A Study of Library Usage in the City of New Braunfels: Using Spatial Analysis to Inform Service Locations

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Rogers, Jonathan D. (Jon): A Study of Library Usage in the City of New Braunfels: Using Spatial Analysis to Inform Service Locations (CRP 386 / PA 388K), Fall 2010

Executive Summary

The City of New Braunfels has only one library facility to serve its patrons. As the City population grows, the New Braunfels Public Library is experiencing an overall greater demand for items and services. To increase its patron services and community visibility, NBPL will establish a satellite location during Summer 2011. However, budget constraints prevent NBPL from creating a bricks-and-mortar facility or purchasing a large bookmobile. Instead, NBPL will offer a mobile satellite unit roughly equivalent to a large van, containing limited materials.

This study posits that NBPL can enhance its level of service by locating a mobile satellite location in areas with proximity to both high and low concentrations (density) of library patrons and circulation. A mobile unit gives NBPL the versatility to reach both high and low user populations.

Using a dataset of more than 13,000 patron and circulation records collected between September 2009 and September 2010, this study considers the following questions: This study addresses the following questions:

1. What is the distribution of NBPL users and the frequency of their library use?
2. Where are the most appropriate locations for satellite services that are most convenient for the highest number of users?
3. Where are the most appropriate locations for satellite services that would attract new users?

In conclusion, the study identifies three potential areas near a mix of residential density, a mix of library patron and circulation density, and within a one-mile buffer of City schools.

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Introduction

Founded in 1845, the City of New Braunfels, Texas (the City) is approximately 32-33 miles north of San Antonio, and it bridges Guadelupe and Comal Counties in Central Texas. Figure 1 below shows the City's location relative to the two counties.

Figure 1: Location of New Braunfels, Texas

City of New Braunfels, Texas, with surrounding counties

The City is in the midst of dramatic population growth. The City's estimated population in 2000 was 36,494.[1] By 2007, the City Council stated that the population totaled 51,066,[2] and additional growth is expected with the conclusion of the 2010 Census.[3]

In keeping with its location along the Guadalupe and Comal Rivers, the City has a number of community resources that support quality of life, including an eighteen-hole municipal golf course, twenty-eight parks on 291 acres of land, the Wein & Saengerfest and Wassailfest Main Street festivals, environmental awareness initiatives, and a vibrant public library.[4] The New Braunfels Public Library (NBPL) was founded in 1928 with a modest shelf of books located in one room of a building downtown.[5] Since that time, the collections and services have grown substantially; NBPL currently holds more than 126,000 items and provides its patrons access to computer and copying services, adult and children's programming, and reference and database access through partnership with the Alamo Area Library System.[6]

At present, the City has only one library facility to serve its patrons. As the City population grows, NBPL experiences an overall greater demand for items and services. Rogers (2009) found that total visitors to the library increased from approximately 200,000 in calendar year 2000 to more than 250,000 in 2008; meanwhile, program attendance increased from 6,000 to almost 14,000 over the same period of time.[7] Further, Rogers (2009) noted the increase in total circulation per month and circulation per visitor between July 1999 and February 2009. For example, his study found that total circulation per month had increased by a factor of 2.5 to 3 (from a low of 15,000 per month in 1999 to a high of more than 50,000 circulation records in 2008), with seasonal increases apparent as more consumers used the library during summer months.[8] Worth noting, most transactions take place within NBPL, although changes to electronic infrastructure allow patrons to make some transactions (i.e., renewals) online.

While NBPL allows non-City residents (i.e. Texas State students, neighboring county residents) to become cardholders for a fee,[9] NBPL finds that it has robust patronage and circulation from City resident adults and minors. More than 13,000 patrons visited NBPL between September 2009 and September 2010, and these patrons

contributed to more than 524,000 circulated items.[10] Figures 2 and 3 below illustrate the percentage of library patrons and the percentage of circulation by category, including City staff, NBPL staff, New Braunfels resident (NB) adults and minors, non-resident (NR) adults and minors, NR property-owning adults and minors, NR students, and NR visitors.

Figure 2: NBPL Percentage of Patrons by Category of User

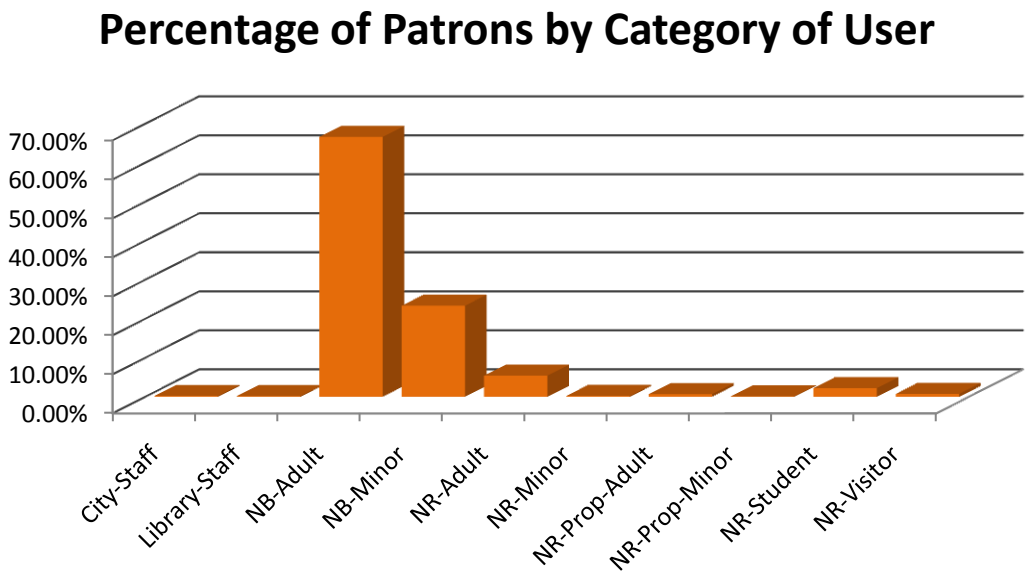
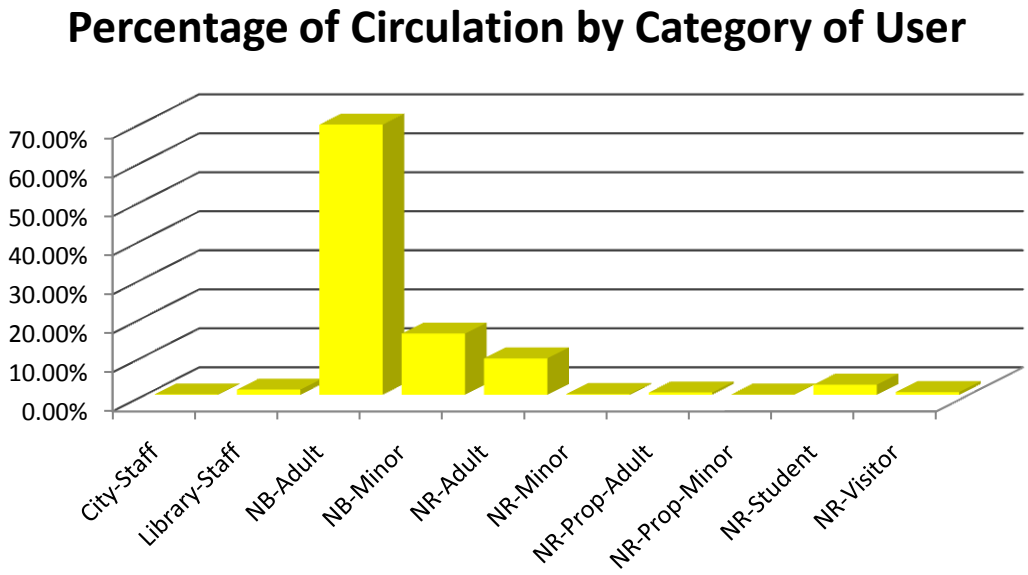


Figure 3: NBPL Percentage of Circulation by Category of User



In total, resident adults (NB-Adults) represent 8,665 of 13,001 total patrons, or 66.65% overall. NB-Adults also account for 363,590 circulations, or 69.28% of the total. Meanwhile, 3,039 patrons were resident minors (NB-Minor), and they contributed to 82,445 circulations, or 15.71% of total circulation.

Satellite Service

City administration officials have indicated interest in creating a summer outreach program through a satellite library location. Creating a second service location within New Braunfels has the potential to generate new users within the community and/or establish a more convenient point of service for current users.

Literature on linear programming (LP) and mathematical optimization provide some utility for identifying a second library location. Brandeau and Chiu (1989) developed a survey of more than fifty location problems using a multivariate taxonomy based on objective (e.g., optimization versus non-optimization), types of decision variables (e.g., location, priority of service area, capacity), and system parameters (e.g., topology, travel time, demand).[11] Gavett and Plyter (1966) use a 'branch and bound' optimization technique to apply the measures of distance and traffic intensity to the location of facilities, given specific parameters.[12] Drezner and Wesolowsky (1978) instead suggest optimizing new facility locations by minimizing the sums of LP distance pairs from facility to facility and from facility to demand points.[13] Alternatively, Swaney and Ward (1985) consider the maximization and equity of public welfare in analysis of optimization for the location of a public agency facility.[14]

Geography and planning literature also provides insights on location choice. Zolnik , et al. (2010) hypothesize that the co-location of public facilities, e.g. schools and libraries, can contribute to cost savings, administrative and service efficiency, and positive community attitude.[15] Focusing on Loudoun County, Virginia, the authors posit that the benefits of co-location can be particularly useful for areas with high population growth.[16] White (1979) also suggests that decisions to locate public facilities should include criteria analysis of accessibility and possibilities for co-location synergy.[17]

With a more long-term approach, the City could consider a new brick-and-mortar facility, potentially co-located with other City departments or developed as a partnership with one of the local school districts. The City also could consider the use of a bookmobile vehicle that would provide mobile services in one or more locations throughout the City. However, the library director (the Director) has indicated that current budget circumstances make both proposals unfeasible for the current fiscal year.[18] Instead, the Director is proposing a more modest approach. To provide satellite service, NBPL will load a van with limited amounts of material and will locate the vehicle in a desirable location.

Hypothesis and Research Questions

The Director and the City GIS Coordinator are interested in the use of spatial analysis to identify areas with high concentrations of library patrons and high concentrations of circulation activity. For NBPL, the policy decision is as follows: locate in an area with low numbers (therefore, making library services more convenient to individuals who do not use NPBL resources frequently) or locate in an area with high numbers (thus, making it easier for frequent clients to obtain library services). While NBPL is particularly concerned about the frequency and density of patrons and

circulation, the City is also interested in locating satellite services in areas that fall within a one-mile buffer of public schools. As indicated, co-location offers the possibility of potential cost savings (assuming a partnership with the New Braunfels or Comal Independent School Districts) and enhanced community benefit from the synergy of public services.

This study will focus specifically on the short-term, mobile satellite considered by NBPL for Summer 2011 and its implications for increasing numbers of users and/or enhancing convenience for existing users. With roughly twenty-square miles of land across Guadalupe and Comal Counties[19] and the unique shape of the New Braunfels city limits, a mobile unit can be a significant asset for sharing NBPL goodwill across the community.

Under the City's municipal code, any zoning district would provide the potential for library use.[20] While this study will consider proximity to certain residential areas for the purpose of making recommendation, the study will focus on the number and concentration of patrons and circulation and a radius of one-mile and one-half-mile around City public schools.

Hypothesis

NBPL can enhance its level of service by locating a mobile satellite location in areas with proximity to both high and low concentrations of library patrons and circulation. A mobile unit gives NBPL the versatility to reach both high and low user populations.

Research Questions

This study addresses the following questions:

1. What is the distribution of NBPL users and the frequency of their library use?
2. Where are the most appropriate locations for satellite services that are most convenient for the highest number of users?
3. Where are the most appropriate locations for satellite services that would attract new users?

Methodology

Two types of data are necessary for spatial analysis of library patrons and circulation: user data and spatial analysis data. With respect to the latter, all references indicate files prepared for use in ESRI ArcGIS (Version 9.3) tools.

User Data

The study required user data, including patron counts, patron addresses, and respective circulation totals. NBPL collects address and circulation data on its cardholders, and City administration officials shared a Excel workbook that included a dataset of more than 13,000 records that covers the twelve month period between September 28, 2009, and September 27, 2010.[21] More detail on this process is provided

in the appendix; however, the following paragraphs outline the basic steps taken to prepare and use the Excel data.

First, to prepare this data set for use, library card numbers were deleted to preserve anonymity and patron addresses were reviewed and revised for uniformity. Second, categories of users were eliminated to allow the study to focus specifically on City staff, NBPL staff, New Braunfels resident (NB) adults and minors, non-resident (NR) adults and minors, NR property-owning adults and minors, NR students, and NR visitors. For example, residents of the local crisis center, New Braunfels Independent School District libraries, and Internet-only patrons were deleted from consideration. More detail on this process is provided in the appendix.

