Z is the constant 1.96 (constant for a 95% confidence interval)

σ_m is the standard error

Confidence Interval

The confidence interval is the mean plus or minus the margin of error.

Survey Results

The following table illustrates the expected work required on Westar's system for a four-year urban and five-year rural cycle. Ranges are the number of trees expected per mile.

Table 12. Summary of workload by mile.

| | | Line Miles | Prunes Clearance Zone Fast | Prunes Clearance Zone Slow | Prunes Outside Clearance Zone Fast | Prunes Outside Clearance Zone Slow | Removals In Clearance Zone | Hazard Trees Outside the Clearance Zone | Spans of Brush |
|-------------|--------------|---------------|----------------------------|----------------------------|------------------------------------|------------------------------------|----------------------------|---|----------------|
| System wide | Total | 19,165 | 5.98 | 4.54 | 29.60 | 5.80 | 6.42 | 0.14 | 6.00 |
| | Urban | 5,897 | 9.34 | 7.08 | 44.98 | 8.94 | 7.22 | 0.18 | 6.34 |
| | Rural | 13,268 | 4.54 | 3.44 | 22.94 | 4.46 | 6.08 | 0.12 | 5.26 |
| Central | Total | 4,937 | 5.46 | 3.30 | 27.38 | 4.38 | 11.48 | 0.18 | 5.78 |
| | Urban | 860 | 6.22 | 5.62 | 48.22 | 8.66 | 6.66 | 0.30 | 6.44 |
| | Rural | 4,077 | 5.34 | 2.94 | 24.04 | 3.70 | 12.26 | 0.16 | 5.66 |
| Northwest | Total | 3,238 | 3.38 | 2.94 | 23.42 | 4.32 | 2.02 | 0.04 | 4.20 |
| | Urban | 850 | 3.86 | 3.38 | 35.52 | 6.92 | 1.66 | 0.08 | 3.34 |
| | Rural | 2,388 | 3.20 | 2.78 | 19.24 | 3.42 | 2.14 | 0.02 | 4.50 |
| Northeast | Total | 5,217 | 3.22 | 3.20 | 30.16 | 5.98 | 3.94 | 0.12 | 4.68 |
| | Urban | 1,809 | 4.96 | 2.72 | 44.14 | 8.86 | 6.06 | 0.10 | 4.42 |
| | Rural | 3,408 | 2.62 | 3.36 | 25.54 | 5.02 | 3.22 | 0.12 | 4.76 |
| Southeast | Total | 2,666 | 6.02 | 2.66 | 24.72 | 5.46 | 3.86 | 0.18 | 4.98 |
| | Urban | 643 | 5.32 | 3.00 | 36.86 | 9.82 | 2.90 | 0.14 | 3.40 |
| | Rural | 2,023 | 6.36 | 2.48 | 19.02 | 3.42 | 4.32 | 0.20 | 5.72 |
| Southwest | Total | 3,107 | 12.46 | 10.38 | 40.98 | 8.80 | 10.78 | 0.24 | 8.40 |
| | Urban | 1,735 | 16.64 | 13.16 | 52.44 | 9.66 | 12.36 | 0.28 | 9.92 |
| | Rural | 1,372 | 7.12 | 6.82 | 26.36 | 7.70 | 8.78 | 0.18 | 6.44 |

Based on the total number of miles in each district and the number of units per mile, the following demonstrates the total workload that is expected system wide.

Table 13. Summary of total workload

| | | Line Miles | Prunes Clearance Zone Fast | Prunes Clearance Zone Slow | Prunes Outside Clearance Zone Fast | Prunes Outside Clearance Zone Slow | Removals In Clearance Zone | Hazard Trees Outside the Clearance Zone | Spans of Brush |
|-------------|--------------|---------------|----------------------------|----------------------------|------------------------------------|------------------------------------|----------------------------|---|----------------|
| System wide | Total | 19,165 | 114,607 | 87,009 | 567,284 | 111,157 | 123,039 | 2,683 | 114,990 |
| | Urban | 5,897 | 55,078 | 41,751 | 265,247 | 52,719 | 42,576 | 1,061 | 37,387 |
| | Rural | 13,268 | 60,237 | 45,642 | 304,368 | 59,175 | 80,669 | 1,592 | 69,790 |
| Central | Total | 4,937 | 26,956 | 16,292 | 135,175 | 21,624 | 56,677 | 889 | 28,536 |
| | Urban | 860 | 5,349 | 4,833 | 41,469 | 7,448 | 5,728 | 258 | 5,538 |
| | Rural | 4,077 | 21,771 | 11,986 | 98,011 | 15,085 | 49,984 | 652 | 23,076 |
| Northwest | Total | 3,238 | 10,944 | 9,520 | 75,834 | 13,988 | 6,541 | 130 | 13,600 |
| | Urban | 850 | 3,281 | 2,873 | 30,192 | 5,882 | 1,411 | 68 | 2,839 |
| | Rural | 2,388 | 7,642 | 6,639 | 45,945 | 8,167 | 5,110 | 48 | 10,746 |
| Northeast | Total | 5,217 | 16,799 | 16,694 | 157,345 | 31,198 | 20,555 | 626 | 24,416 |
| | Urban | 1,809 | 8,973 | 4,920 | 79,849 | 16,028 | 10,963 | 181 | 7,996 |
| | Rural | 3,408 | 8,929 | 11,451 | 87,040 | 17,108 | 10,974 | 409 | 16,222 |
| Southeast | Total | 2,666 | 16,049 | 7,092 | 65,904 | 14,556 | 10,291 | 480 | 13,277 |
| | Urban | 643 | 3,421 | 1,929 | 23,701 | 6,314 | 1,865 | 90 | 2,186 |
| | Rural | 2,023 | 12,866 | 5,017 | 38,477 | 6,919 | 8,739 | 405 | 11,572 |
| Southwest | Total | 3,107 | 38,713 | 32,251 | 127,325 | 27,342 | 33,493 | 746 | 26,099 |
| | Urban | 1,735 | 28,870 | 22,833 | 90,983 | 16,760 | 21,445 | 486 | 17,211 |
| | Rural | 1,372 | 9,769 | 9,357 | 36,166 | 10,564 | 12,046 | 247 | 8,836 |

