APPENDIX D: ANALYSIS AND SUPPORTING DOCUMENTATION

APPENDIX D: ANALYSIS and SUPPORTING DOCUMENTATION

Attachment D-1: Heartland Community College Board Meeting Minutes

MINUTES OF THE REGULAR MEETING OF THE HEARTLAND COMMUNITY COLLEGE BOARD OF TRUSTEES

December 12, 2006

Members present: Cindy Brand, Gregg Chadwick, Harry Dunham, Shiney Thomas-Jacob, Roger Tuttle, Jim White, Charlie Mehl

Members absent: Larry Littell

Others present: Jon Astroth, Rob Widmer, Mary Beth Trakinat, Allan Saaf, Kathleen Collins, Sue Gilpin, Janet Hill-Getz, Bob and Sarah Shaw, Gary Short, Michele Steinbacher of The Pantagraph, Laura Mai

Chair Cindy Brand called the Regular Meeting of the Board of Trustees of Heartland Community College to order at 7:00 p.m. at Heartland Community College, CCB 2011/2012, Normal, Illinois.

PUBLIC COMMENT/INTRODUCTION OF GUESTS

There were no public comments.

CONSENT AGENDA

Mr. Jim White moved to approve the consent agenda. Mr. Roger Tuttle seconded. A roll call vote was unanimous. Motion carried.

Items approved on the Consent Agenda were the minutes of the regular meeting of November 14, 2006, ratification of bills paid during the month of November 2006, and the Board Meeting Calendar.

STAFF REPORTS

Financial

Mr. Rob Widmer, VP Business Services, thanked Mr. Roger Tuttle for reviewing the bills prior to the meeting. Mr. Widmer noted that the interest rates of 5% plus are becoming more common and expenditures are on target for this time of year.

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OTHER REPORTS

Recognition & Correspondence

President Jon Astroth noted that an Ameren inspection of the Pontiac and Lincoln electrical systems revealed no problems - a first in the six-year career of the Ameren inspector. Mr. Jim Hubbard, Division Director of Facilities, attributes this to Mr. Dana Berry, Electrician.

Dr. Allan Saaf, VP Instruction, noted that two faculty members from the Technology Division, Mr. Chris Miller and Ms. Kim Travers, were honored by National Association of Industrial Technology. Dr. Bob Shaw and others have been heavily involved in that organization for some time.

Dr. Saaf invited everyone to attend the Business Essentials graduation on December 20 at 2:00 pm.

Ms. Mary Beth Trakinat, VP Continuing Education, noted that Ms. Christy Post, Director of Adult Education, received an award from the City of Bloomington Township for a four-week program "Skills for Success."

Cabinet/Other

President Astroth distributed a list of possible invitees to the WDC ribbon cutting on August 1, 2007 and asked trustees to bring back any additions.

President Astroth suggested holding the January board retreat and legislative breakfast at HCC.

President Astroth reported that on January 16 at 6:30pm there will be a small reception for the visiting Chinese students. Currently, 19 students have received their visas, and approximately 24 students are expected in all. President Astroth also invited the trustees to a dinner with the Chinese delegation representing the students. Details will follow.

President Astroth thanked the board for participation in recent student life events. Mr. Gregg Chadwick entered the chili cook-off, trustees also attended the press conference on sports and the employee holiday reception. Articles in The Pantagraph were also appreciated.

Mr. Rob Widmer noted that work on the Workforce Development Center continues and May 1, 2007 is still targeted for substantial completion with people moving in during July. The lease at Towanda Plaza ends on July 31, 2007.

Mr. Widmer gave an update on the campus master planning discussions with BLDD noting there is always opportunity for change with time. Referring to the architect's drawing of the campus, he highlighted the following: a student center added to the north end of the Student Commons Building; a classroom facility between the WDC and the ICB and physically connected to both; a multi-purpose auditorium east of the Millennium Boulevard, which would increase to two lanes in and two lanes out; a fitness and recreation center north of the auditorium and east of the boulevard; a child care facility wrapping back around the road being built with the WDC, and west of the boulevard. There are currently 1100 parking spaces, this plan adds approximately 500 new spaces by expanding an existing lot and creating parking east of the boulevard. East of the lake are potential athletic fields for softball, baseball, and soccer, concessions, and parking. The plan looks to the future for facilities and services to be offered by a mature campus. The plan to build as a green campus could include wind power in the future.

TRUSTEE REPORTS

ICCTA

Ms. Cindy Brand noted that the legislative seminar is scheduled for February in Washington, DC.

Student Trustee

Mr. Charlie Mehl distributed his report and noted highlights.

Other

No other reports.

NON-PERSONNEL ACTION ITEMS

Board Policy Revision: Smoke Free Environment – Second Reading

Mr. Roger Tuttle moved to approve the changes to Board Policy 3.4 Smoke Free Environment as presented. Mr. Harry Dunham seconded. Motion carried with a voice vote.

Tax Levy Resolution

Mr. Harry Dunham moved to rescind the action of October 17, 2006 calling for a public hearing and publication notice regarding the 2006 tax levy, and to adopt the "Resolution Regarding Amounts Necessary To Be Levied For The Year 2006" and Certificate of Tax Levy as presented. Mr. Jim White seconded. A roll call vote was unanimous. Motion approved.

CLOSED SESSION

Mr. Jim White moved to go into closed session at 7:42 pm to consider the appointment, employment, or compensation of specific employees, sale and lease of real property, and closed session minutes. Mr. Roger Tuttle seconded. Motion carried with a voice vote.

Chair Cindy Brand reconvened the regular meeting at 7:53 p.m.

PERSONNEL ITEMS

Personnel Actions

Mr. Jim White moved to approve the monthly personnel actions included in monthly personnel actions. Mr. Gregg Chadwick seconded. A roll call vote was unanimous. Motion approved.

PUBLIC COMMENT

There was no public comment.

ADJOURNMENT

Ms. Shiney Thomas-Jacob moved to adjourn. Mr. Harry Dunham seconded. Motion carried with a voice vote.

The meeting was adjourned at 7:54 pm.

Cindy Brand, Chair

Larry Lipell, Secretary

*Note: The student trustee vote is advisory only.

HEARTLAND
COMMUNITY COLLEGE

MINUTES OF THE REGULAR MEETING OF THE HEARTLAND COMMUNITY COLLEGE BOARD OF TRUSTEES
February 20, 2007

Members present: Cindy Brand, Gregg Chadwick, Harry Dunham, Larry Littell, Shiney Thomas-Jacob, Roger Tuttle, Jim White, Charlie Mehl

Members absent: None

Others present: Jon Astroth, Rob Widmer, Mary Beth Trakinat, Helen McKay-Katz, Allan Saaf, Kathleen Collins, Sue Gilpin, Steve Herald, Janet Hill-Getz, Joe McCauley, Dana Rosenberg, Bob Shaw, Gary Short, Pamela Sweetwood, Nicholas Davidson, Mallory Lootens, Cameron McLees, April Phillips, Steve Graham, Ann McCowen, Holly Richrath of The Peoria Journal Star, Michelle Steinbacher of The Pantagraph, Laura Mai

Dr. Catherine Miller, Associate Dean of Health and Human Services, presented a demonstration of the nursing facilities prior to the board meeting.

Chair Cindy Brand called the Regular Meeting of the Board of Trustees of Heartland Community College to order at 7:00 p.m. at Heartland CCB 2011/2012, Normal, Illinois.

Chair Cindy Brand appointed Ms. Shiney Thomas-Jacob as acting secretary to sign documents at this meeting. (Mr. Littell arrived at 7:20 pm.)

PUBLIC COMMENT/INTRODUCTION OF GUESTS

Dr. Kathleen Collins, Dean of Student Services and Academic Support, introduced Ms. April Phillips and Mr. Nicholas Davidson, two Heartland students.

CONSENT AGENDA

Mr. Roger Tuttle moved to approve the consent agenda. Mr. Gregg Chadwick seconded. A roll call vote was unanimous. Motion carried.

Items approved on the consent agenda were the minutes of the regular meeting of January 16, 2007, the minutes of the legislative meeting and board retreat of January 26, 2007, ratification of bills paid during the month of January 2007, and the fall 2007 credit class schedule printing bid.

STAFF REPORTS

Financial

Mr. Rob Widmer, VP Business Services, thanked Mr. Harry Dunham for reviewing the bills. Mr. Widmer reported that the College is in the process of receiving proposals to engage an audit firm, and Mr. Gregg Chadwick agreed to serve as a Board representative on the audit review process. The investment report continues to show rising interest rates, and the revenues and expenses report are on target for this time of year.

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ANNUAL REPORTS

Community Scholars

Dr. Helen McKay Katz, VP Institutional Advancement, introduced Ms. Pamela Sweetwood, Director of Special Programs. Ms. Sweetwood noted that Community Scholars is a two-year program that provides scholarships to 15 in-district high school graduates yearly; the students volunteer for five hours a week each semester at non-profit agencies. Mr. Cameron McLees, a first year student from Normal Community HS, reported on Rotaract Club. Ms. Mallory Lootens, a second year student, reported on her volunteer work at various Heyworth programs and the Children's Discovery Museum.

Marketing and Public Information

Dr. Helen McKay Katz introduced Ms. Janet Hill-Getz, Director of Marketing and Public Information. Ms. Hill-Getz noted that Marketing and Public Information has been very active this year promoting Heartland in magazines, the website, and a sign at the Redbird Arena. The written report provides an overview of marketing activities. A copy of the Foundation's Annual Report was distributed.

Credit Enrollment Spring 10th Day

Dr. Allan Saaf introduced Dr. Kathleen Collins, Dean of Student Services and Academic Support. Dr. Collins reported that spring enrollment and headcount are up since last year. Spring credit hours are at an all-time high for the last five years which represents a 5.5% increase since spring 2006. The FTE is 2,696. Traditional age students represent 64% of the student body, and the largest number of students are from within the district.

OTHER REPORTS

Student Satisfaction Inventory

Dr. Allan Saaf, VP Instruction, asked Dr. Dana Rosenberg, Director of Institutional Research and Planning, to report on the Fall 2006 Student Satisfaction Inventory that she and Mr. Paul Folger, Director of Instructional Development Center and Academic Support Center, prepared. Dr. Rosenberg noted that the advantage of using a nationally normed survey is the ability to compare Heartland's results to the results of students at other community colleges across the country. The faculty administered over 800 surveys in classes and Dr. Rosenberg and Mr. Folger analyzed the results. According to the inventory, overall satisfaction with Heartland exceeds the average with comparison schools. Dr. Rosenberg described future analysis planned for the inventory results.

Recognition & Correspondence

President Jon Astroth noted the following: Heartland has signed on to the Illinois Sustainable University Compact.

Mr. Rick Allbee, Academic Advisor, was published in the *Journal for the Study of the Old Testament*.

Ms. Kim Travers, Assistant Professor of Industrial Technology, was elected chair of the National Association of Industrial Technology's Executive Board.

Cabinet/Other

Dr. Allan Saaf distributed a booklet from the SIT Conference and showed photos of the children's designs, including a hovercraft. Approximately 300 children participated.

Dr. Saaf noted that Heartland will sponsor a College Information Night on February 22, and distributed marketing materials for the event.

Dr. Saaf noted that Ed Carroll, Professor of History, was appointed as vice-chair of a committee for the Abraham Lincoln Illinois Bicentennial Commission.

Mr. Rob Wider noted that the College anticipates substantial completion on May 1, 2007 for the Workforce Development Center. Between May 1 and July 9, furnishings, technology, and equipment will be placed in the building and staff will move beginning the week of July 9.

Mr. Widmer invited interested trustees to attend a web conference on deploying a wind turbine on a college campus on May 1 and 3 from noon to 1:30 pm.

Mr. Widmer discussed electric deregulation and noted that, based on past utilization, the College will save over $100,000 this year by taking advantage of real-time pricing and alternative energy suppliers.

President Jon Astroth distributed a list of upcoming student activities and an article on community colleges going green. He noted that the March 20 Board meeting is in Lincoln, the van will leave at 5 pm, and dinner will be at Guzzardo's prior to the meeting.

President Astroth requested Board feedback on the draft mission statement.

President Astroth presented a PowerPoint currently in use to try to education community members about some of the forces driving the Phase II Campus Project. Dr. Kathleen Collins introduced Ms. April Phillips, President of the Student Government, and Mr. Nicholas Davidson, President of Baccus; both are members of Phi Theta Kappa. Ms. Phillips (after speaking with students on campus, student group liaisons, and the student trustee) reported that the student body encourages the growth and development of the campus; the expansion of the student life activities has had a remarkable impact on the morale and enthusiasm of the student body; students are excited to see the Hawks and the implementation of the athletic programs. She added that student concerns include parking, student to teacher ratio, and maintaining a clean, secure campus. Mr. Davidson added his appreciation to the Board for their efforts in these matters.

Chair Cindy Brand reported on the local Chinese New Year celebrations.

TRUSTEE REPORTS

ICCTA

Mr. Gregg Chadwick reported on the ACCT Public Policy Committee and distributed the legislative agenda which was ratified last fall and reviewed by the ACCT this year.

Ms. Cindy Brand noted March 10 is the next ICCTA meeting and April 25 is Lobby Day.

Student Trustee

Mr. Charlie Mehl distributed his report and noted highlights including: efforts being made for a ride share and clubs working for a hawk presentation during Springfest.

Other

No other reports.

CLOSED SESSION

Mr. Gregg Chadwick moved to go into closed session at 8:10 pm to consider the appointment, employment, or compensation of specific employees; pending litigation; purchase, sale, or lease of real property, and review of closed session minutes. Mr. Larry Littell seconded. Motion carried with a voice vote.

Chair Cindy Brand reconvened the regular meeting at 9:13 p.m.

NON-PERSONNEL ACTION ITEMS

Phase II Master Plan

Mr. Roger Tuttle moved to adopt the Phase II Master Plan (January 2007) as the current facilities master plan for Heartland Community College. Mr. Larry Littell seconded. Motion carried with a voice vote.

Phase II Campus Locally Funded Project

Mr. Harry Dunham moved to approve as a locally funded capital project, a Phase II Campus Project consistent with scope, budget and schedule presented in the Phase II Master Plan (January 2007), and authorize submission of a Locally Funded Capital Project Application for the Phase II Campus Project to the Illinois Community College Board. Mr. Jim White seconded. Motion carried unanimously with a roll call vote.

Phase II Campus Project Architect/Engineer Professional Services

Mr. Jim White moved to retain the firm of BLDD Architects, Inc., based on the existing, satisfactory relationship established between BLDD and the College, to provide in conjunction with qualified consultants, architectural and engineering services for the Heartland Community College Phase II Campus Project. Mr. Larry Littell seconded. Motion carried unanimously with a roll call vote.

Phase II Campus Project Fiscal Agent

Mr. Gregg Chadwick moved to retain First Midstate Incorporated to act as financial consultant and fiscal agent with respect to the proposed Heartland Community College Phase II Campus Project bond issue. Ms. Shiney Thomas-Jacob seconded. Motion carried unanimously with a roll call vote.

Phase II Campus Project Bond Counsel

Mr. Larry Littell moved to retain the law firm of Chapman and Cutler of Chicago, Illinois as Bond Counsel in regard to the proposed Heartland Community College Phase II Campus Project bond issue and hereby authorize the firm to prepare the necessary legal proceedings for the proposed bond issue and advise Heartland of the legal necessities. Mr. Harry Dunham seconded. Motion carried unanimously with a roll call vote.

PERSONNEL ITEMS

Personnel Actions

Mr. Roger Tuttle moved to approve the monthly personnel actions included in monthly personnel actions. Mr. Larry Littell seconded. A roll call vote was unanimous. Motion approved.

Tenure Recommendations

Mr. Larry Littell moved to grant tenure to the following faculty, effective with the 2007-2008 academic year: Francine Armenth-Brothers (Health), Verona Barr (Biology), Jane Chapman (Biology), Bill Marrs (Business and Economics), Kim McHale (Mathematics), Cindy Pulley (Mathematics), Karen Shaw (Education). Ms. Shiney Thomas-Jacob seconded. Motion carried unanimously with a roll call vote.

PUBLIC COMMENT

There was no public comment.

ADJOURNMENT

Mr. Roger Tuttle moved to adjourn. Mr. Larry Littell seconded. Motion carried with a voice vote.

The meeting was adjourned at 9:20 pm.

Cindy Brand, Chair

Larry Littell, Secretary

*Note: The student trustee vote is advisory only.

APPENDIX D: ANALYSIS and SUPPORTING DOCUMENTATION

Attachment D-2: Wind Resource Analysis and Wind Turbine Recommendations

HEARTLAND COMMUNITY COLLEGE

Wind Resource Analysis
and
Wind Turbine Recommendations

October 30, 2009

Mr. Jim Hubbard, Director Operations

CONFIDENTIAL

Alternate Energy Solutions, Inc.
Gratiot Office Plaza – 2nd Floor
23801 Gratiot Ave.
Eastpointe, Michigan 48021
Phone: (586) 498-8840

IMPORTANT NOTICE

This report was written by Alternate Energy Solutions, Inc. for, and on behalf of, the management of Heartland Community College, Normal, Illinois ("Heartland"). The report has as its primary objective the summation of wind monitoring during a twelve month period over calendar years of 2008 and 2009. The secondary objective of the document is to provide a review of probable wind turbine generator energy capture with an initial recommendation to equipment.

This report provides an assessment of the wind regime for the locations identified herein, along with energy capture estimates for select wind turbine generating units and estimates for energy capture, using historical wind data from an optimistic, realistic and pessimistic prospective. This document and the recommendations contained herein have been compiled from data sources believed to be accurate. The computations and recommendations contained in this document are theoretical in nature. Our work included review of the recorded data, local historical data, technical documentation, discussions with manufacturers, and information derived from professional sources.

The report is based on actual metered wind velocity data collected from a single NRG 50m XHD meteorological tower. Short-term data was collected from the National Climatic Data Center (NCDC) for the WBAN FAA/AWSS Station No. 54831 located at Central Illinois Regional Airport – Bloomington Normal (KBMI) and intermediate-term data from WBAN FAA/AWSS Station No. 93822 located at Springfield Capitol Airport (KSPI).

The findings expressed herein are principally theoretical; guarantees of future performance cannot be given. The use of this report by Heartland involves significant project and financial risk. However, this report provides Heartland with a learned opinion and recommendation which must be carefully discussed by the College's Administration and Board of Trustees prior to making a final determination on project suitability for the school and the community.

This document also contains privileged manufacturer's data that is under a conditional non-disclosure agreement. AESI respectfully requests that this report and material therein, be treated confidentially and limited to review by school administrators, directors, officers, business managers, legal representatives and engineers.

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1. Executive Summary

Alternate Energy Solutions, Inc. ("AESI") was engaged by the administration of Heartland Community College ("Heartland") to purchase, assemble, erect and maintain one 50m XHD meteorological tower manufactured by NRG Systems, Inc.; for monitoring, recording and evaluating collected wind data. Wind data collection activities are for the purpose of investigating the viability and practicality of the local wind regime for possible future integration of a wind turbine generator (WTG) to generate electrical energy and offset a portion of the college's base electric load. Our evaluation finds that the local wind regime is suitable for wind power development, provided, turbines designed for medium wind velocities are used and the initial capital cost (ICC) for the project is carefully controlled through thorough pre-engineering design and prudent project work-scope definition and bidding.

One site was selected on campus for wind meteorological tower monitoring and is identified as HCC-1. Construction of the meteorological tower began during the month of June 2008. Data recording began July 4, 2008 and continues to the present day. One calendar year of data was collected prior to the writing of this report. Data was validated against local meteorological sources believed to be accurate. The average annual 50 m level wind velocity recorded at HCC-1 was 6.30 m/s (14.1 mph) yielding an approximated wind power density of 267 w/m^2 for the time period studied.

Wind power density at HCC-1 would be traditionally categorized as a Class II wind regime. The reader of this report should be mindful that technological improvements in wind turbine generator design and rotor efficiency give Class II wind regimes improved stature as viable wind resources. As the price of electrical energy tends to increase, low wind regimes become more viable and acceptable resources for wind generating assets and infrastructure. Additional considerations should include the present and future cost of electrical energy, measured wind velocities compared to historical wind velocities, financial impact of federal and state carbon emission regulations, improved operating efficiencies of new wind turbine technologies with higher rotor hub-heights, and stewardship to our environment.

Four years of historical wind data was compiled using NCDC data from Normal, IL and compared against the recorded wind velocities from HCC-1, beginning with February 2005 through August 2009. Because of the limited local dataset, the data from WBAN FAA/AWSS Station No. 54831, located at Central Illinois Regional Airport – Bloomington Normal (KBMI), was used to identify local events such as icing. Due to the limited dataset from KBMI, a 20 year dataset from WBAN FAA/AWSS Station No. 93822, located at Springfield Capitol Airport (KSPI), was acquired for intermediate-term correlation of wind velocities with HCC-1.

Using the data, an initial list of wind turbine generators in the 1.5 MW (1,500 kW) nameplate rated class was compiled. The International Electro-technical Commission Wind Turbine Survival Standard (IEC Standard 61400) was the reference used against compilation process.

For this study, the wind turbines are presumed to be placed on 80 m (262.4 ft.) towers. The Federal Aviation Association (FAA) and local airport authority (having zoning jurisdiction and ordinance interpretation for Central Illinois Regional Airport) may influence the ultimate location for the project and invoke regulation on tower obstruction lighting.

Extrapolations using recorded tower data with the Power Law and Logarithmic Law infer that the average annual wind velocity for the period fell into the range of 6.95 m/s (15.5 mph) to 7.24 m/s (16.2 mph) at 80 m hub-height; based on extrapolation of the data recorded data from the HCC-1 meteorological tower. Correlated intermediate-term data suggests that at 80m projected P_{50} wind velocities could range from 6.36 m/s (14.2 mph) (pessimistic) to 6.79 m/s (15.2 mph) (optimistic). For this executive summary, projected P_{50} wind velocities were applied to wind turbine manufacturers' power curves and yielded gross energy capture estimates ranging from 3,877 MW-h to 4,415 MW-h, for a typical 1.5 MW wind turbine generator. This equates to gross capacity factors ranging from 29.4% to 33.5%. The capacity factors given in this report are derived from gross generation calculations using an AAER A-1500-77 wind turbine. Wind velocities, power curves, hub-height and other factors will affect a wind turbines gross and net energy capture.

It is important to note that the P_{50} velocities fall marginally below of those wind velocities expressed on wind maps commissioned by Illinois Clean Energy and AWS Truewinds. For example, AWS Truewinds estimates the wind velocity to be 7.21 m/s at 80m in the study region. Excluded from the gross capacity factor computations are potential losses that could occur due to blade soiling, icing of rotor, transmission and distribution line loss, and maintenance (both scheduled and unscheduled). Net Operating Losses generally fall in the range of 5% to 13%. Potential losses are dependent on factors outside the scope of this study.

As part of this study, we were directed to place emphasis on availability of wind turbines for a possible commissioning date in the fall of 2010. The matter of initial capital cost (ICC) expenditures for manufactured wind turbines, project infrastructure and construction, and other ancillary costs, were estimated and based on our knowledge of other projects. The ICC estimates were used to determine the unit cost of energy (UCE) for a proposed single turbine facility. Extensive cost estimating tasks were not undertaken in the composition of this document; and, are generally a part of a formal project pro forma.

We estimate the installed cost of a single 1.5 MW wind turbine installation with an 80 m hub-height at $3,206,638.00 or $2,138/kW for prudently designed and bid projects; projects bid as ECP contracts will typically command an additional project risk premium of 8% to 15%. Unit cost of energy is estimated at $0.04536/kW-h to $0.05038/kW-h, using P_{75} wind velocities, with the cost of maintenance included and estimated at $0.005/kW-h. The cost of maintenance will be determined by the manufacturer and Heartland, reflecting the scope of service and coverage to be provided.

2. Meteorological Tower Locations and Equipment

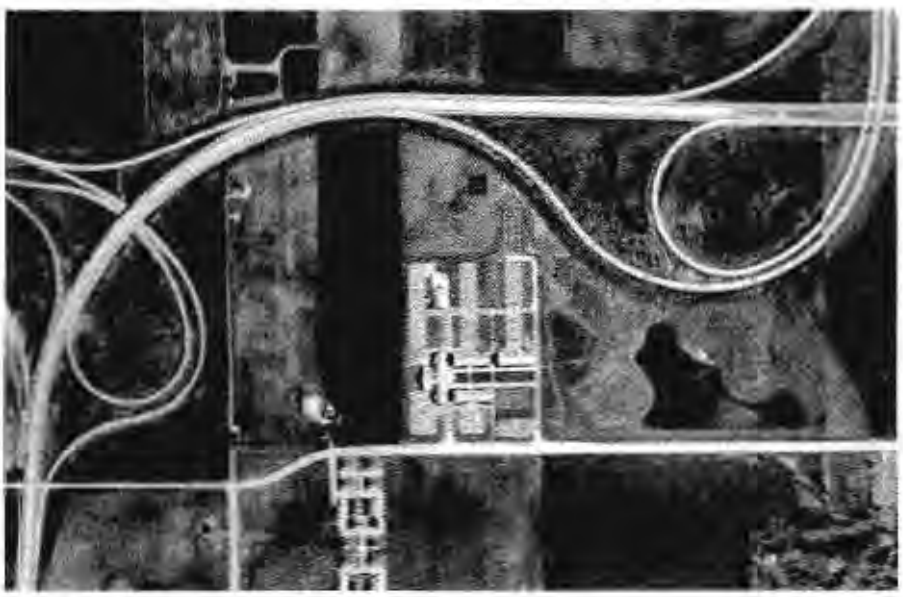
At present, a meteorological tower measures and records the wind velocity at a single site that is being studied by Heartland and AESI for the installation of one wind turbine generator (WTG).

Meteorological Tower Location:

Identifier:	HCC-1
Latitude:	N 40° 32' 17"
Longitude:	W 89° 00' 58"
Elevation:	261 m (856 ft ASL)
Commissioned:	July 4, 2008

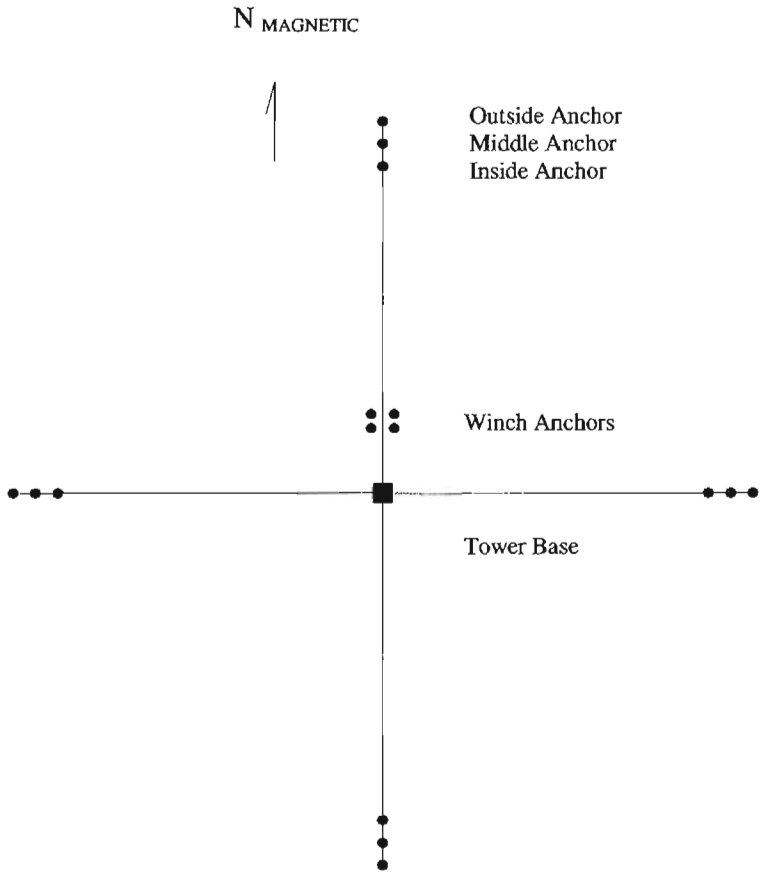
The site is located on the north side of the college's campus and may be described as open field with tall grass, shrubs and small trees; and, furthermore, borders the south of I-55 and east bound Exit No. 164 to I-39. Mr. James Hubbard and Mr. Steven Smith (Farnsworth Group) deemed the location suitable for the installation of the meteorological test tower.

Location of Meteorological Tower HCC-1



The meteorological tower is supported by a total of twenty-four galvanized steel cables, 1/4" diameter, having 7 x 19 filament construction; with 6 cables on each quadrant point, 3 cables per anchor. A total of twelve screw-in anchors provide primary anchoring for the tower. The outside anchors are further supplemented with arrowhead tipping-plate anchors driven to a vertical depth of 4.5 ft. to 5.0 ft.

Approximate Orientation of Tower Base and Anchors at HCC-1



HCC-1 Looking Northwest from Center Campus

(AESI Photo)

Sensors

The meteorological tower is equipped with anemometers, wind vanes, barometric and temperature sensors.

Anemometers are the 1900 NRG #40C (calibrated) devices manufactured by O-Tech and shipped as part of the meteorological tower package. The anemometers provide pulsed data that is sampled by a data logger every two seconds. Ten minute statistics for wind velocity and all other data acquisition channels are periodically recorded to a non-volatile data file. The recorded data is converted to reflect wind velocity in miles per hour (mph) or in meters per second (m/s) as required. In this Report, wind velocities are first given in the following format – m/s (mph).

1900 NRG #40 Anemometer

(Courtesy NRG Systems)

HCC-1 Anemometer Elevations: 50m (2); 40m (1); 30m (1); 20m (1) and 10m (1)

Note: Orientation information for instrument arms was recorded and made a part of the meteorological tower log.

The anemometer at 10 m for HCC-1 was installed to provide an additional correlation point in order to compare wind data at the test site with data recorded at Springfield.

A consensus transfer function has been adopted by the wind industry for use with this anemometer model; the accuracy of which is estimated at ± 0.2 m/s over the device's operational range.

Wind Vanes are the 1904 NRG #200P devices and are installed on the meteorological tower as noted:

HCC-1 Wind Vane: 50m (1) and 40m (1)

Note: Orientation information for instrument arms was recorded and made a part of the meteorological tower log books.

1904 NRG #200P Wind Vane

(Courtesy NRG Systems)

Temperature sensing is provided by the 1906 NRG #110S device, one temperature sensor was placed on the meteorological tower. The device may be programmed to reflect temperature in degrees Fahrenheit or in degrees Celsius. The sensors are approximately 3m above the ground to minimize the effects of changes in temperature due to ground cover heating at the site.

1906 NRG #110S Temperature Sensor

(Courtesy NRG Systems)

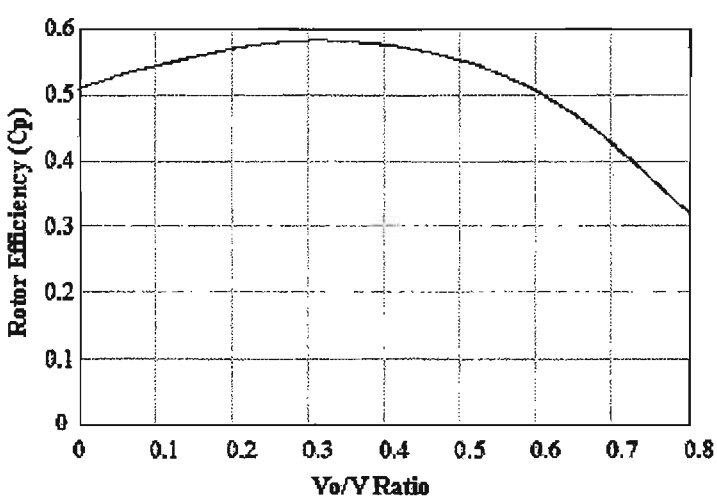
3. Factors Affecting Wind Power and Turbine Performance

A wind turbine generator (WTG) captures the energy of the wind using a rotor, having two or more blades, that is mechanically linked to a generator. As the rotor is forced to turn by prevailing winds, mechanical energy is removed from the wind and transferred into rotary mechanical force (torque) in the shaft of the rotor unit. The rated power and the speed of rotation, for a rotor system, is dependent on a number of factors, some of the main ones are…

- Wind velocity
- Swept area, number of rotor blades and solidity
- Blade pitch
- Generator (asynchronous and synchronous)

Each factor has a significant role in rotation speed and net energy capture. The overall efficiency of a rotor to extract energy from the wind has a theoretical maximum of slightly less than 60%; Betz's Law for Airfoils. The graph below plots rotor efficiency as a function of the V_o/V ratio; where V_o is the downwind velocity and V is the upwind velocity relative to the turbine rotor. Depending on the design and manufacture of wind turbine generator, the rotational speed of the rotor must be increased. To accommodate asynchronous generators, a gearbox is used to step-up the rotation speed of the drive shaft to produce a fixed slower rpm on the rotor and a much faster fixed rpm for generator to produce electricity. In the case of a synchronous generator, the drive shaft from the rotor may be directly coupled to the generator without a gearbox, driving the generator at the slower variable speed of the rotor.

Rotor Efficiency and V_o/V Ratio



Rotor efficiency is not a straight forward topic for the untrained; as an example, when comparing a two-blade rotor system to that of a three-blade unit, the overall efficiency realized by adding the third blade is on average increased by approximately 5%; however, the cost and weight of the three-blade rotor system block is increased disproportionably by 50%, factoring out the rotor hub and internal sub-assemblies.

A discussion on swept area and solidity is appropriate at this point in our discussion. Swept area is the circular area that the tips of the rotor blades form as they spin. The swept area is generally given by the manufacturer in square meters (m^2).

Say we have a wind turbine generator using a three-blade rotor, each blade 27m (88.6ft.) in length. The diameter of the rotor blades forms a circle 54m (177ft.) across the center. Swept area for the example above is calculated using the equation for circular area:

$$\text{Area}_{(\text{circle})} = \frac{\pi D^2}{4} = 2{,}290\ m^2$$

The concept of rotor swept area is important for determining the amount of energy held by the wind passing over the rotor for a given wind regime as presented in the following paragraph.

Using the swept area figure, we can determine the total power that would be available for conversion by the rotor. Assuming that the power in the prevailing wind, referred to as wind power density (WPD) stated in watts/m^2, at a given moment in time, is determined to be 250 watts (w)/m^2; the total power that a rotor having 100% efficiency could extract becomes,

$$\text{Power}_{(\text{rotor swept area})} = \text{WPD} \times \text{Rotor Swept Area}$$

$$\text{Power}_{(\text{power swept area})} = 250\ w/m^2 \times 2{,}290\ m^2 = 572{,}500\ w\ (572.5\ kW)$$

Few manufacturers offer the option to change the size of a wind turbine generator's rotor. When this option is available, it should be considered carefully; a larger diameter rotor has more wind flowing across the blades, converting more of the wind power into mechanical torque and electricity. The added cost for a larger diameter rotor should be weighed along with the use of higher towers to determine the added economic benefit for a wind turbine project.

Another factor that influences rotor operating dynamics is solidity. To determine the general solidity of the rotor, we must know the amount of active surface area that a rotor blade will have against the prevailing wind. Let us say that the example rotor blades have a surface area of $40m^2$. Since this is a three blade rotor, the total active surface area would then be $120m^2$.

Solidity is the percentage of total blade surface with respect to swept area; therefore, $120m^2$ with respect to $2{,}290\ m^2$, we have,

$$\text{Solidity} = \frac{\text{Total Blade Area}}{\text{Total Rotor Swept Area}} \times 100\% = 5.2\%$$

The relationship between the speed of rotor rotation and the number of rotor blades (solidity) is an inverse relationship. That is, as solidity or the number of blades or area is increased, the speed of rotation for a rotor unit operating in a given wind velocity will decrease.

The number and design of the rotor blades is the center focus of the total wind turbine efficiency. Simply stated, the rotor blades are perhaps the most important factor in capturing wind energy. Rotor blades have the distinction of being the least efficient subassembly of the wind turbine generator and account for the greatest energy conversion losses in the entire wind turbine generator system.

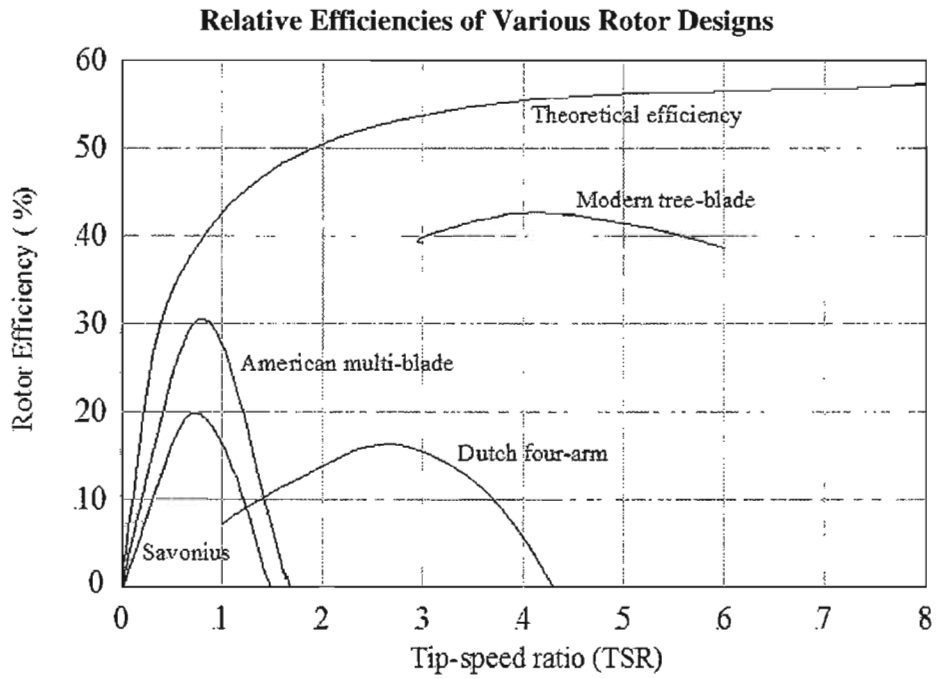
The efficiency factor of a rotor (C_p), operating in a wind turbine generator, is not constant. A rotor, independent of the number of blades, will have a maximum or best operating efficiency when the speed of the rotor movement at its outermost tip (tip speed) is a certain multiple of the prevailing upstream wind velocity acting on the rotor. The relationship between tip speed and wind speed is referred to, in the industry, as tip speed ratio (TSR).