Third, the data was geocoded with the ArcCatalog address locator tool. At this stage, address records were reduced to approximately 13,001 to allow the matching tool to focus on only those locations within New Braunfels. After geocoding the addresses, approximately 10,138 addresses matched (78%), 972 were tied (7%), and 1,889 remained unmatched (15%). After manually performing match/rematch operations to identify unrecognized addresses, the matched total increased to 10,429 (80%). To ensure that data for patrons remained within the city limits, patron data was clipped to a geodatabase feature class (polygon) of the New Braunfels city limits.

In order to calculate frequency of circulations and the percentage of patrons contributing to specific levels of circulation, this study used "countif" and "count" operations within Excel. The former was useful to identify specific categories of users, i.e. NB-Adults, to sort their circulation totals. The latter was useful for creating patron counts according to levels of usage. For 13,001 total users, frequency of circulation was calculated for the following categories of circulated items per person: 0-19 items, 20-99 items, 100-499 items, 500-999 items, 1,000-1,499 items, and over 1,500 items. Using the same number of users, percentages for number of circulations per patron were calculated for four categories: 500-1,500 items, 100-499 items, 20-99 items, and 0-19 items. In order to show percentages, categories for items above 500 were consolidated because of their small size relative to the total. The process of frequency and percentage counting was repeated to illustrate specifically the largest category of patrons, NB-Adults.

Spatial Data

The City makes geographic information systems (GIS) interactive for the general public via the City's website. Generally, shapefiles and other data are available for public download; however, a technical problem with the file return system required that spatial data be obtained manually through a parent directory established by the City's GIS Coordinator.[22] With the City's permission, this study obtained a geodatabase of ten files of various feature types (seven polygons: City Council Districts, City Limits, County Boundaries, School Districts, Zoning Categories, Parcels, and City Land Use; two points: Addresses and Schools: one line: Street Centerlines), all projected for Texas South Central State Plane FIPS 4204 (NAD 1983, feet). This projection was retained for spatial analysis.

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This study focused only on those attributes specific to the New Braunfels city limits; therefore, all files and data were clipped to the city limits as necessary. In order to perform spatial analysis on patrons and circulation, data for patrons was geocoded to street address locations. Next, a "count" option was added to the attribute table to facilitate summing patron numbers within parcels.

Finally, a spatial join was used to link the patron data to parcels for analysis. After patron data was clipped to the city limits, it was joined to City parcels. Each polygon (parcel) was given a summary of the numeric attributes of the points that fall inside the polygon; in this case, the summarized number was the sum of patrons. (For reference, the output file was Join_Output_Patrons.) Subsequently, the average nearest neighbor tool was used to calculate whether or not there were statistically significant clusters within the City limits. Also, hot spot analysis (Getis-Ord Gi*) was performed on Join_Output_Patrons to determine the clusters in which most patrons fall. Within Join_Output_Patrons, parcels with a sum count of one or more patrons were selected, then exported to a new feature class. Hot spot was performed on the new feature class with conceptualization of spatial relationships set to fixed distance band and distance method set to Euclidean distance. Within the new output layer, parcels with high positive Z-scores and p-values less than 0.05 were identified and selected.

Density analysis was completed with the Spatial Analyst Point Density tool. A point file of patrons clipped to the city limits (City_Patrons) was used for input, with population field set for circulation (for circulation density) and count (for patron density). A point file of addresses, also clipped to city limits, was used to compute population density. For all three analysis events, area units were set to acres. After developing circulation density and population density, a dual-transparency color scheme was used to overlay the two measures for reference.

One-mile and one-half-mile buffers around the schools were developed by buffering and dissolving all features within the buffer. Throughout the maps, a solid black line is used to indicate the one-half-mile radius, and a dashed line is used to represent the one-mile radius. While the City indicated interest only in the one-mile area, the shorter distance provides additional context.

Land use representation was developed by selecting high, medium, and low density residential areas, manufactured home communities, mobile home parks, and open spaces from available spatial land use assumption data. While City zoning would allow a library in a commercial area, residential areas were selected for focus to provide a context for the capture of new patrons.

All maps focus on the full extent of the City limits, with color schemes used to illustrate patron and circulation totals, hot spot analysis, and density analysis (population, patrons, circulation). Also, all layouts use an icon for the library to indicate its location. Throughout the layouts, an inset map on the lower left demonstrates the City's location relative to Guadalupe and Comal Counties.

Summary of Findings

Figure	Page	Presentation
4	10	Frequency of Circulation, All NBPL Patrons
5	10	Circulation Frequency as Percentage, All Patrons
6	11	Frequency of Circulation, Resident Adult Patrons
7	11	Circulation Frequency as Percentage, Resident Adult Patrons
8	12	ArcMap: Library Patron Locations
9	13	Average Nearest Neighbor Analysis, Patron Locations
10	14	Hot Spot Analysis, Library Patron Locations
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15	19	Library Patron Density
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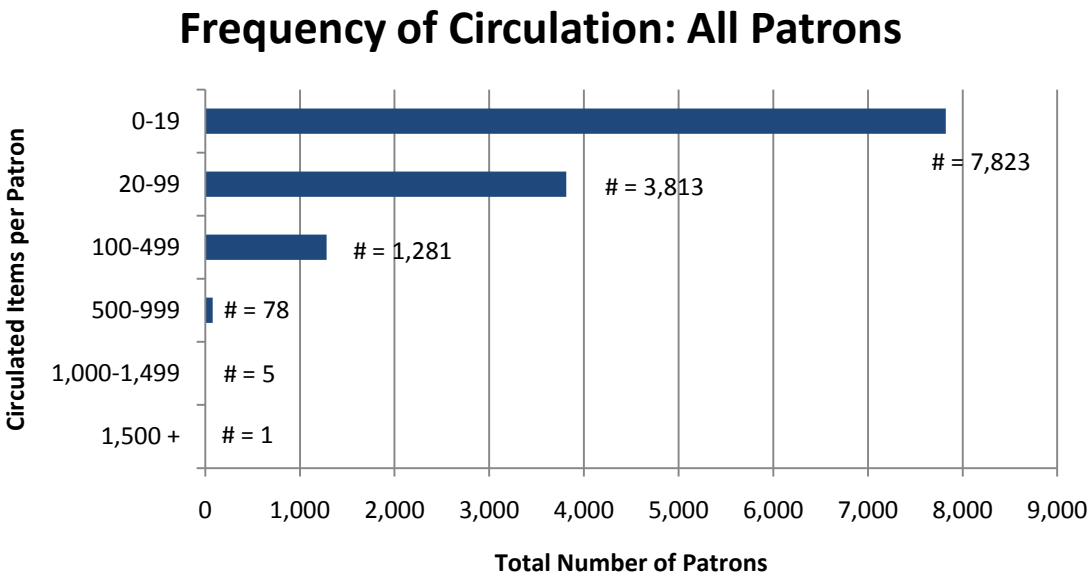
Findings

Figure 4: Frequency of Circulation among All Patrons, NBPL. (n = 13,001)



(Above) The bar chart indicates the total number of patrons checking out items at a given frequency during the months September 2009-September 2010. Data includes all matched addresses for all categories of NBPL patrons. (Below) The pie chart indicates the same data as Figure 4, except that the frequencies are represented as a percentage.

Figure 5: Circulation per Patron among All Patrons.

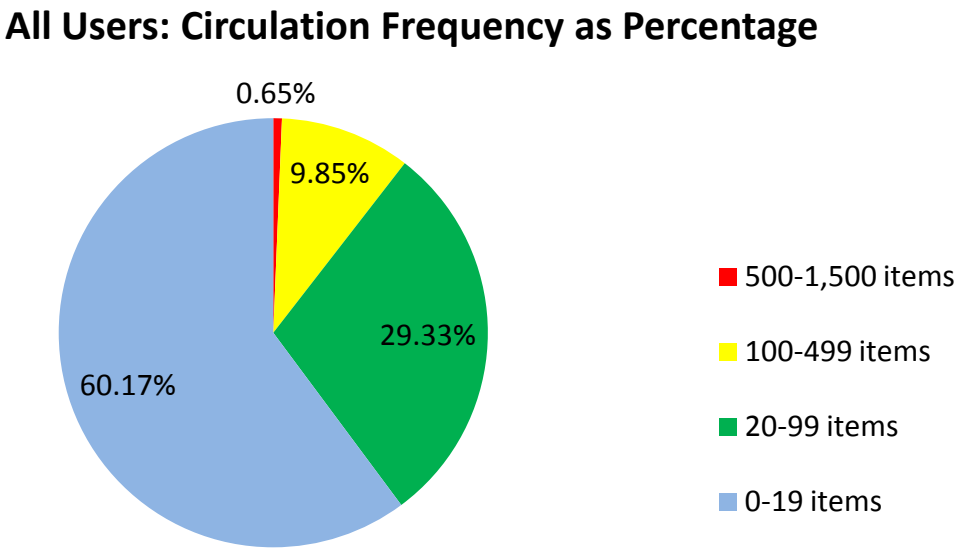
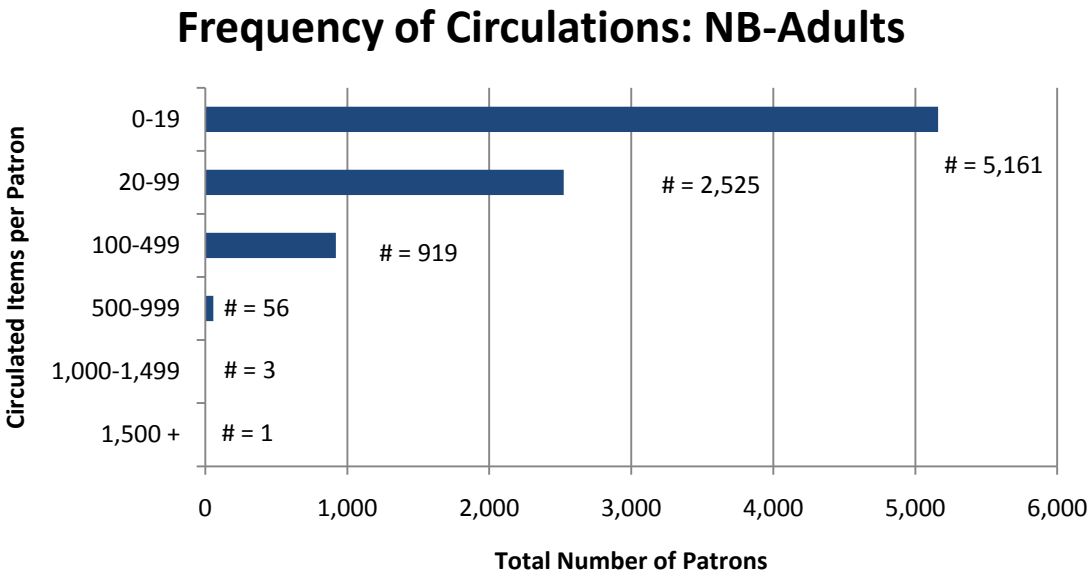


Figure 6: Frequency of Circulation among NB-Adult Users. (n = 8,665)
"NB-Adult" indicates resident adult patron.



(Above) The bar chart indicates the total number of patrons checking out items at a given frequency during the months September 2009-September 2010. Data includes all matched addresses for NB-Adult patrons only. (Below) The pie chart indicates the same data as Figure 6, except that the frequencies are represented as a percentage.

Figure 7: Circulations per Patron among NB-Adults.
Percentage represents amount per category of circulated items.
"NB-Adult" indicates resident adult patron.

