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Distribution of Rain Gardens in Lincoln Nebraska: Are Rain Gardens more Likely to be Built Near Bodies of Water

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Disclaimer: The following thesis was produced in the Environmental Studies Program as a student senior capstone project.

DISTRIBUTION OF RAIN GARDENS IN LINCOLN NEBRASKA:
ARE RAIN GARDENS MORE LIKELY TO BE BUILT NEAR BODIES OF WATER

By

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Abstract

Rain gardens are an important tool in reducing the amount of stormwater runoff and accompanying pollutants from entering the city's streams and lakes, and reducing their water quality. This thesis project analyzed the number of rain gardens installed through the City of Lincoln Nebraska Watershed Management's Rain Garden Water Quality Project in distance intervals of one-eighth mile from streams and lakes. This data shows the distribution of these rain gardens in relation to streams and lakes and attempts to determine if proximity to streams and lakes is a factor in homeowners installing rain gardens.

ArcGIS was used to create a map with layers to determine the number of houses with rain gardens in 1/8 mile distance increments from the city's streams and lakes and their distances from a stream or lake. The total area, number of house parcels, and the type and location of each parcel type were also determined for comparison between the distance interval increments. The study revealed that fifty-eight percent of rain gardens were installed within a quarter mile of a stream or lake (an area covering 60% of the city and including 58.5% of the city's house parcels), and that eighty percent of rain gardens were installed within three-eighth mile of streams or lakes (an area covering 75% of the city and 78.5% of the city's house parcels). All parcels in the city are within 1 mile of a stream or lake. Alone the number of project houses per distance intervals suggested that proximity to a stream or lake was a factor in people's decisions to install rain gardens. However, when compared to the number of house parcels available, proximity disappears as a factor in project participation.

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Acknowledgements

I would like to thank Dr. Cody Knutson for being my thesis advisor and Dr. Qingfeng "Gene" Guan for being my thesis reader. I would also like to thank Amanda Meder for providing me the location of the houses that built rain gardens under Watershed Managements program, and Tan Phem for providing me with shapefiles. Finally, I would like to thank my family and friends for being supportive.

Introduction

Urbanization has resulted in several major problems that cities have to deal with in modern times. One of the major problems faced by large cities is urban stormwater runoff. Urban development of land can increase the amount of runoff by a factor of five (see Diagram 1). Cities can spend millions of dollars dealing with stormwater runoff. Lincoln, Nebraska funds its expensive grey infrastructure improvement projects from bond offering that require voter approval. The residents of Lincoln approved a $9.95 million bond issue in 2005 (City of Lincoln, 2005) and an $8.5 million bond issue in 2007 (City of Lincoln, 2007). The main obvious problems with urban stormwater runoff are the large volume of water that needs to be removed to prevent flooding by injecting it into the waterways and the sediment and pollutants included in the stormwater. As this urban stormwater reaches a surface waterway it can have negative impacts on water quality.

In terms of water quantity, much of the runoff in urban areas comes from rooftops, roads, parking lots, and other impervious surfaces where the water is prevented from infiltrating into the soil (EPA, 2003). Traditionally, city planners built infrastructures to remove the stormwater runoff as fast as possible to prevent flooding. These infrastructures include developing extensive stormwater sewers, artificial waterways, and channelized waterways. Although this is an effective means of keeping a city from flooding, the large injection of water into a surface waterway can have a negative impact on the waterway and does not take into consideration what happens downstream. The sudden and large increase in surface water flow rates from stormwater can cause stream erosion, and weed invasion. It can also alter the natural flow patterns that native species rely on, and increase the chance of flooding downstream.

Another main problem of urban stormwater runoff is the pollution in the water. Stormwater runoff includes sediment and organic waste (EPA, 2003). They create a problem when they reach the surface waterways because they can change the natural turbidity of the water and change its chemical and temperature characteristics (e.g., dissolved oxygen). In addition, the sediment and waste can cover insects and plants along the bottom of streams, rivers, and lakes resulting in their death. Urban stormwater can also include pollutants such as gasoline, motor oil, salt, metals, fertilizers, pesticides, and thermal pollutions (EPA, 2003). These pollutants also change the natural chemical and temperature characteristics of the waterway as well as being toxic to many organisms. The changed nutrient levels may cause algae blooms that can choke off life and make contact with the water dangerous for animals and humans. Unfortunately, many urban stormwater management systems do not treat their discharges and the water is directly released into the surface waterway. In 1987, Congress amended the Clean Water Act to include these non-source water pollutant discharges that enter our nation's streams and lakes.

One green infrastructure that does a good job of addressing both problems is a rain garden. Rain gardens are gardens planted in a depression designed to catch stormwater runoff from roofs, lawns, driveways, or patios. Rain gardens are usually planted with native species. Most native species have the benefit of being drought tolerant, disease resistant, usually do not require fertilizer or watering, and are tolerant to the soil and extremes of the local climate (Dods et al, 2007, p. 27). The purpose of a rain garden is not to create a wetland, but to provide a place to temporarily hold the stormwater and allow it to infiltrate into the soil over a 48 hour period. Thus, rain gardens are able to address both problems in stormwater management. They reduce the volume of water reaching the city stormwater sewer system, while at the same time recharging the groundwater. They also provide a place for sediment to settle, as well as capturing pollutants on site where they can be naturally broken down. Most pollutants are picked up and carried away in the first 1/2 to 1 inch of precipitation or "First Flush" (Wise, 2008, p. 16), which accounts for 90% of rain events in Lincoln, Nebraska (Franti & Rodie, 2009, p. 10). A rain Garden provides the ideal solution where stormwater is kept on site, instead of ending up in a surface waterway.

Since rain gardens are cheap, efficient solutions to stormwater runoff compared to grey infrastructures, this thesis investigates what factors are involved in people's decisions to build rain gardens on private property by analyzing their locations. Specifically, the study evaluates the proximity of rain gardens built by homeowners though the City of Lincoln Watershed Management's Rain Garden Water Quality Project to the streams and lakes in Lincoln. The objective is to determine if a homeowners' proximity to waterways appears to be a factor in the building of rain gardens. The limitation of this study is that it assumes a factor effecting homeowners' decision can be obtained from the statistics of the proximity of homeowners to streams and lakes. This analysis may aid the Watershed Management's Rain Garden Water Quality Project in further marketing the program, once its current grant application is approved by the Nebraska Environmental Trust. This information may aid the program in determining what marketing strategies to use, and who to market to, in an effort to increase the number of homeowners building rain gardens.

Materials and Methods

The site for the study is the city of Lincoln, Nebraska. The Rain Garden Water Quality Project started as a pilot project for the Homes Lake watershed in 2007 and was expanded to the rest of the city in 2008. The pilot started as a segment of the City of Lincoln's Water Quality Improvement Program: Holmes Lake Watershed to maintain the lakes water quality after a $5.5 million renovation of the lake (Laukaitis, 2007). Mayor Chris Beutler expanded the program to the rest of Lincoln in 2008, to help improve the water quality of the other streams and lakes in the city (City of Lincoln Mayor's Office, 2008).

Using ArcGIS, a feature class was created with the locations of the 88 rain gardens that have been built by homeowners though this project in Lincoln, Nebraska. The addresses of the 88 rain gardens were provided by Environmental Educator, Amanda Meder, of the Watershed Management's Water Quality and Education Program. Feature classes of 1/8 mile intervals of distances from streams and lakes in Lincoln, Nebraska were also created. The city limit, and county streams and lakes shapefiles were provided by Senior Engineering Specialist, Tan Pham, of the Watershed Management's GIS/Computer Applications. An ArcGIS map was then created containing these feature classes and shapefiles in order to determine where the houses with rain gardens were from the pilot program and the later expanded program. Next, a property parcel, open space, and parkland shapefile was used from the Lancaster County Assessor's Office to determine where residential house parcels, non-residential house parcels, and open space and parkland were located. Finally, the exact distance of each house from the nearest stream or lake was calculated to determine the mean, median, minimum, and maximum distance.

First, the location of the 88 houses with rain gardens had to be added as a layer to an ArcGIS map containing the county streams and lakes, and city limits shapefiles. An empty map was created in ArcMap and the two shapefiles were added as separate layers. To create the "houses with rain gardens" feature class, the latitude and longitude of the houses had to be found. This was accomplished using Google maps. Each address was entered into Google maps using the satellite view and the latitude and longitude of the center of each house was approximated. The location of the houses and not the rain gardens themselves were used because they were located on private property and it was the perception's of the homeowners that was being studied. The latitudes and longitudes of the pilot program houses and the expanded programs houses were then entered into an Excel worksheet. Using the Excel Worksheet and the "Add x,y data" tool in ArcMap the locations of the houses were plotted as two separate layers on the map. To have a workable houses layers with ObjectIDs, these created layers were exported as feature classes and added as two layers on the map (see map 1). The shapefiles were in the GRS 1980 Transverse Mercator projection coordinates and the locations were made in the GCS_GRS_1980 geographic coordinates.

Second, buffer maps of the distance intervals from streams and lakes were made. Using the buffer tool, buffer layers were made for distances of 1/8, 1/4, 3/8, 1/2, 5/8, 3/4, 7/8, and 1 mile from streams and lakes using the streams and lakes layer. These buffer layers were then exported as a feature class containing ObjectIDs. All areas of Lincoln fell within 1 mile of lakes and streams. These 8 layers were then exported as new feature classes with ObjectIDs (example see Map 2).

The number of houses in each distance range was then found. First the "select by location" function under the selection menu was used. This function located what houses in the "Houses in pilot program" layer, and "Houses after pilot program" intersected each distance buffer layer. After the locations were found in each distance, the houses layers were exported as a new layer that only contained those houses within that distance. Again, each new layer was exported as a new feature class with ObjectIDs. Then, the number and location of houses in each distance interval was analyzed using the "Delete" feature tool. Starting with the 7/8 mile houses map, the 3/4 mile houses were deleted with the delete features tool and a new layer was created containing only the houses in descending 1/8 mile interval increments for both "Houses" layers (see Maps 3 to 9).

Next, the mean, median, minimum, and maximum distances were found. First, the "Houses in pilot program" and "Houses after pilot program" layers, and the country streams and lakes layer were re-projected to NAD 1983 Zone 14 using the "Project" tool. Then the "Near" tool was used to find the distance from each house to the nearest stream or lake. This created a NEAR DIST field in the attributes of the two layers giving distances in meters. These distances were then entered into an Excel worksheet and the convert meters to feet formula was used. The Average, Median, Min, and Max formulas were then used on the feet data to find their respected values (see Table 1).

Finally, the number of residential houses and the location of house units, non-house units, parkland and open space parcels were found for each distance range, as well as the square miles of each distance interval increment. First, with the property parcel layer and the buffer maps of the distance intervals, the "Select by Location" tool was used to find the property parcels for each distance. Again each new layer was exported as a new feature class with ObjectIDs. Then a "Summarize" report was made for each distance and the number of R1, R2, and R3 property classes where added together for each distance. As the distance increments increase the number of residential parcels from the previous distances where subtracted from the total, so parcels that overlapped where counted with the lesser distance layer. Lastly, the location and property type of each parcel was determined for the ranges 0 to 1/8 mile, over 1/8 mile to 1/4 mile, over 1/4 mile to 3/8 mile, over 3/8 mile to 1/2 mile, over 1/2 mile to 5/8 mile, over 5/8 mile to 3/4 mile, over 3/4 mile to 7/8 mile, and over 7/8 mile to 1 mile. First, using the "Erase" tool, I created final buffered feature class for the ranges, 0 to 1/8 mile, over 1/8 mile to 1/4 mile, over 1/4 mile to 3/8 mile, over 3/8 mile to 1/2 mile, over 1/2 mile to 5/8 mile, over 5/8 mile to 3/4 mile, over 3/4 mile to 7/8 mile, and over 7/8 mile to 1 mile. Using the "Clip" tool, layers were made for the parcel, parkland, and open space for each distance interval increments. Then, using the "Select by Attribute" tool, R1, R2, R3, C1, and C2 parcels were found for each distance interval increments, and the property classes were exported as a new feature class. Using the "Union" tool, for each distance interval increments the parkland and open space combined into a new feature class, the R1, R2, and R3 were combined into a new feature class, and the C1 and C2 were combined into a new feature class (see Maps 10 to 17). Finally, using the clipped distance interval increments, the “clip” tool was used to clip each distance interval increment from the “City Limits” shapefile, creating new feature classes. These were then re-projected to NAD 1983 Zone 14 using the “Project” tool and using the “Measure Feature” tool the total area for each distance interval range was found (see Chart 1).

