GIS Predictive Model of Potential Undiscovered Native American Archeology Sites for the Red Wing Locality

Leanne Knott RA694, Fall 2014

MGIS Graduate Project Capstone

St. Mary's University of Minnesota

Presentation

- Research Question
- Historic Context
- Value of Research
- Data for Predictive Model
- Predictive Model Methodology
- Analysis & Outputs
- Results
- Future Investigations

Research Question

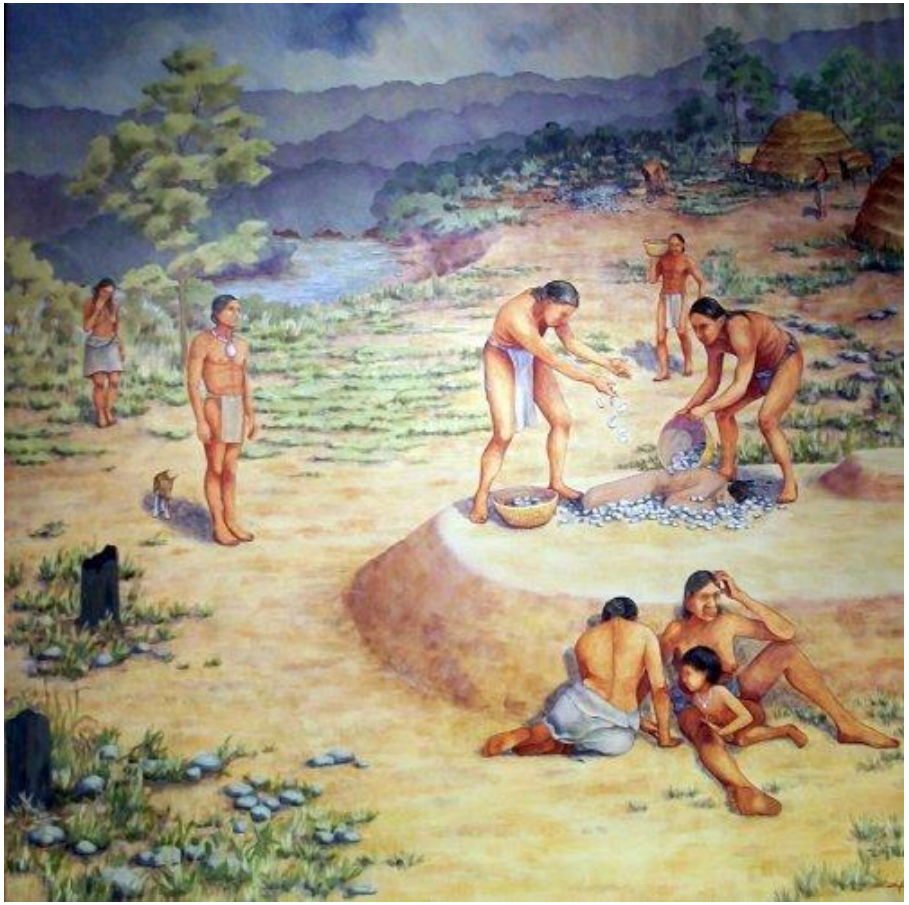
- Where are the potential undiscovered ancient Native American archeological Sites within the Red Wing Locality?

Historic Context

- Red Wing, Minnesota, has long been known as a center for archeological resources.
- Between 1050 and 1300 AD, the Red Wing Locality supported one of the largest populations in the Upper Midwest.

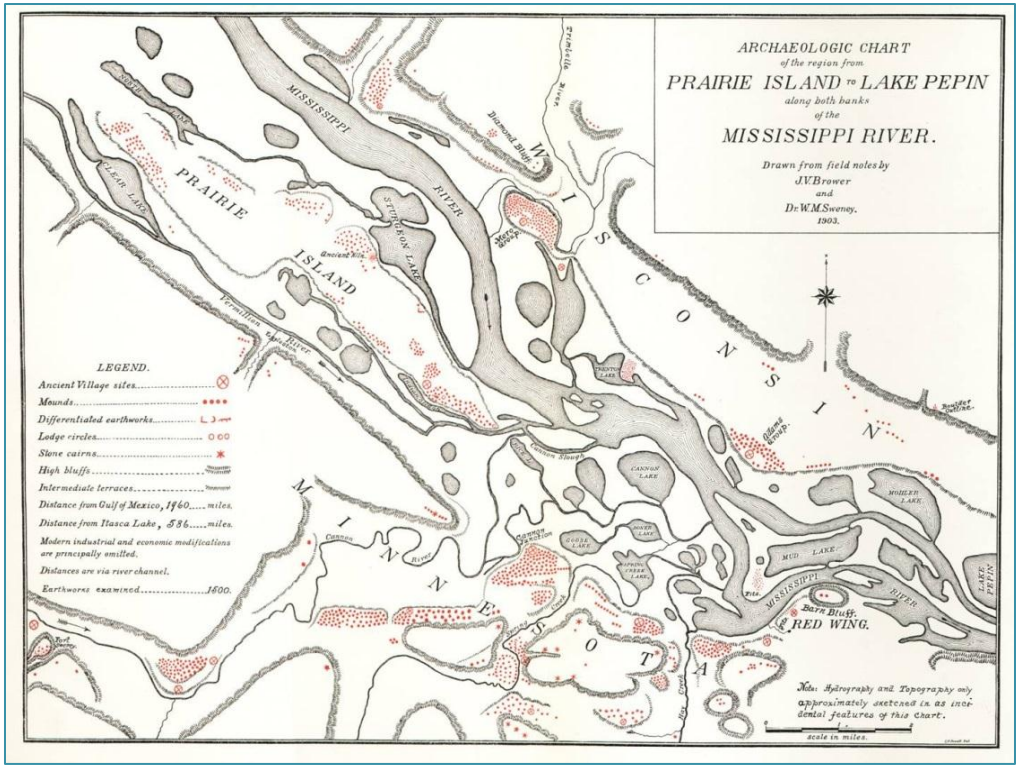
Historic Context

- Key identifying characteristics of Silvernale phase components include the presence of large, fortified villages usually surrounded by numerous conical earthen burial mounds.



