

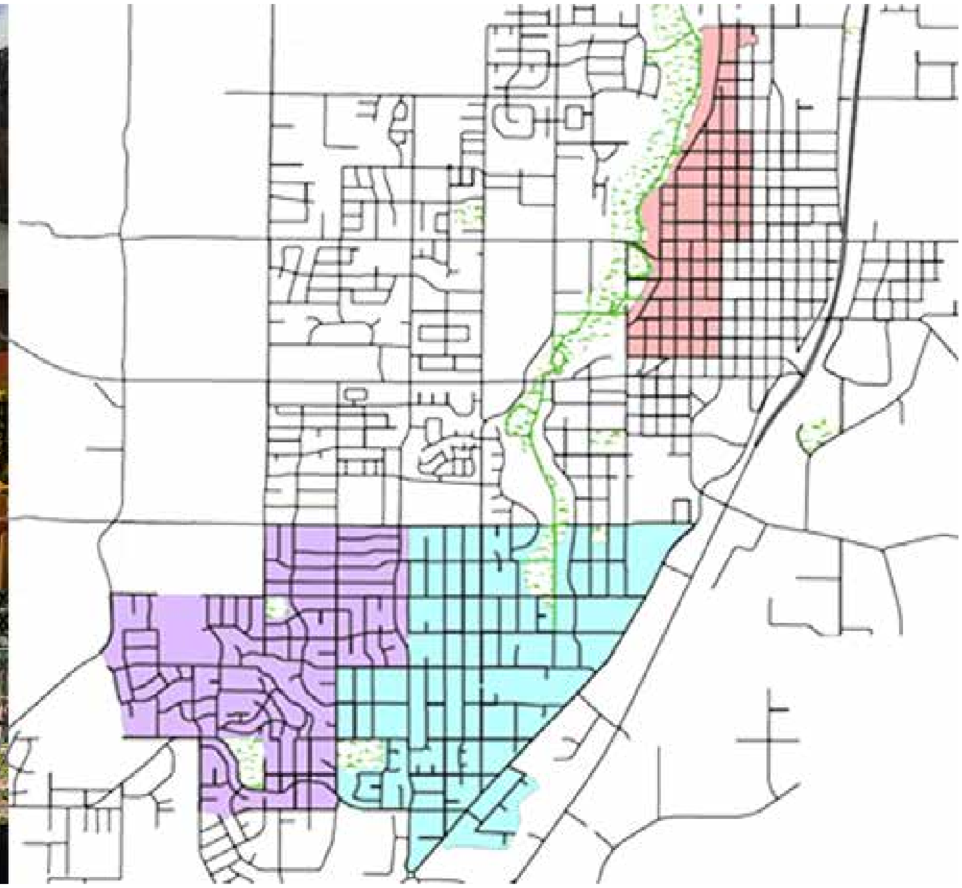

GIS Analysis of Redmond's Great Neighborhood Principles

Spring 2016 • Planning, Public Policy, and Management

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UNIVERSITY OF OREGON

SCI
Sustainable Cities Initiative

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Deborah McMahon, Principal Planner, City of Redmond

About SCI

The Sustainable Cities Initiative (SCI) is a cross-disciplinary organization at the University of Oregon that promotes education, service, public outreach, and research on the design and development of sustainable cities. We are redefining higher education for the public good and catalyzing community change toward sustainability. Our work addresses sustainability at multiple scales and emerges from the conviction that creating the sustainable city cannot happen within any single discipline. SCI is grounded in cross-disciplinary engagement as the key strategy for improving community sustainability. Our work connects student energy, faculty experience, and community needs to produce innovative, tangible solutions for the creation of a sustainable society.

About SCYP

The Sustainable City Year Program (SCYP) is a year-long partnership between SCI and one city in Oregon, in which students and faculty in courses from across the university collaborate with the partner city on sustainability and livability projects. SCYP faculty and students work in collaboration with staff from the partner city through a variety of studio projects and service-learning courses to provide students with real-world projects to investigate. Students bring energy, enthusiasm, and innovative approaches to difficult, persistent problems. SCYP's primary value derives from collaborations resulting in on-the-ground impact and expanded conversations for a community ready to transition to a more sustainable and livable future.

SCI Directors and Staff

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About Redmond, Oregon

Redmond, located in Deschutes County on the eastern side of Oregon's Cascade Range, has a population of 27,427 and is one of Oregon's fastest growing cities. The City's administration consists of an elected mayor and city council who appoint a City Manager. A number of Citizen Advisory Groups advise the City Manager, mayor, and city council.

From its inception, Redmond has had its eyes set firmly on the future. Redmond was initially founded in 1905 in anticipation of a canal irrigation project and proposed railway line. Redmond is on the western side of the High Desert Plateau and on the eastern edge of the Cascade mountain range. Redmond lies in the geographic heart of Oregon. Redmond focuses on its natural beauty, reveling in the outdoor recreational opportunities (camping, hiking, skiing) offered by the Cascade mountain range, four seasons climate, and 300+ days of sunshine annually.

Redmond has been focused on innovative, sustainable growth and revitalization while preserving the city's unique history and culture. In 1995, the City of Redmond began to make critical investments in revitalizing its downtown core. The initial phase of renovations strove to balance growth, livability and historic preservation by rerouting Oregon State Highway 97, improving critical infrastructure, and improving the facades of over 100 buildings in the historic center. The City of Redmond has worked with local businesses to revitalize retail, job creation and housing. To facilitate private sector buy-in, Redmond offers innovative incentive programs such as the Façade Rehabilitation and Reimbursement Grant and the "Downtown Jumpstart" loan competition, as well as Design Assistance.

Often referred to as "The Hub" of Central Oregon, Redmond is situated at the crossroads of US Highway 97 and US Highway 126. It is served by the Burlington Northern Sante Fe Railway, Cascades East Transit Regional Public Transportation Service, as well as a state of the art regional airport served by multiple commercial airlines and FedEx and UPS. In addition to its geographic location, Redmond is viewed as central to business growth in the region.
In 2014, Central Oregon Community College opened a 34,300 square foot Technology Education Center to recruit new businesses and expand existing businesses in Central Oregon. Above all, Redmond prides itself on being a family-friendly city which was the motivation for the work presented in this report.

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Executive Summary

An increasing number of people are choosing to live in places because they offer a high degree of vitality and livability. Many people making housing decisions place features such as accessibility to open space, mixed-use development, walkability, and high quality urban design at the top of the list of demands. Residents want to live in places that are close to amenities they can get to easily and comfortably. Websites specializing in spatial analysis such as walkscore.com and Zillow.com have grown in popularity as people search for the best location to live. Some cities have responded by making infrastructure and policy decisions that reflect these citizens' desires.

The City of Redmond, Oregon, has been experiencing rapid growth over the last decade, nearly doubling its population since 2000. To continue this growing trend in Redmond, the city has developed a set of policy objectives called the Great Neighborhood Principles. These 11 principles listed in the Comprehensive Plan outline the aspects and characteristics of the types of "Great Neighborhoods" Redmond would like to see in their city. Characteristics range from encouraging walkability and public art to advocating for connected street networks.

To ensure that the city is meeting all of these objectives, Redmond formed a partnership with the Sustainable City Year Program at the University of Oregon (UO). This partnership uses the resources, knowledge, and skills of students at UO to identify methods that will help the city accommodate its future growth while still following the Great Neighborhood Principles.

In the spring 2016 term, an Advanced GIS class at UO conducted an analysis of three existing neighborhoods within the City of Redmond to identify how well they have implemented the Great Neighborhood Principles. The goal is to apply this research and incorporate the principles into future neighborhoods as the city grows.

This report first identifies the context and methods of the conducted analysis, which uses a set of walkability and urban design GIS indicators. Many of these same indicators are used in popular spatial analysis websites and provide an in-depth understanding of how the study areas are built. In addition to analyzing these indicators, students also participated in a City of Redmond site visit to collect real-time on-the-ground walkability and urban design data through the smartphone application called Device Magic. Device Magic calculated a score for each site as students entered information into the application form. The combination of the GIS indicators and the Device Magic scores provided students with the data needed to formulate an in-depth analysis of each study area and how they compared to each other.

Using this analysis, the students extrapolated a set of policy recommendations for the City to Redmond to implement. These recommendations aim to better guide city development towards the ideals set forth in the Great Neighborhood Principles. Implementing the recommended policies will strengthen the policies outlined in the Comprehensive Plan and serve as a tool the city can use to monitor, evaluate, and better enforce the use of the Great Neighborhood Principles.

Introduction

The City of Redmond is located 23 miles north of Bend in Central Oregon's Deschutes County. According to the 2010 US Census, the city's population was 26,215. This represents a 94% increase in the past decade according to the 2000 US Census, which indicated the city's population was 13,481. As a result of this near doubling in population, there have been significant changes taking place within the city's neighborhoods. To better understand these changes and how they describe each neighborhood, the City of Redmond has partnered with the Sustainable City Year Program and the University of Oregon Planning, Public Policy, and Management's spring 2016 Advanced GIS class. Students in the class conducted geographic analysis on three separate study areas to not only study their characteristics and demographics but also to compare across neighborhoods, evaluate congruence with the city's Great Neighborhood Principles, and develop policy recommendations.

The Great Neighborhood Principles are a list of 11 qualities that make neighborhoods inclusive and livable for residents of Redmond. The city strives to utilize these strategies throughout its existing neighborhoods and, as the city continues to grow, its future neighborhoods. The purpose of this project is to study how effective the city has been in implementing these strategies in each of the three study areas. While each of the Great Neighborhood Principles are equally important, this assessment focuses on those Principles that correspond to three areas of emphasis: Transportation and accessibility, diversity of land use and housing, and walkability and environmental design quality. By focusing on these Principles, the students were able to quantify the subjective experience of active transportation within each of the study areas in order to form policy recommendations for city leaders.

Context

Students analyzed three distinct neighborhoods in Redmond for this report. This allows for comparison among the neighborhoods while demonstrating how the city is achieving the goals set out in the Great Neighborhood Principles more broadly. For the remainder of the report, these areas will be referred to as Study Areas 1, 2, and 3. The three study areas are outlined in Figure 1.

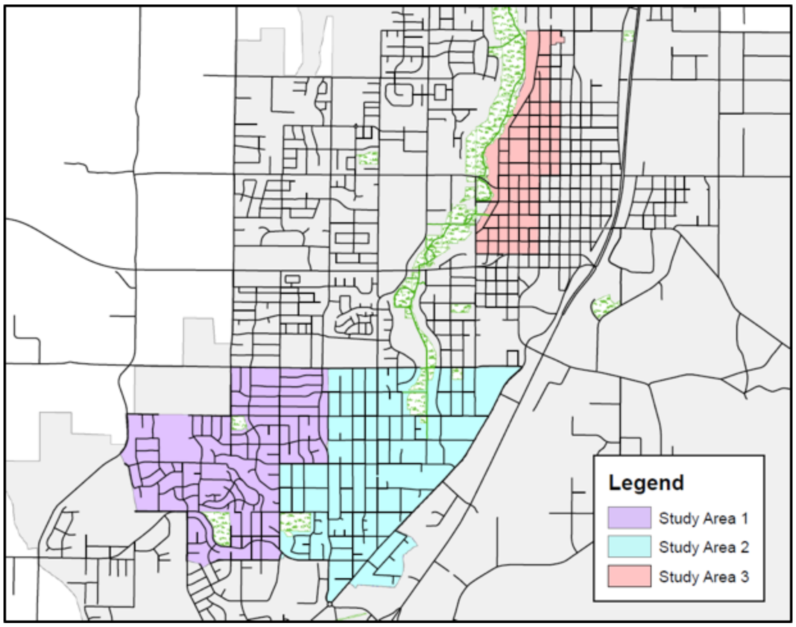


Fig. 1: Three study areas in Redmond, Oregon

Study Area 1, highlighted in purple in Figure 1, is located south and west of the downtown core. Study Area 1 is bounded to the north by Obsidian and Quartz Avenues, to the south by Wickiup and Umatilla Avenues, to the east by 27th Street and 31st Street, and to the west by Cascade Vista and Helmholtz Way. This area completely contains two parks: Valleyview Park and Hayden Park. It is also adjacent to the Umatilla Sports Complex, Sage Elementary School, and Vern Patrick Elementary School. Study Area 1 is the only region of analysis in this report that does not have access to the Dry Canyon.

Study Area 2, show in Figure 1 in light blue, is located immediately the east of Study Area 1 and to the south of the downtown core of Redmond. Study Area 2 is bordered on the north by Obsidian Ave, on the south by Wickiup Ave, on the east by Canal Boulevard, and to the west by 27th and 31st Streets. Prominent amenities and destinations in the area include Sage Elementary School, Umatilla Sports Complex, and the Dry Canyon. There are six trailheads providing entry into the Dry Canyon within Study Area 2.

Study Area 3 is the oldest neighborhood examined in this report, as evidenced by the close proximity to the downtown core. It is shown in peach in Figure 1.

The neighborhood is bordered on the north by Kingwood Avenue, on the south by Glacier Avenue. To the east the area extends to 9th and 7th Streets where it connects to the downtown core, and to the Dry Canyon and Canyon Avenue on the west. Local points of interest include John Tuck Elementary School, Stack Park, the Redmond Library, the current city hall, and the site of the future city hall, which is under construction at this time. There are also several major access points into the Dry Canyon throughout the neighborhood.

These study areas will serve as the unit of analysis for the remainder of the report. All three areas include prominent local amenities that serve to draw residents. They will be important features in the walkability and urban design analyses as well as providing opportunities to guide neighborhood development to be more consistent with the Great Neighborhood Principles.

Methodology

This report focuses on three areas of emphasis: Transportation and accessibility, diversity of land use and housing, and walkability and environmental design quality of the three study areas throughout Redmond. Students established standard methodologies to measure each area of emphasis, including GIS-generated indicators, a walkability audit tool, and an urban design audit tool. Students collected information to make comparisons between the three neighborhoods, to evaluate their congruence with the Great Neighborhood Principles, and to develop recommendations for possible policy changes in the future.

This report attempts to measure how well the current urban fabric is meeting certain Great Neighborhood Principles (GNPs). Specifically these are:

A. *Transportation*. Connect people and places through a complete grid street network and trail system that invites walking and bicycling and provides convenient access to parks, schools, neighborhood service centers, and possible future transit stops.

