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Wheels on the Bus: School Transportation as a Reflection of Sprawl

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Abstract

The second half of the twentieth century constituted a change in land use ideology and development practice brought about by the rise of the automobile, increasing economic upward mobility, and privatization of the family home. During this time, the districting and building of public schools similarly changed, turning schools from local community centers to regional and de-contextualized places of education. The purpose of this study was to investigate the extent to which these development practices have caused children to rely on car and bus transportation to get to and from school. Using the variable of distance within a GIS analysis of three case study locations in California, Maryland, and Pennsylvania, we tested the hypothesis that the increasing regionalization of schools in conjunction with the sprawl of developed parcels diminishes walkability to those schools for the children who attend them. Our results suggest that increased distance from schools and the districting mandates for determining school attendance decrease the ability of children to walk to school, reflecting the shift to automobile-centered land use. Our research also suggests that infrastructure-related walkability is further impeded by economic, cultural, and socio-psychological norms that are in many ways connected to or facilitated by the automobile.

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Abstract: The second half of the twentieth century constituted a change in land use ideology and development practice brought about by the rise of the automobile, increasing economic upward mobility, and privatization of the family home. During this time, the districting and building of public schools also changed, turning schools from local community centers to regional and de-contextualized places of education. The purpose of this study was to investigate how far children in elementary, middle, high, and special education schools live from their schools, and whether these distances allow for walking as a mode of transportation. Using the variable of distance within a GIS analysis of three case study locations in California, Maryland, and Pennsylvania, we tested the hypothesis that the increasing regionalization of schools in conjunction with the sprawl of developed parcels diminishes walkability to those schools for the children who attend them. Our results suggest that increased distance from schools and the districting mandates for determining school attendance decrease the ability of children to walk to school, reflecting the shift to automobile-centered land use. Our research also suggests that infrastructure-related walkability is further impeded by economic, cultural, and socio-psychological norms that are in many ways connected to or facilitated by the automobile.

We affirm that we have upheld the highest principles of honesty and integrity in our academic work, and that we have not witnessed a violation of the Honor Code.

Introduction:

Public schools are amenities not only to the children who attend them, but also to the community at large. Schools are used as polling places, meeting rooms, sites for carnivals and fairs, and shelters in case of emergency. Just as important as the way we use our schools, though, is how we get to them. For much of United States history, schools were centrally located within communities, easily accessible by non-motorized transportation methods.

In colonial Massachusetts, laws dictated that each town with more than fifty families was required to have a schoolmaster. If the town had more than one hundred families, a grammar school was required, and over five hundred families necessitated two grammar schools (Kennedy 2008). Similar regulations were enacted throughout the colonies of the New England area. With the advent of the public school system, and the construction of the first public school in the nation in Dedham, Massachusetts, these laws continued to serve as guidelines for the placement of new schools.

Based on the Land Ordinance of 1785, the townships that were developed during westward expansion of the country were required to set aside land for public schools. In each thirty-six square mile township, one square-mile block -- the centrally-located block 16 -- was dedicated as the site of the public school (Kennedy 2008). These considerations for school placement were typical in the nineteenth and twentieth centuries and were put in place to help keep schools accessible to children, especially by walking.

However, in the post-World War II era, the rising affluence led to dramatic changes in the lifestyles of many middle class Americans, and the increased availability of cars, suburban living began to develop into the predominant lifestyle choice for young families. More families began to purchase private family homes built on increasingly low-density plots of land, laid out

in developments that were more car-friendly than pedestrian-friendly. These residential-only developments spanned large geographic areas, and contained no space for commercial or municipal use. Thus, families began to drive outside of their communities for activities such as going shopping, going to work, and going to school.

Today, requirements for public schools are much more ambiguous than the guidelines set forth in early America. Some laws state only that schools must be "away from major roads and noise distractions," while other schools are purposely situated along highways for easy commuter access. For many students, the morning routine before school includes riding in a parents' car, quickly unloading in one of the multiple lanes of family cars dropping children off in front of the school's main entrance in areas known as "Kiss and Drop-Off" or "Hug-and-Go" zones.

Our curiosity about the impact of land use planning decisions and the increasing regionalization of American public school systems encouraged us to consider the centrality of the automobile within daily life in the United States. We set out to study the extent to which changes in infrastructure since the 1950s have driven children to rely on car and bus transportation rather than walking to get to and from school. However, we were surprised to find that within school districts, adequate records do not exist to answer this question. Therefore, we reformatted our study to investigate how far children in elementary, middle, high, and special education schools live from their schools, and whether these distances allow for walking as a mode of transportation.

In attempting to answer this question, we adopted a case-study approach to collecting and analyzing data. The three locations that we drew upon in our study were: Adams County, Pennsylvania; Frederick County, Maryland; and the San Juan Unified School District in

Sacramento County, California. We chose these locations because of their centrality in the lives of members of our group, as well as the significant amount of time our class spent learning about and visiting Frederick, Maryland. Additionally, these three locations represent three different types of land use, with Adams County falling near the rural end of the development spectrum, Sacramento County near the urban end of the spectrum, and Frederick County somewhere in between. Although we broadly sought the same kinds of data from all three study sites, each location differed from the others in unique ways, and our investigation thus had to be tailored to suit these individual contexts. As such, more specific information regarding each study site is presented.

Adams County, Pennsylvania

Adams County is a rural community situated in south-central Pennsylvania. Development in this region was slow prior to World War II, with 13,000 residents claimed at the establishment of the county in 1800 rising to only 44,000 by 1950. Today, the population tops off at just over 100,000 residents, and the county is experiencing one of the highest growth rates in the state. Twenty-one percent of the county's residents are under the age of 18.

Prior to 1800, Pennsylvania lacked a public education system. A public school law was passed in 1834, requiring each municipality in the state to decide between maintaining independent schools or joining the public system in return for funding. Typically, schools were built on farmland donated by the owner to serve a few of the surrounding farms. Most schools were located no more than one to two miles apart. At the height of this practice, Adams County had as many as 150 schoolhouses. Legislative actions in 1911 and 1919 authorized schools to be consolidated and allowed for the allocation of state funding towards school transportation; thus, the school bus was introduced to Adams County (The Adams County Historical Society). Adams

County saw a steep increase in the number of schools in the County as a whole during the 1960s, at the beginning of what was also a period of much higher population growth than the previous 150 years (Figure 1).

Today, Adams remains broken into six public school districts; Bermudian Springs, Conewago Valley, Fairfield Area, Gettysburg Area, Littlestown, and Upper Adams (Table 1). These have remained the only districts in Adams County since 1971. Bermudian Springs School District includes Bermudian Springs High School, Middle School, and Elementary School. Conewago Valley School District includes New Oxford and Conewago Township Elementary Schools, Conewago Valley Intermediate School, New Oxford Middle School, and New Oxford High School. Fairfield Area School Districts includes one high school, middle school, and elementary school of the same name. Gettysburg Area School District contains three elementary schools, Franklin Township, James Gettys, and Lincoln. A fourth Gettysburg elementary school, Eisenhower, was closed in 2011 and is currently home to two charter schools, and Keefauver Elementary was closed in 2002 and demolished in 2012 to make room for the new Gettysburg Area Middle School, which will open in the fall of 2014.

Littlestown Area School District is composed of Rolling Acres Elementary School, Alloway Creek Intermediate School, Maple Avenue Middle School, and Littlestown Senior High School. Upper Adams School District is made up of Arendtsville Elementary School, Bendersville Elementary School, Biglerville Elementary School, Upper Adams Middle School, and Biglerville High School. Outside of the public school system, Adams County is also home to a host of private schools, including many with religious affiliations. The district boundaries of Adams County's school system have gradually morphed over time, leaving behind a map with

abnormally shaped districts and one incongruent district (Figure 2). Such arbitrary delineations have implications on the suitability of different transportation modes for students.

Table 1. School Districts in Adams County, Pennsylvania.

School District	Area (mi. sq.)	Number of Schools	Student Enrollment	Number of Buses Utilized
Bermudian Springs	75	3	2,010	23
Conewago Valley	73	5	4,024	60
Fairfield Area	61	3	1,195	15
Gettysburg Area	185	6	2,858	36
Littlestown	50	4	2,035	19
Upper Adams	90	5	1,669	22

Frederick County, Maryland

Frederick County is located in Northern Maryland along the border of Pennsylvania, with a land area of 660.22 square miles, a population of 241,409, with 24.4% of the population under the age of 18. The population of Frederick county has been growing rapidly since the period following WWI. In more recent years it has experienced a 15.6% increase in population between 2000 and 2008 (US Census Bureau). The first legislation passed in Maryland in 1732 stated that each county was required to have a school, located in the center of the county. This legislation was then changed in 1816 to require that each election district, rather than each county, contain a school, which would be funded by the county. The creation of a public school system was even further advanced in 1823, when the Maryland General Assembly authorized a primary school system throughout the state, to be supported by tax dollars. This public school system graduated its first full-term class in 1949 and integrated in 1959 (Board of Education of Frederick County 2013: 2).

Today Frederick County, Maryland, contains one county-wide school district, the Frederick County Public School District (FCPS) (Table 2). This school district contains 34 elementary schools, 13 middle schools, and 10 high schools, as well as 9 specialty schools. As opposed to other school districts, FCPS designates what school a child will attend through sub-districts at each individual education level. These sub-districts follow a specific "feeder school" pattern, as each group of elementary schools feeds into a smaller group of middle schools and then into one specific high school. Like Adams County, Frederick County saw a large burst in school construction during the "Baby Boom" years of the 1950-1960s, as well as a secondary "boom" in the 1990-2000s (Figure 3).

Table 2. School Districts in Frederick County, Maryland.

School District	Area	Number of Schools	Student Enrollment
Frederick County Public School District	660.22	66	40,715

Sacramento County, California

Sacramento County is located in northern Central California, with an area of 995 square miles and a population of 1.45 million. As the initial location of the California Gold Rush of 1848-1850, the region experienced an influx of American settlers and foreign entrepreneurs during the period of American Westward expansion. By the end of the 19th century, the area had become a place based primarily on economies of agriculture, horticulture, commerce, and manufacturing (Willis 1913), but the development of the county was by no means complete. As early as 1913, Willis suggested that:

> "Well has [Sacramento County] played her part so far, but it is an insignificant one compared to that which she will play in the near future, when instead of a few thousands, this magnificent valley of the Sacramento shall support millions of happy, prosperous men, women, and children of the mighty empire that is developing so rapidly on the western coast of our country" (Willis 1913: 6).

The prediction held true, and between 1970-1980 and 1980-1990, Sacramento County nationally ranked 22nd and 13th in counties with the greatest absolute population gain (Auch et al. 2004). However, much of this gain was characterized by an increase of low-density growth, which has led to land-use practices of infilling underdeveloped areas within urban portions of the county. Despite these practices, development today continues to extend beyond metropolitan zones, necessitating the continual updating and expansion of the existing highway infrastructure (Auch et al. 2004). The changing profile of residential areas reflects the increasing centrality of automobile transportation to Sacramento County development: while many of the neighborhoods formed prior to World War II "are characterized by gridded streets, narrow lots, alleys, porches, and garages placed in the rear of the lot," the majority of residential areas in the County were not constructed until after WWII, and as such "are characterized by suburban features such as curving streets, wider lots, and homes with attached garages and houses facing streets" (Accessory Dwelling Unit Manual: 5).

The county currently contains 391 public schools within thirteen public school districts (Table 3). However, given the large sample size required for analyzing school transportation modes and walkability within the entirety of the county as well as our desire to keep all three case studies as comparable as possible in extent, for the purposes of this investigation, we chose to focus our attention on San Juan Unified School District (SJUSD), which is located in the northeastern portion of the county and has the largest student population of any of the thirteen districts. Among the 64 public schools contained within the district, which was established in 1960, 42 are elementary schools, eight are middle schools, 11 are high schools, and three are designated special education schools (Figure 4).

Two important features influence transportation within SJUSD: one is the restriction of the district busing system to federally-mandated busing, and the other is the district's Open Enrollment policy. SJUSD, like many other districts in Sacramento County, provides home-to-school transportation only for students who qualify for federally-mandated busing; within the district, mandated busing applies only to students who participate in special education and alternative education programs. Thus, in our analysis of Sacramento County and SJUSD school walkability, designated special education schools are included, along with elementary, middle, and high schools, while this analysis is absent in our other two case studies. Another feature which factors into our study is the Open Enrollment policy, which allows students to apply for attendance at a school other than their resident, or local neighborhood school. Thus, rather than attending the school located closest to their place of residence, students may permanently give up their right to attend their neighborhood school and choose to enroll in any District school in which space is available and for which parents provide private transportation ("Your Guide to Open Enrollment"). This consideration makes SJUSD unique among our case studies, in that students theoretically can attend a school located a mile from their home, or sixty miles from their home, and in that the burden of transportation is automatically conferred to the parents, presumably in a private automobile, rather than to the school district through public busing or even to the student through walking. These two factors prompted somewhat varied analysis from that which we conducted in Adams County and Frederick County.

We used these three case studies in order to test our hypothesis that the current situation after years of regionalization of schools in conjunction with the sprawl of developed parcels is a low level of walkability to those schools for the children which attend them.

Table 3. School Districts in Sacramento County, California.