<u>Results</u>

The data obtained showed that there was variation in the number of the gardens in each distance range. The mean distance was 1339 feet, just slightly over 1/4 of a mile, while the median distance was 1197 feet (see Table 1). The minimum distance was 72 feet, and the maximum distance was 4151 feet (see Table 1). This shows a variation of 4079 feet between distances of houses from streams or lakes in Lincoln Nebraska. The median distance was less than the mean distance, and may be a better indicator of central tendency. The four farthest houses all had z Scores of over 2.00 signifying that they are unusual events skewing the mean. While the median better reflects the distributions of houses towards lesser distances (see Chart 2).

The first four distance ranges had a high number of houses in them, but then the number drastically dropped in the 5th, 6th, and 7th distance ranges (see Chart 2). All distance ranges contained houses except the over 7/8 to 1 mile range. This shows that the largest number of houses was in the Over 1/8 to 1.4 mile range (see Chart 2). The second highest number of houses was in the Over 1/4 to 3/8 mile range, followed by the 0 to 1/8 mile range (Chart 2).

As the distance interval increments increased the sq. mile of coverage decreased (see Table 2), but the percent of house parcels of the total parcels appears to increase (see Maps 10 to 17). As Map 10 shows, much of the land within 1/8 mile of streams and lakes in Lincoln is covered with commercial property, or parkland and open space, but by the over 7/8 mile to 1 mile distance interval the majority of parcels were houses (see Maps 10 to 17). The 0 to 1/8 distance interval coverage had 34.73 sq. miles, but this coverage decreased to 0.30 sq. mile by the over 7/8 mile to 1 mile distance interval (see Table 2).

Discussion

Looking at distance ranges as percentage of total, 58% of houses were located within 1/4 mile of streams or lakes, 80% were located within 3/8 mile of streams and lakes, and only 5% were located beyond 1/2 mile (see Chart 2). The area within 1/4 miles of a lake or stream was 59.94 sq. miles (66.21% of the total 90.53 sq. miles for the city), and the area within 3/8 mile accounted for 75.22 sq. miles (83.08% of the cities area) (see Chart 1). One reason that distance range 0 to 1/8 mile had fewer houses than the Over 1/8 to 1/4 mile range could have been because many streams and lakes are surrounded by green zones, thus preventing many houses from being close to streams and lakes, but the data showed this not to be true. While Map 10 shows the 0 to 1/8 mile distance interval does seem to have a lot of non-house parcels, and parkland and open space, Table 3 shows that it has only slightly less number of house parcels as over 1/8 mile to 1/4 mile distance interval, though over 1/8 mile to 1/4 mile distance interval does appear to have a higher percent of parcels being housing parcels (Map 11). This could mean that for the 0 to 1/8 mile distance interval increment, proximity to a stream or lake may have a negative effect on the decision to build a rain garden, but further study would be needed. More homeowners built rain gardens at closer proximity to streams and lakes than homeowners at farther distances with the exception of homeowners in the Up to 1/8 mile range, but when comparing the number of project houses per available house units, Table 4 shows that the over 1/8 to 1/2 mile distance intervals had similar numbers. Thus, the data seems to show that proximity to a stream or lake is not a factor in the building of rain gardens by homeowners. There also seems to be some clumping of rain gardens in some areas (Maps 1, 3 to 6). This could be caused by homeowners "trying to keep up with the Jones", but it works in the programs favor. That is because the city is trying to get homeowners on the same streets to install rain gardens for a water quality study that will analyze the impact of the gardens on stormwater runoff pollution (City of Lincoln Mayor's Office, 2008).

The study results do not support the hypothesis that proximity to a stream or lake is a factor in homeowners building rain gardens. When analyzed with these distance intervals, it appears the number of project houses is influenced by the number of house units available. The high number of project houses per available house units in the over 3/4 to 7/8 mile distance interval is probably an aberration due to the low number of house units available (see Table 3 and 4). The project houses per house units available in the 0 to 1/8 mile and over 1/2 to 5/8 mile distance intervals were smaller than the over 1/8 to 1/2 mile distance intervals (see Table 4), but this could simply be due to the small sample size of only 88 locations and may disappear as the number of locations increases

Summary & Conclusions

Rain gardens are an important tool in reducing the amount of pollutants that reaches streams and lakes in the city of Lincoln, Nebraska. This helps the city meet its requirements under the Clean Water Act for pollution discharges from its stormwater sewer system, as well as providing safer and healthier streams and lakes for its citizens. The reduction in the volume of stormwater runoff saves the city money by delaying and reducing the need for expensive gray infrastructures to the stormwater sewer system. Rain gardens also help recharge the groundwater table, which helps to provide water to plants and animals in drier periods.

Using ArcGIS, the locations of 88 houses with rain gardens built by homeowners through the City of Lincoln Watershed Management's Rain Garden Water Quality Project were superimposed on county streams and lakes within the City of Lincoln to find the proximity of these houses to the surface water bodies. The goal was to determine if proximity to streams and lakes was a factor in homeowners building rain gardens. The data showed that 58% of rain gardens were built by homeowners living 1/4 mile or less from a stream or lake, and that 80% of rain gardens were built by homeowners living 3/8 mile or less from a stream or lake. When compared with the number of house units available, the data shows that any correlation between houses and proximity disappears. This shows that homeowners were not more likely to build rain gardens the closer they were to a steam or lake, and seems to suggest that proximity is not a significant factor in their decision, because more people also had the opportunity to build rain gardens in those areas. It is important that proximity to a stream or lake is not a factor in homeowner's decisions. With the City of Lincoln's stormwater sewer system, proximity has little to no effect on pollution from stormwater runoff reaching the city's streams and lakes, and it seems the public has an understanding of this from past Watershed Management programs.

Ideally, a survey of the homeowners would have provided more reliable results, but as a third party they might have found that as a violation of their confidentiality with the City of Lincoln Watershed Management's Rain Garden Water Quality Project. Though this study failed to show proximity as a factor, other factors could be studied in the future. House values, income level, size of plots, political party, and environmental ethics could be looked at in future studies to determine if they are factors in homeowner's decisions to build rain gardens. Identifying these factors could further help the City of Lincoln Watershed Management's Rain Garden Water Quality Project program find better ways to market the program by providing billboard locations for ad campaigns, and demographics data helpful in targeting areas for educational programs in schools and communities to increase enrollment in the program in the future. In the long term this would save the city of Lincoln, Nebraska money and improve the water quality of its streams and lakes.

