Historic & Cultural Resources Work

Documents attached:

1. Memorandum of Understanding on Historic/Cultural Work Scope – April 2006 – New Hampshire Department of Historical Resources & Lempster Wind LLC

2. Lempster Viewshed Analysis – March 2006 – performed by Louis Berger Group - "Worst-case" visibility study in a 3-mile project radiusto determine areas for historic property search.

Memorandum of Understanding on Cultural & Historic Resources Work Scope

The Lempster Mountain Wind Power Project, as proposed by Lempster Wind, LLC, a wholly-owned subsidiary of Community Energy, Inc., will include twelve wind turbine generator units located on privately-owned land in Lempster, Sullivan County, New Hampshire. The proposed wind turbines will have a rated capacity of 2.0 megawatts each, and will be comprised of a concrete foundation (approximately 50' x 50'), a 78-meter (255 ft) tubular structural steel tower, a generator inside the "nacelle" on top of the tower, and a "rotor" with diameter of 87 meters (285 ft) comprised of three "blades" that are 40.5 meters (132 ft) long. In total, the maximum height of the tower and rotor is almost 400 feet.

Installation of the wind turbines will require ground disturbance in their placement, in the construction of access roads to the twelve turbines, and in trenches for underground power cables on the Project site to a metering point where PSNH will take the power and transport it to the power grid.

In consultation with New Hampshire Division of Historical Resources on requirements related to Section 106 of the National Historic Preservation Act, the following scope of work shall be performed by Lempster Wind, LLC:

1) Archaeological Phase 1a Survey by a qualified archaeological consultant

- File search at NHDHR offices on archaeological sites recorded in Lempster (performed October 2005, with no findings).
- Field investigation covering all areas of potential ground disturbing activity by the Project, including turbine locations, proposed road alignments, and along proposed power lines.
- Collaboration with cultural groups including local and regional Native American organizations.
- Based on the results of investigations, shovel testing and analysis will be done at identified sensitive areas.

2) Survey of Project Viewshed and Area of Potential Effect

- File search on properties in the project area currently listed on the National Register of Historic Places.
- Preparation of an NHDHR Project Area Form to provide historical and architectural context for the project, in collaboration with the Town of Lempster (and other neighboring towns).
- Viewshed analyses within the 3-mile radius, using GIS and topographical mapping to indicate what areas would be within the viewshed of the project;
- Identification and mapping of properties previously listed on or eligible for the National Register of Historic Places within the viewshed;
- Field survey to locate, record and evaluate the National Register eligibility of any other properties over 50 years of age within the 3-mile viewshed;
- Provide NHDHR with photographs toward the project area from properties (structures, buildings and districts) within a 3-mile radius that meet the following criteria: (1) are in the project's viewshed; and (2) are listed or eligible for the National or State Registers, or have been identified through survey and evaluation as meeting the eligibility requirements for the National or State Registers. Based on review of photographs by NHDHR, photosimulations of wind turbines will be prepared from properties identified as having a potential visual impact.

- Review of properties previously listed on or eligible for the National Register of Historic Places within a 5-mile distance, and provision of photographs toward the project area from an example property (or properties), in order to provide NHDHR with an idea of potential viewshed impacts from that range.

The scope of work for cultural and historical survey as listed above is a result of collaboration between Lempster Wind, LLC/Community Energy, Inc. and the New Hampshire Division of Historical Resources, and it is agreed upon by both parties that Lempster Wind, LLC shall perform this work scope in furtherance of project development and federal and state permitting.