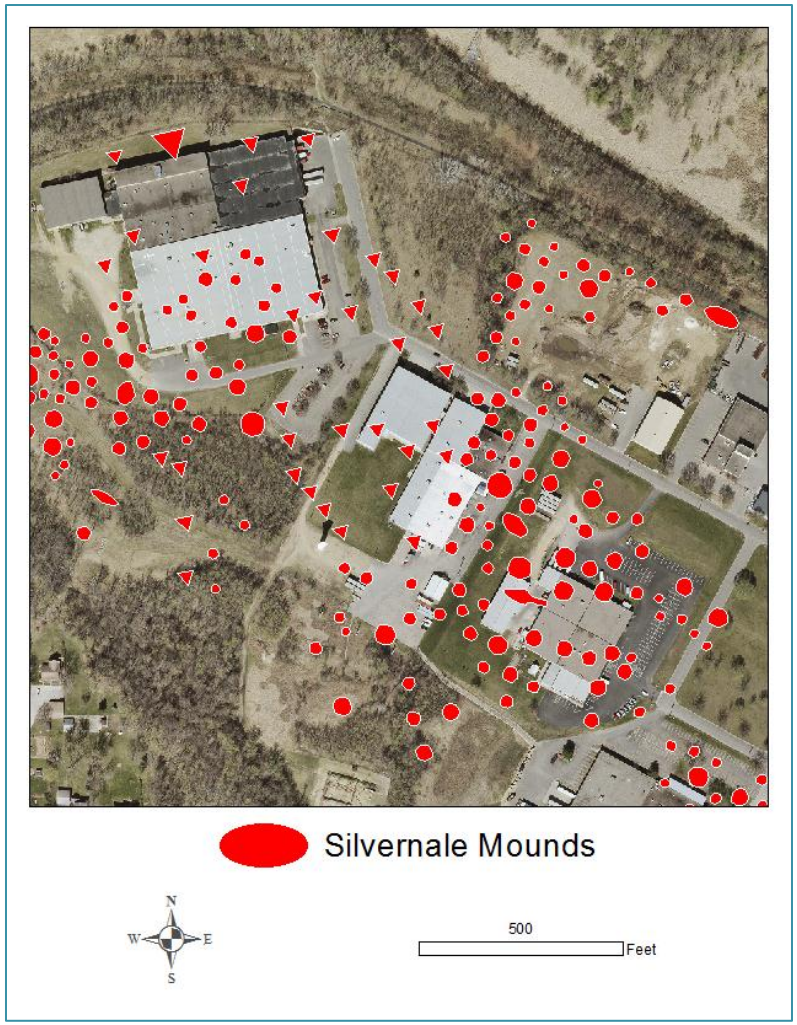
Historic Context

- During the mid-1880s, T. H. Lewis recorded and mapped more than 2000 mounds clustered in this locality.
- At the turn of the century, J. V. Brower and W. M. Sweeney also recorded mounds in the region, particularly on Prairie Island, and documented the presence of several village sites.



Value of Research

- Undocumented Red Wing Locality sites at are risk for destruction if their land use is marked for development. Almost all of the mounds and a substantial part of the village site have been destroyed by the construction of the Red Wing Industrial Park and housing developments on the uplands overlooking the industrial park.



Value of Research

- Availability of developable land is limited to bluff tops and flat non-agricultural land areas, often adjacent to rivers and streams.
- These areas have been well-established as known locales for archeological mounds and villages; some of these same areas are now prime locations for future land development.

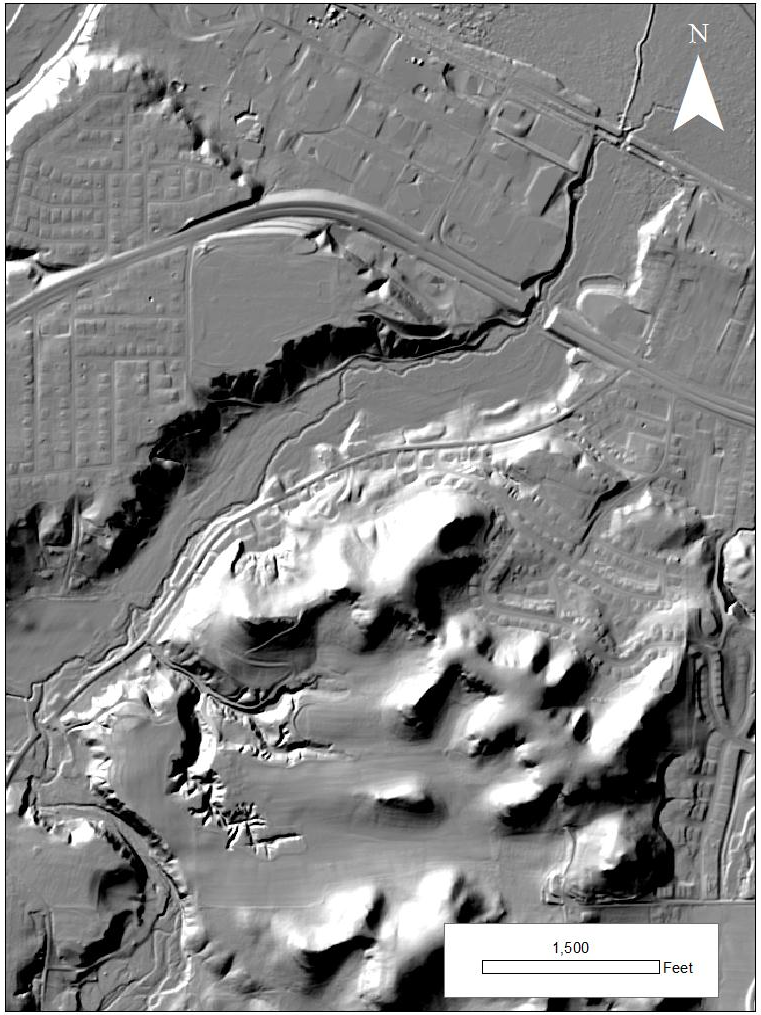
Potential Stakeholders

- City of Red Wing Planning Department
- Goodhue County Land Use
- Prairie Island Indian Community
- MnDOT
- Archeological Researchers

Dr. Ronald Schirmer and field school students at Silvernale site.

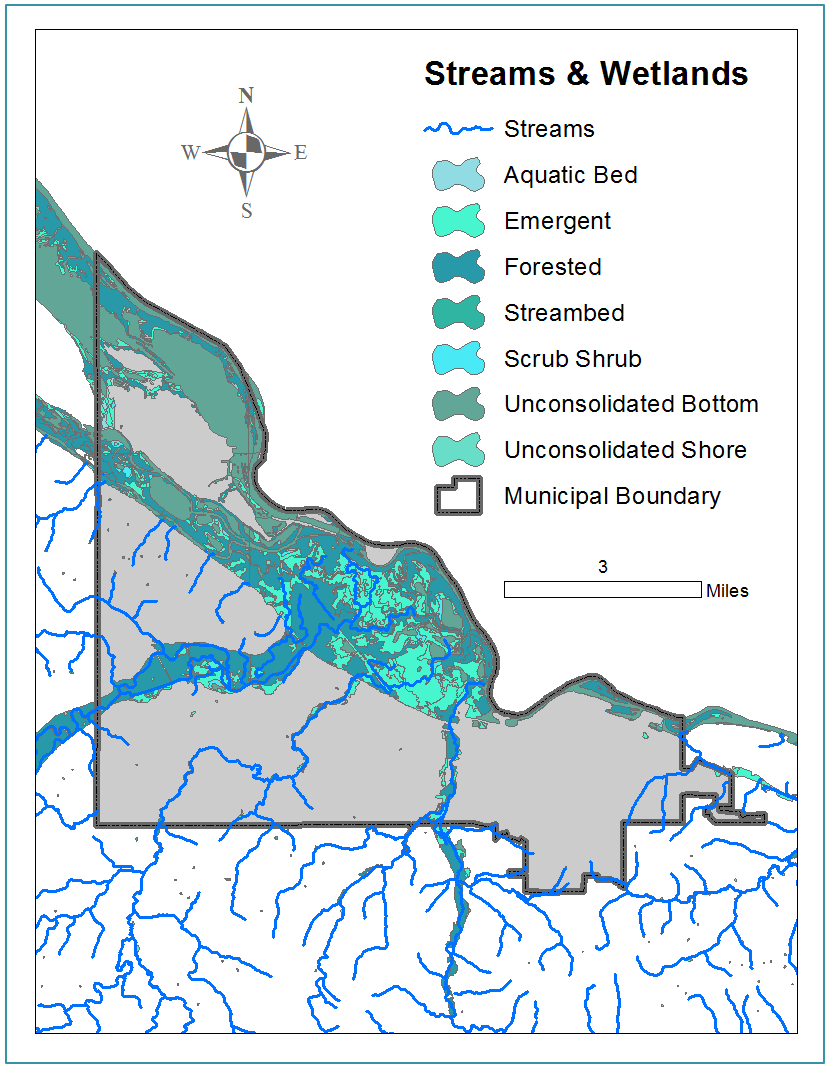
Data for Predictive Model: LiDAR

- LiDAR is an active remote sensing technique which provides sub-randomly distributed three-dimensional terrain point data.
- High resolution ground elevation data, collected via LiDAR by the Minnesota Department of Natural Resources in 2012, exists for the Red Wing Locality.