School District	Area (mi. sq.)	Number of Schools	Student Enrollment
Arcohe Union	116.57	1	414
Center Joint Unified	20.88	12	4,791
Elk Grove Unified	333.19	67	62,137
Elverta Joint	24.6	2	306
Folsom Cordova Unified	91.03	38	19,117
Galt Joint Union	61.46	9	2,792
Galt Joint Union High	258.56	10	2,306
Natomas Unified	37.87	16	12,454
River Delta Unified	368.15	5	2,323
Robla	10.14	10	2,119
Sacramento City Unified	68.93	100	47,616
San Juan Unified	77.12	64	47,752
Twin Rivers Unified	44.59	58	31,420

Methodology:

Utilizing data obtained from the Adams County Office of Planning and Development, the Frederick County GIS Serve as well as the City of Frederick GIS Department, and the City of Sacramento Information Technology Department, we used Geographic Information Systems (GIS) software to analyze walkability to public elementary, middle, high, and -- where applicable -- special education schools within our three case study locations.

We used distance -- more specifically, the distance between school locations and residential parcels -- as a determining factor of walkability for our study. Although distance is by no means the only parameter that influences walkability, we chose to apply it as our primary basis for several reasons. First, other factors that contribute to increased or decreased walkability

were, within the time constraints of this project, unfeasible to measure due to their characteristics and frequencies. For example, the numbers, widths, and extents of sidewalks and road berms within school districts are undoubtedly an important influence on whether or not children are able to safely walk to school. However, collecting data on the locations and sizes of all the sidewalks in Adams County -- let alone all three counties combined -- was beyond the scope of this project. Second, some contributing factors of walkability are too variable seasonally, annually, or geographically to measure across multiple study sites. Weather, for instance, can facilitate or impede walkability depending on the season and the severity of climate patterns from year-to-year. Furthermore, weather patterns differ greatly between Sacramento County and Adams or Frederick County; as such, we felt that a more standardized variable – i.e., feet as a measure of distance -- would be more useful in comparing our three study sites. Third, some of the information that would be pertinent to a study of walkability within these three specific contexts was unavailable for our use, either because such data were inaccessible by the public, or because they have not been collected by relevant agencies, e.g., the number of students actually walking to each school each day.

In order to determine the distance between schools and residential parcels, we ran Euclidean Distance measures around each school within the districts of our three case studies, enabling us to classify parcels based on distance from the schools. We set five classes for each school-to-parcel distance measure based on the level of schooling represented. The walkability classification for each school was set according to values determined by the National Center for Bicycling and Walking, which suggest the average distance for which certain age groups of children can reasonably be expected to walk to school in one half hour. This group determined that for elementary schools, students can be expected to walk one half mile between home and

school. For middle school students, this figure is three-quarters of a mile, and it is one mile for high school students ("Creating Walkable Communities" 1998). Because the special education schools included in our research serve students in Kindergarten-12th grade, the elementary school standards were used to analyze special education schools. These distances are how we defined "walkability" within the scope of our study. We selected the same distances for the third, fourth, and fifth classes for each level of schooling in order to provide a standardized measure of distance that would facilitate comparison between our study sites (Table 4). After classifying our Euclidean Distances according to these parameters, we calculated the percentage of parcels that fell within each class for elementary, middle, high, and special education schools.

Table 4. Euclidean Distance classifications.

School Level	First Class Distance (mi)	Second Class Distance (mi)	Third Class Distance (mi)	Fourth Class Distance (mi)	Fifth Class Distance (mi)
Elementary	0.5	1.0	2.0	5.0	10.0
Middle	0.75	1.0	2.0	5.0	10.0
High	1.0	1.5	2.0	5.0	10.0
Special Education	1.0	1.0	2.0	5.0	10.0

Finally, in attempting to answer our research question, we requested as much data as possible from our case study school districts themselves pertaining to their records the establishment of their schools and of students who walk, ride the bus, drive, or are driven to and from school each day. The variability and in some cases limited scope of the data we received meant that this aspect of our investigation was not as uniformly quantitative across our study sites as we originally anticipated. Although we sought data regarding direct counts of student transportation modes, we were surprised to find that these data were often unavailable. In some circumstances the information was recorded but was not available to the public; in other cases

schools have inconsistently recorded or have historically not recorded such data until very recently. Most frequently, school districts simply *do not* collect such data regarding their students, or collect it only in part (for instance, recording the number of students in a district who ride the bus, but neglecting to record the number of students who walk, drive, or are driven).

Combining our quantitative school-to-parcel measures from the Euclidean Distance measures, our spatial data from our GIS analysis, and our qualitative research concerning other factors influencing walkability and development practices influenced by the automobile, we thus attempted to determine how development practices have encouraged and facilitated reliance upon bus and car transportation modes to and from public schools.

Results:

Adams County

In each of Adams County's school districts, less than 6% of residential parcels in the district fall within walkable distance of the school for elementary school students. In addition, less than 15% of parcels are within one mile of the nearest in-district elementary school. For elementary school students, Gettysburg Area School District and Conewago Valley School District are the most walkable, with 6% of parcels falling within one half-mile of an elementary school (Figure 5). For middle school students the maximum walkability is 9%, which is present in Littlestown Area School District (Figure 6). Littlestown also contains the maximum walkability for high school students, at 11% (Figure 7).

Due to seemingly arbitrary district boundary lines, some students fall outside of even the five-mile buffer of their own elementary school, even though they may fall within the two mile buffer for an elementary school in a different district (Figure 2). Such boundaries are detrimental to the accessibility of schools by foot.

Conewago Valley School District is the only district in Adams County that keeps records of not only the number of students who choose not to utilize a school bus, but of the number of students who are actually registered to walk to and from school. Of all Conewago students, only 0.4% are registered to walk to school; in terms of the actual school population of more than 2,000 students, this figure represents just sixteen students (Figure 8).

Frederick County

Within all of the Frederick County Public School District, 25% of all residential parcels fall within a walkable distance from elementary schools (Figure 9). Fifteen percent of all residential parcels fall within a walkable distance from middle schools (Figure 10), and 30% of all residential parcels fall within a walkable distance from high schools (Figure 11).

In the Frederick County Public School District, more than 50% of elementary school students are registered for school provided transportation each day, as are roughly 75% of middle school students and about 85% of high school students (Table 5). It should be noted although a student may be registered to ride the bus, this registration does not necessarily mean that the student regularly does so; conversely, although a child may live within a walkable distance from his or her school of attendance, that student may not regularly walk to school. It should also be noted that the forms used by the district to record the various transportation types of its students include a section intended to record the frequency of private vehicle use as a mode of student transport; however, this section was not completed for any of the schools in the Frederick County Public School District.

Table 5. Student Bus Registration Forms for Frederick County Public School District (2013).

School Level	Total Number of Students (2013 School Year)	Number of Students Registered for Busing (2013 School Year)
Elementary	17,676	9,631
Middle	8,800	6,418
High	12,569	9,831

San Juan Unified School District

Within the San Juan Unified School District, fewer than 50% of residential parcels are located within a walkable distance of a public school within each level of education, for elementary, middle, high, and special education schools alike (Tables 6, 7, 8, 9). Forty-seven percent of residential parcels fall within a walkable distance from elementary schools (Figure 12), 20% of parcels fall within a walkable distance of middle schools (Figure 13), 39% of parcels are walkable to high schools (Figure 14), and only 4% of residential parcels are located within a walkable distance to special education schools (Figure 15). One hundred percent of all residential parcels fall within five miles of a public school for elementary, middle, high, and special education schools; thus, all residential parcels theoretically are within five miles of a public elementary, middle, high, and special education school. However, these results are complicated by the Open Enrollment policy utilized by SJUSD. Under this policy, students may live within a walkable distance of their neighborhood, or resident, school, yet in fact attend a school well beyond walkable proximity. Quantitative data for precisely how many students decide to attend establishments other than their home schools are kept by SJUSD; however, like data regarding how many students utilize the district-operated federally-mandated busing system, these data are designated only for district use and are not available for public knowledge.

In considering the entirety of Sacramento County, the same complications that students in Adams County face arise for many students in Sacramento County. The establishment of district boundaries complicates the issue of walkability and may lead to reliance on car or bus transport for students who could potentially walk to school, if the nearest school did not lie in a different district than their places of residence. Certain districts in Sacramento County seem to be designed in such a way as to deliberately impede walkability: Twin Rivers School District, for instance, is divided entirely in two sections by Robla School District (Figure 16). Such a policy for districting schools and separating them from the residential neighborhoods of the children who attend them only serves to distance the walkability of schools, as well as the efficacy of a school's role as a center of community interaction.

Table 6. Percentage of residential parcels within distances from elementary schools.

	First Class	Second Class	Third Class	Fourth Class	Fifth Class
Distance from Elementary Schools (mi)	0.5	1.0	2.0	5.0	10.0
Parcels within Distance (%)	47	91	99	100	100

Table 7. Percentage of residential parcels within distances from middle schools.

	First Class	Second Class	Third Class	Fourth Class	Fifth Class
Distance from Middle Schools (mi)	0.75	1.0	2.0	5.0	10.0
Parcels within Distance (%)	20	33	88	100	100

Table 8. Percentage of residential parcels within distances from high schools.

	First Class	Second Class	Third Class	Fourth Class	Fifth Class
Distance from High Schools (mi)	1.0	1.5	2.0	5.0	10.0
Parcels within Distance (%)	39	70	90	100	100

Table 9. Percentage of residential parcels within distances from special education schools.

	First Class	Second Class	Third Class	Fourth Class	Fifth Class
Distance from Special Education Schools (mi)	0.5	1.0	2.0	5.0	10.0
Parcels within Distance (%)	04	14	46	100	100

Discussion:

Our results suggest that, if distance is taken as the primary indicator of walkability, the establishment of schools today, in conjunction with the design of residential development, impedes walkability to and from school and encourages children to rely instead upon car and bus transportation. This conclusion is supported by the data collected in three different case-study locations, representing three different types of land use and development.

The increase in walkability for this school district, compared to Adams County, may be a direct result of the increase in population density and a differing land use pattern: while Adams County is primarily rural, Frederick County encompasses a small city, as well as suburban areas and some rural areas. The difference between walkability to and from public schools in rural Adams County, Pennsylvania, and urban San Juan Unified School District in Sacramento County, California, is striking. The average walkability of elementary schools in Adams County is a mere 4.3%, compared to 25% for Frederick County and 47% for San Juan Unified School District (Figure 17). That contrast continues in middle schools, with walkabilities of 5.1%, 15%,

and 20%, respectively, and high schools, with walkabilities of 5.3%, 30%, and 39%, respectively (Figure 18, 19). On the whole, therefore, urban SJUSD public schools represent an increase in walkability over both Adams County and Frederick County.

The percentage of residential parcels that fall within a walkable distance of special education schools in SJUSD is 4% (Table 9). Given that there are only three designated special education schools in the district, we would expect only a small percentage of residential parcels to exist within a walkable distance of these locations, so this statistic is not surprising. However, this percentage is roughly equivalent to the average frequency of walkable parcels for the entirety of Adams County elementary schools, even though we used the same distance classifications on the school distance types, which suggests an enormous discrepancy between the walkability of rural versus urban areas. Our results, moreover, are likely over-estimates of the actual walkability of these locations, since we ran our distance measures in terms of straight lines. Students, however, often cannot walk "as the crow flies," and must instead contend with street designs like cul-de-sacs that impede walkability.

Although our results do support our hypothesis that the regionalization of schools does decrease walkability to those schools for students who attend them, it is important to note that the locations utilized in this investigation are case studies, and as such the results of this study cannot be directly extrapolated to school systems within the United States, as a whole. The specific contexts of the schools districts within Adams County, Pennsylvania, Frederick County, Maryland, and Sacramento County, California, are unique to those locations, and thus the results of analysis of those locations must be considered within the circumstances of those specific contexts. That being said, however, the National Center for Safe Routes to School has also compiled historical data on the different transportation modes to and from school for

Kindergarten-8th grade students that we feel reflect our walkability results. National averages from the National Center for Safe Routes to School show that during the forty-year period between 1969 and 2009, home-to-school travel modes have almost completely switched, from 12% of students enrolled in Kindergarten through 8th grade using a family vehicle to get to school in 1969, to 45% using a family vehicle in 2009. Conversely, 48% of K-8th grade students walked or rode a bike to school in 1969, while in 2009, only 13% of students did so (Figure 20). School bus use has remained relatively constant, with 38% or students riding the school bus in 1969 and 39% riding the school bus in 2009 ("How Children Get to School" 2011: 4).

This survey also found that in 1969, 89% of these students living within one mile of a school regularly walked or bicycled to school. However, by 2009, only 35% of students in this age bracket utilized these transportation modes even once a week ("How Children Get to School" 2011: 2). Furthermore, the percentage of those students living less than one mile from school declined between 1995-2009. Bearing in mind that the National Center for Biking and Walking suggested that walkable distances of 0.5 miles and 0.75 miles for elementary and middle school students respectively, this decrease in residential locations close to schools itself suggests a decrease in school walkability as an impact of regionalized development and land use. The National Center for Safe Routes to School ultimately concluded that distance is a strongly-associated factor in determining how children get to and from school, with the percentage of children who walk to school being greater among those students who live nearer to schools ("How Children Get to School" 2011: 2).