A wind turbine generator having a rotor tip speed of 50 m/s (112 mph) and a prevailing wind velocity of 10 m/s (22 mph) would have a TSR of 5.

$$\text{TSR} = \frac{\text{linear speed of blade outer most tip}}{\text{free upstream wind velocity}} = 5$$

TSR for a model three-blade rotor may vary between 3 and 7 with rotor efficiencies ranging from 0.25 (25%) at the lower and upper limits of the TSR curve, and peaking mid-range at 0.43 (43%). Energy capture is adversely affected when the rotor is operated at less than its optimum TSR.

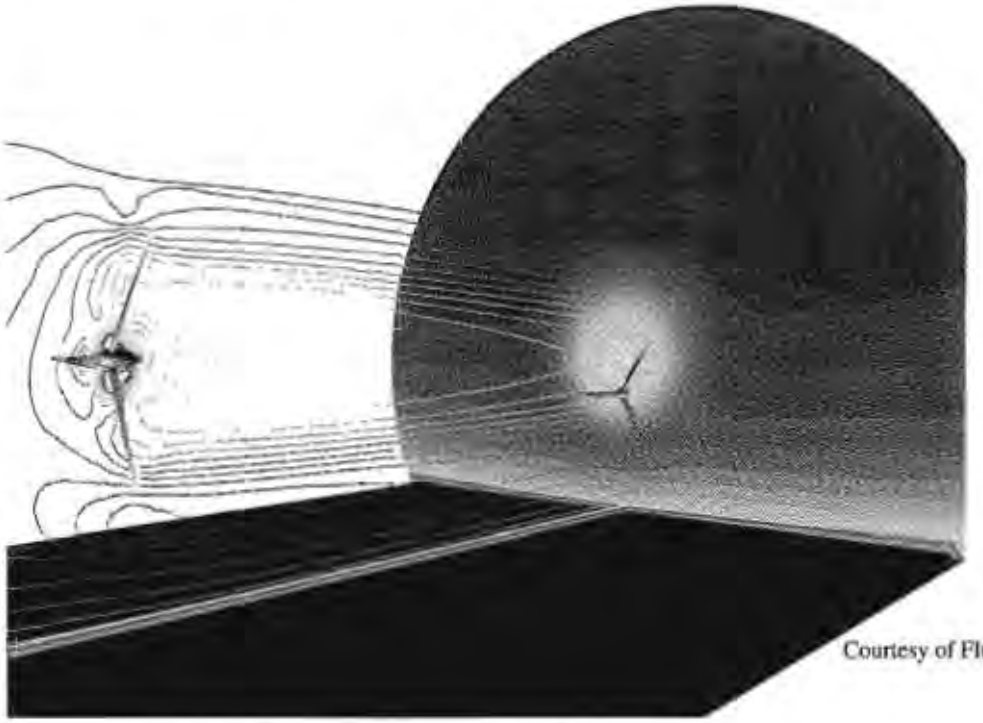
Maintaining an optimum value for TSR is more challenging for the manufacturers of fixed speed wind turbine generators and less problematic for manufacturers of variable speed machines. Energy capture (kW-h) is a function of rotor efficiency, varying with design, as seen in the diagram presented below.



As the wind crosses the rotor blades and power extracted from it, the velocity of the wind behind the rotor is reduced in accordance with the efficiency of the rotor design. This will cause a wake or turbulence zone trailing the rotor where the power in the wind will be reduced for an appreciable distance.

Computational fluid dynamics (CFD) is the accepted method for handling turbine wake problems and elements of micro-siting. In the following diagram, the turbine wake zone is shown generating an adverse affect on a second turbine downstream.

Modeling with computational fluid dynamic (CFD) software.



Courtesy of Fluent, Inc.

The amount of mechanical power that is captured by the rotor from the wind is a function of the difference between upstream wind velocity (flowing toward the rotor) and downstream wind velocity (passing behind the rotor). The spacing between wind turbines becomes very important so that each turbine has wind flow that is not significantly reduced in power. The historical wind direction pattern (shown by what is referred to as a wind rose) and the arrangement of multiple turbines (turbine array alignment) must seek to optimize wind flow to each turbine for energy generation.

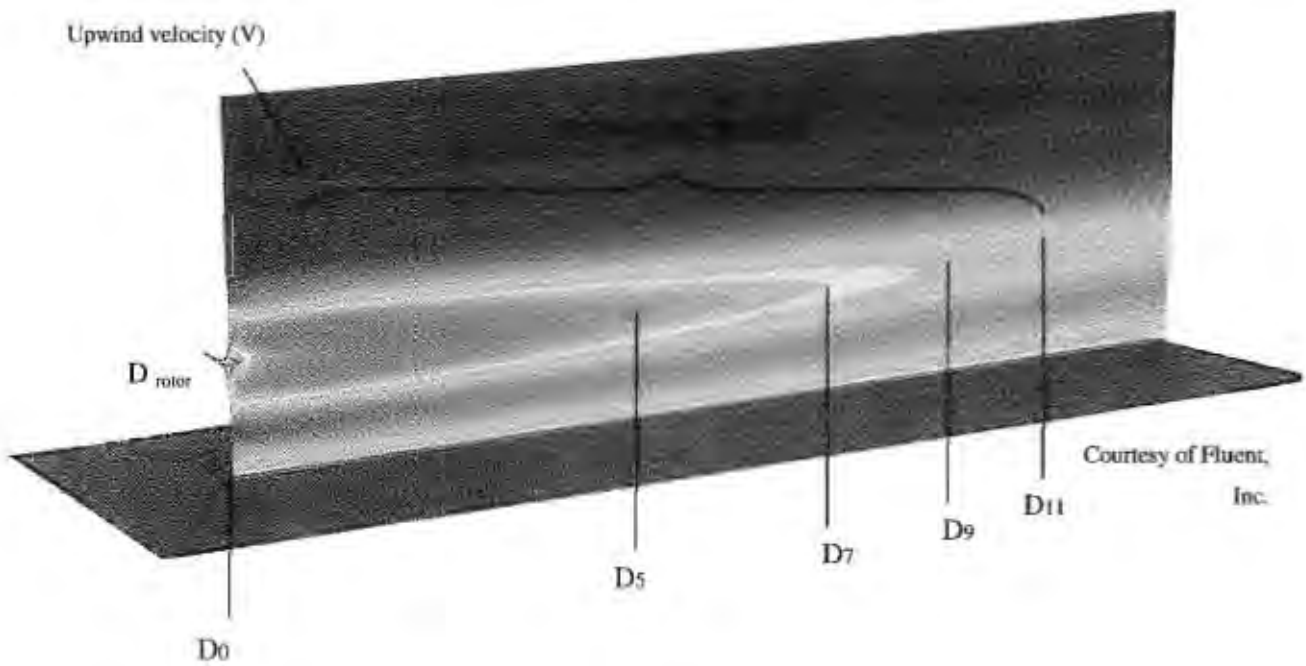
Every practical wind turbine array (multi-turbine placement pattern) design will lose some of the kinetic energy in the wind because of reduced wind flow from one or more turbines, the term for this is "array loss". The key is to lay out the turbine array with special software and engineering to minimize the array losses. In the wind industry, it is not uncommon to find that the distance between rotors perpendicular to the prevailing wind direction from 2 to 5 times the diameter of the rotor (lower rotor distance multiples generally with arrays on ridge formations) are typical. Distances between turbines in the direction of the prevailing wind conservatively range from 8 to 12 times the rotor diameter.

The optimum distance and placement for a wind turbine array is determined by several factors:

- selection of the turbine that will be used
- turbine tower height and rotor size
- wind velocities and wind direction (resource complexity)
- topography of land where project will be built
- amount of land that is available for development
- payment to land owners for use of their property
- array loss percentage project stakeholders would tolerate
- proximity to large buildings and structures

Although array loss will not be a consideration with the installation of a single wind turbine generator at Heartland; wind wake affects from the buildings on campus will have influence on energy capture.

Velocity Magnitude Contours within Turbine Wake



(Approximate rotor diameter multiples added to original diagram)

The placement of a wind turbine at position D_5 within the array plan would produce less energy capture than an identical turbine placed at position D_{11}. In the later position, wind turbulence is lower and has become a

more laminar fluid flow. High wake turbulence will also increase rotor fatigue and failure rates adding increased operational and maintenance costs for the facility.

The energy that is contained in the wind may be found using the following equation:

$$P = \frac{1}{2} \rho V^3 A$$

where P is the mechanical power (kW_{mech}),
ρ is the density of air (1.225 kg/m^3),
A is the area swept by the rotor, and
V is the wind velocity (m/s).

Using the above equation, a wind blowing at an average velocity of 7.0 m/s over a rotor of $1m^2$ will have a wind power density of $210w/m^2$. If we use the rotor having 2,290 m^2 of swept area, the mechanical power in the wind available to the rotor would be 481,100 w (481.1 kW).

The value of mechanical power extracted from the wind when the upstream and downstream wind velocities are known is calculated utilizing the equation:

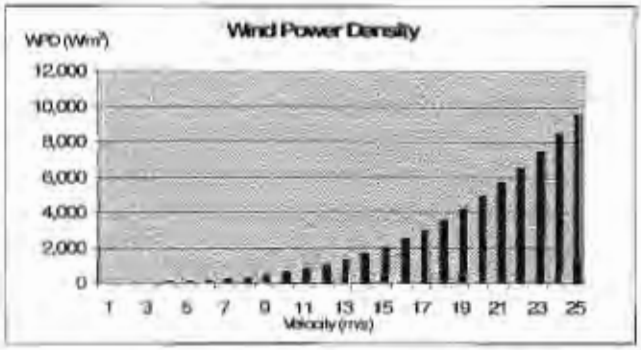
$$P_0 = \frac{1}{2} \rho A \frac{[V + V_0]}{2} \quad V^2 - V_0^2$$

where P_o is the mechanical power extracted (W_{mech}),
V is the upstream wind velocity (m/s), and
V_o is the downstream wind velocity (m/s)

For example, given the upstream wind velocity equal to 7.0 m/s and the downstream wind velocity behind the rotor is measured at 5.0 m/s, the rotor would have captured 201,978 w (201.9kW). The ratio of downwind velocity (V_o) to upwind velocity (V) for this example is 0.714. Inspecting the graph on rotor efficiency (see p.9), we find that the V_o/V ratio of 0.714 intersects with a rotor efficiency of 0.42.

Rotor efficiency can also be determined by dividing mechanical power in the rotor by power in upstream wind. Therefore, taking 201.9 kW (rotor) and dividing by 481.1 kW (upstream), we have an efficiency of 0.42.

Wind velocity is the single most important factor to have when analyzing the potential wind power that would be available for use with wind turbine generators. The relationship of wind power to wind velocity is a cubic (V^3) function.



A thirty percent (30%) increase of wind speed from 10 m/s to 13 m/s will cause the WPD to increase from 613 w/m^2 to 1,346 w/m^2, more than double the available power in the wind.

Wind Power Density Table	
Wind Velocity (m/s)	Wind Power Density (W/m^2)
1	1
2	5
3	17
4	39
5	77
6	132
7	210
8	314
9	447
10	613
11	815
12	1,058
13	1,346
14	1,681
15	2,067
16	2,509
17	3,009
18	3,572
19	4,201
20	4,900
21	5,672
22	6,522
23	7,452
24	8,467
25	9,570

Air density (ρ) is another factor which will influence the amount of energy that a wind turbine generator will glean from the wind. The relationship between air density and energy capture is directly proportional.

Air density is affected by two variables, explicitly, ambient temperature and the barometric (atmospheric) pressure. The traditional equation for finding air density is,

$$\rho = \frac{P}{RT}$$

where R is the physical specific gas constant (287 J kg^{-1} K^{-1}),
P is the air pressure in Pascals (Pa) or Newton/m^2 (N/m^2), and
T is the temperature in °K.

From the equation give above, we see that at as the ambient temperature of air increases, the air density will decrease, the inverse is true for increases in barometric pressure. Therefore, wind flow caused by nearby high pressure systems will tend to have greater power available in the wind. It is also reasonable to state cooler climactic and seasonal winds will have increased power relative to other conditions for the region being studied.

This is one of the equations that is used to calculate the power in the wind at a given velocity. It is also the root formula for determining wind power density (WPD) for a test site.

$$WPD = \frac{1}{2n} \sum_{n=1}^{n} \rho \ V^3$$

Rotor swept area is factored out of the basic equation for mechanical power and is not relevant to power density.

It is very important to know the distribution of the wind velocity in terms of the number of hours over a year that wind occurs at a particular velocity. This gives a better calculation of wind power at a given site that is being evaluated. Knowing the average wind speed is helpful, but not as valuable as velocity distribution.

A given wind site may have an average wind speed of 7 m/s. Depending on the distribution of wind, the site may have a good resource or a weaker resource as exemplified in the following example.

Case 1: Mean wind speed 7.0 m/s during a three hour time period.

Hour #1: 5 m/s
Hour #2: 10 m/s
Hour #3: 6 m/s

$P_1 = 0.5 \times 1.225 \times 5^3 = 76\ w/m^2$
$P_2 = 0.5 \times 1.225 \times 10^3 = 612\ w/m^2$
$P_3 = 0.5 \times 1.225 \times 6^3 = 132\ w/m^2$

Mean WPD: 273 w/m^2

Case 2: Mean wind speed 7.0 m/s during three hour time period.

Hour #1: 5 m/s
Hour #2: 5 m/s
Hour #3: 11 m.s

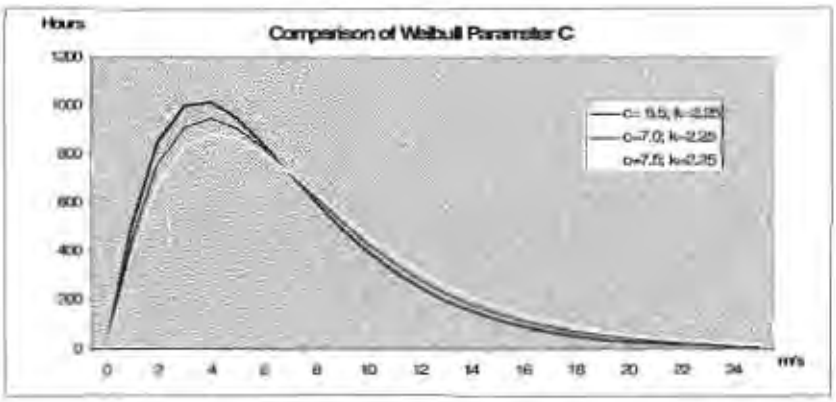
$P_1 = 0.5 \times 1.225 \times 5^3 = 76\ w/m^2$
$P_2 = 0.5 \times 1.225 \times 5^3 = 76\ w/m^2$
$P_3 = 0.5 \times 1.225 \times 11^3 = 815\ w/m^2$

Mean WPD: 322 w/m^2

Both three hour periods have the same average wind speed; the mean equal to 7 m/s. The distribution shown in Case 2 would have more available wind energy for conversion and would have been a better wind resource.

The shape of probability distribution curve for wind is best described by Weibull statistical analysis. A shape factor of 2.00, known as the "Raleigh distribution", approximates the natural distribution pattern for most wind sites.

The following diagram illustrates the difference between variations in the Weibull scale parameter "c" and holding a constant shape parameter "k" = 2.25.



In the graph above, velocity curves are skewed to the right and converge at approximately 7.0 m/s. The higher c-parameter curves have noticeably fewer hours at velocities less than 7.0 m/s; however, and more importantly, they have increased hours at velocities greater than 7.0 m/s. This is important because wind turbine power curves are skewed to the left having greater power output at higher wind velocities.

Conversely, increasing k-parameters tend to have fewer hours at the higher velocities.

4. Overview of Wind Data

This section of the report is a compilation and summary of the significant data collected from the HCC-1 meteorological tower. Tables are provided for anemometer data along with linear and polar graphic diagrams for wind velocity timelines and metrics best described using directional orientation. Additional discussion is given on wind shear and vertical wind profile for the site later in this section.

Tabular Representations

Wind Resource Summary for HCC-1 (07/04/2008 to 07/15/2009)						
Metered Level	50m A	50m B	40m	30m	20m	10m
Mean Wind Seed (m/s)	6.25	6.36	5.97	5.57	5.03	4.05
Median Wind Speed (m/s)	5.80	6.00	5.50	5.10	4.50	3.60
Minimum Wind Speed (m/s)	0.30	0.30	0.30	0.30	0.28	0.23
Maximum Wind Speed (m/s)	26.20	26.20	25.40	24.80	23.10	17.70
Mean Power Density (w/m^2)	260	273	233	198	154	90
Mean Energy Content (kw-h/m^2/yr)	2,278	2,387	2,040	1,734	1,345	790
Weibull k	2.227	2.226	2.170	2.081	1.964	1.773
Weibull c (m/s)	7.06	7.17	6.74	6.30	5.67	4.56
Record Samples (1)	54,246	54,246	54,246	54,246	54,246	54,246

Note (1): A total of 54,246 data records were collected for the 50m, 40m, 30m, 20m and 10m anemometers at HCC-1 and are given in the table above, representing 100% of data for time period. Minor icing caused anemometers and wind vanes to lose data during the recording period. Data for these time periods was replaced with a synthesizing algorithm.

Monthly Average Wind Speed Statistics for HCC-1 (50m A)

Year	Month	Records	Recovery Rate (%)	Mean (m/s)	Min (m/s)	Max (m/s)	SD (m/s)	Weibull k	Weibull c (m/s)
2008	Jul	4,032	100	4.867	0.3	18.9	2.012	2.486	5.457
2008	Aug	4,464	100	4.704	0.3	21.4	1.750	2.850	5.261
2008	Sep	4,320	100	4.721	0.3	12.8	1.997	2.492	5.306
2008	Oct	4,464	100	6.058	0.3	17.1	2.145	2.920	6.743
2008	Nov	4,320	100	6.799	0.3	14.9	2.554	2.913	7.610
2008	Dec	4,464	100	8.271	0.3	24.6	3.828	2.283	9.324
2009	Jan	4,464	100	6.394	0.3	16.5	2.781	2.475	7.220
2009	Feb	4,032	100	7.736	0.3	19.2	3.150	2.641	8.689
2009	Mar	4,464	100	7.348	0.3	26.2	3.508	2.211	8.299
2009	Apr	4,320	100	7.812	0.3	17.0	3.044	2.782	8.783
2009	May	4,464	100	5.777	0.3	16.7	2.504	2.462	6.510
2009	Jun	4,320	100	5.317	0.3	15.4	2.377	2.353	5.988
2009	Jul	2,118	100	4.662	0.3	12.1	1.898	2.628	5.239
All Data		54,246	100	6.254	0.3	26.2	2.956	2.226	7.061

Monthly Average Wind Speed Statistics for HCC-1 (50m B)

Year	Month	Records	Recovery Rate (%)	Mean (m/s)	Min (m/s)	Max (m/s)	SD (m/s)	Weibull k	Weibull c (m/s)
2008	Jul	4,032	100	4.943	0.3	19.2	2.009	2.534	5.543
2008	Aug	4,464	100	4.697	0.3	21.5	1.747	2.843	5.254
2008	Sep	4,320	100	4.739	0.3	12.6	1.993	2.494	5.321
2008	Oct	4,464	100	6.156	0.3	17.4	2.156	2.931	6.845
2008	Nov	4,320	100	6.964	0.3	15.1	2.569	2.967	7.782
2008	Dec	4,464	100	8.414	0.3	24.9	3.881	2.284	9.477
2009	Jan	4,464	100	6.557	0.3	16.7	2.781	2.533	7.396
2009	Feb	4,032	100	7.860	0.3	19.1	3.228	2.607	8.827
2009	Mar	4,464	100	7.455	0.3	26.2	3.590	2.187	8.419
2009	Apr	4,320	100	7.943	0.3	17.2	3.027	2.840	8.916
2009	May	4,464	100	5.938	0.3	17.6	2.564	2.456	6.682
2009	Jun	4,320	100	5.414	0.3	15.4	2.412	2.365	6.097
2009	Jul	2,118	100	4.644	0.3	12.2	1.863	2.673	5.217
All data		54,246	100	6.356	0.3	26.2	2.998	2.225	7.172

Monthly Average Wind Speed Statistics for HCC-1 (40m)

Year	Month	Records	Recovery Rate (%)	Mean (m/s)	Min (m/s)	Max (m/s)	SD (m/s)	Weibull k	Weibull c (m/s)
2008	Jul	4,032	100	4.551	0.3	18.2	1.943	2.397	5.101
2008	Aug	4,464	100	4.255	0.3	20.3	1.590	2.804	4.757
2008	Sep	4,320	100	4.294	0.3	11.9	1.815	2.473	4.819
2008	Oct	4,464	100	5.639	0.3	16.5	2.036	2.816	6.280
2008	Nov	4,320	100	6.583	0.3	14.7	2.489	2.876	7.368
2008	Dec	4,464	100	8.062	0.3	23.9	3.726	2.274	9.078
2009	Jan	4,464	100	6.254	0.3	16.0	2.692	2.488	7.056
2009	Feb	4,032	100	7.484	0.3	18.6	3.114	2.575	8.415
2009	Mar	4,464	100	7.068	0.3	25.4	3.438	2.165	7.984
2009	Apr	4,320	100	7.485	0.3	16.4	2.960	2.735	8.424
2009	May	4,464	100	5.577	0.3	17.0	2.426	2.448	6.286
2009	Jun	4,320	100	5.127	0.3	14.9	2.278	2.376	5.781
2009	Jul	2,118	100	4.404	0.3	11.8	1.726	2.742	4.947
All data		54,246	100	5.970	0.3	25.4	2.892	2.170	6.743

Month Average Wind Speed Statistics for HCC-1 (30m)

Year	Month	Records	Recovery Rate (%)	Mean (m/s)	Min (m/s)	Max (m/s)	SD (m/s)	Weibull k	Weibull c (m/s)
2008	Jul	4,032	100	4.195	0.3000	17.1	1.839	2.338	4.707
2008	Aug	4,464	100	3.963	0.3000	19.0	1.542	2.704	4.438
2008	Sep	4,320	100	3.887	0.3000	11.1	1.697	2.387	4.370
2008	Oct	4,464	100	5.143	0.3000	15.6	1.931	2.730	5.749
2008	Nov	4,320	100	6.170	0.3000	14.2	2.424	2.754	6.920
2008	Dec	4,464	100	7.619	0.2992	22.7	3.586	2.225	8.578
2009	Jan	4,464	100	5.915	0.3000	14.9	2.604	2.434	6.681
2009	Feb	4,032	100	7.049	0.3000	17.9	3.057	2.467	7.942
2009	Mar	4,464	100	6.561	0.3000	24.8	3.372	2.042	7.409
2009	Apr	4,320	100	7.112	0.3000	15.7	2.935	2.621	8.016
2009	May	4,464	100	5.182	0.3000	16.3	2.408	2.283	5.852
2009	Jun	4,320	100	4.796	0.3000	14.3	2.230	2.276	5.418
2009	Jul	2,118	100	4.088	0.3000	11.2	1.696	2.573	4.601
All Data		54,246	100	5.574	0.2992	24.8	2.815	2.081	6.297

Month Average Wind Speed Statistics for HCC-1 (20m)

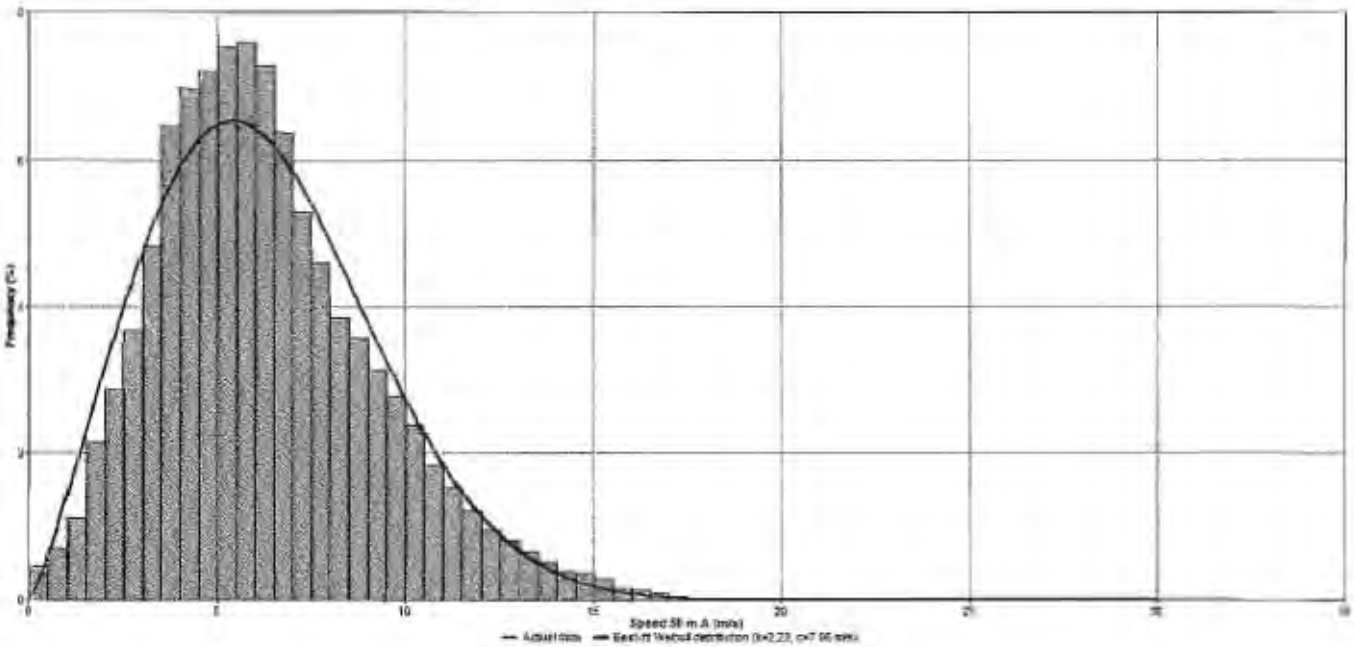
Year	Month	Records	Recovery Rate (%)	Mean (m/s)	Min (m/s)	Max (m/s)	SD (m/s)	Weibull k	Weibull c (m/s)
2008	Jul	4,032	100	3.707	0.3000	15.5	1.724	2.237	4.176
2008	Aug	4,464	100	3.453	0.3000	16.7	1.415	2.564	3.877
2008	Sep	4,320	100	3.442	0.3000	10.5	1.597	2.249	3.878
2008	Oct	4,464	100	4.564	0.3000	14.1	1.797	2.626	5.116
2008	Nov	4,320	100	5.550	0.3000	13.2	2.395	2.429	6.222
2008	Dec	4,464	100	6.991	0.2752	21.0	3.396	2.139	7.867
2009	Jan	4,464	100	5.330	0.3000	13.6	2.411	2.362	6.025
2009	Feb	4,032	100	6.438	0.3000	16.7	2.912	2.353	7.258
2009	Mar	4,464	100	6.088	0.3000	23.1	3.244	1.950	6.860
2009	Apr	4,320	100	6.522	0.3000	15.2	2.827	2.487	7.364
2009	May	4,464	100	4.630	0.3000	15.0	2.223	2.193	5.224
2009	Jun	4,320	100	4.289	0.3000	12.7	2.087	2.150	4.836
2009	Jul	2,118	100	3.570	0.3000	10.4	1.588	2.393	4.026
All Data		54,246	100	5.026	0.2752	23.1	2.679	1.965	5.673

Month Average Wind Speed Statistics for HCC-1 (10m)

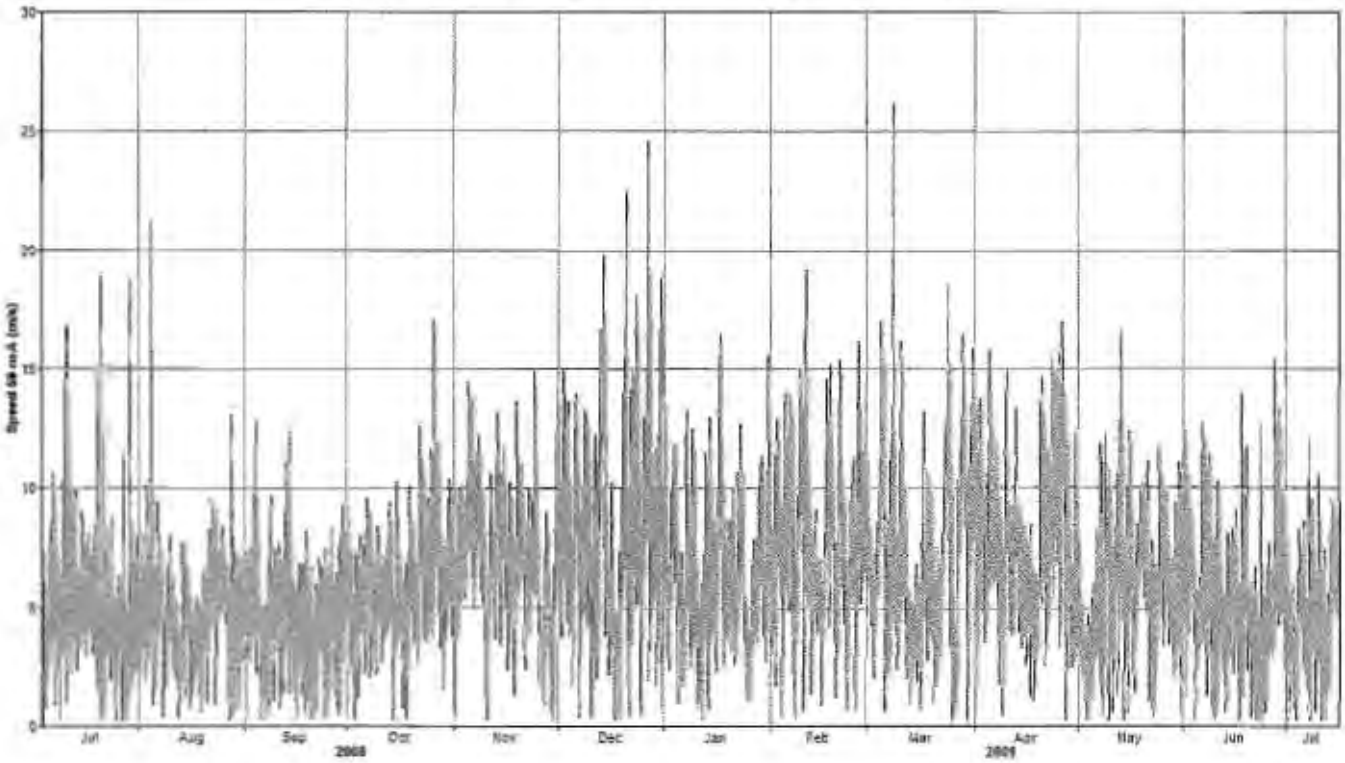
Year	Month	Records	Recovery Rate (%)	Mean (m/s)	Min (m/s)	Max (m/s)	SD (m/s)	Weibull k	Weibull c (m/s)
2008	Jul	4,032	100	2.843	0.3000	12.2	1.513	1.964	3.208
2008	Aug	4,464	100	2.635	0.3000	12.5	1.368	2.014	2.973
2008	Sep	4,320	100	2.591	0.3000	8.6	1.402	1.925	2.921
2008	Oct	4,464	100	3.514	0.3000	11.1	1.513	2.451	3.959
2008	Nov	4,320	100	4.500	0.3000	10.9	2.084	2.251	5.057
2008	Dec	4,464	100	5.948	0.2342	17.7	3.011	2.042	6.693
2009	Jan	4,464	100	4.467	0.3000	11.7	2.124	2.240	5.053
2009	Feb	4,032	100	5.438	0.3000	14.3	2.568	2.249	6.138
2009	Mar	4,464	100	5.085	0.3000	16.7	2.851	1.853	5.727
2009	Apr	4,320	100	5.317	0.3000	13.2	2.546	2.228	6.014
2009	May	4,464	100	3.678	0.3000	12.1	1.889	2.036	4.150
2009	Jun	4,320	100	3.207	0.3000	10.3	1.661	2.030	3.623
2009	Jul	2,118	100	2.758	0.3000	8.6	1.318	2.216	3.116
All Data		54,246	100	4.051	0.2342	17.7	2.382	1.774	4.558

Graphic Representations

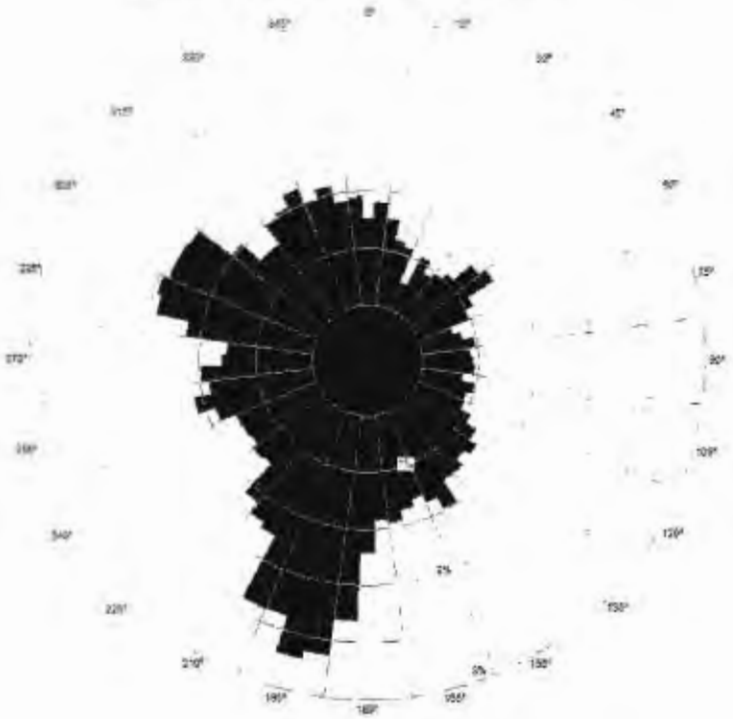
Probability Distribution Function (50m A Data)



10-Minute Average Wind Velocity (50m A Data)



Frequency by Direction 50mA Data



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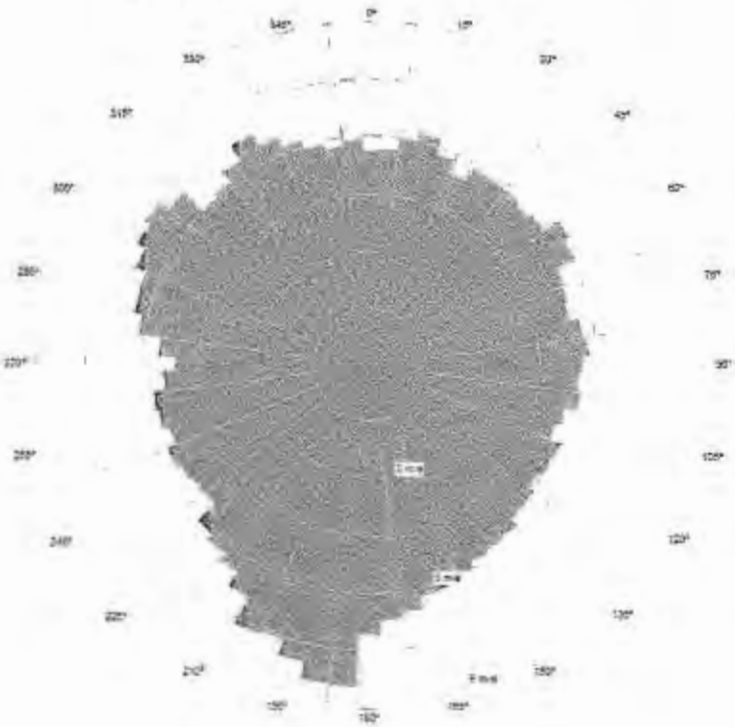
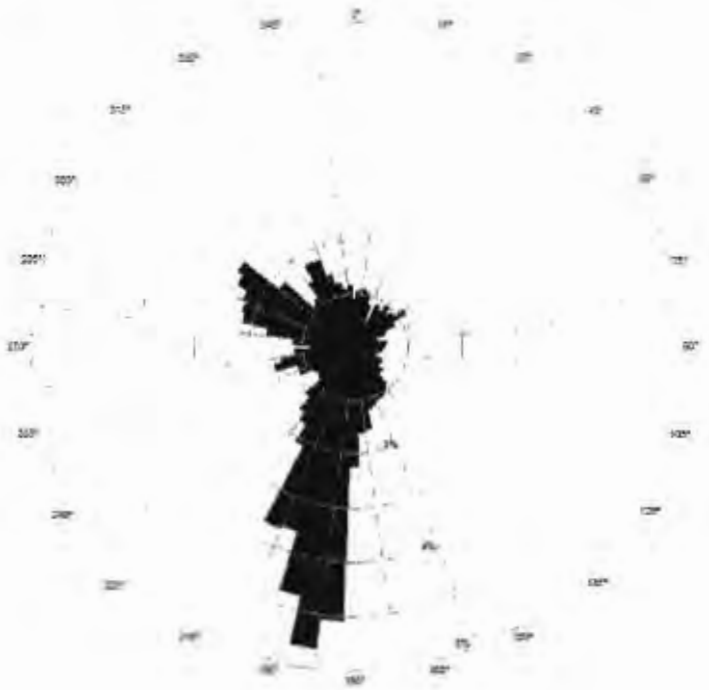
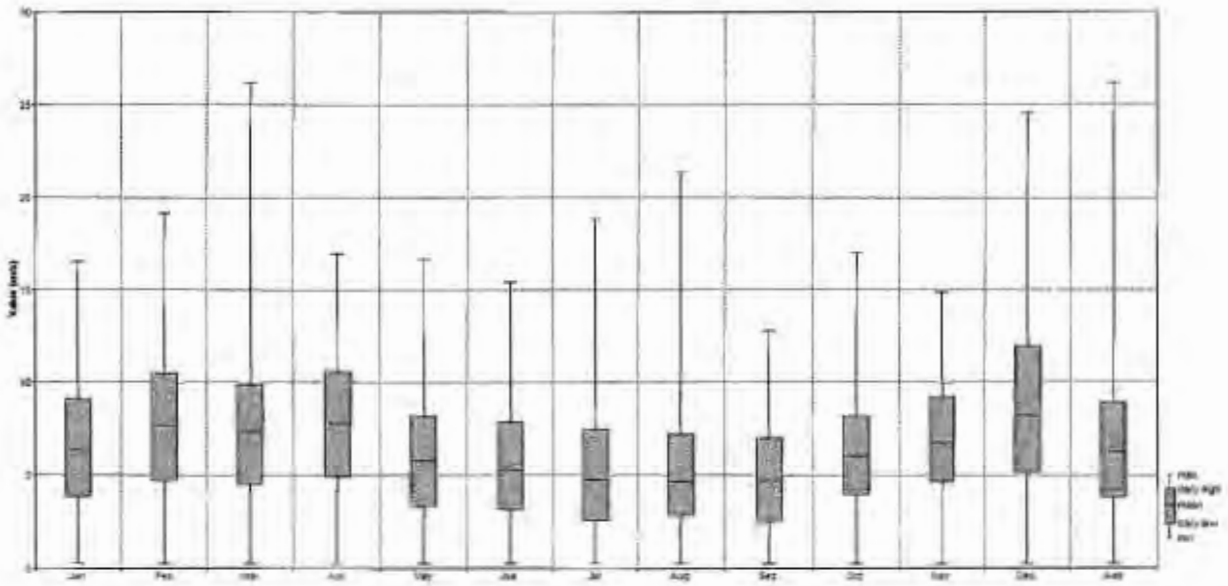


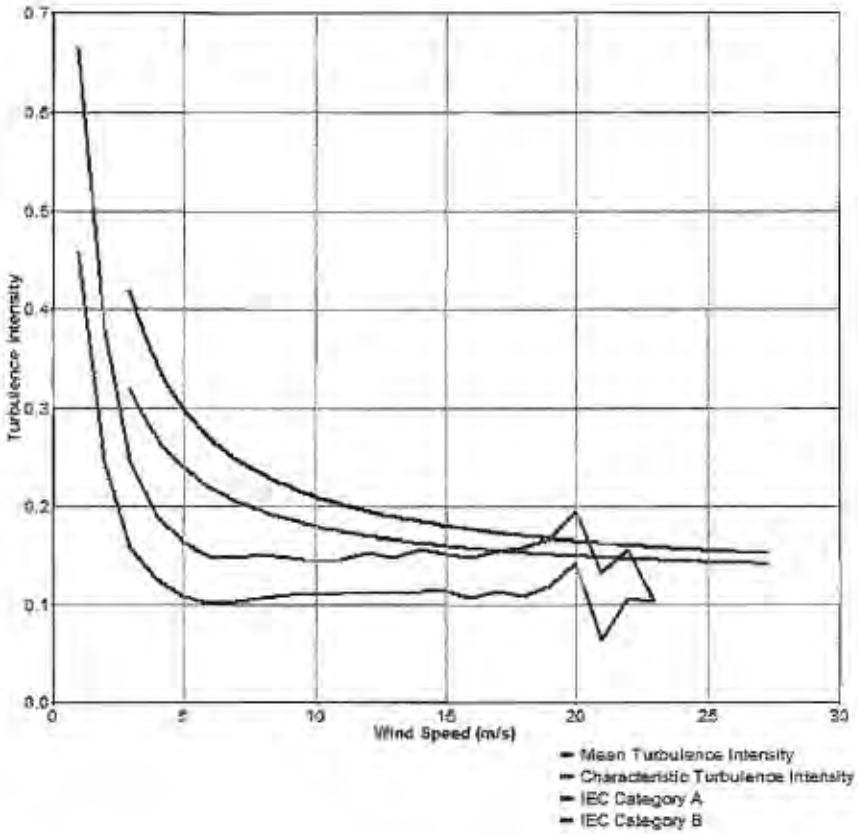
Wind Power Density by Direction (50mA Data)



Box Plot for Wind Velocity (50mA Data)



Turbulence Intensity and Wind Velocity (50mA Data)



Note: Mean and Characteristic Turbulence Intensity values are low at the evaluation metered wind velocities less than 17 m/s.