Recommendations

Based upon the statistical sample survey and additional research into Westar's current practices, DRG provides the following recommendations for Westar:

- 1. Develop and Maintain a Cycle Schedule**
- 2. Conduct an In-Depth Analysis of Outage Data for Circuits Pruned in 2007 and 2008**
- 3. Utilize an Electronic System for Vegetation Management Preplanning and Post Auditing**
- 4. Alter Pruning Contracts for Westar Efficiency**
- 5. Set and Achieve Removal Goals**
- 6. Further Develop Customer Education**
- 7. Utilize ISA Best Management Practices Publication for Utility Pruning of Trees**
- 8. Work With Municipalities to Develop Tree Ordinances in Relation to Power Lines**
- 9. Increase Proactive Storm Management**
- 10. Include Tree Growth Regulators in Maintenance Activities**
- 11. Develop a Comprehensive Tree Failure Database**

1. Develop and Maintain a Cycle Schedule

It is widely recognized that utility pruning of vegetation is best accomplished if done on a regular, cyclical basis (ISA, FMEA, Goodfellow, Johnstone, Browning, Guggenmoos). "Cycle pruning has many demonstrable advantages, including enhanced utility reliability, reduced biological and aesthetic impact on trees and neighborhoods and stabilized or reduced tree maintenance budgets" (ISA).

Westar should switch its focus from reliability pruning to managing its vegetation management program on a dependable cycle schedule that is properly funded. The current funding level that allows for clearing a circuit once every 13 years is not optimal. Given potential growth rates in the rich soils of Kansas and abundant rainfall, a 13-year cycle would require all areas under distribution lines to be void of vegetation. Even if the ROW and area adjacent to the ROW were completely clear, private plantings and volunteer trees would be capable of encroaching upon power lines within the 13-year cycle. Additionally, dead, dying, and otherwise hazardous trees could be standing for several years and potentially fail, causing service interruptions even under normal weather conditions. Ice storms, wind events, and other natural occurrences would further exacerbate the situation.

Current budgetary amounts for vegetation management compete with other operations and maintenance activities on Westar's system. Budget amounts can fluctuate depending on economic climate and requirements of activities such as new line construction and circuit improvements. Over the past several years, Westar has at times been able to supplement vegetation management budgets due to unexpected increases in revenue or available funds from other sources. However, budget amounts have also been decreased for vegetation management to support other activities on the system. Although all activities are vital to providing safe and reliable power, a cycle-based system will require vegetation management budgets to remain at the minimum level required to support cycle maintenance. Even a temporary one year reduction

in vegetation management expenditures will result in additional funds required the following years. Not including inflation, deferring \$1.00 of maintenance one year can cost \$1.21 the following year, and \$1.39 the second year (Browning, 1997). This is due to the increased time required to prune trees that have a reduced power line clearance because of the additional growth experienced by not being pruned on schedule. Deferring routine maintenance also requires utilities to spend additional funds for hot spotting or reliability pruning in areas that should have received routine maintenance. In order for Westar to provide vegetation management that is efficient and effective, a dedicated budget along with proper work allocation should be implemented.

A four-year urban, five-year rural cycle is a reasonable goal for Westar to strive to achieve. To properly maintain vegetation on a cycle basis, "the optimum pruning cycle length is determined by the amount of clearance that can realistically be obtained as well as the expected growth rates of the trees present" (ISA). The current clearance requirements by species in Westar's vegetation manual provides for sufficient clearance by species given a 4/5 year cycle. Goodfellow found that the majority of regrowth of a tree pruned for line clearance occurs during the first three years following pruning (Goodfellow, 1987). Additionally, Browning indicates that the time to prune a tree is fairly constant for the first five years after pruning, ranging from approximately 18 minutes to just under 40 minutes. By the 6th year after pruning, the time required increases rapidly to over 80 minutes (Browning, 1997). A five-year cycle would, therefore, be the longest Westar should allow to maintain economic efficiency.

Cost of the Initial Four / Five-Year Cycle

Based upon current expenditures and units pruned by Westar contractors (January 1 through July 31, 2009), the following information is a generalized estimate of current vegetation management costs by units in 2009 dollars.

Total Routine Expenditures – \$14,862,143

Total Routine Units Worked – 263,702

Cost per unit \$56.36

For this forecast, the following assumptions apply:

- The cost per unit provided above is a baseline cost for this study.
- Urban brush treatments (treatment of one entire span of brush) are generalized to take twice as long as pruning one tree. Therefore, one brush unit will cost twice that of a tree pruning unit.
- Brush spans in rural areas have been identified as having higher concentrations of brush and more difficult access than brush spans in urban areas. Additionally, spans in rural areas can be two to three times that in urban areas (up to around 300 feet). It is estimated that completion of one rural brush unit takes 4.5 times the completion of one tree pruning unit. Therefore, one brush unit will cost 4.5 times that of a tree pruning unit.
- According to Westar's Vegetation Management Program Manual a removal is expected to take twice as long as a routine prune. Therefore one tree removal unit will cost twice as much as a tree pruning unit.
- Total expected cost of pruning work for a four-year and five-year urban cycle is detailed in table 14.

- Work on the new cycles would begin in 2011. Completion of the four-year urban cycle would occur in 2015, completion of the five-year rural cycle would occur in 2016.

Not included in these cost assumptions are:

- Interim CEMI (hotspotting) work.
- Additional Planners required for increased production.
- Additional Supervision required for increased production.
- Inflation, gas price increase, cost of employment increases, equipment increases etc.
- Future tree growth while system is brought under cycle is not included.