Lempster Wind, LLC

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Name: Jeffrey R. Keeler

Title: Project Manager

Date: ~~March~~ APRIL 12, 2006

New Hampshire Division of Historical Resources

Signature: Linda Ray Wilson

Name: Linda Ray Wilson

Title: Deputy SHPO

Date: April 6, 2006

Lempster, NH Wind Farm Viewshed Analysis

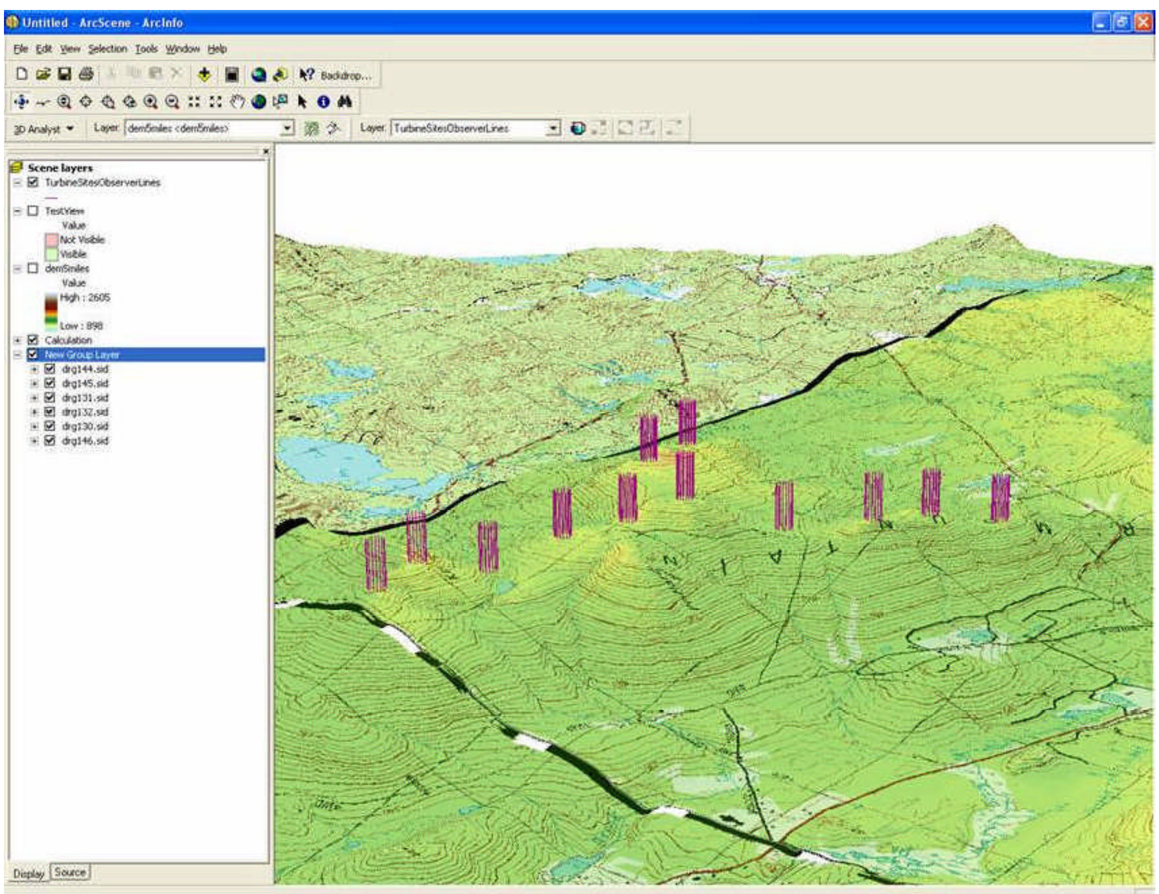
March 2006

ASSUMPTIONS

- The analysis does not account for variations in land cover. The output displays the viewshed assuming the absence of any trees, buildings, or other ground features. Therefore, the analysis examined the worst-case scenario landform viewshed.

- The viewshed is based on standard USGS Digital Elevation Model Data with a ground resolution of 30x30 meters and is therefore suitable only for coarse resolution, small scale analysis. The DEM ground resolution assumes no variation in elevation across evenly spaced 30x30 grid cells.

