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Assessing Accessible Transportation Options Using GIS in Missoula, MT

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ASSESSING ACCESSIBLE TRANSPORTATION OPTIONS
USING GIS IN MISSOULA, MT

By

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  Accessible transportation is an integral service for many people with disabilities and the elderly in order to live healthy and fulfilling lives. This thesis aims to give communities a way of assessing their accessible transportation services to determine if they are adequately providing transportation to these populations. In this project data was gathered through interviews with agencies that provide accessible transportation in Missoula, MT and the surrounding area. This data in conjunction with U.S. Census data was compiled and spatially analyzed using GIS to create maps to assess current accessible transportation and show where additional accessible transportation may be of value. The maps created illustrate the number of options available for locations across the study area and when accessible transportation is available. The maps show that there is variance in the number of options across the study area and that as one moves toward the outskirts of the Missoula area, accessible transportation options are very limited. Additional maps spatially display factors associated with transportation such as cost, purpose for which the transportation can be used, eligibility criteria for the services, and type of additional assistance provided to the rider. These maps indicate there is variance in these factors across the study area also. This indicates that potential users may not have access to the most suitable transportation option depending on where they need to be picked up and dropped off. A second interview was conducted to ascertain the accuracy of the maps and if the agency representatives believe this information can be used to coordinate and collaborate services with each other and help them determine how to expand or restructure services. Four out of five of the agency representatives that participated in the study believe the maps provided useful information to their agency and all agencies agreed that this process would be useful to other communities in assessing their accessible transportation.

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CHAPTER 1
Introduction

> We also know transportation is about more than concrete, asphalt, and steel. It is about people and their daily lives. It is about dreams and aspirations, their connection to the economy and to each other. Transportation is the tie that binds. - Rodney E. Slater, Secretary of Transportation (U.S. Department of Transportation 2000, iii)

Most Americans hold dear the freedom to be able to go where they want, when they want and equate this freedom to a basic human right. The majority of United Statse citizens never think twice about getting into their car and driving to a store for groceries, going to work, visiting a friend, or running some other routine errand. However, this experience of jumping into a car and driving as a part of daily life is not a reality for many of the poor, elderly, and disabled populations who do not have readily available access to a vehicle and are known as the transportation disadvantaged (U.S. Government Accountability Office 2006, 2). The problem of finding adequate transportation may be compounded for people with disabilities, especially those who need specially equipped vehicles. Results in a survey conducted by the Bureau of Transportation Statistics indicate that there are more than 1.9 million people with disabilities in this country who do not leave their homes. Twelve percent of people with disabilities have difficulty getting the transportation they need, compared to three percent of persons without disabilities (U.S. Department of Transportation 2003, 4-5).

While many communities have public and/or private transportation services, almost none have developed methods for examining how well the transportation services they have in place serve their community, especially for the transportation disadvantaged who live there. Learning about the adequacy of established transportation options is the

obvious first step in developing plans for improving and updating services so communities can appropriately meet the transportation needs of the transportation disadvantaged.

An outcome for this thesis is to create a method that communities can use to assess the comprehensiveness of their transportation network for people with disabilities and the elderly. This project focuses on accessible transportation because many people with disabilities have difficulty in operating or even riding in conventional motor vehicles. This increases their inability to find appropriate transportation. The American with Disabilities Act (ADA) defines accessible transportation vehicles as providing a level-change mechanism or boarding device (e.g., lift or ramp) and sufficient clearances to permit a wheelchair or other mobility aid user to reach a securement location. At least two securement locations and devices shall be provided on vehicles in excess of 22 feet in length and at least one securement location and device shall be provided on vehicles 22 feet in length or less (United States Access Board 1994, Part 2: 2).

Many times people with disabilities and the elderly need additional assistance when accessing transportation, even if they do not need specially equipped vehicles. For example, many of the elderly who no longer drive may require extra assistance in getting to and from the transportation vehicle and in boarding or disembarking due to the mobility problems or other disabilities that made them give up driving in the first place. Many of the agencies that use wheelchair accessible vehicles that adhere to the American Disabilities Act (ADA) can hold additional passengers who do not use wheelchairs. Therefore the agencies that provide wheelchair accessible transportation services usually

also provide services to people with disabilities who do not use wheelchairs and the elderly. Therefore, these populations are also being considered in this thesis.

How information about accessible transportation services is presented by agencies to other agencies and to the general public can affect how well they understand the information. If information is presented in a written format, as is many times the case, it is possible to get some idea of the transportation options in a community, but it is not easy to understand how these services are organized spatially. This is especially true since this information is provided separately by each service provider, leaving it to the users to piece together all the available options.