Vertical Wind Shear Projections

Vertical wind shear describes the change in wind velocity from the ground to the upper levels of the atmosphere where the air flow is more laminar and faster than it is nearer the ground; this is due to ground cover, trees, buildings and topography. The importance of characterizing the wind shear at a given location under consideration for a utility scale wind turbine cannot be overemphasized. Wind shear describes the change of wind velocity as a function of elevation above ground. Understanding wind shear is important because it has a direct impact on the mechanical wind power available for conversion at turbine hub height. Wind shear also causes cyclic loading of the rotor blades. Wind speed is further influenced by season and time of day.

In the white paper *Analysis of Wind Shear Models and Trends in Different Terrains*, Ray, Rogers and McGowan, University of Massachusetts, Renewable Energy Research Laboratory the matter of error in extrapolating wind velocity in high wind shear areas was summarized by…

> *"Several U.S. tall towers wind data sets were used to determine the accuracies of different wind shear methods, especially for sites having hills or heavy wooded forests. The results showed that the most accurate predictions for hub height wind speed characterizations were obtained when only wind speed data greater that 4 m/s (8.94 mph) were considered. Based on a statistical analysis of the prediction errors, there was no significant difference between the performance of the log and power laws <u>using either may result in inaccurate predictions of hub height mean wind speeds</u>."*

The two most common methods of estimating wind shear, previously mentioned above, are the Logarithmic (log) law and the Power law. The Logarithmic law is founded on the principles of boundary layer airflow. The law is expressed by the equation:

$$\frac{U(z)}{U(z_r)} = \frac{\ln\left(\frac{z}{z_o}\right)}{\ln\left(\frac{z_r}{z_o}\right)}$$

where Z is the target height,
Z_r is the reference height,
$U(z)$ is the target velocity,
$U(z_r)$ is the reference velocity, and
Z_o is the surface roughness length.

Surface roughness (Z_o) is a length parameter that is used to characterize wind shear, being the theoretical height above ground where the wind s peed would be 0 m/s (0 mph). Surface roughness length parameters are provided in the following table for stable atmospheric conditions.

Data recorded from the HCC-1 meteorological tower had an overall roughness length of 0.545 m. This value seemed elevated and may have been the result of the near occurrence of trees and shrubs, site construction, nearby campus buildings, and crop growth. When analyzed against direction, surface roughness varied between 0.2 m and 1.5 m depending on direction and the time of year. Higher values for roughness were seen during crop season.

SURFACE ROUGHNESS VALUES VARIOUS TERRAINS

Description of Terrain	Surface Roughness Length Z_0 (m)
Very smooth, ice or mud	0.00001
Calm open sea	0.0002
Rough sea	0.0005
Snow cover	0.003
Lawn grass	0.008
Rough pasture and grazing land	0.01
Fallow field	0.03
Crops	0.05
Scattered Trees	0.1
Trees, hedges and scattered buildings	0.25
Forest and woodland	0.5
Suburbs	1.5
City centers with tall buildings	3.0

It is significant to note that Z_o, surface roughness length, is more a corrective quantity than a physical quantity; approximately $1/20^{th}$ of the length of roughness components at the area surrounding the test site, e.g., $Z_o = 1$ m is describing roughness elements which may average 20 m in actual length.

The logarithmic law becomes mathematically undefined when the wind speed at two differing elevations is the same or equal. On occasion, wind speed may decrease with height causing the surface roughness estimates to be unrealistically high. The logarithmic law is popular among European wind developers. Variations to the fundamental equation maybe used to adjust for terrain and ground cover at a particular site. In the United States, the power law method is widely used.

It is an empirically developed relationship given by the following equation.

$$\frac{U(z)}{U(z_r)} = \left(\frac{Z}{Z_r}\right)^{\alpha}$$

where Z is the target height,

Z_r is the reference height,

$U(z)$ is the target velocity,

$U(z_r)$ is the reference velocity: and

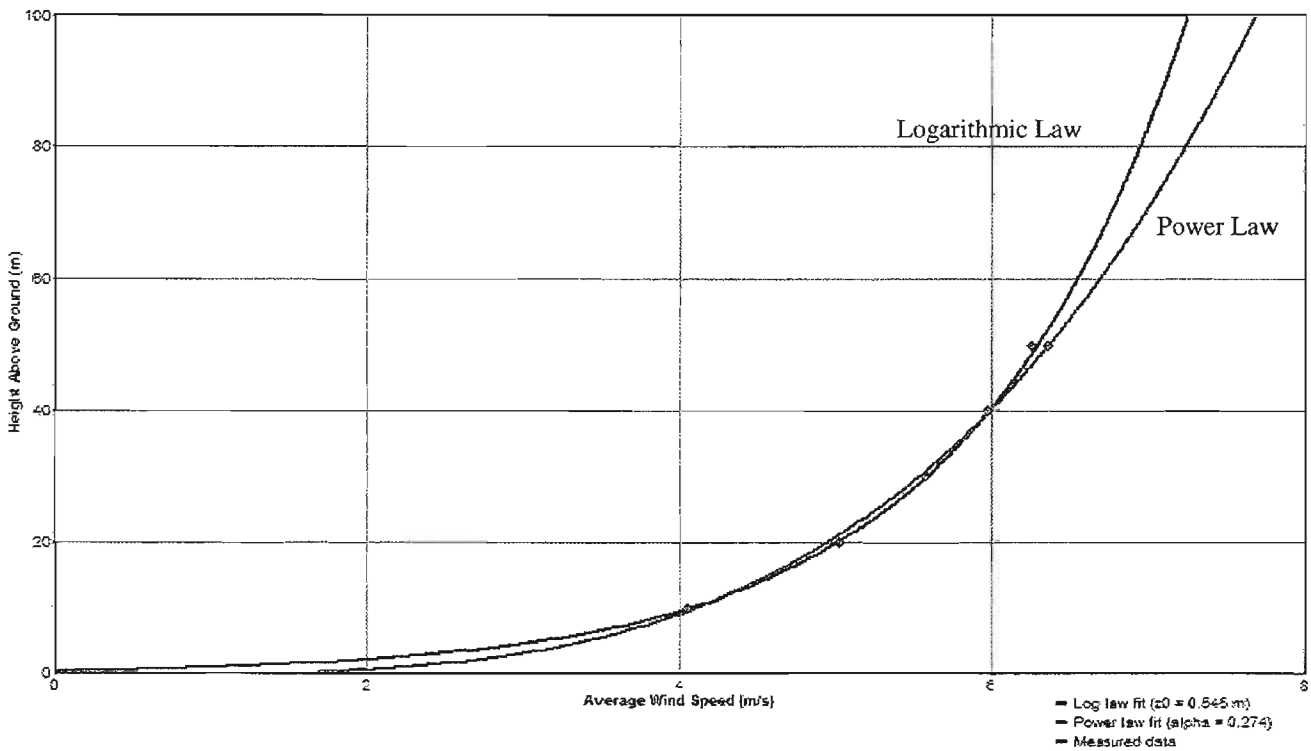
α is the power law exponent.

POWER LAW EXPONENTS FOR VARIOUS TERRAINS

Terrain Description	Power Law Exponent (α)
Smooth hard ground, lake, or ocean	0.10
Short grass on untilled ground	0.14
Level ground with foot-high grass	0.16
Tall row crops, hedges, a few trees	0.20
Many trees with occasional buildings	0.22 – 0.24
Wooded country, small towns and suburbs	0.28 – 0.30
Urban areas with tall buildings	0.4

The calculated power exponent (α) for HCC-1 was 0.274 over the elevations of 10 m to 50 m. The logarithmic and power law methods were applied to the data collected from the HCC-1 meteorological tower and extrapolated wind velocities were derived. The result was the projected wind speeds for elevations of 80 m and higher as depicted by the following set of curve fits provided in the diagram on the following page.

Vertical Wind Shear Projections HCC-1



Elevation	Logarithmic Law	Power Law
80m	6.95 m/s (15.5 mph)	7.24 m/s (16.2 mph)
100m	7.26 m/s (16.2 mph)	7.69 m/s (17.2 mph)

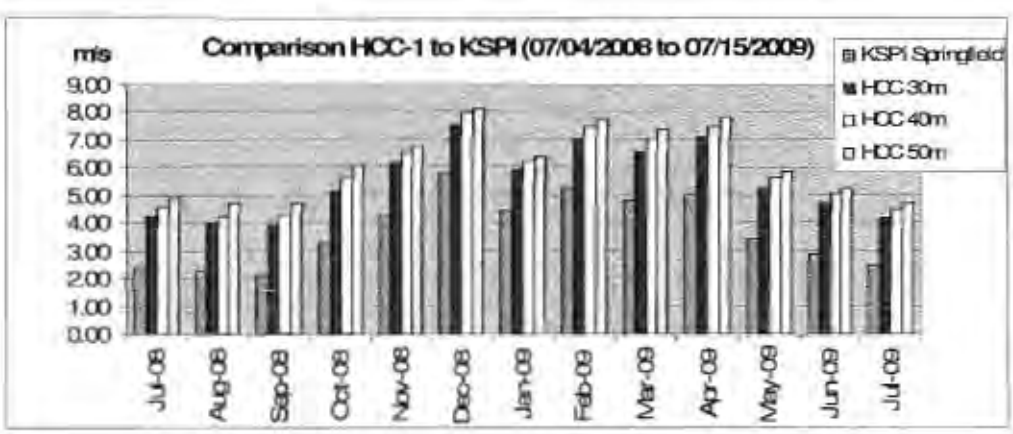
5. Historical Wind Data and Probability

Generally, wind velocities decrease during the summer months and improve during the transitional months of cooling. Wind power density is further improved during the winter months as ambient temperature decreases, resulting in higher air densities, which have a directly proportional relationship to wind power that would be converted by the wind turbine generator. Wind data from weather reporting station WBAN FAA/AWSS Station No. 93822 located at Springfield Capitol Airport (KSPI) was used to estimate intermediate-term wind speeds at 80 m for HCC-1. Data from KSPI was gathered from the station commencing with January 1, 1990 thru July 15, 2009: the data was correlated with the anemometers installed onto HCC-1.

Linear Correlation Results for Monthly Wind Velocities:

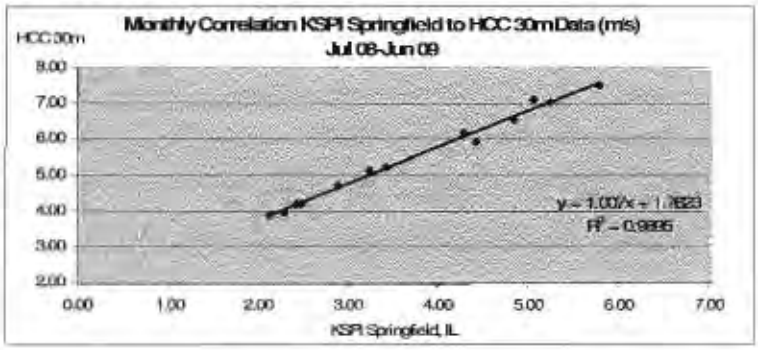
KSPI to HCC-1 10 m	Anemometer	$y = 0.9209x + 0.5687$	$r^2 = 0.9964$
KSPI to HCC-1 20 m	Anemometer	$y = 0.9756x + 1.3357$	$r^2 = 0.9893$
KSPI to HCC-1 30 m	Anemometer	$y = 1.007x + 1.7623$	$r^2 = 0.9895$
KSPI to HCC-1 40 m	Anemometer	$y = 1.0348x + 2.0524$	$r^2 = 0.9861$
KSPI to HCC-1 50 m (A)	Anemometer	$y = 0.9937x + 2.4821$	$r^2 = 0.9722$
KSPI to HCC-1 50 m (B)	Anemometer	$y = 1.0329x + 2.4405$	$r^2 = 0.9752$

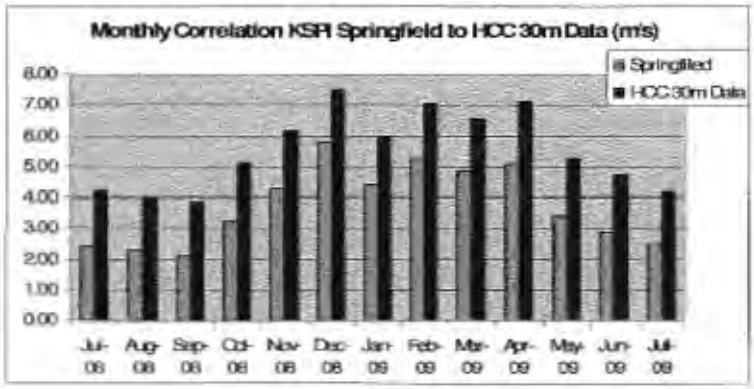
The monthly dataset correlation between KSPI and the 10 m Anemometer was found to be the closest; therefore, that correlation equation was used to estimate intermediate-term wind velocities likely to have been at the HCC-1 site at elevation of 10 m. The tower anemometers were also correlated between each level anemometers were installed, the more significant levels of interest being 30 m, 40 m and 50 m.



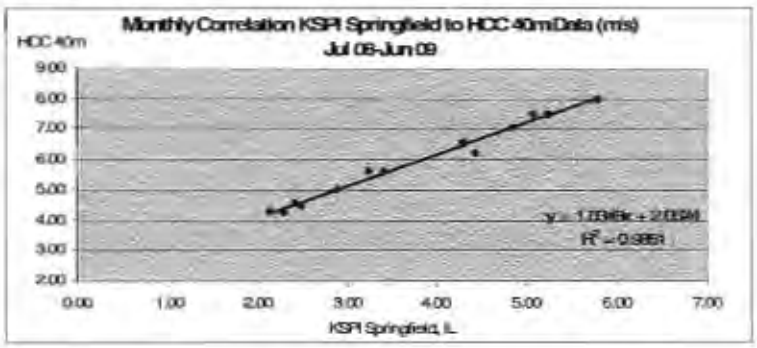
Correlation of HCC-1 Anemometers to KSPI Data

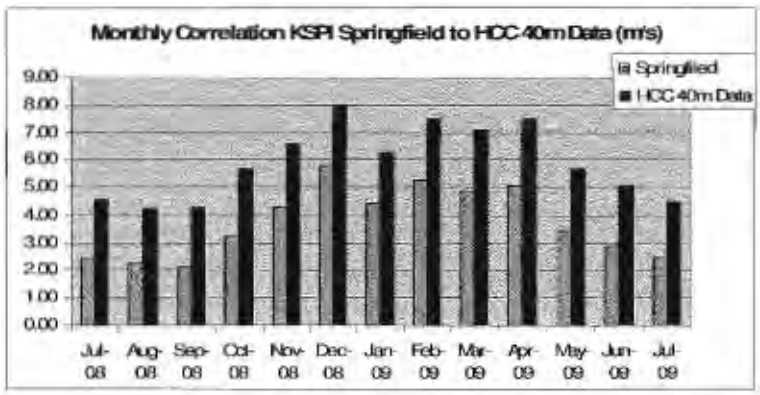
1) Anemometer at 30m to KSPI



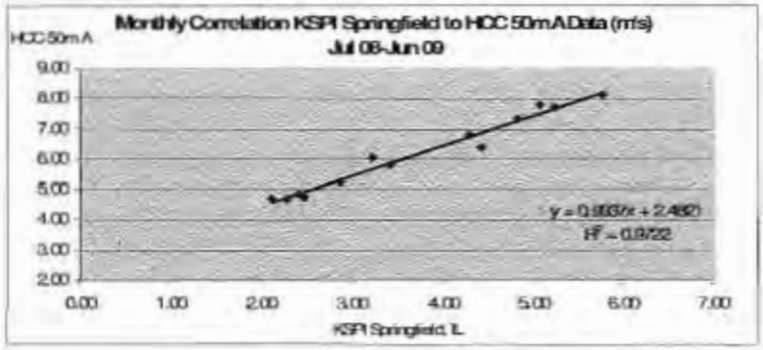


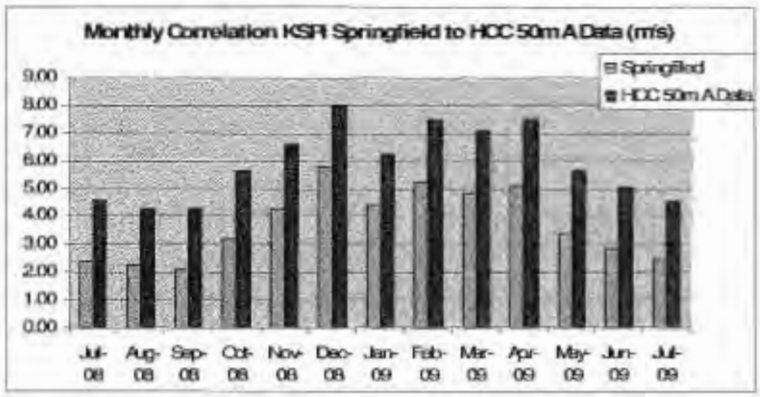
2) Anemometer at 40m to KSPI



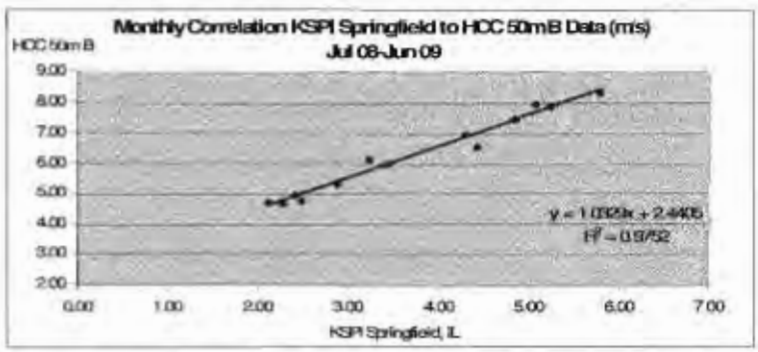


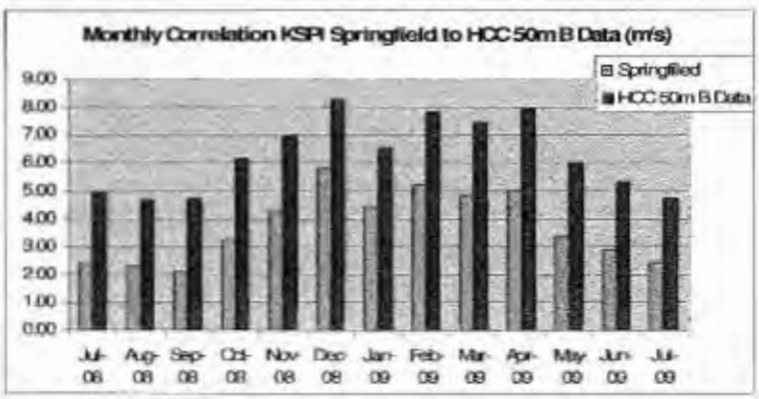
3) Anemometer at 50mA to KSPI





4) Anemometer at 50mB to KSPI



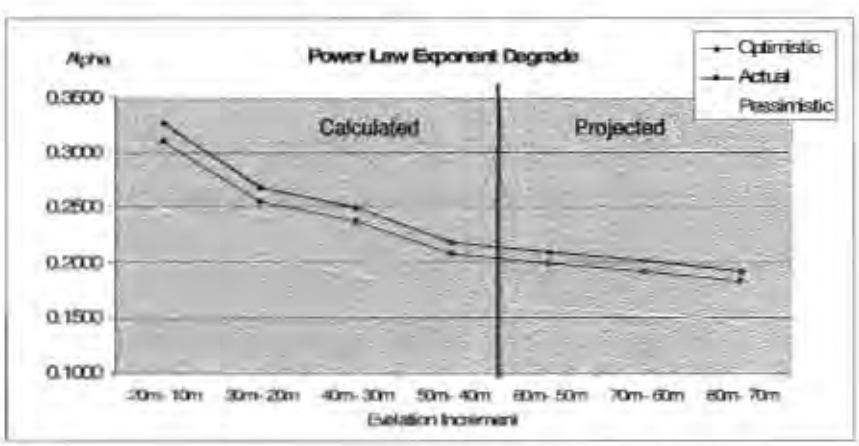


Estimating Historical Wind Velocities at HCC-1

The average annual wind velocity was compiled from the average daily wind velocity for each of the twenty years of data reviewed. Power Law exponents calculated using all metered data levels on the HCC-1 meteorological tower were used to project what the wind regime would have been over the same period of time. The best fit Power Law exponent for the site across the 10 m to 50 m levels was calculated to be: α = 0.2740. When all metered data was considered and incorporated into the calculations, the exponent was reduced as data from the lower anemometer elevations was removed. Applying the adjusted power law exponents to pessimistic, realistic and optimistic projections the following estimates for wind velocities at 60m and 80m were obtained. The results are given in the graph under the table.

Alpha Exponent Values Used in Estimating Wind Velocities

Elevation Increments	HCC-1			Projected		
	Optimistic	Realistic	Pessimistic	Optimistic	Realistic	Pessimistic
$\alpha_{10\ m - 20\ m}$	0.326550	0.311000	0.248800	N/A		
$\alpha_{20\ m - 30\ m}$	0.267750	0.255000	0.204000			
$\alpha_{30\ m - 40\ m}$	0.249900	0.238000	0.190400			
$\alpha_{40\ m - 50\ m}$	0.218400	0.208000	0.166400			
$\alpha_{50\ m - 60\ m}$	N/A			0.210000	0.200000	0.160000
$\alpha_{60\ m - 70\ m}$				0.201600	0.192000	0.153600
$\alpha_{70\ m - 80\ m}$				0.191625	0.182500	0.153600



Probability Table for Velocity Extrapolation

Prob.	Ref.	KSPI	30m	40m	50mA	Optimistic (60m)	Realistic (60m)	Pessimistic (60m)	Optimistic (80m)	Realistic (80m)	Pessimistic (80m)
99	1998	3.55	5.34	5.73	6.01	6.21	6.18	6.07	6.51	6.42	6.10
95	1994	3.60	5.39	5.78	6.06	6.26	6.23	6.12	6.56	6.47	6.15
	2002	3.60	5.39	5.78	6.06	6.26	6.23	6.12	6.56	6.47	6.15
90	1995	3.61	5.40	5.79	6.07	6.27	6.24	6.13	6.57	6.49	6.16
	2001	3.63	5.42	5.81	6.09	6.30	6.26	6.15	6.60	6.51	6.18
	2009*	3.65	5.44	5.83	6.11	6.32	6.29	6.17	6.62	6.53	6.20
75	2003	3.70	5.49	5.88	6.16	6.37	6.34	6.22	6.67	6.58	6.25
	1999	3.71	5.50	5.89	6.17	6.38	6.35	6.23	6.68	6.59	6.26
	2000	3.71	5.50	5.89	6.17	6.38	6.35	6.23	6.68	6.59	6.26
	1993	3.80	5.59	5.98	6.26	6.47	6.44	6.32	6.78	6.69	6.35
50	1997	3.81	5.60	5.99	6.27	6.48	6.45	6.33	6.79	6.70	6.36
	1992	3.85	5.64	6.04	6.31	6.52	6.49	6.37	6.83	6.74	6.40
	2007	3.88	5.67	6.07	6.34	6.55	6.52	6.40	6.86	6.77	6.43
	2005	3.97	5.76	6.16	6.43	6.64	6.61	6.49	6.96	6.87	6.52
	1996	3.99	5.78	6.18	6.45	6.67	6.63	6.51	6.98	6.89	6.54
	2006	4.08	5.87	6.27	6.54	6.76	6.72	6.60	7.08	6.98	6.63
	2008	4.08	5.87	6.27	6.54	6.76	6.72	6.60	7.08	6.98	6.63
	2004	4.15	5.94	6.35	6.61	6.83	6.80	6.67	7.16	7.06	6.70
	1990	4.35	6.14	6.55	6.80	7.03	7.00	6.87	7.37	7.27	6.91
	1991	4.35	6.14	6.55	6.80	7.03	7.00	6.87	7.37	7.27	6.91
Statistics: 20 year dataset											
Min		3.55	5.34	5.73	6.01	6.21	6.18	6.07	6.51	6.42	6.10
1st Q		3.60	5.43	5.82	6.10	6.31	6.28	6.17	6.61	6.52	6.20
Median		3.81	5.59	5.99	6.26	6.48	6.44	6.33	6.78	6.69	6.36
Mean		3.85	5.64	6.04	6.31	6.52	6.49	6.37	6.84	6.74	6.41
3rd Q		4.01	5.80	6.20	6.47	6.69	6.66	6.53	7.01	6.91	6.57
Max		4.35	6.14	6.55	6.80	7.03	7.00	6.87	7.37	7.27	6.91
IQR		0.37	0.37	0.38	0.37	0.38	0.38	0.37	0.40	0.39	0.37

Note*: Partial recording of annual data KSPI during 2000 and for HCC-1 during 2009

6. Wind Turbine Generator Criteria

Manufacturers offer a growing number of choices and options for proponents and developers of wind turbine generating facilities, not only at a fundamental level, for example rigid or more compliant structural design concepts, and fixed or variable speed operation. AESI maintains and periodically updates a database of more than 50 manufacturers of wind turbine generator systems. Mechanical system evaluation focused on rotor pitching and yaw control, maintenance and serviceability. In general, preference was afforded to manufacturers having tower options achieving rotor hub heights of 80 m and standard wind velocity survival ratings.

WTGS Subsystem and Design Evaluation Criteria

Mechanical System

- Rotor
- Blades
- Color and Reflectivity
- Pitch Control
- Nacelle
- Yaw Control
- Drive Train
- Suspension and Bearings
- Tower
- Maintenance and Serviceability
- Corrosion Protection

Electrical System

- Principles of Operation
- Standard/Special Configurations
- Integrated Grid Protection Schemes
- Major Components
- Generator Type
- Converter (Inverter)
- External Electrical/ Grounding
- House Load

Safety

- IEC WTGS Class Parameters
- Temperature Range (Operating and Structural)
- General Fail-Safe Breaking
- Safety Chain (Hard-wired and MPU Supervisory)
- Equipment
- Lightning
- Fire

Wind Turbine Control

- Control System and SCADA
- Cut-in and Cut-out Strategy
- Blade Icing Detection Strategies

AESI anticipates that material and installation costs associated with additional hub-height extending past 80 m (262.4 ft) would be of marginal benefit to Heartland. An economic decision on turbine hub-height can be rendered as a part of the RFP process.

Wind turbine electrical systems were reviewed from the standpoint of generator operation under less than nominal and nominal power output operation, the type of generator configuration (WRIG, synchronous, asynchronous, and permanent magnet) and inverter type. Attention was given to distribution grid interconnection protection settings and to direct tie lower-voltage systems; for example, in the case of fixed speed non-inverter units, the triggering events such as under-voltage and over-voltage, over-frequency and under-frequency, other events including grid-voltage or single or multiple phase drops, phase shift, and power factor.

Wind turbine generator safety-related issues are addressed by International Standard IEC 64100-1 prepared by the IEC Technical Committee No. 88: Wind Turbine Generator Systems. The International Electro-technical Commission (IEC) is a worldwide organization which is composed of national committees for achieving and maintaining standardization of the electrical and electronic fields through collaboration, and publishes International Standards. In IEC 64100-1, Section 6 - External Conditions, guidelines are given to address extreme environmental limits for wind and ambient temperature with respect to wind turbine survival.

Wind conditions at HCC-1 site, at times, are strong. Factors such as maximum sustained wind velocity and wind gust velocity were reviewed, as permitted by the available data. Local wind data for the Normal-Bloomington has been digitized by NCDC for the past five years; and, as such, did not provide for efficient analysis of higher wind conditions. This analysis does not factor a tornado occurrence having the potential to cause severe and or catastrophic damage to a wind turbine generator.

Data from the HCC-1 tower and Springfield was used to estimate the recurrence of high wind conditions.

Location	Period	Maximum Recorded Velocity
HCC-1 50m	07/04/2008 to 07/14/2009	34.1 m/s (76.2 mph)
KMBI (Normal)	01/01/1990 to 07/14/2009	39.34 m/s (88.0 mph)
KSPI (Springfield)	01/01/1990 to 07/14/2009	41.12 m/s (92.0 mph)

Note: KMBI dataset was taken from public domain resource and not validated by NCDC. Substantial data for the calendar year 2000 was not available from the public resource.

The Gumbel distribution method is commonly used to estimate return occurrence of extreme values for wind and temperature based on recorded site data. The Gumbel function does not predict the maximum velocity of wind. Using a limited dataset from anemometer level 50m (B) on the HCC-1 tower does not provide a reliable basis for determining the wind velocities for a given return period; as this calculation resulted in a 41.0 m/s (91.7 mph) velocity 50 year return velocity.

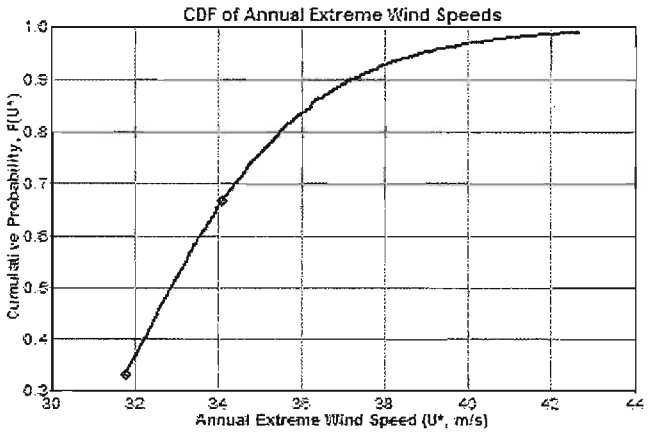
The KMBI Normal-Bloomington dataset (non-validated) for a 50 year return period returned 40.6 m/s (90.8 mph); adjusting to 80m for ground level recording at KMBI and using an estimated Power Law exponent (α = 0.16000), a velocity of 56.6 m/s (126.6 mph). Similar computations for the KSPI Springfield region infer a 50 year return period velocity of 40.4 m/s (90.4 mph) at ground elevation; although, data was not validated by NCDC. Applying the same Power Law parameters infers a 50 year return period velocity of 44.5 m/s (99.5 mph) adjusted to 62.0 m/s (138.7 mph) at 80m. In the event the region experiences tornado activity, the likelihood of significant equipment damage or even destruction is a very real possibility. Appropriate equipment liability and property casualty insurance should be carefully considered by Heartland for extenuating wind and weather conditions.

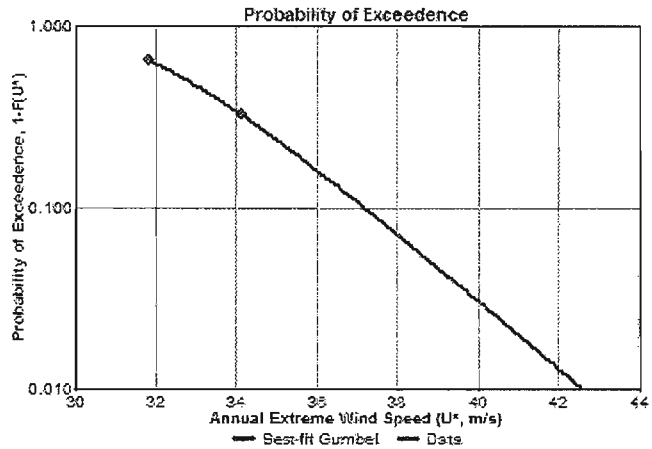
Realistically, high wind conditions are primarily the result of weather systems that are severe, unstable and largely unpredictable with regard to maximum sustained gusts and maximum gusts. The Gumbel function cannot predict the highest wind velocity that will occur on a given test site; but the function can provide insight to what might occur over a period of time.

For the Gumbel function results, please refer to the graphs on the next page.

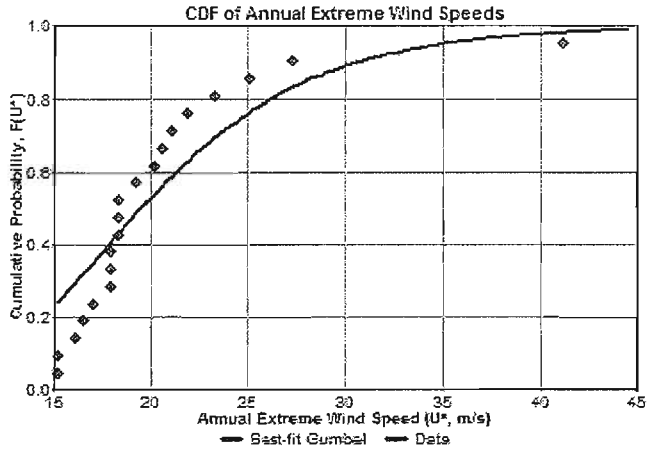
GUMBEL ANALYSIS

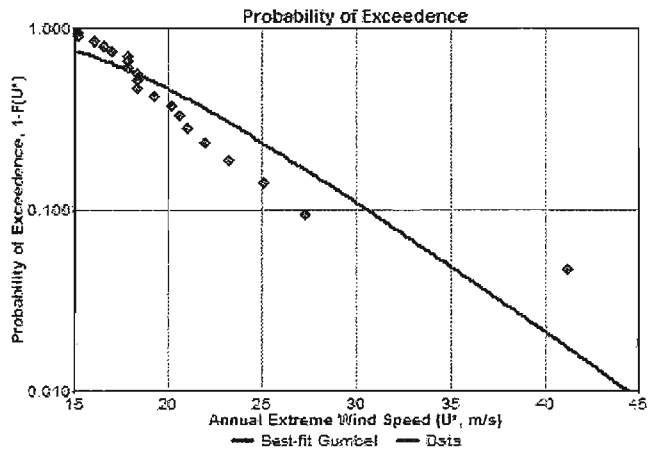
HCC-1





SPRINGFIELD





Legend

— Best-fit Gumbel

◇ Data

WTGS Classes

The IEC standard is relevant for the project development site being proposed. The wind velocities and ambient temperature conditions meet the engineered limits of several IEC WTGS Classes. IEC Class III (A and B) WTG units would be marginally acceptable at the proposed project site based on IEC standards for V_{ref} (10-minute reference), V_{ave} (average annual wind velocity at 80m), and temperature. IEC Class II units would be a more conservative choice and it could be argued that this class would have better operational endurance should $V_{ave} > 7.5$ m/s at 80m, in a given 12-month period. Class I units could be also be used, but the added cost in material, and, compromise in energy capture, may not make the group a good choice.

