TEXAS STATE UNIVERSITY

DEPARTMENT OF GEOGRAPHY

HISTORIC LANDSCAPES AND CELL TOWERS, MITIGATING IMPACT

A STUDY CONDUCTED FOR: LBJ NHP

PREPARED BY

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Objective: Use GIS to create a viewshed model to assess current and potential impact from area towers on the historic landscape at Lyndon B. Johnson National Historic Park (LBJ NHP).

Introduction: The Heritage Preservation Services (HPS) defines historic landscapes as those which,

> Range from thousands of acres of rural tracts to a small homestead with a front yard of less than one acre. Like historic buildings and structures, these 'special places' reveal aspects of our country's origins and development through their form and features and the way they were used (NPS*a* 2005).

Cell phone towers have become as omnipresent as these 'special places', and the spatial relationships between the two are growing closer. Cell towers have been constructed in Grand Canyon, Yosemite, and Everglades National Parks. The interface between preservation and modernization came to national prominence when a tower overlooking "Old Faithful," at Yellowstone Park was erected in 2004 (NPCA 2004). Groups such as Public Employees for Environmental Responsibility (PEER) have been critical of the National Park Service's (NPS) stance on cellular towers. PEER charges NPS with, "failing to: protect the special qualities of the national parks; develop a central management plan for placing the towers; inform and solicit comments from the public; and to have a clear idea of how many cell towers exist in the national park system" (NPCA 2004). In contrast, reporting emergencies, and satisfying visitor demand for coverage have been prevalent arguments for the construction of cellular towers in close proximity or on park units (Kuna 2004, NPS*b* 2005).

Regarding cell phone towers. The National Park Service has been challenged to balance preservation and increasing development (Miller 2004, Kuna 2004). Section 106 of the National Historic Preservation Act (NHPA) established protocol to achieve this balance. NHPA is aimed at identifying historic properties that may be affected by a Federal undertaking, such as licensing and permitting, and through consultation with agencies and interested parties, "avoid, minimize or mitigate any adverse effects on historic properties" (*National Historical Preservation Act,* 1966). However, ambiguities within the act allow much of its interpretation to take place on a local level. Some of these ambiguities particularly pertain to potential impacts on historic places (Rotenstein 2004). In February 2004, Native Americans of the United South and Eastern Tribes, Inc. (USET), and the FCC announced a Memorandum of Understanding (MOU), potentially setting the tone for future NHPA modifications. This MOU was written to help guide tower applicants, who wish to construct towers on USET property, in the consideration of specific religious and cultural assets (FCC*b* 2005). Currently, the FCC is reviewing and revising parts of NHPA to create consistent and balanced regulations (Rotenstein 2004).

Texas is projected as the second fastest growing state in the U.S. (Census 2005), and much of that growth is occurring between the Austin and San Antonio corridor. LBJ NHP facilities are located along

Figure 1. Tower construction threatens historic landscapes in Central Texas.

this transect near the heavily traveled U.S. Hwy 290 and U.S. Hwy 281 intersection. At LBJ NHP it is understood that growth is imminent and more cellular towers will be erected in the coming years. “Shared stewardship” is the first National Park Service core value and reads; “We share a commitment to resource stewardship with the global preservation community” (NPS*c* 2005.) In accordance with responsible stewardship of their historical assets, and realists about desire for cellular coverage, LBJ NHP constructed a GIS viewshed analysis to assist in mitigating the effects of future towers on the historic landscape.

Methods: Two results were desired for the tower project, to assess the effect of currently installed towers, and to construct a product that would assess potential impact to help site towers in the future. For each product slightly different procedures were taken. First, procedures and results for the assessment of impact from currently installed towers will be discussed; followed by procedures and results for prospective placement of towers and potential impact.