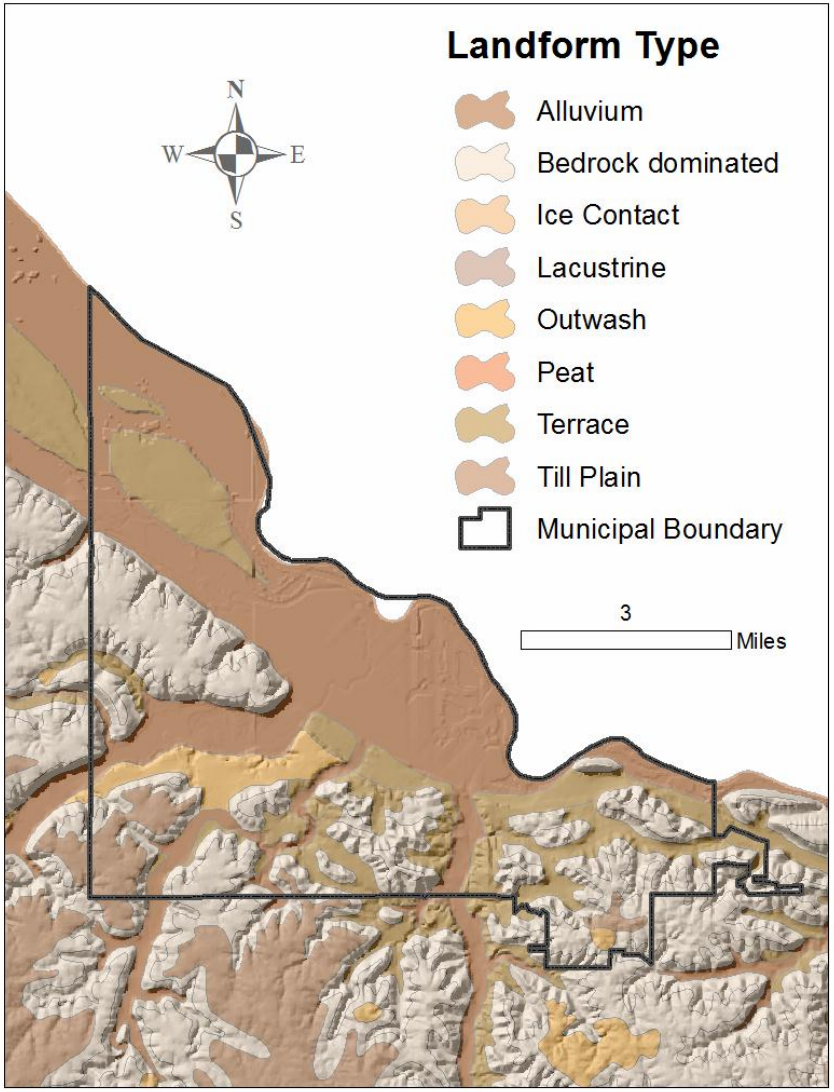
Data for Predictive Model: Hydrology

- Red Wing's surface hydrology water features include the Mississippi River, 50 miles of streams, and approximately 16 square miles of wetlands.



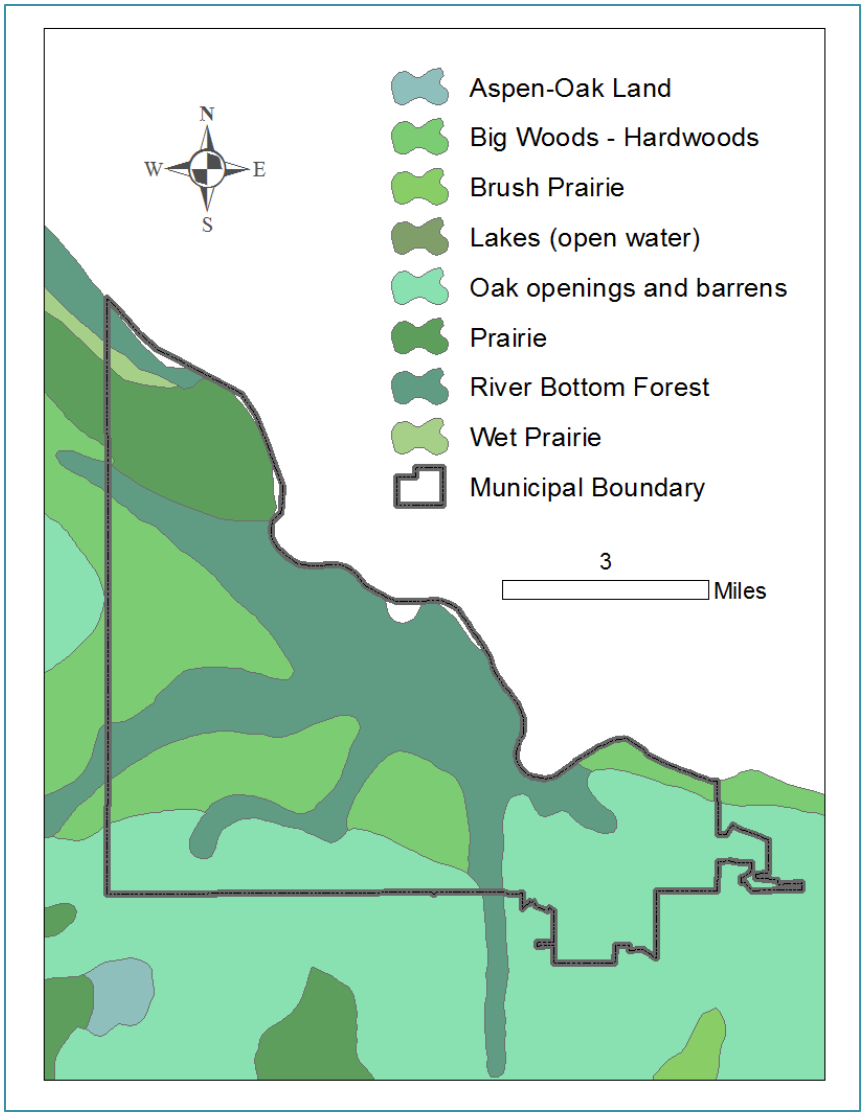
Data for Predictive Model: Geomorphology

- Predominant landform types within the Red Wing boundary including Outwash, Terrace, Bedrock dominated, Alluvium, and Till Plain.
- Terraces are composed of glacial sands and gravels with sometimes extensive zones of silts and clays. The sediments in valley areas are alluvial in origin and consist of finely textured silts and sands