IEC-64100-1 Basic Parameters for WTGS Classes

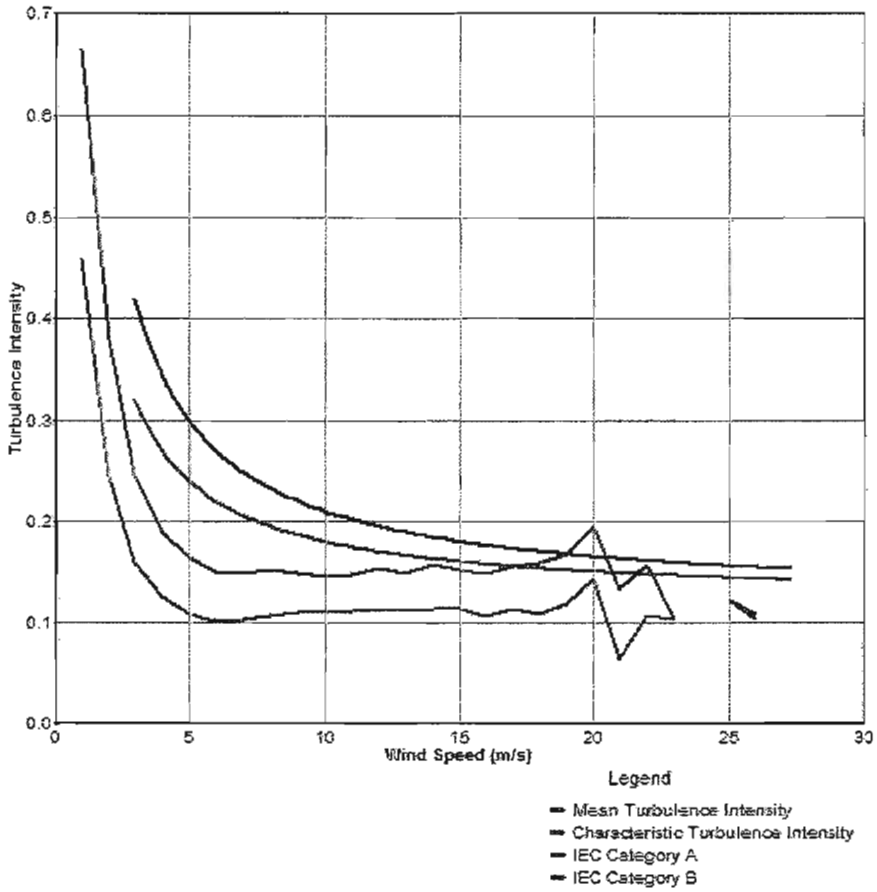
WTGS Class	I	II	III	IV	S
V_{ref} (m/s)	50	42.5	37.5	30.0	Values specified by Manufacturer
V_{ave} (m/s)	10	8.5	7.5	6.0	

where V_{ref} is the reference wind velocity averaged over 10-minutes and

V_{ave} is the annual average wind velocity at hub-height

Due to the nature of datasets being reviewed, long-term estimates on wind turbulence intensity without actual meteorological tower data; therefore, arriving at a determination for appropriate wind turbulence (sub-category A or sub-category B) cannot be accurately achieved without Heartland acquiring actual long term meteorological data for wind velocity at several levels of monitoring. The following graph illustrates the standard deviation for 50 m data measured at the HCC-1 site and shows turbulence to be within Class A and Class B ratings for short term data recorded.

Mean and Characteristic Turbulence (HCC-1)



IEC Sub-category A and B require that Characteristic Turbulence for the wind regime not to exceed a value of 0.1800 and 0.1600, respectively, at $I_{15m/s}$ (the characteristic value of the turbulence intensity at 15 m/s). The HCC-1 tower data for the period of monitoring had the following values.

HCC-1 Turbulence Bins and Related Turbulence Intensities
(07/04/2008 – 07/15/2009)

Bin Midpoint	Low End (m/s)	High End (m/s)	Records	Stand. Dev. (m/s)	Mean Turbulence Intensity	Stand. Dev. Turbulence Intensity	Characteristic Turbulence Intensity
1	0.5	1.5	989	0.457	0.460	0.205	0.665
2	1.5	2.5	2719	0.477	0.244	0.137	0.380
3	2.5	3.5	4617	0.470	0.158	0.088	0.246
4	3.5	4.5	7292	0.496	0.125	0.064	0.189
5	4.5	5.5	7997	0.541	0.109	0.055	0.164
6	5.5	6.5	8067	0.609	0.102	0.047	0.150
7	6.5	7.5	6328	0.715	0.103	0.046	0.149
8	7.5	8.5	4588	0.846	0.107	0.046	0.153
9	8.5	9.5	3633	0.987	0.111	0.038	0.148
10	9.5	10.5	2797	1.090	0.110	0.035	0.145
11	10.5	11.5	1831	1.225	0.112	0.035	0.147
12	11.5	12.5	1185	1.344	0.113	0.041	0.153
13	12.5	13.5	802	1.458	0.113	0.036	0.149
14	13.5	14.5	492	1.578	0.113	0.044	0.157
15	14.5	15.5	354	1.698	0.114	0.038	0.152
16	15.5	16.5	164	1.703	0.107	0.042	0.149
17	16.5	17.5	76	1.911	0.113	0.042	0.156
18	17.5	18.5	19	1.926	0.108	0.051	0.159
19	18.5	19.5	15	2.267	0.120	0.047	0.167
20	19.5	20.5	8	2.862	0.143	0.052	0.195
21	20.5	21.5	8	1.337	0.064	0.068	0.132
22	21.5	22.5	7	2.371	0.107	0.051	0.158
23	22.5	23.5	1	2.400	0.104	0.000	0.104
24	23.5	24.5	0	2.400	0.104	0.000	0.104
25	24.5	25.5	1	3.000	0.122	0.000	0.122

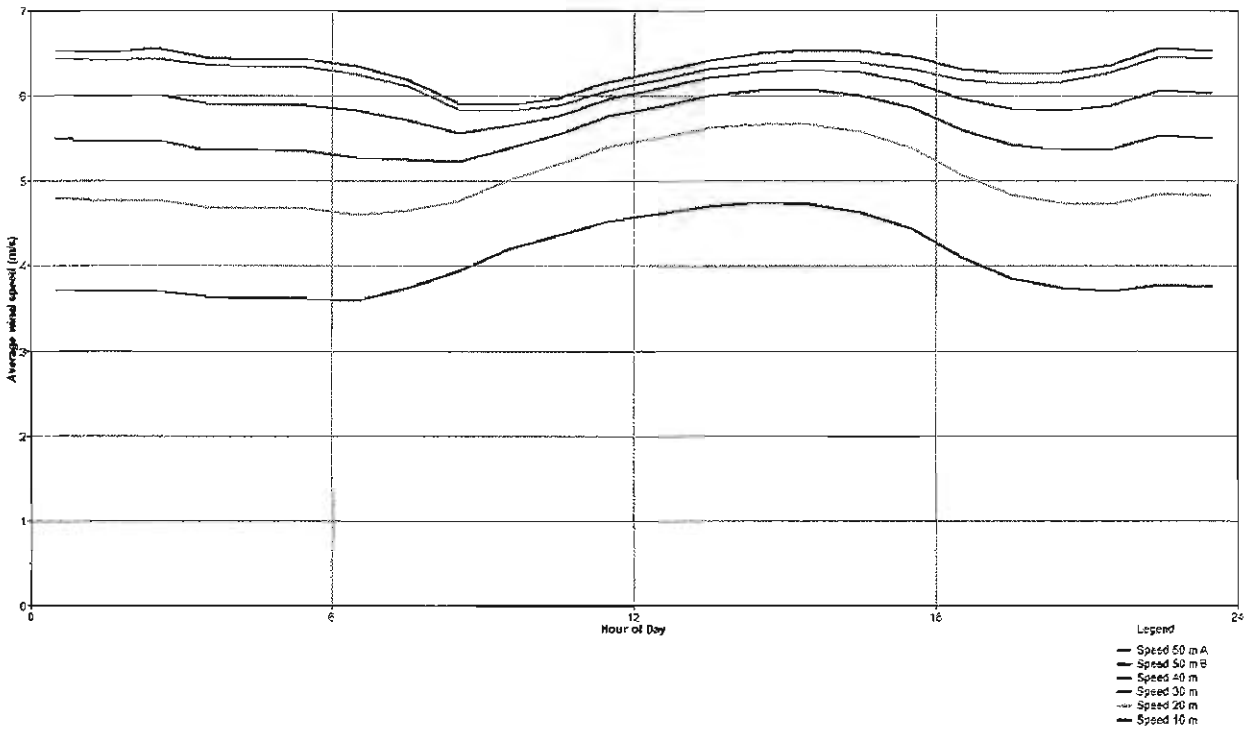
The measured values for the period specified have a characteristic turbulence intensity of 0.152 which are within the threshold of both sub-class A and B of the IEC standard. Notable turbulence intensity occurred in calendar 2008; specifically, in the months of July, August and December.

The manufacturer's load engineer will need to render the final determination on Wind Turbine Class rating and installation suitability.

Diurnal Wind Velocities

Diurnal wind velocities are compiled by sorting and plotting wind velocity against time of day. The graph below gives an indication of the renewable resource and any load carrying capacity that may be awarded to electrical generation so produced. Effective load carrying capacity (ELCC) may be assigned a credit representing a generator's expected (or actual) contribution to meeting the system reliability goals.

Diurnal Velocity Patten HCC-1



7. Comparison of Power Curves and Energy Capture Projections

The turbines selected for review were confined to units having 1.1MW to 1.65 MW power ratings on their nameplate. Not all units in this nameplate category were evaluated, some units were screened out due to availability issues and others because of limited operating history of the underlying technologies utilized in the manufacture of the wind turbine product line. The power curves for the selected units were used to calculate gross energy capture against collected wind data from HCC-1. These WTGS units are listed:

Manufacturer	Model/Rotor	Nameplate Rating	Hub-Height
AAER/ Fuhrländer	A-1500 77	1500 kW (1.5 MW)	80 m
AAER	A-1650 77	1500 kW (1.5 MW)	80 m
General Electric	1.5sle	1500 kW (1.5 MW)	80 m
Nordex	N60	1300 kW (1.3 MW)	85 m
Suzlon	S66	1250 kW (1.25 MW)	74 m
Vestas	V82	1650 kW (1.65 MW)	80 m

Gross energy capture was estimated for each of the units given above at an average hub-height velocity of approximately 6.70 m/s. Time increment calculations of output power, with wind shear profile recalculated for each time step, were made against the HCC-1 dataset so that reasonable comparison could be rendered. The following table holds the results for these computations.

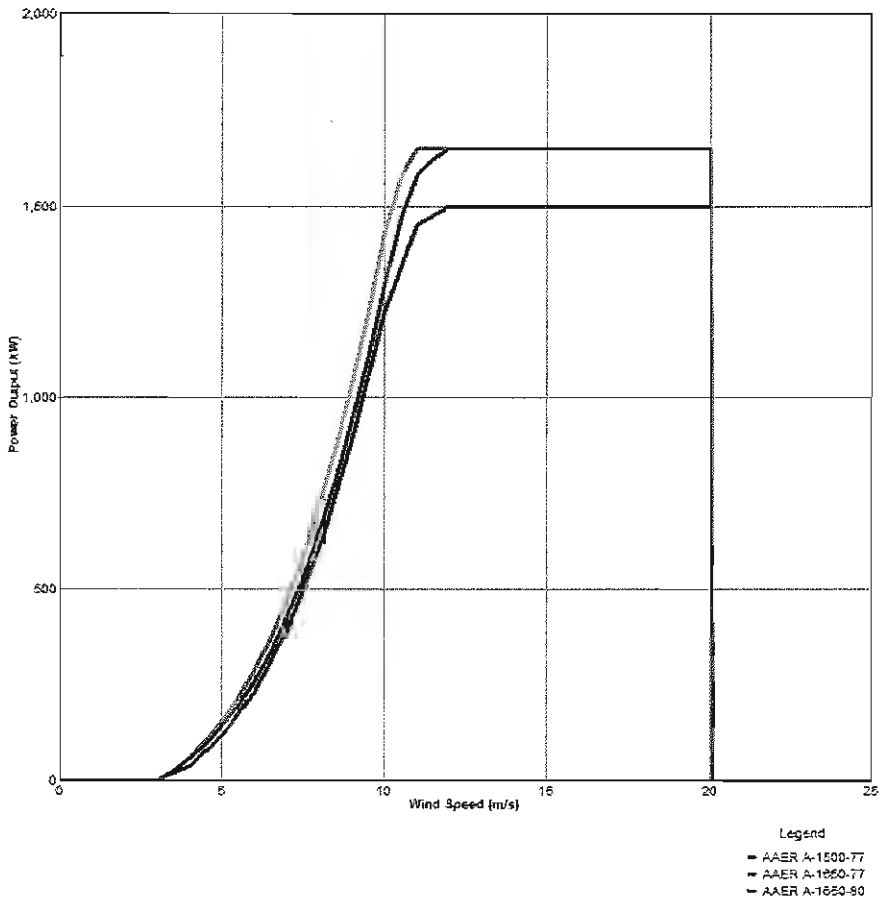
Manufacturer	Model	Power Rating (kW)	Time at Rated Power (%)	Average Gross Power Output (kW)	Average Gross Energy Output (kW-h/yr)	Average Gross Capacity Factor (%)
AAER/Fuhrländer	A-1500 77	1500	6.10	472	4,134,516	31.5
AAER	A-1650 77	1650	6.10	516	4,515,984	31.2
General Electric	1.5sle	1500	3.83	431	3,774,248	28.7
Nordex	N60	1300	1.02	303	2,650,543	23.3
Suzlon	S66	1250	2.34	348	3,047,545	27.8
Vestas	V82	1650	3.79	513	4,495,955	31.1

Note: This table does not include energy loss that is inherent with system operation; factors contributing to operating losses e.g., blade icing, blade soiling, preventative and curative maintenance, copper loss, and structure wake from buildings and other man-made or natural features contributing to wind flow diversion (de-grading) or convergence (additive).

Power curves for the units being evaluated, had similar characteristics; however, the AAER and Fuhrländer technologies exhibited the highest percentage time of operation at rated capacity. Comparing the energy capture from the table on the previous page, three units have gross energy captures in excess of 4,000,000 kW-h/yr; namely the AAER/Furhländer units and the Vestas V82 unit. From an energy generation perspective, these units would have the best operating advantage to produce electricity, for Heartland, having the lowest unit cost of energy (UCE). The comparison of power output curves for each of the evaluated wind turbine generators is given herein.

Comparison No. 1

AAER/Fuhrländer A-1500 77 Power Curve
AAER A-1650 77 Power Curve
AAER A-1650 80 Power Curve



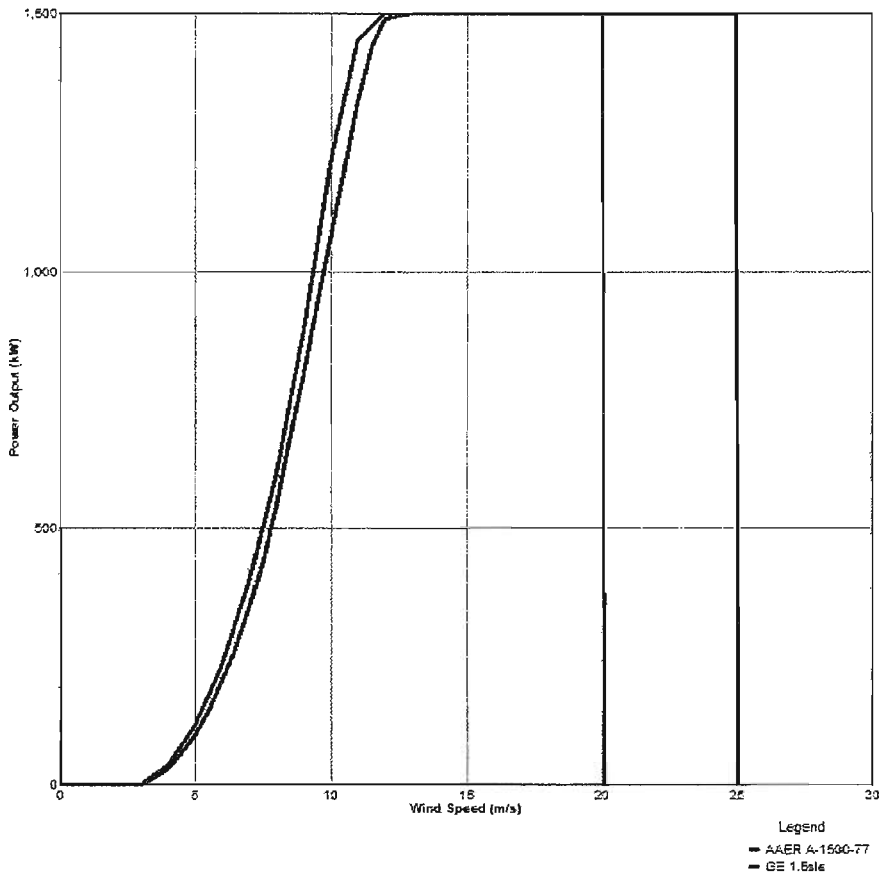
It is our understanding, and thus appropriate to inform the reader of this report, that the IPR rights for the Fuhrländer A-1500 wind turbine are held not by Fuhrländer but by Pfleiderer of Germany. Fuhrländer purchased the European manufacturing rights from Pfleiderer. Pfleiderer acquired Wind Tech, an Austrian designer of wind turbine technology as part of corporate strategy in order to gain wider exposure to the renewable energy market. Wind Tech was the original designer of PW-1500 technology. This unit is a proven

unit with many systems operating in the world energy market. The new subsidiary manufactured and installed the unit as the PW-1500. When Fuhrländer purchased the manufacturing rights it was relabeled the FL-1500. AAER has a separate agreement with Pfleiderer for manufacturing and marketing the turbine in North America as the A-1500.

Fuhrländer affiliates recently installed several larger units along the western side of the State of Michigan, specifically, two FL-2500 units. The project proponents planned on additional units; however, it is interesting to note that an apparent business decision was made to change manufacturer and model for the remainder of the project build-out. A second valuable consideration is that AAER perhaps has one of the higher North American production content rates for any wind turbine that is being sold on this continent. Shipping costs for towers and components manufactured abroad tend to increase the ICC and UCE of the project. The AAER units have been evaluated by the U.S. Navy and the U.S. Marine Corps. Recent installations in California and Rhode Island have been commissioned and continue to be functionally acceptable.

Comparison No. 2 AAER/Fuhrländer A-1500 77 Power Curve

General Electric 1.5sle Power Curve



Comparing the General Electric 1.5sle power curve against that of the AAER A-1500; the General Electric unit has a slower ramp-up in power output as a function of wind velocity. This is seen as a separation between the power output curves plotted to the graph on the previous page. The General Electric 1.5sle does operate over a higher wind velocity range; i.e., the GE 1.5sle will cut-out at 25 m/s (55.9 mph) whereas the AAER A-1500 77 will cut-out at 20 m/s (44.7 mph). This is not all that significant from an energy production perspective, relative to Heartland, because the wind regime's dataset record for HCC-1 infers that the probability distribution of wind velocities between the two cut-out values would be negligible. The following table shows the amount of time wind velocities between 21 m/s (46.9 mph) to 25 m/s (55.9 mph) occurred during the monitoring period at HCC-1.

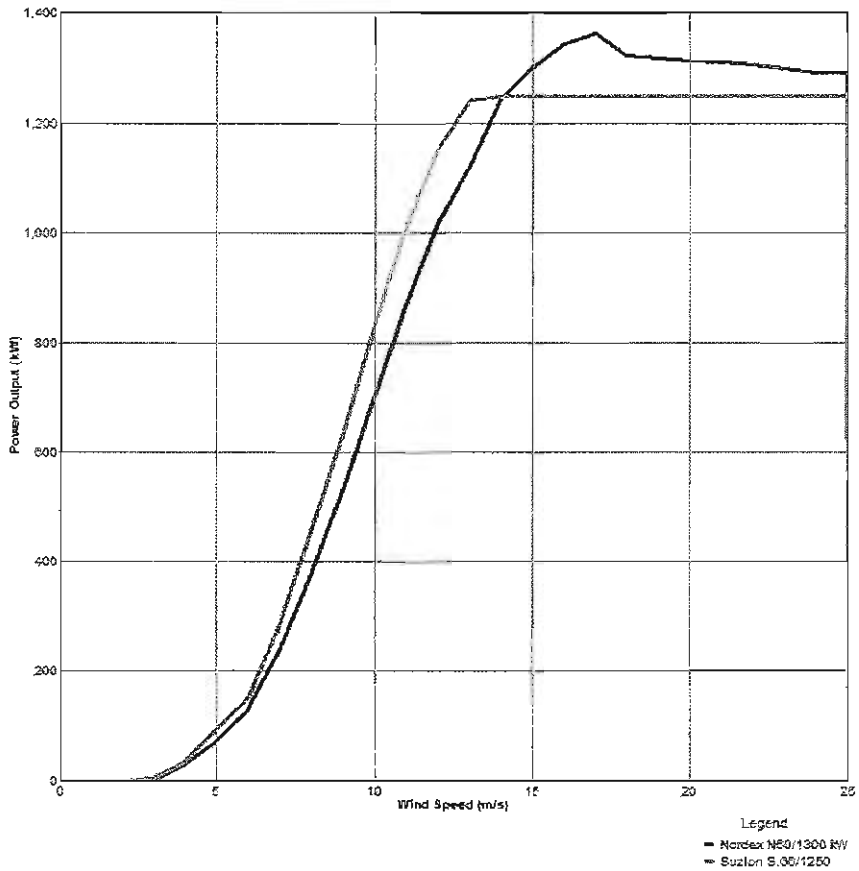
Probability Distribution of HCC-1 50m (A) Data

Bin Lower (m/s)	Bin Higher (m/s)	Frequency (%)	Hours/Yr.
0	1	1.174	102.9
1	2	3.265	319.9
2	3	6.542	573.5
3	4	11.306	991.1
4	5	14.169	1,242.1
5	6	15.146	1,327.7
6	7	13.645	1,196.1
7	8	9.896	867.5
8	9	7.420	650.4
9	10	5.905	517.6
10	11	4.223	370.2
11	12	2.752	241.2
12	13	1.775	155.6
13	14	1.187	104.1
14	15	0.754	66.1
15	16	0.452	39.6
16	17	0.229	20.1
17	18	0.072	6.3
18	19	0.028	2.5
19	20	0.020	1.8
20	21	0.015	1.3
21	22	0.009	0.8
22	23	0.009	0.8
23	24	0.002	0.2
24	25	0.002	0.2
25	26	0.000	0.0
26	27	0.004	0.4
27	28	0.000	0.0
28	29	0.000	0.0
29	30	0.000	0.0

The result in our computation is that the General Electric unit would produce 360,042 kW-h less electrical energy than the AAER A-1500 77, given identical operating conditions with the HCC-1 dataset. From this information, we would suggest that the AAER A-1500 77 would have a lower unit cost of energy and improved operating capacity factor.

Comparison No. 3 Nordex N60 1300 Power Curve

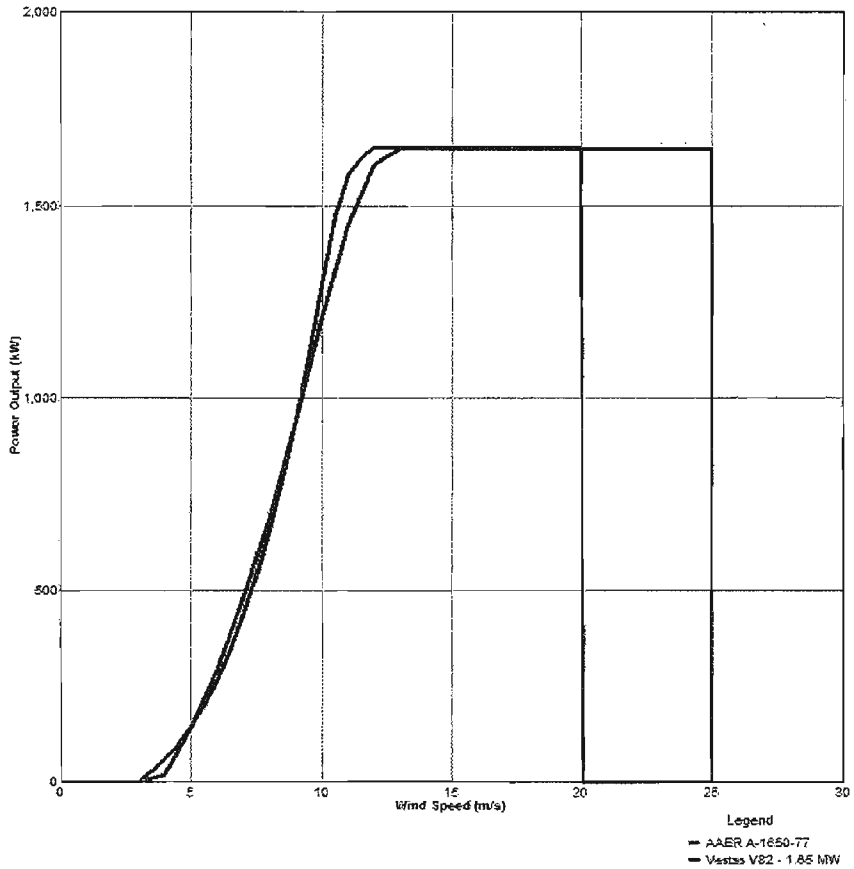
Suzlon S66 1250 Power Curve



In comparing units having nameplate power rating lower than 1500 kW (1.5MW), the Nordex N60 1,300 kW unit and the Suzlon S66 1,250 kW (1.25 MW) unit had relatively favorable energy captures for the group. The Nordex N60 has better power output ramp v. velocity after cut-in at 3 m/s (6.7 mph); however, the Suzlon S66 derives added benefit from wind velocities that occur between 14 m/s (31.3 mph) and 20 m/s (44.7 mph). The Suzlon S66 would provide better energy capture when compared to the Nordex N60 for the HCC-1 dataset.

Comparison No. 4 AAER A-1650 77 Power Curve

Vestas V82 1.65 Power Curve



Looking at units in the next incremental power class, the Vestas V82 1.65 MW wind turbine and the AAER A-1650 77 wind turbine were found to yield almost identical energy captures. Both units would make good selections in this nameplate power rating category. Should AAER's manufacturing and load engineers feel comfortable with warranting the unit with the 80m rotor option, then the added energy capture would be gain for the benefit of Heartland is difficult to ignore.

Our evaluation of the two units suggests that the AAER A-1650 77 would likely produce 4,515,984 kW-h of energy. That figure compares to 4,495,955 kW-h for the Vestas V82 1.65 MW unit, yielding capacity factors of 31.5% and 31.1% and net output ratings of 516 kW and 513 kW, respectively; less infrastructure losses.

It is our understanding that the Vestas V82 1.65 MW unit has revised the engineering specification on the gearbox due to past difficulties in the field. This will need verification from Vestas should the unit be considered for installation.

Energy Capture Projections

Computations under Group I (Optimistic) are based upon the velocity projections theoretically derived from data and should be given appropriate weight when factoring project risk. The values provided under Group II (Realistic) reflect a conservative estimation of projected energy generation for the contemplated project, based on risks relating to the unpredictability of wind velocity due to weather pattern direction and other factors which will influence and add to the unpredictability of wind velocity in general. The values provided under Group III (Pessimistic) reflect a more conservative estimate and AESI would recommend that prudent financial planning and project risk analysis, undertaken by the Heartland Management and Board of Trustees, use the values provided in Group III as the lower measure of energy capture for any pro forma calculations and business modeling.

Probability Levels for Energy Production AAER A1500-77 (80m) (1)(2)(3)

	P_{50}	P_{75}	P_{90}	P_{95}	P_{99}
Group I – Optimistic					
Velocity	6.79	6.67	6.57	6.56	6.51
MW-h (gross)	4,415	4,267	4,142	4,129	4,066
Capacity Factor (gross)	0.335	0.325	0.315	0.314	0.309
Group II – Realistic					
Velocity	6.70	6.58	6.49	6.47	6.42
MW-h (gross)	4,305	4,154	4,041	4,016	3,953
Capacity Factor (gross)	0.327	0.315	0.307	0.305	0.300
Group III – Pessimistic					
Velocity	6.36	6.25	6.16	6.15	6.10
MW-h (gross)	3,877	3,737	3,621	3,608	3,544
Capacity Factor (gross)	0.294	0.284	0.275	0.274	0.269

NOTES TO PROBABILITY TABLE

Note (1): Velocities derived from metered and historical values believed to be accurate. Energy capture is based on manufacturer power curves assuming a standard Weibull shape parameter, k = 2.000.

Note (2): It is important to recognize that the 50m Weibull parameter k = 2.225 for HCC-1 data collected and, thus, will yield energy captures which are lower than those represented in the table above. Insufficient HCC-1 data history exists to adjust energy capture for Weibull k parameter at this time.

Note (3): The k parameter describes the shape of the wind distributiou and will change from year to year (see plot for Probability Distribution Function, p. 24)

8. Estimated Development Cost and Load Demand

The wind turbine industry is currently in a state of change, being affected by the recent downturn in the national economy and further complicated with a lack of liquidity in the financial lending markets. Large developers and manufacturers will likely find themselves with projects that are no longer finance-able; leaving only the strongest project proponents to see project development through to completion. Construction companies, manufacturers and heavy equipment vendors will come under pricing pressure as equipment demand contracts. Estimates for installed projects with 80 m towers fall into two ranges: fully engineered, $2,100/kW to $2,200/kW; and EPC project bids, $2,200/kW to $2,540/kW. We believe $2,138/kW is a reasonable estimate based on pricing information available to AESI for project bids during the Fall of 2010 that have been fully engineered.

Other factors which will influence the availability of wind turbines and balance of plant resources include, cost of fuel and transportation, liquidity in the credit markets, stability of the U.S. dollar, and international, federal, state and local regulation on carbon emission legislation now pending in the U.S. Congress.

The following rough calculations, for a single 1500 kW wind turbine generator, at 80 m, are made for the purpose of discussion and do not include the cost of maintenance:

- Estimated Initial Capital Cost (ICC) — $3,206,638
- P_{75} wind velocities — 6.25 m/s (P75 Pessimistic) to 6.67 m/s (P75 Optimistic)
- Annual energy capture w/Weibull k=2.0 — 3,737,000 kW-h to 4,267,000 kW-h
- Life-cycle net energy capture (25 yrs.) — 93,425,000 kW-h to 106,675,000 kW-h
- Adjust for losses and Weibull k — 79,411,250 kw-h to 90,673,750
- Un-levered unit cost of energy (UCE) — $0.04036/kW-h to $ 0.04538/kW-h

The assumptions and estimates in this section of the report are based on 100% cash and grant financing and include operation and maintenance at $0.005/kW-h; maintenance can average $0.004/kW-h to $0.0091/kW-h depending on items relevant to the warranty service maintenance agreements and turbine supply agreements negotiated with the manufacturer.

The sale of green attributes will further enhance the financial pro forma for the proposed project. The state of Illinois recently enacted a Renewable Portfolio Standard (RPS) mandating state utilities to offset carbon emissions. Each MW-h of electrical generation produce by a wind turbine generator will also produce a fungible Renewable Energy Certificate (REC) which may be sold to a utility for purpose of complying with the

state RPS. The sale of Renewable Energy Certificates (RECs) is currently estimated at $0.005/kW-h to $0.010/kW-h.

The U.S. Congress and the White House will most likely provide enhanced financial incentives for the development of renewable energy projects in an effort to stimulate economic activity and employment with energy and general infrastructure development and maintenance programs. The incentives may encompass low interest guaranteed loans, interest free clean renewable energy bonds, and accelerated depreciation of capital equipment under the Modified Asset Cost Recovery Schedule (MACRS). Heartland may find it advantageous to form a Public Private Partnership for the purpose of attractive project equity financing the proposed development.

COST ESTIMATE FOR HEARTLAND CAMPUS WTGS INSTALLATION

	L1 Power Option and Underground Collector w/80m Turbine 1500-77	L2 Power Option (Not Applicable)	L3 Power Option (Not Applicable)	L4 Power Option (Not Applicable)
Turbine and Tower [1]				
AAER/FL A-1500-77 (80m)	2,250,000			
Transportation	120,000			
FAA Navigation Beacons	10,000			
Total Turbine and Tower	2,380,000			
Structural				
75m Foundation and Rebar				
80m Foundation and Rebar	130,000			
100m Foundation and Rebar				
Civil				
Site Work	17,400			
Access Roadways	20,000			
Horizontal Drilling				
Electrical				
Concrete	6,000			
Wiring Methods	55,303			
Raceway & Boxes	27,000			
Electrical Power	36,000			
Crane [2]				
Rental Primary Crane	115,000			
Rental Auxiliary Crane	30,000			
Transportation (Mob/Demob) [3]	25,000			
Labor	35,000			
Erection of Tower and Setting Turbine [4]				
Labor	15,000			
Contractor Misc. [5]	13,000			
Contingencies (7%)	35,819			
Project Developer/Manager (3%) [6]	84,616			
Design Engineering	75,000			
Geotechnical	15,000			
Avian/EIS	70,000			
Micro-Siting	21,500			
Total	$3,206,638			
Cost/kW	$2,138			

NOTES TO COST ESTIMATE TABLE

Note (1): Turbine cost was calculated in US Dollars after conversion from Euro Dollars and Canadian Dollars as required. Currency conversion factors used: 1 USD = 1.54 Euro; 1 USD = 1.02 CAD .

Note (2): Crane rental fees based on 14 day commitment. Prices vary widely based on region, size and advance reservations.

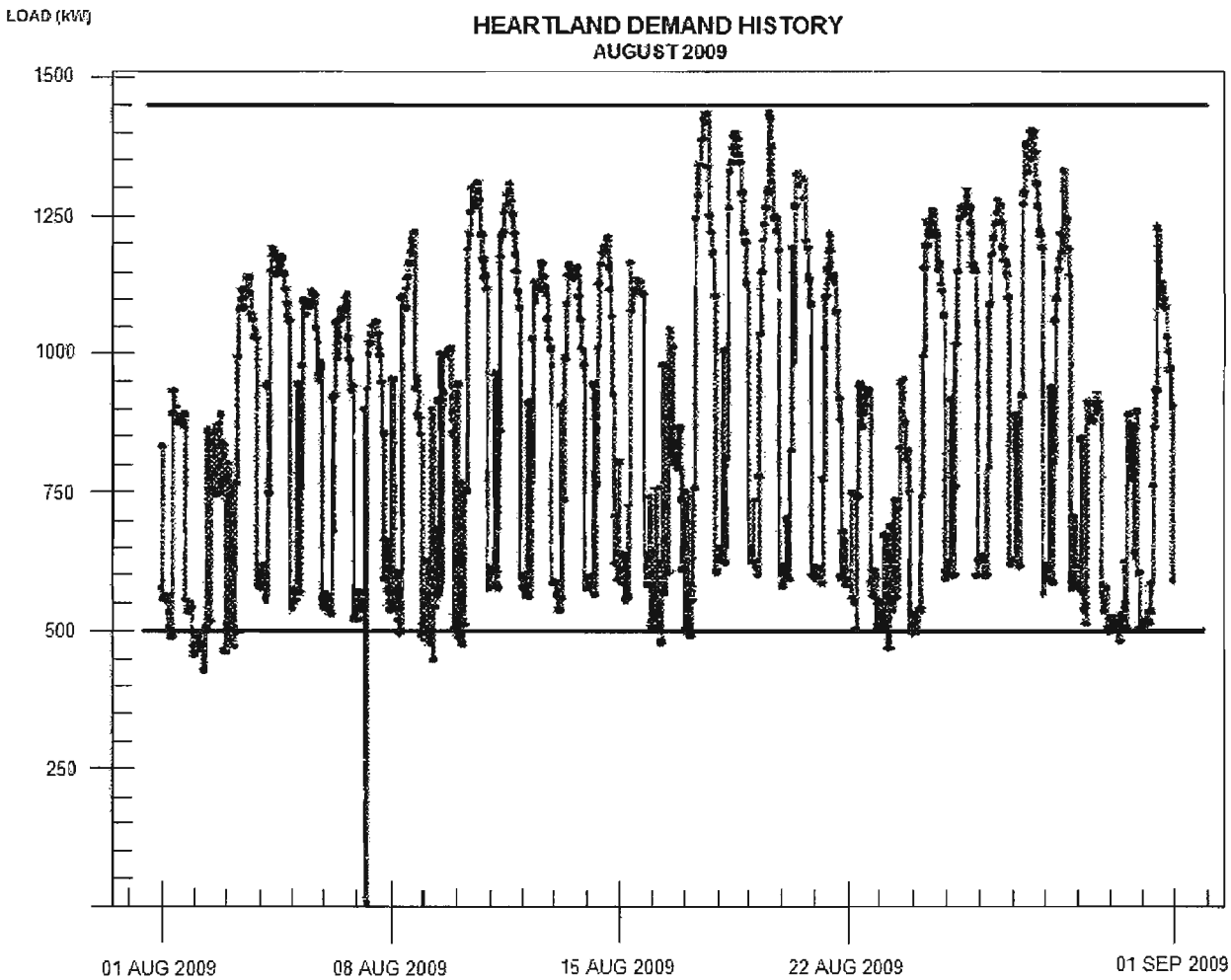
Note (3): Crane Mob, Demob, Rental and labor is based on one turbine installation with rental for one month.