Table 14. Estimated cost of initial pruning for four-year urban/five-year rural cycle.

| | | Prunes Clearance Zone Fast | Prunes Clearance Zone Slow | Prunes Outside Clearance Zone Fast | Prunes Outside Clearance Zone Slow | Removals In Clearance Zone | Hazard Trees Outside Clearance Zone | Spans of Brush | Total Cost |
|------------|--------------|----------------------------------|----------------------------------|--|--|----------------------------------|--|-------------------|--------------|
| Systemwide | Total | \$6,459,234 | \$4,903,833 | \$31,972,126 | \$6,264,809 | \$13,868,990 | \$151,220 | \$21,914,319 | \$85,534,530 |
| | Urban | \$3,104,195 | \$2,353,073 | \$14,949,324 | \$2,971,253 | \$4,799,205 | \$59,824 | \$4,214,260 | \$32,451,134 |
| | Rural | \$3,394,942 | \$2,572,379 | \$17,154,176 | \$3,335,119 | \$9,093,059 | \$89,734 | \$17,700,059 | \$53,339,467 |
| Central | Total | \$1,519,241 | \$918,223 | \$7,618,466 | \$1,218,732 | \$6,388,604 | \$50,085 | \$6,476,778 | \$24,190,130 |
| | Urban | \$301,481 | \$272,399 | \$2,337,214 | \$419,747 | \$645,615 | \$14,541 | \$624,288 | \$4,615,275 |
| | Rural | \$1,227,024 | \$675,552 | \$5,523,904 | \$850,185 | \$5,634,199 | \$36,765 | \$5,852,489 | \$19,800,118 |
| Northwest | Total | \$616,829 | \$536,531 | \$4,274,002 | \$788,373 | \$737,274 | \$7,300 | \$3,045,413 | \$10,005,722 |
| | Urban | \$184,917 | \$161,922 | \$1,701,621 | \$331,510 | \$159,048 | \$3,832 | \$320,012 | \$2,862,863 |
| | Rural | \$430,681 | \$374,154 | \$2,589,467 | \$460,290 | \$576,035 | \$2,692 | \$2,725,401 | \$7,158,719 |
| Northeast | Total | \$946,777 | \$940,896 | \$8,867,948 | \$1,758,300 | \$2,316,957 | \$35,284 | \$5,015,528 | \$19,881,691 |
| | Urban | \$505,698 | \$277,318 | \$4,500,304 | \$903,323 | \$1,235,698 | \$10,196 | \$901,284 | \$8,333,821 |
| | Rural | \$503,236 | \$645,372 | \$4,905,592 | \$964,216 | \$1,236,962 | \$24,049 | \$4,114,244 | \$12,392,671 |
| Southeast | Total | \$904,540 | \$399,680 | \$3,714,322 | \$820,396 | \$1,159,974 | \$27,046 | \$3,181,208 | \$10,207,167 |
| | Urban | \$192,794 | \$108,718 | \$1,335,787 | \$355,872 | \$210,189 | \$5,074 | \$246,428 | \$2,454,862 |
| | Rural | \$725,144 | \$282,760 | \$2,168,590 | \$389,936 | \$985,101 | \$22,803 | \$2,934,779 | \$7,509,112 |
| Southwest | Total | \$2,181,877 | \$1,817,647 | \$7,176,029 | \$1,540,973 | \$3,775,383 | \$42,027 | \$4,180,952 | \$20,714,887 |
| | Urban | \$1,627,136 | \$1,286,845 | \$5,127,824 | \$944,599 | \$2,417,235 | \$27,380 | \$1,940,046 | \$13,371,066 |
| | Rural | \$550,561 | \$527,363 | \$2,038,311 | \$595,410 | \$1,357,843 | \$13,919 | \$2,240,905 | \$7,324,311 |

The data presented in the above table is in 2009 dollars and observed vegetation levels, and it assumes that all work will be completed in one year. It does not account for inflation, increased fuel/equipment/labor costs. It also does not account for the expected increase in tree numbers. Given the amount of vegetation encroaching on Westar's overhead facilities, it is difficult to accurately quantify the increase in vegetation Westar can expect after program implementation in 2011. During 2010, and the four to five years until the entire system is brought into a routine cycle, additional vegetation will encroach Westar's facilities, increasing the amount crews will be required to clear. Guggenmoos described this as a potential 25% increase per year. Westar's facilities already have more vegetation in the vicinity of its power lines when compared to areas of Guggenmoos' study so they should expect a substantial increase, but not in the 25% range.

It is estimated that the initial pruning cost of bringing Westar's system onto a four-year urban, five-year rural cycle will be approximately \$85.5 million. It should be kept in mind that this is an initial cost projection for pruning work only. It does not include the cost of additional program procedures outlined as recommendations in this document, such as third-party pre-planning, auditing, and electronic GIS data capturing/management capabilities, nor does it account for inflation, employment/equipment costs, etc. Additionally, adjustment must be made for future tree growth.

It is not expected that bringing the entire system onto a 4/5 year cycle can be accomplished in one year as assumed in Table 14. With 19,165 circuit miles of over head line required to be brought onto a new cycle, costs and manpower will need to be spread out over several years. During that time period, trees that were not part of the sample study, or were not within 4-5 years growth of the power lines during 2009, will continue to encroach, requiring additional funding to mitigate. Guggenmoos describes the annual rate of change in tree workload as being a minimum of 25%. That is for each year a circuit is not pruned, an additional 25% more trees will require pruning (Guggenmoos, 2004).

This compounding of work (additional tree growth) until the completion of the first full cycle greatly increases the overall cost of managing vegetation in Westar's system. Compounding the amount of vegetation by 25% per year would seem extraordinary given the amount of work already required. However, Guggenmoos's data was from utility ROW which had been historically maintained on regular cycles. The ROW floor was essentially much more open, with less vegetation than was observed in Westar's ROW. This gives the opportunity for far more additional trees to sprout and/or grow into the vicinity of the overhead facilities. In Westar's case, the ROW already is very dense with vegetation in most areas and the additional growth is not expected to be on the same level as a ROW that had been historically maintained on a regular basis. Westar should still expect a substantial yearly increase in workload, but it is difficult to quantify given the current conditions. Westar should initially plan for an annual 10% increase in workload while getting the system onto a 4/5 year cycle. Monitoring the actual increase will be essential and work must be allocated to complete the first cycle on schedule. Any further delay will continue to result in an increase in workload and investment requirements.