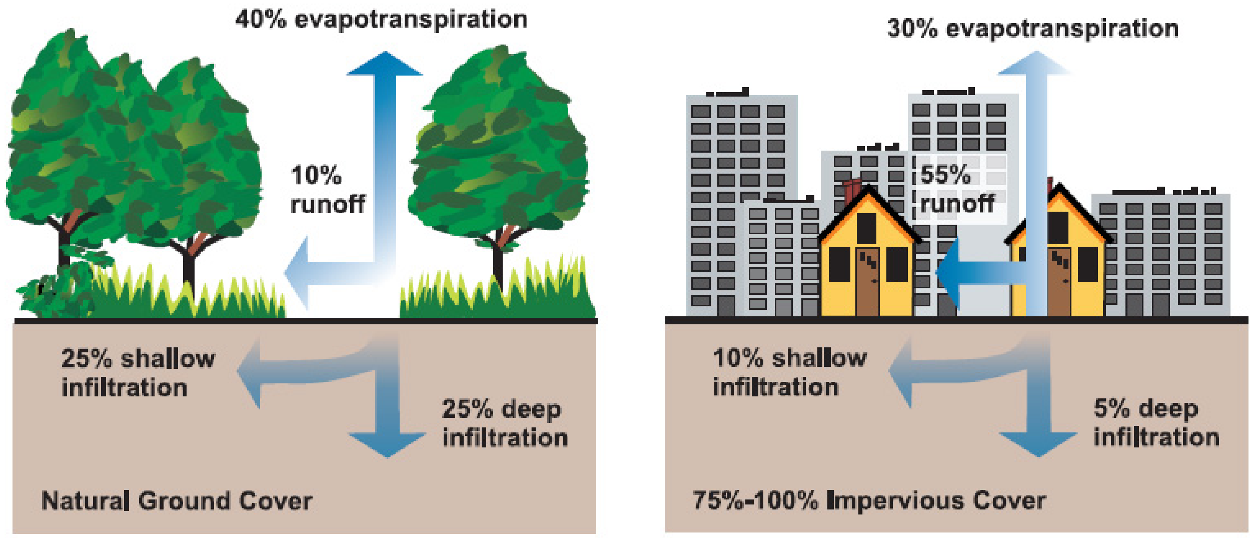
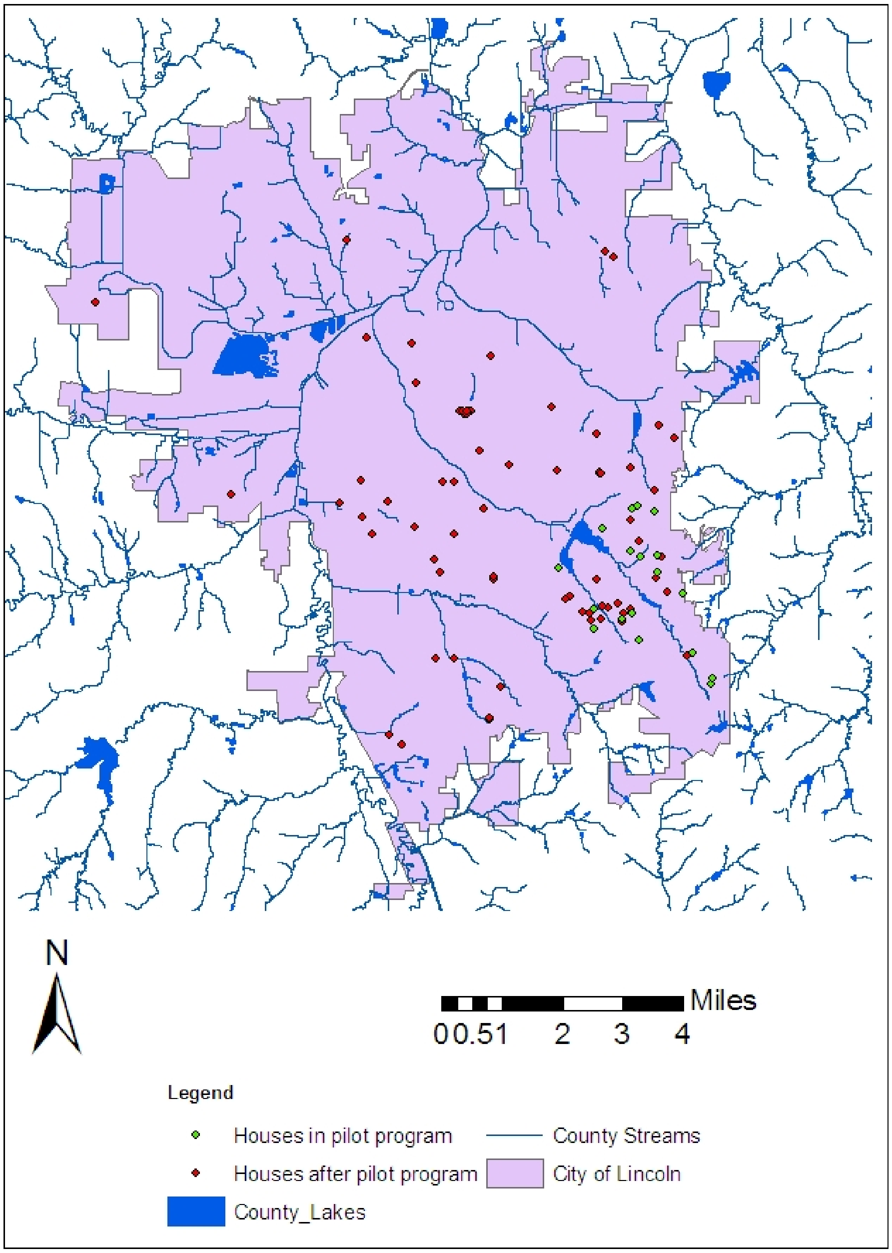
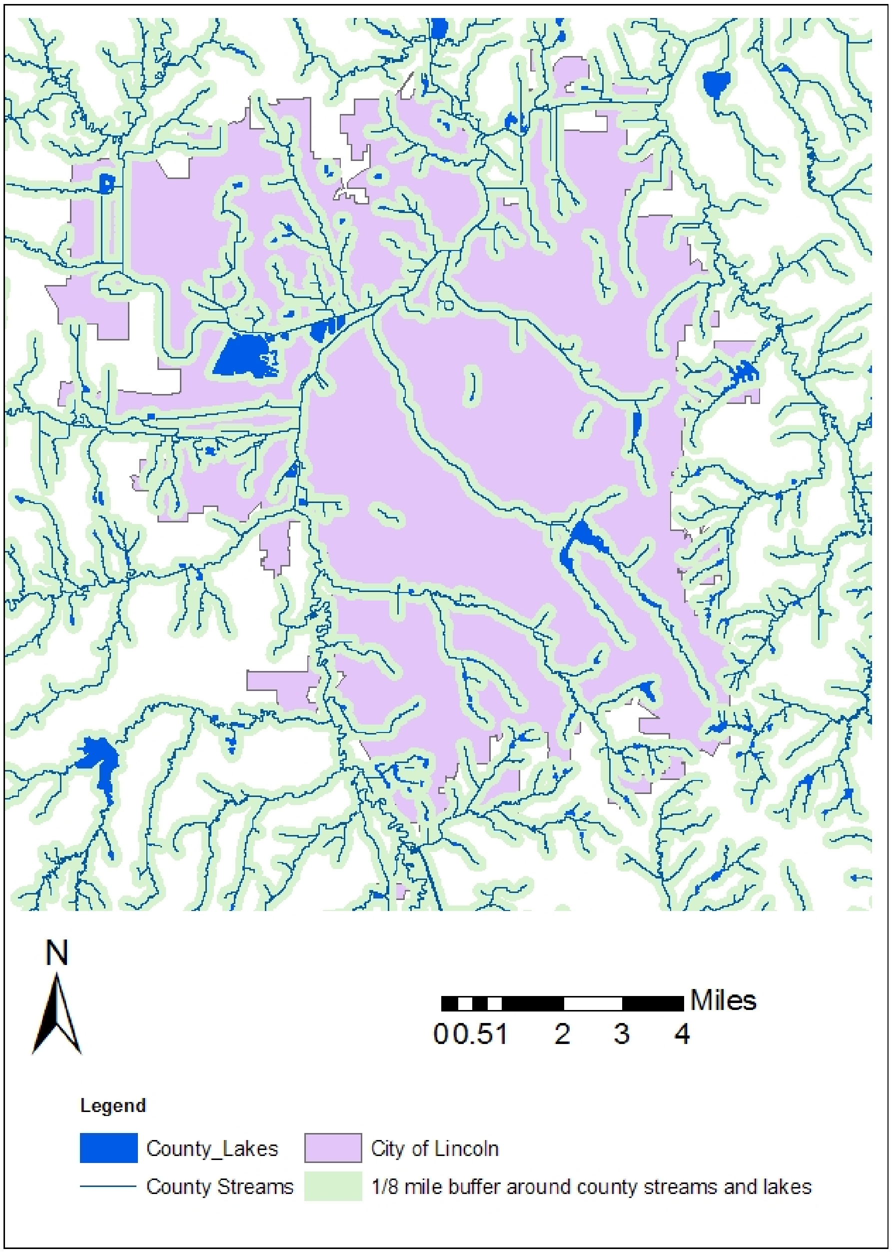


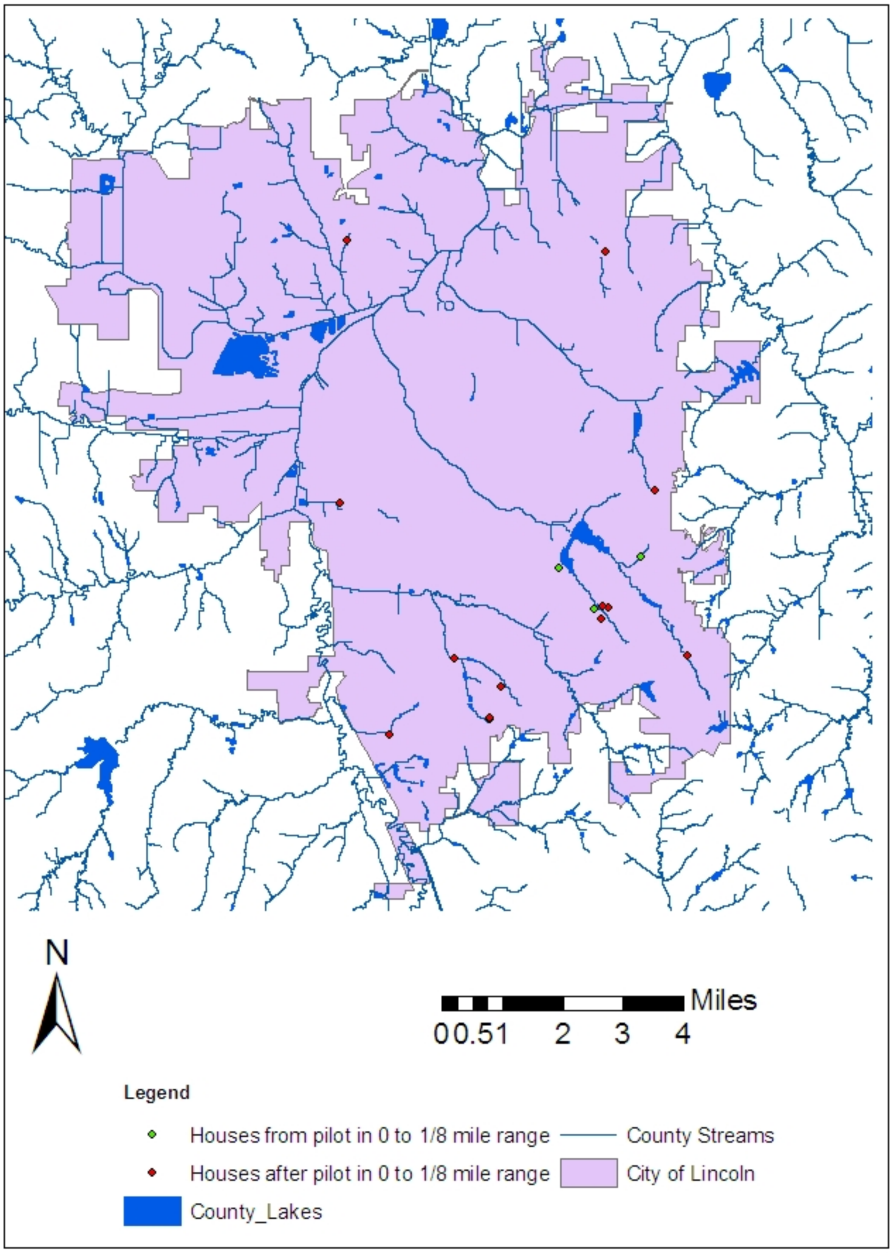
Diagram 1: Natural & Impervious Cover Diagrams (Source: EPA, 2003, http://www.epa.gov/npdes/pubs/nps_urban-facts_final.pdf)



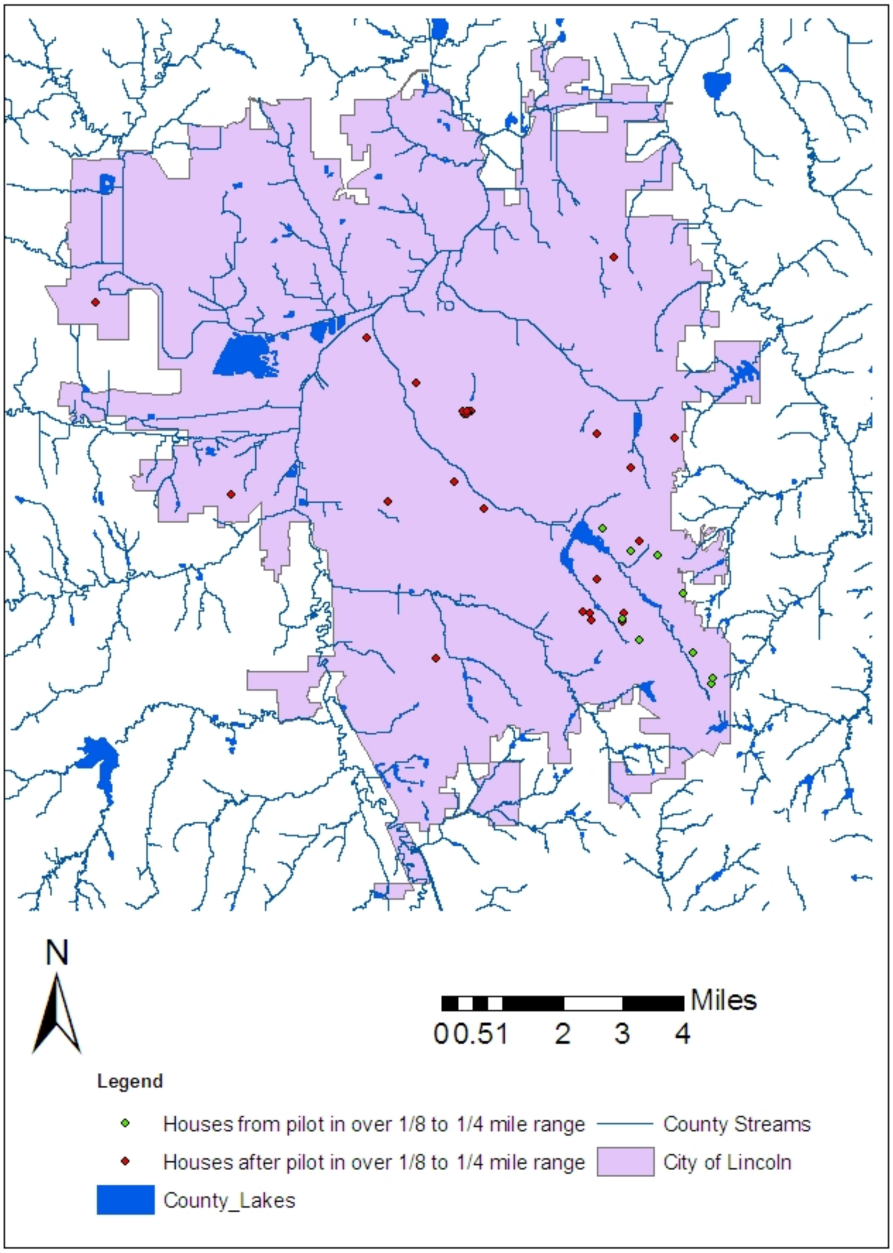
Map 1: Map of the Houses in the Program and the Streams and Lakes in and around Lincoln