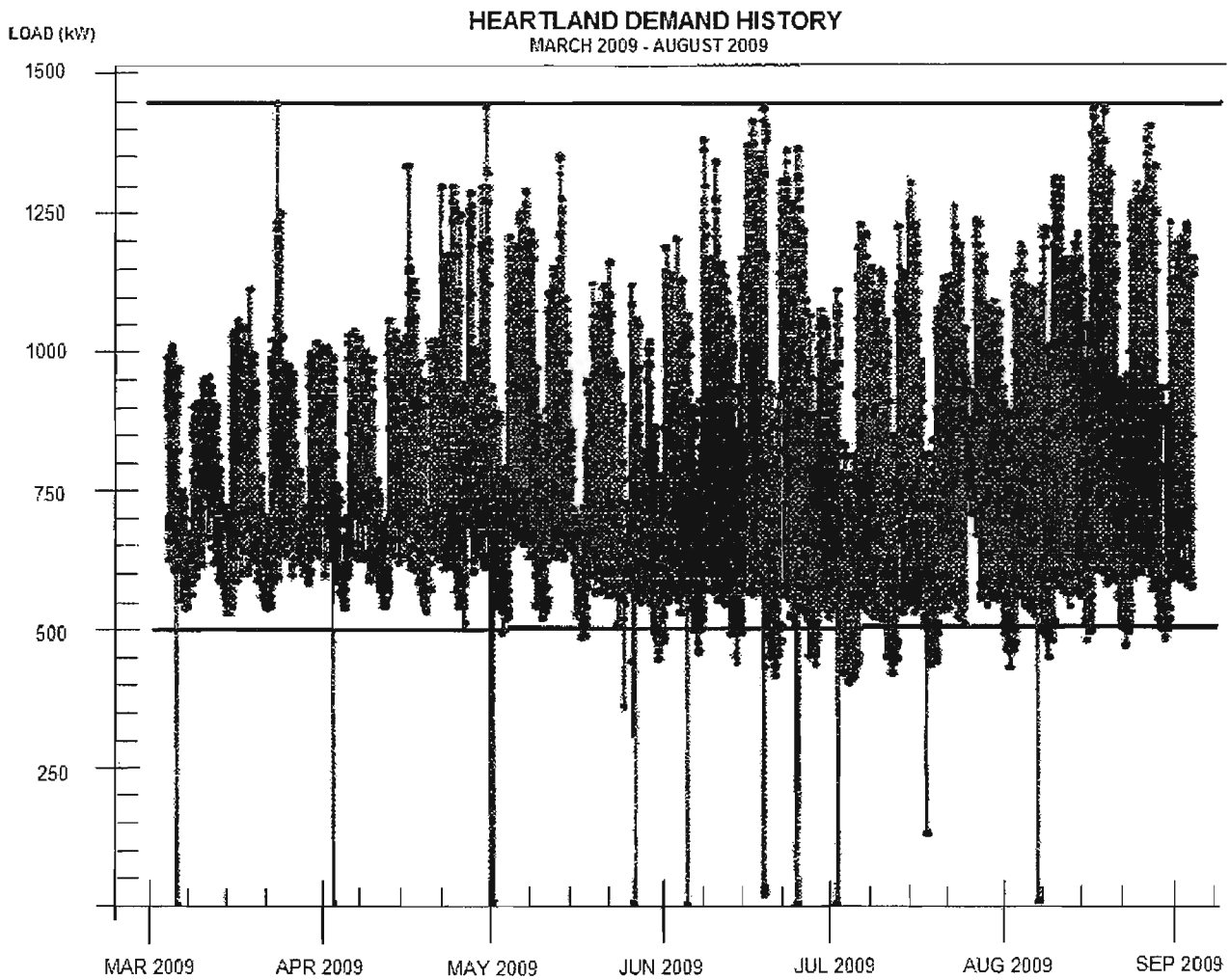
Note (4): Erection Labor is per turbine installation

Note (5): Contractor miscellaneous fees provide a margin for minor equipment rental, scaffolding and spent supplies.

Note (6): Project Developer/Manager fee based on 3% of total cost of project less Design Engineering cost.

The installation of a 1.5MW wind turbine generator is anticipated to offset approximately 500kW of electrical load; the current electrical load for Heartland Community College averages 815 kW with an estimated daily swing between 1,250 kW to 510 kW, e.g., graphics load timelines given below for August 2009 and for the period March 2009 thru August 2009. The reader of this Report should note that these demand graphs do not represent electrical demand that is expected going forward into 2010 and beyond; due to the additional buildings and facilities that have been constructed on the campus and, as of yet, have not been connected to the electrical infrastructure. We suspect, based on the limited information we have on building loads, that Heartland could easily experience an increase of 15% to 20% in energy demand.





Datasets with actual load demand timestamps were not provided to AESI, for the purpose of comparing the number of times a 1.5MW wind turbine would have provided more power output than would have been required by campus load. Therefore, from our perspective, it is probable this condition would have occurred on more than one occasion. From our estimation of power flow, we believe that a 1.5MW to 1.65MW wind turbine generator would be the most appropriate nameplate unit for renewable energy generation at Heartland Community College's Normal Campus. With the additional demand, the probability of exporting power will lessen, the degree of which is currently undetermined.

Heartland will need to decide how the institution wishes to handle the negotiation of power out-flow into the local distribution grid. This decision should be rendered upon discussions with the electric provider and the exact point of coupling (interconnection) of the wind turbine generator to the electrical system. We believe that there may be justification for the wiring of the secondary wind turbine generation into the electrical switchgear of the college. This will depend on a number of technical and code factors as the project moves forward.

In our opinion, Heartland should not need their electric supplier to firm or back-up generation from the wind turbine under a special contractual agreement; however, careful consideration should be given to how Heartland handles these negotiations for any surplus power off-take and the matter of forward sales of Renewable Energy Certificates (RECs) generated by the proposed project.

Depending on how negotiations with the electric supplier and or distributor are handled, the facility could simply operate as load offset generator depending or a parallel generating facility conditioned on whether the interconnection is made before or after the first division of main. The registration of the facility as a Qualified Facility (QF) under Federal Energy Regulatory Commission (FREC) or Illinois Commerce Commission (ICC) rules, a MISO QF or Local Utility QF, respectively, should be carefully evaluated.

Under State of Illinois Law, Heartland may have the right to establish a Retail Electrical Supplier status; for the purpose of selling electrical energy back to itself or to another designated party thought the Midwest Independent System Operators' (MISO) transmission grid network. The generating facility could be located on-site or off-site.

9. Closing Comments

Alternate Energy Solutions, Inc. was engaged by the administration of Heartland Community to study the wind regimes at the Normal, Il campus. We believe that the proposed wind turbine development project will provide valuable electrical energy offset for the college and an effective energy cost hedge against the likely occurrence of inflation in the energy markets. Our evaluation is based on the data which has been gathered from the HCC-1 Meteorological Tower, local and regional short- and long-term monitoring stations.

We are recommending that Heartland Community College pursue discussions with AAER, of Bromont, Quebec (Canada), for a cost quotation on the AAER A-1500/1650 wind turbine. We also suggest that Heartland not limit the discussion to AAER, due to the fact that the VESTAS V82 provides essentially the same performance outcomes. Heartland should be aware that VESTAS may not entertain discussions for a single wind turbine, as the company has traditionally engaged projects that are 30MW or larger. However, in light of the current economic conditions and multiple wind generation projects being postponed in North America, companies may be more willing to consider smaller equipment orders.

We believe that is would not be pragmatic to use multiple lower nameplate generating units because of turbine array and structural interference losses on the limited campus area.

We are very grateful to Heartland Community College for selecting our company for this study and look forward to assisting with this project as deemed appropriate by you.

Respectfully submitted,

John Wolar

John Wolar
Alternate Energy Solutions, Inc.

APPENDIX A:

Selected Wind Turbine Manufacturer and General Specifications – AAER A1500-77

APPENDIX D: ANALYSIS and SUPPORTING DOCUMENTATION

Attachment D-3: Shadow Flicker and Noise Report

WES Engineering Inc.

706 S. Orchard St, Madison, WI 53715, Ph#608-259-9304 WWW.WESENGINEERING.COM

Heartland College Wind Turbine– Shadow Flicker and Noise Report, New Location

(100kW turbine recently installed in Illinois, WES Engineering acted as Wind Engineer on this project)

Sep 28, 2010
WES Engineering Inc.
706 S. Orchard St
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608-259-9304 ph
608-299-0426 fax
Wes Slaymaker, P.E.
President

Shadow Flicker Background

Shadow flicker from wind turbines is defined as alternating changes in light intensity caused by shadows cast from moving turbine blades. Shadow flicker can only occur when a particular combination of conditions coincide at a specific location, time of day, and time of year. A location that may be sensitive to shadow flicker, such as a dwelling is referred to as a shadow receptor.

For shadow flicker to occur, the sky must be clear, and the turbine must be operating, otherwise no moving shadows are cast. For shadow flicker to occur at the location of a shadow receptor, the turbine rotor must be located in the line of sight from the receptor to the sun. Furthermore, for the shadow flicker to be visible, the change in light intensity must be above the level of perception of the human eye.The distance between a wind turbine and a receptor affects the intensity of the flickering. Shadow flicker intensity decreases with greater separation from the receptor to the turbine, up to a point where the change in light intensity is below what the human eye can distinguish. Shadows cast close to a turbine are more intense, distinct and "focused" because a greater proportion of the sun is intermittently blocked by the passing blades. As separation between the receptor and the turbine increases, the proportion of the sun that is blocked decreases and the shadows become less intense and less discernible. Shadow flicker intensity is also significantly reduced if the plane of the rotor is at an angle other than perpendicular to the line of sight from the receptor to the sun, again because a smaller proportion of the sun is blocked by the passing blades. Ambient lighting conditions also affect the visibility of shadow flicker. Changing light intensity is more noticeable in a darkened room than outdoors where ambient light levels are higher.

The normal maximum distance used for modeling shadow flicker is approximately 3280 feet (1000m) from the turbine(s). At distances beyond 1000m the changing light intensity is low enough that a person does not perceive the turbine rotor as "chopping" through the sun, but rather as an object with the sun behind it. Shadow flicker is only discernible at distances beyond 1000m in rare circumstances such as in a darkened room with a single window facing the turbine.

The frequency or speed of the flickering is related to the rotor speed and number of blades on the turbine. Modern utility sized turbines are typically 3-bladed with rotor speeds below 20 RPM. This translates to blade passing frequencies less than 1 Hz or 1 cycle per second. At these low frequencies, shadow flicker does not pose a health threat. The Epilepsy Foundation states that frequencies below 3Hz do not cause seizures in people with photosensitive epilepsy.

Generally shadow flicker occurs during clear sky conditions, when the sun is low on the horizon, either at sun rise or sun set. As the elevation of the sun in the sky changes throughout the year, the location of the shadow flicker also changes, so a specific shadow receptor is only affected at certain times of day and at certain times of year. By considering the spatial relationship between the turbines and the receptors (geographic locations and ground elevations) as well as the geometry of the turbines (hub height and rotor size), the occurrence of shadow flicker can be accurately modeled and predicted to within a few minutes at any location around the turbine(s).

Modeling Approach

The Garrad Hassan WindFarmer software, which is a wind plant design software package, was used to model and assess the shadow flicker for Heartland College. The WindFarmer shadow flicker model determines a theoretical maximum amount of shadow flicker, in total hours of flicker per year, at any point up to the maximum specified calculation distance from the turbines. By defining specific shadow receptor locations, the model can also determine the time of day, day of year, and duration for every possible occurrence of shadow flicker at a receptor.

The shadow flicker model uses the following inputs:

- Geographic location of the wind plant (latitude and longitude)
- Turbine location (coordinates)
- Receptor locations (coordinates)
- Digital terrain map (ground elevation data)
- Turbine geometry (hub height and rotor diameter)

The amount of shadow flicker determined by the model is a theoretical maximum or "worst case" amount due to the following set of implausible conditions:

- Every day is sunny and cloudless
- The turbines are always operating
- The rotor plane is always perpendicular to the line of sight from the receptor to the sun
- There are no obstacles such as trees or walls between the receptors and the turbines
- The limits of human perception of changing light intensity are not considered

The theoretical maximum hours of shadow flicker per year can then be de-rated to be statistically representative of actual conditions using the following climatological data:

- Wind speed frequency distribution
- Directional wind distribution
- Sunshine hours from long term monthly reference data

The de-rated hours of shadow flicker per year are still conservative as there is no consideration given to the presence of blocking obstacles or the intensity of the flicker. The Heartland project has not selected a turbine so Consultant cannot calculate wind speed frequency related operating hours, as each turbine has a different cut- in speed. The directional distribution is represented by the wind rose determined from the project met tower data, shown on next page, and is predominantly Southerly winds and next is Northwest. This means the impacted building will receive the most shadow flicker potential from Northwest winds, and those occur the most in winter months. Detailed calculations can be made to be more exact on reduced shadow flicker hours if actual site wind and cloud cover data is used.

Shadow Flicker Modeling

Below in Figure 1 is the modeled shadow flicker from a turbine that has 82m rotor and 80m tower (the current proposed Heartland 1.5MW turbine). The maximum theoretical shadow flicker at the nearest college building is 102 hours per year, and likely below 50 actual hours per year after reductions for clouds, low winds and rotor orientation. The shadow impact is in May, June and July with the greatest time of 70 minutes per day from 5:30 pm to 6:40 pm. A second building receives 8 maximum hours per year, and likely less than 4 real hours per year. There are no other residences or buildings that would receive shadow flicker. A separate detailed report of hours of impact is attached as Appendix A, and gives the date and time of shadow flicker at the buildings closest to the turbine.

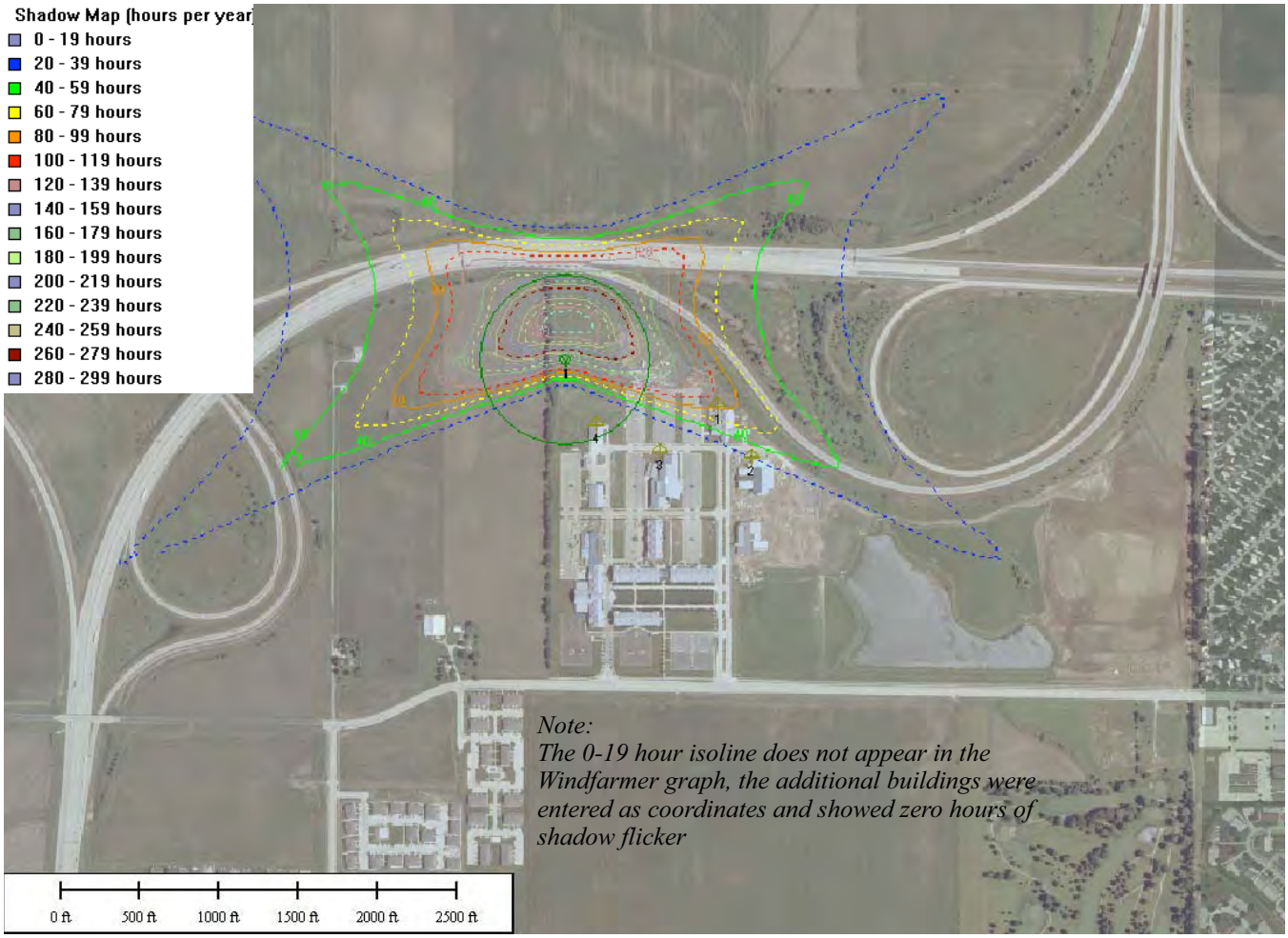

Figure 1- Shadow Flicker Map: Overview

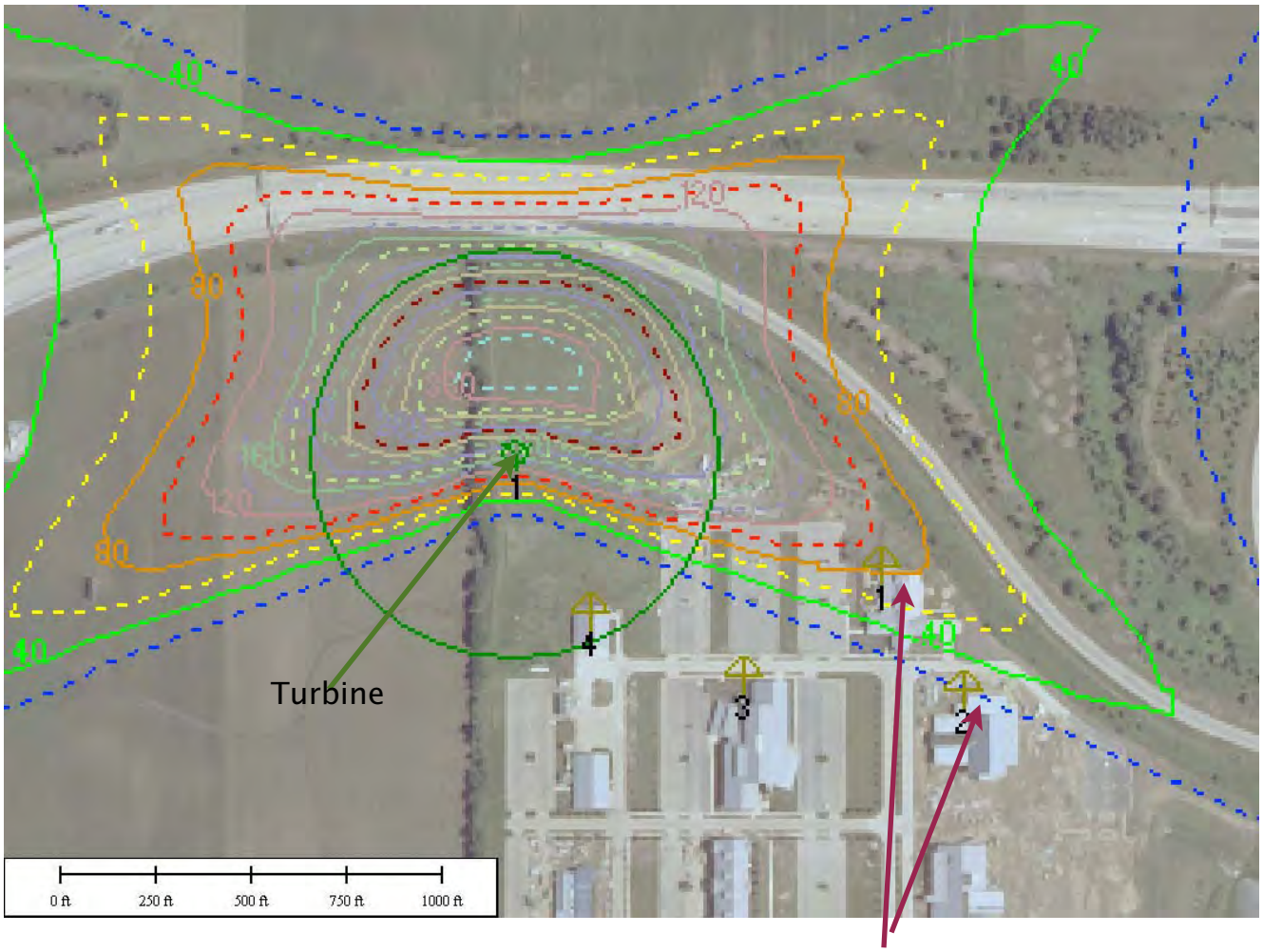

Figure 2- Shadow Flicker Map: Close-up

Buildings with Shadow

Shadow over Roadway

The shadow flicker area does cross the Interstate and there will be some areas of the roadway and exit with greater than 100 hours of shadow flicker in one year. The effects of shadow flicker on drivers has not been documented in scientific reports. The observed effects are that the drivers speed minimizes any effects as the speed of travel and direction of travel either accelerate the time under the shadow or decrease the time and make the shadow seem as if it is traveling with the vehicle. There are numerous operating wind turbines within 400' of Interstate highways operating for more than 5 years with no known complaints, including Valley City, ND near I94, near I-435 in Kansas, I-80 in Iowa and the new two turbines along I-88 near Geneseo, IL.

Noise Modeling

Noise Propagation Background

Sound is a result of fluctuating air pressure. The standard unit for measuring sound pressure levels is the decibel (dB). A decibel (dB) is a unit that describes the amplitude (or difference between extremes) of sound, equal to 20 times the logarithm to the base 10 of the ratio of the measured pressure to the reference pressure, which is 20 micropascals (µPa). Typically, environmental and occupational sound pressure levels are measured in decibels on an A-weighted scale (dBA). The A-weighted scale de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear (i.e., using the A-weighting filter adjusts certain frequency ranges (those that humans detect poorly)) (Colby, *et al.*, 2009). The Day Night Average Sound Level (DNL) is a standard environmental noise description which is essentially a twenty-four hour average noise level with ten decibels added to the night time noise levels. This 10 dBA penalty accounts for peoples increased sensitivity to noise at night.

The EPA has an existing design goal of DNL less than or equal to 65 dBA and a future design goal DNL of 55 dBA for exterior sound levels (EPA, 1977). It is important to note that the EPA noise guidelines are design goals and not enforceable regulations. However, these guidelines and design goals are useful tools for assessing the sound environment.

The Illinois Pollution Control Agency has developed a comprehensive approach to the measurement and assessment of commercial and industrial noise, and thus are relevant to the development and operating of wind energy projects.

Section 901.101 Classification of Land According to Use

Illinois defines land as one of three types, Class A is residential, Class B is mixed use and Class C is industrial. The below rules apply for noise regulation from Class C land, which includes alternative energy sources (the wind project), to Class A land (residential).

"Except as elsewhere provided in this Part, no person shall cause or allow the emission of sound during daytime hours from any property-line-noise-source located on any Class A, B or C land to any receiving Class A land which exceeds any allowable octave band sound pressure level specified in the following table, when measured at any point within such receiving Class A land, provided, however, that no measurement of sound pressure levels shall be made less than 25 feet from such property-line-noise-source. "

For the nearby residential areas the noise modeling was done near the "property edge" for the multifamily units and the trailer park, and near the residence edge at the one older farm house. Previous studies and analysis all model and predict at the receptor, even if sound measurement is made at the property edge.

Table 1- Illinois PCB allowable day time octave band sound power levels limits, Sec. 901.102 of the Illinois State Noise Regulation

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB) of Sound Emitted to any Receiving Class A Land from		
	Class C Land	Class B Land	Class A Land
31.5	75	72	72
63	74	71	71
125	69	65	65
250	64	57	57
500	58	51	51
1000	52	45	45
2000	47	39	39
4000	43	34	34
8000	40	32	32

Table 2- Illinois PCB allowable night time octave band sound power levels limits, Sec. 901.102 of the Illinois State Noise Regulation

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB) of Sound Emitted to any Receiving Class A Land from		
	Class C Land	Class B Land	Class A Land
31.5	69	63	63
63	67	61	61
125	62	55	55
250	54	47	47
500	47	40	40
1000	41	35	35
2000	36	30	30
4000	32	25	25
8000	32	25	25

(Source: Amended at 30 Ill. Reg.5533, effective March 10, 2006)

For this assessment the first column is used from the night time limits as the wind turbine is assumed to be Class C land, and the night limits are lower than the day limits. The IL PCB 35 IAC 901 regulations contains tables of land class, and an "alternative energy source" function code 4314 is a land class C[1].

There are also limits to any "tonal" conditions, which is defined as sound spectra in which any 1/3 linear octave band sound pressure level exceeds the arithmetic average of the two adjacent 1/3 octave bands by the following amounts:

- 5 dB for such one-third octave band with a center frequency from 500Hz to 10,000 Hz, inclusive
- 8 dB for such one-third octave band with a center frequency from 160Hz to 400 Hz, inclusive
- 15 dB for such one-third octave band with a center frequency from 25Hz to 125 Hz, inclusive

The wind turbine does not have any tonal conditions per this definition as can be seen in Table 4 (next page) Octave Band Spectra from the wind turbine manufacturer, as measured at turbine, but at large distances from turbine this condition may apply for the 2000 Hz and above frequency bins if there is no background noise increasing the dB noise level in the higher frequencies. At this site the traffic noise will likely prevent this tonal penalty if measurements are taken after the turbine is operating.

Below is the excerpt from the turbine supplier in regards tonality:

At the reference measuring point R_0, a ground distance from the turbine base equal to hub height plus half the rotor diameter, the GE 1.5xle turbine has a value for tonality of $\Delta L_a \leq 4$ **dB**, irrespective of wind speed, hub height, and grid frequency.[3]

[1] Title 35 Environmental Protection, Subtitle H: Noise Chapter I: Pollution Control Board Part 901 Sound Emission Standards and Limitations for Property Line-Noise-Sources
[3] as defined according to IEC 61400-11: 2002

5 Octave Band Spectra

Following is a table with the octave band values at nominal turbine operation, typically corresponding to wind speeds larger than 10 m/s at 10-meter height.
Octave band spectra as a function of smaller wind speed at 10-meter height depend on hub height and surface roughness. Indicative octave band values can be derived using the table below thereby multiplying the tabled values below with the L_{WA} level for a given wind speed at 10-meter height (section 2) and dividing this by 104 dB(A):

$$\text{Octave Band value } (V_{i,10\text{-}m}) = \text{Octave Band value (nominal operation)} \cdot L_{WA}(V_{i,10\text{-}m}) / 104 \text{ dB(A)}.$$

Note: The octave band spectra are informative only.

Octave [Hz]	Sound power level [dB]
63	83.4
125	92.2
250	97.8
500	99.4
1000	97.7
2000	93.4
4000	86.6
8000	84.8
Sum	**104.0**

Table 4- Octave Band Output of Sample 1.5MW Wind Turbine- GE xle

<u>Summary of Acoustic Criteria</u>

The criteria used to evaluate the wind turbine impact at nearby "receptors" is the following:

- EPA 55dBA L_{dn} (24) outdoors at all residential receptors. Assuming wind turbine is operating at steady state sound level at the receiver location the L_{dn} is approximately 6.4 dB above the measured L_{eq}, so an L_{dn} of 55 dBA corresponds to maximum L_{eq} of 48.6 dBA.
- IL PCB nighttime octave frequency band dBL limits for Class A land from Class B land- see Table 2.
- OSHA limits per 29 CFR 1926.101 where long term exposure limits of 8 hours or more for hearing protection must be below 90 dBA.

Background Noise and Noise Measurement

The existing noise environment for the wind turbine location in this area is characterized by heavy interstate highway traffic, intermittent car traffic on campus, and other campus activities that includes students talking, maintenance staff doing repairs or grounds work, and an outdoor daycare center. The site is bounded to the north and West by a four lane divided I-55/74. To the south lies the Heartland College campus and Raab Rd. The nearest residential area is located over 2,000 feet away from the proposed wind turbine location, and the next closest residential area to the East is over 3,500 feet from the turbine.

The sound readings were recorded between approximately 8 a.m. and 9 a.m. WES used a Larson Davis Model 831 Sound Level Meter with a windscreen over the end of the microphone. The unit was set for an A-weighted measurement (dBA).

Below in Table 3 are the sound pressure values from a variety of sources in the environment.

TYPICAL SOUND PRESSURE LEVELS MEASURED IN THE ENVIRONMENT AND INDUSTRY

Noise Source At a Given Distance	A-Weighted Sound Level in Decibels	Qualitative Description
Carrier deck jet operation	140	
	130	Pain threshold
Jet takeoff (200 feet)	120	
Auto horn (3 feet)	110	Maximum vocal effort
Jet takeoff (1000 feet) Shout (0.5 feet)	100	
N.Y. subway station Heavy truck (50 feet)	90	Very annoying Hearing damage (8-hour, continuous exposure)
Pneumatic drill (50 feet)	80	Annoying
Freight train (50 feet) Freeway traffic (50 feet)	70 to 80	
	70	Intrusive (Telephone use difficult)
Air conditioning unit (20 feet)	60	
Light auto traffic (50 feet)	50	Quiet
Living room Bedroom	40	
Library Soft whisper (5 feet)	30	Very quiet
Broadcasting/Recording studio	20	
	10	Just audible

Adapted from Table E, "Assessing and Mitigating Noise Impacts", NY DEC, February 2001.

Table 3. Typical Sound Pressure Levels Measured in the Environment and Industry.

Sound decreases significantly with distance from the source. For example, sound pressure at 25 feet from a wind turbine hub drops by a factor of 4 at 50 feet, and by a factor of 16 at 100 feet. In the logarithmic scale of decibels, this equates to a drop of approximately 6 dBA for each doubling of the distance from point sound source. At a distance of approximately 350 meters (approximately 1,150 feet), sound from the wind turbine is in the range of 45 dBA (Table 3, cited in Colby et al. (2009)).

Modern wind turbines have been designed to significantly reduce the noise of mechanical components, so the most audible noise is the sound of the wind interacting with the rotor blades, often resulting in what can be described as a "whooshing" sound. However, modern wind turbines are generally quiet in operation and this sound is anticipated to be less noticeable by humans when compared to sound from road traffic, and campus activities for this Heartland College site.

Noise would be temporarily emitted from the project site by construction equipment during the approximately five-month active construction period. However, due to the noise-generating activities from the existing highway, college traffic, etc., as described above, the wind turbine project construction noise would not be expected to significantly increase the overall ambient noise emissions from the site on a L_{dn} (24) measurement, as there are few periods of significant activity during that lengthy period. For example the foundation excavation occurs in two days (noisy), but then there are many days with little additional noise when foundation rebar is tied, and after the concrete is poured it must cure for 30 days. There are approximately 20 days of significant construction activity during this period, times when large equipment such as bulldozer or cranes are being operated and generating a lot of additional noise.

Acoustic Modeling Methodology:

The Noise modeling was done with the Windfarmer noise modeling software module. Whereas specific sound level data was not available for the AAER A-1500 turbine that Heartland is evaluating[1], sound level data was available for a similar 1.5MW turbine (the GE 1.5 xle) with the same hub height (80 m), and almost identical rotor diameter (80.5 m vs. 80 m). The guaranteed sound power level supplied by the turbine manufacturer of 104dBA at the nacelle was utilized. Windfarmer allowed this maximum sound power level to be entered by octave band, see below Table 4 for the octave band values. The turbine noise levels are GL certified and the actual values are below the guaranteed sound power level and so reflect the conservative maximum noise estimate.

Below in Figure 3 is the modeled noise for the Heartland 1.5MW turbine on an 80 m tower. The modeling shows the maximum noise level from the turbine using the sound power level provided by GE of 104 dBA at the nacelle (this is similar to the maximum sound power level identified by other

manufacturers[1] - Acciona, Vensys). The turbine will normally operate below this level. This noise level maximum is reached when wind speeds are above 8 m/s (18 mph), and as wind speeds increase even higher the turbine noise is masked by the background noise of the wind blowing past leaves and other objects. The closest building to the proposed wind turbine location (the Receiving and Storage Building) is modeled at 51.8 dBA maximum. There are several other buildings close to the turbine (Physical Plant Building, Workforce Development Center, Child Development Lab) with maximum sound levels between 47.37 and 45.48 dBA. The building with outdoor daycare (Child Development Center) has modeled sound maximum of 45.48 dBA. The background sound level at most of these buildings during the day would be expected to be similar or higher than the maximum level from the turbine due to on campus traffic, heating and ventilating systems, and the thousands of students, faculty and staff moving throughout the campus on a daily basis, and poses no health risk to the occupants of these buildings. There were two residential areas nearby. The residential area approximately 1,800-2,000 feet Southwest had maximum noise levels ranging from 39.54 to 37.63 dBA, and the residential area due east (residential trailer park setting) had maximum sound level ranges of 31.7 to 30.5 dBA. All other residences are further away and well below the EPA 55 DNL to 65 DNL range at residences, or ILPCB octave band limits. Table 5 below contains the octave band frequency estimates for the nearest residential area as compared to the modeled noise output from the turbine). The 1,000 Hz band has the closest values to the limit.

[1] Limited manufacturer noise level data was available for the AAER A-1650, a model similar to the AAER A-1500. While octave band level data was not available, the maximum guaranteed sound power level at hub height was listed as 103 dB. To ensure conservative results, the GE 1.5 xle was selected for modeling purposes due to its similar size, availability of octave band data, and slightly louder sound power level of 104 dB.

Octave Band Frequency Analysis

Octave Hz	Sound power level NRO 104-Rev.3 [dB]	Sound power level NRO 103-Rev.3 [dB]	Sound power level NRO 102-Rev.3 [dB]	Sound power level NRO 101-Rev.3 [dB]	Sound power level NRO 100-Rev.3 [dB]
63	83.4	82.6	81.7	80.8	80.0
125	92.2	91.3	90.3	89.3	88.4
250	97.8	96.8	95.7	94.7	93.8
500	99.4	98.4	97.3	96.3	95.3
1000	97.7	96.7	95.7	94.7	93.7
2000	93.4	92.5	91.5	90.5	89.6
4000	86.6	85.7	84.8	83.9	83.1
8000	84.8	84.0	83.1	82.2	81.4
Sum	104.0	103.0	102.0	101.0	100.0

Table 4b- GE xle turbine octave band values with noise reduction option (NRO)

To calculate a dB(A), weight each octave band level accordingly and then logarithmically add each band together. dB(A) is a weighted broadband level which approximates the ear's sensitivity to different frequencies. The weightings are as below: {-26.2, -16.1, -8.6, -3.2, 0, 1.2, 1, -1.1} (from 63 to 8k)

LA=10*log10(sum(10^((Ln-Wn)/10))) where n=each octave band, L = level and W = weighting.

The octave band centre frequencies are 63, 125, 250, 500, 1000, 2000, 4000 and 8000 Hz.

Below in Table 5 the GE turbine octave bands are used in the above formula and the equivalent dBA is 102 dBA (some error in the calculation or in the provided octave bands, reduces it from 104dBA)

Freq	GE turbine	scale correction	corrected	divide by ten
31.5	80	-39	41	4.1
63	83.4	-26	57.4	5.74
125	92.2	-16	76.2	7.62
250	97.8	-9	88.8	8.88
500	99.4	-3	96.4	9.64
1000	97.7	0	97.7	9.77
2000	93.4	1	94.4	9.44
4000	86.6	1	87.6	8.76
8000	84.8	-1	83.8	8.38
	La=	101.6506538998	dBA	
Table 5- GE	**Sound Power Level at generator**			

Freq	GE turbine at base	scale correction	corrected	divide by ten
31.5	40	-39	1	0.1
63	43.4	-26	17.4	1.74
125	52.2	-16	36.2	3.62
250	57.8	-9	48.8	4.88
500	59.4	-3	56.4	5.64
1000	57.7	0	57.7	5.77
2000	53.4	1	54.4	5.44
4000	46.6	1	47.6	4.76
8000	44.8	-1	43.8	4.38
	La=	61.65	dBA	
Table 6- GE	**Sound Power Level at ground level**			
Freq	1870 feet	scale correction	corrected	divide by ten
31.5	17.8	-39	-21.2	-2.12
63	21.2	-26	-4.8	-0.48
125	30	-16	14	1.4
250	35.6	-9	26.6	2.66
500	37.2	-3	34.2	3.42
1000	35.5	0	35.5	3.55
2000	31.2	1	32.2	3.22
4000	24.4	1	25.4	2.54
8000	22.6	-1	21.6	2.16
Table 7-	**Sound Power Level at nearest residence**			

Below in Table 8 are the octave band limits set by the IL PCB and the octave band frequencies modeled at the nearest residential structure Southwest of the campus on Raab Rd.