Impact Assessment: Data collection, integration and analysis are the fundamental steps in assessing current tower influence. The essential components to calculate tower viewshed include x,y coordinates, tower height and a Digital Elevation Model (DEM). A combination of data from a Global Positioning System (GPS) and Federal Communications Commission (FCC) would yield the necessary point files for tower sites. Using “Pathfinder Office” a data dictionary was created for sites that would be GPSed. The data dictionary housed fields for tower height and contact information, available on the placard accompanying each tower site (figure 2). The data dictionary was then

exported to a "Trimble XT" GPS, which was set to InterMountain Support Office (IMSO) GPS unit configuration standards (NPS 2005). It was decided with LBJ NHP supervisors that the area of potential effect and control for tower structures was 5 miles. Tower sites within 5 miles of each park unit and that were accessible were GPSed. Pathfinder Office was used for post-processing procedures, including differential correction, projection and exportation. The area of effective control was determined to be 5 miles. Correspondingly, only towers within the control area were included in the model and search radii for each tower was limited to 5 miles. For towers that were inaccessible because of their location on private property, data available from FCC's website was used (FCC*a* 2005). The FCC point data was edited in ArcMap, georeferencing tower sites that could be seen in 1995 USGS DOQQ orthophotography. Using ArcMap's *spatial join* feature the FCC data was merged to the GPSed dataset. Records for the FCC points were populated after the join, and control parameter fields for viewshed were added. These controls included:

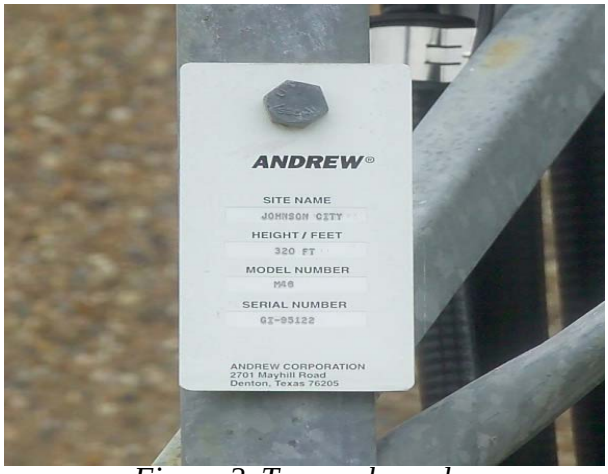

Figure 2. Tower placard.

- OFFSETA - offsets the point from the base elevation (Tower height)
- OFFSETB - offsets each raster cell for viewer height (2 meters)
- RADIUS2 – limits search distance from viewer position

To complete data collection a 1 arc second (30 meter), National Elevation Dataset (NED) was acquired through USGS (USGS 2005). Using the '3d analyst' extension in ArcMap

the viewshed was run using the NED as 'input raster', tower points as 'input point' and allowing for the earth's curvature and using the default refractivity setting of 0.13.

Results: Viewshed calculates what areas can be seen from the tower locations, but the intent is to find how many towers can be seen from any given area. Therefore, results rely on the assumption that line of sight works from the target to the source. Results were displayed as a classed map, using a red to blue dichromatic color ramp, symbolizing strong to weak effect respectively (figure 3). The darkest shade of red represents areas that can see all towers (that were within the five-mile effect zone) while the darkest shade of blue represents areas where no towers are visible. Based on the viewshed analysis, a majority of the Ranch District is in a "high impact" zone, and the Johnson City District is completely within a "high impact" zone.

Potential Impact: To negotiate the location of future tower structures, park supervisors need a viewshed depicting potential impact from "yet to be located" towers. The product of this analysis will provide geographic information that can be used with aerial photography, Digital Raster Graphics (DRG) or GPS to identify real-world locations that would minimally alter the historical landscape. Many of the techniques used in the potential impact analysis were comparable to the impact assessment. However, this viewshed analysis put the viewer in the park at important structure sites, defined as those structures that are historical, heavily visited, and/or topographically diverse. Using the *feature to point* command, points were created at the centroids of polygons representing park structures. Important structures for the model included the "LBJ Boyhood Home,"

and the “Hay shed.” Given the small acreage and homogenous topography of the Visitor Center (40 acres) a single point in the Johnson Settlement could sufficiently represent viewshed for the entire Johnson City District. To consider a variety of tower heights four points representing 100’, 200’, 300’, and 400’ were stacked on top of one another at structure points. Again OFFSETA was set by the tower height; OFFSETB, to 2 meters and RADIUS2 set the maximum search distance to 5 miles. The NED data was used again as the elevation model, and viewshed was run individually for each location. A multi-site composite using ‘composite bands’ was then constructed to clarify the effect on viewshed when moving across space. In consideration of graphical output limitations and ease of interpretation the composite was conducted with the two structure points representing the greatest spatial disparity (LBJ Boyhood Home, Hay shed).