Maps showing the locations served by a transportation provider help to illustrate spatially where transportation is available, but just creating maps that show service coverage does not provide enough information to adequately analyze accessible transportation in an area. Such maps do not address other pertinent issues that need to be taken into account when examining accessible transportation. These issues include who in the community is eligible for the services, costs of services, if there is more than one option for services for a particular location, when the services are offered, what purpose for which the service can be used, and exactly what assistance the service is able to provide to the users.

One way to assess these issues is to use the spatial analytical capabilities of a Geographic Information System (GIS) to visualize and spatially analyze the transportation services in a community. Though many definitions for Geographic Informational System (GIS) exist, one broad definition is that GIS is a "system of

computer hardware, software, and procedures designed to support the capture,

management, manipulation, analysis, modularity and display of spatially referenced data

for solving complex planning and management problems" (U.S. Federal Interagency

Coordination Committee, 1988). Spatial analysis can lead to new ways of understanding

transportation services and identifying patterns that were not apparent previously. If GIS

assessment reveals that existing transportation resources do not provide adequate

coverage and therefore are not adequately meeting essential travel needs (e.g., travel to

work, medical services, shopping, etc.), the community then has data to support

investigating new options and to apply for new sources of funding to better meet the

transportation needs of all its citizens.

Since funds for providing transportation are limited, it is especially important to

find ways to improve the efficiency of accessible transportation and to ensure that it is

available to those who need it.

<p style="text-align:center;">Research Goals</p>

The purpose of this thesis is to assess the current state of accessible

transportation, using Missoula, Montana as a case study, by collecting data for

several variables related to accessible transportation and by spatially analyzing this

data using GIS. Furthermore, a framework will be created for knowledge-based

decision-making regarding areas of greatest need for improving accessible

transportation, both spatially and across time. Table 1 defines the attributes examined

and the name of the variable associated with each.

Table 1. Attribute definitions and variable names

Attribute	Definition	Variable Name
Where	Locations where the transportation service will pick up or drop off passengers	Service Area
Who	Who is eligible to use the transportation service	Eligibility
When	Times the transportation service is available	Time of Service
Why	Purposes for which the passenger can use the service	Purpose
How much	Cost of the service for the passenger	Cost

It is hoped that a visual display of information regarding transportation in an easily understandable format, will help local agencies learn what other transportation options are currently being provided, discern if current services are meeting the needs of disabled and elderly residents, and determine the areas of greatest need when expanding or changing their transportation service options. Additionally, this information can help agencies to coordinate their services and facilitate collaboration between agencies to create a plan to better serve the community regarding accessible transportation. Furthermore, transportation users can use this information to find the transportation services that will fit their specific needs.

<u>Objectives</u>

To achieve this purpose, several objectives will need to be met. The following objectives form the framework for the methodology of this thesis project.

Objective 1: identify all accessible transportation options in Missoula, MT. It is important to determine which transportation options have been either developed or adapted to accommodate people with disabilities since they are the segment of the population found to have the greatest need for alternative transportation.

Objective 2: use interviews to gather all relevant information regarding the accessible transportation options that is necessary to analyze the current option. Each agency that provides transportation has a different mission in regards to their services. These agencies may focus on providing transportation to different populations or may limit the purpose for which their services may be used. The reasons for these differences can depend on a variety of factors such as the agency's funding source, the amount of funds available, and/or the capacity of the vehicles they operate. Times the services are available, cost of the services, and level of assistance available are also important factors when determining the adequacy of the transportation system to meet the needs of people with disabilities and the elderly. This information will be gathered by interviewing representatives at each of the agencies identified in the first objective.

Objective 3: create a series of maps using GIS that accurately portrays current accessible transportation in Missoula, MT. As previously noted, the first step in determining if improvements in accessible transportation options are needed is to evaluate its current state. One way to evaluate transportation is to use a GIS to create a spatial representation of options that are available. These representations can show either a snapshot in time of transportation services or changes in services over a period of time. In addition spatial representations can be manipulated to refocus attention on different attributes related to transportation depending on the area of interest.

Objective 4: create a framework for knowledge-based decision making regarding improving transportation options using GIS. Once the current state of transportation has been established, analysis can be done that takes into account other

relevant factors. For this project, the population distribution of people with disabilities and the elderly will be analyzed in relation to the density of transportation options over the study area. This information will provide a way to identify areas that may benefit from additional transportation options.