	Class C	at 1870 feet
Freq	IL PCB night limit dB	Turbine dB
31.5	69	55.5
63	67	45.9
125	62	44.7
250	54	43.3
500	47	38.9
1000	41	34.2
2000	36	28.9
4000	32	22.1
8000	32	22.3

Table 8- Octave band frequency of turbine at nearest residences versus IL PCB limits

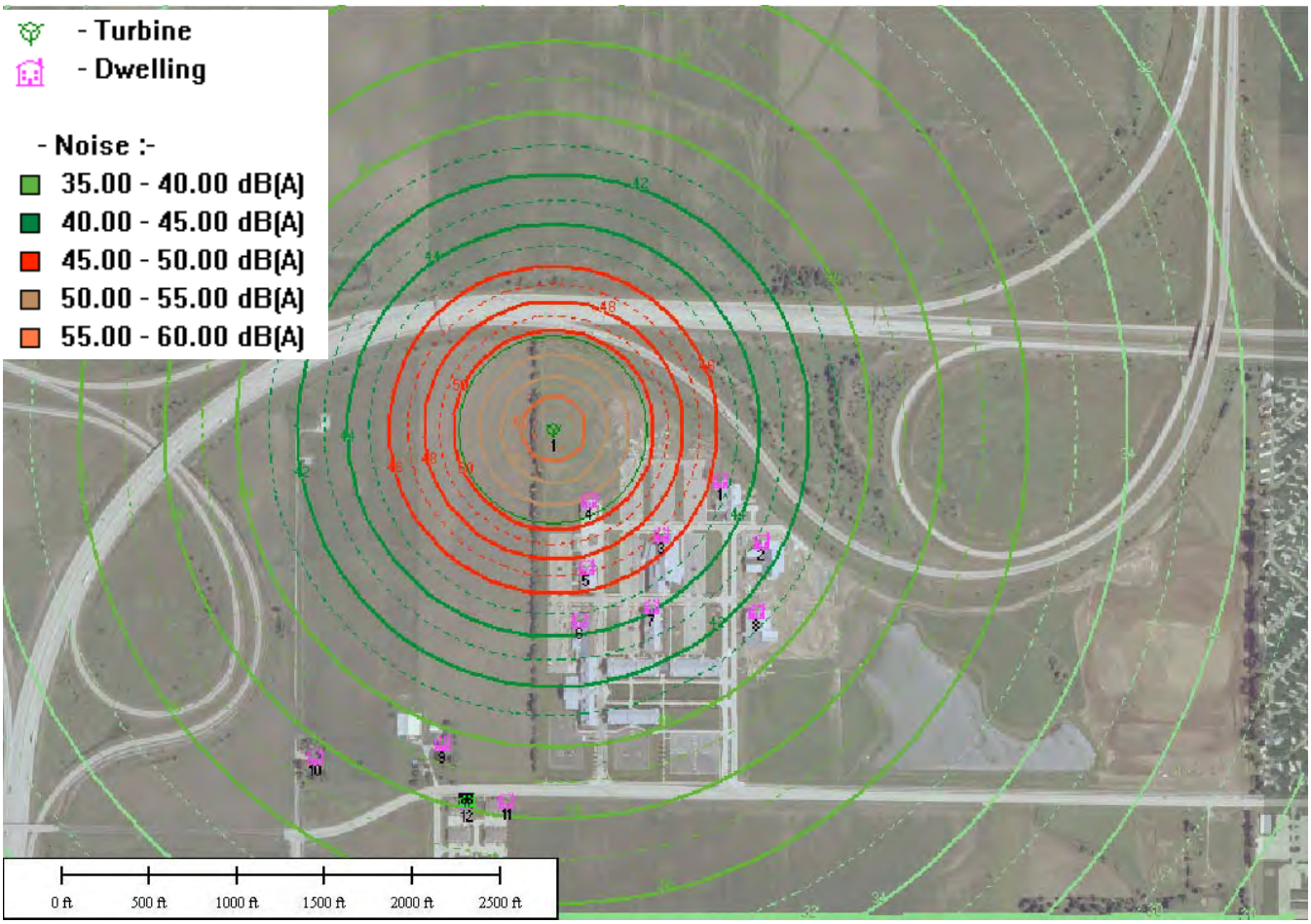

Figure 3- Heartland project noise modeling in dBA: Overview

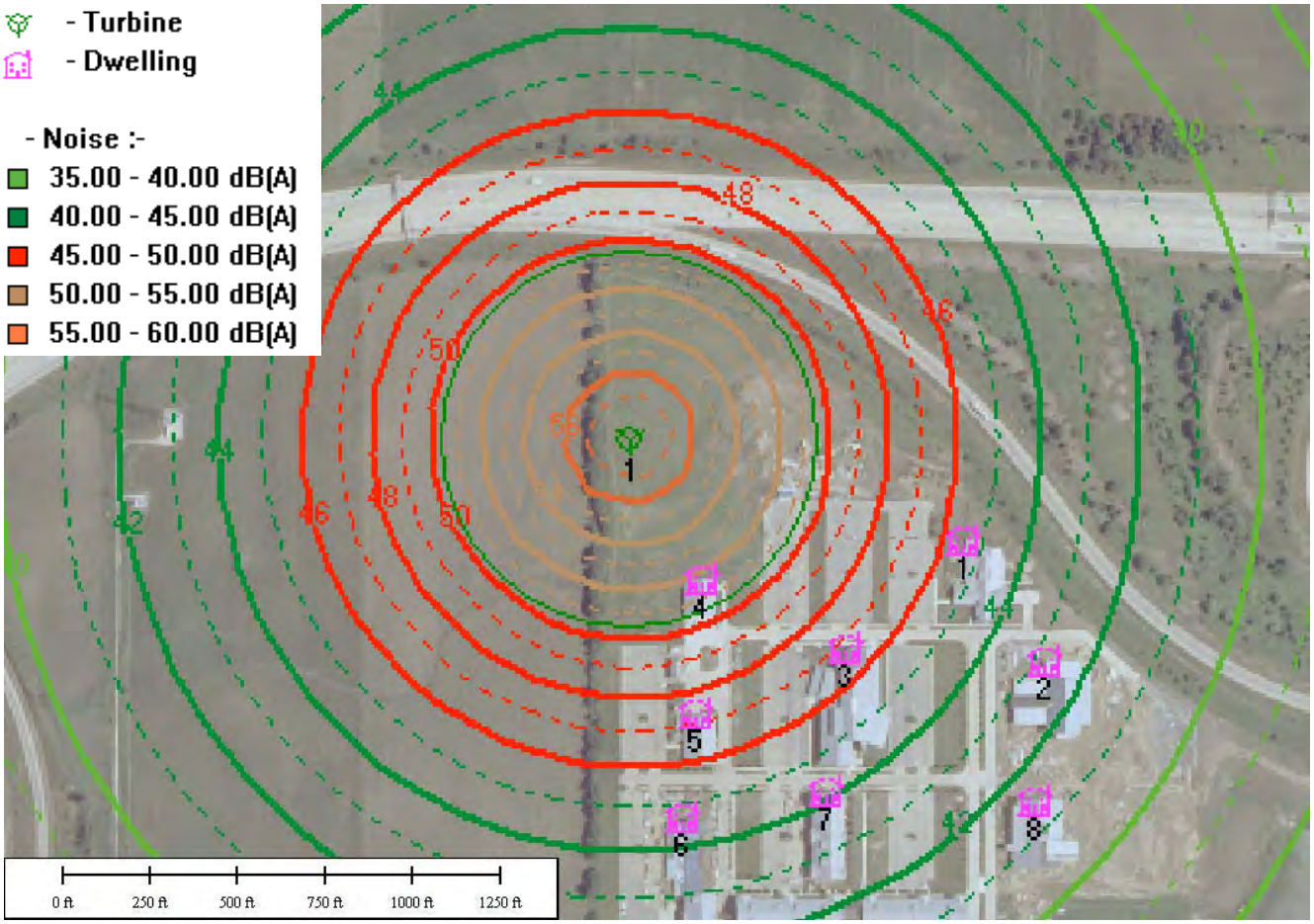

Figure 4- Heartland project noise modeling in dBA: Closeup

Appendix A

GH WindFarmer Report
Heartland College Windfarmer shadow flicker and Noise data
28 Sep 2010

1 Project: Heartland - Dwellings noise

Dwelling ID	Noise prediction (dB(A))	Noise limit type	Absolute noise limit (dB(A))	Relative to background noise limit (dB(A))
1	45.48	Absolute	45.00	Not applicable
2	42.83	Absolute	45.00	Not applicable
3	46.83	Absolute	45.00	Not applicable
4	51.80	Absolute	45.00	Not applicable
5	47.37	Absolute	45.00	Not applicable
6	44.73	Absolute	45.00	Not applicable
7	44.22	Absolute	45.00	Not applicable
8	41.47	Absolute	45.00	Not applicable
9	39.54	Absolute	45.00	Not applicable
10	37.62	Absolute	45.00	Not applicable
11	38.41	Absolute	45.00	Not applicable
12	38.20	Absolute	45.00	Not applicable

Table 1 - Project: Heartland - Dwellings noise

2 Shadow Flicker Data

WindFarmer Site Shadow Flicker Report 4.1.1.0
File name:Heartland Windfarmer shadow terrain Sep 28 2010 C:\Documents and Settings\WES\My Documents\WES Engineering\Projects\Illinois\WIU Prospects\Heartland\Heartland Windfarmer shadow terrain Sep 28 2010.wow
Date: September 28, 2010

Latitude	40 deg 32 min	North
Longitude	89 deg 1 min	East
Calculation time interval	10	Min
Maximum distance from turbine	1000	m
Minimum sun elevation	3	deg
Year of calculation	2010	
Model the sun as a disc	No	
Consider distance between rotor and tower	Yes	
Turbine orientation	Rotor plane facing azimuth +180	
Terrain and visibility	Turbine visibility considered	
Visibility line of sight algorithm checks every	10.0	m

3 Project: Heartland

Number of shadow receptors: 4

Receptor ID:1 (Refer to Figure 2 in report for map of receptors)

Height: 2m
Easting: 329517m
Northing: 4489275m
Bearing: 180deg
Tilt: 0deg

Turbine ID:1	<label>	Hours per year	102
Day: dd/mm index	Maximum minutes	Start time hh:mm	Stop time hh:mm
Worst Day !: 141	70	17:30	18:40
29/04 119	10	18:00	18:10
30/04 120	10	18:00	18:10
01/05 121	30	17:50	18:20
02/05 122	30	17:50	18:20
03/05 123	30	17:50	18:20
04/05 124	40	17:40	18:20
05/05 125	50	17:40	18:30
06/05 126	50	17:40	18:30
07/05 127	50	17:40	18:30
08/05 128	50	17:40	18:30
09/05 129	50	17:40	18:30
10/05 130	50	17:40	18:30
11/05 131	50	17:40	18:30
12/05 132	50	17:40	18:30
13/05 133	50	17:40	18:30
14/05 134	60	17:30	18:30
15/05 135	60	17:30	18:30
16/05 136	60	17:30	18:30
17/05 137	60	17:30	18:30
18/05 138	60	17:30	18:30
19/05 139	60	17:30	18:30
20/05 140	60	17:30	18:30
21/05 141	70	17:30	18:40
22/05 142	70	17:30	18:40
23/05 143	70	17:30	18:40
24/05 144	70	17:30	18:40
25/05 145	70	17:30	18:40
26/05 146	70	17:30	18:40
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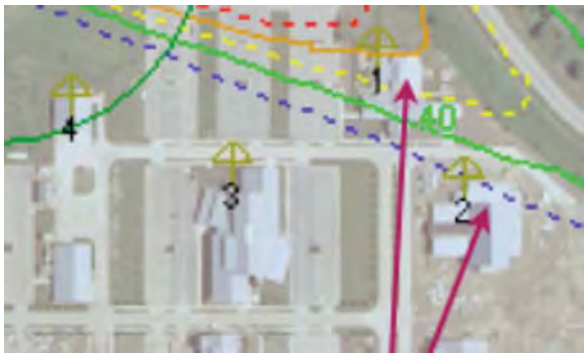
29/05 149	70	17:30	18:40



30/05 150	70	17:30	18:40
31/05 151	70	17:30	18:40
01/06 152	70	17:30	18:40
02/06 153	70	17:30	18:40
03/06 154	70	17:30	18:40
04/06 155	70	17:30	18:40
05/06 156	70	17:30	18:40
06/06 157	70	17:30	18:40
07/06 158	70	17:30	18:40
08/06 159	70	17:30	18:40
09/06 160	60	17:40	18:40
10/06 161	60	17:40	18:40
11/06 162	60	17:40	18:40
12/06 163	60	17:40	18:40
13/06 164	60	17:40	18:40
14/06 165	60	17:40	18:40
15/06 166	60	17:40	18:40
16/06 167	60	17:40	18:40
17/06 168	60	17:40	18:40
18/06 169	60	17:40	18:40
19/06 170	60	17:40	18:40
20/06 171	60	17:40	18:40
21/06 172	60	17:40	18:40
22/06 173	60	17:40	18:40
23/06 174	60	17:40	18:40
24/06 175	60	17:40	18:40
25/06 176	60	17:40	18:40
26/06 177	60	17:40	18:40
27/06 178	60	17:40	18:40
28/06 179	60	17:40	18:40
29/06 180	60	17:40	18:40
30/06 181	60	17:40	18:40
01/07 182	60	17:40	18:40
02/07 183	60	17:40	18:40
03/07 184	60	17:40	18:40

04/07 185	60	17:40	18:40
05/07 186	60	17:40	18:40
06/07 187	60	17:40	18:40
07/07 188	60	17:40	18:40
08/07 189	60	17:40	18:40
09/07 190	60	17:40	18:40
10/07 191	60	17:40	18:40
11/07 192	70	17:40	18:50
12/07 193	70	17:40	18:50
13/07 194	70	17:40	18:50
14/07 195	70	17:40	18:50
15/07 196	70	17:40	18:50
16/07 197	70	17:40	18:50
17/07 198	70	17:40	18:50
18/07 199	70	17:40	18:50
19/07 200	70	17:40	18:50
20/07 201	70	17:40	18:50
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28/07 209	60	17:40	18:40
29/07 210	60	17:40	18:40
30/07 211	50	17:50	18:40
31/07 212	50	17:50	18:40
01/08 213	50	17:50	18:40
02/08 214	50	17:50	18:40
03/08 215	50	17:50	18:40
04/08 216	50	17:50	18:40
05/08 217	50	17:50	18:40
06/08 218	50	17:50	18:40
07/08 219	40	17:50	18:30
08/08 220	40	17:50	18:30
09/08 221	30	18:00	18:30
10/08 222	30	18:00	18:30
11/08 223	30	18:00	18:30
12/08 224	20	18:00	18:20
13/08 225	10	18:10	18:20

Table 2 - Project: Heartland - Shadow Flicker Data - Turbine ID:1 <label>

Receptor ID:2
(Refer to Figure 2 in report for map of receptors)
Height: 2m
Easting: 329582m
Northing: 4489174m
Bearing: 180deg
Tilt: 0deg

Turbine ID:1	<label>	Hours per year	8
Day: dd/mm index	Maximum minutes	Start time hh:mm	Stop time hh:mm
Worst Day !: 160	20	18:40	19:00
07/06 158	10	18:40	18:50
08/06 159	10	18:40	18:50
09/06 160	20	18:40	19:00
10/06 161	20	18:40	19:00
11/06 162	20	18:40	19:00
12/06 163	20	18:40	19:00
13/06 164	20	18:40	19:00
14/06 165	20	18:40	19:00
15/06 166	20	18:40	19:00
16/06 167	20	18:40	19:00
17/06 168	20	18:40	19:00
18/06 169	20	18:40	19:00
19/06 170	20	18:40	19:00
20/06 171	20	18:40	19:00
21/06 172	20	18:40	19:00
22/06 173	20	18:40	19:00
23/06 174	20	18:40	19:00
24/06 175	20	18:40	19:00
25/06 176	20	18:40	19:00
26/06 177	20	18:40	19:00
27/06 178	20	18:40	19:00
28/06 179	20	18:40	19:00
29/06 180	20	18:40	19:00
30/06 181	20	18:40	19:00
01/07 182	20	18:40	19:00
02/07 183	20	18:40	19:00
03/07 184	10	18:50	19:00
04/07 185	10	18:50	19:00
05/07 186	10	18:50	19:00

Table 3 - Project: Heartland - Shadow Flicker Data - Turbine ID:1 <label>

Receptor ID:3

Height: 2m
Easting: 329406m
Northing: 4489185m
Bearing: 180deg
Tilt: 0deg

Turbine ID:1	<label>	Hours per year	0
Day: dd/mm index	Maximum minutes	Start time hh:mm	Stop time hh:mm
Worst Day !: 1	0	00:00	00:00

Table 4 - Project: Heartland - Shadow Flicker Data - Turbine ID:1 <label>

Receptor ID:4

Height: 2m
Easting: 329285m
Northing: 4489237m
Bearing: 180deg
Tilt: 0deg

Turbine ID:1	<label>	Hours per year	0
Day: dd/mm index	Maximum minutes	Start time hh:mm	Stop time hh:mm
Worst Day !: 1	0	00:00	00:00

Table 5 - Project: Heartland - Shadow Flicker Data - Turbine ID:1 <label>

References

Kamperman G.W. and R. R. James. 2009. Guidelines for selecting wind turbine sites. Sound and Vibration: 8-12. July. http://www.sandv.com/home.htm.

Kamperman, G. W. and R. R. James. 2008. Simple Guidelines for Siting Wind Turbines to Prevent Health Risks. Proceedings NoiseCon 2008. Dearborn, Michigan: Institute of Noise Control Engineering.

Colby, W. D., Dobie, R., Leventhall, G., Lipscomb, D.M., McCunney, R.J., Seilo, M.T., Sondergaard, B. 2009. Wind Turbine Sound and Health Effects An Expert Panel Review. Prepared for AWEA and CanWEA.

APPENDIX D: ANALYSIS and SUPPORTING DOCUMENTATION

Attachment D-4: Stakeholder List and Notice of Scoping

EA STAKEHOLDER LIST
Heartland Community College Wind Turbine Project
Normal, IL (McLean County)

Name	Title	Organization	Address	City and State	Zip
Ms. Sarah Sheehan		Office of the Governor	100 W. Randolph, 6-100 - James R. Thompson Center	Chicago, IL	60601
Mr. Thomas E. Jennings	Director	Illinois Department of Agriculture	State Fairgrounds, P.O. Box 19281	Springfield, IL	62794
Jonathan Feipel	Deputy Director	Illinois Department of Commerce and Economic Opportunity	500 East Monroe (Illinois Energy Office)	Springfield, IL	62701
Mr. Manuel Florez	Chairman	Illinois Commerce Commission	527 East Capitol Avenue	Springfield, IL	62701
Mr. Doug Scott	Director	Illinois Environmental Protection Agency	1021 North Grand Ave. East - P.O. Box 19276	Springfield, IL	62794
Ms. Janet Grimes	Director	Illinois Historic Preservation Agency	1 Old State Capitol Plaza	Springfield, IL	62701
Mr. Marc Miller	Director	Illinois Department of Natural Resources	1 Natural Resources Way	Springfield, IL	62702
Mr. Gary Hannig	Secretary, Attn: Barbra Stevens, Environment Section	Illinois Department of Transportation	2300 S. Dirkesn Parkway	Springfield, IL	62764
Mr. Mark Pruitt	Executive Director	Illinois Power Agency	100 W. Randolph, 6-100 - James R. Thompson Center	Chicago, IL	60601
Mr. Phil Wallis	Vice President	National Audubon Society	225 Varick Street, 7th floor	New York, NY	10014
Ms. Michelle P. Scott	General Counsel	National Audubon Society	225 Varick Street, 7th floor	New York, NY	10014
Ms. Kim Van Fleet	Biologist National Audubon Society	Important Bird Area Coordinator and Staff	225 Varick Street, 7th floor	New York, NY	10014
Mr. Eric Glitzenstein		Meyer Glitzenstein & Crystal	1601 Connecticut Ave., N.W., Suite 700	Washington, D.C.	20009
Mr. William Eubanks		Meyer Glitzenstein & Crystal	1601 Connecticut Ave., N.W., Suite 700	Washington, D.C.	20009
Mr. Stephen Packard	Director	Audubon of the Chicago Region	1718 Sherman Avenue #210	Evanston, IL	60201
Mr. Joe Williams	NAGPRA Rep	Kickapoo Tribe	1107 Goldfinch Road	Horton, KS	66439
Mr. Earl Meshiguad		Potawatomi Hannaville Indian Community	N14911 Hannahville Boulevard Rd.	Wilson, MI	49896
Mr. Jimmy Finch	THPO	Potawatomi -Citizen Band	1601 Gordon Copper Dr.	Shawnee, OK	74801
Mr. Steve Ortiz		Potawatomi-Prarie Band			
Mr. Philip Shopodock	Chairman, Executive Council	Potawatomi-Forest County Community	PO Box 340	Crandon, WI	54520
Mr. Thomas Cuddy		Federal Aviation Administration- Office of Environment and Energy	800 Independence Avenue, SW, Room 900	Washington, DC	20591
Mr. Ken Westlake		EPA Region 5 – IL, IN, MI, MN, OH, WI - NEPA Implementation Office of Enforcement and Compliance Assurance	77 West Jackson Boulevard, Mail Code E-19J	Chicago, IL	60604
Mr. Richard Nelson		USFWS - Rock Island Field Office	1511 47th Avenue	Moline, IL	61265
Ms. Jody Miller		USFWS - Rock Island Field Office	1511 47th Avenue	Moline, IL	61265
Ms. Heidi Woeber		USFWS - Rock Island Field Office	1511 47th Avenue	Moline, IL	61265
Mr. Matthew Sailor		USFWS - Rock Island Field Office	1511 47th Avenue	Moline, IL	61265
Mr. Jeffrey Gosse		USFWS - Region 3	1 Federal Drive	Ft. Snelling, MN	55111
Dr. James Hartman (Attn: SAIE_ESOH)	Assistant Secretary of Army (Installations & Environment) OH, WI Office of Regional Environmental and Government Affairs – North	DOD Region V- IL, IN, MI, MN	5179 Hoadley Rd Aberdeen	Aberdeen Proving Ground, MD	21010
Ms. Cathy O'Connell	Army Region 5 Regional Environmental Coordinator	Horne Engineering Services, LLC Office of Regional Environmental and Government Affairs	Northern APG-EA	Aberdeen Proving Ground, MD	211010
Citizens for Clean Energy, Inc		Citizens for Clean Energy, Inc.	3417 Fourth Avenue, South	Great Falls, MT	59405
Mr. Greer Goldman	Assistant General Counsel	National Audubon Society- Audubon Public Policy Office	1150 Connecticut Avenue, NW	Washington, DC	20036
Mr. Steve Stockton		City of Bloomington	109 E. Olive Street	Bloomington, IL	61701
Mr. Michael Ireland		City of Bloomington Township	816 S. Mercer Avenue	Bloomington, IL	61701
Mr. William Friedrich		Bloomington Township Public Water District	16748 E. 825 North Road	Bloomington, IL	61705

EA STAKEHOLDER LIST
Heartland Community College Wind Turbine Project
Normal, IL (McLean County)

Name	Title	Organization	Address	City and State	Zip
Mr. Robert Carter		Bloomington and Normal Water Reclamation District	2015 West Oakland Ave. Rd. P.O. Box 3307	Bloomington, IL	61701
		Central Illinois Regional Airport	3201 CIRA Drive, Suite 200	Bloomington, IL	61704
Mr. Chris Koos	Mayor	Town of Normal	100 E. Phoenix Avenue. P. O. Box 589	Normal, IL	61761
Mr. Robert Cranston		Normal Township	P.O. Box 426	Normal, IL	61761
Mr. Jerry Henderson		Normal-Towanda Drainage District	11 Inglewood	Bloomington, IL	61704
Mr. Terry Lindberg		McLean County	115 E. Washington Street- Government Center (Rm. 401) P.O. Box 2400	Bloomington, IL	61702
		McLean County Historical Society	200 North Main Street	Bloomington, IL	61701
Mr. Scott Hoeft		McLean County Farm Bureau	2243 Westgate Drive, Suite 501	Bloomington, IL	61705
	McLean County Unit	University of Illinois Extension	402 North Hershey Road	Bloomington, IL	61704
Mr. Rhea Edge *		John Wesley Powell Audubon Society	P.O. Box 142	Normal, IL	61761
Mr. Dick Bishop		Sierra Club Prairie Group	P.O. Box 131	Urbana, IL	61803
Dr. Allen Goben		Heartland Community College	1500 W. Raab Road	Normal, IL	61761
Dr. Al Bowman		Illinois State University	421 Hovey Hall, Campus Box 1000	Normal, IL	61790
Mr. Richard Wilson		Illinois Wesleyan University	1312 Park Street	Bloomington, IL	61701
Mr. Joseph E. Crowe	Deputy Director, Region 3 Engineer	Illinois Department of Transportation	13473 IL Hwy. 133, P.O. Box 610	Paris, IL	61944
Ms. Darlene Wills	CDL Director	HCC Child Development Lab	1500 W. Raab Road	Noral, IL	61761
Mr. Jonathan L. Casebeer	Chief Environmental Branch	Illinois Department of Military Affairs	1301 North MacArthur Blvd.	Springfield, IL	62702

* Address updated based on public comments.

Department of Energy
Washington, DC 20585

July 16th, 2010

TO: Distribution List

SUBJECT: Notice of Scoping – Heartland Community College Wind Energy Project, Normal, Illinois (McLean County)

The U.S. Department of Energy (DOE) is proposing to provide federal funding to the Illinois Department of Commerce and Economic Opportunity (DCEO) for Heartland Community College's Wind Energy Project. Heartland Community College is proposing to install a single 1.5 megawatt (MW) wind turbine along with an associated gravel access road and electrical transmission equipment on the northern end of the Heartland Community College's campus, and just south of Interstate 55 in Normal, IL (GPS: *Lat.* 40.537781, *Long.* -89.015576). The proposed wind turbine would provide electricity directly to the college, enabling it to reduce the electrical demands of the institution and lower the carbon footprint associated with daily operations. The average elevation of the turbine site is 850 feet. The specific wind turbine has not been selected; however Heartland Community College has submitted their preferred turbine height of 397 feet above ground level to the Federal Aviation Administration (FAA) for their review and has received a "Determination of No Hazard to Air Navigation." Pursuant to the requirements of the National Environmental Policy Act (NEPA), the Council on Environmental Quality regulations for implementing the procedural provisions of NEPA (40 CFR Parts 1500-1508), and DOE's implementing procedures for compliance with NEPA (10 CFR Part 1021), DOE is preparing a draft Environmental Assessment (EA) to:

- Identify any adverse environmental effects and potential associated mitigation measures should this proposed action be implemented;
- Evaluate viable alternatives to the proposed action, including a no action alternative;
- Describe the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity; and
- Characterize any irreversible and irretrievable commitments of resources that would be involved should this proposed action be implemented.

The EA will describe and analyze any potential impacts on the environment that would be caused by the project and will identify possible mitigation measures to reduce or

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eliminate those impacts. The EA will describe the potentially affected environment and the impacts that may result to:

- Air Quality and Climate;
- Geology/Soils;
- Biological Resources;
- Water Resources;
- Waste Management and Hazardous Materials;
- Cultural and Historical Resources;
- Land Use;
- Noise;
- Infrastructure;
- Transportation and Traffic;
- Aesthetics;
- Human Health and Safety; and
- Socioeconomics and Environmental Justice.

DOE will make this letter available to all interested federal, state and local agencies to provide input on issues to be addressed in the EA. Agencies are invited to identify the issues, within their statutory responsibilities that should be considered in the EA. The general public is also invited to submit comments on the scope of the EA.

No formal public scoping meeting is planned for this project. Figures of the proposed project area are attached to this letter. This letter, as well as the draft EA, when available, will be posted on the DOE Golden Field Office online reading room: http://www.eere.energy.gov/golden/Reading_Room.aspx.

The DOE Golden Field Office welcomes your input throughout the NEPA process. Please provide any comments on this scoping letter on or before ***July 30th, 2010*** *to:*

John Jediny
NEPA Document Manager
Department of Energy
Energy Efficiency and Renewable Energy
(OIBMS-EE-3) Rm. 5H-095
1000 Independence Avenue
Washington, DC, 20585
John.Jediny@ee.doe.gov

We look forward to hearing from you.

Sincerely,

John Jediny
NEPA Document Manager

Heartland Community College

Wind Turbine Project Location

McLean County, Illinois

Heartland Community College
Wind Turbine Project Location
McLean County, Illinois

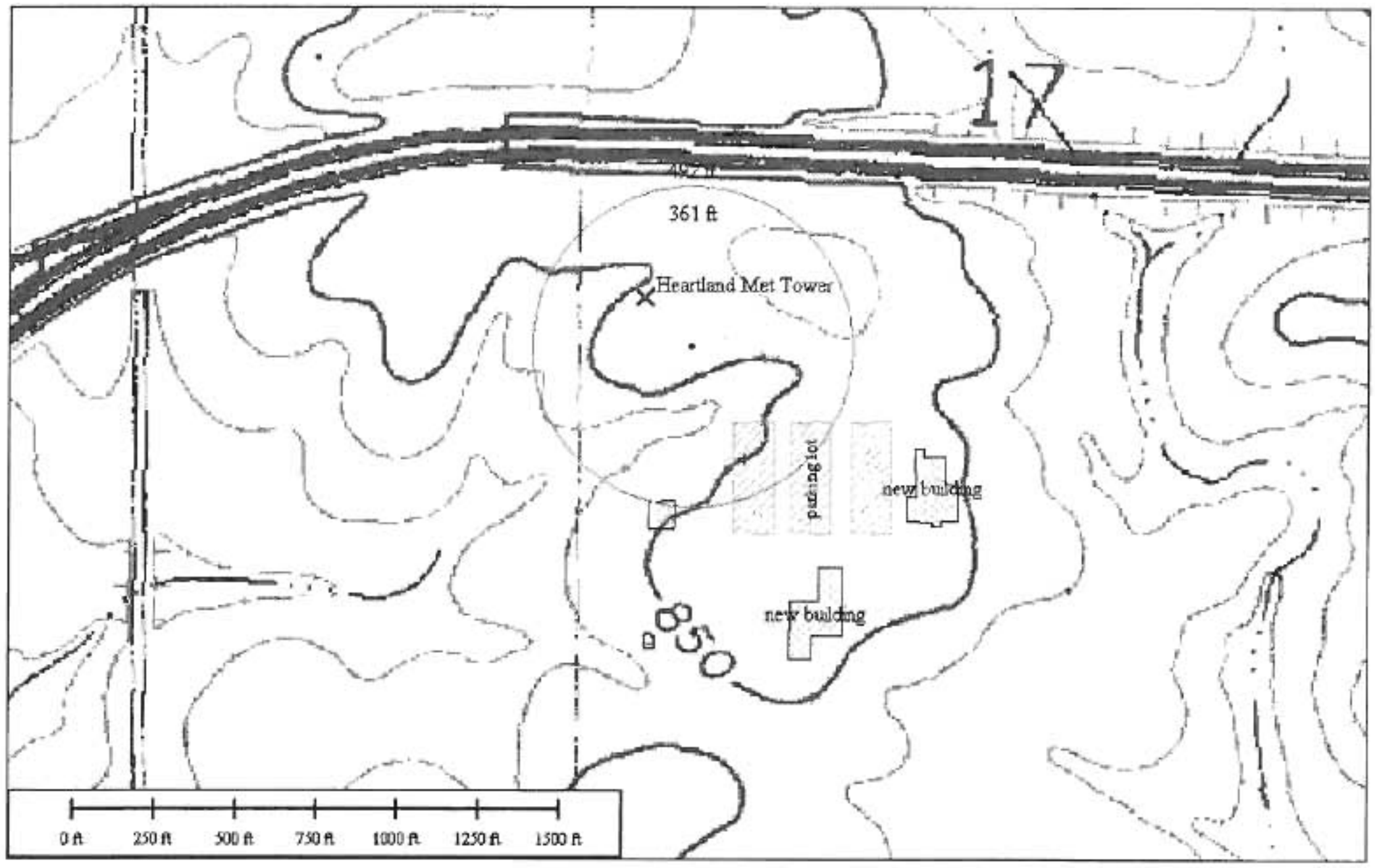

Figure 1 - Project Area- Topographical map

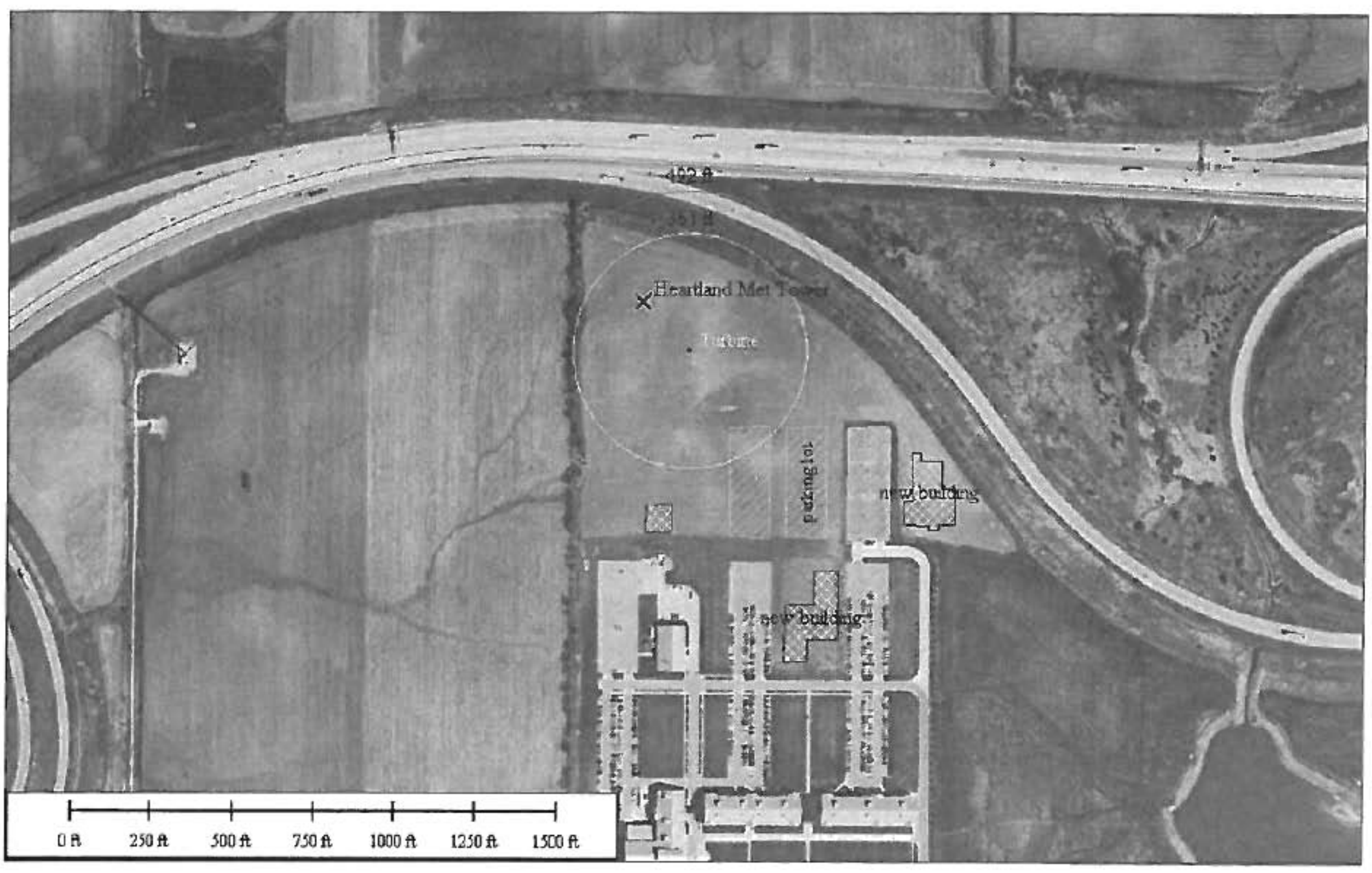

Figure 2 - Project Map- Aerial photo (Yellow ring - 1.1X, green ring – 1.5X)

NOTICE OF AVAILABILITY

The U.S. Department of Energy (DOE) is proposing to provide American Reinvestment and Recovery Act federal funding to the Illinois Department of Commerce and Economic Opportunity (DCEO) for Heartland Community College's (HCC) Wind Energy Project.

DOE's Proposed Financial Assistance to Illinois DCEO

Heartland Community College (HCC) Wind Energy Project

1500 W. Raab Rd., Normal, IL– McLean County

DOE/EA: 1807D

Heartland Community College is proposing to install a single 1.5 megawatt (MW) wind turbine on the north side of HCC's campus in Normal, IL. DOE's Golden Field Office has prepared a Draft Environmental Assessment (EA) in accordance with the National Environmental Policy Act (NEPA).

Comments on any potential issues and/or associated environmental impacts of implementing the proposed project will be accepted until ***October 16th, 2010*.** DOE encourages your participation in this process.

You can submit comments by either mail or email. DOE Headquarters, c/o John Jediny (EE-3C), 1000 Independence Ave., SW, Washington, DC 20585, or by email to: John.Jediny@ee.doe.gov.

The Draft Environmental Assessment, with appendices is available for your review on the **DOE Office of NEPA Compliance & Golden Field Office Websites**:

http://nepa.energy.gov/draft_environmental_assessments.htm

http://www.eere.energy.gov/golden/reading_room.aspx

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NOTICE OF AVAILABILITY

The U.S. Department of Energy (DOE) is proposing to provide American Reinvestment and Recovery Act federal funding to the Illinois Department of Commerce and Economic Opportunity (DCEO) for Heartland Community College's (HCC) Wind Energy Project.

DOE's Proposed Financial Assistance to Illinois DCEO
Heartland Community College (HCC) Wind Energy Project
1500 W. Raab Rd., Normal, IL- McLean County DOE/EA: 1807D

Heartland Community College is proposing to install a single 1.5 megawatt (MW) wind turbine on the north side of HCC's campus in Normal, IL. DOE's Golden Field Office has prepared a Draft Environmental Assessment (EA) in accordance with the National Environmental Policy Act (NEPA).
Comments on any potential issues and/or associated environmental impacts of implementing the proposed project will be accepted until October 16th, 2010. DOE encourages your participation in this process.
You can submit comments by either mail or email. DOE Headquarters, c/o John Jediny (EE-3C), 1000 Independence Ave., SW, Washington, DC 20585, or by email to: John.Jediny@ee.doe.gov.
The Draft Environmental Assessment, with appendices is available for your review on either the DOE NEPA or the Golden Field Office websites:

http://nepa.energy.gov/draft_environmental_assessments.htmhttp://www.eere.energy.gov/golden/Reading_Room.aspx

Oct 01, 2010 Save ad

Accounts Payable Clerk

We seek applicants for a full-time position responsible for accounts payable functions and processing payments for College and Foundation funds. Also serves as the primary liaison between the College and external vendors regarding accounts payable. Requires an associate's degree in a business oriented field of study or minimum of two years' related work experience. Preferred qualifications include keyboarding and accounting / accounts payable skills, familiarity with PeopleSoft or another ERP system, and proficiency with Microsoft Office products.
Review of applications will begin on October 11, 2010 and continue until position is filled. For consideration, please submit letter of application and resume to:

Human Resources
1500 W. Raab Road
Normal, IL 61761

Heartland Community College strategic goals affirm the value
of diversity among students
and employees. Heartland
Community College is an equal opportunity employer.