Though we chose distance as the primary factor on which to base walkability within this investigation, many more factors affect student transportation choice than the distance between place of residence and location of schools. These factors include include: the presence or absence

of sidewalks and peripheral safe walking features such as crosswalks and low speed limit zones; the topography of the area; the safety of the surrounding neighborhoods; and the climate of the region. A study by the Centers for Disease Control and Prevention found that in 2004 distance was the leading barrier to active travel (61.5%), followed by traffic-related danger (30.4%), weather concerns (18.6%), danger resulting from crime (11.7%), and school mandates which prohibit students from walking or biking (6.0%). "Other" concerns (15.1%) also played a part in the formation of this trend (Martin et al. 2007: 98). Some of these "other" concerns may have arisen as a result of parental and student perceptions of neighborhoods and neighborhood safety, which are often closely associated with the decision of families to move to less dense regions that are primarily residential and are established at a distance from the boundaries of urban centers: in other words, the suburbs.

Loukaitou-Sideris (2006) argues that the built environment, in addition to socio-psychological factors and socio-demographic behavior, is influential in the formation of perceived risks, which have the potential to constrain behavior. The built environments of suburban neighborhoods, then, which are auto-centric and are designed in ways that tend to impede walkability -- such as in cul de sacs -- have the power to both physically and psychologically influence whether or not children are able to walk to school and, if they are able, whether or not they will choose to walk to school. Timperio et al. (2003) found that the ways children perceive their local neighborhoods may be an important factor in influencing the physical activity of those children, and that such perceptions may be influenced by parental perceptions of those same environments. When parental perceptions of danger regarding walking, generally associated with the number of roads children must cross in order to reach

their destination, increased, the likelihood of those parents' children walking or bicycling was lower.

School districting and policies are additional factors that often serve to impede walkability to school for children. As we saw in our case study locations, school districts may be established with physical boundaries that are oddly-shaped, abruptly truncated, and even completely separated from other portions of the district. This means that students living on the periphery of school districts who might live near and be able to walk to a public school are restricted from doing so by their inclusion within a different district, and instead forced to rely upon other forms of transportation to attend classes each day. School transportation policy also may impede walkability: for instance, although the National Center for Bicycling and Walking establishes national standards for how far a child can be expected to walk to school depending his or her age, Pennsylvania Public School Code of 1949 allows a school district to ask a child, regardless of age, to walk up to a mile and a half to a bus stop. The mile and a half is measured by public roads and does not include any private lane or walkway of the child's residence.

In addition to the increasingly auto-driven design of our towns, cities, and residential areas as well as the decreasing frequency of daily practices and social norms that promote walking, increasing economic upward mobility is a factor that may be contributing to an increased reliance on private vehicle transportation to and from schools. Greater and more accessible private wealth within American families allows more teenagers of driving age eligible to own or use private automobiles to travel to school, rather than walking. This increased access is compounded by the perception of car-owning and car-driving youth in American popular culture, contributing to a perception within the media of driving as "cool" and influential, making walking a less-desirable socio-cultural alternative. The centrality of the automobile

within our society, then -- even with regards to traveling to and from public school -- is not only a physical factor resulting from the infrastructure of our development patterns and our interactions with the natural environment, but also a social and psychological determinant that is influenced by popular culture and social norms, particularly since the auto-centric culture of purely residential areas is self-perpetuating.

This reflection of our reliance on the automobile visible within these previous studies is also present in our investigation, particularly in the case of Conewago Valley School District. Despite the fact that all schools within Conewago Valley School District represent a walkability of between 5-7%, only 0.4% of Conewago's students are registered as walkers. It is important to note that registration as a walker does not preclude students from being driven to school by a parent or driving themselves. Even more striking is the fact that Conewago Valley School District is the only system for which we can make this comparison, as the other school systems analyzed within this study do not keep records of the number of students walking to school.

This lack of recorded data represents an important insight, looking beyond the scope of this project. We feel that more quantitative, holistic data of all student modes of transportation must be regularly collected within all school districts, both for the types of transportation that students register to use, and those which they generally use in practice. The absence of concrete, quantitative data pertaining to the number of students who walk itself speaks to the auto-centric mentality of our present society. Numbers of students who walk are frequently not recorded because they are so minimal, or because walking is conceptually interchangeable with being driven or driving oneself in a private automobile; that is to say, schools regard student transportation in terms of binaries: bused, or not-bused. By falling within the category of "not-bused," students who walk or use a private vehicle to get to and from school are presumed to fall

beyond the scope of a school district's responsibility during their home-to-school travel. This designation thus supercedes, at least in terms of data collection, the distinctions between walking and driving, placing less emphasis on walkability as an important aspect of school and city design and planning.

The choice of walking versus using a car or bus to get to school has wide-ranging impacts. Studies have shown that children who are able to walk to school typically have fewer health problems, especially those brought on by excessive weight (Brownson and Boehmer 2005). Children who walk to school rather than ride in a car or bus are also more likely to become engaged in their natural environment. Recording transportation data is thus important in order to accurately understand the impacts that our decisions regarding residential and town planning, school zoning, and auto-centric design are having upon our environment, our health, and our communities. Furthermore, attempts to change present trends of walkability can never truly be judged to be successful or ineffective unless the impacts of the current patterns of transportation use are not first understood.

Conclusion:

Schools track how many children get to school by a method other than the school bus, but few differentiate between being driven and walking. With the increased recognition that infrastructure design, transportation modes, and both human and environmental health are all closely linked, it is important to encourage school systems to begin tracking students' chosen modes of transportation to and from school. With the data currently available, we can determine who could potentially walk to school, but it is impossible for us to know who actually does walk to school on a regional level. What our results do achieve, however, is to provide a clearer understanding of the kinds of data that are currently available for those interested in learning

more about how built environments and development influence walkability within our communities, and what kinds of questions can be answered based on those available data.

As we were conducting this study, we found that school districts simply do not keep data about historic transportation modes, or the number of their students who walk to school on a regular basis. The very fact that schools do not keep these data shows how little we as a society value and rely upon walking as a mode of transportation. However, we feel that there are multiple health, environmental, and social, interactive benefits that would accrue if students walked to school -- and within their communities -- and which are impacted by development and land use practices. Therefore, we suggest that school districts keep rigorous and standardized transportation use data in order to help understand the social and environmental impacts that our development practices are having across different geographic regions, school district types, and patterns of land use and development, and to improve them in the future. Moving forward, we would be interested in constructing more comprehensively quantitative analyses of the relationships between school location, residential infrastructure planning, and transportation use, and in understanding how these factors impact environmental quality, the health of children, and the quality of children's engagement with the natural world.

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Appendix

Figure 1. Map of Historical Public School Establishment in Adams County, Pennsylvania.

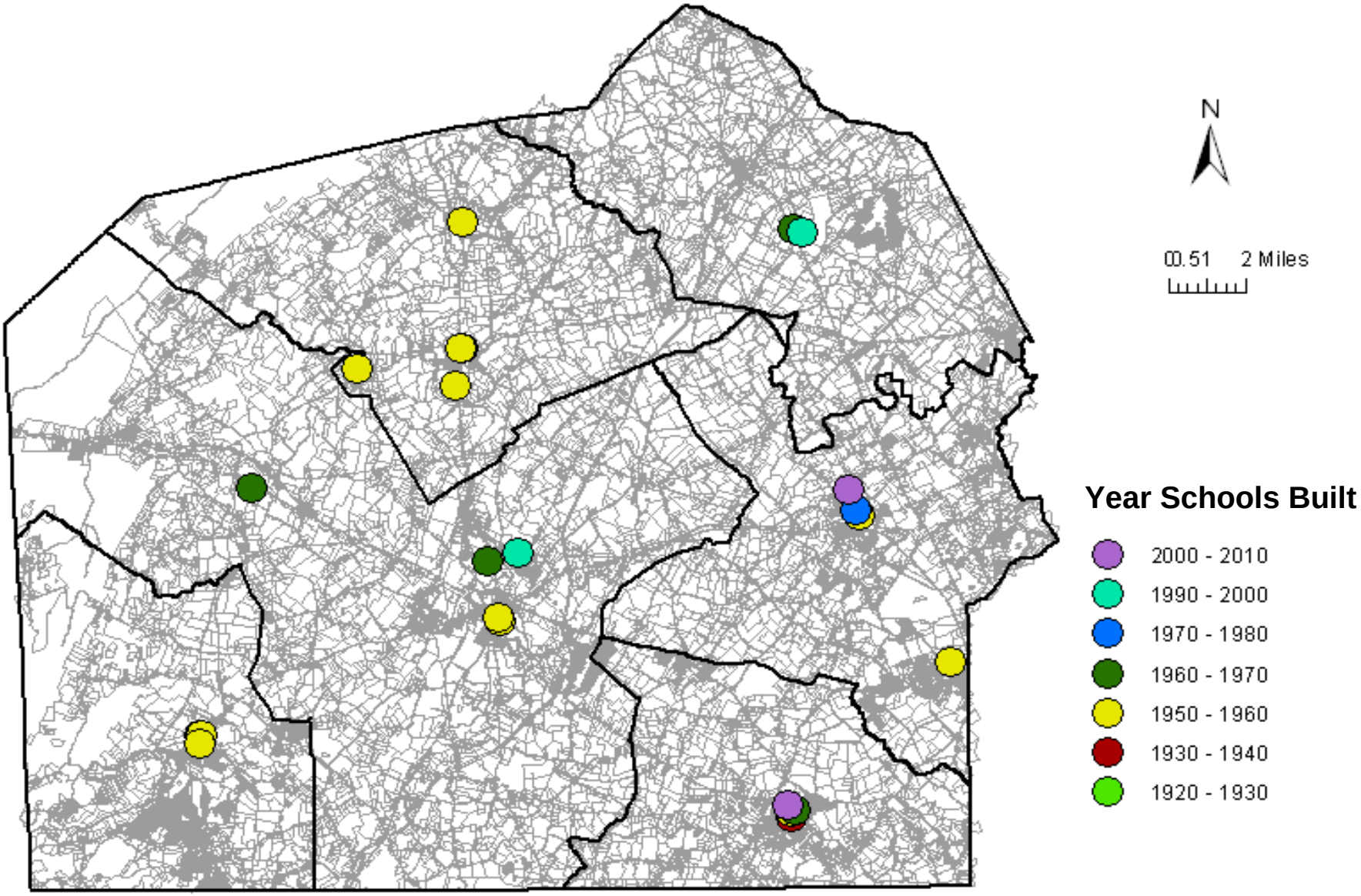

Figure 2. Map showing the abnormally-shaped and discontinuous school district boundaries in Adams County, Pennsylvania.

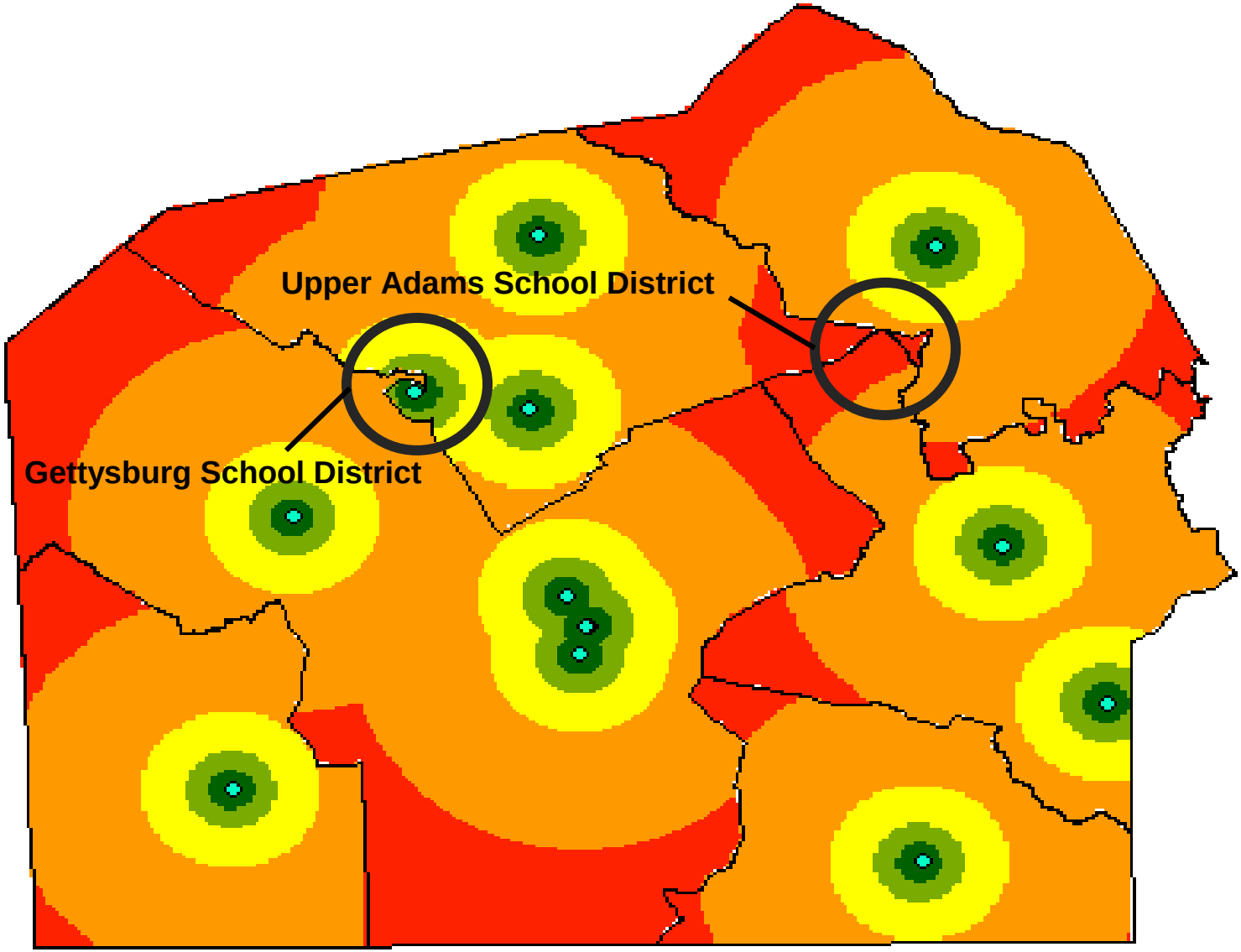

Figure 3. Map of Historical Public School Establishment in Frederick County, Maryland.