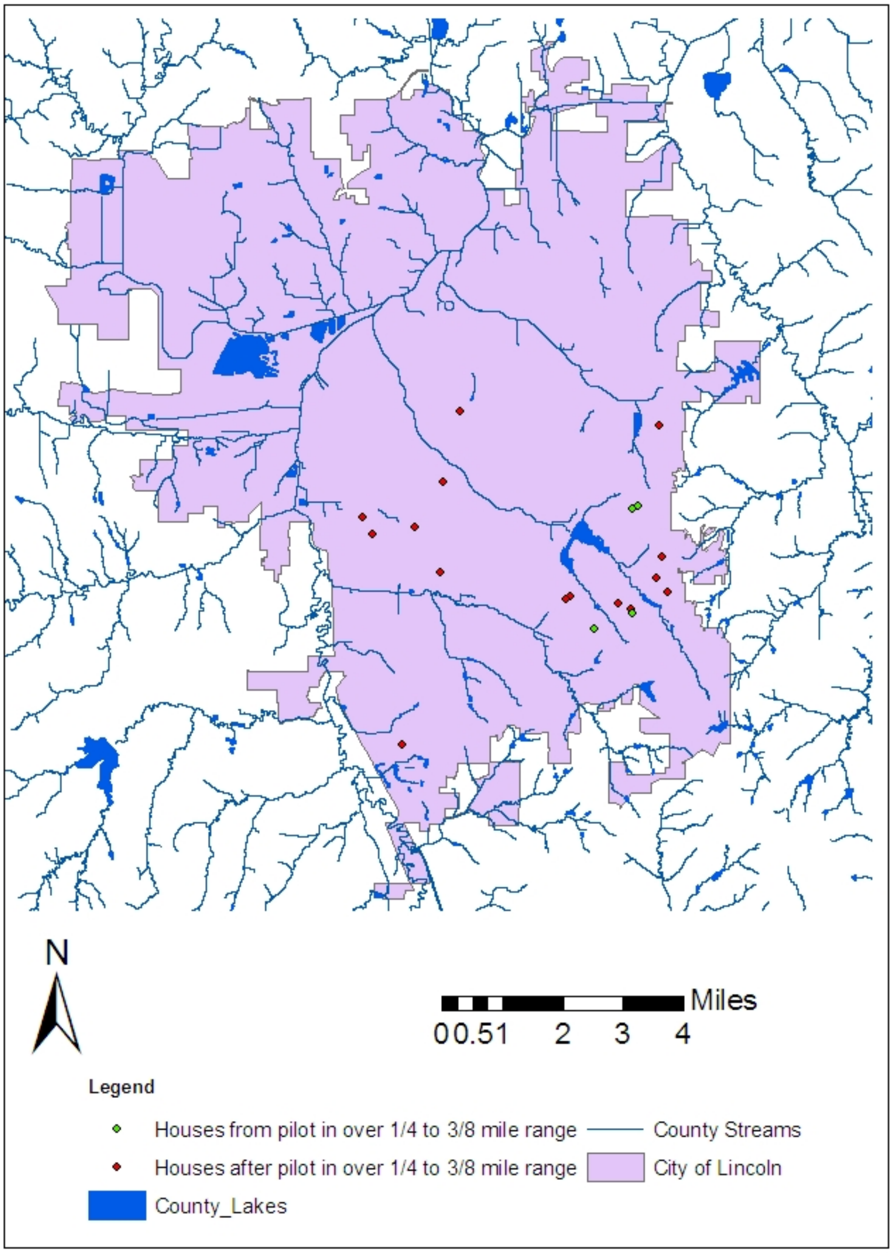
Map 2: 1/8 Mile Buffer around Streams and Lakes in and around Lincoln



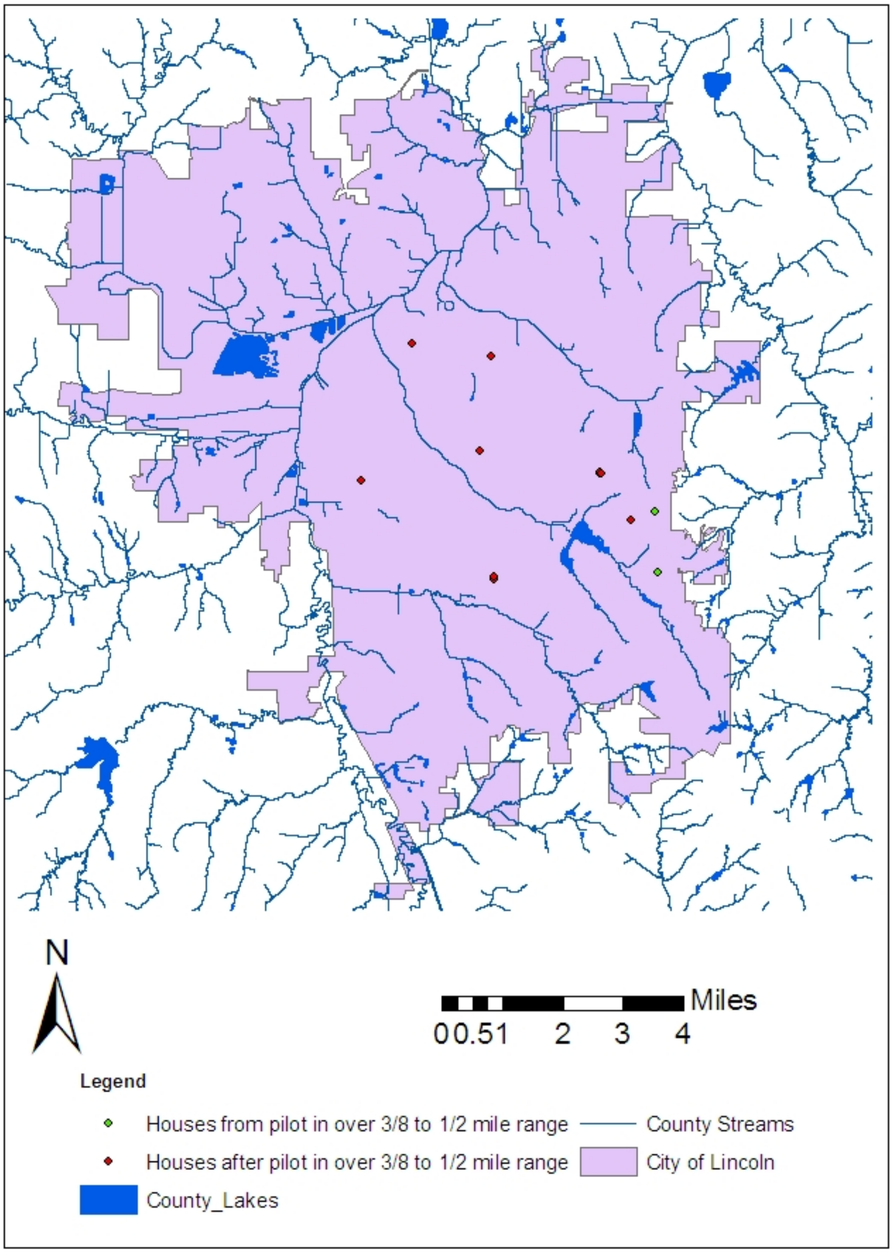
Map 3: Location of Project Houses in 0 to 1/8 Mile Distance Interval



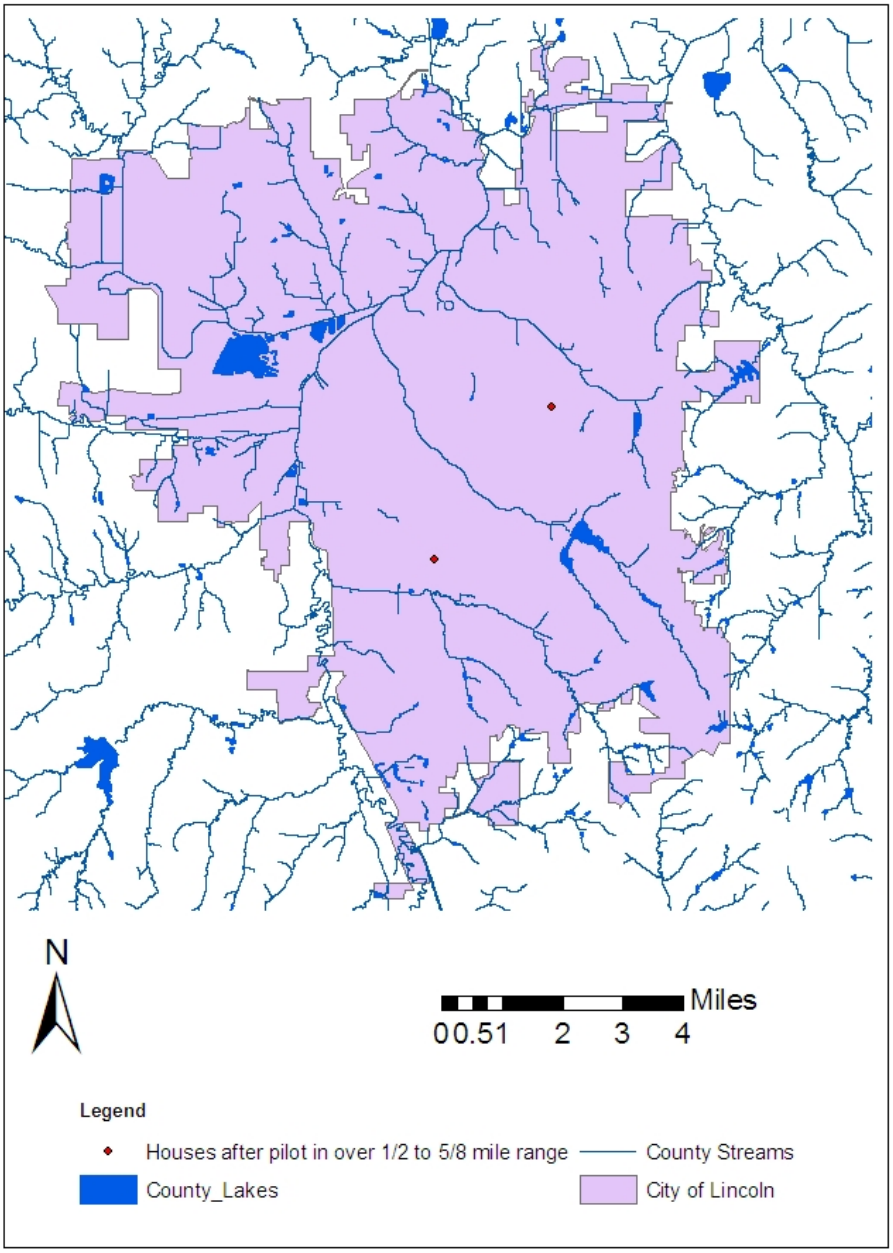
Map 4: Location of Project Houses in Over 1/8 to 1/4 Mile Distance Interval