A key component would be to also increase supervision and oversight of Westar's pruning contractors. Westar's contractors are contracted on a time and material basis. There is little incentive for the contractor, other than associated agreements in place, to assure the most efficient use of personnel and equipment. Based upon records from January 1 through July 31, 2009, crews are pruning tree units at a rate of .67 units/man-hour. These production rates can be attributed to the close proximity of trees to the power lines in Westar's system; however, time and material based contracts are inherently less productive than unit price or lump sum contracts. Once trees are cleared and a cycle established, Westar can expect pruning activities to be more productive as outlined in Browning and Wait's research.

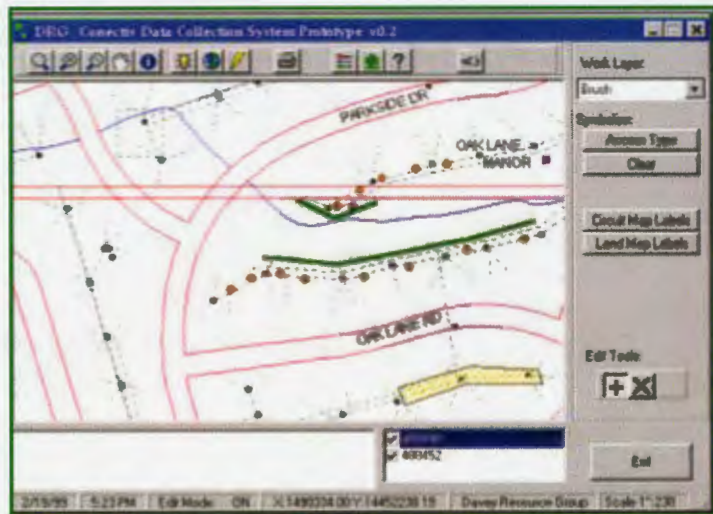
An option that Westar could utilize rather than attempting to bring the entire system onto a manageable cycle at once would be to specify a district as a pilot program. For example, the Southwest district has a reasonable amount of line miles, and also has one of the highest numbers of circuits and customers. The city of Wichita, located in the Southwest district, is a major population center in the State of Kansas, and could provide a good test case for managing a cycle in an urban environment. Once the specified district system is brought onto a cycle schedule and improvements are in place, Westar could then begin to transition other districts into the new program. Results could be presented to the KCC to determine the best method for bringing the entire system on line.

2. Conduct an In-Depth Analysis of Outage Data for Circuits Pruned in 2007 and 2008

Vegetation management along distribution lines is assumed to significantly increase system reliability. By undertaking an in depth analysis of outage data from recently pruned circuits, Westar will be able to demonstrate to its customers and other stakeholders that its vegetation management program is providing a valuable and necessary service. Tree caused outages account for 18.7% of total normalized outages in Westar territory during the period of 2005 through 2007 (14,494 tree caused outages, 77,352 total outages). To demonstrate the real reliability advantages of vegetation management, Westar should conduct an analysis of outage data prior to circuit pruning and after the circuit was pruned. By looking at circuits pruned in 2007, Westar can examine the outage statistics two years prior to pruning and two years after pruning (assuming the analysis takes place in 2010 with all outage data from 2009 available). To further demonstrate the potential benefits of vegetation management on system reliability, Westar can also analyze data from circuits pruned in 2008 by looking at data from 2007 and 2009. By conducting this analysis, Westar can present a case to its customers that dedicating additional funds to vegetation management will allow for significant improvements in Westar's abilities to provide safe and reliable power to its customers.

3. Utilize an Electronic System for Vegetation Management Preplanning and Post Auditing

Westar has approximately 20,000 miles of distribution line throughout its system; even with a five-year cycle, 4,000 miles of line per year will require pruning activities. Given the large amount of area that must be covered on an annual basis, it is difficult for the five supervisors to accurately report and track current and pending workloads throughout the system. Currently, Westar also is able to utilize approximately ten preplanners for its contract pruning crews; however, these individuals are not able to utilize an electronic data collection system. Preplanning with



an electronic data collection system is an effective method used by progressive utilities to plan and conduct line clearance operations (Johnstone, 2008). Utilizing preplanners and an electronic GIS database will allow Westar to more effectively manage a cycle-based system. Before pruning activities are conducted, trained utility arborists identify all work required on a circuit, entering information into an electronic management system. Work reports can be generated to efficiently route crews to work locations. Upon completion of work, pruning contractors sign the work order and the data is reconciled into the management system.

After pruning activities are conducted, Westar can then employ an audit program to further assure quality of work from its contractors. Using the electronic system, post-pruning auditing can be efficiently conducted and any areas of concern can be brought back to the contractor to

rectify. Third-party auditors ensure that a statistically valid sample of all pruned units are pruned to specifications and can monitor the cleared areas for missed trees. Currently, post pruning audits are routinely conducted by district supervisors. Utilizing an electronic data capturing method and audit system can be more effective in holding contractors responsible for the quality of work they produce for Westar, increasing both contractor and client efficiencies.

Preplanners can also be utilized to provide notification to property owners regarding specific trees that are scheduled to be pruned. Currently, Westar does require its contractors to leave door hanger notification of pending work to be completed on a property. However, armed with specific GIS knowledge and tree counts on a property, a preplanner can speak with property owners regarding specific actions to be taken. They can also be effective in assisting in negotiating removals of incompatible trees on a property.

The cost of an electronic vegetation management system and associated equipment varies. Many companies license stand alone systems that can cost upwards of \$20,000 or more for completely customized software. Subscription based systems are also an option and can range from \$2,500 to \$5,000 per year including service and support contracts. Although a recurring cost, these subscription based systems often do save money by reducing in-house IT services that must be provided by the end user. Additional costs of up to \$4,000 for each field user are also required for field computer equipment. As with software, many companies also lease field computers and provide technical support for the user. Westar should solicit bids for software and associated hardware in order to select the most economical and efficient system for its use.