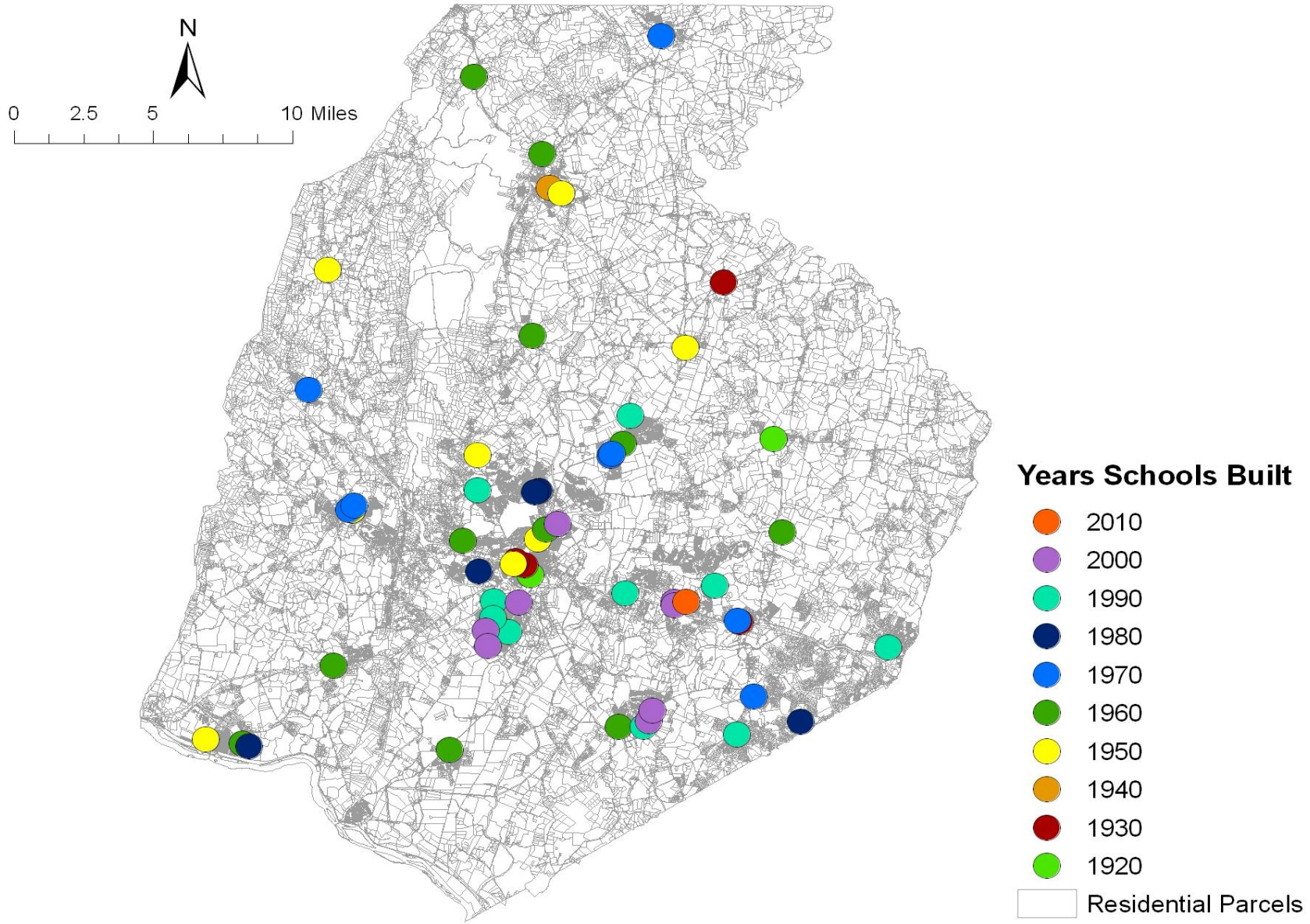

Figure 4. Map of Historical Public School Establishment in San Juan Unified School District, California.

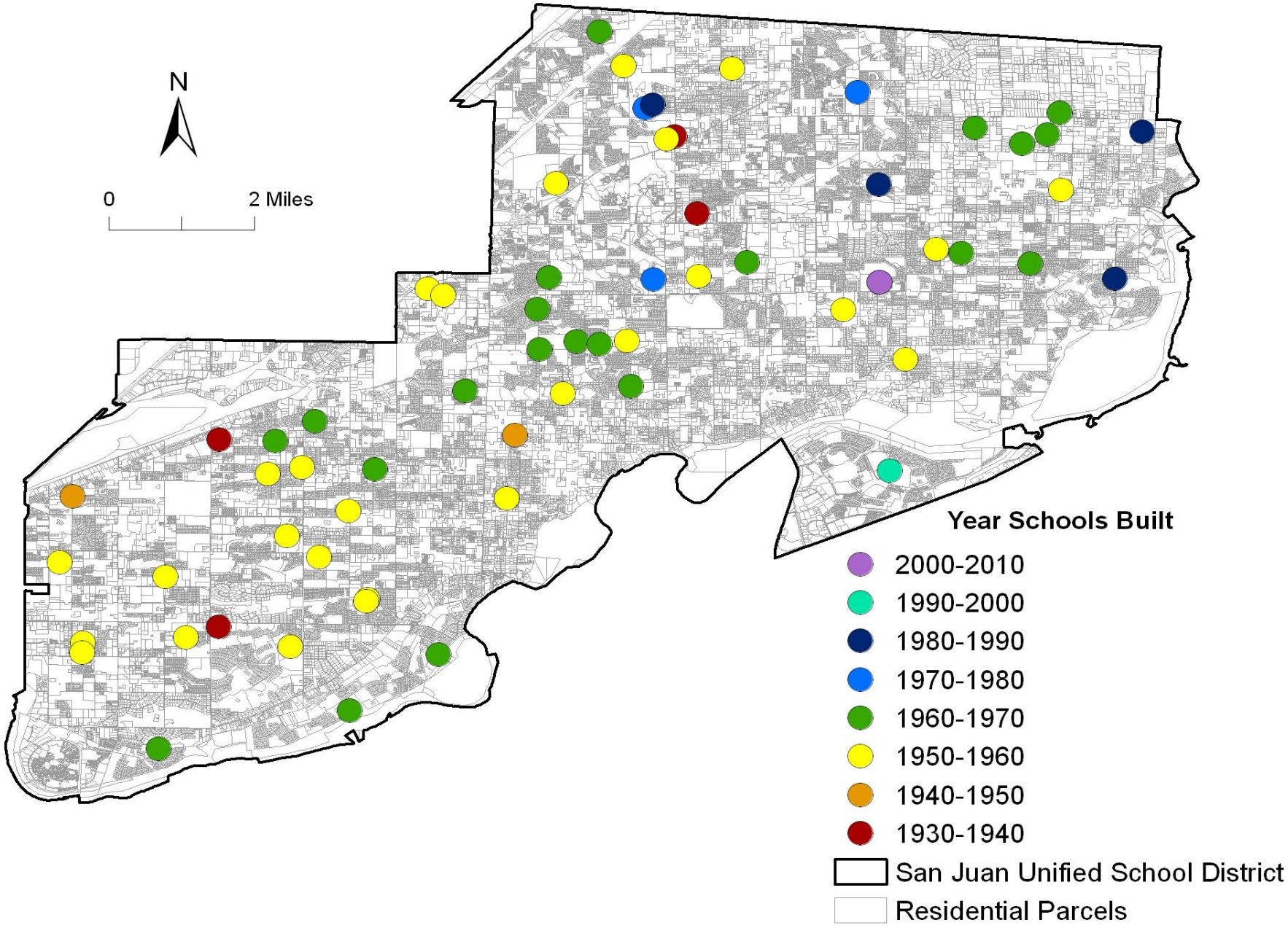

Figure 5. Map of Walkable Distances for Elementary Schools in Adams County, Pennsylvania.

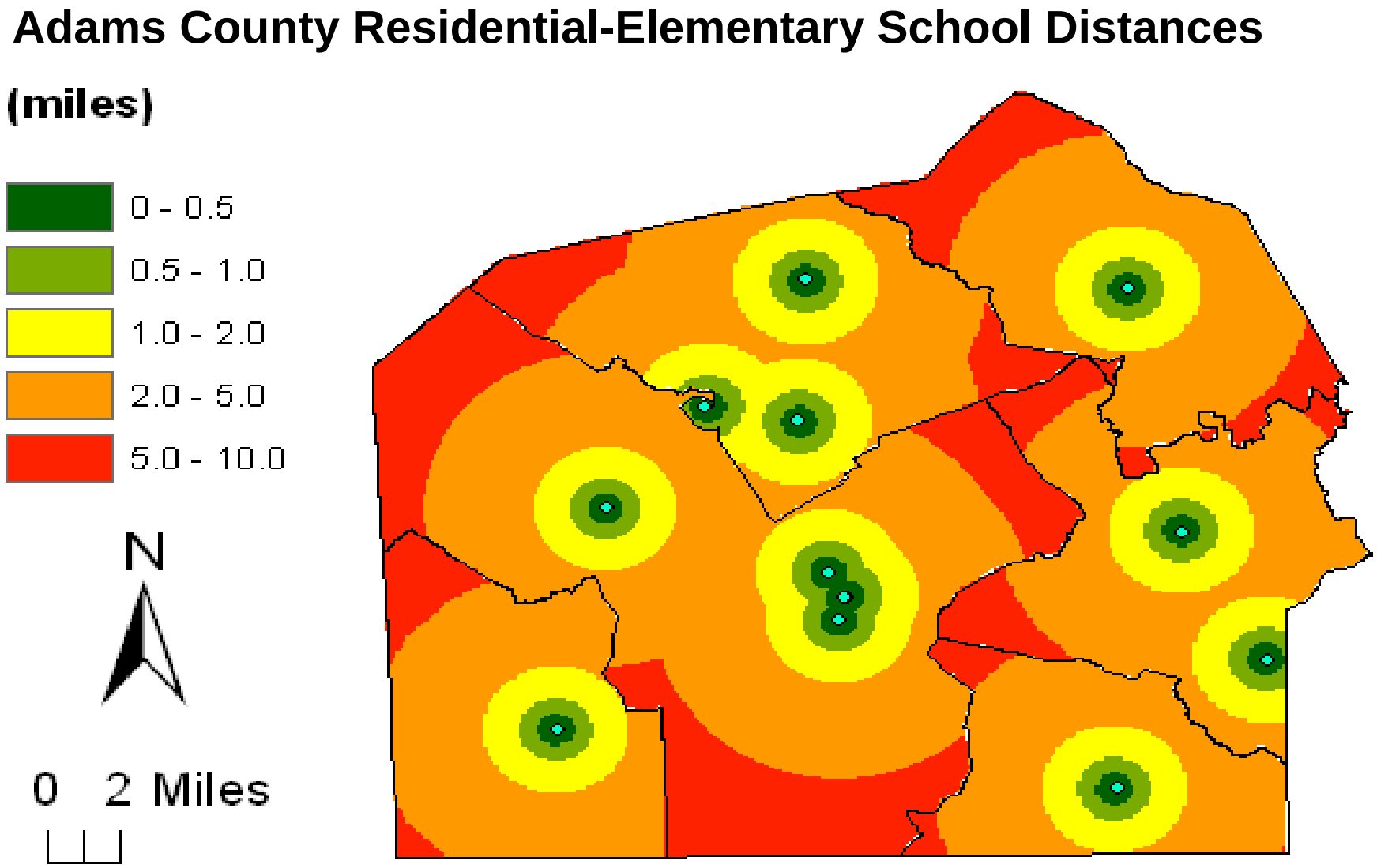

Figure 6. Map of Walkable Distances for Middle Schools in Adams County, Pennsylvania.