Objective 5: evaluate the usefulness of the information provided by the maps to facilitate coordination and collaboration among agencies that provide accessible transportation. Since a variety of agencies are responsible for providing transportation to these populations and there are limited funds and options, it is essential that these agencies work together to provide the best array of accessible transportation possible. This can only be done if agencies are knowledgeable about the transportation system as a whole, including each other's missions and services, and are willing to work together.

Significance of the Study

Results of this project will show the extent of spatial and temporal options among the accessible transportation services found in Missoula, MT and will help examine if the options are distributed in a way that addresses the unique population patterns of the community. Agencies will be able to use this information to better coordinate their services to fill any gaps or, alternatively, have evidence to support the need for additional funding for more services. This information is also important for the general public in order to improve the community's overall understanding of transportation services and the issues surrounding accessible transportation. People with disabilities and the elderly will be able to also use the information in a variety of ways including determining where might be the best place for them to live in a community, choosing where they may make

appointments for services, and deciding which transportation option may best fit their need for a particular purpose. Furthermore, the methods employed in this project could be duplicated in other rural or small urban communities to assess their unique accessible transportation systems.

<center>Study Area</center>

Missoula is located in western Montana deep in the heart of the Rocky Mountains. It is found in a deep valley surrounded by mountains and is cut by three major rivers, the Clark Fork, the Bitterroot, and the Blackfoot. According to the 2000 Census, in 2000, the City of Missoula covered a total area of 23.9 square miles or 15,296 acres (U.S. Census Bureau 2000). Missoula is currently the second most populous city in Montana. In 2000, there were 57,053 people and 24,141 households residing in the city limits; a 2004 estimate put the city's population at 61,790 (U.S. Census Bureau 2004). In 2000, the population density was 2,397 per square mile, and there were 25,225 housing units at an average density of 1,060 per square mile. The University of Montana is also located in Missoula, though many of the students are not counted in its population since they have permanent residency elsewhere. According to the University of Montana Web site, in 2007 the University had 13,858 students.

There are many suburbs and communities within ten miles of Missoula (East Missoula, Bonner, Milltown, Orchard Homes, Frenchtown, and Lolo); when these surrounding suburbs and communities are taken into account, the population grows to over 100,000. These communities are within the commuting zone of Missoula. Commuting zones were established by Tolbert and Sizer (1990) through analyzing

county-to-county flow of commuters with a hierarchal cluster algorithm. Although the study area is completely in Missoula County, the City of Missoula was identified as the largest population place for the commuting zone and therefore is the most likely destinations for commuters. Missoula is the regional medical, business, and shopping hub for these communities. Therefore these communities and suburbs have been included in the study area (Map 1).
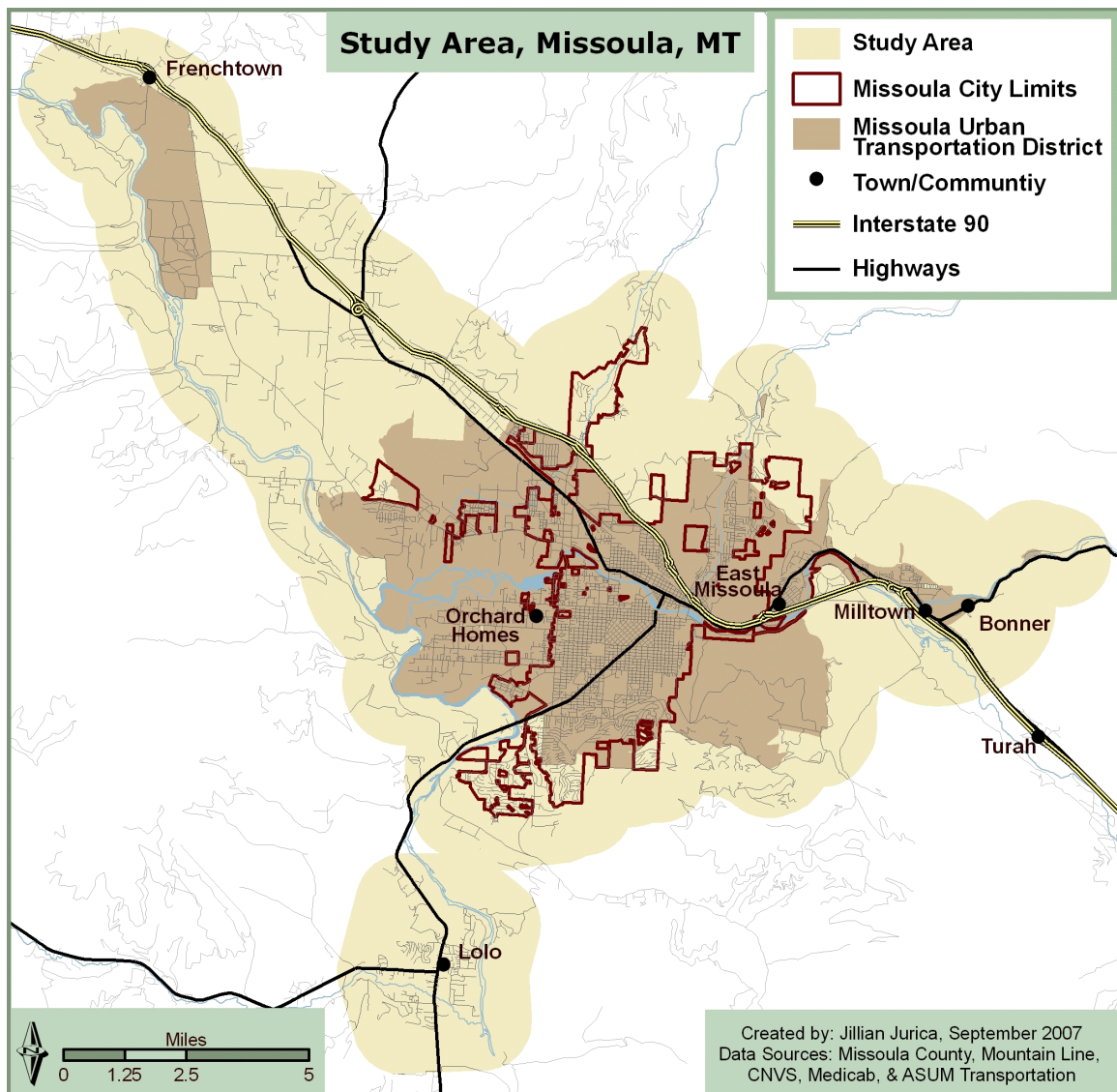
Map 1. Study area