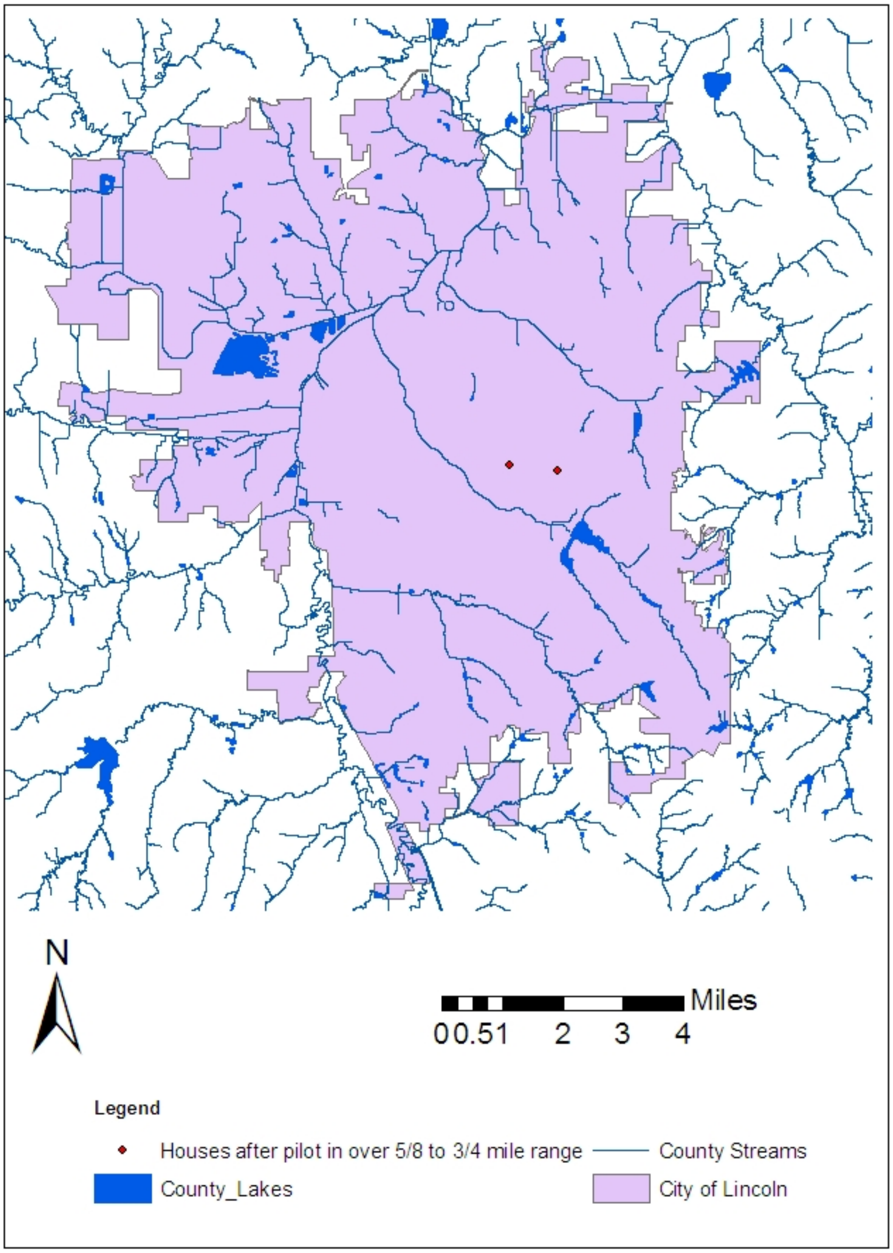
Map 5: Location of Project Houses in Over 1/4 to 3/8 Mile Distance Interval



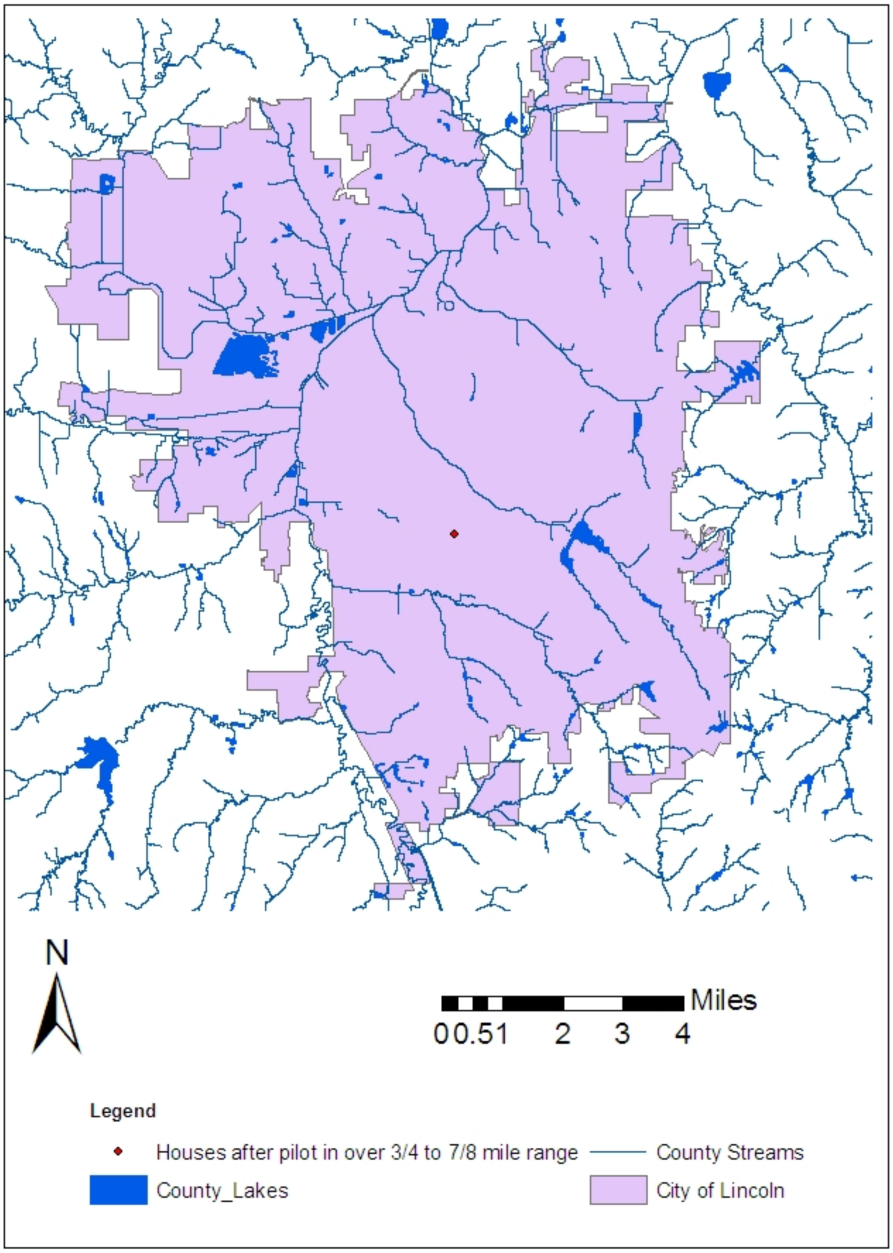
Map 6: Location of Project Houses in Over 3/8 to 1/2 Mile Distance Interval



Map 7: Location of Project Houses in Over 1/2 to 5/8 Mile Distance Interval



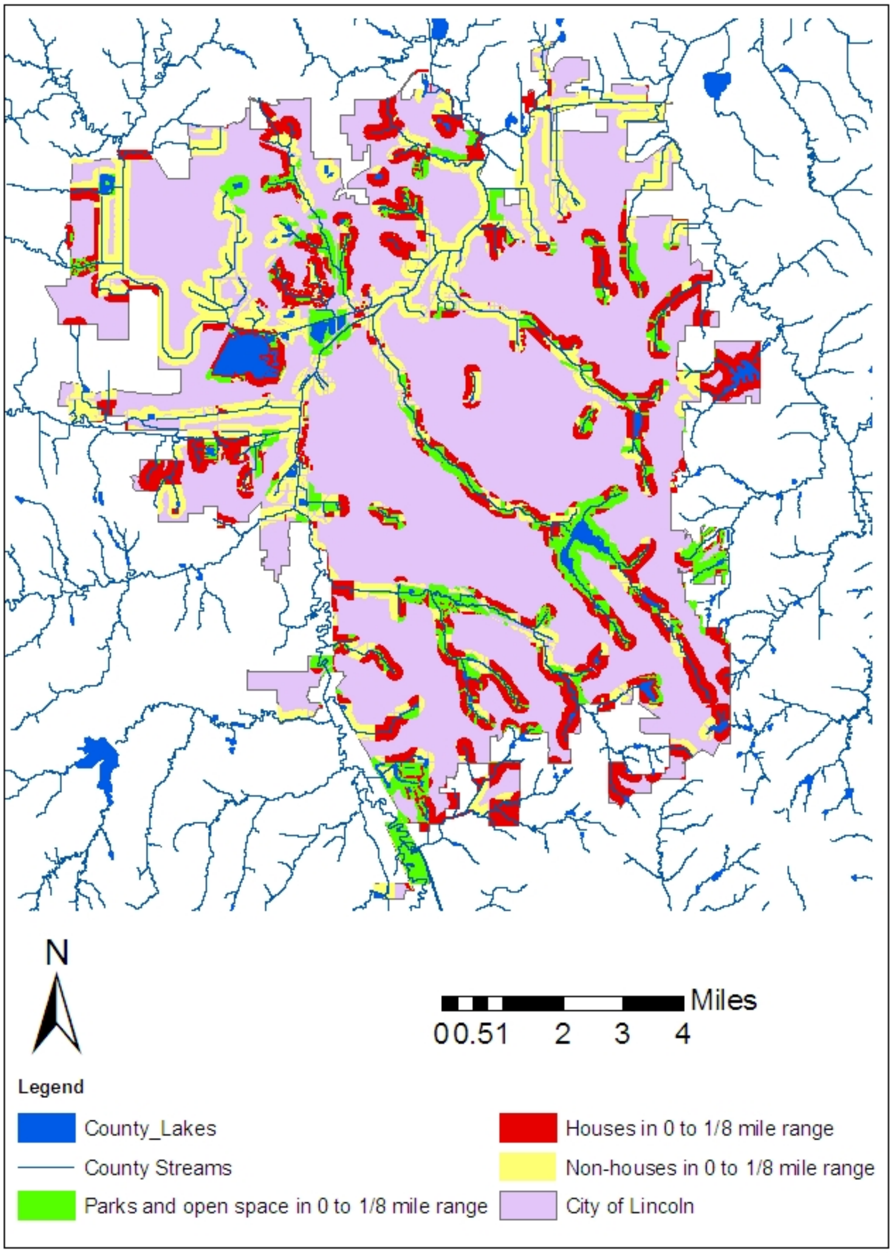
Map 8: Location of Project Houses in Over 5/8 to 3/4 Mile Distance Interval