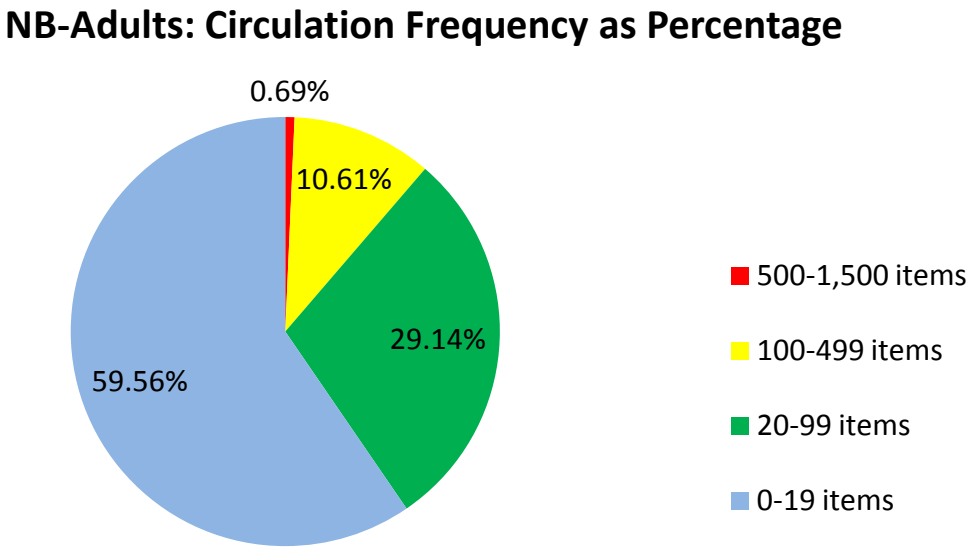
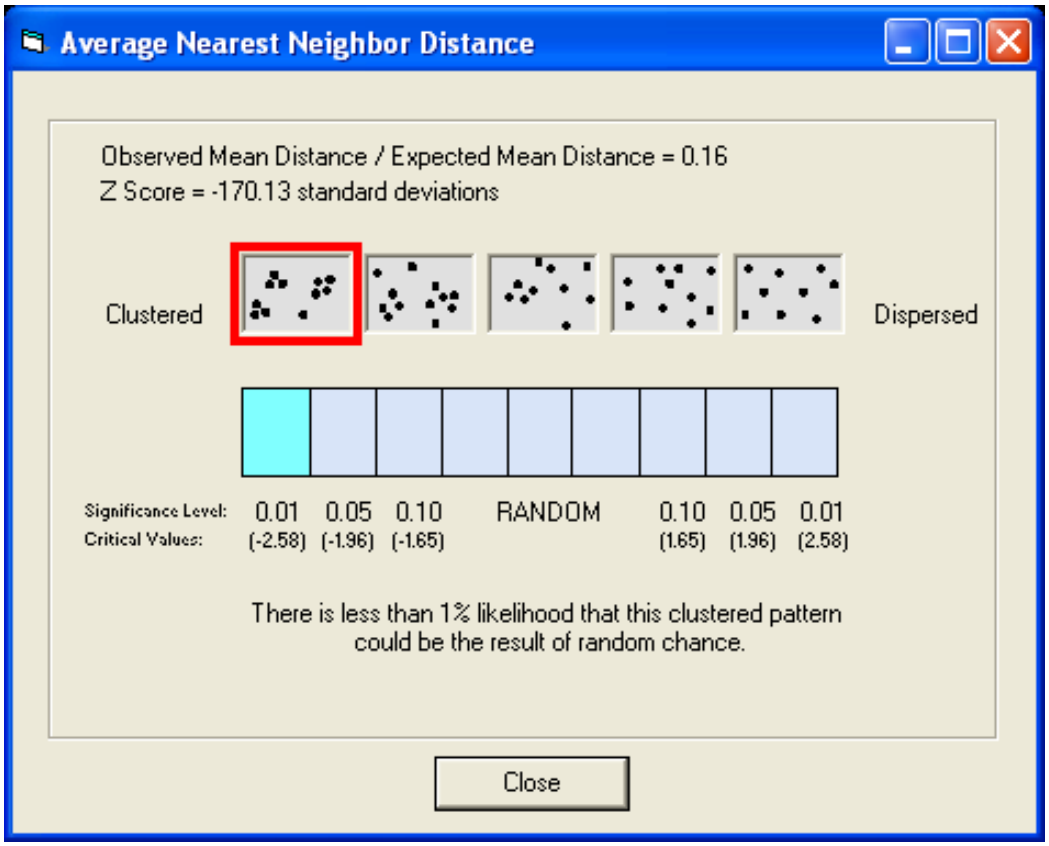


Figure 8: ArcMap view of Library Patron Locations

Figure 9: Screenshot of Results, Average Nearest Neighbor Distance Tool



This figure illustrates the results of average nearest neighbor analysis on NBPL patrons. The index of 0.16 indicates clustering. As noted in the screenshot above, the very low negative Z-score (-170.13 standard deviations) and the p-value of 0.01 indicate that it is unlikely that the observed pattern of clustering is the result of random chance.