B. *Housing*. A mix of housing types and densities should be integrated into the design of new neighborhoods.

C. *Open spaces, greenways, recreation*. All new neighborhoods should provide useable open spaces with recreation amenities that are integrated to the larger community. Central parks and plazas shall be used to create public gathering places. Incorporate significant geological features such as rock outcroppings, stands of clustered native trees, etc. into the design of new neighborhoods. Neighborhood and community parks shall be shown in appropriate locations consistent with polices in Redmond's Parks Master Plan.

D. *Integrated design elements*. Streets, civic spaces, signage, and architecture shall be coordinated to establish a coherent and distinct character for the Master Development Plan. Plans may integrate design themes with adjacent developed or planned areas.

E. *Diverse mix of activities*. A variety of uses is encouraged in order to create vitality and bring many activities of daily living within walking and biking distance or a short drive of homes.

F. *Public art*. Public art is encouraged at the gateways to neighborhoods and/or in and around the center of neighborhoods to provide focal points.

By focusing on walkability and urban design, students can assess these goals in several ways. Walkability is directly called for in GNP A. In order to promote walkability, GNP E also calls for a diverse mix of activities within walking distance. This also includes parks and a mix of housing types, which are listed independently of other activities. Great Neighborhood Principles D and F seek to address urban design, which also contributes to the walkability of areas. Measuring the mix of activities, walking infrastructure, and urban design of these neighborhoods will allow us to quantify how compliant they are with the Great Neighborhood Principles listed above.

Continuous advancements in mapping and database technology have created a better understanding of urban networks and connectivity. Popular websites such Walkscore.com and Zillow.com have given the average person the ability to conduct advanced neighborhood characteristic analysis' to better understand their surroundings. These online resources provide a tool to provide overall geographic understanding to its users, and serves as a baseline for this analysis. Similar methods, processes, and analysis strategies used in these online resources are used to analyze the three identified study areas in Redmond.

In order to complete an account of neighborhood conditions, students performed a GIS analysis to generate indicators that summarize existing conditions and characteristics in each of the three study areas. These indicators not only allow for a comparison of the conditions within each neighborhood, but also allow for comparison across the three study areas. Students chose indicators based on their ability to measure aspects that describe whether the study areas meet the ideal neighborhood conditions listed in the Great Neighborhood Principles.

These indicators include transportation and accessibility measurements such as: Average block length, intersection density, and street density. Diversity of use and housing measurements such as: Land-use entropy, housing mix, housing density, near distance, and the percentage of parcels within walking distance to parks. In order to better understand the importance of these measurements, each of these indicators is described in more detail below.

Transportation and Accessibility Indicators

Average Block Length

As a measure of an area's accessibility to nearby amenities, average block length calculates the average distance between street intersections within neighborhoods. Typically, areas with shorter block lengths are considered to be more walkable than areas with longer blocks. The frequency of block intersections serves to break a pedestrian's trip into manageable chunks making the trip easier to traverse and more enjoyable.

Intersection Density

Intersection density is related to block length but provides an alternate way to evaluate the connectedness of the street network. This indicator measures the number of intersections within a given area. Higher intersection density implies a greater number of connections for users of the street network.

Street Density

Street density measures the linear feet of roadway per unit of area. While the prior measures look at connectivity, this is a measure of the amount of street space within an area. In general, greater amounts of street space, regardless of the connectivity, should improve the ability of residents to move within the neighborhood and access services.

Diversity of Use and Housing Indicators

Land Use Entropy

Entropy is complex calculation that measures distribution throughout a specified area. This is helpful to urban scholars and policymakers because it allows them to determine how well land use types are spread across a region. Entropy can be useful to determine if there is a clustering of a certain type of land use and what uses could be better distributed evenly. The entropy equation presents a range of values from 0 to 1, with 1 being a completely even distribution of land uses and 0 being essentially no distribution of land uses.

Housing Mix

A mixture of housing types provides the opportunity for residents to choose housing types that meet their needs, but can promote increased density if the area is not dominated by single-family units. Multi-family dwelling units, among other types, typically raise residential density levels in a neighborhood. This can promote a more positive pedestrian experience and support a greater number of amenities within a walkable area.

Housing Density

Housing density is most often measured in units per acre of land and is dependent upon a variety of factors. Typically, higher densities can support a greater number of amenities within a smaller area. Encouraging and allowing higher housing densities also meets land use goals established by the City of Redmond and Oregon’s land use planning statutes.

Near Distance

Near analysis, a GIS tool, measures nearness through average distance between uses. Near analysis for this study determines the average distance to different types of amenities relative to residential parcels. Average distance between uses is a good indicator of walkability as it shows how far one must travel to get to services or amenities.

Percentage of Parcels within Walking Distance of Parks

This report also analyzed the percentage of parcels within 0.25 miles of a park. The Great Neighborhood Principles call for parcels to be within 0.5 miles of park space, however, the unit of analysis for this report is smaller (City of Redmond

2007). Looking at the percentage of parcels within the catchment area of parks is useful to see whether certain parcels are skewing the near distance, which averages all parcels in the study area.

Walkability and Urban Design Audit Tools

In addition to calculating these GIS indicators, students travelled to Redmond to learn the complex nuances within the city from staff face-to-face. On the visit, students in groups took a walking tour of each study area in order to conduct site analysis. To conduct this analysis, groups used two separate forms within Device Magic, a real-time spatial data collection smartphone application, to survey the study areas based on their attributes related to both walkability and urban design. When completed, the forms would calculate and assign each intersection two scores, one based on its walkability attributes and one on its physical setting and overall design. During the two hours of site analysis, students were able to collect 67 walkability assessments and 63 urban design assessments.

Upon returning from Redmond, students conducted a high level analysis of the points collected during the site visit as they pertain to the three main areas of emphasis discussed earlier: Transportation and accessibility, diversity of land use and housing, and walkability and environmental design quality.

The following section identifies the findings within each study area related to each of these areas of emphasis. In closing, this report also offers some recommendations to improving the city's utilization of the Great Neighborhood Principles.

Findings

Below are findings from GIS analysis and on-site data collection. Data for each study area is presented categorically, with recommendations and comparison between areas found in the next section of this report.

Study Area 1

Study Area 1 is located to the south and west of the downtown core. The area is home to several parks and abuts two elementary schools, as well as the Umatilla Sports Complex. Many parcels in this area are also a short walk from the Dry Canyon. The analysis below assesses various characteristics of this study area to determine if it is supportive of active transportation modes.

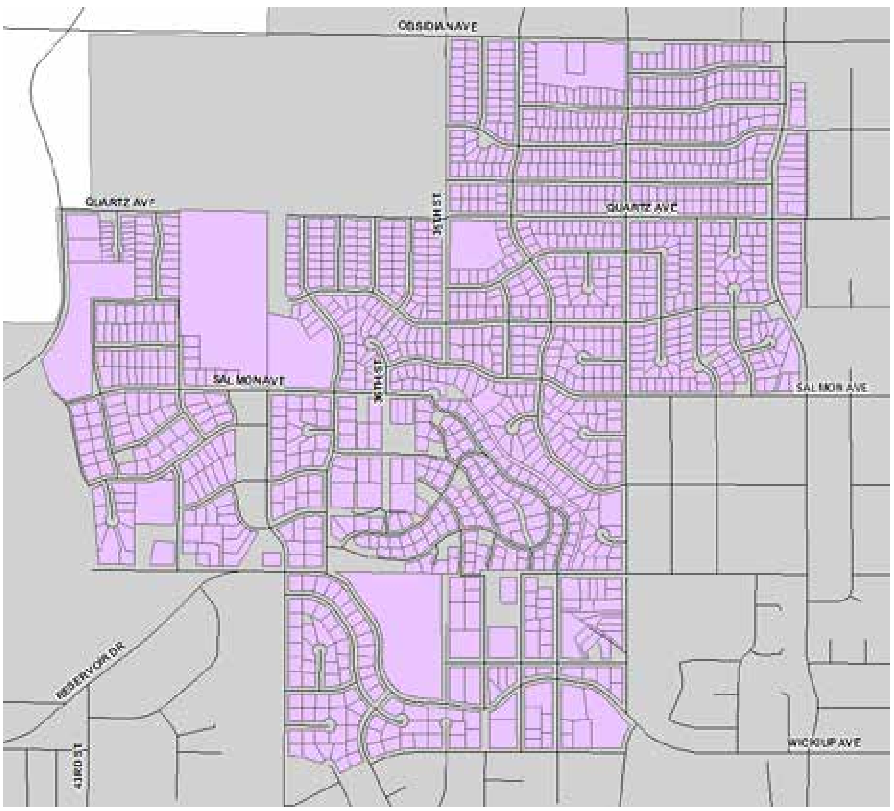


Fig. 2: Map of Study Area 1

Transportation/Accessibility

Average Block Length

Study Area 1 has an average block length of 404.78 ft. Average block length can be an indicator of walkability. Shorter block lengths allow for easier navigation and shorter travel distances for pedestrians. Study Area 1 is slightly above the desired block length for a pedestrian orientation discussed in the literature, however, it is far from the maximum block length many jurisdictions permit.

Intersection Density

Study Area 1 has 235 real nodes, that is links or streets that connect to other streets, and encompasses 447.23 acres. The intersection density is 0.53 real nodes per acre. Figure 3 below shows links and nodes in Study Area 1.

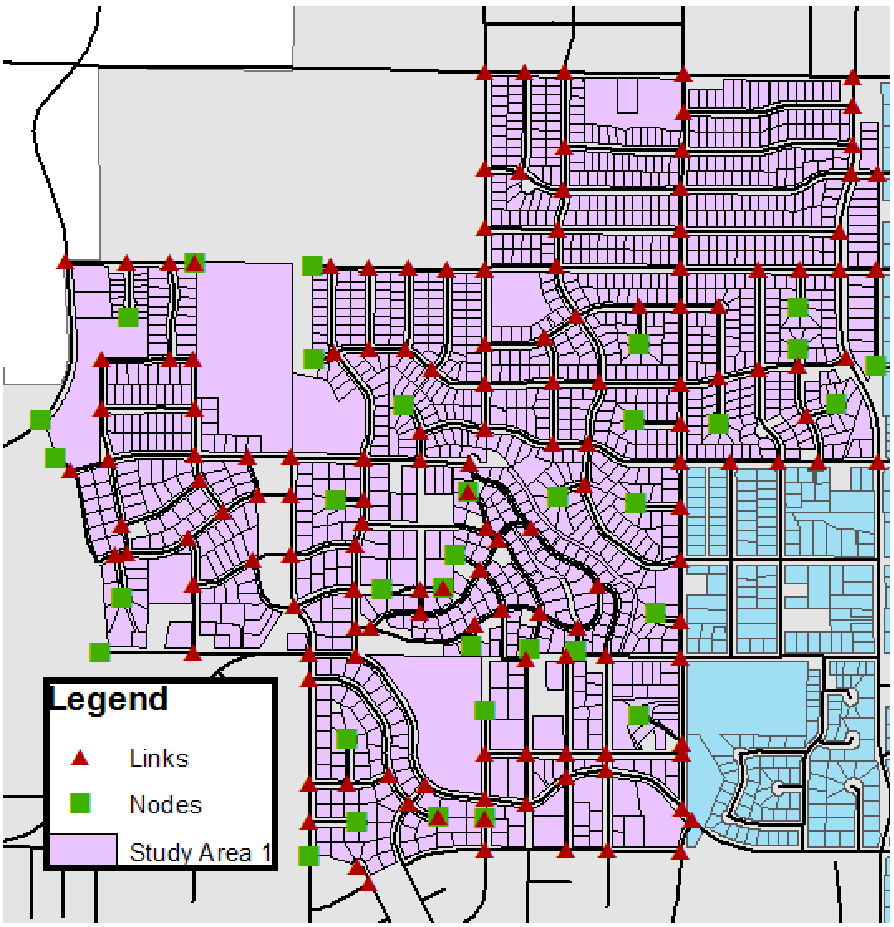


Fig. 3: Links and nodes in Study Area 1

Street Density

Study Area 1 contains 16.51 linear miles of roadway. This translates to 194.92 linear feet per acre.

Diversity of Use/Housing

A diversity of uses and how close the uses are to residences greatly impact the ability of pedestrians to access local amenities. Several analytical methods were employed to explore current land use conditions in each of the study areas. A diversity of uses is described through Great Neighborhood Principle F.

Land Use Entropy

Table 1: Land use mix in Study Area 1

Study Area 1	Area (sq. ft.)	% of Total
Single-Family Residential	11,170,651	97%
Multifamily Residential	140,855	1%
Commercial	-	0%
Other	228,548	2%

Study Area 1 is 97% single-family homes. The rest of the area is split between multi-family dwellings and other non-commercial uses. There are no commercial parcels within the study area. This leads to a low entropy score of 0.0543, implying that the uses in the neighborhood are highly homogenous.

Housing Mix

Great Neighborhood Principle B specifically calls for a “mix of housing types,” to meet these goals. Study Area 1 has 1,245 single-family parcels and only two multi-family parcels.

Housing Density

Study Area 1 contains 1,050 housing units on 447.23 acres. It has a housing density of 2.35 dwelling units per acre.

Near Distance

As seen in Table 2, there is considerable variation in the distance to different types of destinations for parcels in Study Area 1.

Table 2: Average distance from residential parcels to destinations in Study Area 1

	Near Distance (ft.)		
	Parks/Open Space	Commercial	Civic Sites
Study Area 1	906.17	5,332.42	2,442.35

The average parcel in Study Area 1 is 906.7 feet from a park, which meets the goal set forth in Great Neighborhood Principle D. Civic sites, including municipal services, are an average of 2,442.35 feet from residential parcels. Commercial space is the farthest away, with an average walk of over one mile.