- The turbines are modeled as a series of 16 vertical lines surrounding the 12 turbine centerpoints for a total of 192 vertical lines. These lines are all offset from the centerpoint at a distance equal to the radius of the total blade sweep. The bottom elevation for each line is equal to the elevation at the turbine centerpoint and the top elevation is calculated by adding 398.6 feet (the total turbine height including the blade sweep) to the bottom elevation. The 3D turbines appear as silos which would in reality encompass the entire turbine, again representing a worst case scenario. The following figure depicts the modeled 3D turbines:



- The viewshed analysis deems the project visible from an entire 30x30 meter grid if any length of one or more of the 192 vertical lines is potential visible from that grid cell given simply the geometry of the terrain. The analysis deems the project not visible only under the condition that it would be impossible for *any* of the 192 lines to be visible given simply the geometry of the terrain (for example on the back-side of a neighboring ridge). **This is again consistent with the worst case scenario methodology, and could result in a "visible" calculation for an entire 30x30 meter grid cell if even 1 foot of the blade tip was visible from any location** in that 30x30 meter cell.

METHODS

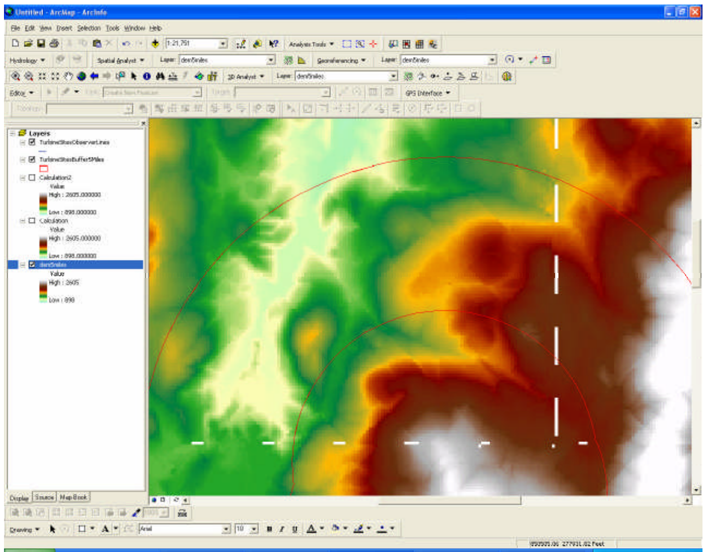
Preparing the Digital Elevation Model

- USGS Digital Elevation Models are packaged as individual USGS 7.5 minute topo quad sized raster datasets. To perform analysis over a wide area many DEMs must be merged into a single raster dataset. The following steps were used to create a single DEM covering the same extents as a 5 mile buffer around the wind project:

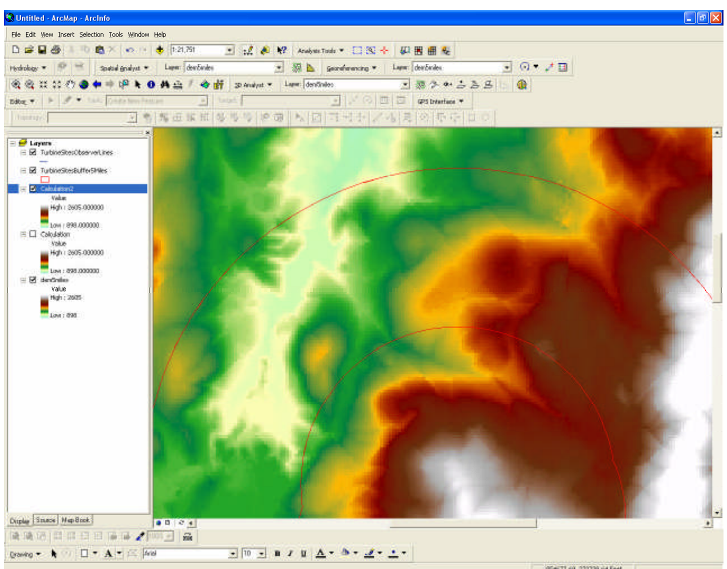
1) Downloaded the necessary DEMs from NHGRANIT
2) Added DEMs to ArcMap
3) Verified that all DEMs were in the same projection and datum
4) Verified that all DEMs were in the same horizontal and vertical units
5) Merged all DEMs using the Raster Calculator "merge" function
6) Buffered the wind turbines 5 miles
7) Set the Spatial Analyst Options to use the 5 mile buffer as an analysis mask
8) Ran the merged grid through the Raster Calculator to clip the grid to the 5 mile buffer
9) Saved the resulting grid as "dem5miles"