Results: Five classes rank impact from siting towers in local areas. The class range spans from “no impact” from siting towers 400 feet tall and under, to “high impact” representing areas that could see a tower of any height (figures 4, 5). For the composite, “LBJ Boyhood Home” viewshed was assigned red resulting in a red-scale, and “Hay shed” viewshed was assigned green and blue resulting in a cyan-scale (figure 6). Assumptions that were applicable in the impact assessment relate to potential impact.

Discussion: Several technical considerations should be taken into account for subsequent viewshed analysis. 1/3 arc second or 10 meter seamless DEM data is currently available for some areas within the U.S., and it is likely that this finer spatial resolution DEM will

soon be available for Blanco and Gillespie Counties. Running the viewshed with a 10meter DEM will significantly improve the accuracy of viewshed analysis.

Operator choice dictates many of the variables included in and the output from viewshed models. An almost infinite number of classification and visualization schemes are available in ArcMap and ArcScene. These alternate representations can range from simplistic, “can or can’t see” models, to 3d animation. Other viewer controls, particularly azimuth and vertical angle can be used to imitate real-world obstacles such as trees or buildings. These additional controls are most applicable when the desired result is a viewshed from a point location and is not intended to represent an area. Also, linear features can be used as viewer input to assess the viewshed characteristics from roads or hiking trails. Ultimately, the viewshed model and following representation should be tailored per specific purpose and audience.

Physical considerations as to Line of Sight (LOS) and perception will also be crucial for tower siting. Reasonably, viewshed analyses represented valley areas as being out of view, but it is unlikely that relays could be made from such locations. Perhaps viewshed analysis will be most valuable in locating existing towers at the highest elevations, which could host additional relays, interceptor, etc. Several factors may contribute to a tower’s perceived effect on the historic landscape such as height above the horizon, color, and breadth. To provide additional support in tower mitigation it is suggested that these perception variables be researched to assess their potential effect.

Conclusions: A foundational viewshed model to assess tower impact has been presented. The methods used here can be applied to future studies at LBJ NHP, as surrounding spatial relationships grow more complex. The proactive approach taken by LBJ NHP to assess tower impact will be a valuable asset in negotiating the preservation of historic landscapes.