4. Alter Pruning Contracts for Westar Efficiency

With the current state of Westar distribution circuits it is difficult for pruning contracts to be set up on anything other than a time and materials basis. We expect that under current conditions, contractors would have difficulty accurately bidding on rates for a lump sum contract. A lump sum contract is where a contractor will give a utility a bid for pruning a given circuit based on the amount of vegetation present. Overgrown alleyways leading to inaccessibility of the easement contribute to this difficulty. Also, as a comprehensive database relating to individual tree counts is lacking, accurate and auditable unit based pricing is not possible. As circuits are cleared and a cycle is established, Westar could move to lump sum or unit based pricing. Lump sum and unit based pricing puts the responsibility of production monitoring on to the contractor, not Westar, as the current time and material pricing scheme requires. By moving to unit based or lump sum pricing, along with more accessible easements with fewer tree conflicts, Westar should see a dramatic increase in contractor and budgetary efficiency.

5. Set and Achieve Removal Goals

Westar's vegetation management manual describes the desire to remove trees whose placement is incompatible with Westar's power lines. Generally, trees that are directly under the power lines and will not require significant time investment (about twice as long to remove as to prune) should be considered for removal. Even with a four- to five-year cycle, fast-growing trees under the power lines have the potential to break cycle and contact the lines before the next scheduled pruning. A fast-growing tree growing in the rich soils with the abundant rainfall Kansas experiences can grow eight to ten feet per year. With typical high voltage line heights being around 30 feet from the ground for a distribution system, fast-growing trees are obviously not compatible. Even more incompatible are trees under Westar's open-wire secondary lines which often have less clearance to the ground than higher voltage distribution lines. These lines are

historically difficult for Westar to maintain, and are a large cause of vegetation related tree outages. With growth rates for many trees in Westar's territory approaching 10feet/year due to high rainfall and fertile, productive soil, trees under these lines are not compatible with even a two-year pruning cycle.

Currently, along circuits that Westar has pruned recently, removal rates are excellent. Data from nine circuits worked in 2009 shows that there are nearly as many units removed (22,225) as there are units pruned (24,388). Westar contractors are working at reducing future workload by removing trees that are current or future issues for power line clearance. This practice should continue, with the goal of reducing the impact future intrusions by maintaining a clear power line easement.

The most effective way to implement and manage a tree removal program would be to utilize preplanners to identify and secure permission from private property owners for removal. Currently, Westar's vegetation management program does not require permission from property owners as long as the tree meets removal criteria. Trees identified as removal candidates are painted by the preplanner, and a notice of intent to remove and prune trees is left with the property owner. Westar has been very successful with this method, however, improved customer service and satisfaction would identify signed permission as a best management practice. The preplanner can secure permission, put specific removal information into the vegetation management system, and flag/mark the removal trees for the pruning contractor to remove. It is common in tree removal programs to leave wood on site to be used as firewood for the customer. Westar's vegetation management program manual states that "usable firewood on private property should be stacked adjacent to the work area, unless the customer requests that the firewood be removed from the property".

As part of a removal program, a replacement and right tree, right place education program should also be further developed. Westar currently provides tree planting guides to its customers annually. However, to ensure customers fully understand and appreciate the goals of proper tree planting (increasing safety and reliability while reducing future workload by the utility) right tree right place programs should be expanded to include workshops and events at Arbor Day activities.

In the best interest of municipalities maintaining their urban forest canopy coverage, widespread removal under Westar power lines might be viewed as counter productive. Currently, Westar works with many of the municipalities in its territory with a removal/replacement program for public owned trees. Westar may remove trees that are incompatible with power lines, but works with the local government to replace them with trees that are compatible, or replaces them with trees in a location that is not affected by over head power distribution.

6. Further Develop Customer Education

Westar already has several customer education elements in place. The packets given to homeowners when notifying of work conducted on its property are of very high quality and, if read, can be a great resource for property owners to learn more about Westar's need to keep power lines clear of vegetation. However, if the recommendations of this study are put in to action, additional education will become necessary to assure the proper understanding and success of the program. It is likely that given the current 13-year period between pruning activities on a circuit, many property owners are completely unaware of what the vegetation management program entails. To change direction and begin entering properties every four or

five years will involve considerable education of the customers on behalf of the vegetation management program. To increase the level of customer education, Westar should consider the following to educate its customers on the expanded vegetation management program:

- **Public Education Material** – Westar already takes advantage of existing public information staff with practical knowledge of the local customers. They can use this relationship to further develop online, mailer, and other public education media to explain the new steps Westar is taking to improve service reliability and public safety. Customers who face a potential rate increase will want to know that their dollars are being spent wisely so part of this campaign should include demonstrations of how this new program serves to increase reliability and budgetary efficiency in the long run. Some utilities are able to take advantage of public service announcements, radio and television ads, etc., to further increase the visibility of its program. Westar has used these educational tools in the past. Any additional information must be presented to the public in an acceptable and cost effective manner.
- **Sponsor Arbor Day Events** – Although Westar’s current “Green Team” does perform planting events throughout the territory, dedicating certain events around Arbor Day activities has been successful for many utilities to educate customers about power line safety and vegetation management programs. Utilities often give away free trees that are compatible with being planted around power lines, provide safety education regarding maintaining a safe distance from overhead electrical facilities, educate the public about the dangers of underground utilities, and other aspects of power delivery. These events are a great opportunity for utilities and municipalities to showcase their programs, and to collaborate on programs such as tree planting and educating about right tree, right place designs for landscaping.