Percentage of Parcels within Walking Distance of Parks

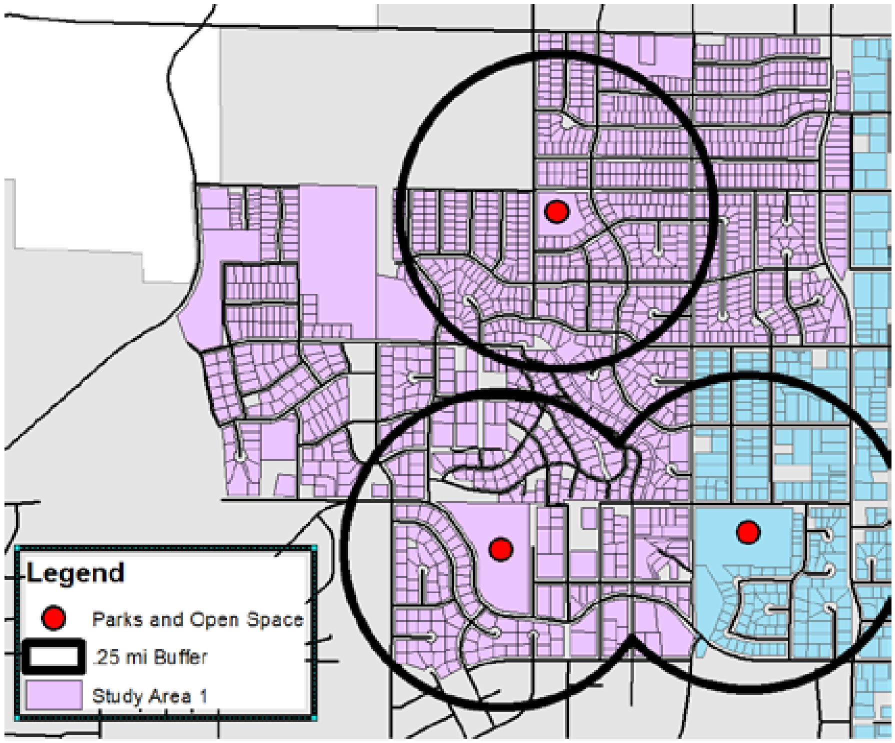


Fig. 4: Study Area 1 parks and open space

Figure 4 shows the parcels within Study Area 1 that fall within 0.25 miles of a park or designated open space. In total, 59% of parcels are within 0.25 miles of parks and open space.

Walkability/Urban Design

Urban Design Assessment Tool

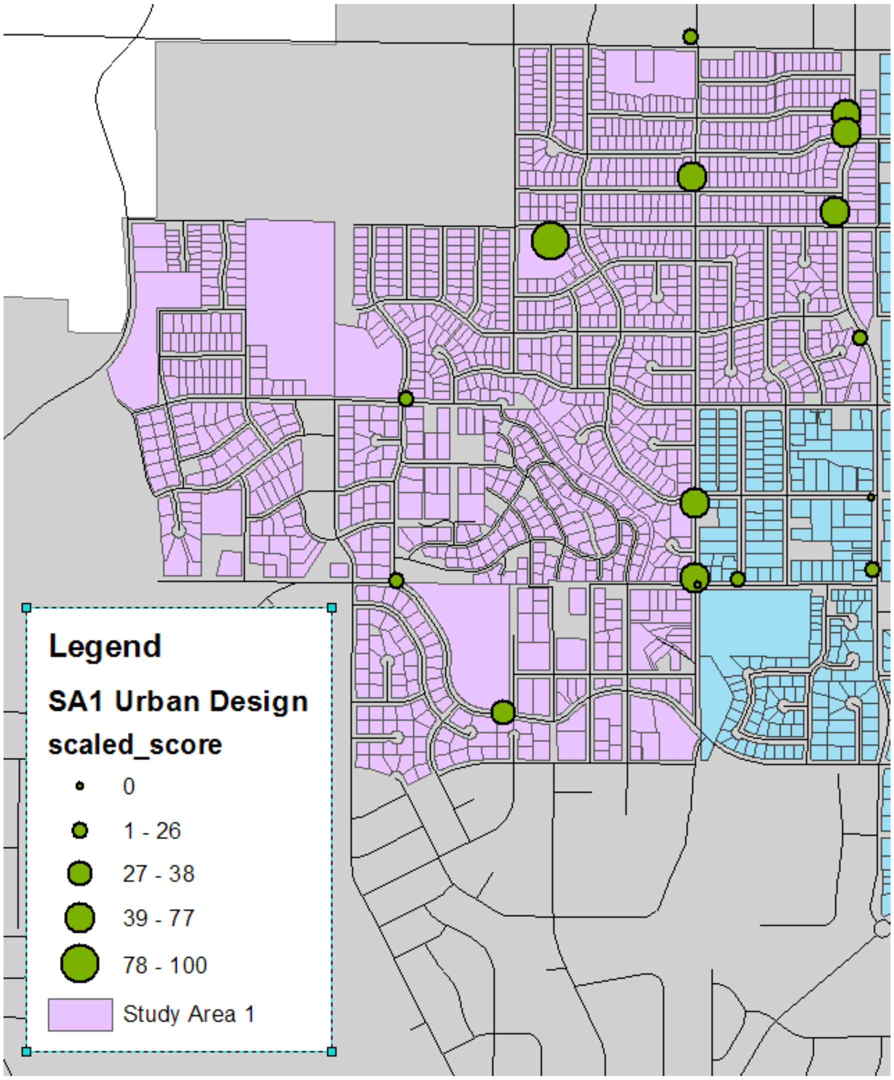


Fig. 5: Study Area 1 - Urban Design

As shown in Figure 5 above, there is considerable variation in urban design assessment scores throughout the neighborhood. While some areas score highly, others are subjectively not as inviting as a pedestrian-oriented space. Improving these subjective qualities can help improve the walkability of the area. The maximum score received at a location was 100 (out of a possible 100) and the lowest was a zero. The average score for the neighborhood was 34.4, while the median was a 26. This shows considerable variation, but a generally low urban design score for this area.

Walkability Audit Tool

Scores for the walkability audit were similar to the urban design assessment because there is considerable variation around the neighborhood. The minimum reported score was 33 (out of 100), with the maximum reported score of 91. The average walkability score was 66.5; this is considerably higher than the urban design assessment average. The high degree of variability in scores around the neighborhood may be an impediment for residents seeking to utilize active transportation. Figure 6, below, shows the scores within Study Area 1.

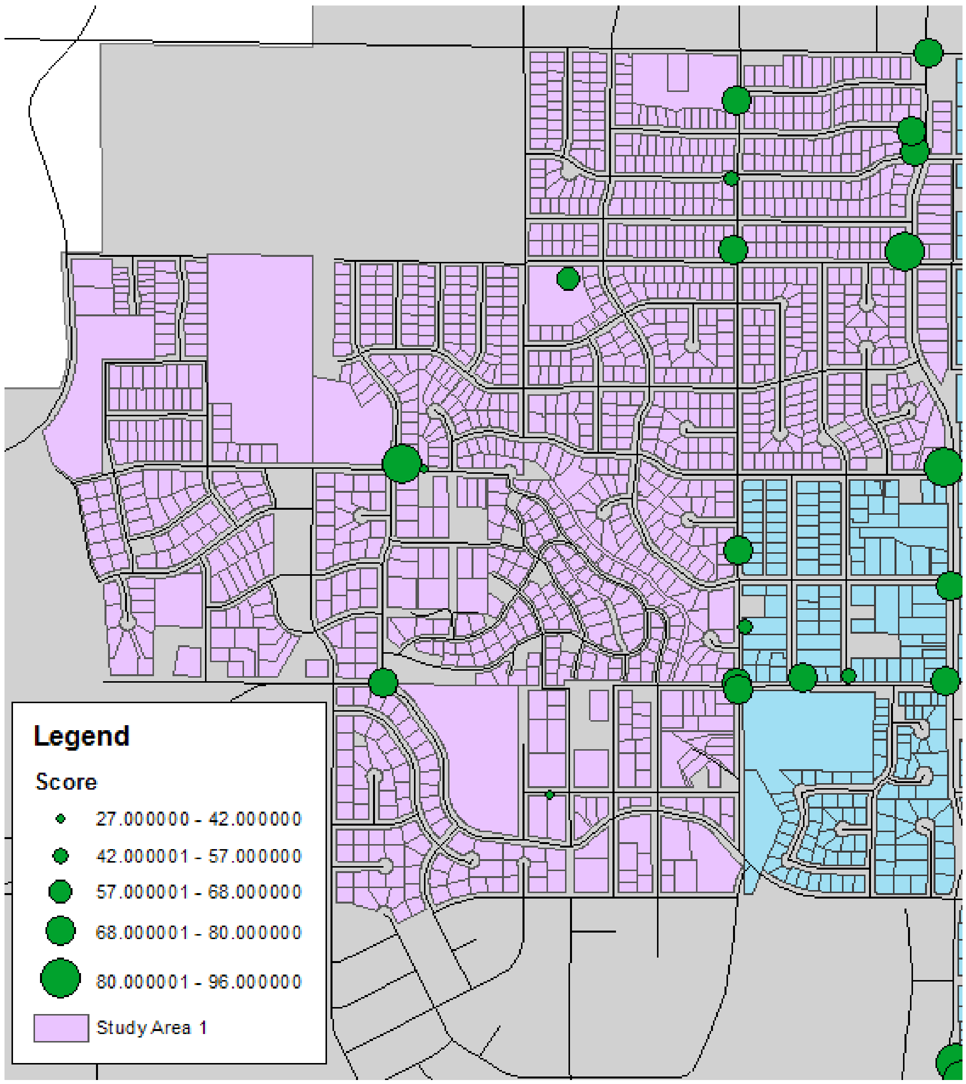
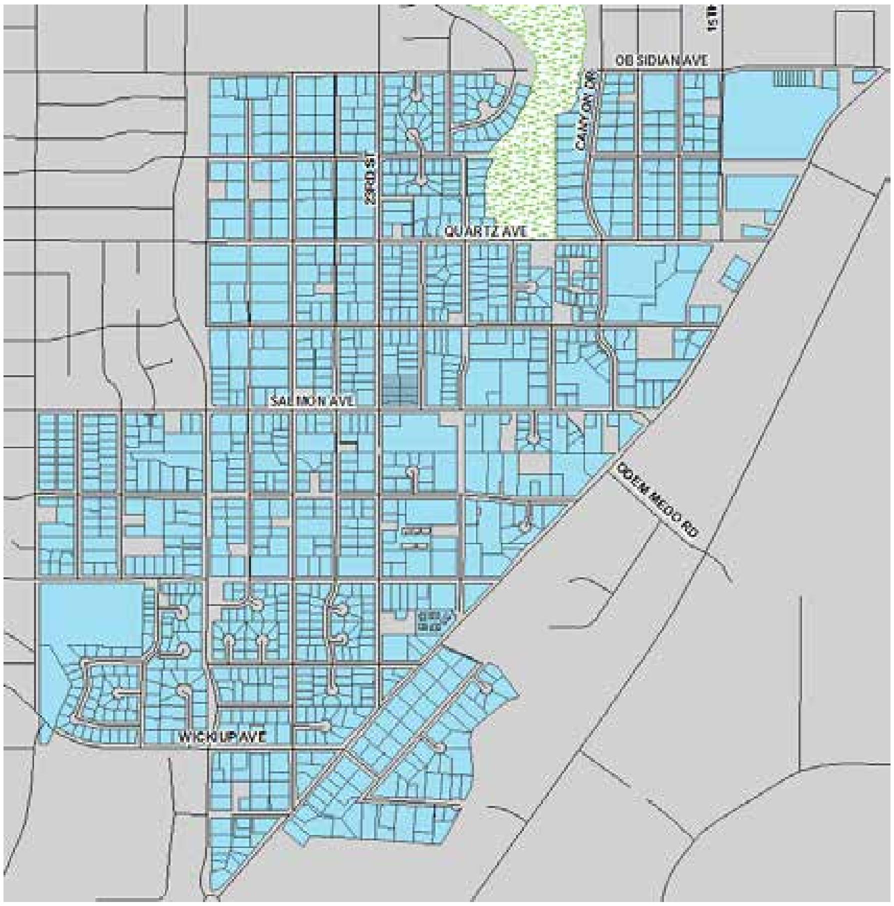


Fig. 6: Walkability audit in Study Area 1

Study Area 2

Study Area 2 is a primarily residential neighborhood located south of Redmond's downtown core. The neighborhood is bound on the east by Canal Boulevard, on the west by SW 27th Street, on the south by the intersection of those two roads, and on the north by SW Obsidian Avenue. Study Area 2 is the largest of the three study areas, covering approximately 534 acres, which has an effect on its overall walkability and accessibility to amenities.

Fig.7: Map of Study Area 2



Transportation/Accessibility

Average Block Length

Study Area 2 has an average block length of 421.9 feet. Jennifer Dill, a professor at Portland State University, suggests that bicycle and pedestrian-oriented areas should have block lengths around 330 feet (Dill 2003). Dill also found that maximum block lengths are usually around 600 feet. Study Area 2 has an average block length that is slightly above the desired pedestrian-orientation, however, it has the longest average length of any of the study areas in Redmond.