Figure 10: ArcMap view of Library Patron Hot Spot Analysis

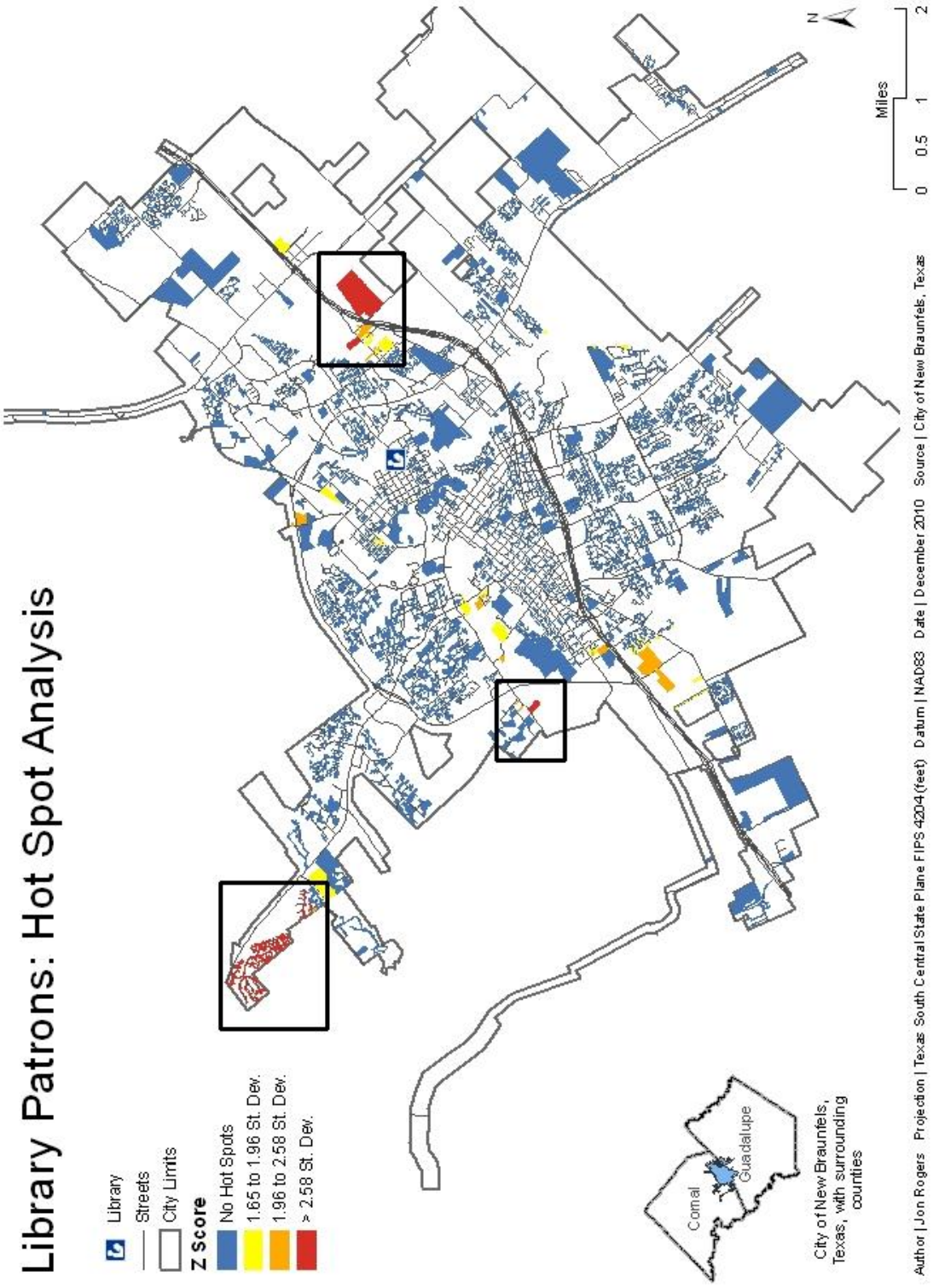


Figure 11: ArcMap view of Total Patron Counts per City Parcel

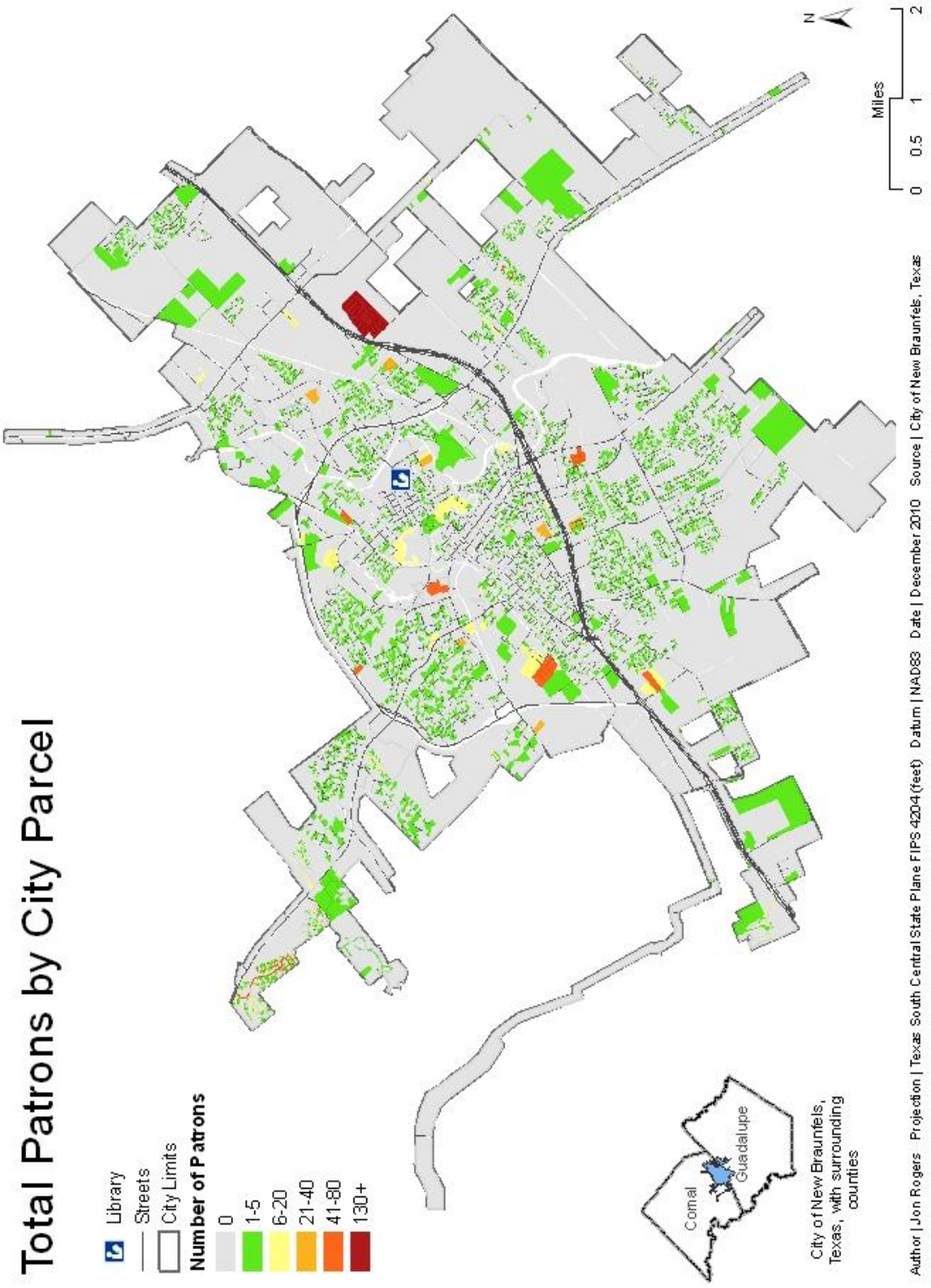


Figure 12: ArcMap view of Total Circulation per City Parcel

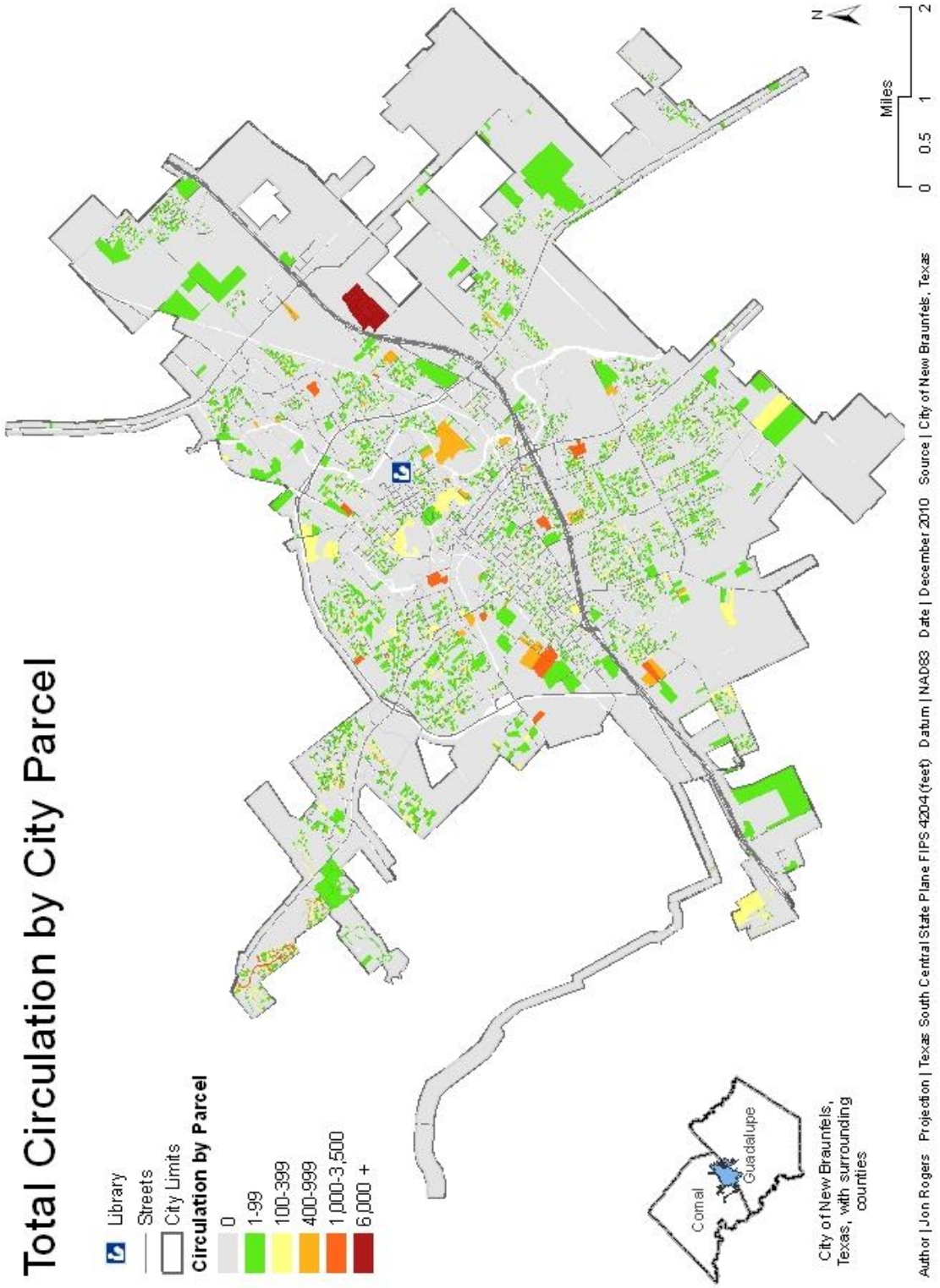


Figure 13: New Braunfels Population Density

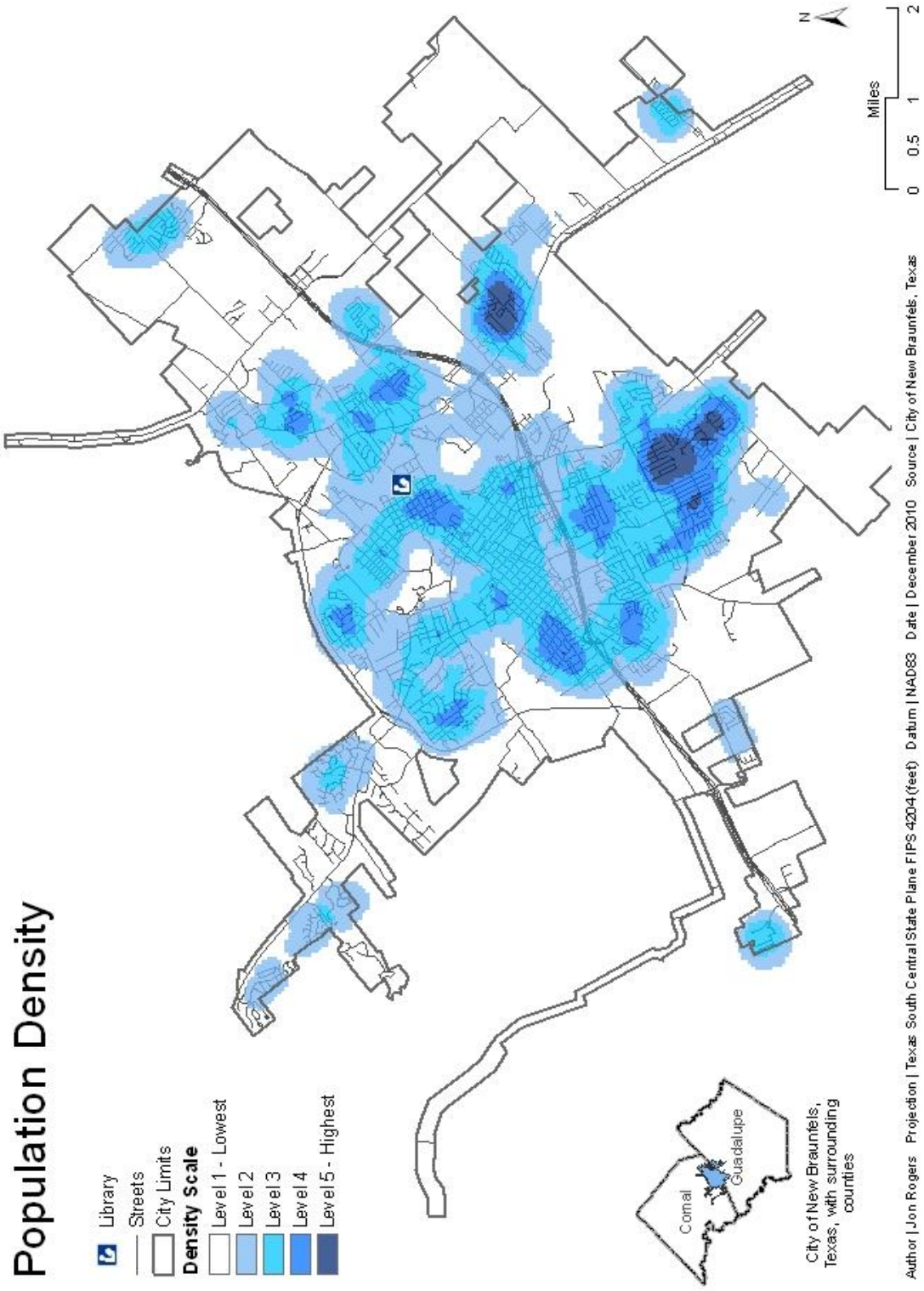


Figure 14: New Braunfels Land Use, Residential and Open Spaces

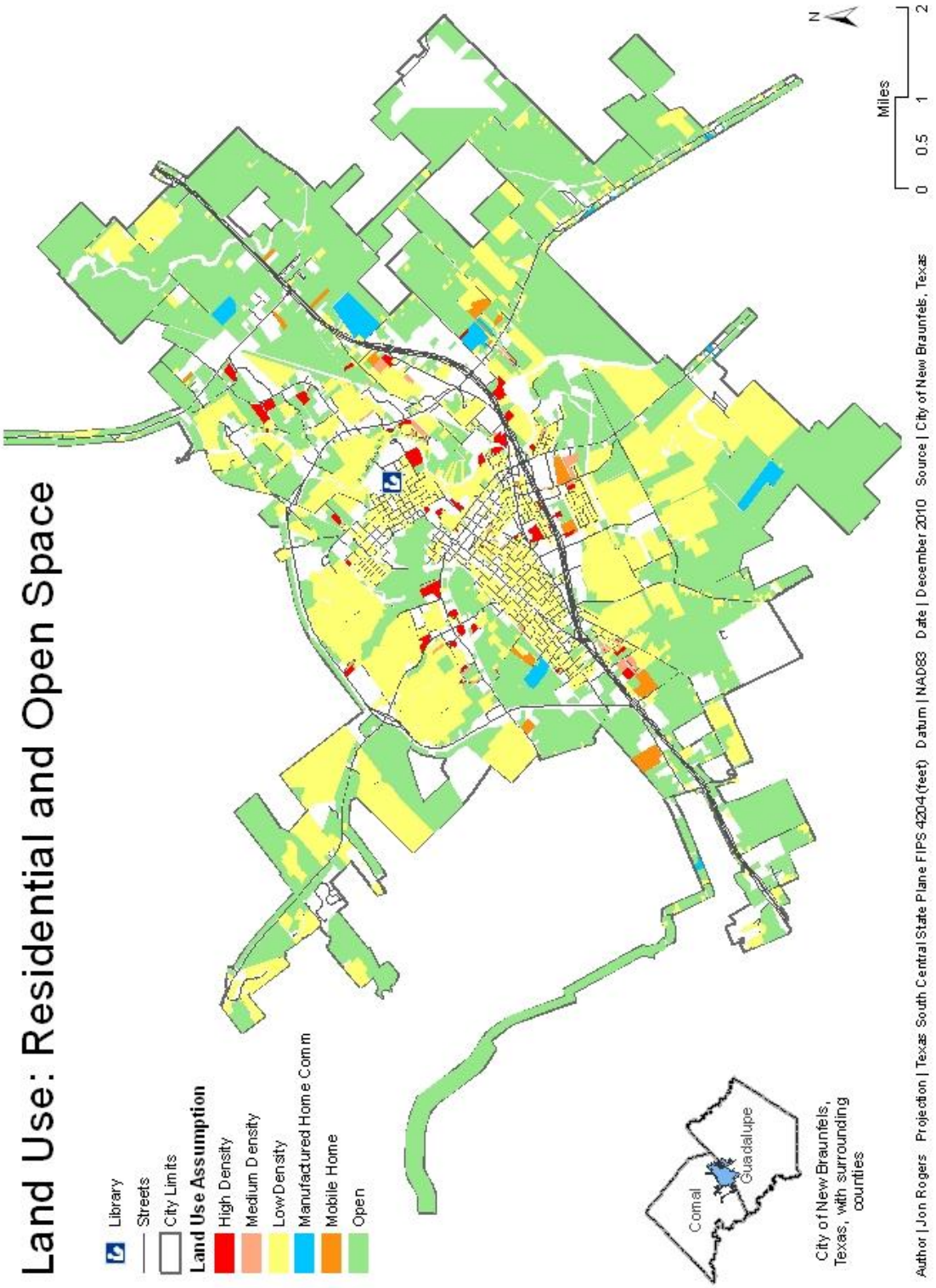


Figure 15: Library Patron Density

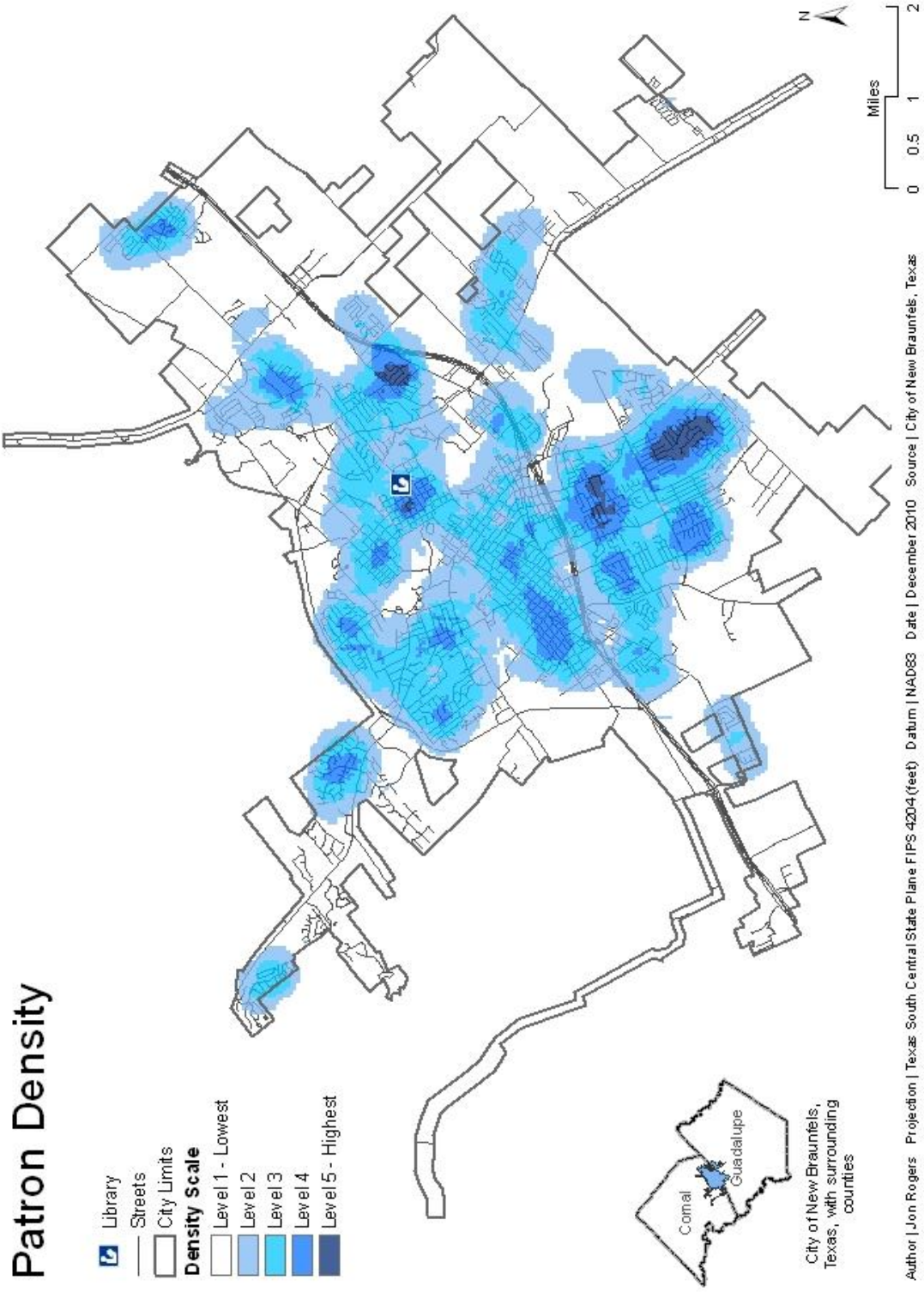


Figure 16: Library Circulation Density

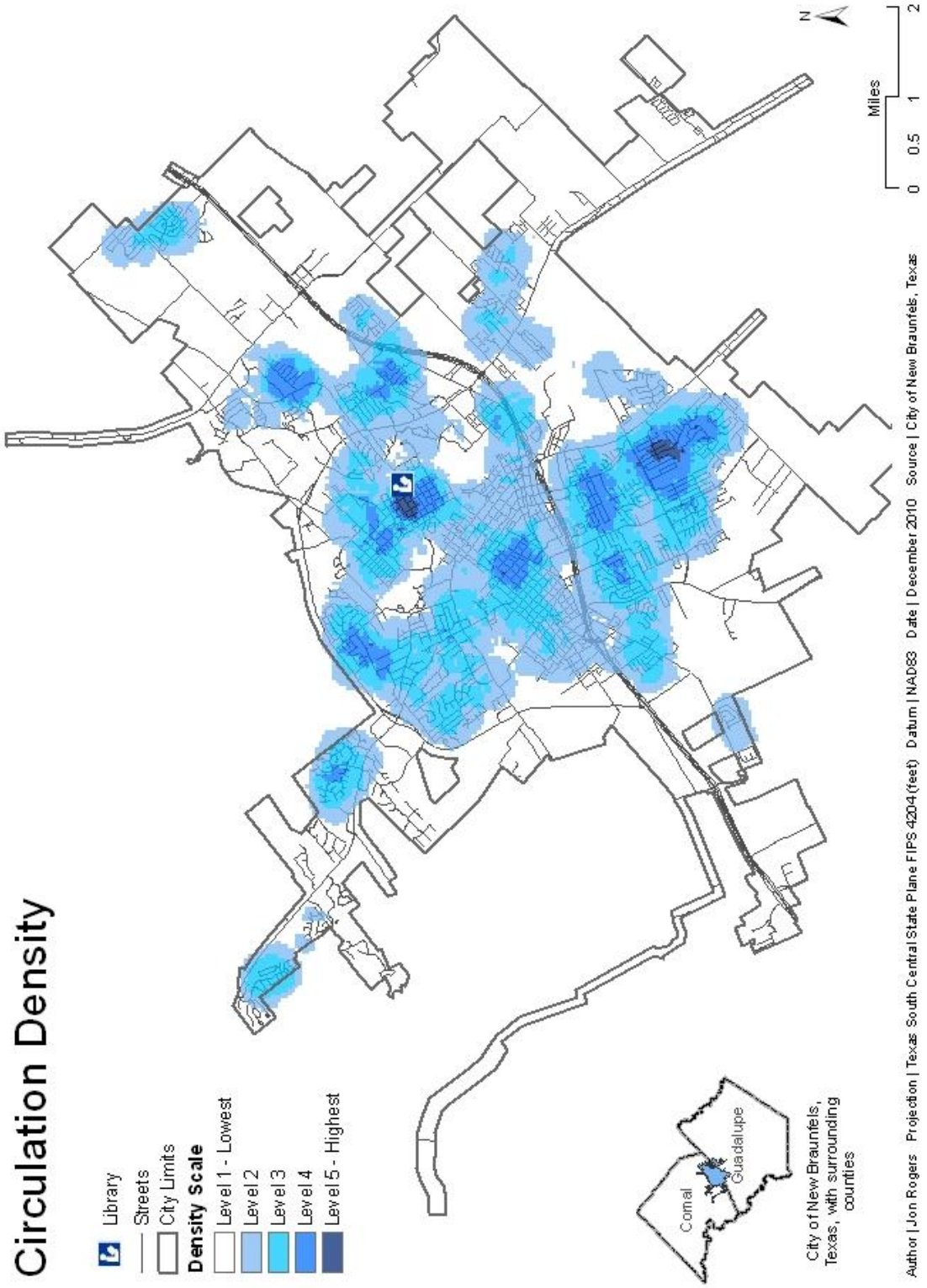


Figure 17: Patron Density Relative to the Location of Schools

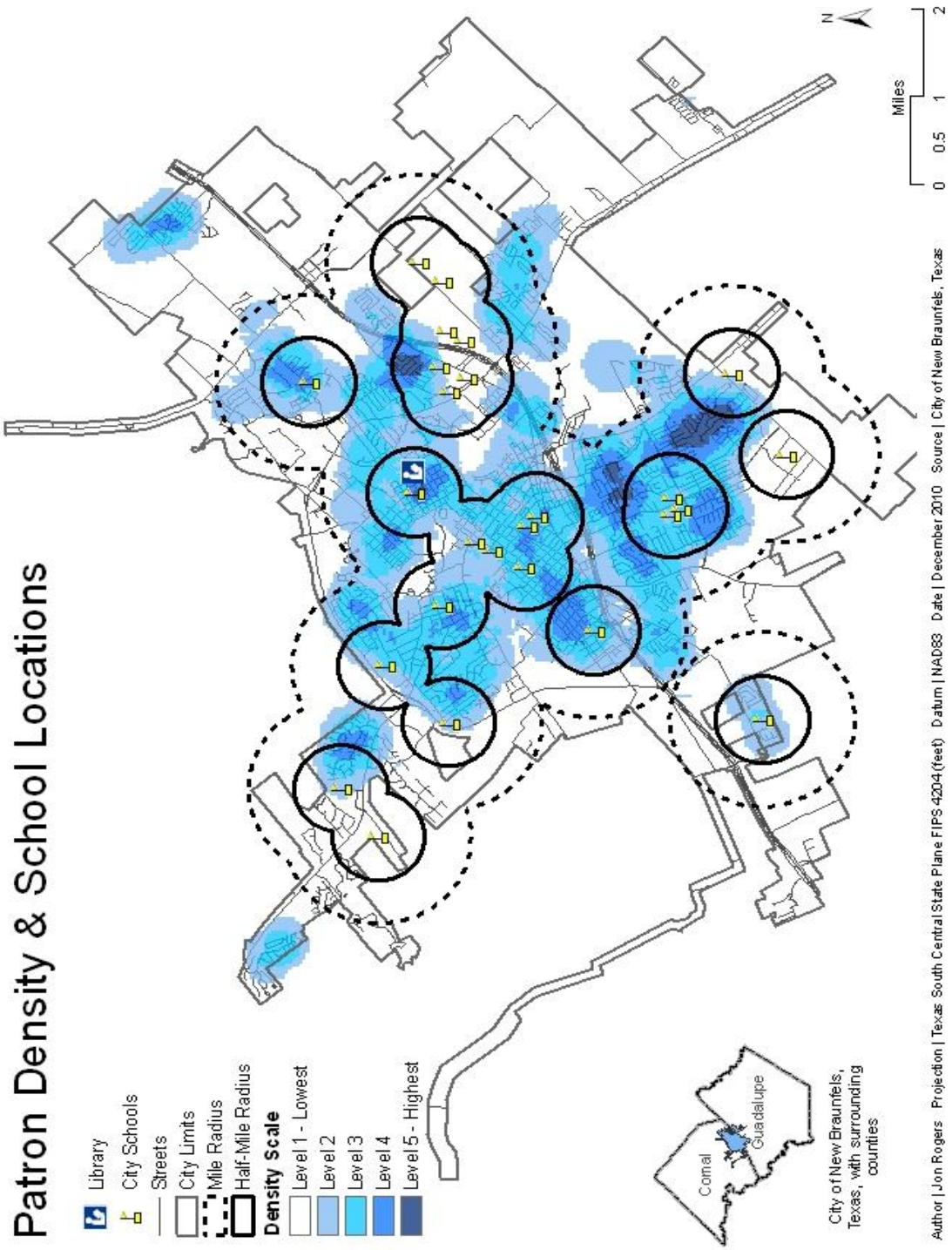


Figure 18: Circulation Density Relative to the Location of Schools

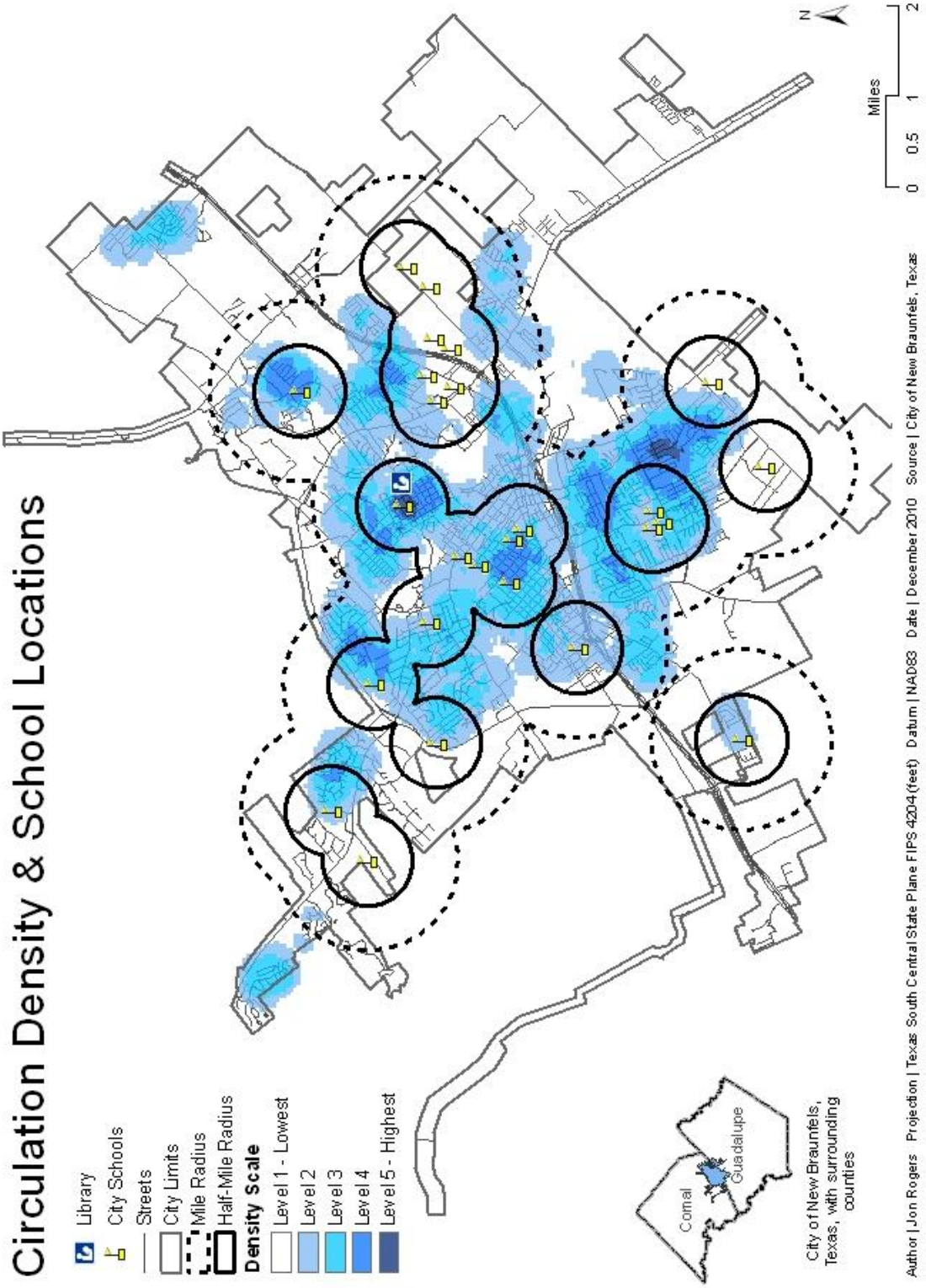


Figure 19: Overlay of Patron and Circulation Density Scales

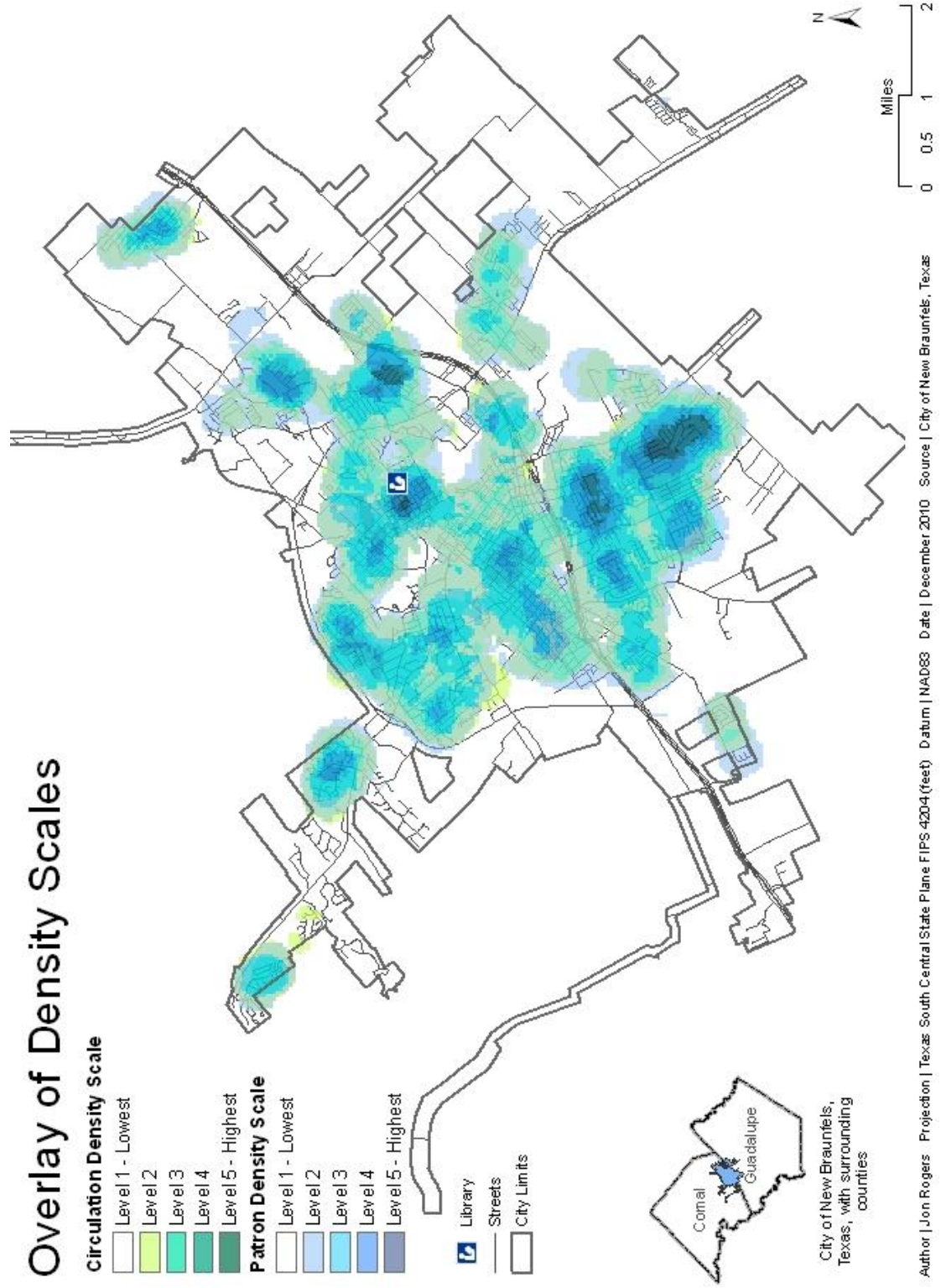
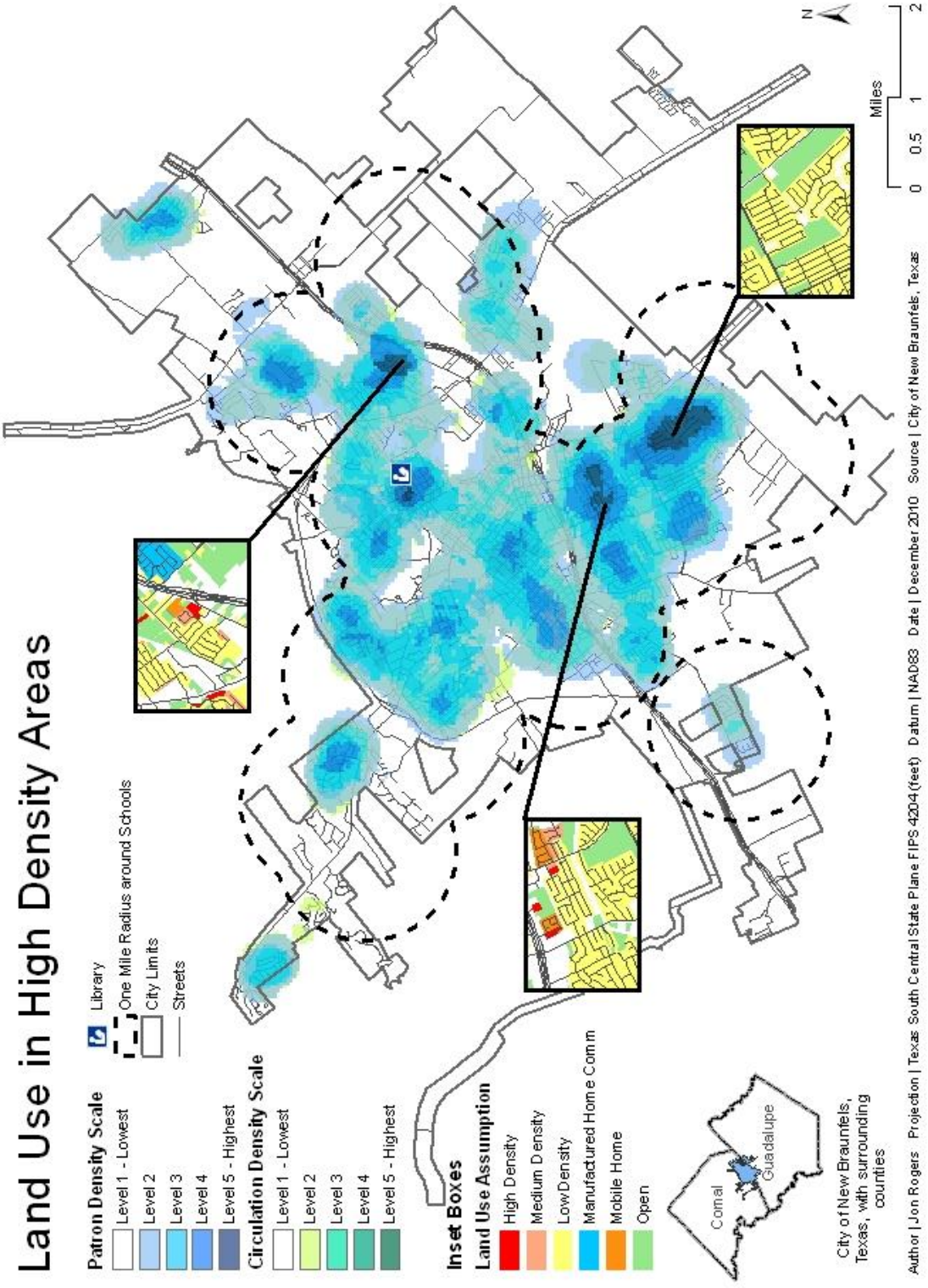


Figure 20: Land Use Specifics in Highlighted High Density Areas



Analysis

Frequency of Circulation

Examination of circulation frequency among all patrons (Figures 4 and 5, p. 10) shows that 60.17 percent of library patrons check out less than twenty items over the course of a given year. Another 29.33 percent of patrons contribute to circulation of 20-99 items in a calendar year. In total, nearly 90 percent of yearly circulation comes from users who check out less than two items per week.

Figures 2 and 3 (p. 4 above) demonstrated that resident (NB) adults represent the vast majority of patronage and circulation at NBPL. Among 13,001 library patrons across ten distinct categories of users, 8,665 were NB adults (66.65 percent), while 3,039 were NB minors (23.38 percent). The next highest category was non-resident (NR) adults, totaling 706 patrons (5.43 percent). NB adults contributed to 69.28 percent of total circulation (363,590 records), while NB minors added another 15.71 percent (82,445 records). NR adults again had the third highest category of circulation; despite limited numbers, they checked out 49,047 items (9.35 percent of total circulation).