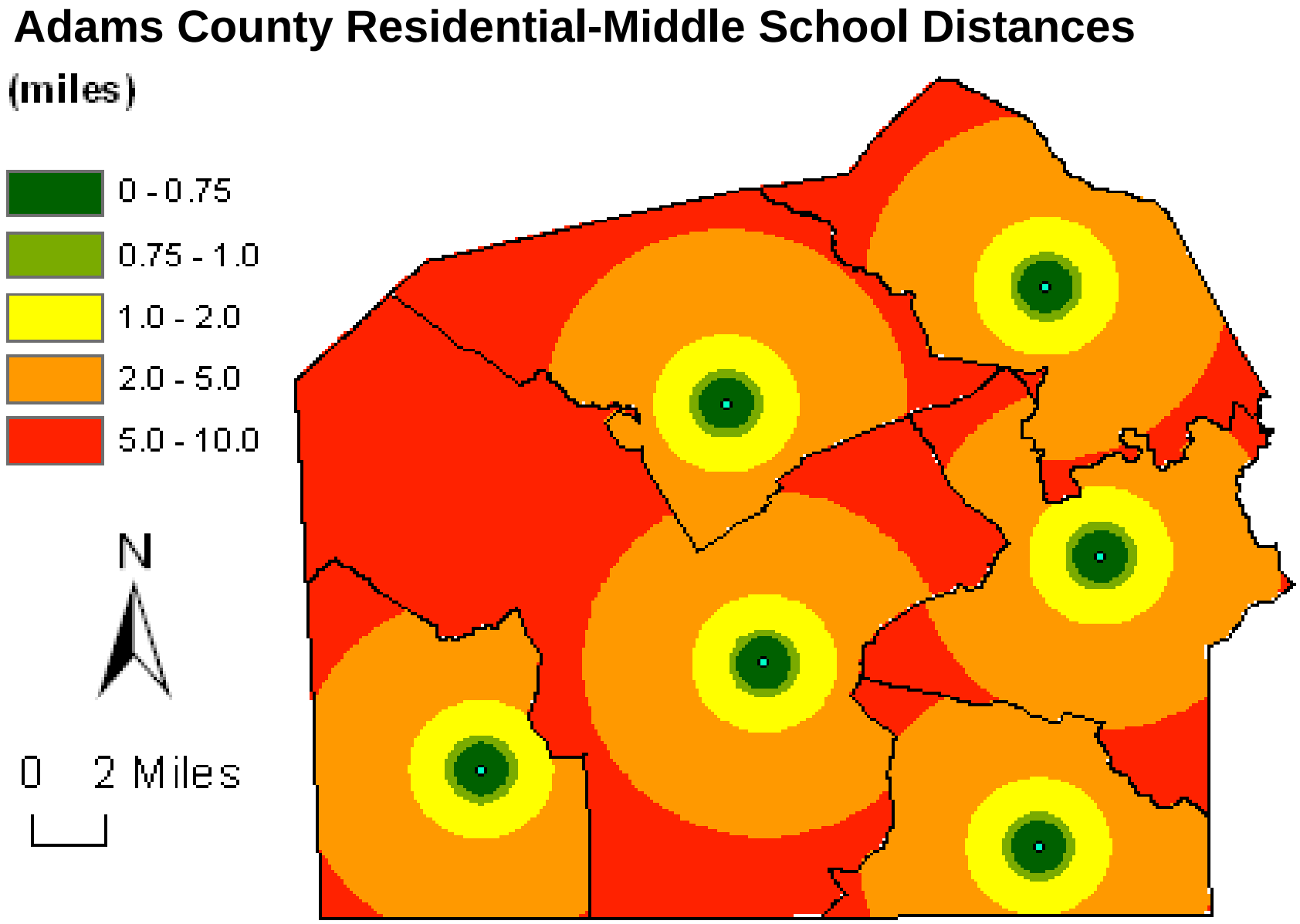

Figure 7. Map of Walkable Distances for High Schools in Adams County, Pennsylvania.

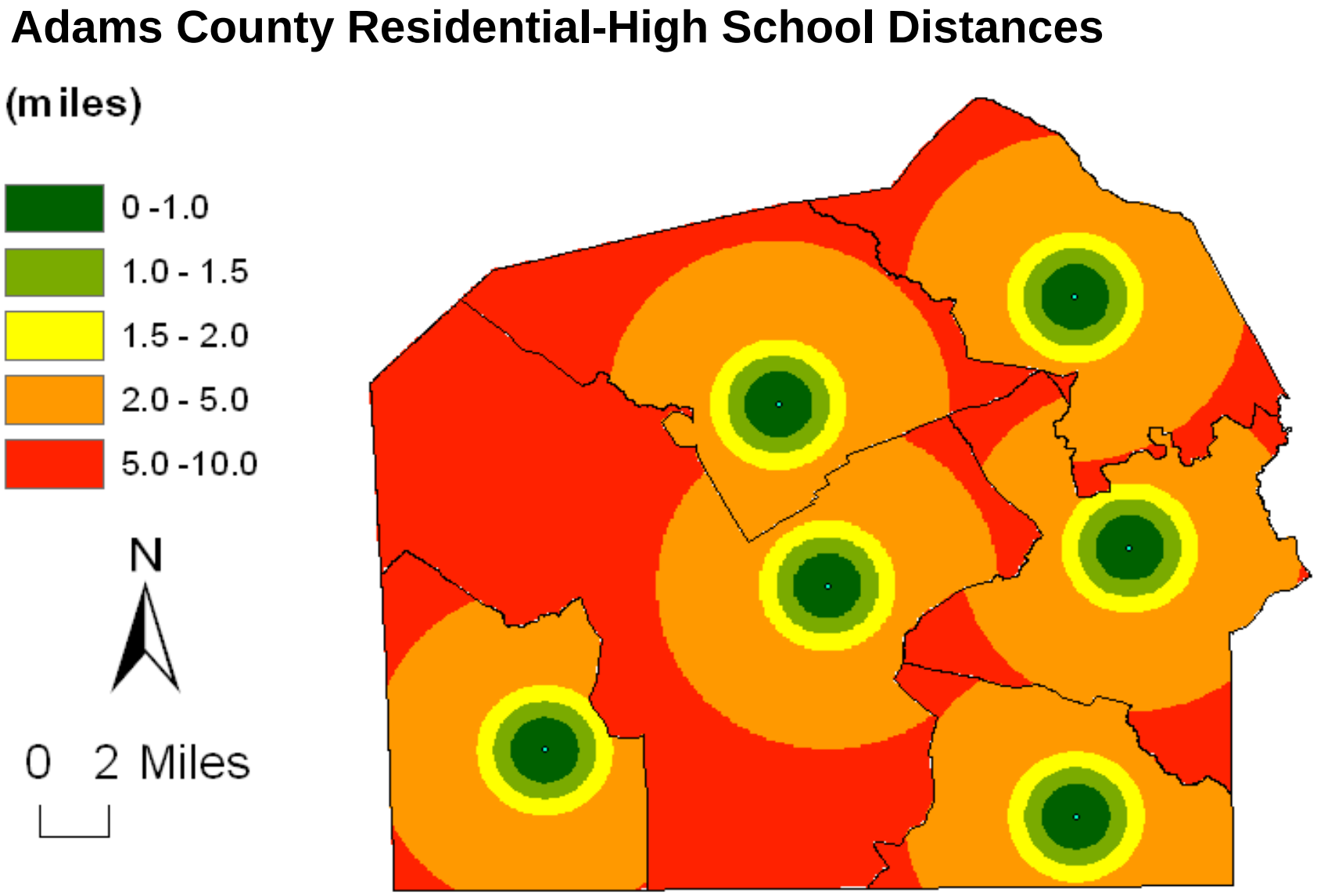

Figure 8. Kindergarten-12th Grade Student Transportation Modes for Conewago Valley School District in Adams County, Pennsylvania.

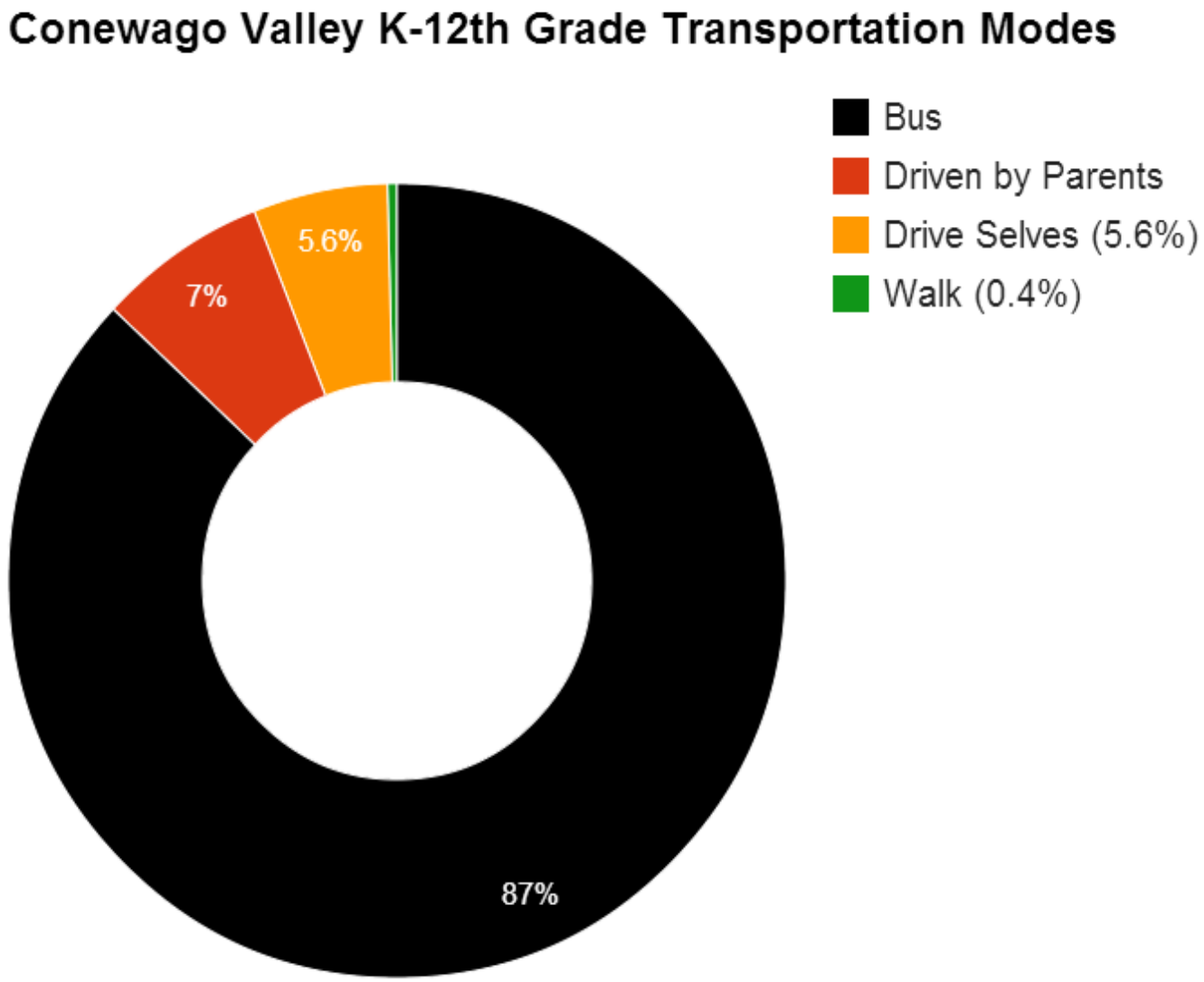

Figure 9. Map of Walkable Distances for Elementary Schools in Frederick County Public School District, Maryland.

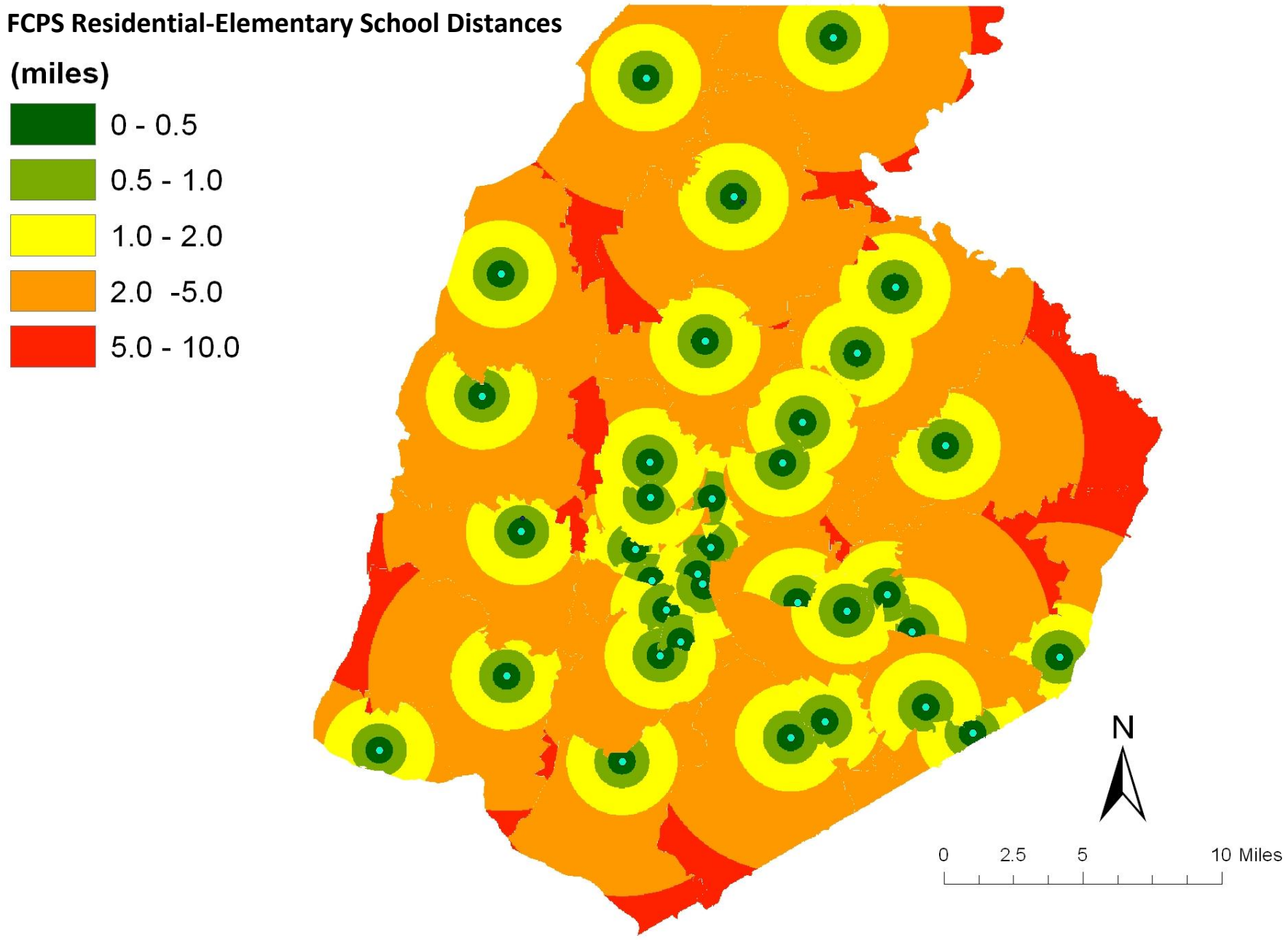

Figure 10. Map of Walkable Distances for Middle Schools in Frederick County Public School District, Maryland.