Cleaning the Digital Elevation Model

- The creation of a single project wide DEM using the methods above has some drawbacks. Merging multiple USGS quads into a single raster often results in data gaps along the original topo quad seams. These data gaps are displayed in the raster as 'NoValue' cells. Often GIS analysts simply use a "neighborhood mean" to smooth out the DEM. This process converts each grid cell's value to the mean of the 9 surrounding grid cells. This process does eliminate the gaps but also reduces the accuracy of the DEM. To maintain the original DEM accuracy we generated a grid using the "neighborhood mean" process described above but instead of using this smoothed grid for the rest of the analysis we merged this smoothed grid with the original grid in the Raster Calculator with the analysis mask and analysis extents set to the smoothed grid. This process uses the original grid as the base but replaces the 'NoValue' cells with the cell values from the smoothed grid. Once completed we then clipped the grid to the 5 mile buffer (steps 7-9 from the above section) to remove the extra grid cells created at the outer edges of the grid during the "neighborhood mean" process. The resulting grid was saved as “dem5milesfill”. A comparison of the original merged DEM (dem5miles) and the cleaned DEM (dem5milesfill) can be seen in the following figures:



Original Merged DEM (dem5miles)



Cleaned DEM (dem5milesfill)

Creating the 3D Observer Lines

- The 3D observer lines (as described in the assumptions section of this document) were created by first buffering the turbine centerpoints by 142.7 feet (the blade radius) to account for the blade sweep. The output polygons from this buffer were generalized in ArcMap using a vertex threshold of 10 feet creating polygons with 16 vertices surrounding each of the 12 turbine centerpoints. The turbine buffer polygon shapefile was then converted to a point shapefile with points being placed at each of the 16 vertices for each of the 12 polygons for a total of 192 points. These points were assigned Z values (elevations) based on the DEM calculated ground elevations at each of the associated turbine centerpoints. This file was then copied and the Z-values were shifted higher by 398.6 feet. The two point shapefiles, one for bottom elevations and one for top elevations, were merged. This new point shapefile was converted to a 3D line shapefile consisting of 192 vertical lines by connecting the bottom elevation points to the top elevation points.

Running the Analysis

- The viewshed analysis was performed using the "Viewshed" tool available through ArcGIS 8.3's 3D Analyst extension. The analysis used the following inputs: "Input Surface" was set to the revised DEM grid (dem5milesfill) and the "Observer Points" were set to the 3D line shapefile described above. No adjustment was made for Earth curvature due to the extents of the project. The Z-factor was 1 as the units for both the DEM and the 3D lines were feet.

OUTPUT

Once the processing was complete the output was in the form of a grid with values ranging from 0 (not at all visible) to 267 (where the entire project is visible). The grid cell values represent the number of observer lines which are visible from that cell. Therefore a value of 0 indicates that the turbine is not visible, while values above 0 indicate that some portion of the turbines may be visible. The USGS Digital Elevation models are derived from a variety of sources and often contain small errors which when input into a broader analysis create further anomalies. In this analysis a series of east-west bands of grid cells values ranging from 1 to 4 were generated. These bands were obvious anomalies and were therefore removed by only selecting values of 5 and above as predicting visibility. This has little impact on the overall analysis as the spacing of the 3D observer lines (spaced evenly in a circle at ~16 meters apart) is smaller than the resolution of the grid (30 meters) making it nearly geometrically impossible for a *any less than 4* observer line to be visible from any one grid cell.

Analysis with a 10 Meter DEM

- The USGS has begun to make 10 meter grid cell DEMs available for a large portion of the country in hopes of providing greater resolution. 10 meter grid cell DEMs are available for the entire project area. Unfortunately the 10 meter DEMs are often prone to errors, and therefore do not provide much, if any, greater verifiable accuracy than a 30 meter DEM for this type of analysis. We can however use the 10 meter DEM to verify the accuracy of the previous analysis using the 30 meter DEM we calculated viewshed using the same method using the 10 meter DEM. The results of this analysis exhibited very similar patterns of visibility and therefore served as a good indication that the 30 meter grid cell DEM analysis was successful. Because of the high instance of errors and the intent of the analysis being to examine worst case scenarios, we felt that it would be inappropriate to use the 10 meter DEM which could imply greater resolution and accuracy than the analysis truly represents.