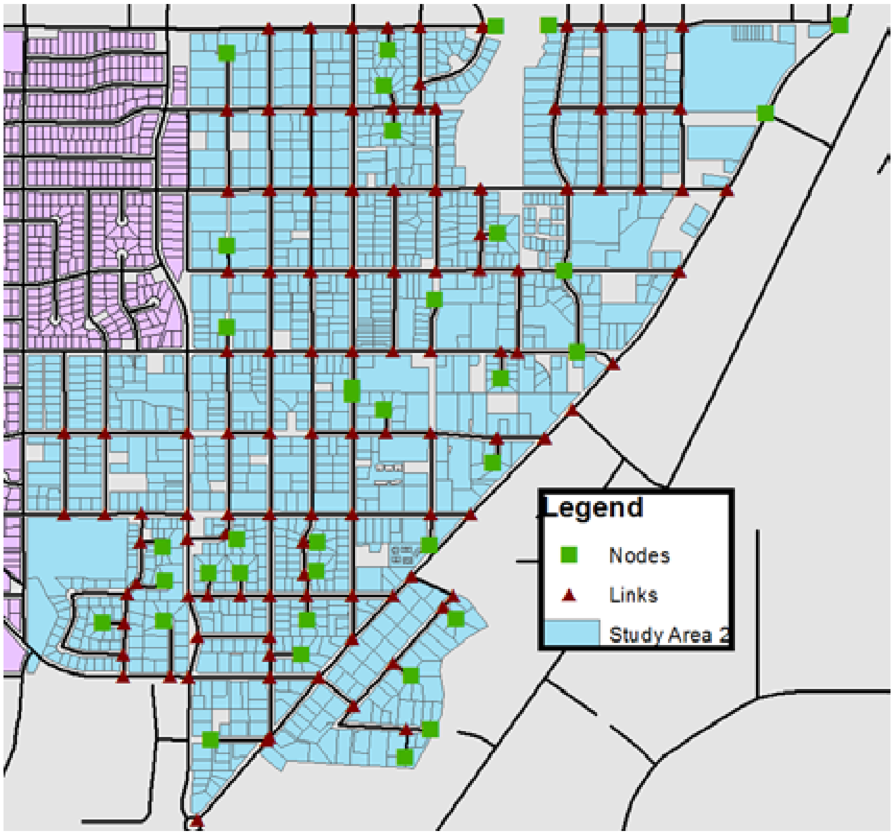


Fig. 8: Links and nodes in Study Area 2

Intersection Density

Figure 8, above, shows link and node points of intersections in Study Area 2. Study Area 2 has 186 real nodes, which are the connection or intersection between streets, and encompasses 534.06 acres. The resulting intersection density is 0.35 real nodes per acre. For such a large study area, this neighborhood has a relatively low number of nodes. This is likely due to its stark orientation towards automobile-based transportation. A large average block length with fewer intersections allows for vehicles to travel with little interference.

Street Density

Long block lengths over the large area of this neighborhood contributes to its low street density. Study Area 2 has 16.78 linear miles of roadway, which translates to 165.90 linear feet per acre, the lowest of all neighborhoods studied. The study area is partially made up of a gridded street network but newer portions of the area have features like cul-de-sacs and winding roads, making quick walking access difficult.

Diversity of Use/Housing

Land Use Entropy

Study Area 2 is largely made up of single-family residences, covering 90% of the land area. While all of the multi-family units are located on the eastern neighborhood boundary along Canal Boulevard. The neighborhood has very limited commercial development and no industrial uses. The dominance of single-family housing has a direct effect on the distribution of land uses, or entropy, in the study area. The entropy calculation for Study Area 2 is near zero, at 0.099, meaning there is minimal distribution of use.

Housing Mix

There is a total of 1,066 single-family parcels found in Study Area 2. The study area has the greatest number of multi-family units than any other study area at 33 units. However, this still does not meet the goal of a mixture of housing types set forth in Great Neighborhood Principle B. The lack of multi-family parcels also likely affects the overall density of the neighborhood.

Table 3: Land use mix in Study Area 2

Study Area 2	Area (sq. ft.)	% of Total
Single-Family Residential	13,413,694	90%
Multi-family Residential	937,147	6%
Commercial	45,141	0%
Other	485,549	3%

Housing Density

Study Area 2 has approximately 1,004 housing units and covers around 534 acres of land. The resulting housing density is 1.879 units per acre. Being that the neighborhood is largely single-family homes and only one section of multi-family units, this is the lowest housing density of any study area.

Near Distance

Study Area 2 has significant assets in its access to parks and open space. However, these assets are located on the periphery of the neighborhood and are difficult to access for those who live in the middle of the neighborhood. The accepted measure of walkability is that amenities are within 0.25 mile or 1,300 feet. As can be seen in Table 4 below, only parks and open space are considered accessible via walking.

Table 4: Average distance from residential parcels to destinations in Study Area 2

Near Distance (ft.)			
Column1	Parks/Open Space	Commercial	Civic Sites
Study Area 2	845.1	2090.69	2267.56

Percent of Parcels within Walking Distance of Park

The location of Study Area 2 in relation to Dry Canyon Trial, Ray Johnson Park, Baker Park, and the Umatilla Sports Complex make it great place to experience open space as a resident on the outer perimeter of the neighborhood. However, the lack of open space in the center of the neighborhood increases the average distance a resident must travel. Still, over half, 58%, of the residents in Study Area 2 are within 0.25 mile of a park.

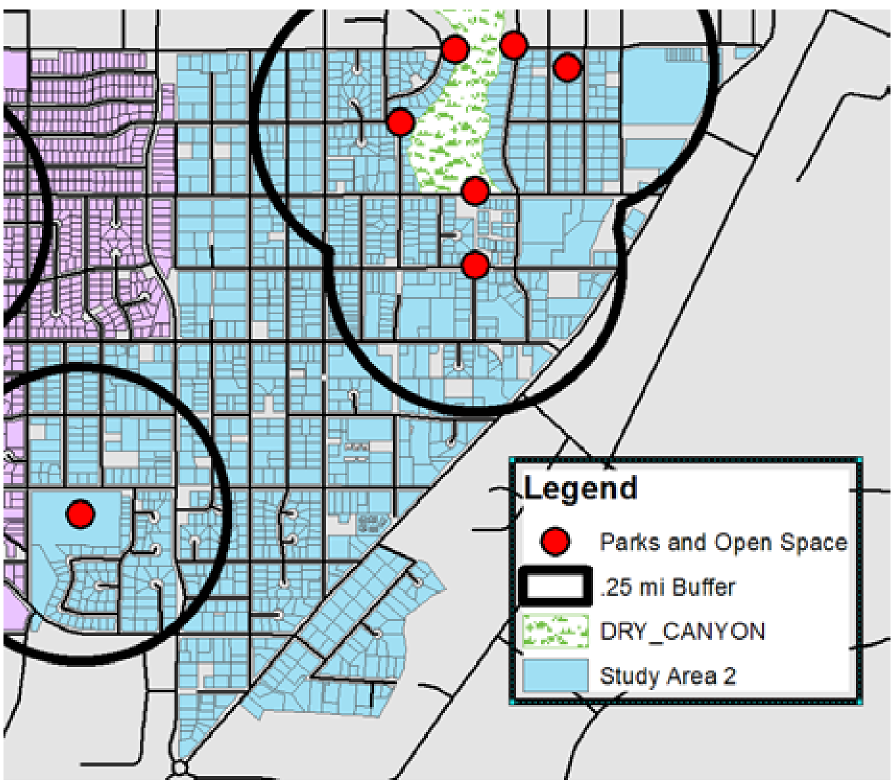


Fig. 9: Parks and open space in Study Area 2

Walkability/Urban Design

Research suggests that walkability is enhanced by high quality urban design. This report employs a tool to measure urban design, as well as a tool to quantify walkability based on existing infrastructure.

Urban Design Assessment Tool

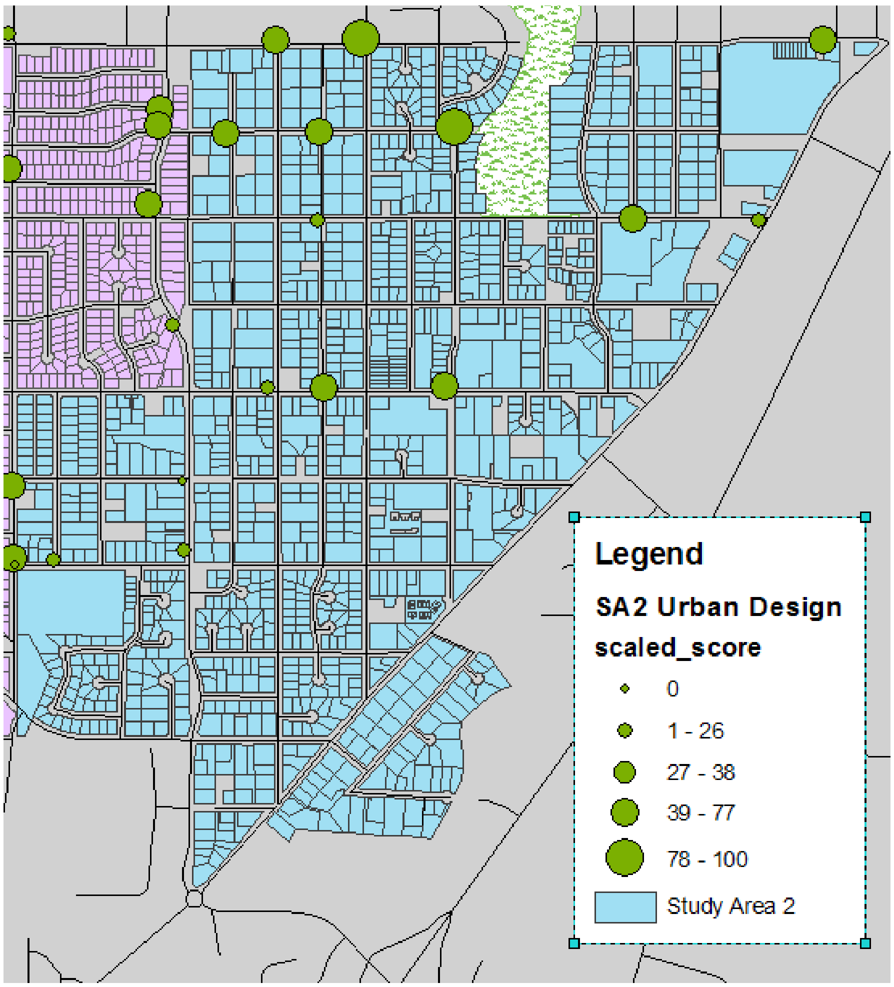


Fig. 10: Urban design assessment scores for Study Area 2

As shown in Figure 10 above, there is considerable variation in urban design assessment scores throughout the neighborhood. While some areas score highly, others are subjectively not as inviting as a pedestrian-oriented space. Improving these subjective qualities can help improve the walkability of the area. The maximum score received at a location was 100 (out of a possible 100) and the lowest was a zero. The Dry Canyon Trail, Ray Johnson Park, Baker Park and the Umatilla Sports Complex are all situated in Study Area 2. These parks and recreational open spaces add to the complexity and desirability of the neighborhood. However, there is a lack of signage to the Dry Canyon Trail.

Walkability Tool

Sidewalks in Study Area 2 are disjointed and discontinuous. Although some roads through the area (Salmon, Quartz and 27th) have wide sidewalks and crosswalks that are well marked, Handicap and wheelchair accessibility in these areas is low; no sidewalks and broken pavement force pedestrians to walk in the street.

Canal Street lacks sidewalks and is not handicaped accessible. This is a main street connecting car traffic from suburban neighborhoods, such as Study Area 2, to public facilities and amenities within the greater Redmond area. Because of this, the traffic volume and rate of speed is higher on this road, making it less safe and desirable for pedestrians and cyclists. The presence of a major thoroughfare in this neighborhood directly impacted the lower walkability scores for the study area.

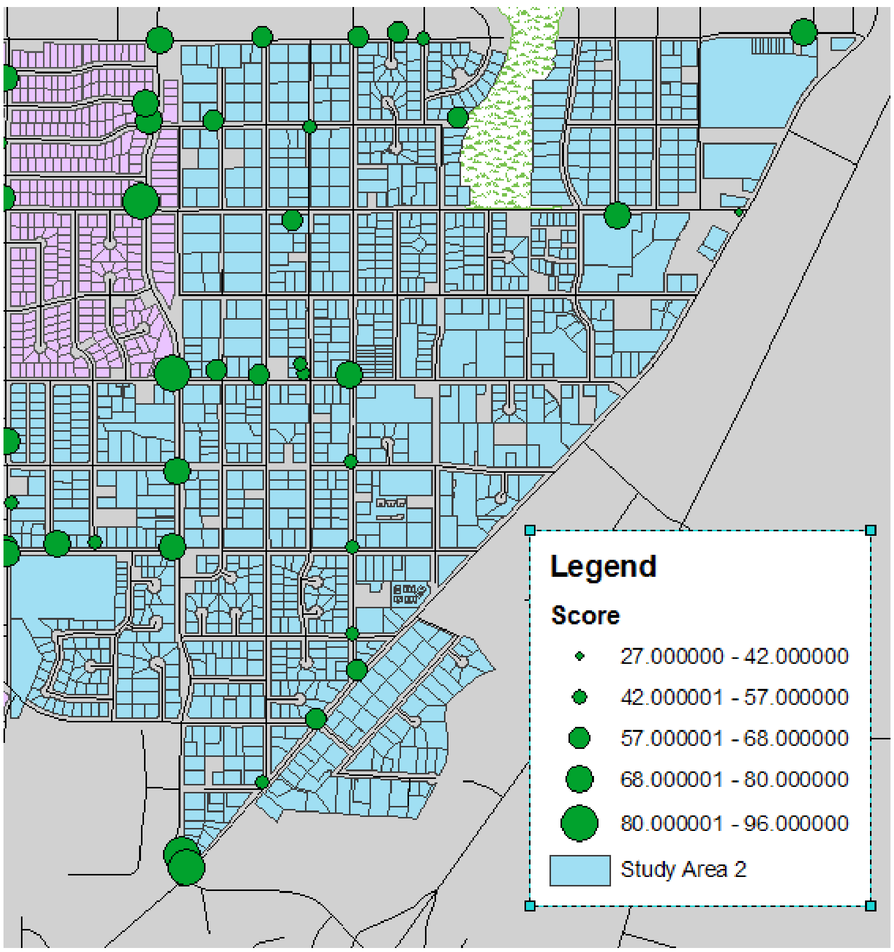


Fig. 11: Walkability scores in Study Area 2

Study Area 3

Study Area 3 is located adjacent to the downtown core and the Dry Canyon. It is home to several parks, schools, and other amenities. This neighborhood is more historic than the other study areas, and accordingly, has unique features that enhance the walkability of this area.