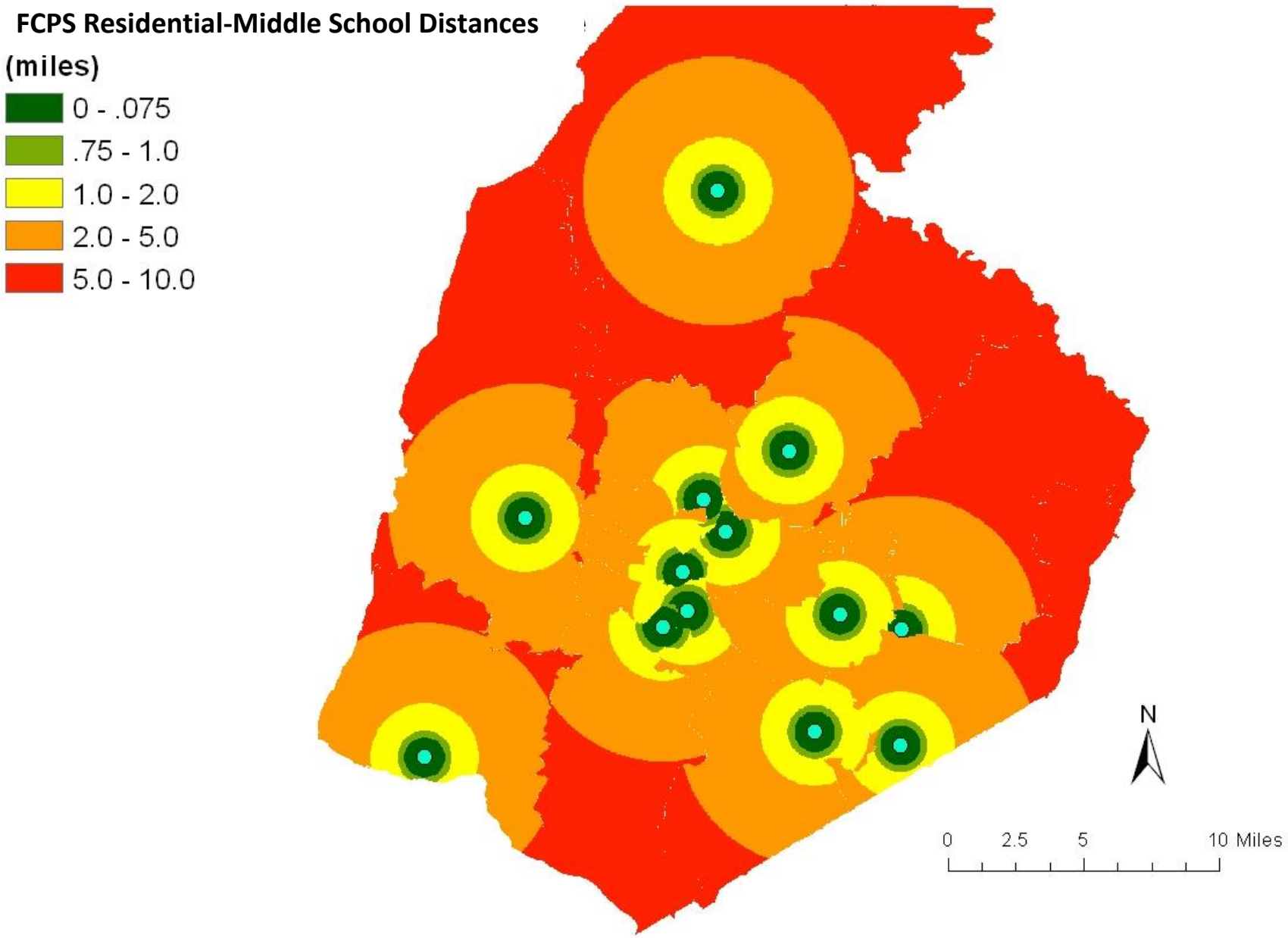

Figure 11. Map of Walkable Distances for High Schools in Frederick County Public School District, Maryland.

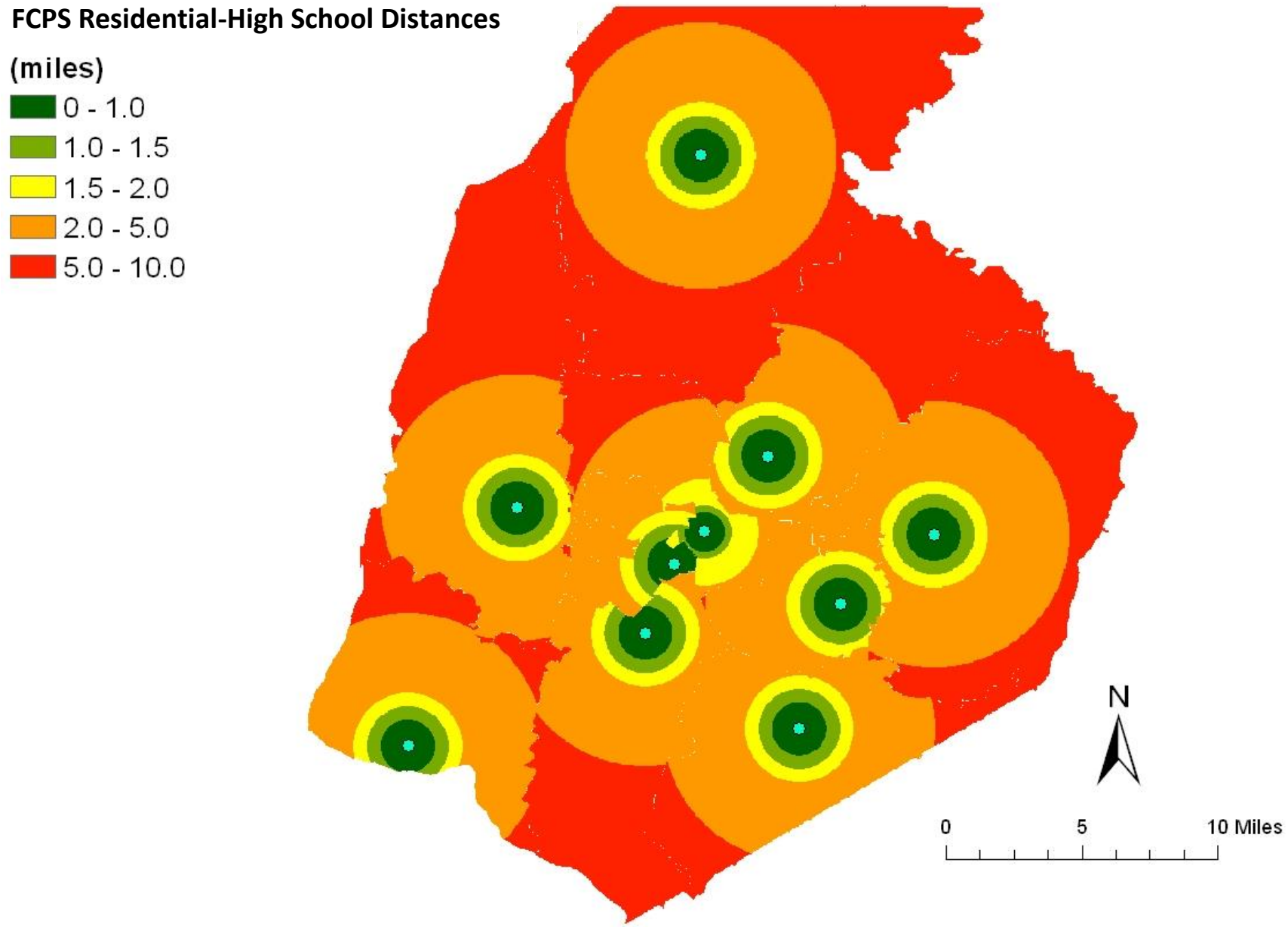

Figure 12. Map of Walkable Distances for Elementary Schools in San Juan Unified School District, California.

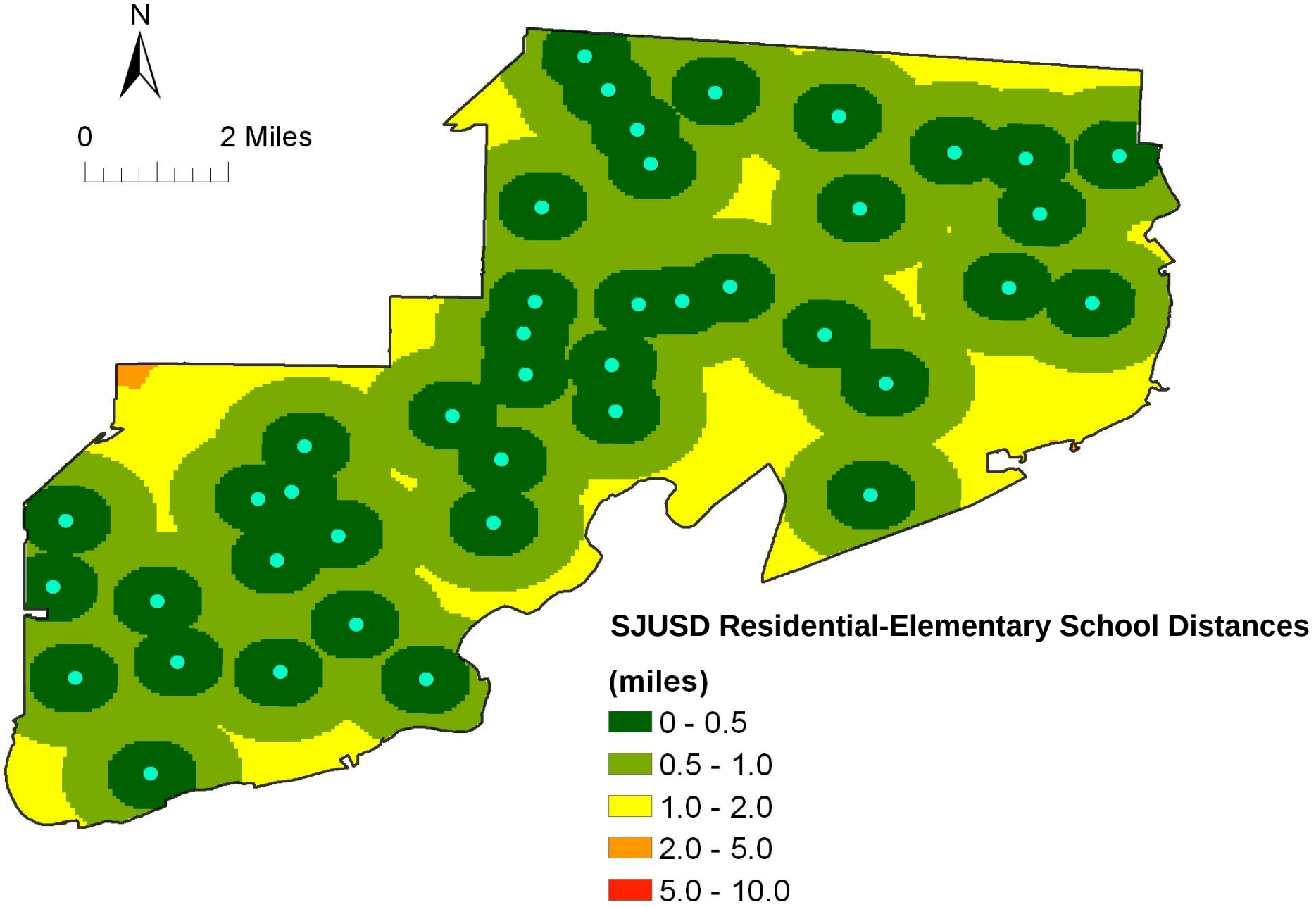

Figure 13. Map of Walkable Distances for Middle Schools in San Juan Unified School District, California.