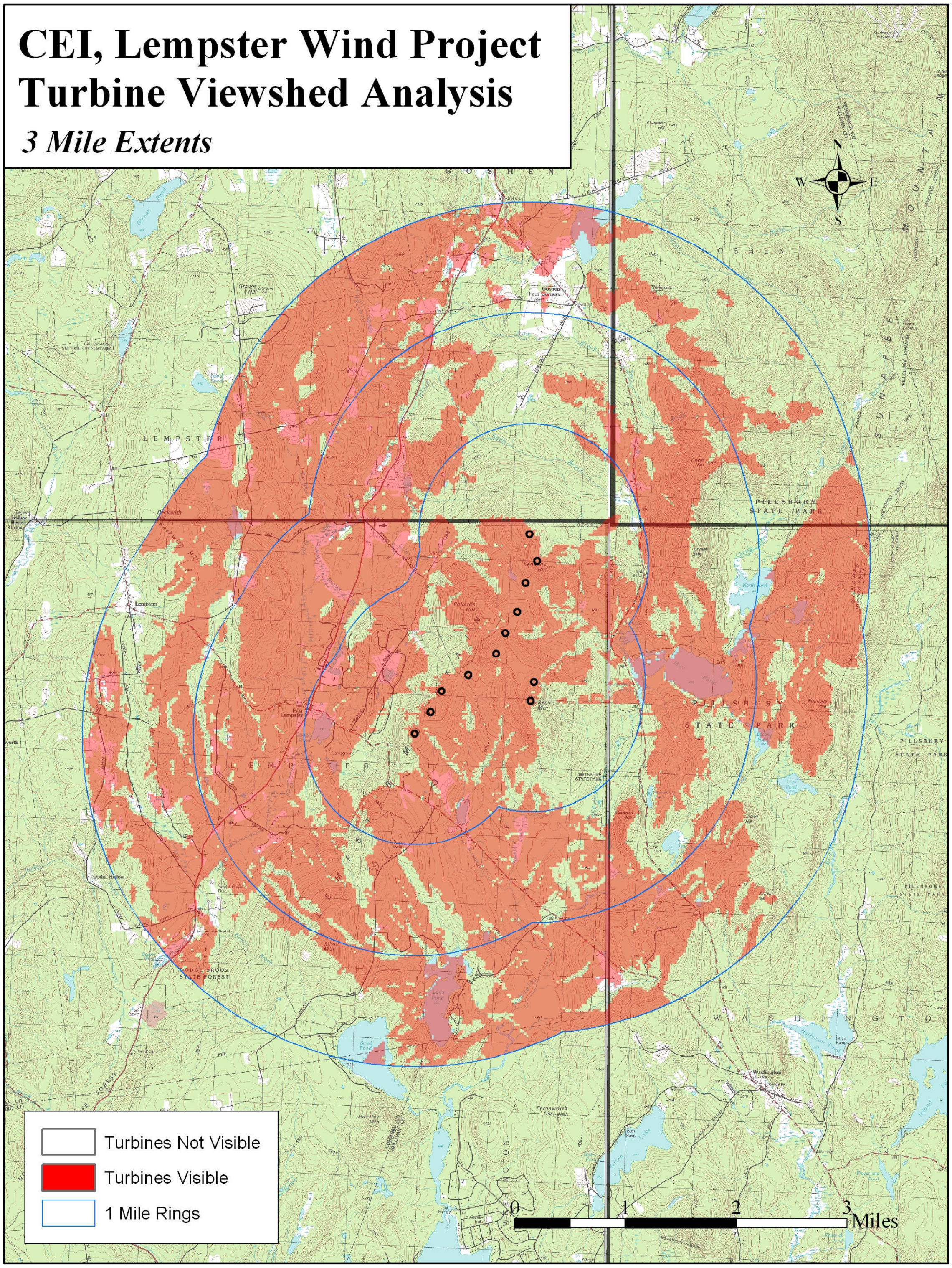


Figure 2. Turbine Viewshed (3 mile extent)