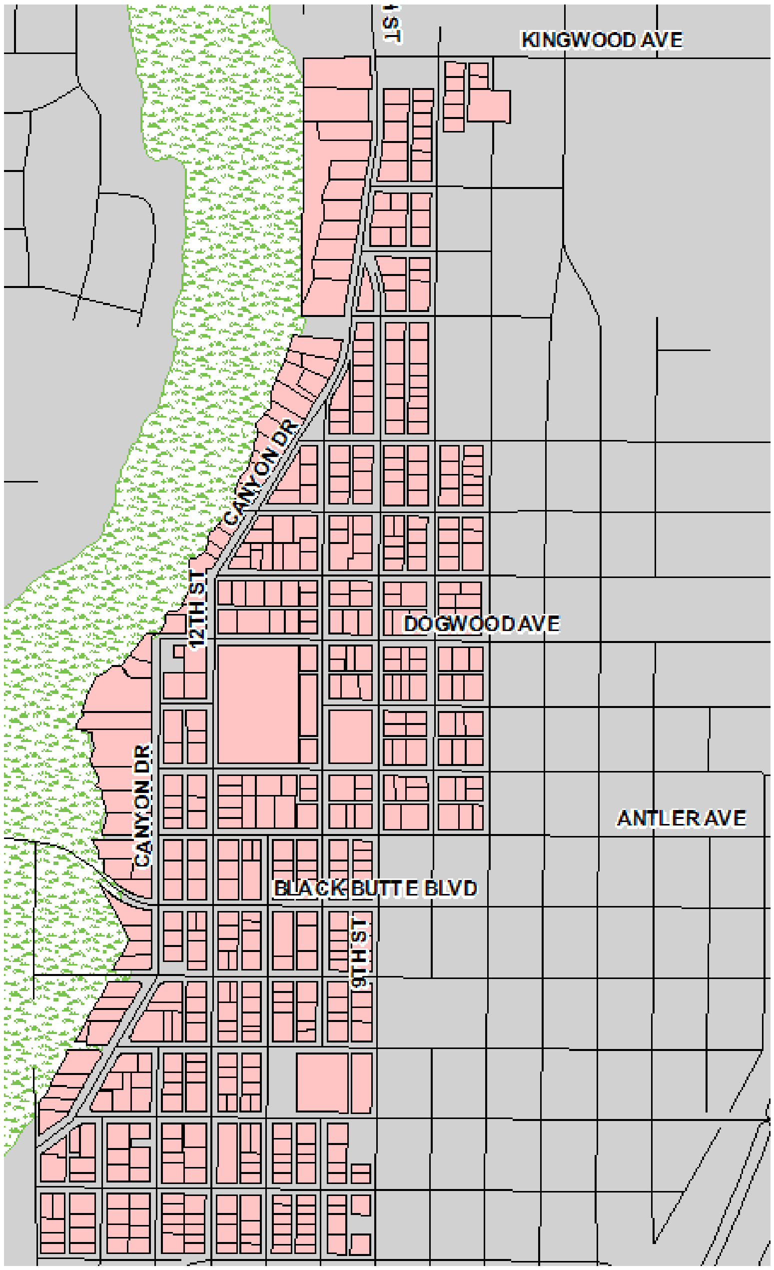


Fig. 12: Map of Study Area 3

Transportation/Accessibility

Average Block Length

Study Area 3 has an average block length of 327.93 feet. This is near the threshold established by Jennifer Dill of 330 feet for streets oriented towards bicycling and walking. The short block length adds to the walkability of the area and helps to promote compliance with Great Neighborhood Principle A.

Intersection Density

The earlier development of Study Area 3 is likely responsible for the highly gridded street network found in this area. The gridded network combined with short block lengths creates the relatively high intersection density of 0.81 real nodes per acre. The study area has 154 links, or intersections with connections, and only seven roads that terminate. Nearly all of the dead ends are at the Dry Canyon. This type of street network is highly conducive to pedestrian activity. Figure 13 shows the links and nodes (dead-ends) for Study Area 3.

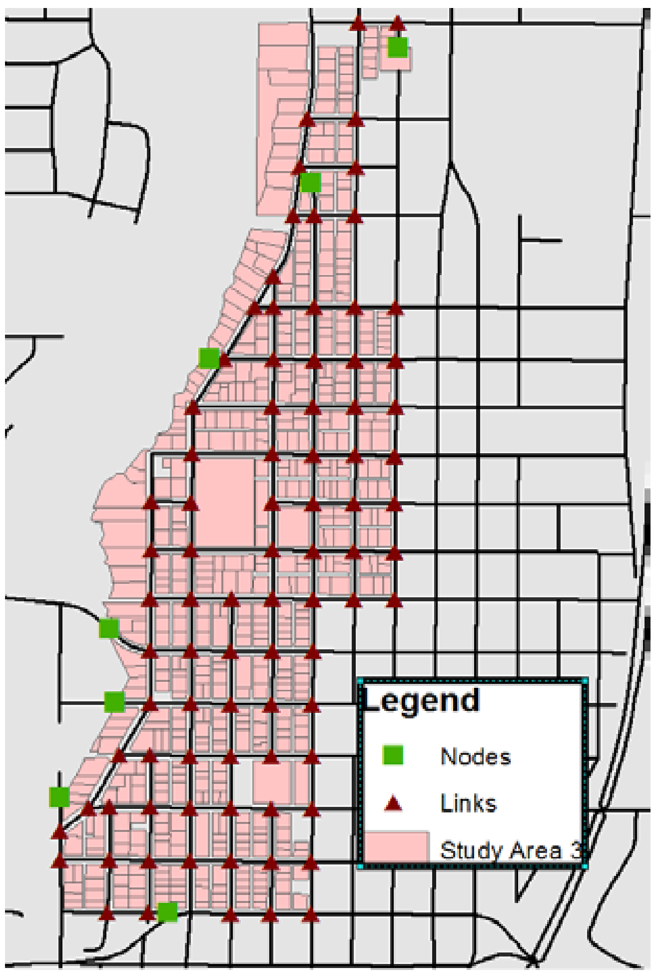


Fig. 13: Links and nodes in Study Area 3

Street Density

The short block lengths and gridded network also contribute to a correspondingly high street density. There are a total of 9.56 linear miles of roadway in Study Area 3. The total street density for the neighborhood is 256.92 linear feet of roadway per acre. This provides pedestrians with a multitude of options on how to travel to destinations and decreases the distance residents must walk to access amenities near them.

Diversity of Use/Housing

As noted above, the Great Neighborhood Principles seek to create vibrant neighborhoods through a mixture of uses and housing types. Below are the current conditions in Study Area 3.

Land Use Entropy

Table 5: Land use mix in Study Area 3

Study Area 3	Area (sq. ft.)	% of Total
Single-Family Residential	4,568,946	88%
Multi-family Residential	30,002	1%
Commercial	72,286	1%
Other	508,839	10%

Single-family homes dominate Study Area 3, comprising 88% of all area in the neighborhood. Multi-family units and commercial uses are approximately 1% each. The remaining 10% of the study area are other uses, such as schools or municipal buildings. The dominance of single-family homes results in an entropy of 0.107, again indicating highly homogenous use of land.

Housing Mix

A total of 486 single-family parcels and three multi-family parcels can be found in Study Area 3. The lack of multi-family parcels also likely affects the overall density of the neighborhood.

Housing Density

Study Area 3 has an estimated 358 housing units and 189.91 acres. This translates to a housing density of 1.883 units per acre.

Near Distance

Study Area 3 benefits greatly from proximity to the downtown core, Dry Canyon, and municipal buildings. Residents are, on average, quite close to all studied types of amenities. Table 6, below, shows the relatively short distances between the average residential parcel and the studied amenities.

The average distance to all amenity types is below the threshold for walkability, which is approximately 1,300 feet. Close proximity to destinations is a hallmark of a walkable neighborhood.

Table 6: Distance to amenities for Study Area 3

Near Distance (ft.)			
	Parks/Open Space	Commercial	Civic Sites
Study Area 3	637.91	594.75	740.36

Percentage of Parcels within Walking Distance of Parks

The presence of the Dry Canyon on the western edge of Study Area 3, combined with local parks, provides many recreational opportunities for residents of this area. Figure 14 shows a 0.25 mile buffer from parks and open space opportunities. In total, 90% of residents of Study Area 3 are within 0.25 miles of parks and open space.

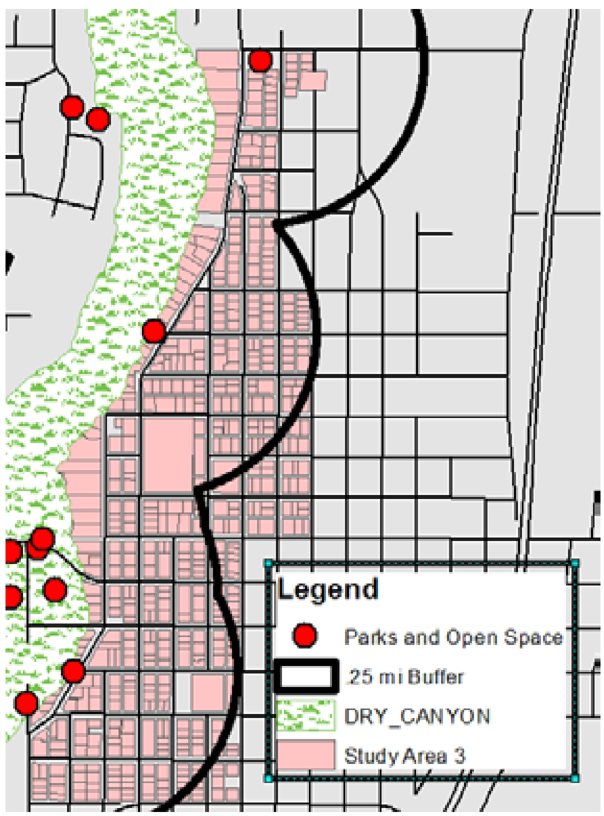


Fig. 14: Parks and open space in Study Area 3

Walkability/Urban Design

An assessment of the urban design qualities and the physical infrastructure of the neighborhood is found below.

Urban Design Assessment Tool

Study Area 3 featured a high degree of variability in urban design assessment scores. The tool produced values ranging from a minimum of six (out of 100) to a maximum of 95. The average of scores was 45.4. The relatively low average score, but high degree of variance suggests that certain areas in the neighborhood are highly pleasant from a pedestrian standpoint, while others are highly unpleasant. Figure 15 below shows the urban design scores for locations within the study area, as well as some photos documenting higher and lower scoring areas.

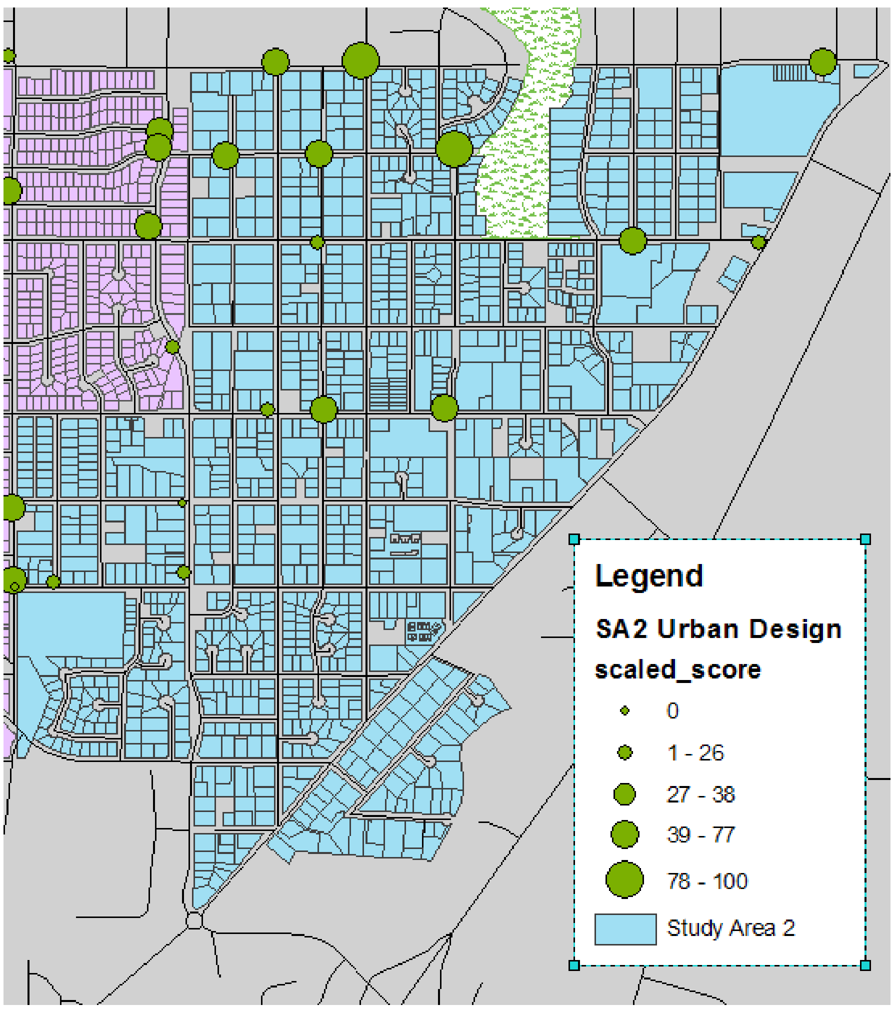


Fig. 15: Urban design assessment scores for Study Area 3

Walkability Audit Tool

The walkability audit tool developed by the Center for Disease Control and Prevention produced more encouraging results compared to the urban design assessment. Study Area 3 has an average walkability audit score of 61.7. The minimum score was 32 (out of 100) and the maximum was 87. Some areas lacked sidewalks, had excessive traffic or speed of traffic, or had limited infrastructure (e.g. ADA compliant ramps) that improve walkability. The map shown below, Figure 16, demonstrate the areas of this neighborhood that are walkable and those that need improvements.