7. Utilize ISA Best Management Practices Publication for Utility Pruning of Trees

As a companion document to the ANSI A300 (Part 1), the ISA Best Management Practices (BMPs) for utility pruning of trees is designed to further educate and explain proper utility pruning of trees to the pruning professionals. Recognizing that vegetation is one of the leading causes of utility service interruptions, the International Society of Arboriculture published these BMPs to assist both utilities and tree pruning professionals in achieving their vegetation management goals in an efficient and safe manner. This publication describes proper pruning techniques, safe work practices, procedures for remote/rural environments, and procedures for pruning trees after storms create widespread service interruptions. This document also graphically demonstrates the procedures it describes, which is beneficial to the understanding of the techniques presented in the document. The ISA Best Management Practices Publication should be used as a further educational tool for Westar employees and contractors. Many of the

practices it describes are already in use by Westar and its contractors. However, this document was created to further educate and inform its users of the best practices for managing utility rights-of-way. It is recommended that the annual training of pruning contractors and Westar personnel involve this publication and it is available for reference for all personnel just as Westar's vegetation management manual is currently used.

8. Work With Municipalities to Develop Tree Ordinances in Relation to Power Lines

Westar should continue to work with all local governmental units in its service territory to ensure all have ordinances related to tree planting in the vicinity of power lines. Many jurisdictions in Westar's territory do have these ordinances. For those that currently have ordinances in place, Westar should review them for completeness and work with those governmental units to ensure they are being enforced.

An ordinance can assist Westar with its vegetation management goals when working in an urbanized area. The ordinance should allow for the needs of multiple stakeholders to be met. For example, a city may be interested in increasing its overall tree canopy coverage, while Westar is interested in not having trees that conflict with power lines. The ordinance may require a specified number of trees for new developments but specify that, when planted within proximity to power lines, they only achieve a mature height of 25 feet or less.

Items that may be included in a tree ordinance are:

- **Exclude utilities from permit processes** – Many municipalities require a permit to work on trees in the public right-of-way. Since utilities often have a larger amount of work in a city than other organizations, they should be exempted from performing line clearance pruning, or be issued annual permits.
- **Designate annual meetings** – Utilities and urban forestry officials in a city should meet annually to discuss future work, and work performed in the previous year.
- **Use qualified tree pruning contractors** – Establish a rule that only qualified line clearance tree pruning contractors can work within ten feet of power lines.
- **Include utility rights to remove trees** – The ordinance should provide provisions that allow the utility to remove trees in the public right-of-way. Often, utilities work with urban forestry officials to identify and process these removals. The utility offering replacement trees to the city for each removal can also assist with long-term vegetation management goals.
- **Provide specific tree planting provisions** – The ordinance can require trees planted on public or private property in the vicinity of power lines will grow to a specific maximum height at maturity. Existing trees that are in conflict can be removed and replaced using long-term planning.
- **Define significant trees** – The ordinance can define significant or historical trees. These trees may be large-growing trees that were planted before or after power lines were in place and hold a significant value to members of the community. The utility and city can agree to a process that allows these trees to remain where others may be removed (Abernathy, et al.).

9. Increase Proactive Storm Management

The Kansas area is subject to severe weather events that can cause widespread disruption of power. Tornadoes, ice storms, and high winds can all contribute to tree failure around power lines. With respect to tornadoes, there is little that can be done to prepare and proactively manage trees near power lines to reduce impact. High winds and ice storms are another factor. Storms can produce sustained winds of 40-50mph in Westar's service territory. These winds, often accompanied by rain, can uproot trees and cause limb failure leading to power outages. Westar has experienced three major ice storms in the past decade in the years 2002, 2005, and 2007. All of these ice storms had significant impact on Westar's service reliability. After the 2007 ice storm, nearly 30% of Westar's customers were left without power (Williams, 2008).

Pruning for storm reliability is much different than pruning for system reliability. Tree failure during storms is just as often from trees that appear healthy as those with identified issues. Trees overhanging conductors are a major source of power outages from major storms. Further, it was shown that after the 2002 ice storm in the Carolinas, municipalities with the most restrictive pruning ordinances and greatest amount of overhanging branches had the highest amount of service interruptions (Guggenmoos, Everly, 2002). Removal of limbs overhanging power lines is also a common method of proactive storm management. Westar's current vegetation management manual specifies that most overhanging limbs are to be removed. Exceptions are provided for limbs that are 15 feet above lines with certain protective devices such as fuses.



Overhangs, however, do exist on a large part of Westar's system. With auditing of the pruning contractors by the district supervisors in place, the most likely cause of the observed overhangs may be extended cycle length. Shortening the cycle and increasing auditing with tracked results could lessen the impact of trees overhanging the conductors during storm events. Proper management of these limbs in areas where maintenance has not occurred for an extended period may be a difficult "sell" to customers. They may not be used to seeing the more drastic aesthetic appearance of their trees after this type of pruning. Again, Westar would need to work closely with a customer education department to improve the relationship and educate customers on the reasons behind the increased management of its trees. The ultimate goal is to reduce the frequency and duration of outages after a major storm event.

Even more difficult to promote, but just as effective in ice storms, is pruning branches outside of the ROW. These limbs/branches are not necessarily overhanging the power lines, but growing toward them with the potential for contact when weighted with ice or large amounts of snow (Guggenmoos). Pruning to reduce the potential impacts of storms requires pruning trees directionally away from the power lines in a much larger area around the lines than normal circuit pruning.

Given that there's no process to forecast when and where a major weather event will occur in a given year, to completely "storm harden" the system would require a significant investment. Priority could be given to circuits as pruning activities are now prioritized, i.e., the circuits with the most potential customers affected would receive proactive storm management. Timing of this work could coincide with the introduction of a more aggressive cycle pruning program, and education program to inform the public of the reasons behind the additional pruning measures. Public education for storm hardening work is also easiest immediately after a significant event. Storm related restoration work can also help to facilitate storm hardening pruning activities. If Westar finds that introducing a cycle-based approach to vegetation management and working toward storm hardening the system is not attainable at the same time, it should plan to provide as much proactive work for future storms as possible.