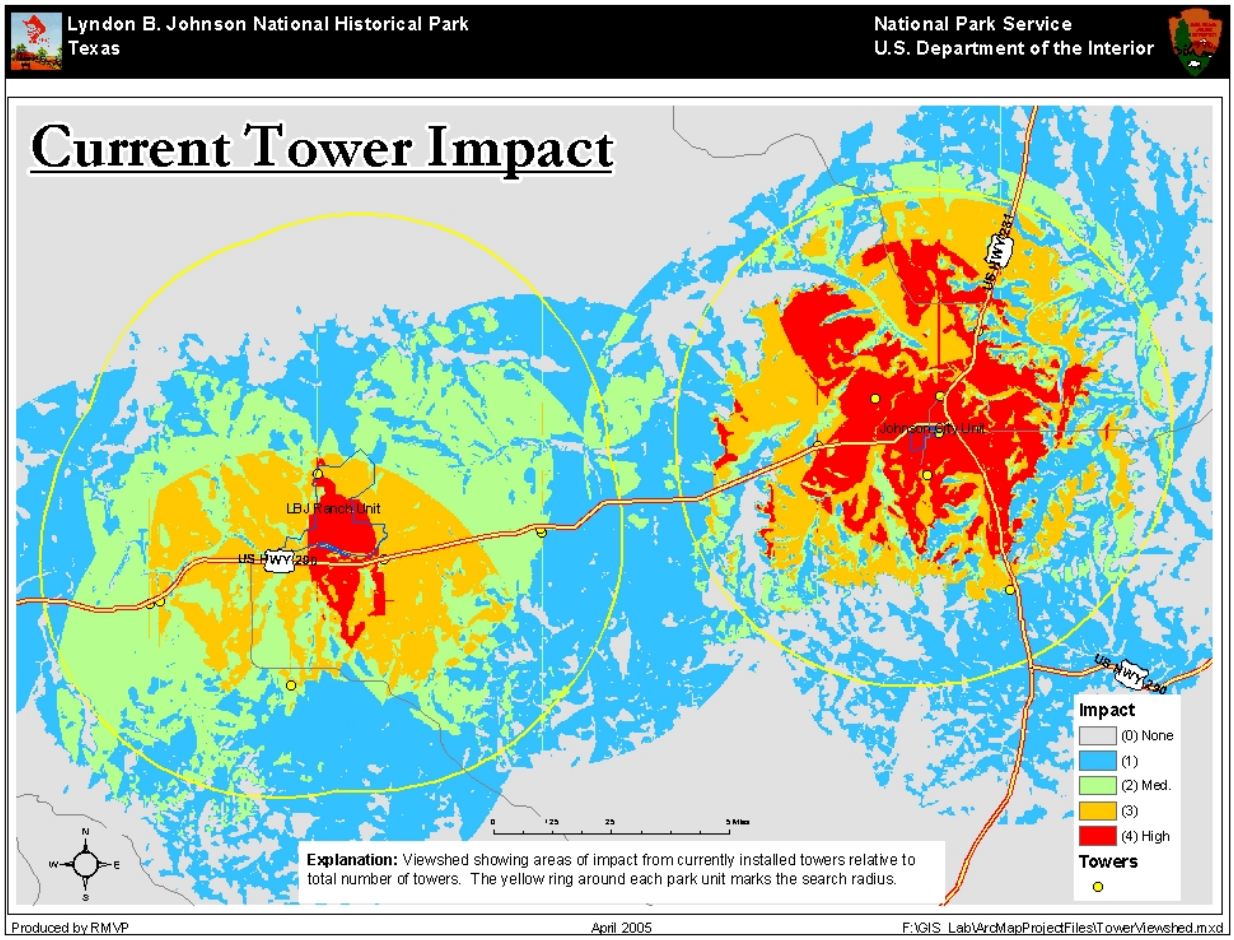

Figure 3

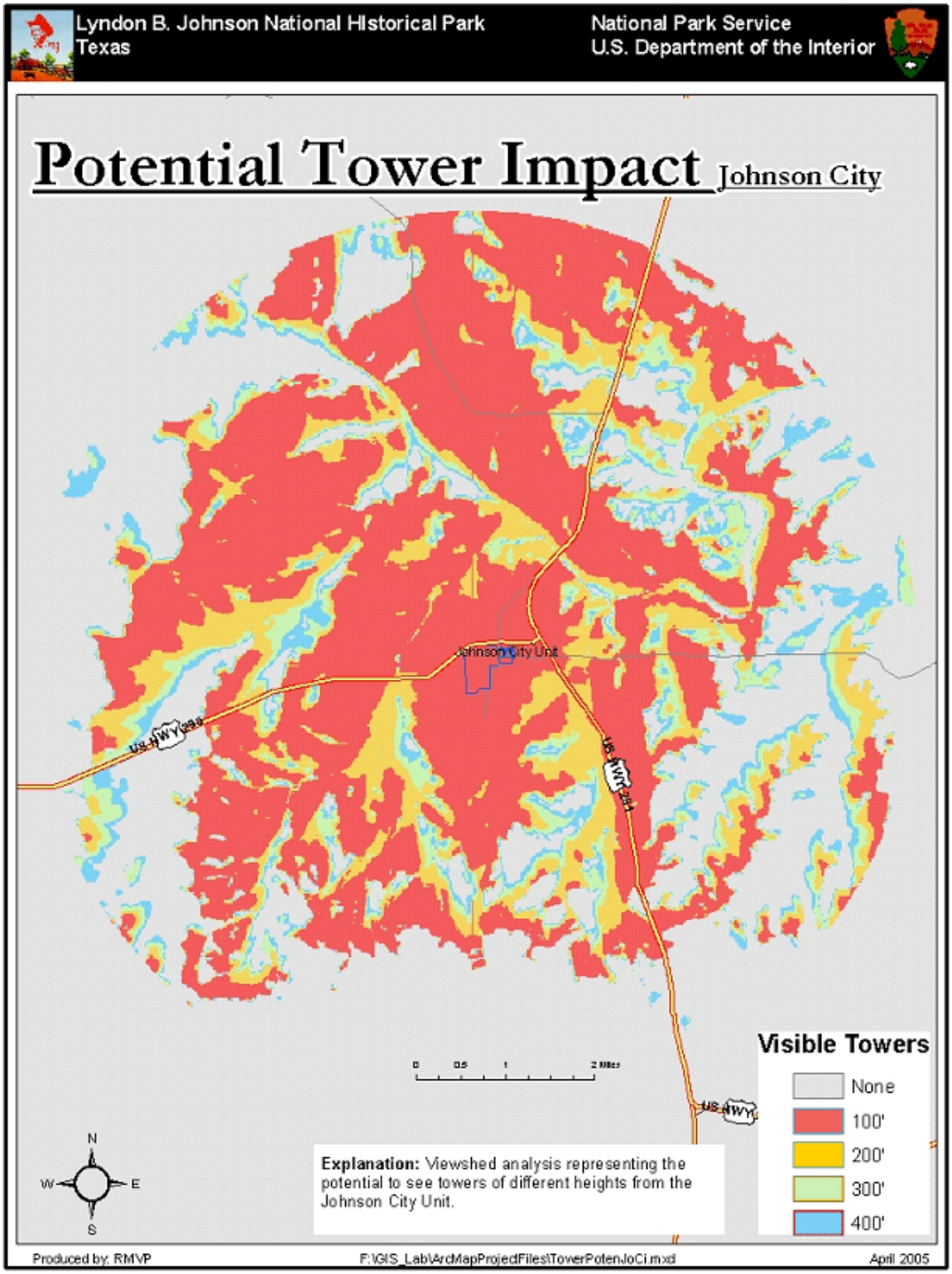
Lyndon B. Johnson National Historical Park
Texas
National Park Service
U.S. Department of the Interior
Potential Tower Impact Johnson City
Johnson City Unit
US HWY 290
US HWY 281
US HWY
Visible Towers
None
100'
200'
300'
400'
Explanation: Viewshed analysis representing the potential to see towers of different heights from the Johnson City Unit.
N
W
E
S
Produced by: RMVP
F:\GIS_Lab\ArcMapProjectFiles\TowerPotenJoCi.mxd
April 2005