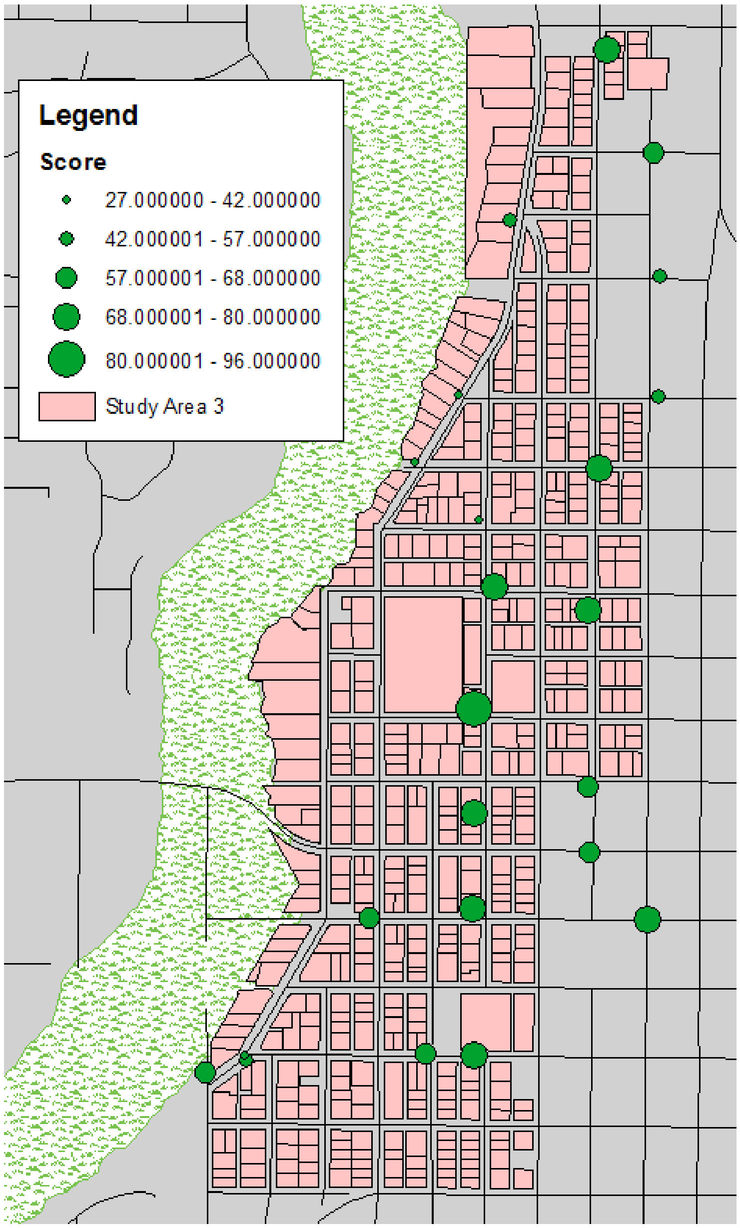


Fig. 16: Walkability scores in Study Area 3

Cross Student Area Analysis

Based on the above metrics, comparisons between the study areas show the strengths and weaknesses for each area. These comparisons could allow for policy recommendations that lead to strategic placement of the most useful investments in order to improve walkability and ultimately, the livability of each of the study areas.

Transportation Infrastructure

Dispersed infrastructure creates access barriers to amenities by making them difficult or dangerous to reach. As noted previously, certain facets of the street network can greatly enhance or inhibit the experience of people walking and biking through a neighborhood.

Average Block Length

All three study areas feature relatively short block lengths. Study Area 3 is endowed with the shortest block length, at 327.93 feet. This is very close to the 330 feet that experts consider ideal for a walkable neighborhood (Dill 2003). Study Areas 1 and 2 feature longer, though not exceptionally, block lengths of 404.78 and 421.9, respectively. Although the shorter block length found in Study Area 1 is preferable, all three are relatively walkable by these standards.

Intersection Density

Study Area 3 featured the highest intersection density of all of the neighborhoods, with an overall density of 0.81 intersections per acre. Study Area 1 features 0.53 intersections per acre, considerably lower. Study Area 2 fared the worst in this metric with only 0.35 intersections per acre. Compared to the other study areas, Study Area 3 has the most options in regards to route choice and the most direct routes. Looking at the maps in the findings section of the report above, it is clear that the street network in Study Area 3 is almost entirely a grid, while there are a greater number of cul-de-sacs in Study Areas 1 and 2. As development continues in Redmond, a connected street network should be emphasized to ensure that neighborhoods allow residents to efficiently travel to local amenities.

Street Density

Study Areas 1 and 2 feature an overall street length that is greater than Study Area 3, however, when normalized by acreage, the density of their street networks are considerably smaller. Study Area 3 has 265.92 linear feet of roadway per acre of land, while Study Areas 1 and 2 have 194.92 and 165.90 linear feet per acre, respectively. These numbers indicate that there is proportionally more road space in Study Area 3. This provides greater access to amenities.

The number of linear feet of roadway is simply another way of measuring the amount of infrastructure dedicated to transportation. Combined with the connectivity measures above, it is clear that Study Area 3 features a network that is more conducive to active transportation modes. Providing greater choice allows people walking and biking to choose more direct and shorter routes and provides greater access to local features.

Diversity of Land Use/Housing

The physical network that enables active transportation is a key component of walkable and bikeable neighborhoods, however, infrastructure must also provide amenities to reach. The Great Neighborhood Principles acknowledge that a mixture of uses, variety of housing types, and proximity to open spaces and recreational areas are desirable qualities in neighborhoods through Principles B, C, and E.

Land Use Entropy

Scores for land use entropy can range from 0, which would indicate a completely uniform set of uses, to 1, which indicates a completely mixed land use pattern. Table 7 shows the distribution of uses, as well as the measure of entropy, for each of the three study areas.

Table 7: Cross study area analysis of entropy and land use

	Entropy	Percent Single-Family	Percent Multi-Family	Percent Commercial	Percent Other
Study Area 1	0.0543	97%	1%	0%	2%
Study Area 2	0.0992	90%	6%	0%	3%
Study Area 3	0.1070	88%	1%	1%	10%

As shown above, all of the study areas were dominated by single-family housing. Commercial activity in these three neighborhoods is minimal to non-existent. Study Area 2 has a comparatively large portion of multi-family housing. Study Area 3 has a large amount of ‘other’ uses, including institutional and governmental due to schools and city services in the area. These differences account for why Study Areas 2 and 3 have greater entropy. It should be noted, however, that all of these scores are relatively low and indicate a high degree of separation of uses.

Housing Mix

Housing mix is related to entropy but addresses a slightly different measure. Providing a mixture of housing types is one of the Great Neighborhood Principles, however, none of the study areas provides many options for residents. Table 7 above, shows the respective amounts of area dedicated to single-family and multi-family housing. While this does not show the proportion of units in each area, the proportion of area dedicated to each use is illustrative of the lack of housing options in all study areas.

Study Areas 1 and 3, particularly, have very little multi-family housing. Six percent of land in Study Area 2 is dedicated to multi-family units.

Housing Density

Housing density in all three study areas is relatively low. Table 8 shows the absolute number of units estimated by the Census and the number of dwelling units per acre.

Table 8: Cross study area comparison of housing density

	Num. Dwelling Units	Housing Density (DU/acre)
Study Area 1	1050	2.347
Study Area 2	1004	1.879
Study Area 3	358	1.883

Study Area 3 has significantly fewer units than the other two neighborhoods, however, it is comprised of a much smaller area. The density of housing units in Study Areas 2 and 3 are comparable, with both just below 1.9 units per acre. Study Area 1 is slightly denser, with 2.347 units per acre. Combined with the housing mix indicating an overwhelming majority of area covered by single-family units, this indicates that the homes are not on small lots.

Near Distance

The final land use metric in this report analyzed the distance of parcels to near-by amenities. As Table 9 below shows, there is considerable difference in the study areas for how close residents are to various types of activity. Study Area 3 is the closest to all types of amenities that were reviewed, and all of the amenities are well within the 1,320 feet (0.25 miles) that is considered a walkable distance.

Table 9: Cross study comparison of parks and open space

Near Distance (ft.)			
Column1	Parks/Open Space	Commercial	Civic Sites
Study Area 1	906.17	5332.42	2442.35
Study Area 2	845.1	2090.69	2267.56
Study Area 3	637.91	594.75	740.36

Study Area 1 has an average distance to parks and open space that is within the threshold of walkability, however, distances to civic sites are closer to half a mile and commercial activities are approximately a mile away.

Study Area 2 is similar to Study Area 1 in that the only amenities within 0.25 miles on average are parks or other open spaces. Commercial spaces and civic sites are both approximately 0.5 miles away from the average parcel.

Walkability/Urban Design

The walkability and urban design assessment tools provide a way to quantify inherently subjective measurements. The standardization allows a comparison between different areas. These tools were employed in each of the study areas, and the results can be taken in context with the measurements derived from the GIS analysis above.

Urban Design Assessment Tool

Study Area 3 had the highest mean Urban Design score at 45.4. As compared to Study Areas 1 and 2, Study Area 3 is the most inviting in terms of infrastructure designed for pedestrian walkability. This may likely be due to the gridded street network that is present in the Study Area. While Study Areas 1 and 2 are home to many infrastructure attributes that serve as barriers to a high quality urban design such as winding roads and cul-de-sacs.

However, there is a lack of consistency in urban design throughout the city as seen by the large variance of scores seen within each study area. There are some areas that are distinctly designed for pedestrians alongside intersections that are dangerous for pedestrians because they are explicitly built for cars. With an average score of less than 50, Study Area 3 is still largely designed more for cars than pedestrians.

Walkability Audit Tool

The walkability audit tool developed by the Centers for Disease Control and Prevention produced more encouraging results compared to the urban design assessment. Study Area 1 had the highest average walkability score at 66.1, which is considerably higher than its average Urban Design score of 34. This large variation may be an indicator of a study area that has consistent and effective walkability infrastructure such as sidewalks, ADA ramps, and labeled crosswalks, but lacks the type of destination or amenity mix that is needed to have quality urban design.

Study Area 3 also scored highly in the walkability audit tool, its gridded street network and pedestrian connections offer a sense of comfort for pedestrians. While Study Area 2 scores a little lower because of the location two minor arterial thoroughfares that move traffic at high speeds through the neighborhood.

Recommendations

Students hope that this report can serve as a model for the City of Redmond to use to conduct further neighborhood analysis in other parts of the city. Compliance with the Great Neighborhood Principles can be evaluated using the methodology and analysis outlined in the above sections. Once the analysis has been conducted, the city can then begin to formulate changes in local policy that help to steer existing and future neighborhoods to towards the Great Neighborhood Principle ideal. Below are recommendations that resulted from this evaluation. Each recommendation includes the related Great Neighborhood Principles.

A connected, gridded street network including shorter block lengths should be the standard in future infrastructure projects

Related Great Neighborhood Principles: A, C, and E

The nature of a street network is that it is generally static. In other words, once a street network is built, it takes considerable investment to change. Improvement in any of these areas will take significant time and are unlikely to change in the near future. Although existing neighborhoods will not likely benefit from improvements to the infrastructure of their street network, these data can serve as a tool to help understand how to better construct new neighborhoods to comply with Great Neighborhood Principle A, regarding walkable and bikeable neighborhoods, and Great Neighborhood Principle C, regarding open space access for residents.

Should the city be presented with opportunities to change the neighborhood street network, shorter block length should be considered a preferential option to best comply with Great Neighborhood Principle A. However, as development continues in Redmond, a connected street network should be emphasized to ensure that neighborhoods allow residents to efficiently travel to local amenities. Of the three studied neighborhoods, Study Area 3 should be looked to by the City of Redmond as a good example of how to build transportation infrastructure that makes neighborhoods walkable and accessible to its residents.

Encourage higher densities and a mix of uses in existing neighborhoods through zoning and development code

Related Great Neighborhood Principles: B, C, E, and F

Unlike improvements to the street network that require years of planning and large funding commitments, shorter-term, less expensive improvements are possible to many of the facets of the indicators studied.

Overall, all three of the study areas are predominately single-family residential areas with little other surrounding uses. Increasing the entropy of land uses implies a need to increase the amount of uses that is not single-family residential. Changes in zoning, development incentives, and placement of municipal services in these neighborhoods are all examples of ways to increase other types of uses. These can help to provide locations for residents to go, as well as provide an environment that encourages walkable development.

Encouraging denser development can improve the walkability of the neighborhood by providing additional places to go and greater amenities within walking distance. Encouragement of development on smaller lots and the construction of multi-family housing would increase the housing density of these neighborhoods and therefore their vitality and livability.

In order to improve the walkability of Study Areas 1 and 2, improving the mix of uses will greatly decrease the average distance from parcels to amenities. While residents of these areas have adequate access to parks and open space, defined in the walkability literature and in the Great Neighborhood Principles, other types of services are unavailable to these areas. In order to better achieve Great Neighborhood Principle A, other types of uses could be allowed and encouraged in Study Areas 1 and 2.

General Policy Recommendations

The recommendations outlined above are ones that can be implemented through site-specific development decisions on a case-by-case basis. This takes initiative at the city leadership level that is consistent and objective over time. The Great Neighborhood Principles within the city's Comprehensive Plan policies already provide an excellent framework for creating great neighborhoods in Redmond. While the Principles provide a clear vision, clear and enforceable standards will encourage consistent utilization and effective application of these principles throughout the city. Changes to the Redmond Development Code that outline specifically how the principles should be implemented could provide consistency in the development process of new neighborhoods as Redmond grows.

Conclusion

Redmond continues to grow at a rapid pace and will need to make decisions on how it will meet the demands of this new population. More and more residents of cities expect to live in areas with amenities in walking distance and that have desirable urban design features. The city has already taken a significant step to accommodate residents through the adoption of the Great Neighborhood Principles as part of their Comprehensive Plan, however these policies are subjective and are not easily monitored or enforced.

This study was conducted on a relatively small portion of the City of Redmond but the methods, analysis, and implications can be applied to the city on a larger scale. The recommendations in this report are ones that could be adopted to provide more clarity and structure to the Great Neighborhood Principles. Particularly, as the city grows and new subdivisions are formed, new development standards and zoning requirements enforcing certain principles could provide a framework to build neighborhoods that are walkable, vibrant, and livable for everyone.