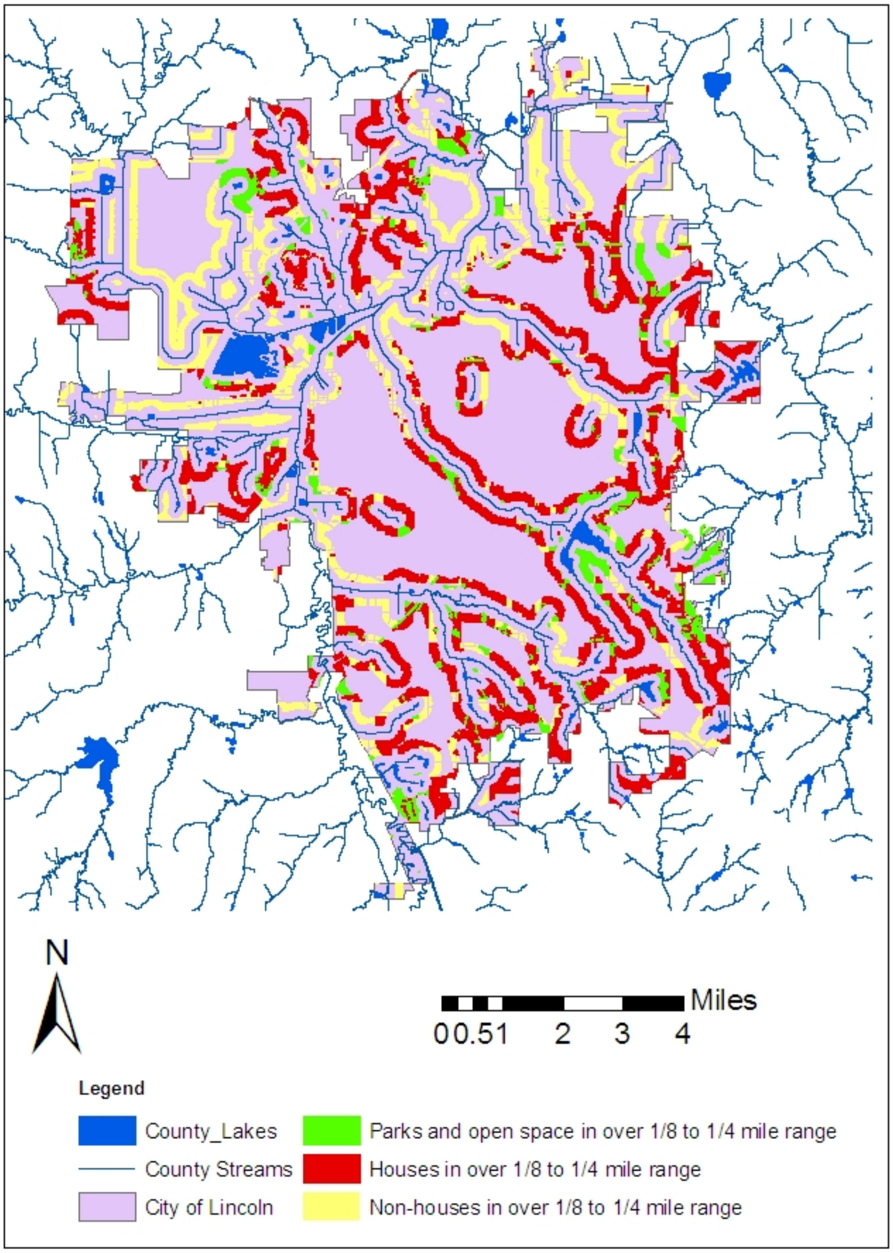
Map 9: Location of Project Houses in Over 3/4 to 7/8 Mile Distance Interval

mean	median	max	min
1339	1197	4151	72

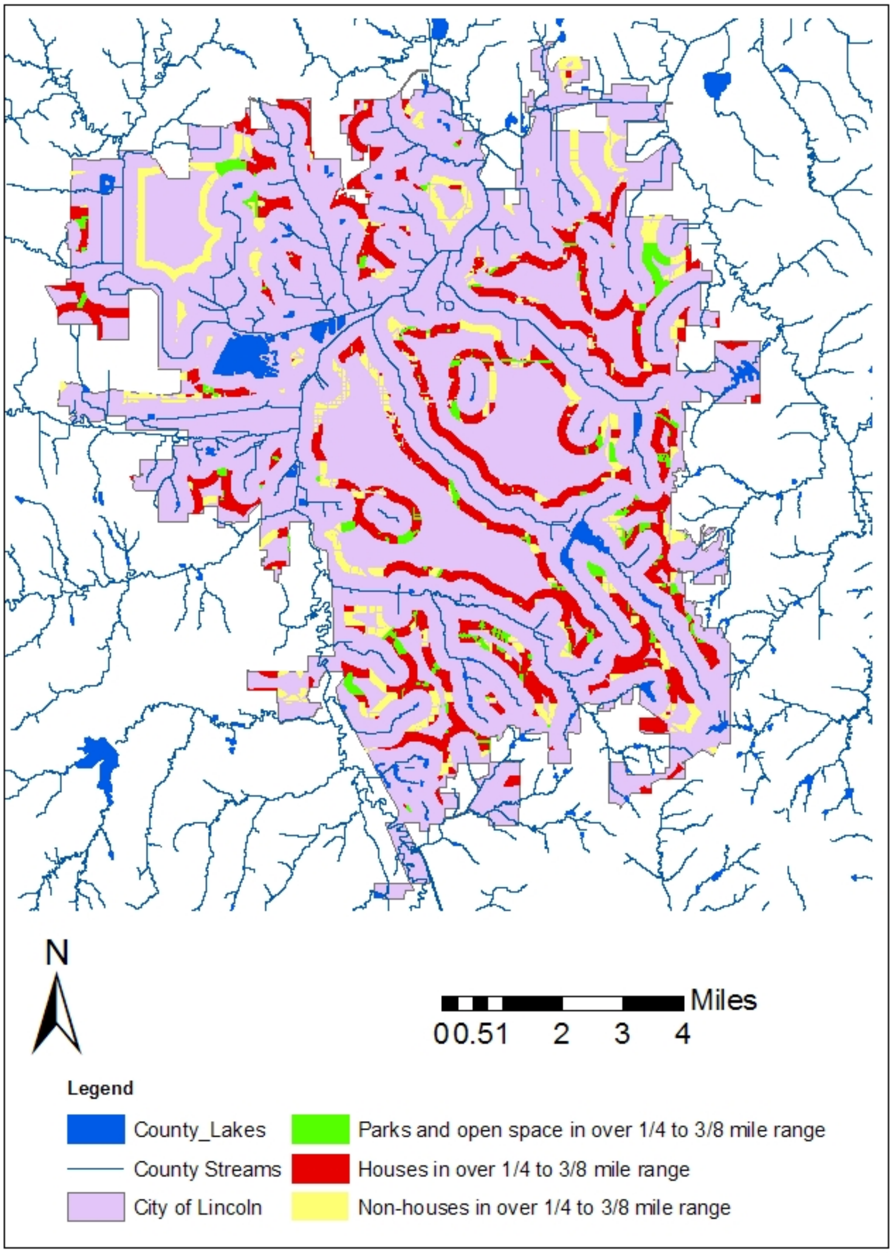
Table 1: Statistics of House Distances from Streams and Lakes



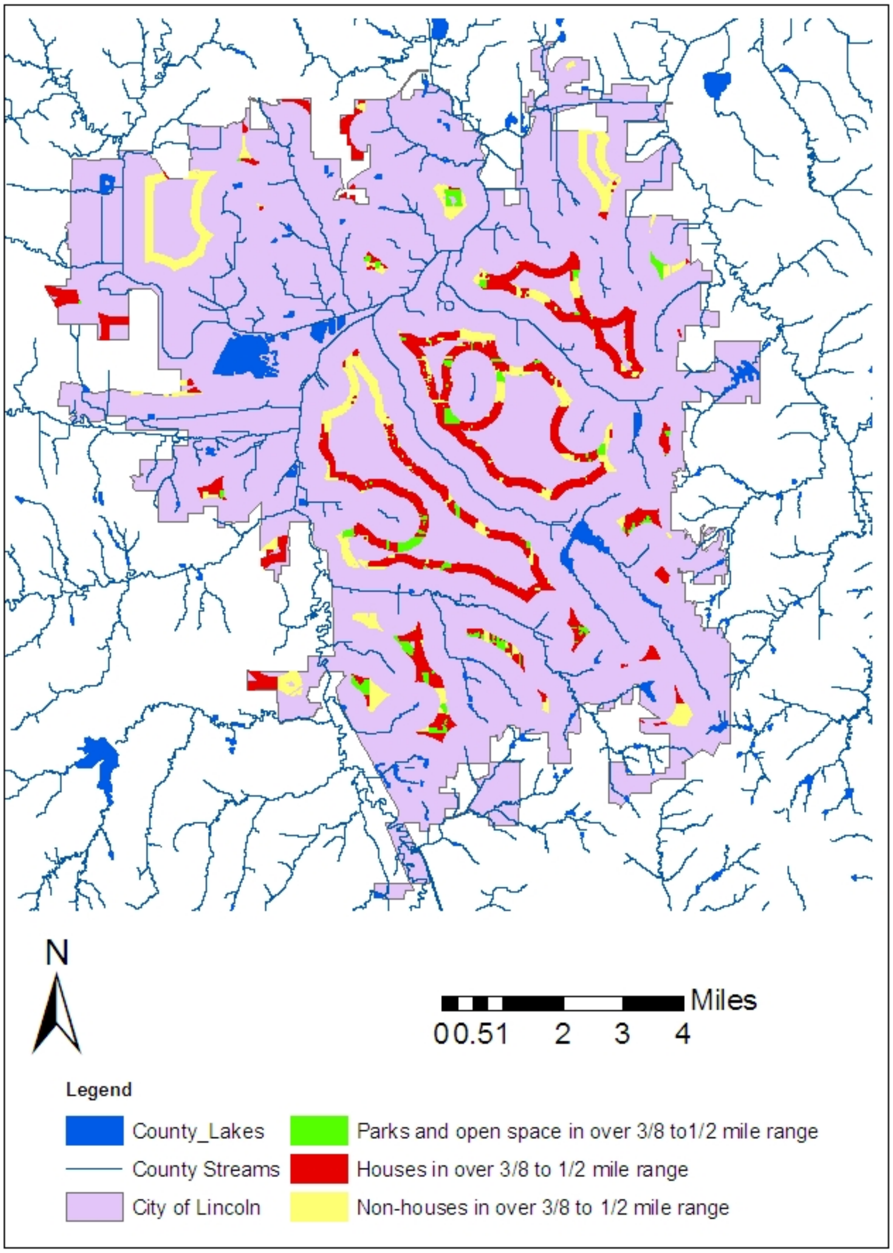
Map 10: Location of Parcel Types in 0 to 1/8 Mile Distance Interval