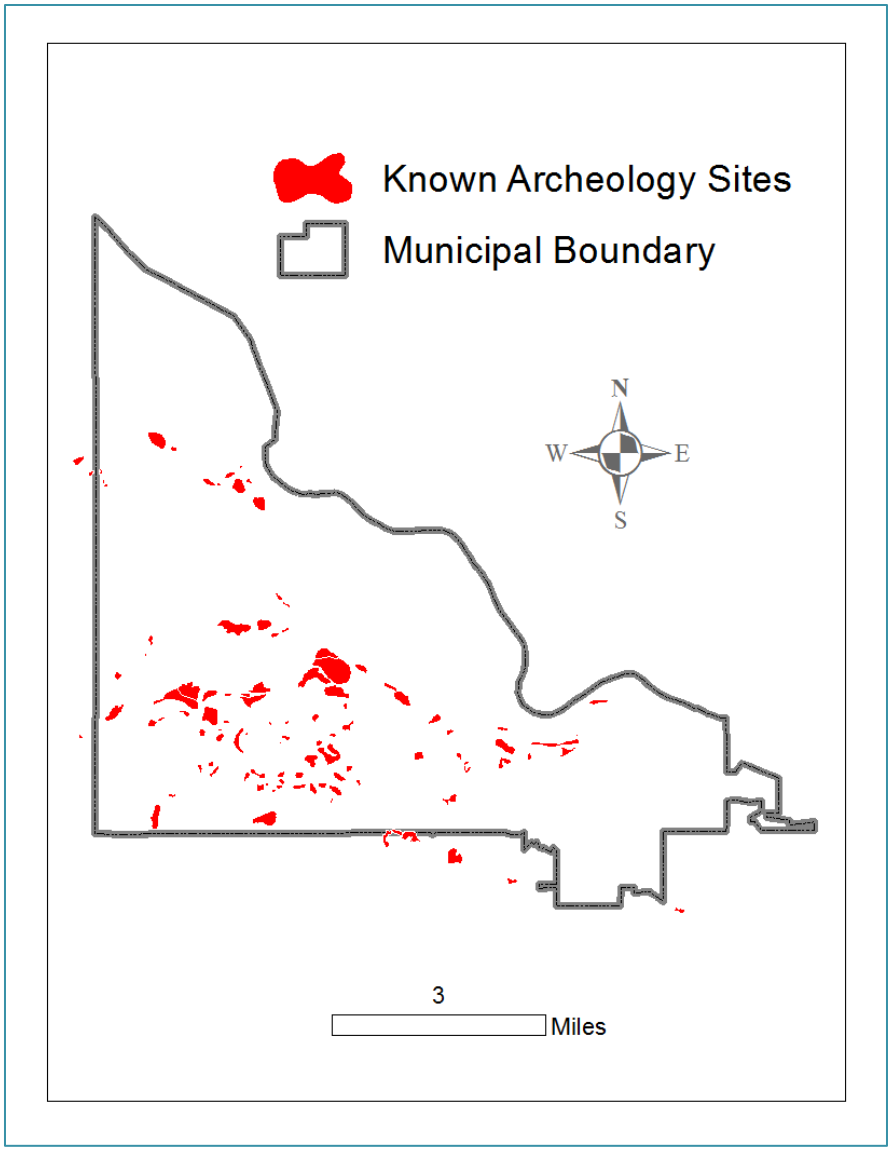
Data for Predictive Model: Historic Vegetation

- Vegetation was an integral part of the hunter-gatherer's landscape. Trees and shrubs provided food, fuel, building materials, and protection from the elements.
- High local diversity of vegetation types would have made a wider range of resources easily accessible.



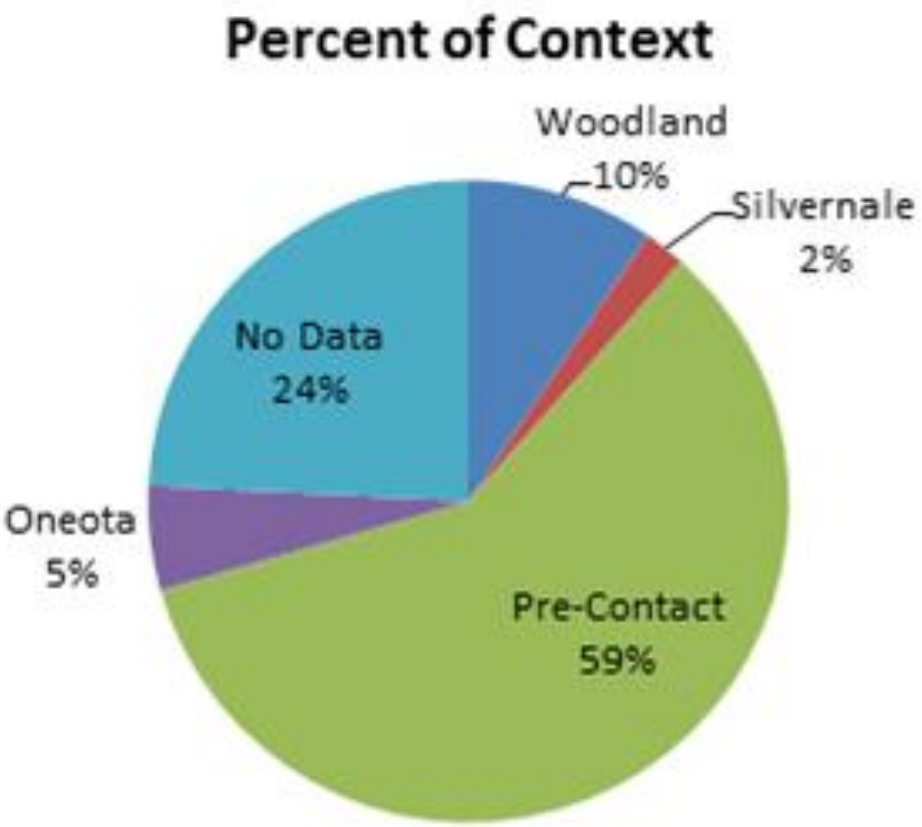
Data for Predictive Model: Known Sites

- The majority of known Red Wing Locality archeological sites are within the City of Red Wing municipal boundary.
- An important delimitation for this study included a project focus area within the City of Red Wing municipal boundary due to the completeness of data sources as compared to those available for adjacent areas.



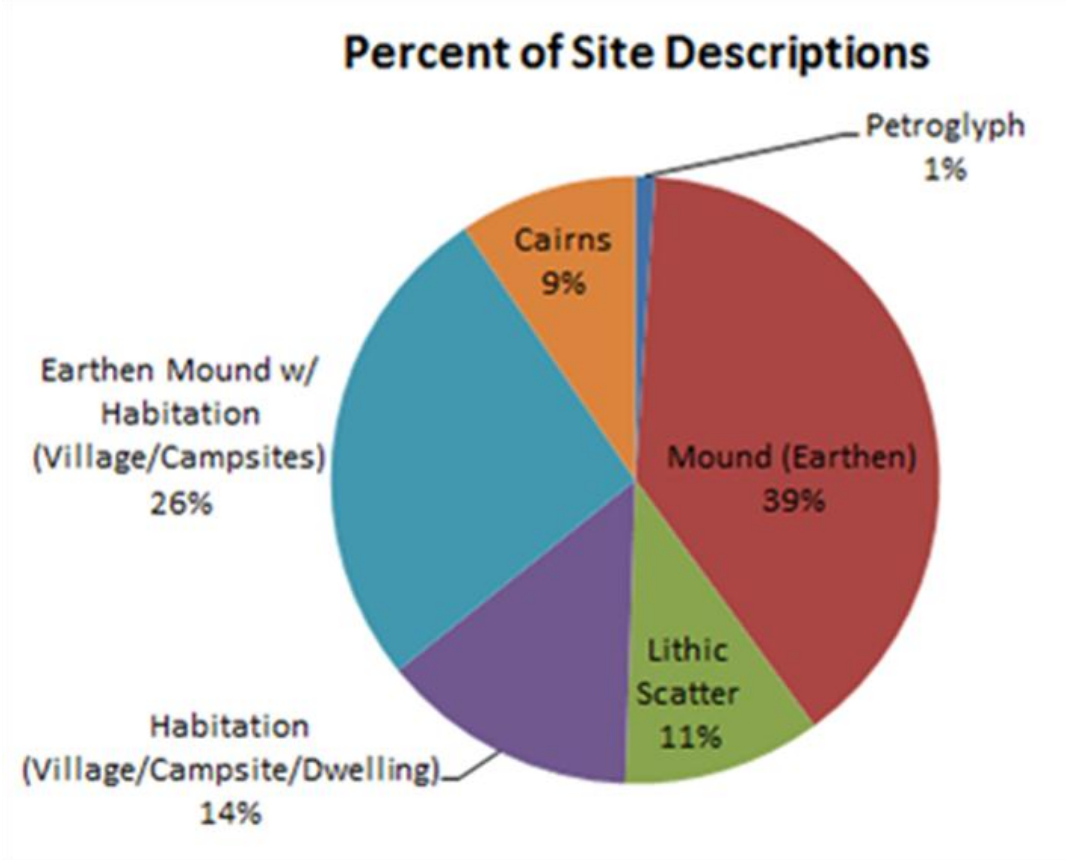
Cultural Context

- The four major eras of archeological cultural context include Woodland, Silvernale, Oneota, and Pre-Contact. Figure 8 shows percentages of each context for known sites.