Figures 6 and 7 (p. 11) indicate that circulation frequency among NB adults follows the same trend as circulation among all patrons. Nearly 60 percent of all NB adult patrons (5,161 patrons out of a total 8,665) checked out less than twenty items between September 2009 and September 2010. Another 29 percent (or 2,525 patrons) checked out 20-99 items. Worth noting, sixty patrons checked out 500-1,600 items over the twelve-month period; of this group, one individual alone circulated between 1,500-1,600 items.

Distribution of Users

Figure 8 (p. 12) illustrates the fact that library patrons can be found in most areas of the City, with the greatest overall number in the north and south central areas of the City. After running the average nearest neighbor tool on the spatial distribution of library patrons (Figure 9, p. 13), this study finds that clustering of library patrons is not a result of random chance. The very low negative Z-score (-170.13 standard deviations) and the p-value of 0.01 indicate statistical significance. However, this study does not consider enough variables to determine causation of the finding (see Limitations below).

Figure 10 (p. 14) demonstrates the application of Getis-Ord Gi* hot spot analysis on the patron data. Results falling in the range of below -2.58 standard deviations (cold spots) to + 1.65 standard deviations were grouped in a single category of "no cold spots." Three rectangles indicate areas that statistical analysis found most significant: one is a low-density residential area in the northwest, close to State Highway 46; another is a manufactured home community in the west-central area of the City, near Wald and Landa; the third is a larger manufactured home community in the northeast, with close proximity to Interstate 35. While the statistical analysis is interesting, consultation with the City GIS Coordinator yielded consensus that other areas of the City merit consideration for site location. Density analysis was used to explore this issue.