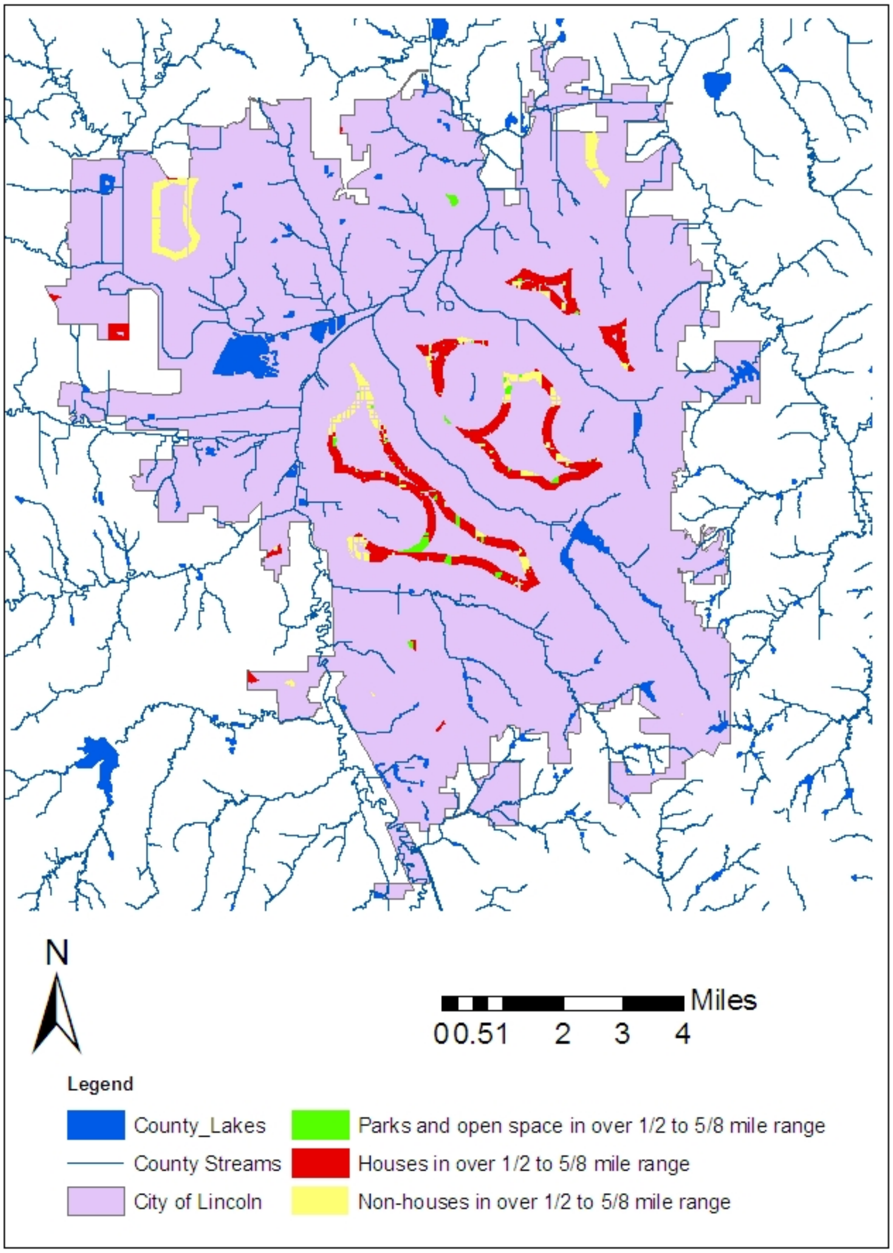
Map 11: Location of Parcel Types in Over 1/8 to 1/4 Mile Distance Interval



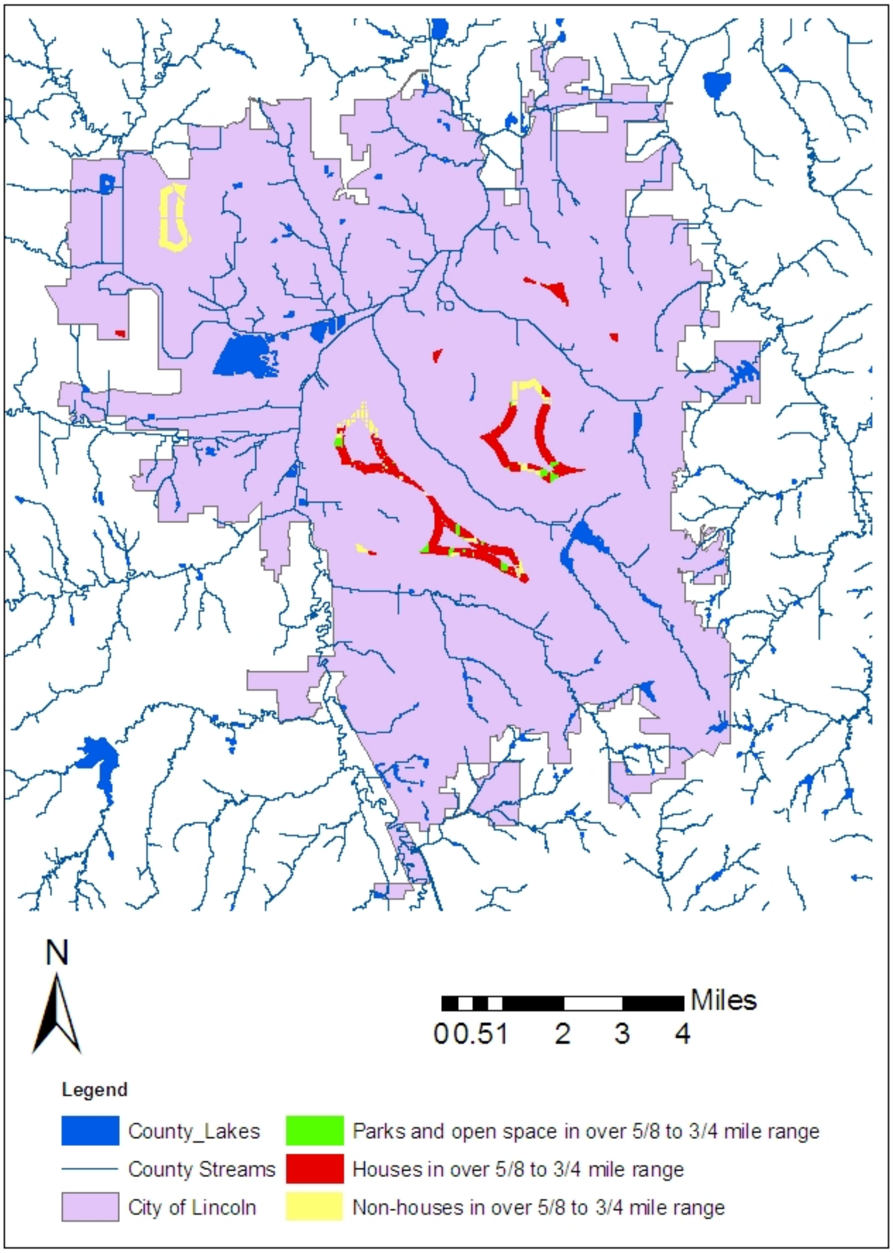
Map 12: Location of Parcel Types in Over 1/4 to 3/8 Mile Distance Interval



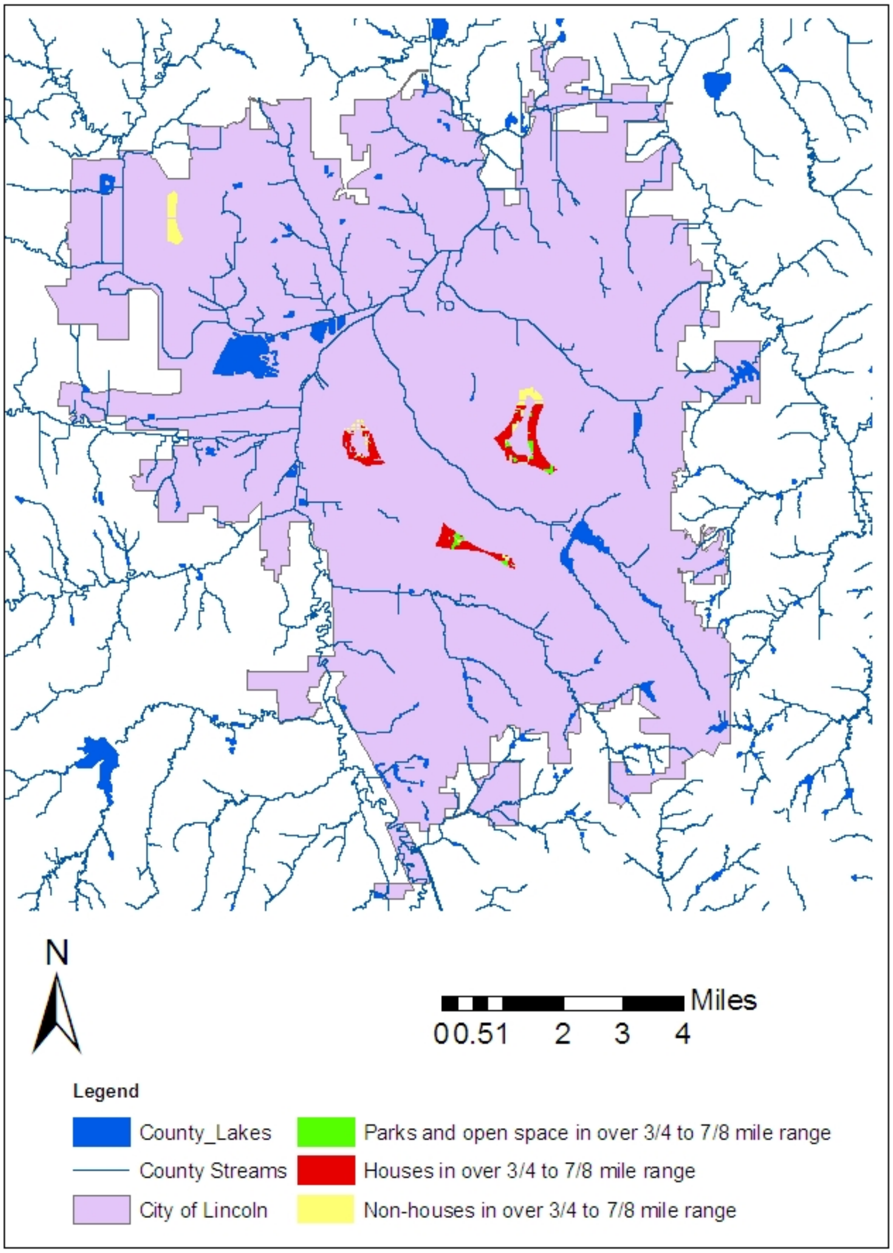
Map 13: Location of Parcel Types in Over 3/8 to 1/2 Mile Distance Interval



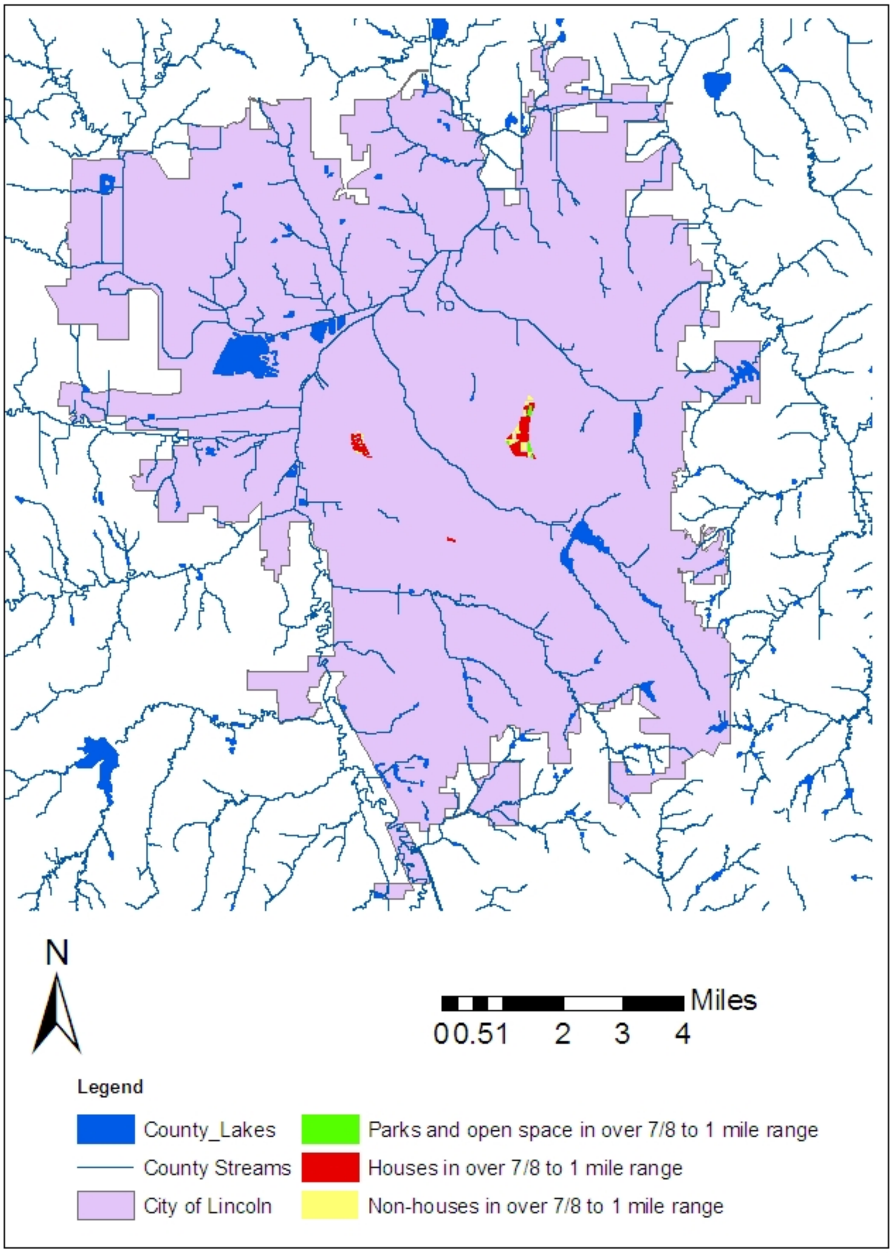
Map 14: Location of Parcel Types in Over 1/2 to 5/8 Mile Distance Interval