Cultural Context

- Common cultural characteristics of these sites include earthen mounds and evidence of both habitation sites and villages.
- Less common cultural characteristics include cairns, lithic scatter, and petroglyphs.



MnModel – Archeological Site Predictive Model

- MN Model – Minnesota Department of Transportation
- Conceptual historic water features model created by staff at UMD

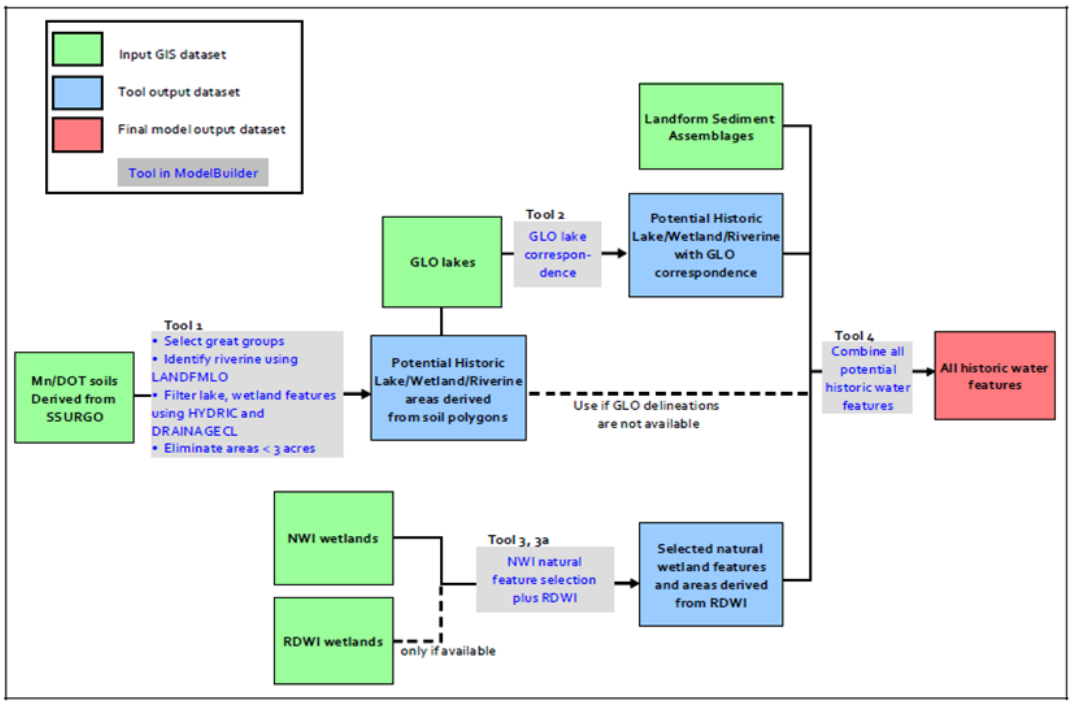


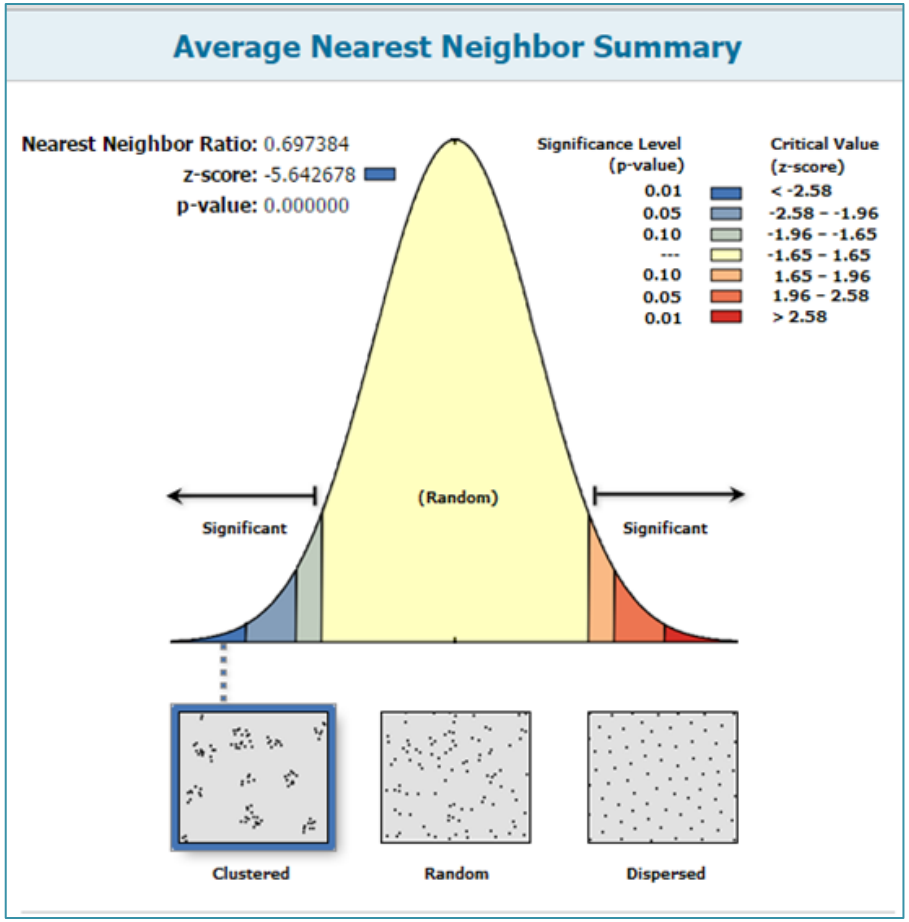
Figure 2. Conceptual Model to Create Historic Water Features Layer for MnModel Phase 4.

Predictive Model Methodology

- Phase I – Cluster analysis of known sites for significance
- Phase II – Analyze environmental characteristics of known sites
- Phase III – Utilize a weighted model index for Red Wing parcels to indicate high, medium or low site potential

Cluster Analysis

- The first step of the predictive modeling process was to establish whether known sites patterns were random/dispersed (Ho) or clustered (Ha).
- An Average Nearest Neighbor (Spatial Statistics Toolbox) analysis was performed on the Known Sites data.
- Given the z-score here of -5.64, there is less than 1% likelihood that this clustered pattern could be the result of random chance.



Weighted Model Index: Geomorphology

- Data from each of the predictive model datasets was clipped by the Known Sites polygon feature dataset and environmental characteristics analyzed.
- Acreage of geomorphology landform types was calculated, aggregated, and assigned weighted values.