Figures 11 and 12 (p. 15-16) illustrate totals of patron locations and circulation per parcel across the City. Noted in green on Figure 11, 5,327 parcels have 1-5 total patrons, and these areas are spread throughout the City. Similarly, 4,347 parcels have circulation totals of 1-99 items. As we note from the frequency of circulation totals, the majority of NB adult users have circulation of less than 100 items per year. Of note, the manufactured home community in the northeast again registered as a hot spot; it has more than 130 total patrons, and it contributed to more than 6,000 items (6,425) of circulation.

Figure 13 (p. 17) portrays City population density. The map demonstrates that the City's population density is most profound in the south and south-central areas of the City. Compared with Figure 14 (p. 18), this data seems to be at odds with the distribution of high and medium-density residential housing in the City. Further analysis reveals that the City has 964 parcels with a land-use assumption of low density housing, compared to only 55 high-density parcels and 71 medium-density parcels. Flexibility within City zoning laws provide NBPL the opportunity to place a satellite location in virtually parcel. In considering a location that has the potential to capture new users among the current low-patron, low-circulation populations, the south and south-central areas offer extensive low-to-medium residential land in areas that correspond with higher population density.

Figures 16 and 17 (p. 19-20) reveal, understandably, high patron and circulation density around NBPL itself. This analysis does not mirror the hot spot analysis above; instead, the highest levels for patron and circulation density occur in the south and south-central areas, particularly in areas south of Interstate 35. Since the City expressed an interest in identifying populations within a one-mile buffer of public schools, Figures 17 and 18 (p. 21-22) repeat density analysis for patrons and circulation, respectively, while illustrating a) the approximate location of school facilities, b) the desired one-mile radius, and c) a more precise one-half-mile radius around each school. One area of high patron and circulation density in the northeast is within a mile of seven school locations; similarly, three high density clusters in the south, below Interstate 35, fall nearly within the one-half-mile radius of a three-school cluster (near Walnut Avenue).