HEARTLAND
COMMUNITY COLLEGE

Sep 26, 2010 Save ad

Child Health and
Development Specialist

focus in Health and Nutrition
40 hrs/52 wks/yr., $14.48/hr.
5% incentive for Bilingual/
Spanish speaking individuals

Position requires two year degree in nursing and/or licensed RN, experience with an early childhood program is preferred. Excellent organizational skills, ability to communicate effectively, coordinate with various community agencies, pass DCFS background check, valid IL drivers license and reliable insured transportation. If qualified submit letter of interest, resume, 3 letters of recommendation and College transcripts by noon Sept. 28, 2010 to

Heartland Head Start, Attn: C Busick
206 Stillwell, Bloomington, IL 61701
or fax 309-662-9470. EOE

Sep 19, 2010 Save ad

COLLEGE PARK DR., 212 - Quiet, 2 bedroom, dishwasher, remodeled, No pets, $450/mo. Ph. 309-275-1829,
Close to Heartland, ISU, Parkside Dist.

Sep 10, 2010 Save ad

Heartland Apartment Management
Ph. 309-828-8105

Sep 04, 2010 Save ad

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HEARTLAND COMMUNITY COLLEGE

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- Proposed Funding for HCC's Wind Energy Project
- Heartland to Have Open House Oct. 11

More news and events

HCC Financial Aid now entirely online

Register for spring classes!

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Proposed Funding for HCC's Wind Energy Project

The U.S. Department of Energy (DOE) is proposing to provide American Reinvestment and Recovery Act federal funding to the Illinois Department of Commerce and Economic Opportunity (DCEO) for Heartland Community College's (HCC) Wind Energy Project.

View the official notice of availability* (in PDF format, 22 KB, 1 page) from the U.S. Department of Energy.

**Note: You must download and install Adobe® Acrobat® Reader™ in order to view and print the notice of availability.*

News & Events

- Spring Enrollment Going On Now!
- Proposed Funding for HCC's Wind Energy Project
- Heartland to Have Open House Oct. 11
- Fall 2010 Tuition Due
- HCC to Host Red Cross Blood Drive Oct. 13
- Attend the Health & Fitness Expo!
- Proposals Being Accepted for Assessment Fair
- Bio-degradable Heartland Refillable Travel Mugs
- HAC Presents Family Movie Toy Story 3 on Oct. 9

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APPENDIX D: ANALYSIS and SUPPORTING DOCUMENTATION

Attachment D-5: GE xle 1.5MW Specifications

GE Energy

1.5MW
Wind Turbine

imagination at work

a product of
ecomagination

The industry workhorse

The world needs a reliable, affordable and clean supply of electric power with zero greenhouse gas emissions, which is why GE continues to drive investment in cutting-edge wind turbine technology.

Building on a strong power generation heritage spanning more than a century, our 1.5 MW wind turbine—also known as the industry workhorse—delivers proven performance and reliability, creating more value for our customers.

Our product strategy is focused on results that contribute to our customers' success and wind farm return on investment. Every initiative we pursue bears our uncompromising commitment to quality and product innovation. Our reputation for excellence can be seen in everything we do. GE's commitment to customer value and technology evolution is demonstrated in our ongoing investment in product development. Since entering the wind business in 2002, GE has invested over $850 million in driving reliable and efficient wind technology.

GE 1.5 MW...the most widely used wind turbine in its class

- **12,000+** turbines are in operation worldwide
- **19** countries
- **170+** million operating hours
- **100,000+** GWh produced

Data as of March, 2009

Global footprint

GE Energy is one of the world's leading suppliers of power generation and energy delivery technologies—providing comprehensive solutions for coal, oil, natural gas and nuclear energy; renewable resources such as wind, solar and biogas, and other alternative fuels. As a part of GE Energy Infrastructure—which also includes the Water, Energy Services and Oil & Gas businesses—we have the worldwide resources and experience to help customers meet their needs for cleaner, more reliable and efficient energy.

GE has six wind manufacturing and assembly facilities in Germany, Spain, China and the United States. Our facilities are registered to both ISO 9001:2000 and our Quality Management System, providing our customers with quality assurance backed by the strength of GE. Our wind energy technology centers of excellence in Europe, Asia, and North America, as well as our teams of engineers and scientists, use Six Sigma methodology coupled with the latest computational modeling and power electronic analysis tools to manufacture wind turbines with the performance and reliability necessary to meet our customers' challenges.

As the cornerstone of GE technology for more than 100 years, our four Global Research Centers are focused on developing breakthrough innovations in the energy industry. We believe wind power will be an integral part of the world energy mix throughout the 21st century and we are committed to helping our customers design and implement energy solutions for their unique energy needs.

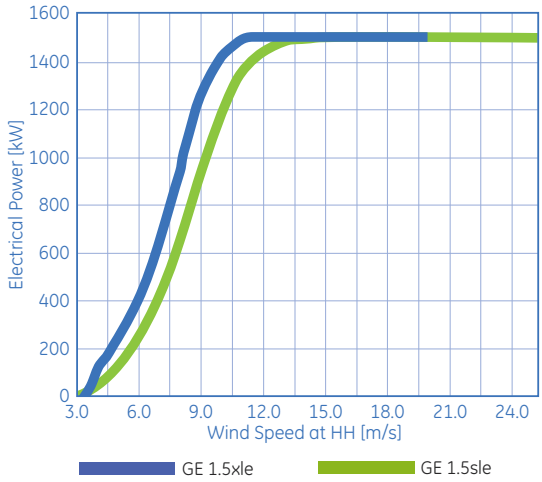
Advancing wind capture performance

As a leading global provider of energy products and services, GE continues to invest in advancing its 1.5 MW wind turbine product platform. With a core focus on enhancing efficiency, reliability, site flexibility and delivering multi-generational product advancements, GE's 1.5 MW wind turbine is the most widely used turbine in its class. Our commitment is to fully understand our customer's needs and respond with new technology enhancements aimed at capturing maximum wind energy to deliver additional return on investment.

Technical data

		1.5sle	1.5xle
Operating Data			
Rated Capacity:		1,500 kW	1,500 kW
Temperature Range: (with Cold Weather Extreme Package)	Operation:	-30°C – +40°C	-30°C – +40°C
	Survival:	-40°C – +50°C	-40°C – +50°C
Cut-in Wind Speed:		3.5 m/s	3.5 m/s
Cut-out Wind Speed (10 min avg.):		25 m/s	20 m/s
Rated Wind Speed:		14 m/s	11.5 m/s
Wind Class — IEC:		IIa (V_{e50} = 55 m/s V_{ave} = 8.5 m/s)	IIIb (V_{e50} = 52.5 m/s V_{ave} = 8.0 m/s)
Electrical Interface			
Frequency		50/60 Hz	50/60 Hz
Voltage		690V	690V
Rotor			
Rotor Diameter:		77 m	82.5 m
Swept Area:		4657 m^2	5346 m^2
Tower			
Hub Heights:		65/80 m	80 m
Power Control		Active Blade Pitch Control	Active Blade Pitch Control

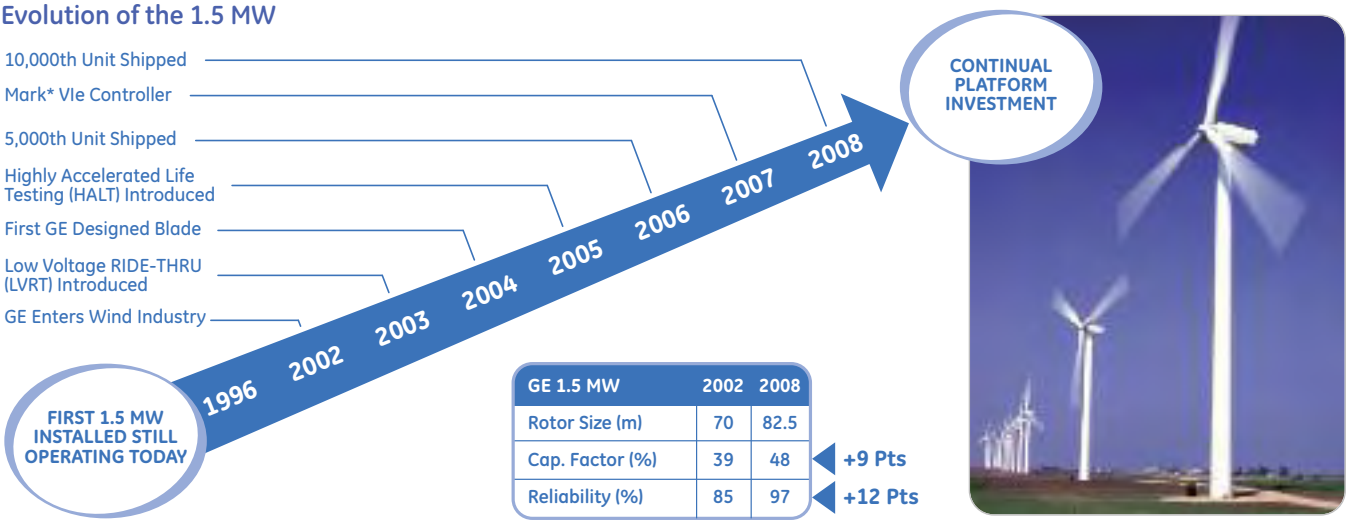
Power curve



1.5sle — *Classic workhorse, an efficient and reliable machine with proven technology*
1.5xle — *Built on the success of the 1.5sle platform, captures more wind energy with 15% greater swept area*

GE's 1.5 MW wind turbine is designed to maximize customer value by providing proven performance and reliability. GE's commitment to customer satisfaction drives our continuous investment in the evolution of the 1.5 MW wind turbine through technological enhancements.

Evolution of the 1.5 MW



GE 1.5 MW	2002	2008
Rotor Size (m)	70	82.5
Cap. Factor (%)	39	48
Reliability (%)	85	97

+9 Pts
+12 Pts

Commitment to continued investment

GE's commitment to investing in technology and increasing customer value is demonstrated with our exciting new customer options for increasing turbine performance, flexibility and reliability.

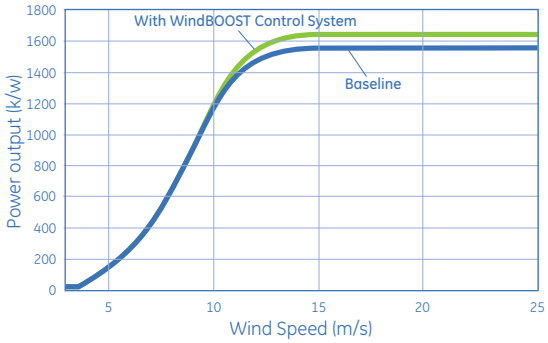
Enhanced performance

WindBOOST* Control System

This exciting new customer option for increasing performance, WindBOOST* control system, is a unique offering in the wind industry and the latest addition to the 1.5 MW product platform. This software upgrade provides:

- Up to 4% increased annual energy production (AEP), resulting in higher return on investment.
- Patent-pending control technology for optimum rotational speed, resulting in increased energy production.
- Remote capability to turn feature on and off at the turbine level.
- Increased power output while maintaining grid stability.

WindBOOST* Control System
Power Curve Density 1.2 (kg/m^3)



Improved flexibility

Reinforced Tower

GE's investment in a reinforced tower design opens up new potential wind sites for our customers, enabling us to deliver reliable and safe products that meet product and regulatory compliance expectations. GE's reinforced tower sections have the same length and external diameter as the standard GE North American modular system, but are specially built to handle seismic loads.

- Allows wind farms to be located in designated seismic prone areas with good wind resources.
- GE provides an evaluation to determine if the site requires reinforced tower due to seismic activity.

Increased reliability

Condition Based Maintenance (CBM)

GE Energy's integrated Condition Based Maintenance (CBM) system proactively detects impending drive train issues, enabling increased availability and decreased maintenance expenses. Factory or field installed and tested, the CBM solution can improve reliability on a single wind farm or multiple wind farms. GE's CBM allows operators to understand an issue weeks—or even months—in advance. This permits operators to:

- Continue to produce power while parts, crane, and labor are resourced.
- Plan multiple maintenance events with the same resources.
- Reduce or limit the extent of damage to the drivetrain and reduce repair costs.

Leading reliability and availability perform

GE's 1.5 MW wind turbine and services are designed to set the industry standard for product reliability and availability performance. GE's continual investments in technology, established infrastructure, research capabilities and globally recognized business processes allow GE to create and deliver customer value by maximizing energy capture and return on investment. This is evident through our model year performance trend where availability performance significantly improves each year.

GEARBOX

- HALT testing on every design
- Cylindrical roller bearings
- Improved oil filtration, heating and cooling

MAIN SHAFT

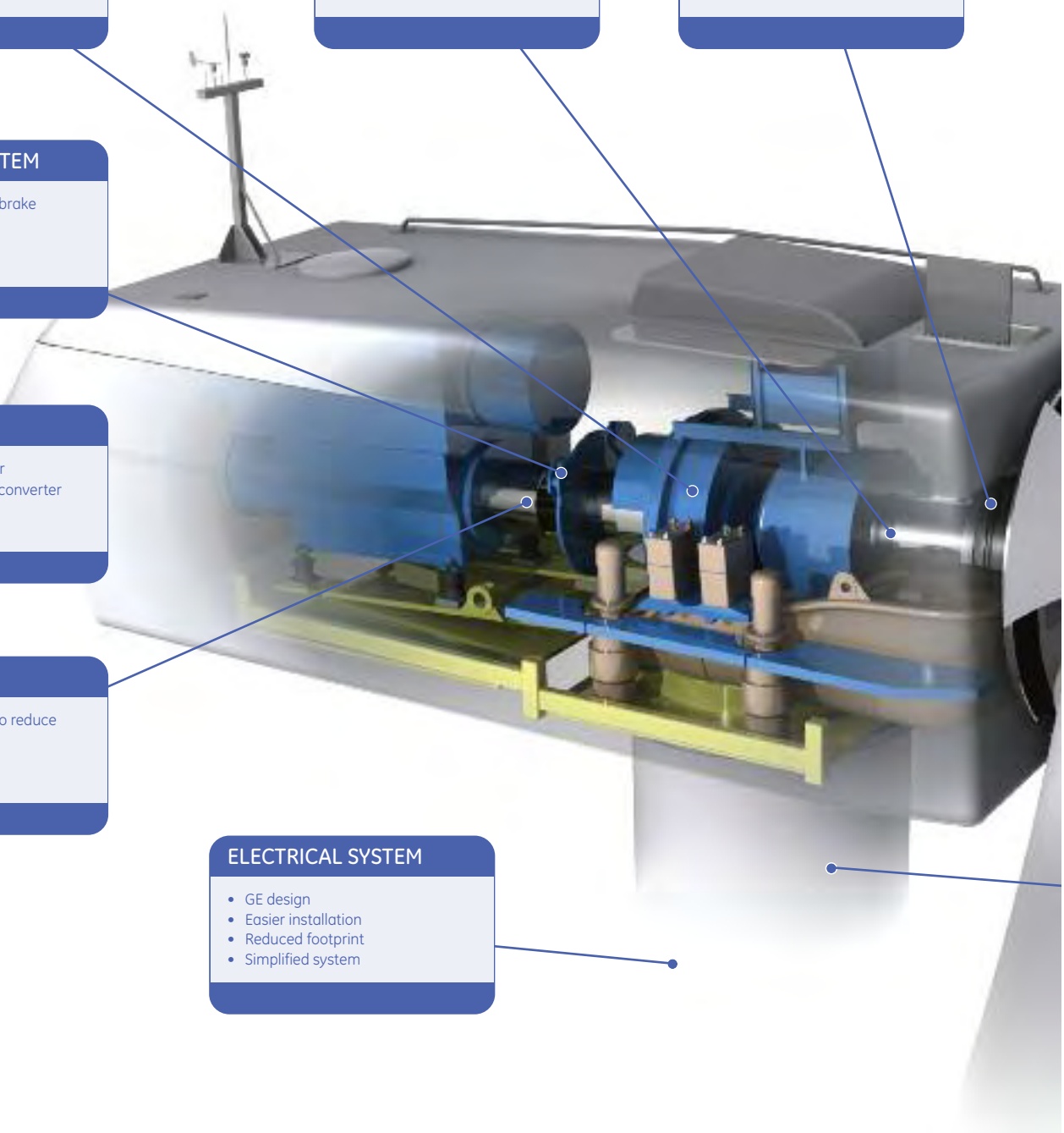
- Material upgrade
- Expanded operating range

MAIN BEARING

- Increased bearing robustness

SOFT BRAKE SYSTEM

- Hydraulic secondary brake



CONTROL

- GE Mark VIe controller
- Integrated pitch and converter diagnostics

COUPLING

- Slip coupling design to reduce gearbox loads

ELECTRICAL SYSTEM

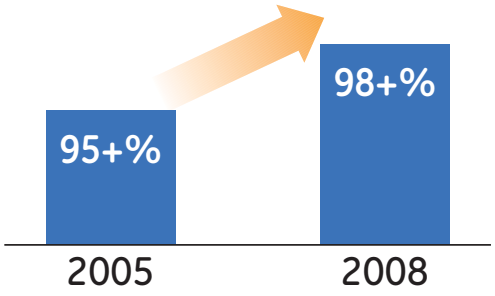
- GE design
- Easier installation
- Reduced footprint
- Simplified system

ance

Delivering reliability through advanced technology

To optimize turbine reliability and availability, GE focuses on reducing the number of downtime faults, and providing faster Return-to-Service (RTS). Our rigorous design and testing process—including specialized 20-year fatigue testing and Highly Accelerated Life Testing (HALT)—reflects our ongoing investment in key turbine components.

1.5 model year availability



PITCH

- GE designed pitch electronics
- Increased pitch drive robustness
- Greater torque

BLADES

- Includes GE designs
- Improved capacity factor
- HALT testing

TOWER

- Modular tower system
- Hub height flexibility

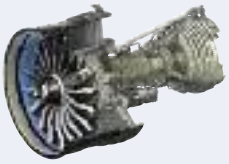
Technological expertise

GE Infrastructure

Energy

- Controls, materials, power electronics
- Fulfillment and logistics capability
- Efficient supply chain management

Aviation



Aerodynamic and aero-acoustic modeling expertise

Rail

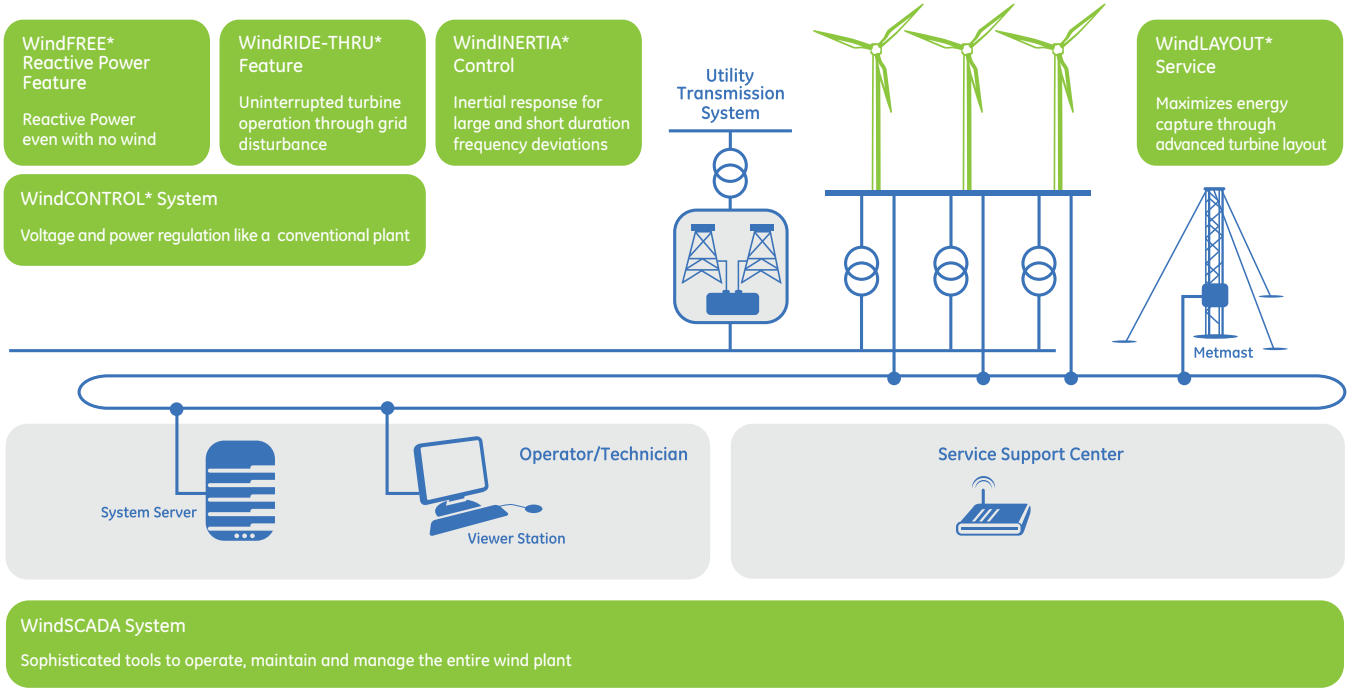
Gearbox and drive train technologies

GE Global Research

- Energy conversion
- Material sciences
- Smart grids

Optimized wind power plant performance

Wind turbine performance is a critical issue in light of increasingly stringent grid requirements. GE's unrivaled experience in power generation makes us the industry leader in grid connection. By providing a sophisticated set of grid-friendly benefits similar to conventional power plants, GE's patented integrated suite of controls and electronics take your wind power plant to the frontline of performance and seamless grid integration.



FEATURE	DESCRIPTION	BENEFITS
WindCONTROL* System	Voltage and power regulation like a conventional power plant	Ability to supply and regulate reactive and active power to the grid Additional features include power frequency droop, power ramp rate limiters and integrated capacitor/reactor bank control
WindFREE* Reactive Power Feature	Provides reactive power even with no wind	Provides smooth fast voltage regulation by delivering controlled reactive power through all operating conditions Eliminates the need for grid reinforcements specifically designed for no-wind conditions
WindRIDE-THRU* Feature	Low voltage, zero voltage and high voltage ride-through of grid disturbances	Uninterrupted turbine operation through grid disturbances Meets present and emerging transmission reliability standards
WindINERTIA* Control	Provides temporary boost in power for under-frequency grid events	Provides inertial response capability to wind turbines that is similar to conventional synchronous generators without additional hardware
WindLAYOUT* Service	Service to optimize turbine layout for a site	Opportunity to increase annual energy production for a site
WindSCADA System	Tools to operate, maintain and manage wind power plant	Real-time data visualization, reporting on historical data, alarm management and secure user access

Project execution

GE understands that grid compatibility, site flexibility, and on-time delivery are critical to the economics of a wind project. That's why the 1.5 MW wind turbine has been engineered for ease of integration and delivery to a wide range of locations, including those with challenging site conditions.

Our global project management and fulfillment expertise offer customers on-time delivery and schedule certainty. Regardless of where wind turbine components are delivered, GE's integrated logistics team retains ownership and responsibility for this critical step. Utilizing the GE Energy Power Answer Center, our engineering and supply chain teams are ready to respond to any technical, mechanical or electrical questions that may arise.

As one of the world's largest power plant system providers, GE is uniquely positioned to provide customers with full-service project management solutions. With offices in North America, Europe, and Asia, our world class Global Projects Organization utilizes decades of fulfillment expertise in project management, logistics, plant start-up and integration from Gas Turbine, Combined Cycle, Hydro, and Aero plants.

Here are some examples of how GE has worked with customers to solve project challenges and maximize their value through on-time delivery and advanced logistic capabilities:

Challenge:
Site with late grid availability due to project location change

GE's solution:
Pre-commissioning service: GE can bring portable generators on site and pre-commission turbines even without back feed power

Customer benefit:
Faster commissioning once grid became available

Challenge:
Project site with difficult geographic access

GE's solution:
Well-choreographed team with challenging terrain transportation expertise

Customer benefit:
More site flexibility; schedule target met

World-class customer service

GE's wind turbine fleet is one of the fastest growing and best-run fleets in the world. Utilizing our decades of experience in product services in the power generation industry, GE provides state-of-the-art solutions to ensure optimal performance for your wind plant.

24x7 Customer Support

GE's customer support centers in Europe and the Americas provide remote monitoring and troubleshooting for our installed fleet of wind turbines around the world, 24 hours a day, 365 days a year. The customer support centers are able to quickly perform remote resets for over 250 turbine faults. It is one of the most effective ways to ensure continuous monitoring and fault resets of your wind assets by qualified technology experts.

Technical Skills and In-depth Product Knowledge

GE's wind customer support centers have dedicated teams to dispatch for troubleshooting, repair and maintenance, available 24 hours a day, 365 days a year. This model ensures wide coverage of large wind turbine fleets without compromising technical skills or quality.

GE taps into our extensive product knowledge for timely resolution of many issues. All turbine faults are investigated using a structured technical process, which is then escalated as necessary. We also use feedback from this process in product development.

Operations and Maintenance Support

Driven by a highly skilled work force and the operating knowledge of over 12,000 1.5 MW wind turbines, GE offers a wide range of services tailored to the operation and maintenance needs of your wind assets. Our offerings range from technical advisory services, transactional services and remote operations to full on-site operations support including availability guarantees.

Parts Offerings

GE has utilized the extensive Parts and Refurbishment experience of its Energy Services business to establish a global center of excellence for wind parts operations. The wind parts resources are aligned to provide a full range of offerings for all types of parts and refurbishment needs, including routine maintenance kits, consumables and flow parts, and key capital parts such as gearboxes and blades.

With the launch of our 24/7 parts call center (877-956-3778), and the development of online ordering tools, we are increasing the channels that our wind plant operators can utilize to order required wind turbine parts, including emergency requests for down-turbine needs.

For wind plant operators looking for additional benefits that a contractual parts relationship with GE can offer, the wind parts team has developed tailored offerings that can provide ongoing inventory-level support and parts lead-time guarantees. One of the exciting advantages of a GE wind parts and refurbishment program is membership in the capital parts pool, with a priority access to often hard-to-source capital parts.

Conversions, Modifications and Uprates (CM&U)

Continuous technological improvements are key for GE to be a world leader in the wind industry. Our CM&U offerings utilize the new technology developments in the 1.5 MW platforms to improve the performance of existing assets. These offerings are designed to improve reliability and availability, and increase turbine output and improve grid integration.

Long-Term Asset Management Support

GE is your reliable partner as we strive to build long-term relationships with asset managers. Utilizing our strengths, we can provide parts solutions, field technician and customer training, and a wide range of specialized services to complement local on-site capabilities.

Environmental Health and Safety, a GE commitment

Maintaining high Environmental Health and Safety (EHS) standards is more than simply a good business practice; it is a fundamental responsibility to our employees, customers, contractors, and the environment we all share.

GE is committed to maintaining a safe work environment. We incorporate these values into every product, service and process, driving EHS processes to the highest standards.

Powering the world...responsibly.

For more information, please visit
www.ge-energy.com/wind
or contact your GE Energy sales representative at
800-821-2222

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*WindFREE, WindINERTIA, WindBOOST and Mark VIe are trademarks of General Electric Company.
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APPENDIX D: ANALYSIS and SUPPORTING DOCUMENTATION

Attachment D-6: IHPA List of Historic Illinois Tribes

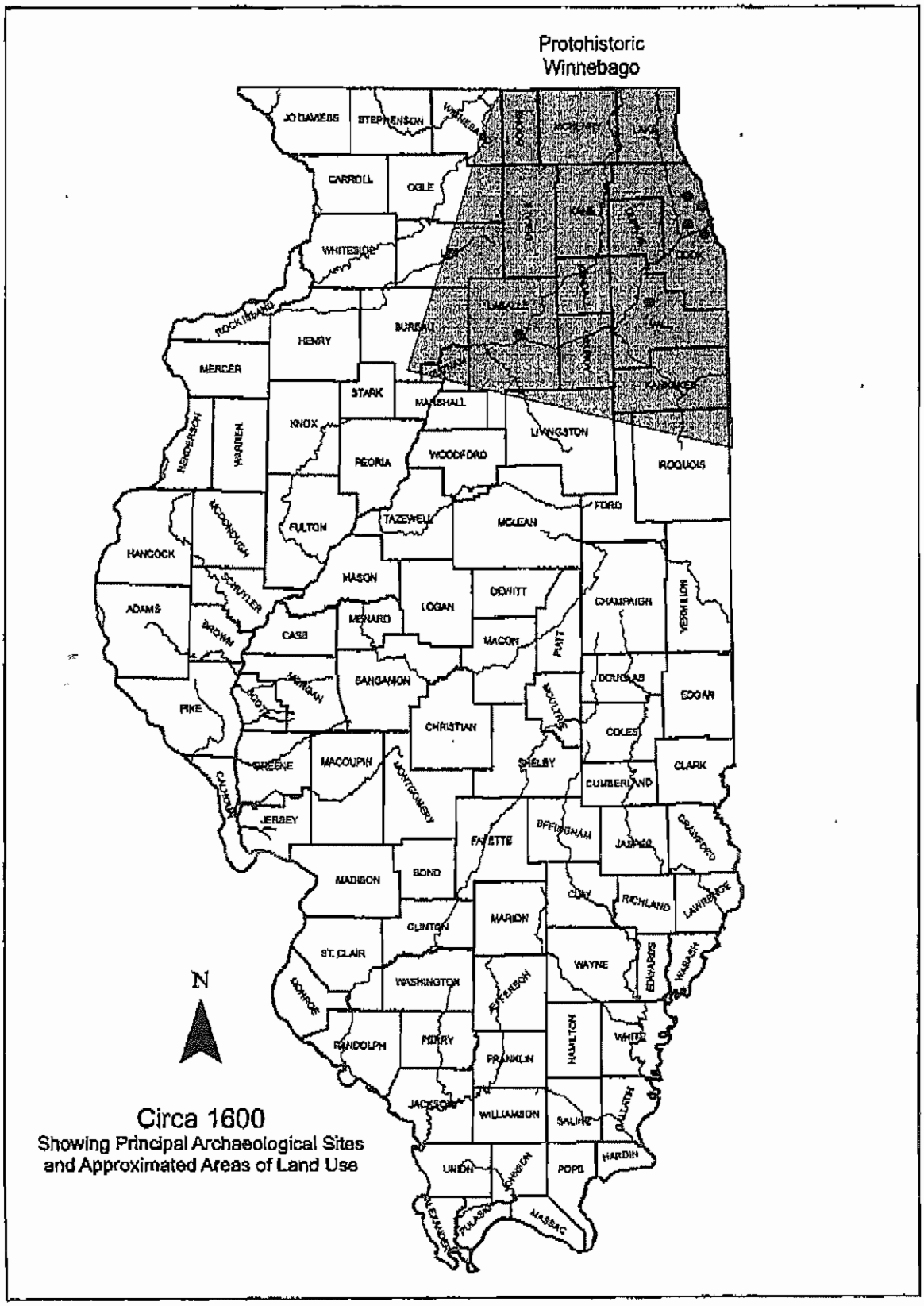
Illinois Tribal Consultation Workshop Tribe Contact List

Tribe (in alphabetical order)	Main workshop contact identified	Tribe Attended Nov. 5th-6th Workshop
Absentee Shawnee Nation of Oklahoma	Karen Kaniatobe, NAGPRA Rep 2025 Gordon Cooper Drive Shawnee, Oklahoma 74801 main office: (405) 275-4030 x 199 fax: (405) 878-4533 email: kkaniatobe@astribe.com	No
Ho Chunk Nation of Wisconsin	Bill Quackenbush, THPO W9815 Airport Road Black River Fall, WI 54615 (715) 284-7181 Bill.Quackenbush@ho-chunk.com	Yes
Iowa Tribe of Kansas and Nebraska	Pat Murphy American Indian Art Center 206 S. Buckeye Abilene, KS 67410 (785) 263-0090 indart@ikansas.com	Yes
Kaw Nation	Crystal Douglas (580) 269-2552 cdouglas@kawnation.com Ray Ball (580) 269-2552 rball@kawnation.com	Yes
Kickapoo Tribe of Kansas	Joe Williams, NAGPRA Rep 1107 Goldfinch Road Horton, KS 66439 (785) 486-2601 x 2110 Joe.Willaims@ktik-nsn.gov	Yes

Kickapoo Tribe of OK	Kent Collier P.O. Box 70 McCloud, OK 74851 (405) 964-2075 kentcollier2000@yahoo.com	No
Omaha Tribe NE	Tony Provost omaharedman@yahoo.com 402-846-5167	No
Osage	Dr. Andrea A. Hunter, THPO Osage Nation 627 Grandview P.O. Box 779 Pawhuska, OK 74056 ahunter@osagetribe.org	Yes
Peoria	Mr. John P. Froman, Chief Peoria Tribe of Indians of Oklahoma P.O. Box 1527 Miami, OK 74355 (918) 540-2535	No
Pokagon Band Of Potawatomi	Mark Parish, THPO 58620 Sink Road Dowagiac, MI 49047 (269) 782-9602	No
Ponca Tribe Nebraska	Larry Wright ldwrightjr@gmail.com 402-540-7122 Gary Robinette garyr@poncatribe-ne.org 402-857-3519 Rick Wright berrick@cableone.net 402-371-9577	Yes
Ponca Tribe OK	Delbert Cole wanxe_sabe@hotmail.com 580-762-5818	No

Potawatomi Hannahville Indian Community	Earl Meshiguad Hannahville Indian Community N14911 Hannahville Boulevard Road Wilson, MI 49896 (906)-723-2271 earlmeshiguad@hannahville.org	No
Potawatomi-Citizen Band	Jeremy Finch, THPO 1601 Gordon Copper Drive Shawnee, OK 74801 jfinch@potawatomi.org (405) 878-4672	No
Potawatomi-Prairie Band	Steve Ortiz (785) 966-4000 stevo@pbpnation.org	Yes
Potowatomi-Forest County Community	Mr. Philip Shopodock, Chairman Executive Council Forest County Potawatomi Community P. O. Box 340 Crandon, WI 54520 Mike Alloway (715) 478-7474	No
Quapaw	Mr. John Berrey, Chairman Quapaw Tribal Business Committee P.O. Box 765 Quapaw, OK 74363 (918) 542-1853 Fax: (918) 542-4694 john.berrey@qdsllc.com Aditional contact identified: Ardina Moore 918-397-5308 918-542-8870 ardina@sbcglobal.net	No