Geomorphology Type	Acreage	% of Total	Weight
Alluvium	126	13	**2**
Bedrock Dominated	178	18	**2**
Outwash	258	27	**3**
Terrace	397	41	**3**
Till Plain	8	1	**1**
Total	**967**	**100**	

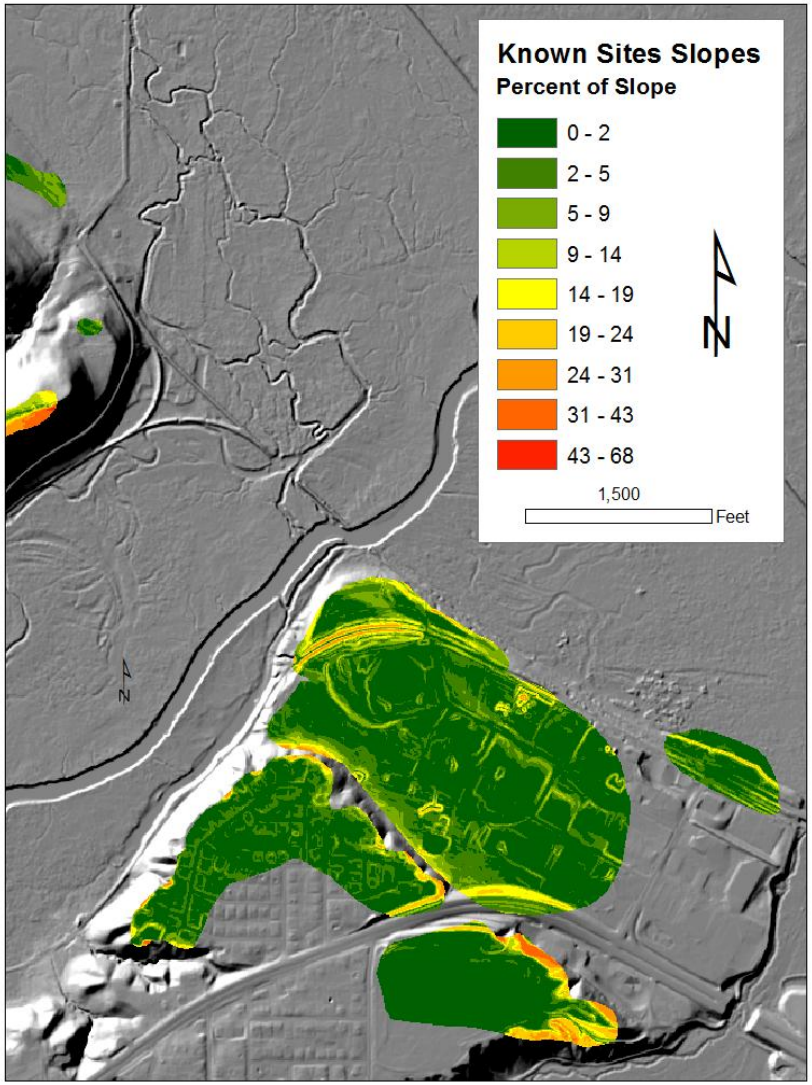
Weighted Model Index: Historic Vegetation

- The weighted score is an indication of the likelihood of that associated characteristic being present within the known site polygons.
- The same process was performed on historic vegetation with weighted results shown in Table 2.

Historic Vegetation Type	Acreage	% of Total	Weight
Big Woods	476	49	**3**
Oak Openings & Barrens	166	17	**1**
River Bottom Forest	323	34	**2**
Total	**967**	**100**	

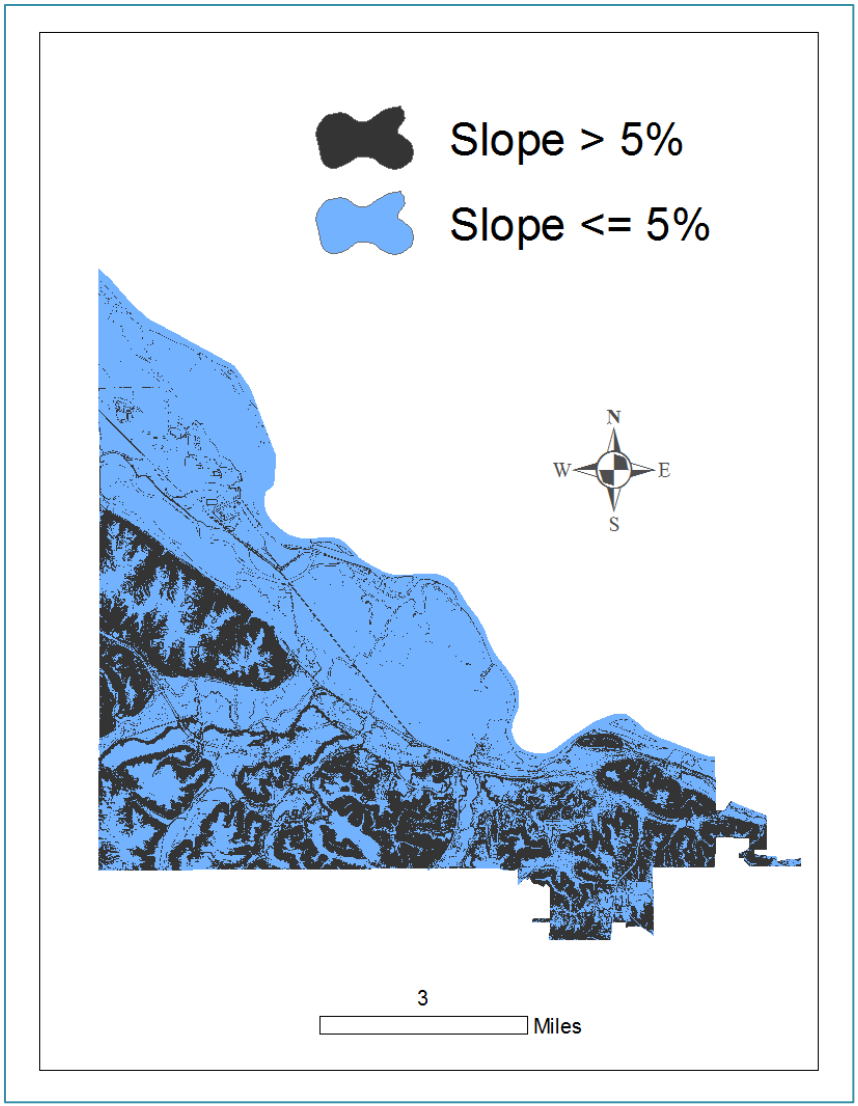
Slope Analysis

- Slope values were derived from DEM raster data with the mean slope resulting in 4.92 percent