Figure 19 (p. 23) demonstrates a modest attempt to overlay the patron and circulation density scales to create an additional layer of visual darkness for the purpose of identifying high levels of cross-density. Discounting the area most immediate to the NBPL facility, three locations emerge: 1) an area in the northeast, along Interstate 35, roughly near the corner of Post and Gruene Roads; 2) an area in the southeast, approximately located around Dove Crossing; and 3) an area in south central New Braunfels in the vicinity of County Line Road and Walnut. Figure 20 (p. 24) shows the residential and open-space land use for each location. Each offers a mix of low-to-high residential density.

Limitations

Statistical analysis indicated statistical significance associated with the clustering of library patrons. However, this study does not consider enough variables to make a determination of the causation for this clustering. The observation would be more useful if compared to socioeconomic and demographic data for the area. Library patrons may

be located in areas with lower rents or housing prices, possibly creating a need for free entertainment and information resources. For example, one area of high circulation per parcel occurs around the public housing area near Rosa Parks Drive. Additionally, this study does not consider the marketing impact of existing library outreach to the community. For example, more patrons may become aware of NBPL programs and resources because they see advertisements closer to their homes downtown.

Consideration of a mobile satellite location has both good and bad elements. On one hand, zoning laws and mobility in a relatively small City make it possible for NBPL to interact with different clusters of users over the course of a summer. With a mobile unit, NBPL does not require the capital investment necessary for a bricks-and-mortar structure or a temporary co-location. On the other hand, if a mobile unit will change locations, more administrative and marketing resources will be necessary to prevent patrons from going to the wrong location (and therefore having a negative association with library use). Additionally, materials provided in a mobile unit will be limited by space, and NBPL risks not having the appropriate books available for the patrons seeking mobile services. If the satellite will target specific groups of users, i.e. resident teens, NBPL will need to be prepared for its response to non-target users that want to make use of the mobile facility.

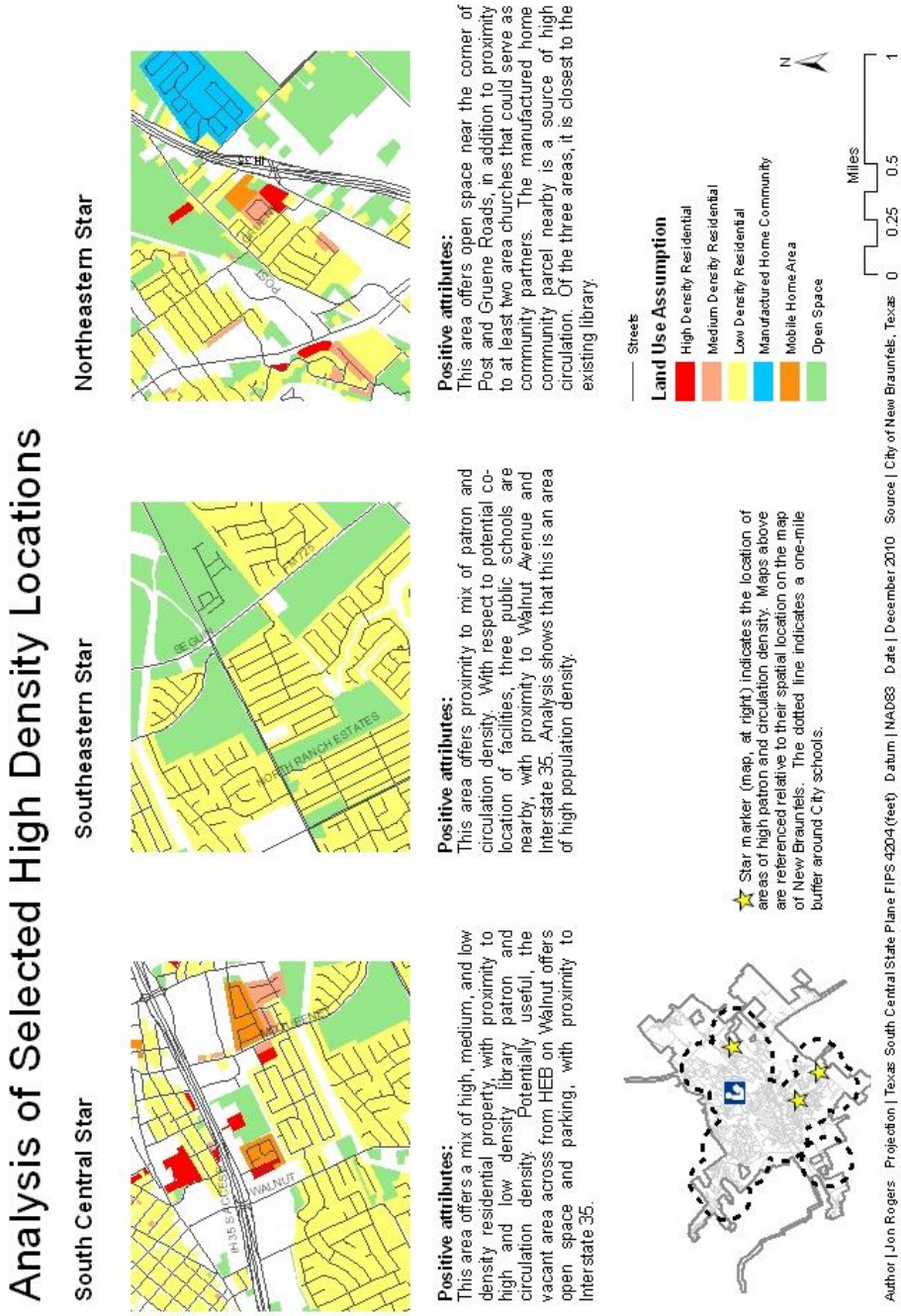
While this study focuses on parcel data, the small size of many City parcels potentially obscures the value of information. Because many of the smaller parcels, particularly in the central to south-central areas of the City, have modest-to-high counts of patrons and circulation totals, larger areas (i.e. census blocks) might provide a more accurate resource for the consideration and development of a longer-term satellite location. The odd shape of the City limits also creates an obstacle for appropriate visual representation. Additional study might begin by eliminating areas of the City in order to narrow the geographic scope.

Conclusion and Recommendations

Current Situation

While NBPL might be able to capture the highest number of users by locating a mobile satellite near one of its statistical hot spots, patron and circulation density analysis reveal that the library has the potential to meet the needs of patrons with varying degrees of interest by locating its mobile facility near one of three identified high cross-density areas (Figure 21, p. 28 below). Placing a mobile unit around one of the three points provides an opportunity for visibility in areas with extensive low-density housing and existing interest in library materials.

Figure 21: Analysis of Selected High Density Locations



The south central location offers a mix of residential density in proximity to a mix of patron and circulation density. North of this location, on Walnut Avenue, a shopping center remains vacant as a result of Target and Ross stores' moves to the tax increment reinvestment zone north on Interstate 35. As a result, the center offers open parking in a highly trafficked area between downtown and the highway. HEB Grocery and Walmart have nearby stores, which increase the chances for visibility. This study does not identify or consider the possibility of locating a mobile satellite within vacant store space.

The southeastern location is very similar to the south central location in terms of its residential, patron, and circulation mix. Patron populations in this area could be easily served by a mobile satellite on the vacant Walnut Avenue property. However, the southeastern location is slightly closer to the three public schools close to the corner of Walnut Avenue and County Line Road. With schools on break during the summer, a mobile satellite could take advantage of available parking (or, potentially, open building space) to offer services in this area.

The northeastern location involves open space near a mix of residential density, including the manufactured home community that serves as a hot spot for NBPL patrons and circulations. This area is nearby at least two area churches that could serve as partners for the purpose of providing location or parking space. Additionally, the area has close proximity to Interstate 35. Locating a mobile satellite here offers potential for high visibility; however, this location may be too close to the existing library facility to generate differentiated interest.

The Way Forward

While this study examines spatial patterns among library patron and circulation totals, more information on the background of patrons would be helpful in determining an appropriate branch location. Ideally, a wider range of data, either through a supplemental survey or through mining of patron records, would generate a more thorough picture of the ages and socioeconomic circumstances associated with NBPL users. If the purpose of a mobile satellite is to create the highest visibility among the greatest number of potential users, a location should be selected that offers desirable attributes: location safety, high traffic, pleasant atmosphere – possibly close to popular downtown commercial areas, schools, or churches. However, analysis might indicate that those who would reap the greatest benefit from a mobile facility are those with lower incomes and limited mobility. In this case, a mobile unit could be more effective in transit to areas of need within the City.

As the City continues to grow, NBPL will no doubt consider the possibility of branch expansion. Additional research on the value of co-location and cross-department synergy is necessary to develop a better picture of the value-added for a long-term facility. Developing a structure that would serve multiple departments offers the possibility of capital efficiency, but would need to be designed in such a way to respect the users and city officials using the space. Possibly, the New Braunfels and Comal Independent School Districts may have valuable input about the feasibility of creating a joint school-library facility.

APPENDIX

Please note: All referenced materials are listed as endnotes and can be found at the end of the Appendix.

Expanded Methodology

Insights

I lived in New Braunfels for two years and volunteered in NBPL for approximately 11-12 months during that time. Additionally, during Summer 2010, I served as a Management and Budget Analyst (Intern) in City Hall. While I have studied volunteer use in NBPL as part of a prior course on Program Evaluation, many of my insights regarding this particular project come from continued, informal conversations with C. Michael Parma, GIS Coordinator, and Gretchen Pruett, Library Director. As appropriate, these conversations are cited as interviews in the references section.

Data Sources

To perform this study, I obtained an Excel document that provides addresses and circulation totals for library cardholders.[23] This data is confidential; names and library card numbers have been removed to protect patrons. As noted above, the City of New Braunfels makes geographic information systems (GIS) interactive and provides files to the public through viewer software on the City's website.[24] However, due to a problem with the file return system, I had to extract files from a parent directory link (posted to, then removed from, http://data.nbtexas.org/GIS/) provided to me by the City's GIS Coordinator, C. Michael Parma.[25] From the parent directory, I obtained geodatabase files with ten various feature types (seven polygons: City Council Districts, City Limits, County Boundaries, School Districts, Zoning Categories, Parcels, and City Land Use; two points: Addresses and Schools: one line: Street Centerlines).

<u>Preparing Excel Data</u>

1. Opened workbook "newbraunfels_stats.xlsx."
    a. I obtained this data as an email attachment from the City of New Braunfels GIS Coordinator.[26]
2. Selected all data from "Patron Data for GIS layer – 9-3" worksheet and pasted into new worksheet "PatronRev" in same workbook.
    a. I have retained the library's distinction between non-resident (NR) and city resident (NB) users.
    b. Circulation data was collected between the dates September 28, 2009, and September 27, 2010.
3. Deleted library card number column from the data set. This information is irrelevant for the study, and deletion will provide an additional layer of anonymity.
4. Custom sorted data to determine how many entries have alternate mailing addresses (address line 1, line 2, city, state, ZIP –columns H through M).
    a. *Note*: For the purpose of this note and subsequent notes regarding the Excel workbook, the terms "entry" or "entries" refer to lines of Excel data that associate address data with a patron.
    b. Only six entries have alternate mailing addresses (out of 13,634 total). One is a San Marcos address, but the patron is identified by her/his primary address as a city resident.
5. Deleted mailing address data columns from the data set.

6. Custom sorted data to determine how many entries have a second line for primary address data.
    a. Some patrons include their apartment number with line one. Others list this information as a second line.
    b. Only eighteen patrons have a second address line. This information will be combined with the primary address line to make the data set uniform.
7. Deleted primary address line 2 from the data set.
8. Custom sorted data to determine how many entries are categorized as "Institute."
    a. At the library/circulation director's discretion, some city help organizations (e.g. teen crisis assistance) are allowed to check out materials.[27]
    b. Only four entries are categorized as "Institute," and this information can be deleted without harm to the study.
9. Deleted "Institute" category of users.
10. Custom sorted data to determine how many entries are categorized as "Crisis Center."
    a. At the library/circulation director's discretion, residents of the city crisis center are allowed to check out materials.[28]
    b. Only nine entries are categorized as "Crisis Center," and this information can be deleted without harm to the study.
11. Deleted "Crisis Center" category of users.
12. Custom sorted data to determine how many entries are categorized as "NBISD."
    a. In a new partnership between the public library and the New Braunfels Independent School District, schools are allowed to get a library card in the name of the school, with the school librarian listed as the responsible borrower.[29]
    b. Only two entries are categorized as "NBISD," and this information can be deleted without harm to the study.
13. Deleted "NBISD" category of users.
14. Custom sorted data to determine how many entries are categorized as "Internet."
    a. Library patrons may use Internet services within the public library.
    b. Thirty-one patrons are categorized as "Internet." The address records are incomplete for this subsection. Because this study addresses material circulations, the records will be removed from the data set.
15. Deleted "Internet" category of users.
16. Custom sorted data to determine how many entries are categorized as "New Member."
    a. The library director stated that this category was, essentially, an error and that these users could be considered as residents. However, this analysis will require data analysis in-house at the library for review of the addresses.[30]
    b. Nineteen patrons are categorized as "New Member." Because there is an element of uncertainty regarding whether these individuals are city or non-city residents, the records will be removed from the data set.
17. Deleted "New Member" category of users.