Appendix A: Urban Design Assessment Scores

The urban design assessment tool used in this report seeks to measure subjective urban design qualities and quantify the results so that areas can be compared and improved. The tool measures several concepts. The brief descriptions that follow are paraphrased from a field manual used by students in the class (Clemente, et al. 2005):

- Imageability: The sense that a location is distinct, recognizable, and memorable
- Enclosure: The physical definition of the streetscape by features that contribute to a room-like quality
- Human Scale: The degree to which physical elements are proportional to human activity
- Transparency: The degree to which street-goers can see other human activity from the street, especially through windows or open space
- Complexity: The variety and differentiation of physical elements

Appendix A: Urban Design Assessment Scores

Table 10: Raw data collected for the Urban Design Assessment

Urban Design Assessment Raw Data													
ID	user	submission	image1	image2	image3	image4	image5	image6	image7	imagiability	image_scaled	enclosure1	enclosure2a
1	T.Machala	11648928	0	0	0	0	0	0	0	0	0	4	0
2	Y.Zhang	11648976	0	0	0	0	0	0	0	0	0	1	1
3	E.Stuckmayer	11648995	0	2	0	1	0	0	0	1.55	34	3	0.95
4	L.Miller	11649001	0	2	1	3	4	0	2	3.1	69	2	0
5	H.Hixson	11649011	1	0	0	0	0	0	2	0.45	10	2	0.5
6	E.Stuckmayer	11649079	0	2	0	10	0	0	0	2.54	56	4	0.2
7	H.Hixson	11649099	0	0	0	0	2	1	1	0.82	18	4	1
8	T.Machala	11649109	0	1	0	0	0	0	3	0.78	17	4	0
9	L.Miller	11649136	1	0	1	1	1	0	1	1.59	35	1	0
10	Y.Zhang	11649148	0	0	0	0	0	0	0	0	0	2	0.2
11	E.Stuckmayer	11649162	0	5	0	8	0	0	0	4.48	100	4	0.2
12	T.Machala	11649201	0	0	0	0	1	0	7	0.22	4	4	1
13	E.Stuckmayer	11649248	1	1	0	8	0	0	1	2.03	45	3	0.8
14	Y.Zhang	11649250	1	0	0	0	0	0	0	0.41	9	3	0.7
15	L.Miller	11649266	0	1	1	1	1	0	5	1.98	44	4	0.5
16	H.Hixson	11649268	1	1	0	0	0	1	2	1.81	40	0	0.5
17	T.Machala	11649284	0	0	0	0	2	0	0	0.16	3	2	0
18	E.Stuckmayer	11649312	0	0	0	8	0	0	1	0.9	20	4	0
19	Y.Zhang	11649368	0	1	0	1	0	0	0	0.83	18	2	0.2
20	E.Stuckmayer	11649383	0	2	0	1		0	0	1.55	34	3	0.6
21	L.Miller	11649410	0	0	0	0	0	0	0	0	0	2	0
22	T.Machala	11649492	1		2	2	2	0	0	2.73	60	4	0.3
23	H.Hixson	11649519	1	1	0	0	1	0	0	1.21	27	1	0.1
24	E.Stuckmayer	11649510	0	1	0	14	0	0	0	2.26	50	4	0
25	L.Miller	11649607	1	3	0	2	0	0	2	2.83	63	3	0
26	E.Stuckmayer	11649613	0	0	0	5	0	0	0	0.55	12	4	0.1

27	H.Hixson	11649660	1	1	0	0	0	0	0	1.13	25	3	0.1
28	E.Stuckmayer	11649700	0	1	0	8	0	0	1	1.62	36	4	0.1
29	E.Stuckmayer	11649743	0	3	0	4	0	0	0	2.6	58	4	0.4
30	H.Hixson	11649805	1	1	0	0	0	0	1	1.15	25	1	0.5
31	L.Miller	11649850	0	0	0	1	1	0	0	0.19	4	2	0
32	E.Stuckmayer	11649879	0	1	0	11	0	0	1	1.95	43	3	0.1
33	E.Stuckmayer	11650025	0	1	0	4	0	0	0	1.16	25	3	0.2
34	L.Miller	11650040	0	0	0	4	0	0	0	0.44	9	4	0
35	H.Hixson	11650063	1	1	0	0	1	0	0	1.21	27	4	0.3
36	E.Stuckmayer	11650085	1	1	1	3	0	0	0	2.43	54	3	0
37	T.Machala	11650167	1	1	0	1	0	0	0	1.24	27	2	0.5
38	E.Stuckmayer	11650201	0	0	0	1	0	0	1	0.13	2	3	0.3
39	L.Miller	11650222	0	1	0	2	0	0	0	0.94	20	2	0
40	T.Machala	11650300	0	0	0	0	0	0	0	0	0	4	0.3
41	E.Stuckmayer	11650403	1	1	0	5	0	0	0	1.68	37	4	0.3
42	Y.Zhang	11650436	1	0	0	0	0	0	0	0.41	9	3	0.1
43	L.Miller	11650490	1	1	1	1	4	0	2	2.57	57	2	0.2
44	T.Machala	11650511	0	0	1	4	1	0	5	1.59	35	4	0
45	Y.Zhang	11650537	0	0	0	0	0	0	0	0	0	2	0.6
46	L.Miller	11650603	2	0	0	4	2	1	4	2.14	47		0.8
47	Y.Zhang	11650625	0	0	0	0	0	0	0	0	0	3	0
48	E.Stuckmayer	11651376	0	1	0	5	0	0	0	1.27	28	4	0.4

Urban Design Assessment Raw Data

ID	user	submission	enclosure2b	enclosure3a	enclosure3b	enclosure	encl_scaled	humanscale1	humanscale2	humanscale3	humanscale4	humanscale5	humanscale
1	T.Machala	11648928	1	1	1	-3.91	24	1	1	10	4	0	0.53
2	Y.Zhang	11648976	1	1	1	-2.26	68	1	0.2	10	5	0	-0.3
3	E.Stuckmayer	11648995	0.1	0.5	0.3	-1.519	87	3	0.1	20	1	0	-2.12
4	L.Miller	11649001	0	0.8	0.6	-3.07	46	2	0.2	20	0	0	-1.32
5	H.Hixson	11649011	0	1	1	-3.87	25	2	0.1	10	1	0	-1.35
6	E.Stuckmayer	11649079	0.4	0.5	0.2	-1.868	78	2	0.5	20	40	0	1.01
7	H.Hixson	11649099	1	1	1	-3.19	43	2	0.1	10	4	2	-1.12
8	T.Machala	11649109	0	1	1	-4.85	0	4	1	20	0	0	-1.92
9	L.Miller	11649136	0	0.2	0.9	-2.565	60	1	0.2	12	0	0	-0.556
10	Y.Zhang	11649148	0.2	0.4	0.4	-1.732	81	2	0.2	15	10	0	-0.805
11	E.Stuckmayer	11649162	0.1	0.3	0.3	-2.085	72	4	0.75	25	2	0	-2.11
12	T.Machala	11649201	0.5	0.75	0.75	-2.7575	55	4	1	10	0	0	-1.89
13	E.Stuckmayer	11649248	0.3	0.4	0.2	-1.078	99	3	0.8	25	0	0	-1.415
14	Y.Zhang	11649250	0.2	0.4	0.6	-2.12	71	3	0	20	0	0	-2.28
15	L.Miller	11649266	0.2	0.5	0.7	-2.935	50	4	0.2	20	0	0	-2.8
16	H.Hixson	11649268	1	1	1	-2.31	66	0	0	10	0	0	-0.03
17	T.Machala	11649284	0.5	0.75	0.75	-2.8575	52	2	1	10	5	2	-0.08
18	E.Stuckmayer	11649312	0.1	0.5	0.2	-2.294	67	4	0.8	30	0	0	-2.17
19	Y.Zhang	11649368	0.05	0.8	0.7	-3.098	46	2	0.03	15	2	0	-1.392
20	E.Stuckmayer	11649383	0.4	0.5	0.1	-1.051	99	3	0.2	30	2	0	-1.99
21	L.Miller	11649410	0	0.8	0.4	-2.632	58	2	0.3	12	0	0	-1.186
22	T.Machala	11649492	0.35	0.7	0.65	-3.1125	45	4	0.75	20	0		-2.195
23	H.Hixson	11649519	0.1	1	1	-3.754	28	3	0.1	10	3	0	-1.99
24	E.Stuckmayer	11649510	0.2	0.5	0.3	-2.419	63	4	0.8	25	0	0	-2.155
25	L.Miller	11649607	0	1	0.8	-4.102	19	0	0	12	0	0	-0.036
26	E.Stuckmayer	11649613	0.3	0.4	0.2	-1.892	77	4	0.7	20	0	1	-2.21
27	H.Hixson	11649660	0	1	1	-4.468	10	3	0	20	0	0	-2.28
28	E.Stuckmayer	11649700	0.5	0.3	0	-1.124	97	4	0.3	30	2	1	-2.58

29	E.Stuckmayer	11649743	0.7	0.6	0.4	-2.022	74	4	0.2	20	0	0	-2.8
30	H.Hixson	11649805	0	1	1	-3.56	33	1	0	25	0	0	-0.815
31	L.Miller	11649850	0	0.8	0.2	-2.194	69	0	0.2	16	0	0	0.172
32	E.Stuckmayer	11649879	0.15	0.5	0.4	-2.303	66	3	0.8	25	4	1	-1.175
33	E.Stuckmayer	11650025	0.3	0.6	0.4	-2.232	68	3	0.8	20	0	0	-1.4
34	L.Miller	11650040	0	0.7	0.3	-2.891	51	0	0	20	0	0	-0.06
35	H.Hixson	11650063	0	1	1	-4.634	5	4	0.05	10	0	0	-2.935
36	E.Stuckmayer	11650085	0.2	0.6	0.4	-2.47	62	3	0	40	1	1	-2.25
37	T.Machala	11650167	0.7	0.4	0.4	-1.046	100	2	1	10	2	0	-0.31
38	E.Stuckmayer	11650201	0.3	0.3	0.5	-1.953	76	3	0	30	0	0	-2.31
39	L.Miller	11650222	0	0.4	0.2	-1.626	84	0	0.4	10	0	0	0.41
40	T.Machala	11650300	0.3	0.7	0.7	-3.269	41	4	1	10	3	0	-1.74
41	E.Stuckmayer	11650403	0.5	0.6	0.2	-1.844	79	4	0.8	20	0	2	-2.06
42	Y.Zhang	11650436	0	0.8	0.9	-3.965	23	3	0.05	20	2	0	-2.125
43	L.Miller	11650490	0	0.2	0.6	-2.074	72	0	0	10	4	0	0.17
44	T.Machala	11650511	0	1	1	-4.85	0	4	1	10	0	3	-1.77
45	Y.Zhang	11650537	0.1	0.6	0.7	-2.479	62	3	0	20	0	0	-2.28
46	L.Miller	11650603	0.3	0.8	0.4	-1.154	97	1	0.5	16	2	4	0.022
47	Y.Zhang	11650625	0.1	0.8	0.7	-3.505	35	3	0.03	15	0	0	-2.232
48	E.Stuckmayer	11651376	0.4	0.4	0.25	-1.6915	83	4	0.8	25	0	0	-2.155

Urban Design Assessment Raw Data

ID	user	submission	human_scaled	transparency1	transparency2	transparency3	transparency	trans_scaled	complexity1	complexity2a	complexity2b	complexity3
1	T.Machala	11648928	87	1		0	1.22	57	4	1	1	0
2	Y.Zhang	11648976	66	0.2	1	0	0.914	41	5	3	4	0
3	E.Stuckmayer	11648995	20	0	0.95	0.1	0.6895	30	9	3	3	0
4	L.Miller	11649001	40	0.1	0	0	0.122	2	7	3	4	0
5	H.Hixson	11649011	40	0.1	0.5	0	0.457	19	6	4	5	0
6	E.Stuckmayer	11649079	100	0.4	0.2	0.1	0.675	30	19	5	4	0
7	H.Hixson	11649099	46	0.1	1	0	0.792	35	4	3	3	1
8	T.Machala	11649109	25	0.75	0	0.2	1.021	47	4	4	1	0
9	L.Miller	11649136	60	0.1	0.1	0.2	0.295	11	6	4	3	0
10	Y.Zhang	11649148	53	0.2	0.4	0	0.512	22	10	4	5	0
11	E.Stuckmayer	11649162	20	0.75	0.2	0	1.049	48	15	6	3	0
12	T.Machala	11649201	26	1	1	0.06	1.9218	91	4	4	1	0
13	E.Stuckmayer	11649248	38	0.85	0.8	0.1	1.626	77	16	6	3	0
14	Y.Zhang	11649250	16	0	0.4	0	0.268	9	4	2	3	0
15	L.Miller	11649266	3	0.3	0.2	1	1.03	47	6	3	2	0
16	H.Hixson	11649268	73	0.1	0.5	1	0.987	45	16	4	4	0
17	T.Machala	11649284	72	1	0.5	1	2.085	100	7	7	2	0
18	E.Stuckmayer	11649312	19	0.8	0.15	0	1.0765	50	13	4	4	0
19	Y.Zhang	11649368	39	0.03	0.2	0	0.1706	5	8	3	4	0
20	E.Stuckmayer	11649383	23	0.2	0.6	0.1	0.699	31	6	2	3	0
21	L.Miller	11649410	44	0.3	0	0	0.366	14	6	4	2	0
22	T.Machala	11649492	18	0.5	0.3	0	0.811	36	2	2	0	0
23	H.Hixson	11649519	23	0.1	0.1	0.2	0.295	11	4	4	3	0
24	E.Stuckmayer	11649510	19	0.8	0.2	0	1.11	51	8	4	3	0
25	L.Miller	11649607	73	0.1	0	1	0.652	28	4	4	2	0
26	E.Stuckmayer	11649613	18	0	0.1	0	0.067	0				
27	H.Hixson	11649660	16	0	0.5	0.25	0.4675	19	8	5	4	0
28	E.Stuckmayer	11649700	8	0.3	0.2	0	0.5	21	5	3	3	0