Sac and Fox Nation of Mississippi in IOWA	Mr. Jonathan Buffalo, NAGPRA Rep. Sac & Fox Tribe of Mississippi 349 Meskwaki Road Tama, IA 52339 (641) 484-4678 NEW NUMBER: (641) 484-3185 jbuffalo@meskwaki.org	No
Sac and Fox Nation of Missouri	Kirby Rubidoux, NAGPRA Rep 305 N Main Street Reserve, KS 66465 (785) 742-7471	No
Sac and Fox Nation of OK	Sandra Massey, NAGPRA Rep Route 2, Box 246 Stroud, OK 74079 (918) 968-3526 smassey@sacandfoxnation-nsn.gov	Yes
Winnebago Tribe of Nebraska	David Smith P.O. Box 687 Winnebago, NE 68071 (402) 878-2380 theking@huntel.net	No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WHITESIDE
LEE
DUPAGE
ROCK ISLAND
HENRY
BUREAU
LASALLE
GRUNDY
WILL
MERCER
STARK
MARSHALL
KANKAKEE
KNOX
LIVINGSTON
HENDERSON
WARREN
PEORIA
WOODFORD
IROQUOIS
MCDONOUGH
FULTON
TAZEWELL
MCLEAN
FORD
HANCOCK
MASON
DEWITT
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ADAMS
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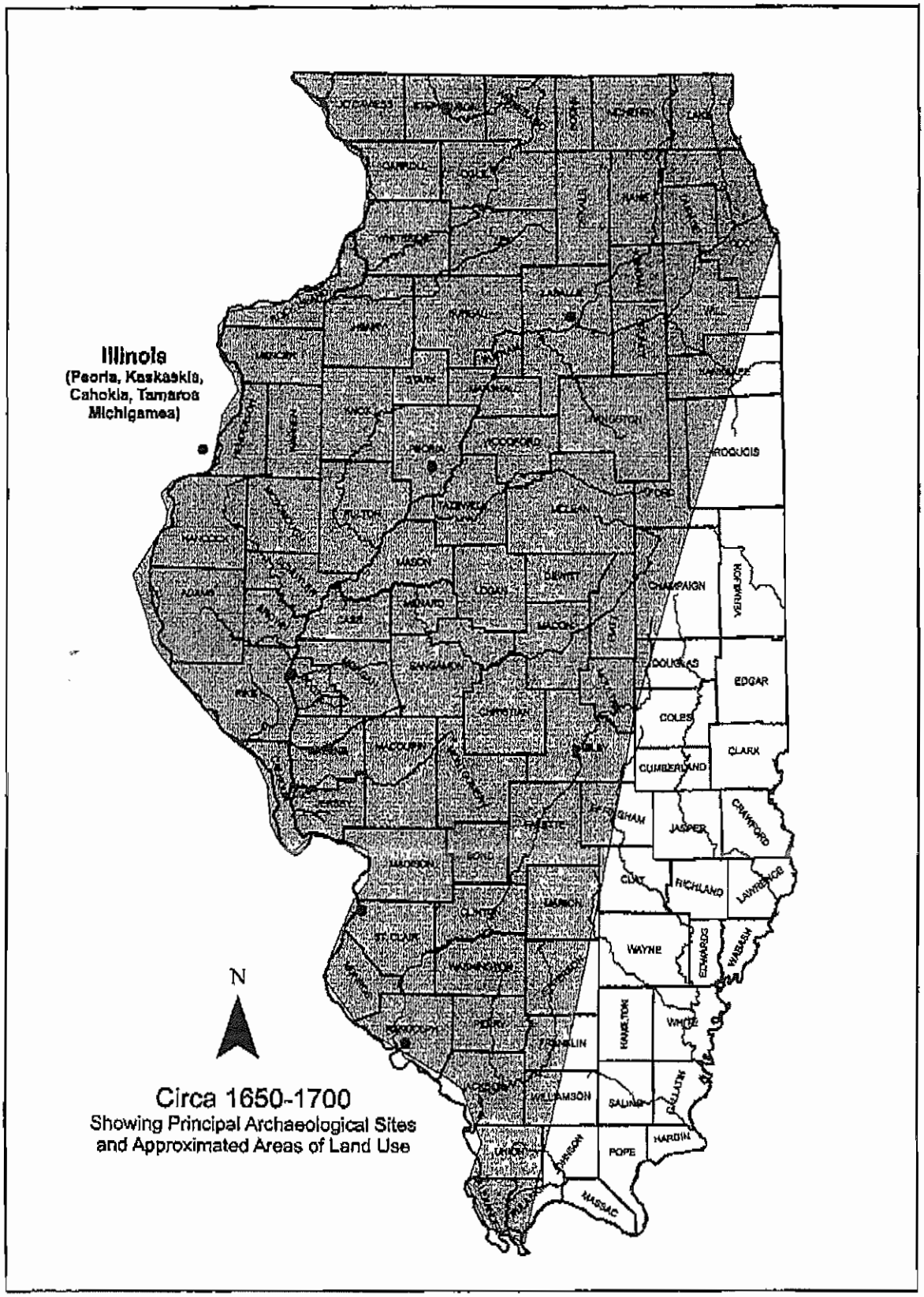
and Approximated Areas of Land Use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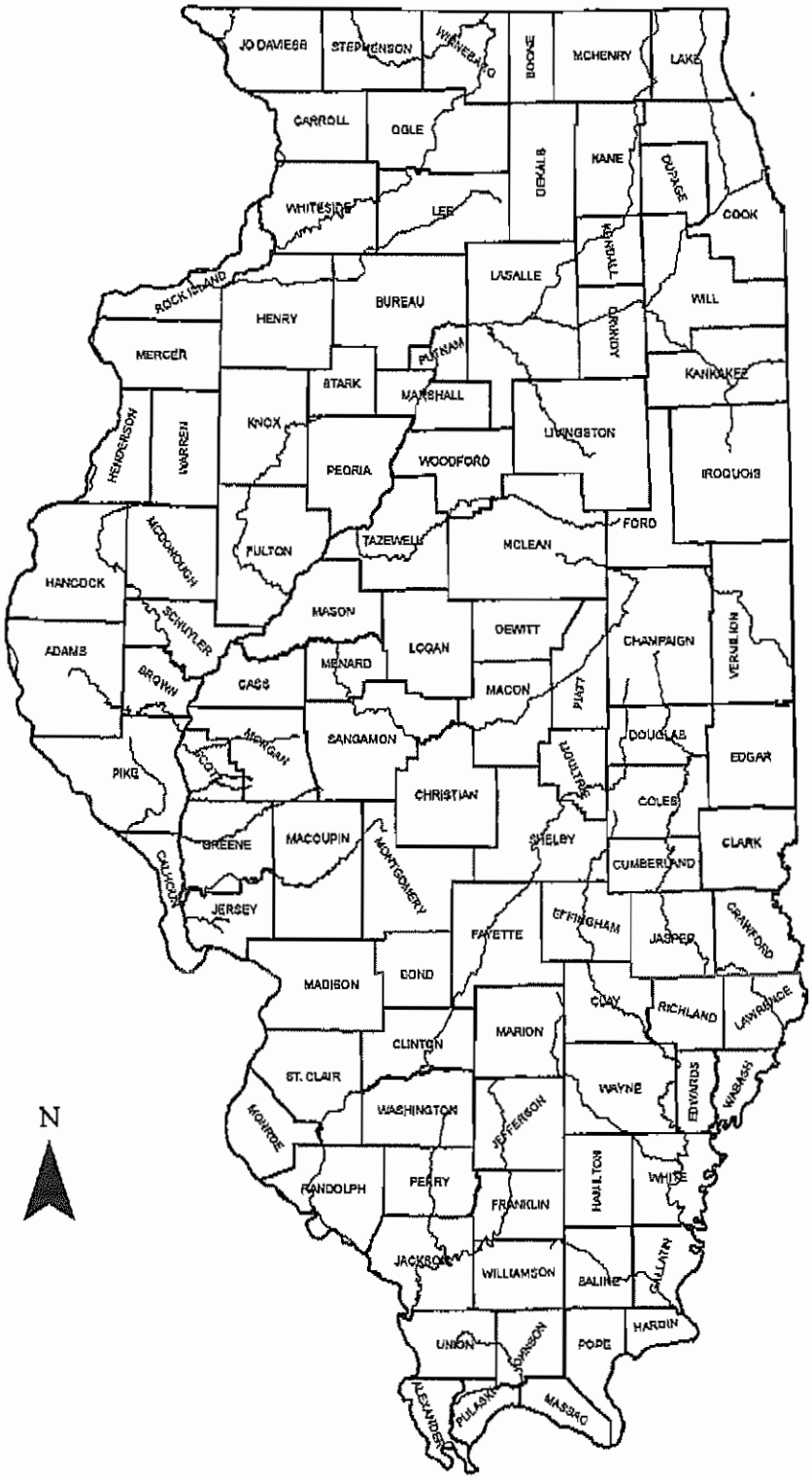
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LASALLE
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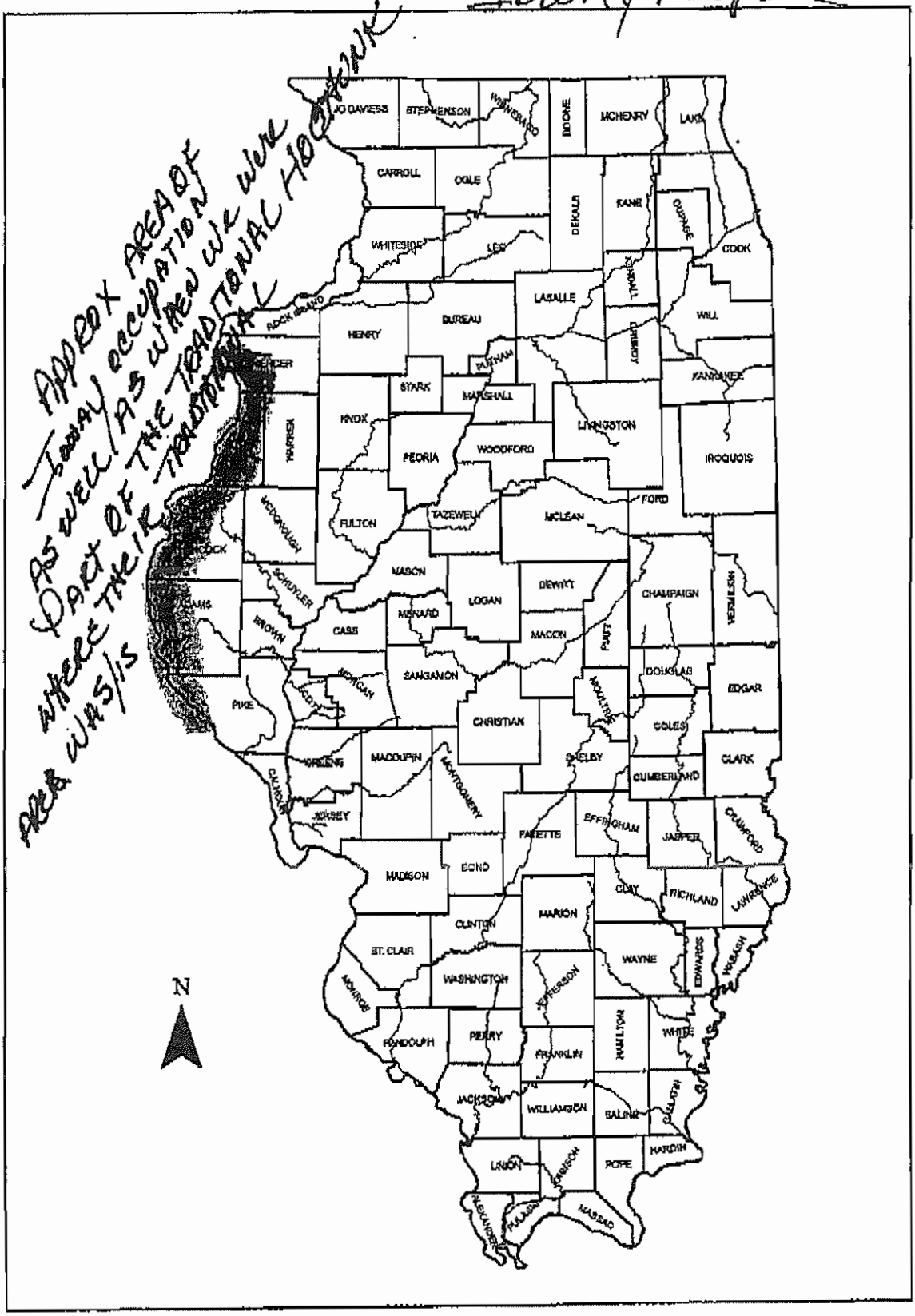
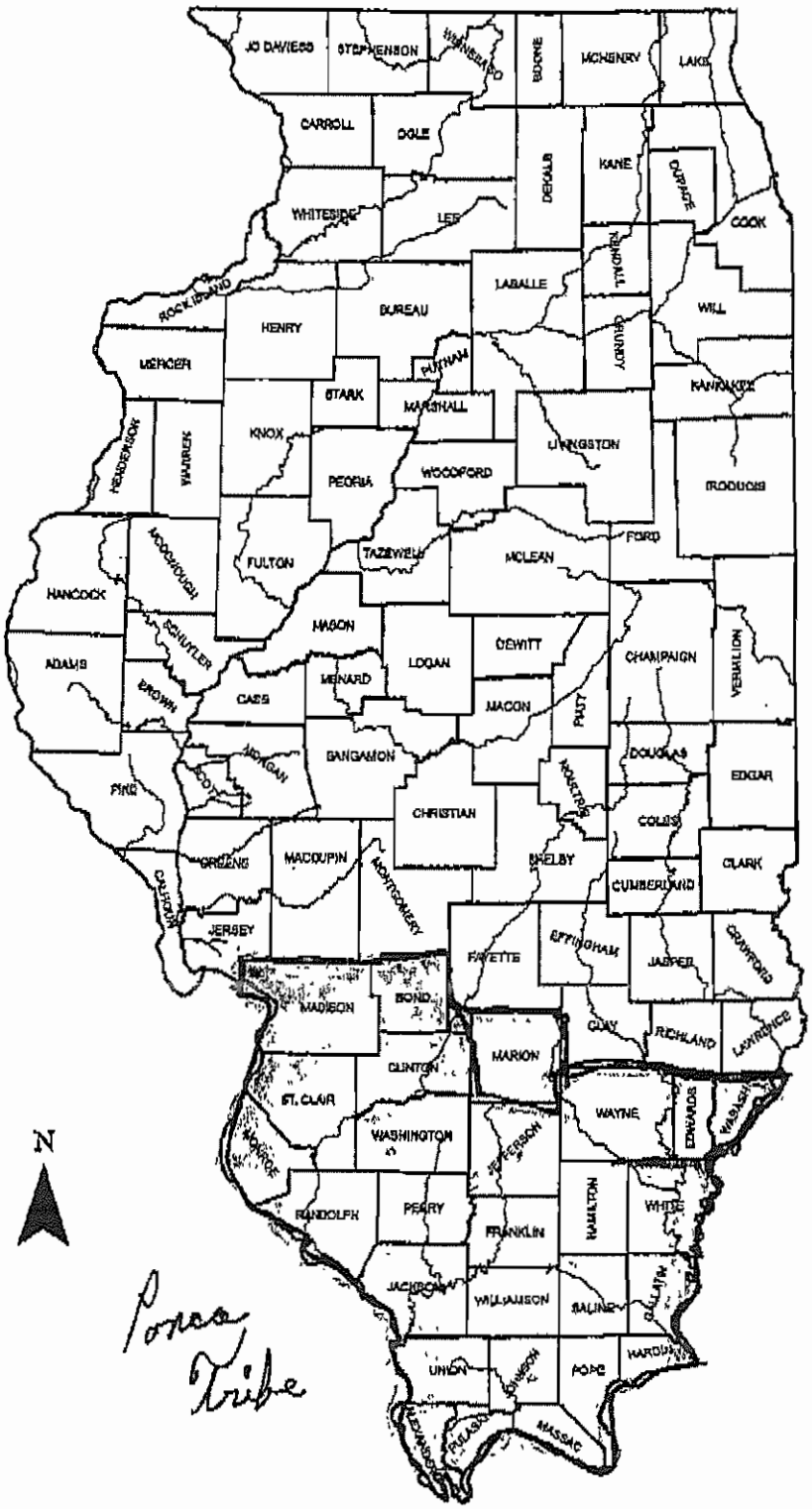
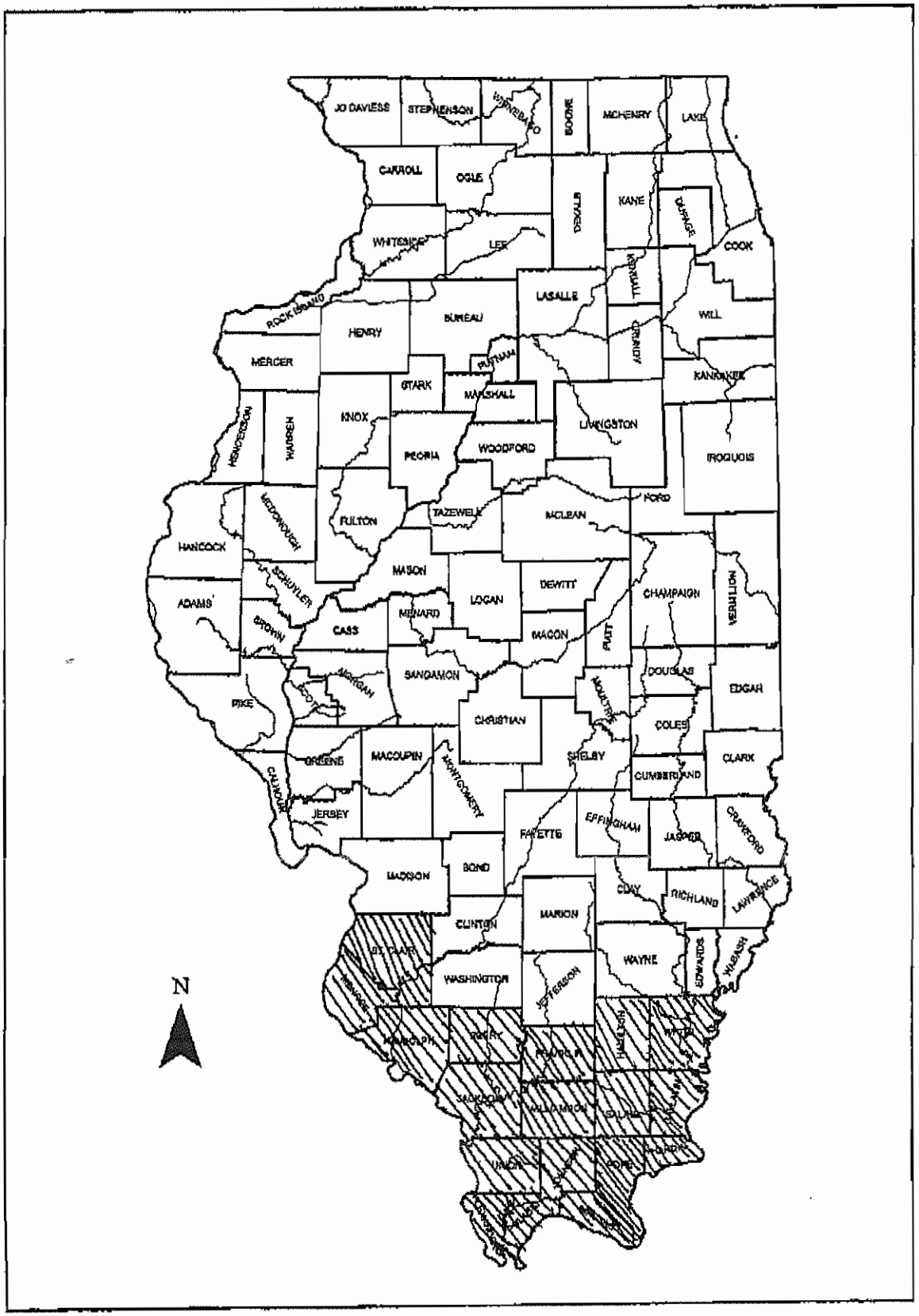


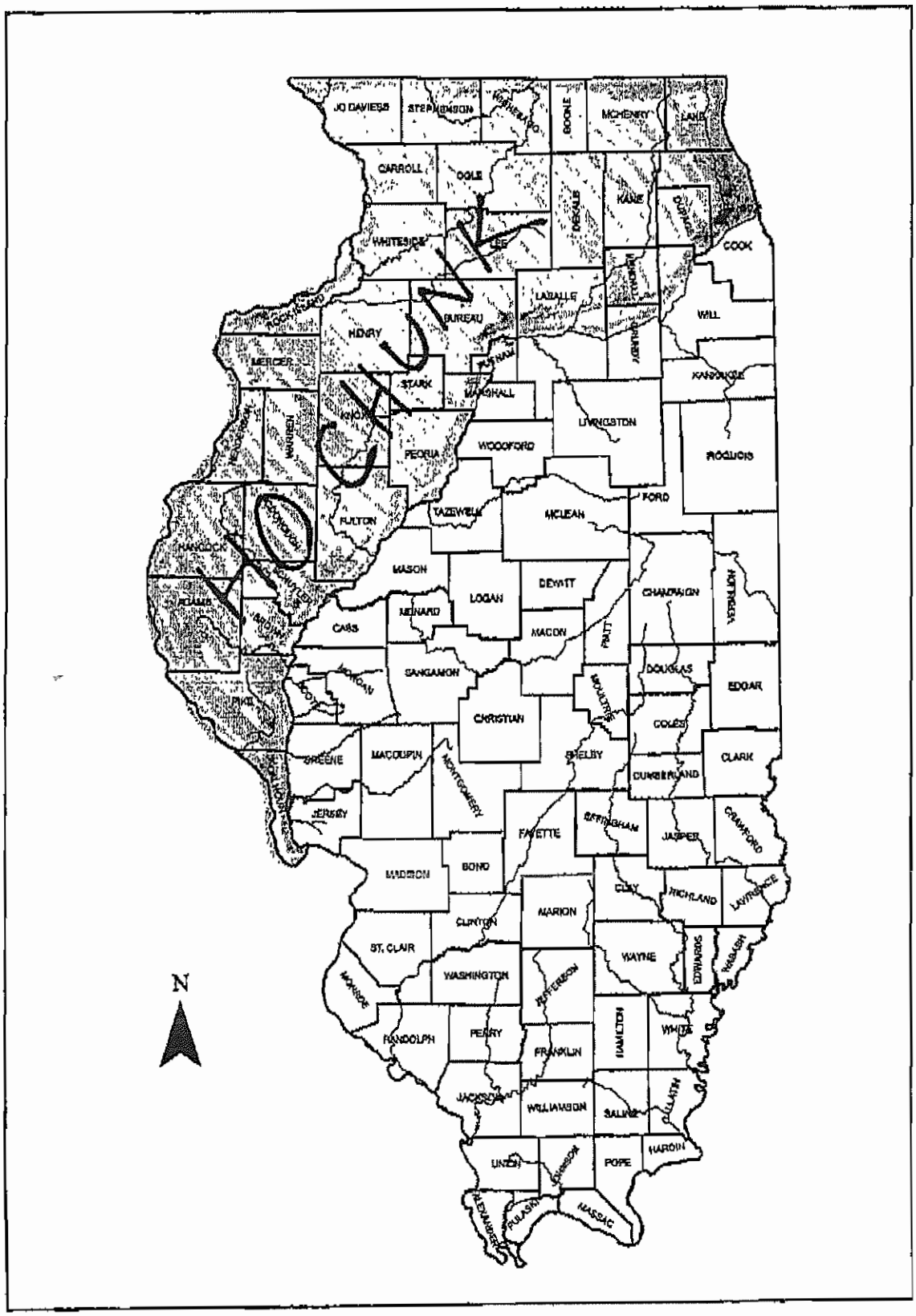
PONCA TRIBE OF NEBRASKA



580 267-2512
1-866-404-5297
cdouglas@kawnation.com

KAW Nation
Crystal Douglas

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KANE
DUPAGE
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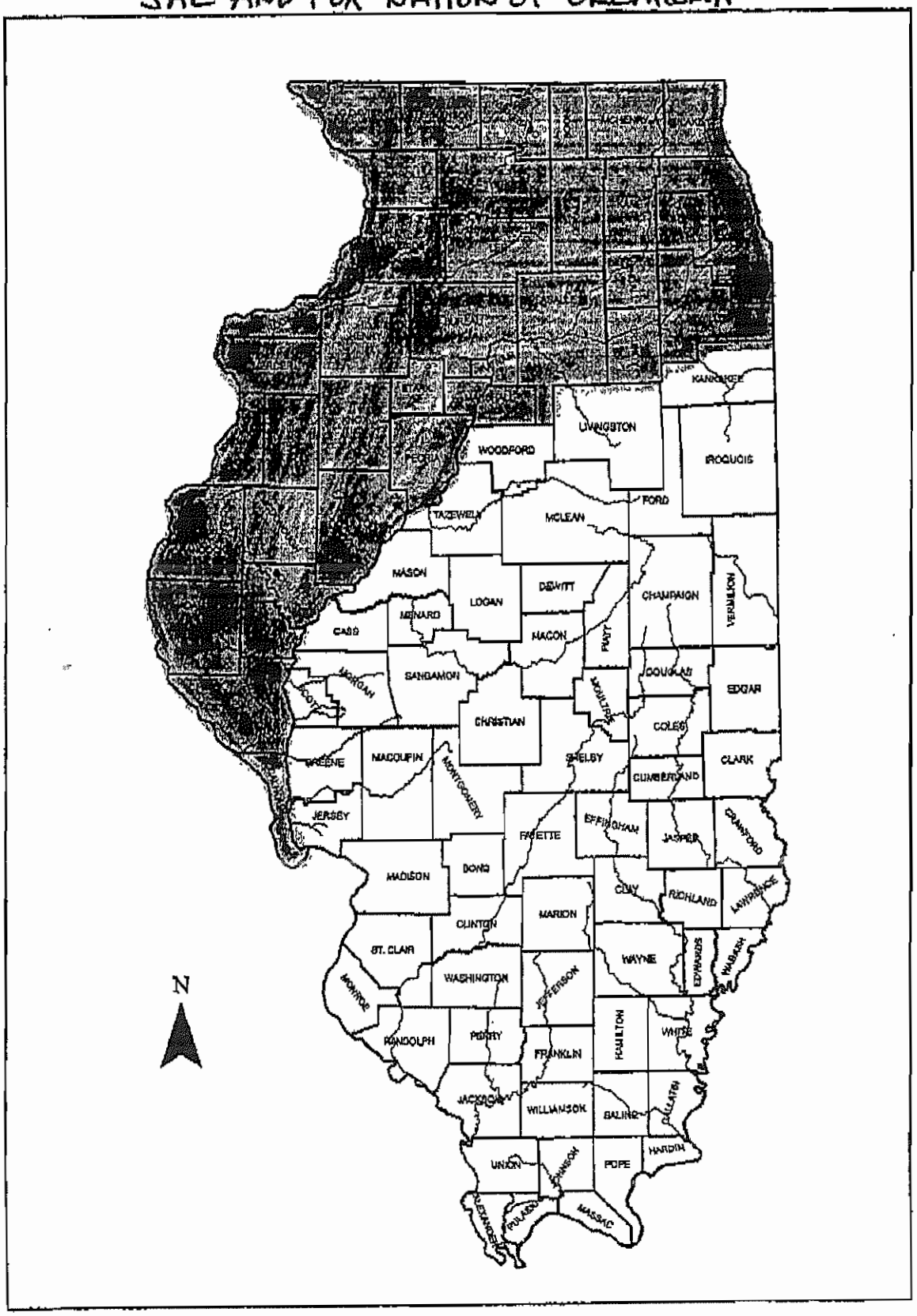
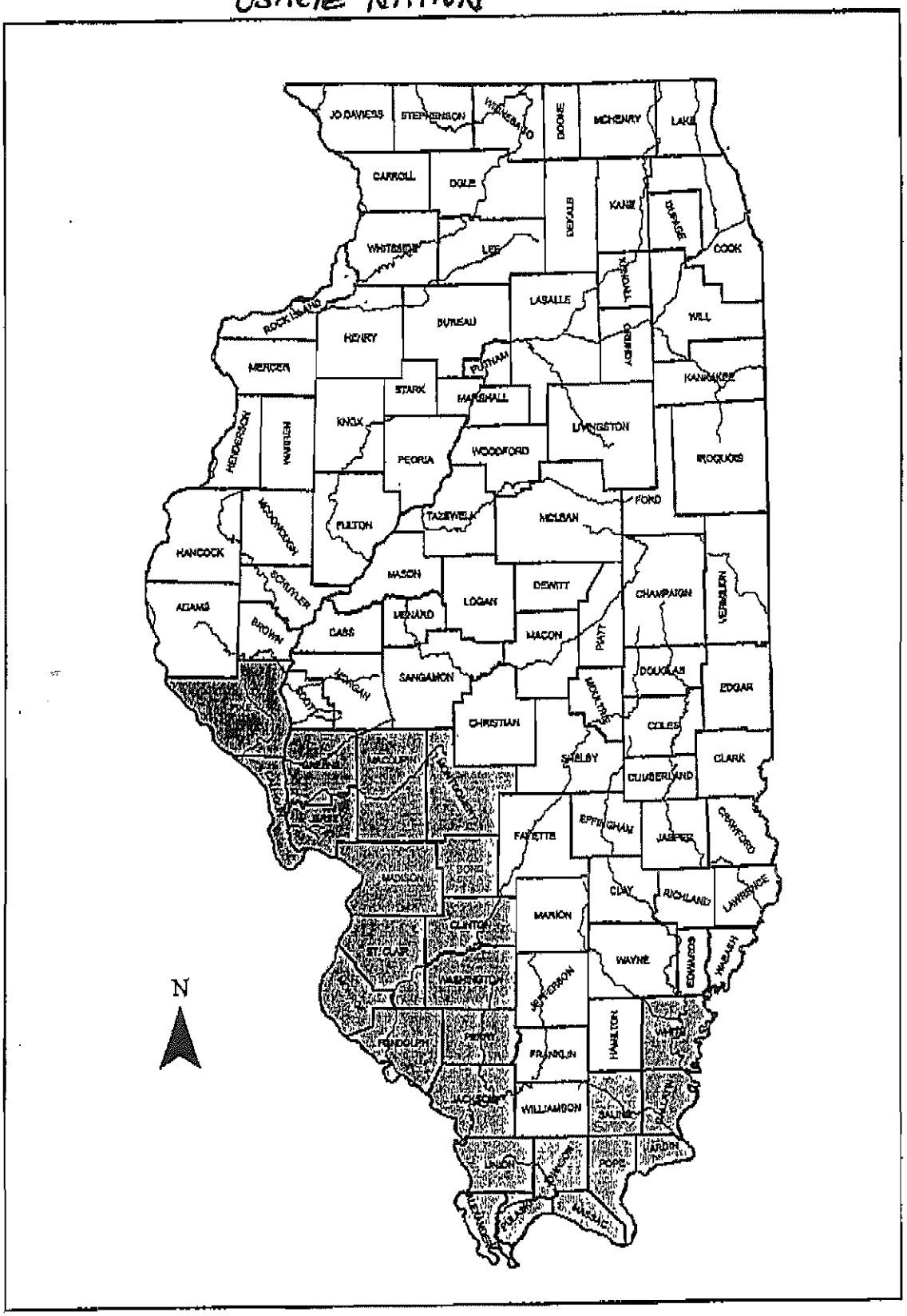
LEE
COOK
LASALLE
GRUNDY
WILL
HENRY
BUREAU
MERCER
PUTNAM
STARK
MARSHALL
KANKAKEE
LIVINGSTON
WARREN
PEORIA
WOODFORD
IROQUOIS
FORD
FULTON
TAZEWELL
MCLEAN
HANCOCK
MASON
DEWITT
CHAMPAIGN
VERMILION
ADAMS
LOGAN
MENARD
CASS
MACON
PIATT
SANGAMON
DOUGLAS
EDGAR
MONTGOMERY
CHRISTIAN
MOULTRIE
COLES
GREENE
MACOUPIN
SHELBY
CLARK
CUMBERLAND
JERSEY
EFFINGHAM
JASPER
CRAWFORD
FAYETTE
MADISON
BOND
CLAY
RICHLAND
LAWRENCE
MARION
CLINTON
ST. CLAIR
WAYNE
EDWARDS
WABASH
WASHINGTON
JEFFERSON
MONROE
RANDOLPH
PERRY
FRANKLIN
HAMILTON
WHITE
JACKSON
WILLIAMSON
SALINE
GALLATIN
UNION
JOHNSON
POPE
HARDIN
ALEXANDER
PULASKI
MASSAC
N

SAC AND FOX NATION OF OKLAHOMA



OSAGE NATION



APPENDIX D: ANALYSIS and SUPPORTING DOCUMENTATION

Attachment D-7: On Campus Bird Surveys

Heartland Community College prairie, nonnative grassland, and pond
June 14, 2008; 6:50 am-8:20 am
clear, mid-60s to mid-70s; pond high; construction road through entire north side and northwest quadrant
observer: Angelo Capparella

Canada Goose--21 (15 young, 6 adults)
Mallard--13 (7 young, 6 adults)
Ring-necked Pheasant--1
Great Blue Heron--1
Killdeer--1
Spotted Sandpiper--1
Rock Pigeon--2
Mourning Dove--3
Chimney Swift--2
Purple Martin--1
Barn Swallow--6
American Robin--3
European Starling--12
Common Yellowthroat--1
Song Sparrow--2
Red-winged Blackbird--53
Eastern Meadowlark--7
House Sparrow--3

18 species

Heartland Community College prairie, nonnative grassland, and pond
July 1, 2007; 6:55 am-8:20 am
breezy, mostly sunny, 57-68 degrees
observer: Angelo Capparella

Canada Goose--34 (includes young)
Mallard--17 (includes young)
Great Blue Heron--1
Killdeer--8
Spotted Sandpiper--2 (1 adult, 1 young)
Pectoral Sandpiper--1
Peep shorebird species--1
Rock Pigeon--1
Mourning Dove--2
Chimney Swift--1
American Crow--1
Tree Swallow--3

Northern Rough-winged Swallow--1
Barn Swallow--2
American Robin--2
Common Yellowthroat--1
Song Sparrow--4
Dickcissel--5
Red-winged Blackbird--66
Eastern Meadowlark--5
Common Grackle--2
American Goldfinch--4
House Sparrow--4

23 species

Heartland Community College prairie, nonnative grassland, and pond
June 25, 2006; 6:15 am-7:15 am
calm winds, partly cloudy, lower 70s
observer: Angelo Capparella

Canada Goose--ca 20 (includes young)
Mallard--ca 40 (includes young)
Great Blue Heron--1
Red-tailed Hawk--1
Killdeer--6
Spotted Sandpiper--2
Chimney Swift--1
Barn Swallow--2
Common Yellowthroat--1
Song Sparrow--5
Dickcissel--5
Red-winged Blackbird--very many
Eastern Meadowlark--4
House Sparrow--4

14 species

Site	Date	Mallard	Northern Shoveler	Green-Winged Teal	Blue-Winged Teal	Redhead	Ring-Necked	Lesser Scaup	Bufflehead	Wood Duck	Hooded Merganser	Common Goldeneye	Canada Goose (large)	White-Fronted Goose	Coot	Goslings	Mallard (ducklings)	Blue-Winged Teal (Ducklings)
Heartland	3/9/2009	32	0	1	0	6	12	1	0	0	0	2	98	0	0			
	3/16/2009	12	1	0	0	52	0	0	4	0	0	0	65	1	4			
	4/2/2009	10	0	0	0	16	0	0	0	0	0	0	21	0	5			
	4/15/2009	10	0	0	0	10	0	0	0	0	0	0	20	0	6			
	5/7/2009	3	0	0	0	0	1	0	0	0	0	0	10	0	4			
	5/29/2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Sum		**67**	**1**	**1**	**0**	**84**	**13**	**1**	**4**	**0**	**0**	**2**	**214**	**1**	**19**			
Tipton	3/9/2009	6	0	0	0	0	0	0	0	0	0	0	0	0	0			
	3/16/2009	2	0	0	0	0	0	0	0	0	0	0	0	0	2			
	4/2/2009	2	0	0	0	0	0	0	0	0	0	0	0	0	17			
	4/15/2009	0	0	0	0	0	0	0	0	0	0	0	3	0	20			
	5/7/2009	2	0	0	0	0	0	0	0	0	0	0	0	0	2			
	5/29/2009	1	0	0	0	0	0	0	0	0	0	0	0	0	0			
Sum		**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**41**			
Water Trt	3/9/2009	0	0	0	0	0	0	0	0	0	0	0	2	0	0			
	3/16/2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	4/2/2009	2	0	0	5	0	0	0	0	5	0	0	0	0	0			
	4/15/2009	0	5	0	12	0	0	0	0	0	2	0	0	0	0			
	5/7/2009	3	0	0	6	0	0	0	0	0	0	0	0	0	0			
	5/29/2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Sum		**5**	**5**	**0**	**23**	**0**	**0**	**0**	**0**	**5**	**2**	**0**	**2**	**0**	**0**			
Franklin E	3/9/2009	4	0	0	0	0	0	0	0	3	0	0	0	0	0			
	3/16/2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	4/2/2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	4/15/2009	0	0	0	0	0	0	0	0	0	0	0	2	0	0			
	5/7/2009	0	0	0	4	0	0	0	0	0	0	0	2	0	0			
	5/29/2009	4	0	0	2	0	0	0	0	0	0	0	0	0	0			
Sum		**8**	**0**	**0**	**6**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**4**	**0**	**0**			
Franklin W	3/9/2009	2	0	0	0	0	0	0	0	0	0	0	0	0	0			
	3/16/2009	0	0	0	0	0	0	0	0	0	0	0	2	0	0			
	4/2/2009	0	0	0	0	0	0	0	0	0	0	0	2	0	0			
	4/15/2009	0	0	0	2	0	0	0	0	0	0	0	2	0	0			
	5/7/2009	1	0	0	2	0	0	0	0	0	0	0	4	0	0	2		
	5/29/2009	1	0	0	0	0	0	0	0	0	0	0	0	0	0			
Sum		**4**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**0**	**0**			
Franklin G	3/9/2009	0	0	0	0	0	0	0	0	0	0	0	2	0	0			
	3/16/2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	4/2/2009	2	0	0	0	0	0	0	0	0	0	0	0	0	0			
	4/15/2009	0	0	0	20	0	0	0	0	0	0	0	0	0	0			
	5/7/2009	0	0	0	20	0	0	0	0	0	0	0	0	0	0			
	5/29/2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Sum		**2**	**0**	**0**	**40**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**			
Floodplain E	3/9/2009	2	0	0	0	0	0	0	0	0	0	0	0	0	0			
	3/16/2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	4/2/2009	0	0	0	0	0	0	0	0	0	0	0	2	0	0			
	4/15/2009	0	0	0	7	0	0	0	0	0	0	0	2	0	0			
	5/7/2009	3	0	0	4	0	0	0	0	0	0	0	0	0	0			
	5/29/2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Sum		**5**	**0**	**0**	**11**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**0**			
Floodplain W	3/9/2009	12	0	1	0	0	10	0	0	0	0	0	5	0	0			
	3/16/2009	8	0	0	0	0	0	0	0	0	0	0	0	0	0			
	4/2/2009	0	0	2	0	0	0	0	0	0	0	0	0	0	0			
	4/15/2009	0	0	0	0	0	0	0	0	0	0	0	2	0	0			
	5/7/2009	0	0	0	0	0	0	0	0	0	0	0	2	0	0			
	5/29/2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Sum		**20**	**0**	**3**	**0**	**0**	**10**	**0**	**0**	**0**	**0**	**0**	**9**	**0**	**0**			

Species	Heartland	Tipton Trails	Bloomington Water Treatment	Floodplain East	Floodplain West	Gully	West	East	Complex Total
Mallard	67	13	5	5	20	2	4	8	14
Northern Shoveler	1	0	5	0	0	0	0	0	0
Green-Winged Teal	1	0	0	0	3	0	0	0	0
Blue-Winged Teal	0	0	23	11	0	40	4	6	50
Redhead	84	0	0	0	0	0	0	0	0
Ring-Necked	13	0	0	0	10	0	0	0	0
Lesser Scaup	1	0	0	0	0	0	0	0	0
Bufflehead	4	0	0	0	0	0	0	0	0
Wood Duck	0	0	5	0	0	0	0	3	3
Hooded Merganser	0	0	2	0	0	0	0	0	0
Common Goldeneye	2	0	0	0	0	0	0	0	0
Canada Goose (large)	214	3	2	4	9	2	10	4	16
White-Fronted Goose	1	0	0	0	0	0	0	0	0
Coot	19	41	0	0	0	0	0	0	0
Goslings	12						6		
Mallard (ducklings)		3							
Blue-Winged Teal (ducklings)								3	