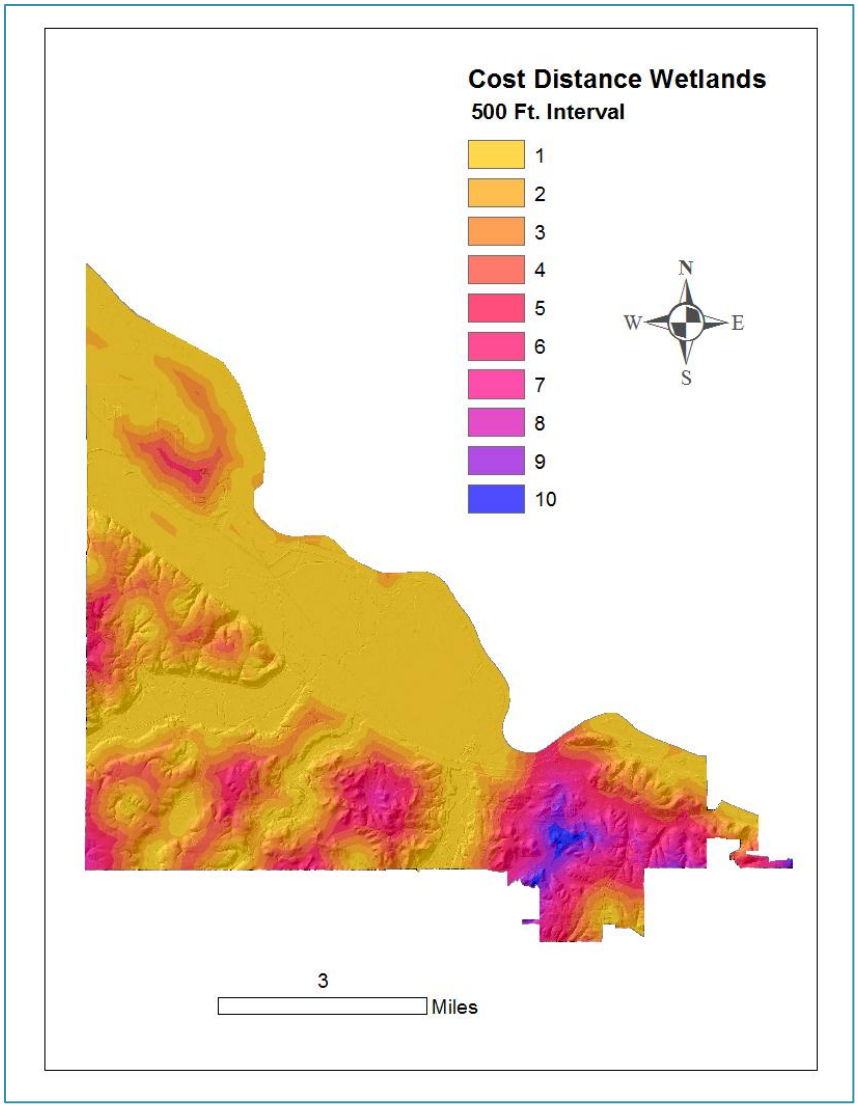
Slope Analysis

- Raster surface values were recalculated using the Map Algebra Raster Calculator Tool.
- Figure 13 shows slopes greater than 5 percent were assigned a value of 0, while slopes that were less than or equal to 5 percent were assigned a value of 1. Raster values of 1 were converted into shapefile vector format.



Cost Distance Analysis

- Proximity to surface hydrology was calculated utilizing the Spatial Analyst Cost Distance tool using an input value of 500 ft.
- Wetlands were selected for the Cost Distance Analysis. Values were reclassified using ArcGIS. Lower values on the scale indicate higher proximity to wetland features.



Parcel Weighted Index Model

- Fields were added to the parcel dataset attribute table: Geomorph Score, Hist Veg Score, Cost Dist Score, Slope Score, and Known Sites Score. Parcels containing Known Sites were assigned a score of 1 while parcels not containing Known Sites were assigned a value of 0.
- Parcels were selected using Select by Location from each of the weighted output datasets and assigned weighted model scores

Geomorph Score	Hist Veg Score	Cost Dist Score	Slope Score	Known Sites Score	Final Score
2	2	3	0	0	7
2	2	3	0	1	7
2	0	1	0	0	3
3	0	1	1	0	5
2	1	2	0	0	5
1	1	2	0	1	5
2	3	3	1	2	11
2	1	2	1	0	6
1	0	2	0	1	4

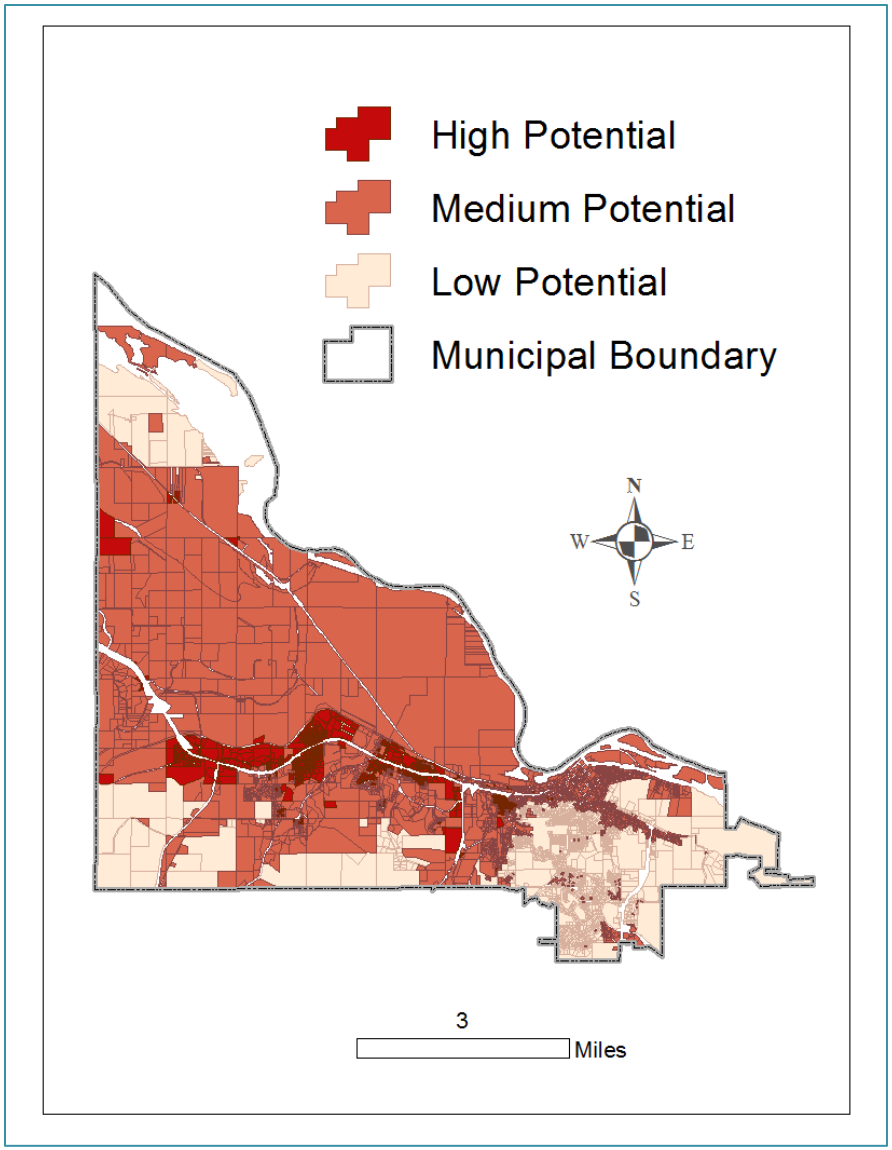
Parcel Weighted Index Model

- Weighted model scores were added for a final score output. 'Final Score' attribute values ranged from 3 to 11 and were aggregated into 3 categories. Higher weighted index scores indicated a higher probability of archeology sites within the parcel. Choosing 3 categories simplified visualization and reflected the generalized nature of the input datasets.
  - ☐ Values 3-5 = 1
  - ☐ Values 6-8 = 2
  - ☐ Values 9-11 = 3

- A final score value of 3 indicated high potential for archeology sites, a value of 2 indicated medium potential, and a value of 1 indicated low potential.