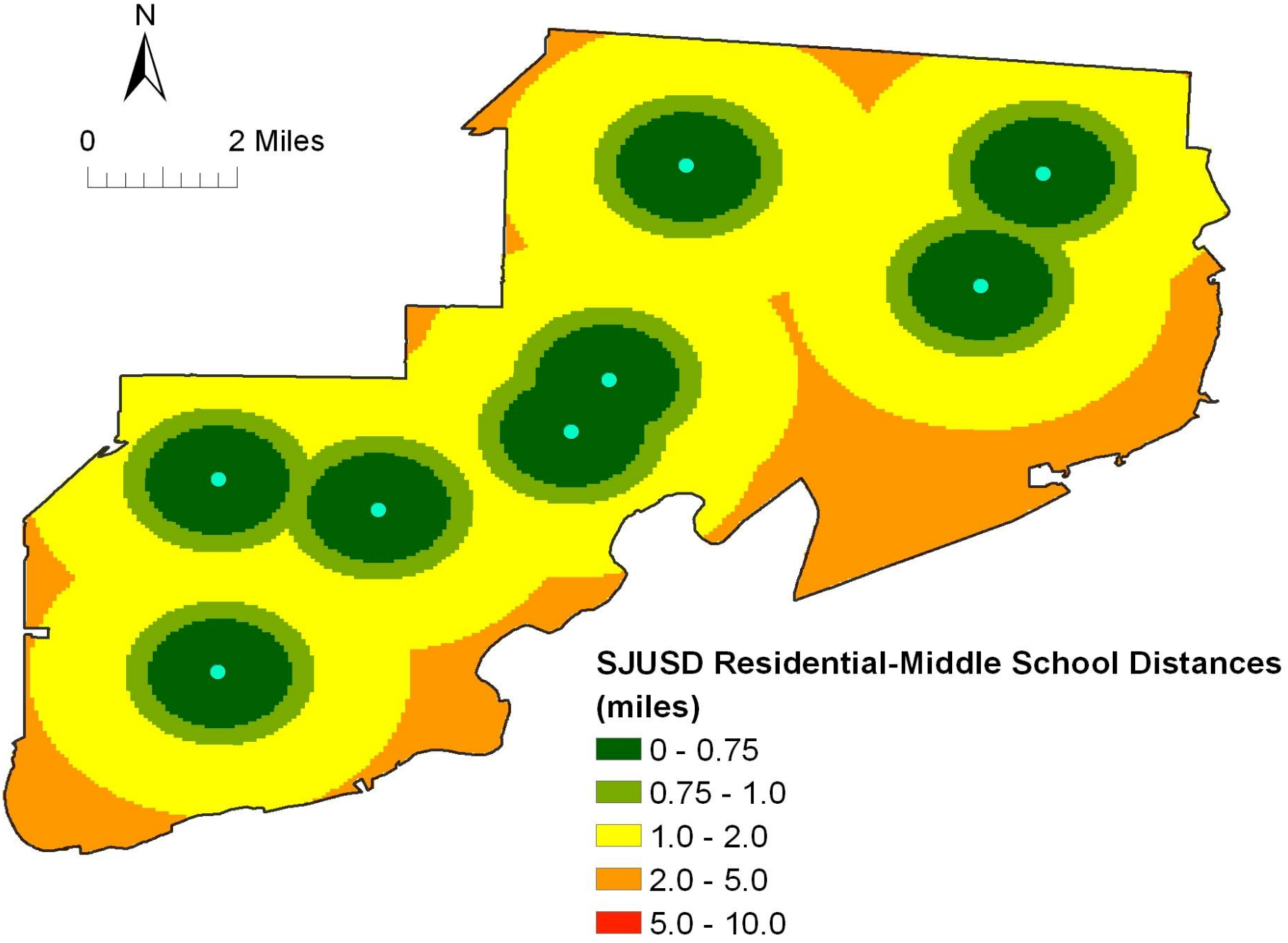

Figure 14. Map of Walkable Distances for High Schools in San Juan Unified School District, California.

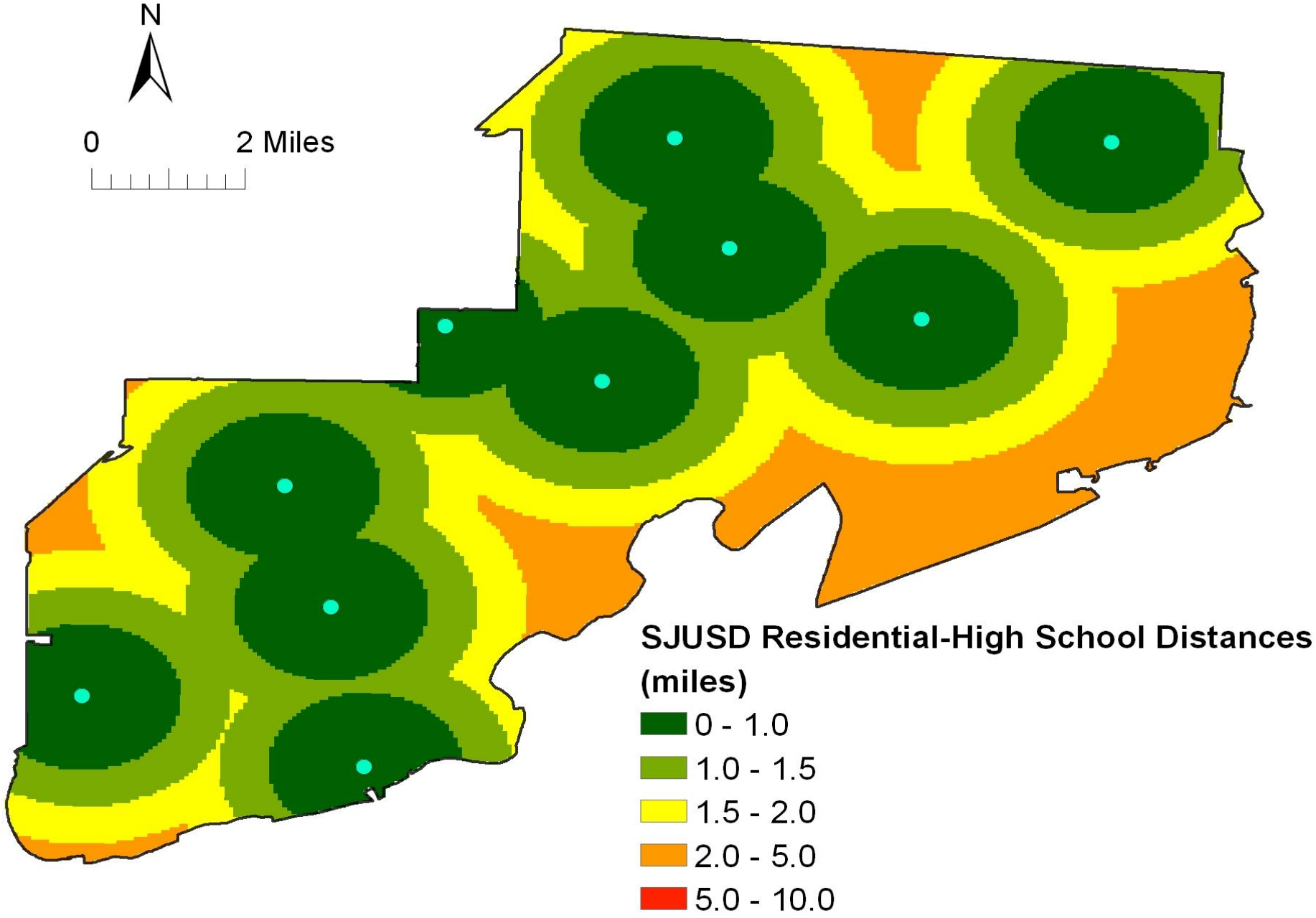

Figure 15. Map of Walkable Distances for Special Education Schools in San Juan Unified School District, California.

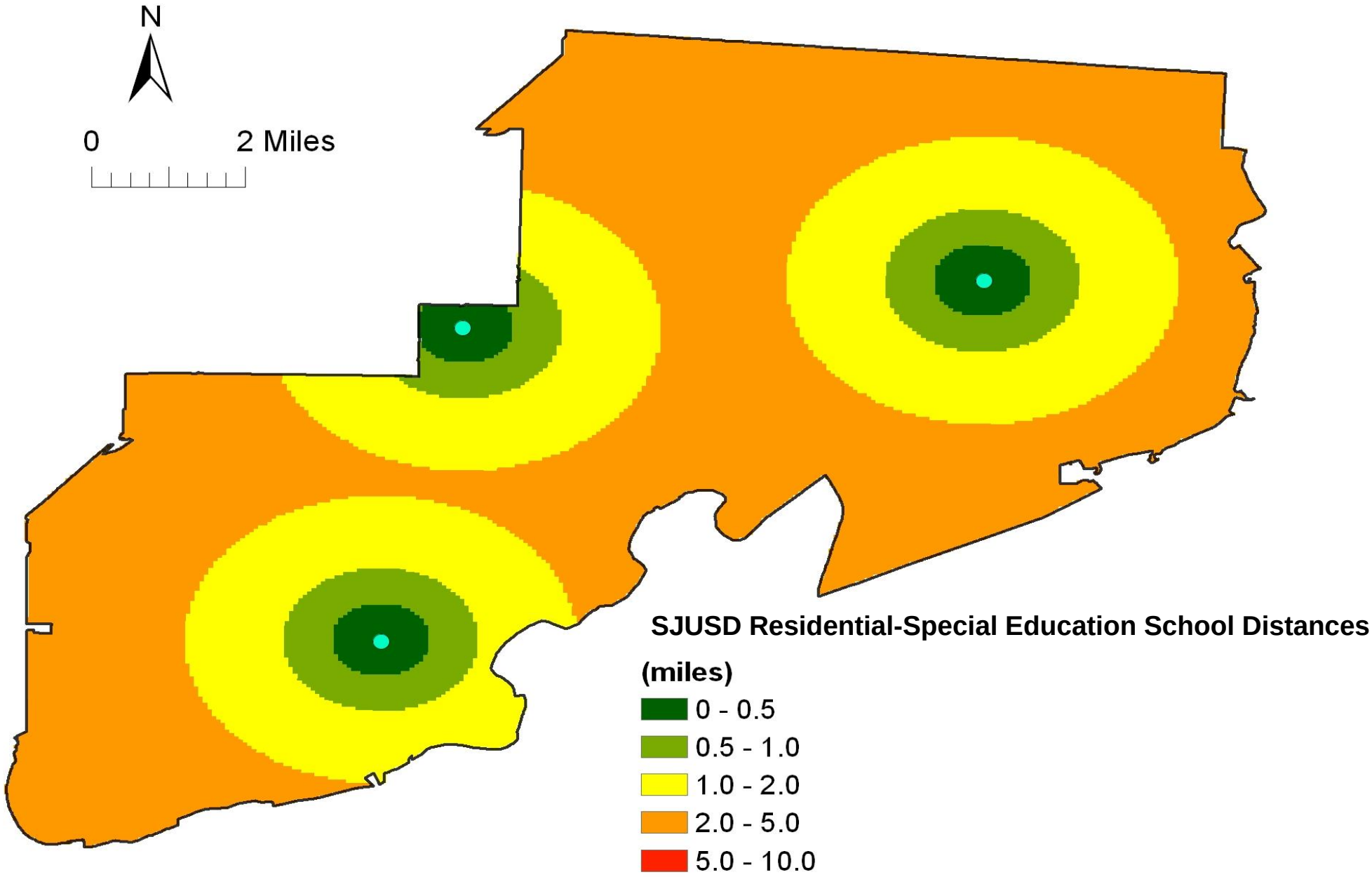

Figure 16. Map of Public Schools and School Districts in Sacramento County, California.

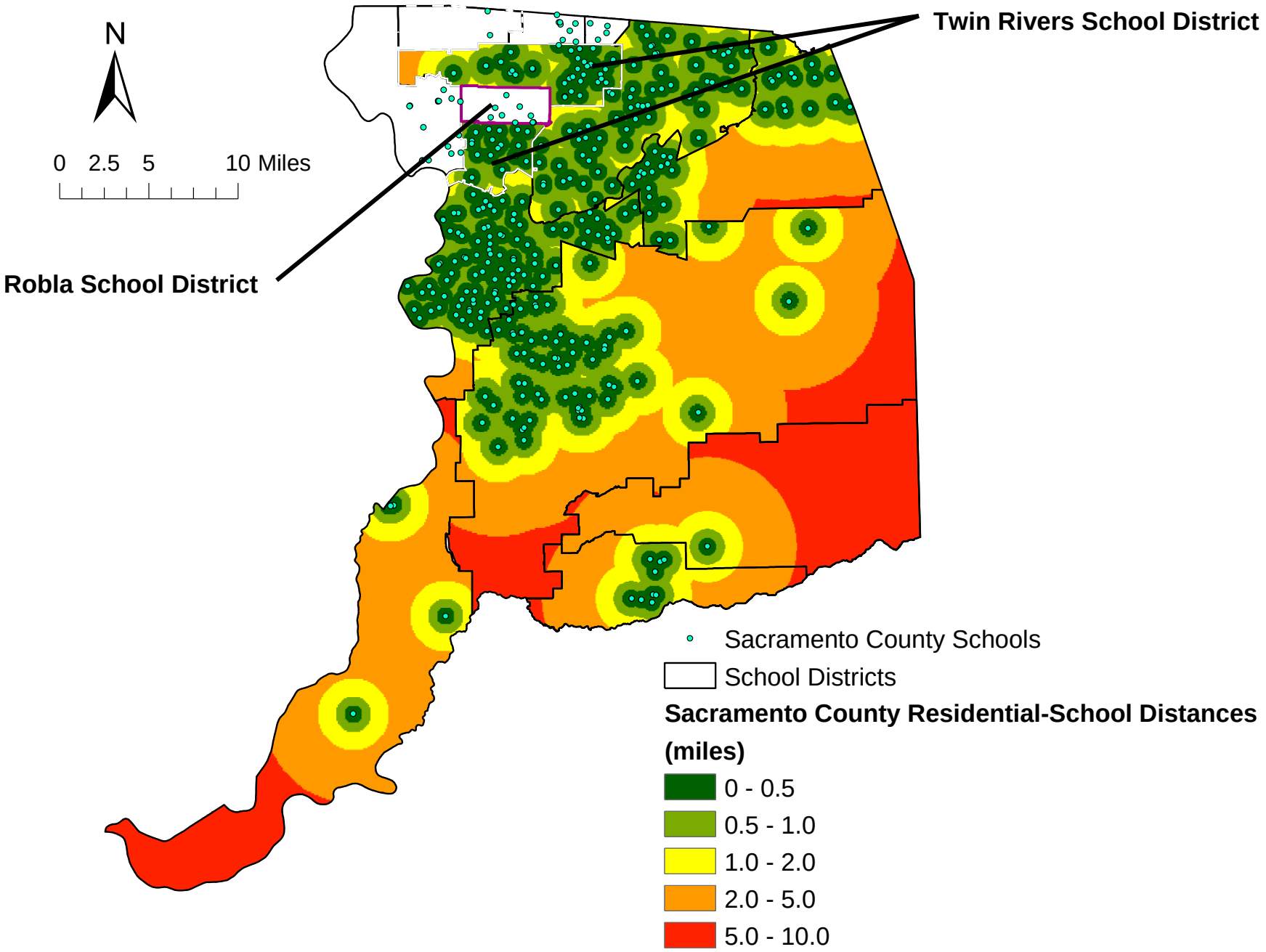

Figure 17. Comparison of Walkability of Elementary Schools by District.