Figure 4

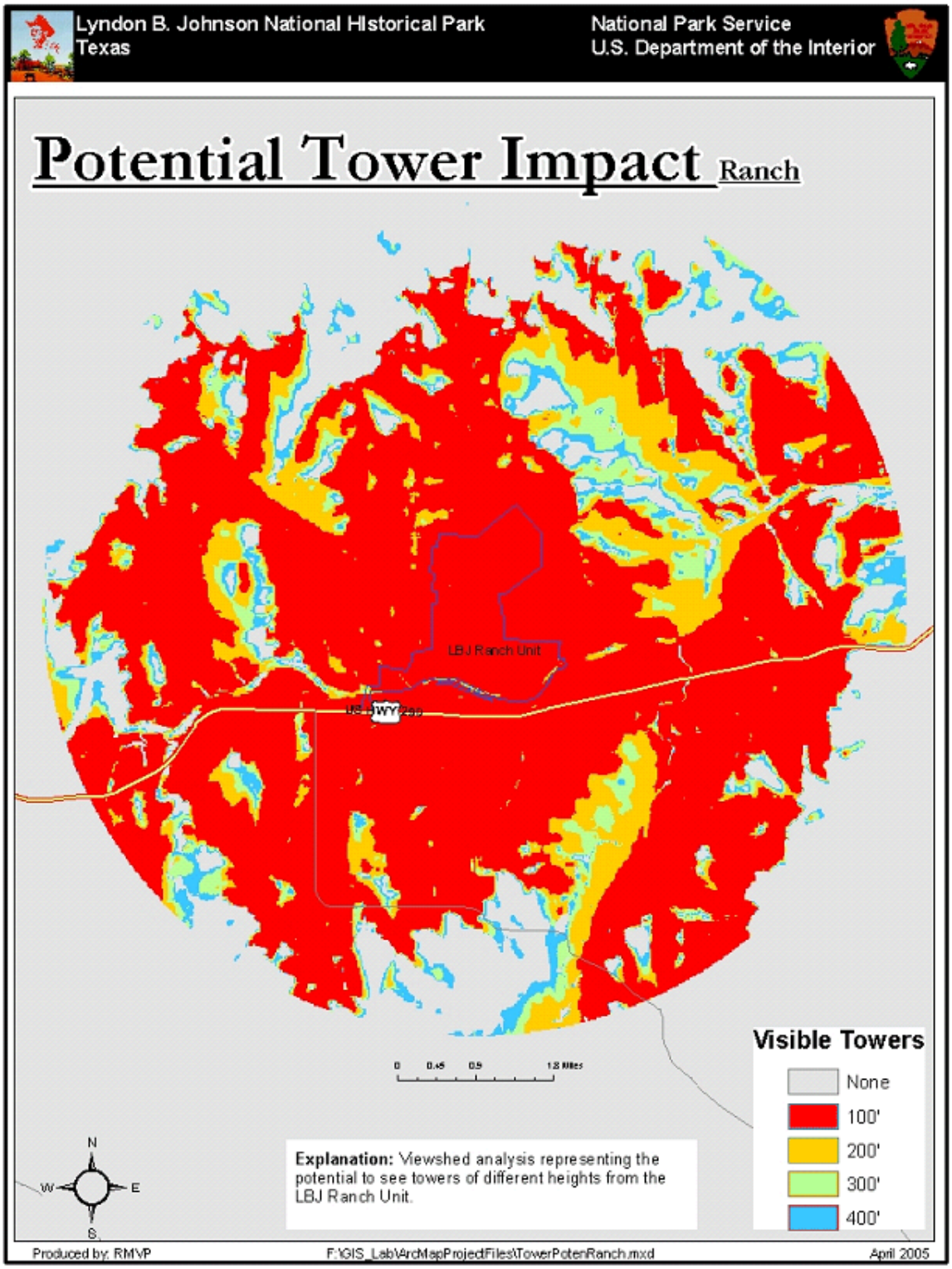
Lyndon B. Johnson National HIstorical Park
Texas
National Park Service
U.S. Department of the Interior
Potential Tower Impact Ranch
LBJ Ranch Unit
US-290
0 0.45 0.9 1.8 Miles
N
W
E
S
Explanation: Viewshed analysis representing the potential to see towers of different heights from the LBJ Ranch Unit.
Visible Towers
None
100'
200'
300'
400'
Produced by: RM\VP
F:\GIS_Lab\ArcMapProjectFiles\TowerPotenRanch.mxd
April 2005