29	E.Stuckmayer	11649743	3	0.2	0.2	0	0.378	15	4	3	2	0
30	H.Hixson	11649805	53	0	0	1	0.53	22	4	2	2	0
31	L.Miller	11649850	78	0.2	0	0	0.244	8	4	3	2	0
32	E.Stuckmayer	11649879	44	0.8	0.1	0.2	1.149	53	17	5	4	0
33	E.Stuckmayer	11650025	38	0.8	0.2	0	1.11	51	7	3	3	0
34	L.Miller	11650040	72	0	0.7	0	0.469	19	4	3	2	0
35	H.Hixson	11650063	0	0	0	0.5	0.265	9	5	5	4	0
36	E.Stuckmayer	11650085	17	0	0	0.5	0.265	9	8	5	2	0
37	T.Machala	11650167	66	1	0.75	0	1.7225	82	3	3	2	0
38	E.Stuckmayer	11650201	15	0	0.3	0.3	0.36	14	4	2	2	0
39	L.Miller	11650222	84	0.4	0	1	1.018	47	8	2	3	0
40	T.Machala	11650300	30	1	1	0	1.89	90	4	4	1	0
41	E.Stuckmayer	11650403	22	0.8	0.2	0.3	1.269	59	9	5	4	0
42	Y.Zhang	11650436	20	0.05	0.05	0.4	0.3065	11	3	2	6	0
43	L.Miller	11650490	78	0	0.2	0.02	0.1446	3	5	3	3	0
44	T.Machala	11650511	29	1	0	0.05	1.2465	58	5	5	2	0
45	Y.Zhang	11650537	16	0	0.35	0	0.2345	8	6	6	8	0
46	L.Miller	11650603	74	0.5	0.8	0.04	1.1672	54	4	3	3	1
47	Y.Zhang	11650625	17	0.03	0.05	0	0.0701	0	3	3	5	0
48	E.Stuckmayer	11651376	19	0.8	0.4	0.2	1.35	63	8	3	3	0

ID	user	submission	complexity4	complexity5	complexity	comp_scaled	location	Y_coor	X_coor	total_score	scaled_score
1	T.Machala	11648928	2	4	1.25	47		44.272477	-121.179743	-0.91	36
2	Y.Zhang	11648976	0	0	1.42	53	27th sw obsidian ave	44.260211	-121.20021	-0.226	43
3	E.Stuckmayer	11648995	0	0	1.5	56	Obsidian/25th	44.262008	-121.196855	0.1005	47
4	L.Miller	11649001	1	2	1.87	70	Canyon and evergreen	44.272479	-121.1831	0.702	53
5	H.Hixson	11649011	0	4	1.94	73	31st and obsidian	44.26209087	-121.2045592	-2.373	20
6	E.Stuckmayer	11649079	0	1	2.61	98	Obsidian/23rd	44.262056	-121.194406	4.967	100
7	H.Hixson	11649099	0	0	1.67	63	31st and pumuce	44.25928104	-121.2045189	-1.028	34
8	T.Machala	11649109	0	3	1.33	50	Canyon and evergreen	44.272262	-121.184007	-3.639	6
9	L.Miller	11649136	1	0	1.87	70	Canyon and dechutes	44.274004	-121.182374	0.634	52
10	Y.Zhang	11649148	0	0	2.02	76	27th SW Quartz ave	44.258603	-121.200499	-0.005	45
11	E.Stuckmayer	11649162	0	0	2.49	94				3.824	87
12	T.Machala	11649201	0	2	1.3	49	Cascade and 12th	44.274601	-121.180814	-1.206	32
13	E.Stuckmayer	11649248	0	0	2.54	96	Pumice/21st	44.260225	-121.191685	3.703	86
14	Y.Zhang	11649250	0	0	1.02	38	27th & SW Reindeer	44.256084	-121.199776	-2.702	16
15	L.Miller	11649266	0	1	1.26	47	Cascade and 12th	44.274674	-121.178649	-1.465	30
16	H.Hixson	11649268	0	2	2.26	85	harden park	44.2579796	-121.2084622	2.717	75
17	T.Machala	11649284	1	1	2.52	95	10th	44.275958	-121.178526	1.8275	65
18	E.Stuckmayer	11649312	0	0	2.05	77				-0.438	41
19	Y.Zhang	11649368	0	0	1.57	59	SW salmon ave 25th	44.254794	-121.197021	-1.919	25
20	E.Stuckmayer	11649383	1	0	1.41	53	Salmon/21st	44.254883	-121.191918	0.618	52
21	L.Miller	11649410	0	0	1.46	55	10th and fir	44.28075	-121.178572	-1.992	24
22	T.Machala	11649492	0	0	0.56	21	Birch and 10th	44.277461	-121.178644	-1.207	32
23	H.Hixson	11649519	0	0	1.48	56	30th and salmon	44.25475861	-121.2124644	-2.759	15
24	E.Stuckmayer	11649510	1	0	1.97	74	Salmon/24	44.25483	-121.195403	0.766	54
25	L.Miller	11649607	0	2	1.42	53	Nw fir dead end	44.281464	-121.179672	0.764	54
26	E.Stuckmayer	11649613			0	0	Quartz/24th	44.258281	-121.195591	-3.485	8
27	H.Hixson	11649660	0	0	2.03	76	37th and reservoir	44.2511183	-121.212686	-3.121	12

28	E.Stuckmayer	11649700	0	0	1.3	49	Pumice/24	44.260106	-121.195584	-0.284	42
29	E.Stuckmayer	11649743	1	0	1.42	53	Pumice/26	44.260062	-121.198252	-0.424	41
30	H.Hixson	11649805	0	1	0.93	35	35th and reservoir	44.24848911	-121.2096531	-1.765	26
31	L.Miller	11649850	0	0	1.13	42	Canyon at ivy	44.28434	-121.17808	-0.458	40
32	E.Stuckmayer	11649879	0	0	2.48	93		44.260572	-121.200189	2.101	68
33	E.Stuckmayer	11650025	0	0	1.4	53	17th/Quartz	44.258355	-121.18651	0.038	46
34	L.Miller	11650040	0	0	1.13	42	7th near les scwab	44.284605	-121.175256	-0.912	36
35	H.Hixson	11650063	0	0	1.88	71	31st and umatila	44.25107559	-121.2042331	-4.214	0
36	E.Stuckmayer	11650085	0	0	1.79	67	12/obsidian	44.262109	-121.181079	-0.235	43
37	T.Machala	11650167	0	0	1.08	40	Kingwood and 8th	44.287152	-121.1764	2.6865	75
38	E.Stuckmayer	11650201	0	1	0.93	35	Quartz/canal	44.258364	-121.182876	-2.843	15
39	L.Miller	11650222	1	0	1.51	57	Fir at 7th	44.280983	-121.176122	2.252	70
40	T.Machala	11650300	0	0	1.24	46	8th and dogwood	44.279137	-121.176588	-1.879	25
41	E.Stuckmayer	11650403	0	0	2.08	78	Umatilla/31st	44.251216	-121.204316	1.125	58
42	Y.Zhang	11650436	0	0	1.33	50	Umiatilla ave sw 30th	44.251192	-121.203115	-4.044	1
43	L.Miller	11650490	0	2	1.36	51	8th and black butte	44.275735	-121.176558	2.1706	69
44	T.Machala	11650511	0	5	1.79	67	Deschutes and 7	44.273188	-121.175456	-1.994	24
45	Y.Zhang	11650537	0	0	2.64	100	27th umatilla	44.251409	-121.199379	-1.885	25
46	L.Miller	11650603	2	4	2.37	89	Between library and city	44.273242	-121.176351	4.5452	95
47	Y.Zhang	11650625	0	0	1.44	54	27th sw timber	44.252861	-121.199425	-4.227	0
48	E.Stuckmayer	11651376	0	0	1.45	54	31/33	44.252728	-121.204353	0.2235	48

Appendix B: Walkability Audit Scores

Table 11: Raw data collected using the Walkability Audit tool

Walkability Audit Tool Raw Data													
ID	Collector	A	B	C	D	E	F	G	H	I	Y_coor	X_coor	Score
1	A.Martin	3	5	5	4	3	4	5	3	3	44.272568	-121.17876	80
2	L.Piccolotti-Holt	4	5	4	5	3	1	5	2	1	44.261882	-121.19993	72
3	A.Martin	2	5	3	2	3	4	2	3	3	44.272582	-121.17972	61
4	K. Bao	5	5	4	3	3	1	4	3	3	44.261052	-121.20446	73
5	A.Mills	5	3	2	4	5	4	5	4	1	44.2601955	-121.20021	75
6	L.Piccolotti-Holt	5	3	4	3	3	1	5	2	1	44.261978	-121.19692	65
7	A.Martin	2	3	2	4	1	1	1	4	4	44.272469	-121.18332	47
8	A.Martin	1	3	2	2	1	1	2	4	4	44.272526	-121.18333	42
9	A.Mills	5	3	4	5	5	4	5	4	3	44.2584859	-121.20046	85
10	L.Piccolotti-Holt	3	1	3	3	3	5	5	3	1	44.26201	-121.19408	60
11	A.Martin	2	3	3	5	3	4	1	5	4	44.272284	-121.18412	64
12	K. Bao	5	3	2	1	2	2	2	1	2	44.25971	-121.20457	48
13	L.Piccolotti-Holt	3	4	3	3	3	1	4	3	2	44.262094	-121.19292	60
14	A.Mills	5	3	4	4	5	4	5	4	4	44.2548462	-121.19949	84
15	A.Martin	4	4	2	3	3	3	3	5	4	44.274526	-121.18086	68
16	L.Piccolotti-Holt	1	4	5	3	1	1	2	3	3	44.261983	-121.19216	53
17	A.Martin	5	4	3	5	3	4	5	4	2	44.274671	-121.17881	80
18	A.Mills	3	3	3	3	3	3	3	3	3	44.2549183	-121.19819	60
19	A.Martin	4	4	5	2	3	4	4	4	2	44.27604	-121.17878	75
20	K. Bao	4	3	2	5	3	3	3	5	2	44.257991	-121.20843	67
21	A.Mills	3	3	5	3	3	3	3	3	2	44.2548461	-121.19693	65
22	A.Martin	5	4	5	4	3	4	5	5	3	44.277543	-121.17883	87
23	A.Mills	3	3	3	3	3	2	2	3	3	44.2548941	-121.19563	56
24	A.Martin	3	4	4	4	3	4	5	4	1	44.279279	-121.17844	74
25	A.Mills	4	4	4	3	3	3	4	3	3	44.2548686	-121.19428	71
26	A.Martin	1	2	2	2	1	1	2	3	2	44.280244	-121.17876	35
27	K. Bao	3	1	5	1	1	1	2	1	2	44.254738	-121.21178	41
28	A.Martin	1	2	1	3	1	1	2	4	2	44.281082	-121.18004	36
29	K. Bao	5	5	4	5	5	3	4	5	5	44.254809	-121.21231	91
30	A.Mills	3	4	3	2	3	1	2	2	3	44.2530148	-121.19419	53
31	A.Mills	2	2	5	2	2	2	2	2	3	44.2512066	-121.19412	50
32	A.Martin	2	1	1	2	1	1	2	3	2	44.282053	-121.17916	32
33	L.Piccolotti-Holt	3	3	3	5	4	1	5	2	2	44.258103	-121.19596	63
34	L.Piccolotti-Holt	3	5	1	3	5	5	1	5	2	44.260304	-121.19111	67
35	L.Piccolotti-Holt	2	3	3	3	2	1	2	3	1	44.255079	-121.1957	47
36	K. Bao	5	4	3	3	4	2	4	4	3	44.251088	-121.2127	73

Walkability Audit Tool Raw Data													
ID	Collector	A	B	C	D	E	F	G	H	I	Y_coor	X_coor	Score
37	L.Piccolotti-Holt	1	3	5	3	1	1	4	3	3	44.260098	-121.19549	54
38	A.Mills	2	3	3	3	3	3	2	3	3	44.2493729	-121.19411	55
39	A.Martin	1	4	2	4	1	1	2	5	2	44.284568	-121.17818	49
40	A.Martin	3	5	4	4	3	1	3	5	3	44.287007	-121.17626	71
41	A.Mills	3	3	5	2	3	4	3	2	2	44.2486266	-121.19398	63
42	K. Bao	5	5	3	3	4	2	4	5	3			78
43	K. Bao	1	1	5	1	1	1	1	1	2	44.249188	-121.20876	33
44	A.Mills	4	3	3	3	5	4	3	3	1	44.247567	-121.19514	67
45	A.Martin	4	4	3	4	3	1	3	2	1	44.285545	-121.17533	60
46	A.Mills	3	3	3	3	3	3	2	2	3	44.2462296	-121.19671	56
47	L.Piccolotti-Holt	5	4	3	5	3	1	5	3	1	44.260547	-121.20033	71
48	L.Piccolotti-Holt	1	4	5	4	1	1	4	3	3	44.260195	-121.19831	59
49	L.Piccolotti-Holt	5	3	4	4	3	1	5	3	3	44.258268	-121.18642	71
50	L.Piccolotti-Holt	5	5	2	3	3	1	5	4	3	44.262166	-121.18096	71
51	K. Bao	5	5	3	4	3	1	4	4	3	44.251021	-121.2043	74
52	A.Martin	3	3	2	5	3	2	3	2	1	44.28376	-121.17517	55
53	A.Mills	5	4	4	5	5	4	5	5	3	44.2444097	-121.19891	90
54	A.Martin	2	3	3	3	2	1	1	3	2	44.282041	-121.17518	46
55	K. Bao	5	4	5	3	3	3	4	3	3	44.253395	-121.20432	77
56	A.Mills	5	5	5	5	5	4	5	5	3	44.2446738	-121.19908	96
57	A.Martin	3	4	3	4	3	4	3	4	4	44.281002	-121.17636	70
58	K. Bao	5	4	4	3	4	2	4	4	3	44.258516	-121.20451	76
59	A.Martin	3	4	4	4	3	4	4	5	5	44.278958	-121.17656	78
60	L.Piccolotti-Holt	1	1	1	3	1	1	1	2	2	44.258343	-121.18285	27
61	A.Martin	3	4	2	2	3	4	2	5	5	44.276427	-121.17653	64
62	A.Mills	4	4	3	5	4	3	4	5	3	44.2512244	-121.20279	78
63	A.Martin	5	2	1	4	3	4	5	3	3	44.275483	-121.17649	65
64	A.Mills	3	4	3	3	3	1	3	3	1	44.2512615	-121.20171	57
65	A.Martin	5	4	5	5	3	1	4	4	4	44.274535	-121.1753	80
66	A.Mills	5	3	2	4	4	3	5	3	3	44.2511913	-121.1994	71
67	A.Mills	5	4	3	4	4	4	4	4	2	44.2527985	-121.1993	78
68	L.Piccolotti-Holt	3	3	3	3	3	1	2	3	3	44.25209	-121.20417	54
69	L.Piccolotti-Holt	5	5	3	4	3	1	5	4	3	44.25112	-121.20433	76

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