Map 15: Location of Parcel Types in Over 5/8 to 3/4 Mile Distance Interval



Map 16: Location of Parcel Types in Over 3/4 to 7/8 Mile Distance Interval



Map 17: Location of Parcel Types in Over 7/8 to 1 Mile Distance Interval

Distance Interval Increment	Square miles	Percent of City Area
0 to 1/8 mile	34.73	38.37
over 1/8 mile to 1/4 mile	25.21	27.84
over 1/4 mile to 3/8 mile	15.28	16.87
over 3/8 mile to 1/2 mile	8.08	8.92
over 1/2 mile to 5/8 mile	3.98	4.39
over 5/8 mile to 3/4 mile	1.99	2.2
over 3/4 mile to 7/8 mile	0.96	1.06
over 7/8 mile to 1 mile	0.30	<.01%

Table 2: Sq. Miles and Percent of Total City Area for each Distance Interval Increment

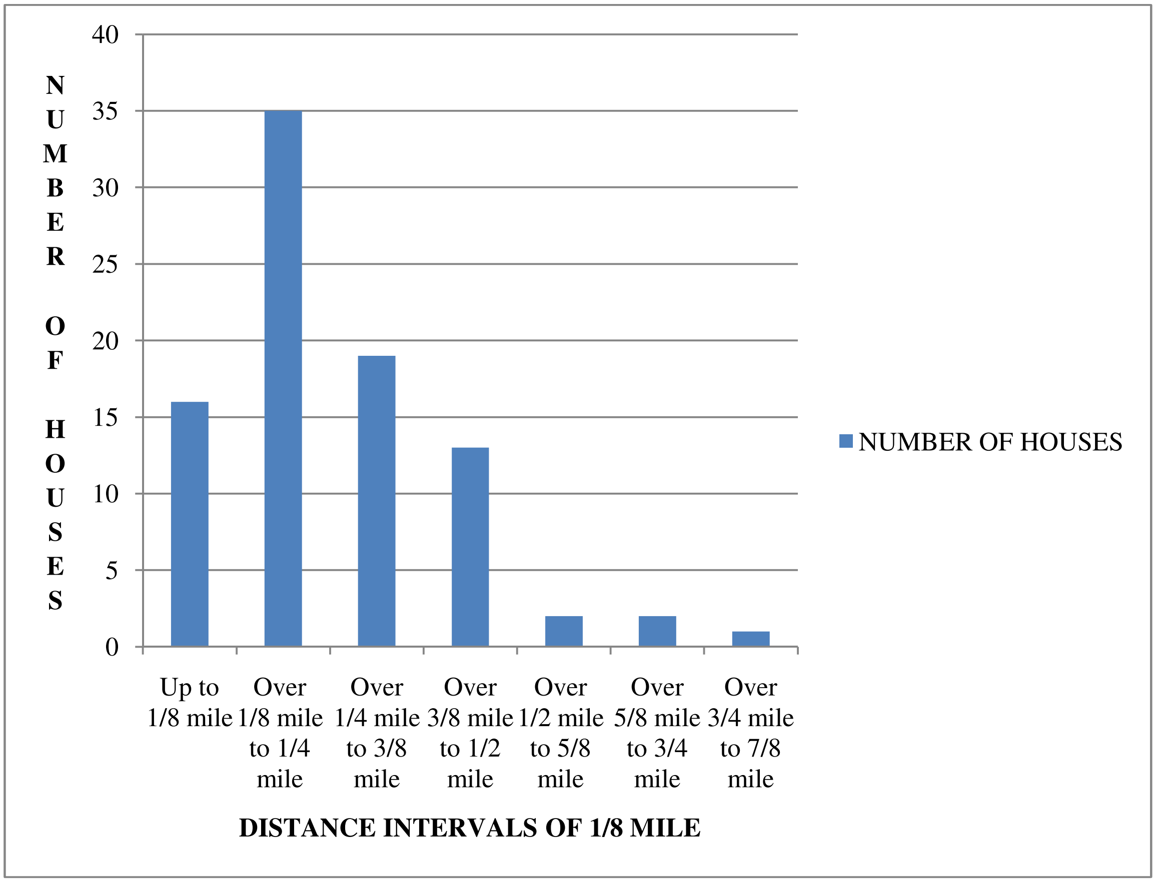


Chart 1: Number of Houses per Distance Interval Increments

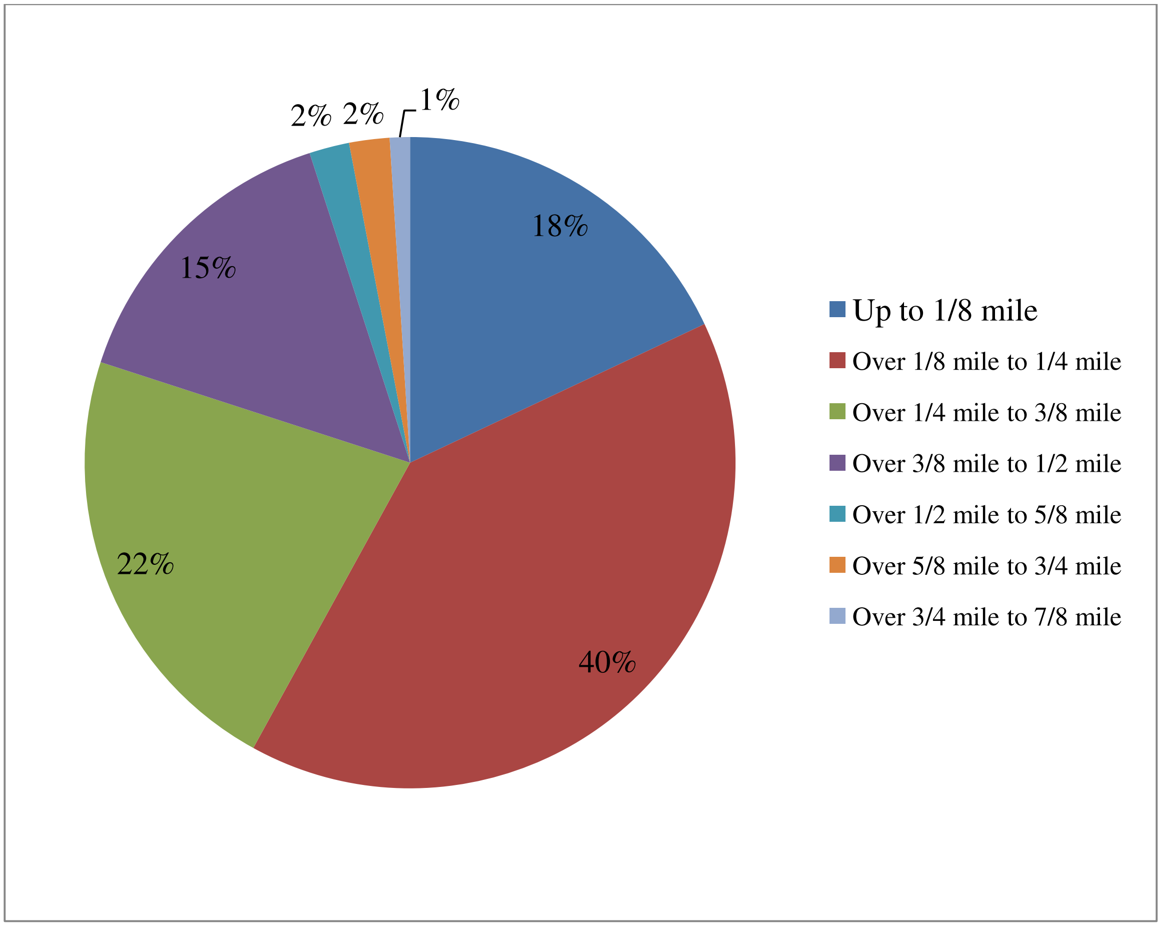


Chart 2: Percent of Houses in each Distance Interval Increment

0 to 1/8 mile	22931
over 1/8 mile to 1/4 mile	24478
over 1/4 mile to 3/8 mile	16235
over 3/8 mile to 1/2 mile	9236
over 1/2 mile to 5/8 mile	4786
over 5/8 mile to 3/4 mile	2159
over 3/4 mile to 7/8 mile	966
over 7/8 mile to 1 mile	336

Table 3: Number of House Parcels in each Distance Interval Increment

Up to 1/8 mile	0.000697745
Over 1/8 mile to 1/4 mile	0.001429855
Over 1/4 mile to 3/8 mile	0.001170311
Over 3/8 mile to 1/2 mile	0.001407536
Over 1/2 mile to 5/8 mile	0.000417885
Over 5/8 mile to 3/4 mile	0.000926355
Over 3/4 mile to 7/8 mile	0.00297619

Table 4: Number of Project Houses per House Units in each Distance Interval Increment

References

City of Lincoln 2005 Stormwater Bond Issue: Fact Sheet. (n.d.). Facts about the 2005 Storm Sewer Bond Issue. Retrieved December 15, 2009 from http://www.lincoln.ne.gov/city/pworks/watrshed/bond/2005/facts.htm

City of Lincoln 2007 Stormwater Bond Issue: Fact Sheet. (n.d.). Facts about the 2007 Stormwater Improvement Bond Issue. Retrieved December 15, 2009 from http://www.lincoln.ne.gov/city/pworks/watrshed/bond/2007/facts/index.htm

City of Lincoln Mayor's office. (2008, May 27). Residents Can Apply For Rain Garden Grants. http://lincoln.ne.gov/city/mayor/media/2008/052708a.htm

Dods, David, Schmidt, Rusty, & Shaw, Dan. (2007). The Blue Thumb Guide to Raingardens: Design and Installation for Homeowners in the Upper Midwest. Waterdrop Innovations, LLC

EPA, (2003, February). Protecting Water Quality from Urban Runoff: Clean Water is Everybody's Business. Retrieved December 15, 2009 from http://www.epa.gov/npdespub/pubs/nps_urban-facts_final.pdf

Franti, Thomas G., & Rodie Steven N, (2009, Spring). Rain Gardens and Urban Stormwater Management Education in Nebraska. *Water Current*, 41(2), 10-11. Retrieved May 3, 2010 from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1234&context=water_currentnews

Laukaitis, Algis J. (2007, June 25). Rain gardens could sprout in watershed. *Lincoln Journal Star* http://journalstar.com/news/local/article_60051d7f-b495-5a8c-86e6-a3d1e7bad655.html

Wise, S., (2008, August/September). Green Infrastructure Rising. *Planning*, 74(8), 14-19