Figure 5

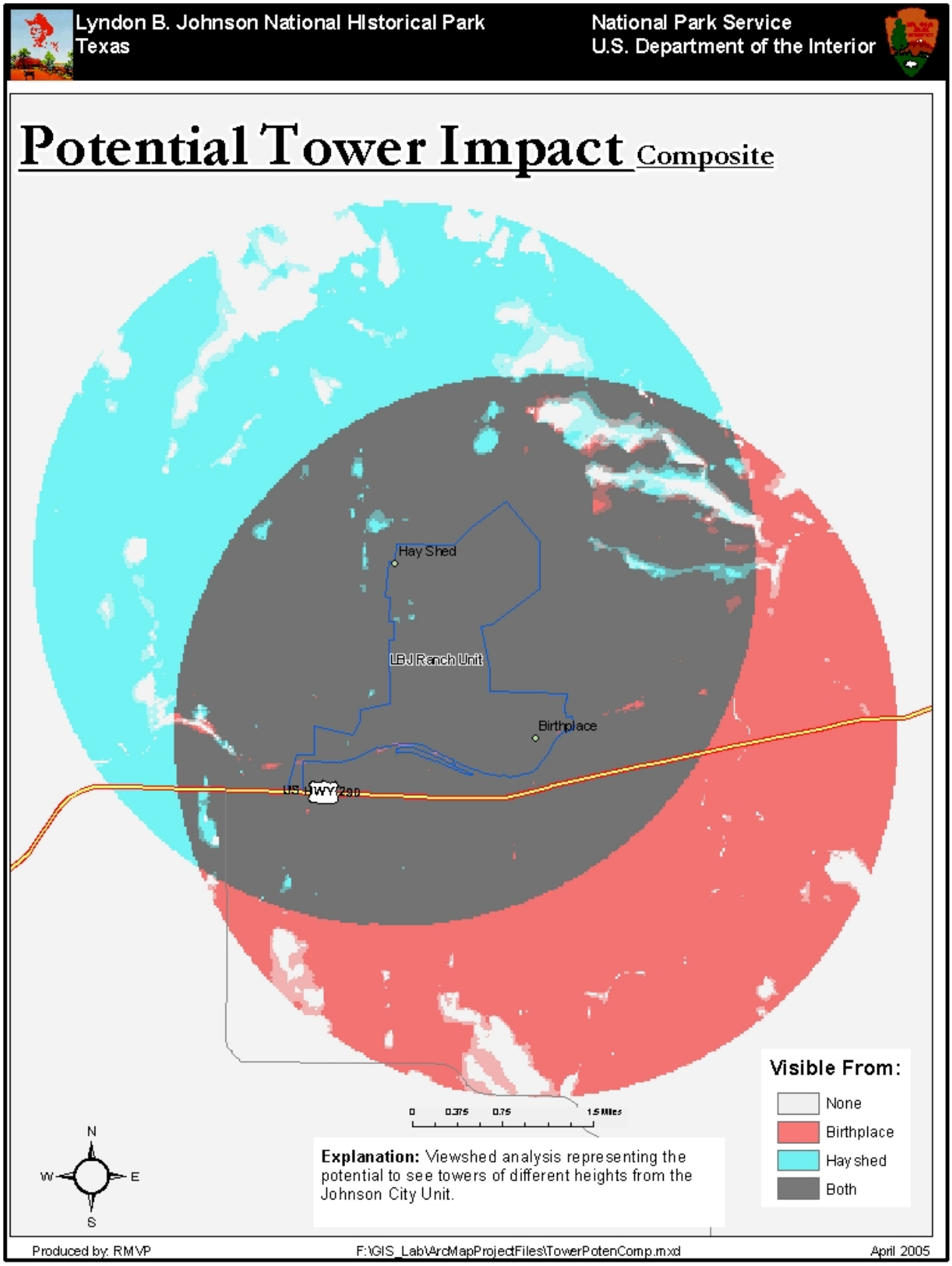
Lyndon B. Johnson National Historical Park
Texas
National Park Service
U.S. Department of the Interior
Potential Tower Impact Composite
Hay Shed
LBJ Ranch Unit
Birthplace
US HWY 290
0 0.375 0.75 1.5 Miles
N
W
E
S
Explanation: Viewshed analysis representing the potential to see towers of different heights from the Johnson City Unit.
Visible From:
None
Birthplace
Hay shed
Both
Produced by: RMVP
F:\GIS_Lab\ArcMapProjectFiles\TowerPotenComp.mxd
April 2005

Figure 6

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