18. Custom sorted data to determine how many entries are categorized as "Library Use" or "Lost."
    a. Three entries are categorized as "Library Use," i.e. checkouts for library programs, and three entries are categorized as "Lost."
19. Deleted "Library Use" and "Lost" categories of users.
20. Custom sorted data to determine how many entries are categorized as "NR Stud Limited."
    a. Only one entry is a non-resident student, and she/he is listed as restricted, although the address is listed in New Braunfels. For the purpose of this study, this person could be considered as a non-resident student.
21. Reclassified one entry from "NR Stud Limited" to "NR Student."
22. Custom sorted data to determine how many entries, for all categories, have incomplete address records.
    a. 149 entries, including resident and non-resident adults and minors, have incomplete address records, i.e. missing any street address and possibly the city and state records. Given the available information, it is not possible to associate the incomplete records with an address.
    b. For another 73 entries, street address information was provided, but the state or ZIP records were inappropriately entered. In these cases, it was possible to edit address data to create a complete record.
        i. One entry for an address on IH 35 South Frontage Road could not be accurately located or matched with a ZIP code on Google Maps. This entry was deleted.
        ii. One entry with a post office box identified two addresses – one for Cibolo, Texas, but another with New Braunfels. Because the library card was issued for a resident adult, the entry was retained with the New Braunfels listing.
23. Edited address record entries that provided a street address but inappropriately entered city, state, or ZIP Code information.
24. Deleted address record entries that had no street address or no street/city/state address.
25. Custom sorted data to ensure that the state abbreviation for "Texas" – TX – was appropriately applied across all Texas records.
    a. In many cases, "TX" was in appropriately entered as "T," "T.," or "TE."
26. Changed records to show "TX" as the primary address state for Texas residents.
27. Changed records to eliminate misspellings or all caps spelling of "New Braunfels" under primary address city.
28. Changed library code records to eliminate category numbers.
    a. "19 – NR-STUDENT" becomes "NR-Student."
    b. "22 – Staff" becomes "Library-Staff."
    c. "23 – NR-VISITOR" becomes "NR-Visitor."
    d. "4 – City" becomes "City-Staff."
    e. "13 – NB-ADULT" becomes "NB-Adult."
    f. "14 – NB-MINOR" becomes "NB-Minor."
    g. "15 – NR-ADULT" becomes "NR-Adult."
    h. "16 – NR-MINOR" becomes "NR-Minor."

i. "17 – NR-PO-A" becomes "NR-Prop-Adult"
    i. Non-residents who own property (thus, "PO") in New Braunfels (and their families) are entitled to free library cards under library regulations.[31]
j. "18 – NR-PO-A" becomes "NR-Prop-Minor."

29. After making the changes to the Excel document (as described above), the data set has 13,406 entries. (1 entry = 1 patron)
30. After re-review and revision of address data, the Excel document included 13,001 total patrons.
    a. Count and sort functions were performed to calculate the frequency of circulation by user category and by percentage.
    b. Countif and division functions were performed to separate the data by category and calculate patrons and circulation numbers and percentages.

Preparing ArcGIS files

1. The City of New Braunfels makes geographic information systems (GIS) interactive and provides files to the public through viewer software on the City's website.[32] However, due to a problem with the file return system, I had to extract files from a parent directory link (posted to, then removed from, http://data.nbtexas.org/GIS/) provided to me by the City's GIS Coordinator, C. Michael Parma.[33]
2. From the parent directory, I obtained a geodatabase with ten files of various feature types (seven polygons: City Council Districts, City Limits, County Boundaries, School Districts, Zoning Categories, Parcels, and City Land Use; two points: Addresses and Schools: one line: Street Centerlines).
3. All of the files received have a projected coordinate system of Texas South Central State Plane FIPS 4204 (NAD 1983, feet) and a geographic coordinate system of GCS North American 1983. For the purpose of this study, I will retain as final the original source data projection.
    a. To verify the projected coordinates, I opened ArcCatalog to examine the metadata for each file. The projection was consistent across all files.
4. All of the files received were renamed for clarity, as shown in the chart below.

OLD	NEW
GeoPRD_GDO_BNDY_CONBCityCouncilDist	*City_Council_Districts*
GeoPRD_GDO_BNDY_CONBCityLimits	*City_Limits*
GeoPRD_GDO_BNDY_Counties	*Counties*
GeoPRD_GDO_BNDY_SchoolDistricts	*School_Districts*
GeoPRD_GDO_BNDY_Zoning	*Zoning*
GeoPRD_GDO_geoAddr_VW	*Addresses*
GeoPRD_GDO_geoParcels	*Parcels*
GeoPRD_GDO_LandUse	*Land_Use*
geoprd_GDO_Schools	*Schools*
GeoPRD_GDO_StreetCenterlines	*Streets*

5. Excel data will need to be geocoded for use in ArcGIS, using the address locator tool to connect points with my streets file.

Formatting the Maps: Repeated Aspects (All Maps Except Figure 21)

1. For each map, I used the font Arial.
    a. Title size = Arial 22
    b. Legend elements = Arial 8-10, depending on data presented
    c. Scale bar = Arial 8, stepped scale line.
        i. Two miles of distance, indicating 0, 0.5, 1, and 2 miles.
    d. North star = ESRI North, size 36.
    e. Inset map = City of New Braunfels, Texas, with surrounding counties.
        i. City shown at ratio 1:2,700,000, with full extent of Comal and Guadalupe Counties
        ii. Color for counties kept as hollow, with gray county line marking county borders.
        iii. Color for city kept as oxide blue, with a gray 70% line of 0.25 width marking city limits.
    f. Large map = City of New Braunfels
        i. Library icon from ESRI, size 16.
        ii. Streets symbolized with a gray 70% line of 0.10 width.
        iii. City inset generally set with fill color = no color to highlight other colors used.
        iv. City limits border set as gray 60% line of 1.50 width.
    g. Map size kept at 8.5" x 11" throughout ArcMap analysis. All maps were entered into Word documents as JPEG figures and rotated 90 degrees left. Size was recalculated at 5.8" x 8.1" to preserve headings and page formats.

Other Symbology

1. For rogers_final_patrons, patron symbol set as circle, size 5, color oxide blue.
2. For rogers_patron_schools, et al., school symbol set as ESRI school 2, size 16, color solar yellow.
3. For rogers_patron_count, number of patrons grouped according to categories meaningful to a distribution. In total, six categories used to express groupings between 0 and 130 + patrons. Color scheme used to indicate in dark red the parcel with the highest number.
4. For rogers_circulation_count, grouping mirrored process for patron counts. Again, color scheme used to indicate in dark red the parcel with the highest circulation.
5. For rogers_patron_v_circ3, in order to overlap circulation and patron density, the transparency of patron density was set at 55%, and the transparency of circulation density was set at 30%. Circulation density was changed from graded blues to greens to create color comparison and contrast.
    a. In using blues and greens, I hoped to show overlapping dark areas. The intent was not necessarily to show the two attributes separately.

Working with ArcGIS

1. Address Locator: Associate the Excel data set with City streets.

a. Using file "Streets," I will use ArcCatalog to set a new address locator, using US Streets.
    i. I tried this process first with US Streets with Zones and matched under 50%. A retry with US Streets proved much more effective, as noted below.
b. I reduced the Excel sheet further, deleting all addresses not in New Braunfels, to improve matching. This takes the data set down to 13,001 records.
c. I set name in address locator = nbstr3.
    i. House from left = Left_Low
    ii. House to left = Left_High
    iii. House from right = Right_Low
    iv. House to right = Right_High
    v. Street name = Street_Name
    vi. Street type = Street_Type
    vii. The field containing STREET is recognized if it is named ADDRESS.
    viii. Spelling sensitivity = 60
    ix. Minimum candidate score = 10
    x. Minimum match score = 40
d. After developing an address locator and geocoding addresses, I had a matched total of 10,138 (78%), tied 972 (7%), and unmatched 1,889 (15%).
e. I ran match / rematch to determine what records a) were within the city limits but b) were not recognized, possibly because of address glitches (i.e. Common Street entered as West Common Street). After manually matching unmatched addresses, I was able to increase the matched total to 80% (10,429).

2. Clipping: Matching geodatabase files with the City Limits
    a. In rogers_final.mxd, I opened ArcToolbox > Analysis Tools > Extract > Clip
    b. I set input features to School_Districts, and clip features to City_Limits.
    c. I set output feature class to School_District_City_Clip in my data folder.
    d. After clipping the file, I removed School_Districts from my data frame.
    e. In rogers_final.mxd, I opened ArcToolbox > Analysis Tools > Extract > Clip
    f. I set input features to Schools, and clip features to City_Limits.
    g. I set output feature class to Schools_Clip in my data folder.
    h. After clipping the file, I removed Schools from my data frame.
    i. I repeated this process with School Districts (although this file was not used: School_District_City_Clip), Addresses (Addresses_Clip), Streets (City_Streets), Parcels (City_Parcels), and Patrons (City_Patrons).
3. Placing Patrons in Parcels
    a. Generated Near Table
        i. Input City_Patrons
        ii. Near City_Parcels

   b. Buffered City Parcels to distance of 12 feet – roughly the width of one street
      i. This allowed patron addresses affiliated with a street to be captured with a parcel
      ii. Side type = Full, Dissolve type = None
   c. Created "count" (number = 1) within City_Patrons
   d. Implemented spatial join of City_Patrons to City_Parcels_Buffer
      i. Joined points to polygons
      ii. Each polygon received a summary of the numeric attributes of the points that fall inside it, and a count field showing how many points fall inside it; attribute summary = sum.
      iii. Result was saved as new layer, join_output_patrons
4. Hot Spot Analysis
   a. Using join_output_patrons, selected attributes such that SumCount (sum of counted patrons in a given parcel) >= 1.
   b. Data was saved and exported as join_output_patrons_count1.shp.
   c. Using Hot Spot Analysis (Getis-Ord Gi*), input feature class set as join_output_patrons_count1.
      i. Input field = Sum_Count
      ii. Conceptualization of Spatial Relationships = Fixed Distance Band
      iii. Distance Method = Euclidean
      iv. Output = join_output_patrons_count1_H.shp
   d. Using output, selected by attributes such that GiZScore > 2.58 and GiPValue < 0.05.
   e. Rectangle, color black, outline width = 2.00 used to indicate hot spots on map rogers_final_near
   f. Results of less than 1.65 standard deviations grouped and relabeled as "No Hot Spots."
   g. Results of greater than 2.58 standard deviations renamed as "> 2.58 St. Dev" and assigned color poinsettia red.
   h. Results between 1.96 and 2.58 standard deviations renamed as "1.96 to 2.58 St. Dev" and assigned color electron gold.
   i. Results between 1.65 and 1.96 standard deviations renamed as "1.65 to 1.96 St.Dev" and assigned color solar yellow.
5. Buffers: Establishing areas around schools
   a. Input City_Schools.
   b. Output City_Schools_MileBuf.
   c. Distance set to 1 mile, side type = full, end type = round, dissolve type = all.
   d. Symbology for mile radius set to dashed 4:4 black line, width = 2.00.
   e. Process was repeated for a half-mile buffer (City_Schools_HaMileBuf), with symbology set to solid black line, width = 2.00.
6. Spatial Analyst: Point Density
   a. To create patron density:
      i. Input point features = City_Patrons.
      ii. Population field = Count

iii. Output cell = 198.247249, neighborhood settings = circle, radius = 1652.060410
iv. Units = map, Area units = acres
v. Groupings narrowed from nine classes to five, assigned as Level 1 – Lowest (color hollor), Level 2 (oxide blue), Level 3 (big sky blue), Level 4 (cretean blue), Level 5 (dark navy).
vi. Process repeated exactly for population density (Input point features = Addresses_Clip, population field = AddrKey) and circulation density (Input point features = City_Patrons, population field = Circulatio).

7. Library shapefile
    a. Open City_Patrons attributes.
    b. Select by attributes, ARC Street = 700 E. Common St.
    c. Export data as Library.shp.
    d. Set symbology as ESRI library symbol, size 16.
8. Land use abridged
    a. Open Land Use attributes
    b. Select by attributes, "LU_ASSUMPT" = res med den; high den res; manuf home comm.; mobile home park; res low den; open.
    c. Export data as res_and_open_lu.
        i. Because City zoning allows municipal functions, including libraries, to locate anywhere in the City, I wanted to isolate areas with residential density and open space for the purpose of identifying potential capture of new and current patrons.
    d. Set High Density Residential = mars red, Medium Density = cantaloupe, Low Density = autunite yellow, Manufactured Home Community = big sky blue, Mobile Home = ESRI R-T mobile home residential (orange), and Open = ESRI park and open space (green).

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