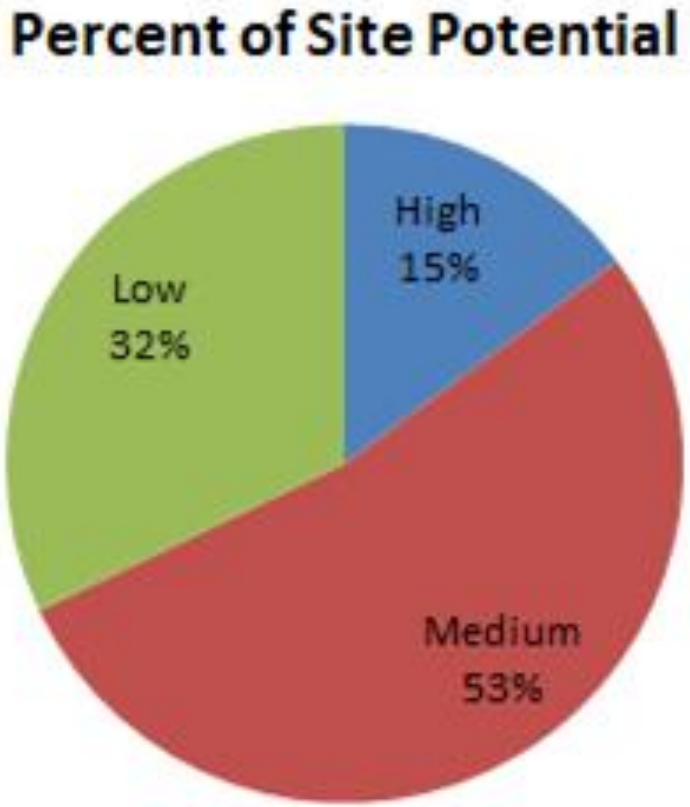
Results

- A predictive value was assigned to each of the approximately 8,000 parcels in the Red Wing parcel dataset.
- The analysis pattern indicated strong potential along areas with a relatively flat slope with adjacency to surface water features, terrace or outwash geomorphology, historic vegetation types that included Big Woods (including Oak, Maple, Basswood, and Hickory trees), and proximate to Known Sites.



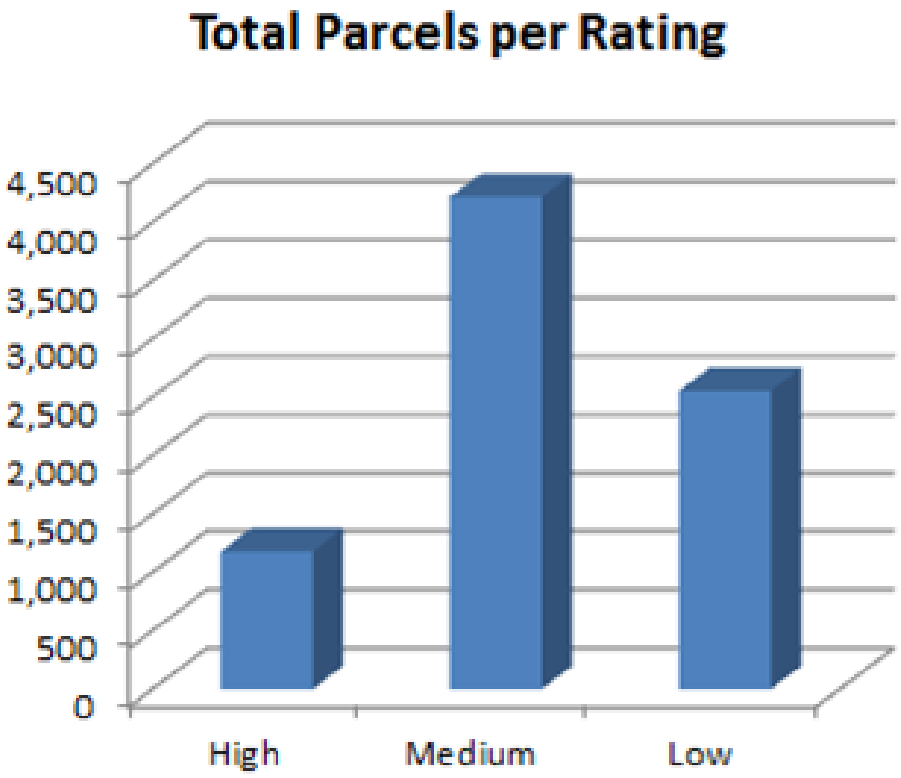
Results

- Percent by predictive value was analyzed. This shows the largest percent of parcels indicate a medium potential for archeology sites.



Results

- Total parcels per rating are shown in Figure 18. 1,182 parcels indicated high potential, 4,219 parcels indicated medium potential, and 2,557 parcels indicated low potential.

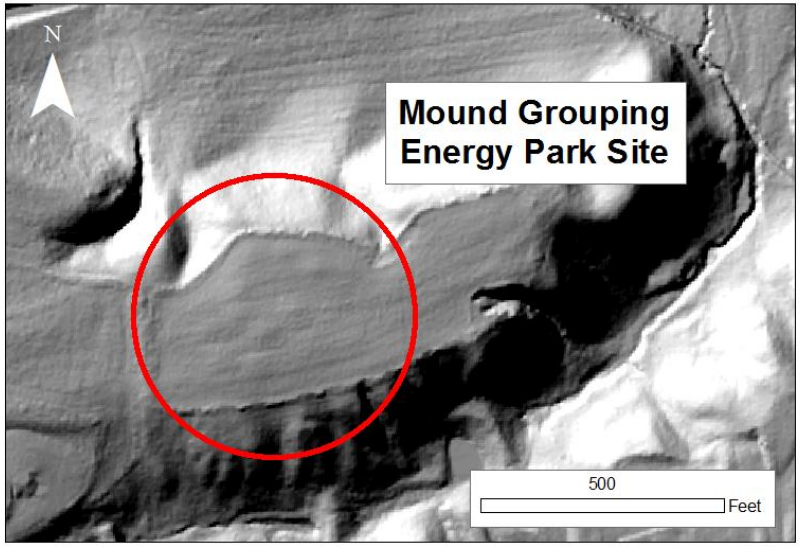


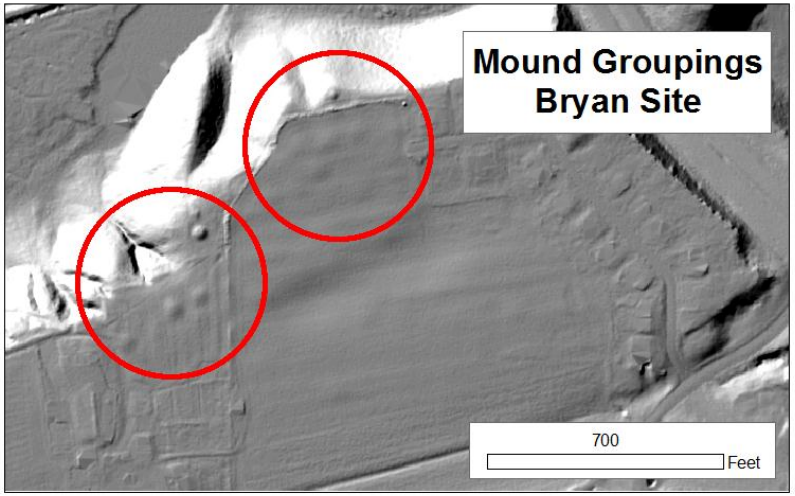
Conclusions

- Summary project outcomes from the GIS design and methodology achieved a desired weighted rating system that can lay the groundwork for further investigation by City of Red Wing and Goodhue County staff when reviewing zoning applications. GIS databases, geoprocessing, and visualization tools were all key factors in reaching desired project outcomes.
- Link to AGOL Web Application

Continuing Investigations

- Visual methods utilizing hillshade DEM raster data may support the validity of site potential identification.
- Even mounds and mound groups that have been degraded by erosion and/or modern agricultural practices can be identified by shape and pattern distribution.





Continuing Investigations

- High resolution imagery can provide markers that may indicate potential mound groups and village sites.
- The following slides show areas with visual indications of degraded mound areas in rural Red Wing and Welch Township.

N
Bryan Site 2012
150
Feet

N
Bryan Site 2014
150
Feet

N
T113N
R16W
450
Feet

N
T113N
R16W
130
Feet

N
T113N
R16W
100
Feet

Acknowledgements

- I would like to thank City of Red Wing and Goodhue County staff for permission to utilize their data and source materials in this project.
- I would also like to thank John Ebert, Greta Poser and Dr. David McConville for their support, professionalism, and technical guidance during this project and throughout my MGIS degree program experience.

Questions?