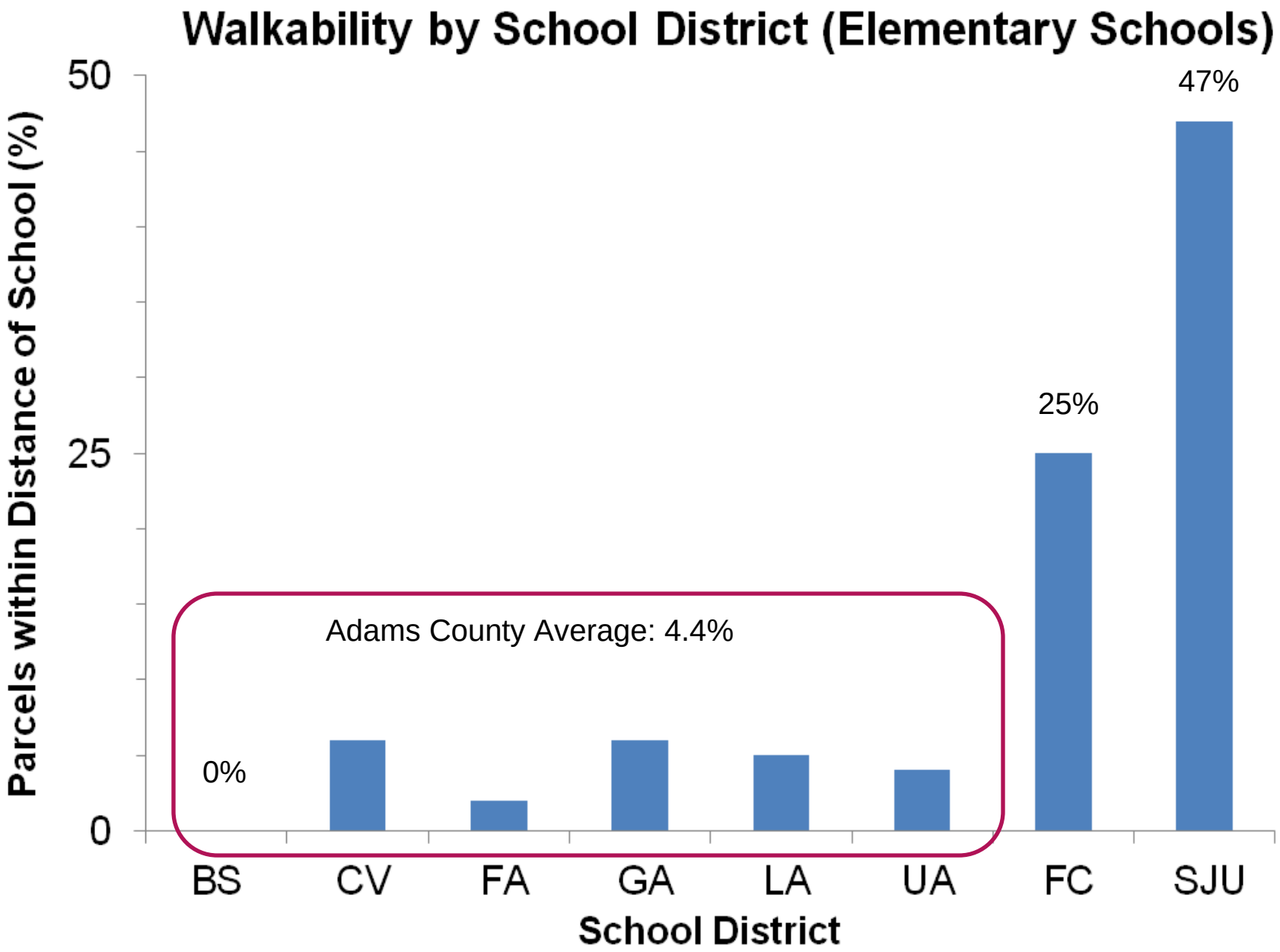

Figure 18. Comparison of Walkability of Middle Schools by District.

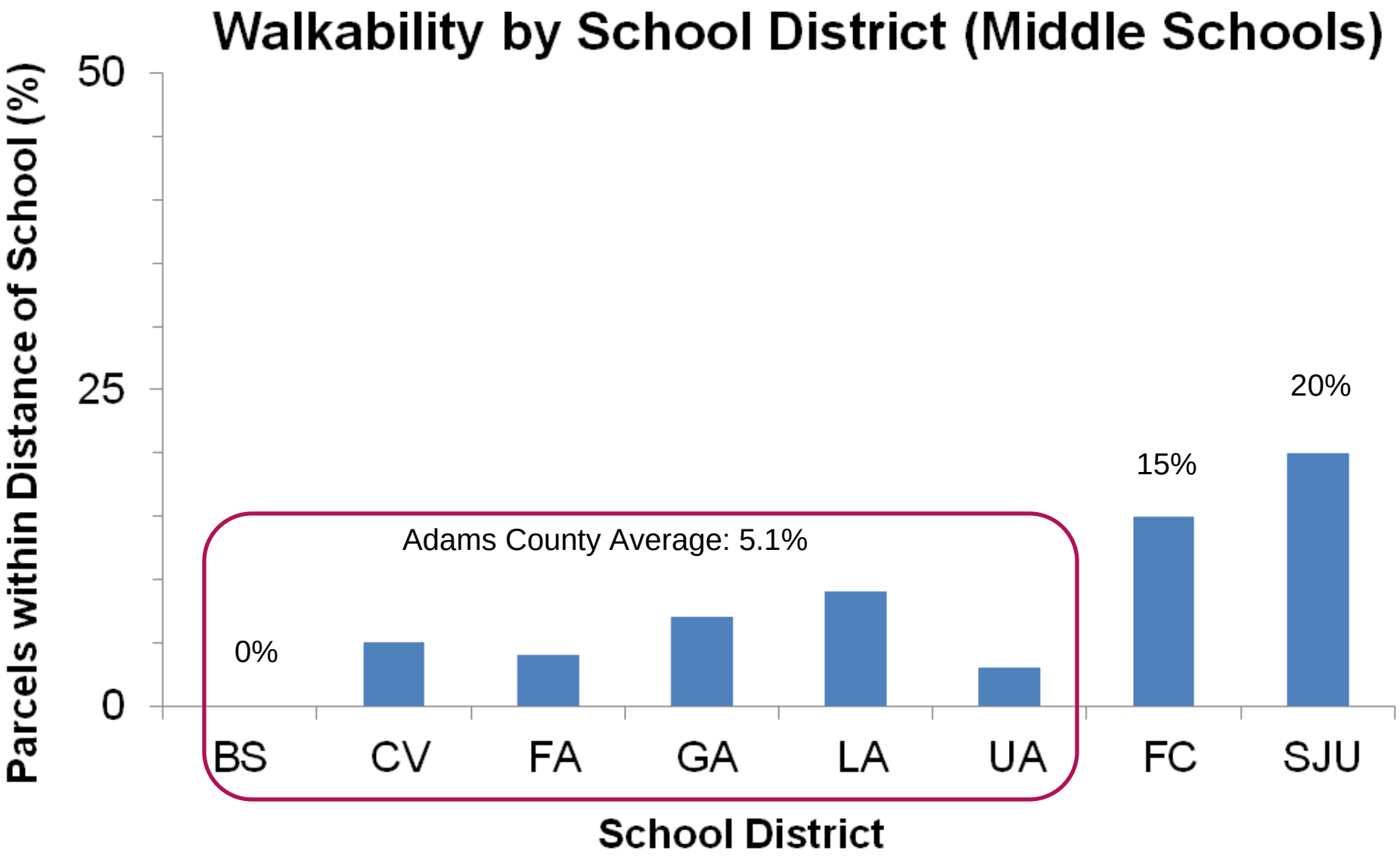

Figure 19. Comparison of Walkability of High Schools by District.

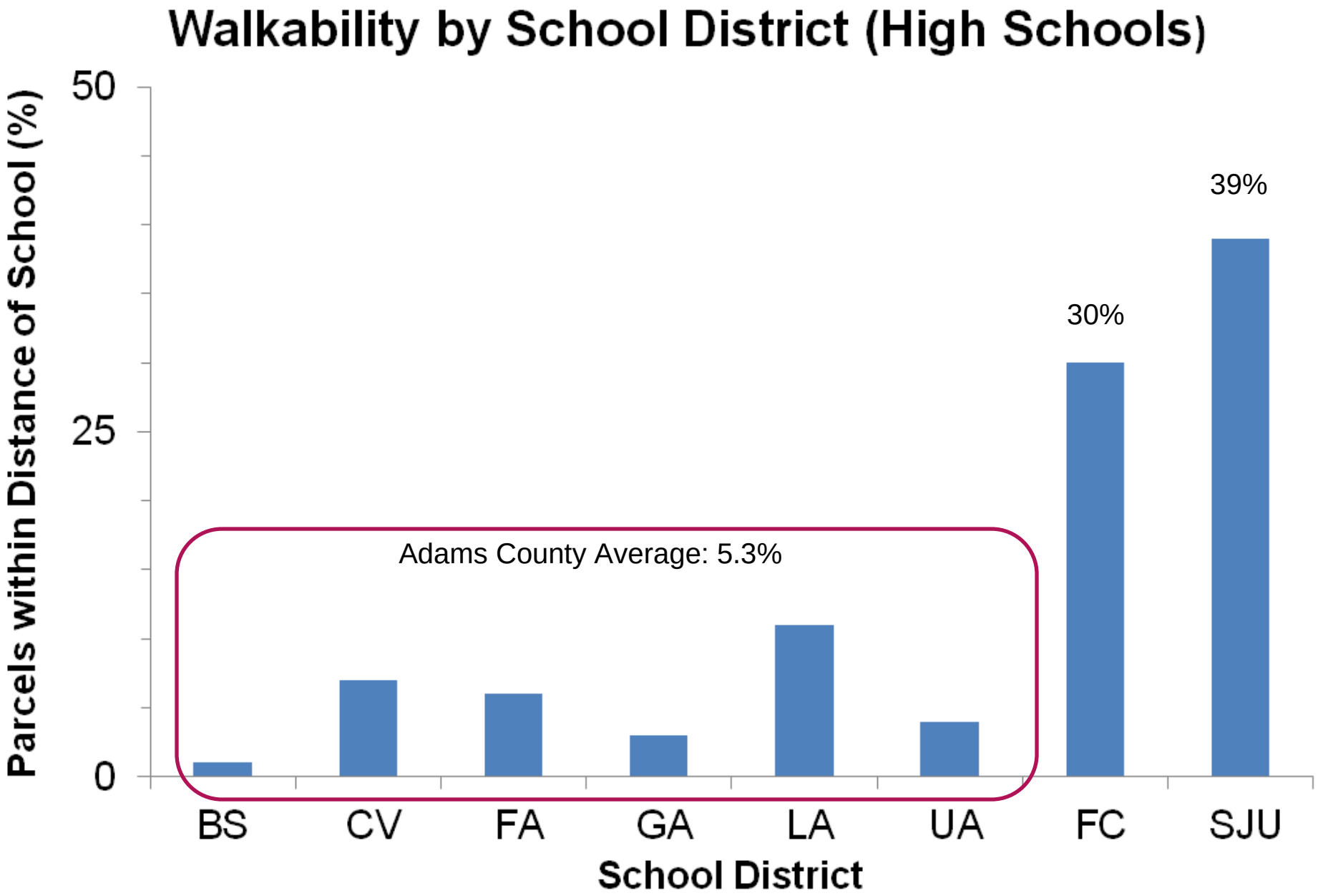

Figure 20. 1969-2009 Transportation Modes for Kindergarten-8th Grade Students.