10. Include Tree Growth Regulators in Maintenance Activities

Even with a four to five year cycle schedule, proper pruning techniques and removal of incompatible trees near power lines, there are trees on every utility system that will not hold cycle for various reason. These "cycle buster" trees may be too large to effectively remove, or removal of these trees may not be permitted. Repeated off cycle pruning of these trees is not efficient. In these instances many utilities have had success with initiating tree growth regulator programs. TGRs control the natural responses of a tree causing it to grow more slowly than an untreated tree in the same location. TGRs are applied as a soil injection around the base of the target tree. They only affect growth and not other natural processes so they have been proven safe for use around private property. TGRs have been in use in the horticulture industry for decades and have proven to be effective for many species. Treated trees often have darker foliage and more dense crowns contributing to a healthier and more attractive specimen, especially when compared to one that requires annual or semi annual pruning for power line clearance. The most effective time frame of a TGR is in the first two to three years after pruning. This is also the time when a tree pruned for power line clearance will exhibit its heaviest regrowth response (Goodfellow 1987).

The investment required for beginning a TGR program is reasonable. Westar can expect an equipment cost of roughly \$2,500 for soil injection equipment for application. Treatment price is generally \$4 to \$6 per inch of DBH per tree. DBH can be best defined as the diameter of the tree trunk as measured at 4.5ft from ground level.

During the field sampling, the three most common tree species found were identified for each area. Below are those species and the effectiveness of reducing growth by the TGR agent Cambistat.

Table 15. Top three species observed and expected performance of Cambistat.

| | Species | Percent of Tally | % Reduction |
|-------------|---|------------------|-------------|
| System wide | Hackberry Common (<i>Celtis occidentalis</i>) | 14.6% | 50-70% |
| | Elm Siberian (<i>Ulmus pumila</i>) | 11.4% | 50-70% |
| | Maple soft (<i>Maple spp</i>) | 5.9% | 50-60% |
| Central | Elm Siberian (<i>Ulmus pumila</i>) | 15.0% | 50-70% |
| | Hackberry Common (<i>Celtis occidentalis</i>) | 12.6% | 50-70% |
| | Mulberry species (<i>Morus spp</i>) | 7.8% | 40-60% |
| Northeast | Hackberry Common (<i>Celtis occidentalis</i>) | 15.2% | 50-70% |
| | Maple soft (<i>Maple spp</i>) | 8.7% | 50-60% |
| | Elm American (<i>Ulmus americana</i>) | 7.0% | 50-70% |
| Northwest | Hackberry Common (<i>Celtis occidentalis</i>) | 12.4% | 50-70% |
| | Osage Orange (<i>Maclura pomifera</i>) | 11.9% | 30-40% |
| | Elm Siberian (<i>Ulmus pumila</i>) | 8.6% | 50-70% |
| Southeast | Hackberry Common (<i>Celtis occidentalis</i>) | 17.9% | 50-70% |
| | Elm American (<i>Ulmus americana</i>) | 9.4% | 50-70% |
| | Elm Siberian (<i>Ulmus pumila</i>) | 8.5% | 50-70% |
| Southwest | Elm Siberian (<i>Ulmus pumila</i>) | 21.8% | 50-70% |
| | Hackberry Common (<i>Celtis occidentalis</i>) | 13.6% | 50-70% |
| | Cedar species (<i>Cedrus spp</i>) | 6.3% | 20-30% |

11. Develop a Comprehensive Tree Failure Database

Another important factor in hazard tree mitigation and risk management is to develop a comprehensive outage investigation system in relation to trees. When a tree caused outage occurs, either company or contract personnel should document the reasons for failure and enter the information into a centralized database. Components of the documentation should include at minimum:

- Circuit identification
- Property identification (address)
- Tree Species
- Failure Type – grow in, complete failure, branch failure
- Cause of Failure – overhanging limbs, decay, weak limb attachment
- Weather Conditions at Time of Failure – can be used to provide normalized outage statistics

Over time, Westar can utilize this data to assist in predicting the rates of outages by assessed factors. This data can help them in identifying potential failures and mitigate the situation before and failure and outage occur. Westar currently captures similar data whenever a circuit lock-out occurs. This program can be expanded to include tree related failures.

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Appendix A – Data Collection Tally Sheet

| | | | |
|---|-------------|--------------|--------|
| Data Collector | | Start Pole # | |
| Date | | End Pole # | |
| Three Dominant Species _____ (use hatch mark tallies in each column below and then total in boxes) | | | |
| Prune Trees | | | |
| | Beneath ROW | Outside ROW | Totals |
| Fast grower | | | |
| Slow grower | | | |
| Lift access | | | |
| Climb access | | | |
| Public owned | | | |
| Private owned | | | |
| | Total: | Total: | |
| Removals in ROW | | | |
| | | | |
| | | | Total: |
| Hazard Trees (at edge of ROW & beyond) | | | |
| | | | |
| | | | Total: |
| Brush Spans (veg. <4" diameter) | | | |
| | | | |
| | | | Total: |
| Minimum Clearance: | | feet | |

Appendix B – Systemwide Samples Data Summary

| DATA SUMMARY | | Sample size is 1/2 mile | |
|--------------------|---------------------|-------------------------|--|
| System Wide | Sample Count 973 | Percent 2.37% | |

| # of Prunes - Clearance Zone Fast | |
|--|----------------------------|
| Mean # of Fast Clearance Zone Prunes is | 2.99 per 1/2 mile |
| Standard Deviation | 8.58 |
| Standard Error | 0.28 |
| Margin of Error | 0.54 |
| The # of Fast Clearance Zone prunes is between | 2.45 and 3.53 per 1/2 mile |

| # of Prunes - Clearance Zone Slow | |
|--|----------------------------|
| Sample Mean | 2.27 |
| Standard Deviation | 5.83 |
| Standard Error | 0.19 |
| Margin of Error | 0.37 |
| The # of Slow Clearance Zone prunes is between | 1.91 and 2.64 per 1/2 mile |

| Spans of Brush | |
|--|----------------------------|
| Sample Mean | 2.80 |
| Standard Deviation | 2.56 |
| Standard Error | 0.08 |
| Margin of Error | 0.16 |
| The # of Slow Clearance Zone prunes is between | 2.63 and 2.96 per 1/2 mile |

| # of Prunes - Outside Fast | |
|---|------------------------------|
| Sample Mean | 14.80 |
| Standard Deviation | 17.16 |
| Standard Error | 0.55 |
| Margin of Error | 1.08 |
| The # of Fast prunes outside is between | 13.72 and 15.88 per 1/2 mile |

| # of Prunes - Outside Slow | |
|---|----------------------------|
| Sample Mean | 2.90 |
| Standard Deviation | 5.68 |
| Standard Error | 0.18 |
| Margin of Error | 0.36 |
| The # of Slow prunes outside is between | 2.55 and 3.26 per 1/2 mile |

| # of Removals In Clearance Zone | |
|--|----------------------------|
| Sample Mean | 3.21 |
| Standard Deviation | 8.03 |
| Standard Error | 0.26 |
| Margin of Error | 0.50 |
| The # of Removals in the Clearance zone is between | 2.71 and 3.72 per 1/2 mile |

| # of Hazard Trees | |
|----------------------------------|----------------------------|
| Sample Mean | 0.07 |
| Standard Deviation | 0.37 |
| Standard Error | 0.01 |
| Margin of Error | 0.02 |
| The # of Hazard Trees is between | 0.05 and 0.10 per 1/2 mile |

| Samples Rural | | Sample Count | |
|---------------|-----|--------------|--|
| | 679 | | |

| # of Prunes - Clearance Zone Fast | |
|--|----------------------------|
| Mean # of Fast Clearance Zone Prunes is | 2.27 per 1/2 mile |
| Standard Deviation | 8.77 |
| Standard Error | 0.28 |
| Margin of Error | 0.55 |
| The # of Fast Clearance Zone prunes is between | 1.72 and 2.82 per 1/2 mile |

| # of Prunes - Clearance Zone Slow | |
|--|----------------------------|
| Sample Mean | 1.72 |
| Standard Deviation | 5.09 |
| Standard Error | 0.16 |
| Margin of Error | 0.32 |
| The # of Slow Clearance Zone prunes is between | 1.40 and 2.04 per 1/2 mile |

| Spans of Brush | |
|--|----------------------------|
| Sample Mean | 2.63 |
| Standard Deviation | 2.26 |
| Standard Error | 0.07 |
| Margin of Error | 0.14 |
| The # of Slow Clearance Zone prunes is between | 2.49 and 2.78 per 1/2 mile |

| # of Prunes - Outside Fast | |
|---|------------------------------|
| Sample Mean | 11.47 |
| Standard Deviation | 16.76 |
| Standard Error | 0.54 |
| Margin of Error | 1.05 |
| The # of Fast prunes outside is between | 10.42 and 12.53 per 1/2 mile |

| # of Prunes - Outside Slow | |
|---|----------------------------|
| Sample Mean | 2.23 |
| Standard Deviation | 5.43 |
| Standard Error | 0.17 |
| Margin of Error | 0.34 |
| The # of Slow prunes outside is between | 1.89 and 2.57 per 1/2 mile |

| # of Removals In Clearance Zone | |
|--|----------------------------|
| Sample Mean | 3.04 |
| Standard Deviation | 8.67 |
| Standard Error | 0.28 |
| Margin of Error | 0.54 |
| The # of Removals in the Clearance zone is between | 2.50 and 3.58 per 1/2 mile |

| # of Hazard Trees | |
|----------------------------------|----------------------------|
| Sample Mean | 0.06 |
| Standard Deviation | 0.37 |
| Standard Error | 0.01 |
| Margin of Error | 0.02 |
| The # of Hazard Trees is between | 0.04 and 0.09 per 1/2 mile |

| Samples Urban | | Sample Count | |
|---------------|-----|--------------|--|
| | 294 | | |

| # of Prunes - Clearance Zone Fast | |
|--|----------------------------|
| Sample Mean | 4.67 |
| Standard Deviation | 7.90 |
| Standard Error | 0.46 |
| Margin of Error | 0.90 |
| The # of Fast Clearance Zone prunes is between | 3.76 and 5.57 per 1/2 mile |

| # of Prunes - Clearance Zone Slow | |
|--|----------------------------|
| Sample Mean | 3.54 |
| Standard Deviation | 7.10 |
| Standard Error | 0.23 |
| Margin of Error | 0.81 |
| The # of Slow Clearance Zone prunes is between | 2.73 and 4.36 per 1/2 mile |

| Spans of Brush | |
|--|----------------------------|
| Sample Mean | 3.17 |
| Standard Deviation | 3.11 |
| Standard Error | 0.10 |
| Margin of Error | 0.20 |
| The # of Slow Clearance Zone prunes is between | 2.97 and 3.36 per 1/2 mile |

| # of Prunes - Outside Fast | |
|---|------------------------------|
| Sample Mean | 22.49 |
| Standard Deviation | 15.55 |
| Standard Error | 0.91 |
| Margin of Error | 0.98 |
| The # of Fast prunes outside is between | 21.51 and 23.46 per 1/2 mile |

| # of Prunes - Outside Slow | |
|---|----------------------------|
| Sample Mean | 4.47 |
| Standard Deviation | 5.95 |
| Standard Error | 0.35 |
| Margin of Error | 0.68 |
| The # of Slow prunes outside is between | 3.79 and 5.15 per 1/2 mile |

| # of Removals In Clearance Zone | |
|--|----------------------------|
| Sample Mean | 3.61 |
| Standard Deviation | 6.33 |
| Standard Error | 0.37 |
| Margin of Error | 0.72 |
| The # of Removals in the Clearance zone is between | 2.89 and 4.33 per 1/2 mile |

| # of Hazard Trees | |
|----------------------------------|----------------------------|
| Sample Mean | 0.09 |
| Standard Deviation | 0.38 |
| Standard Error | 0.02 |
| Margin of Error | 0.04 |
| The # of Hazard Trees is between | 0.05 and 0.14 per 1/2 mile |

Appendix C – Tree Inventory Data

Southwest WGA 012006 NA
 Southwest WBS 012006 WCHFA
 Southwest WCI 012006 WCHFA
 WGA 012006 NA
 WBS 012006 WCHFA
 WCI 012006 WCHFA

RUSA 012006
 WBS 012006
 WCI 012006

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