The extent of the study area was determined by the locations of accessible transportation available in Missoula, Montana and the surrounding area. A buffer of three-fourths of a mile around the service areas of the agencies participating in this study was created, with the exception of the wheelchair user-only service provided by Medicab, which serves a nine-county area. The study area encompasses all of Missoula's city limits and the suburbs and small towns surrounding Missoula. For all locations outside the study area, there is only the one accessible transportation option for wheelchair users provided by Medicab. Additionally, none of the agencies expressed that there was any plan of extending their transportation service area beyond the study area boundaries in the near future. Therefore it was determined by the author there would be no basis to extend the study area any further.

Missoula is a small but growing urban area, just like countless other small urban areas around the United States. And as the area continues to grow, building and maintaining a transportation system that keeps up with the population changes will continue to be a challenge. The problems that can arise as a consequence of not having adequate transportation are more than mere inconveniences for people with disabilities and the elderly. The research findings presented in the following chapter demonstrates how every aspect of a person's life can be negatively affected by not being able to get to the places they need or want to go.

CHAPTER 2
Literature Review

To adequately understand the significance of transportation for people with disabilities and the elderly, it is important to review previous research into issues surrounding transportation for people with disabilities and the elderly. In addition, I examined changes in settlement patterns and projected trends in population composition over the next twenty years to determine the effects these factors may have on the need for a greater number of transportation options and larger service areas. Finally, research regarding disabilities in the fields of geography and GIS was reviewed to get an overall view of how the study of disabilities fits into the field of geography and how this study can add to this body of research. The results of this review are presented in this chapter.

Change in Settlement Patterns Contributing to Urban Sprawl

One factor that contributes to the need for better transportation systems in the United States is the settlement pattern of "urban sprawl" that has developed over the years. Urban sprawl is the pattern of low-density land use, which is characterized by large suburban residential areas. It can be traced back to the industrial revolution when the increased demand for local labor caused major growth of many cities in the eastern US. The wealthy were able to escape the congestion and poverty that characterized the rapidly industrializing cities by building exclusive residential neighborhoods around the edges of cities.

Next, the expansion of the railroad network in the 1880s allowed cities and towns to develop new industrial centers along the railroad tracks some distance away from existing residential neighborhoods, sometimes giving rise to separate suburban

communities. During this period, the development of streetcars enabled middle-class residents to move to the edge of the expanding city, while the poor continued to live within walking distance of factories in the industrial center where they worked.

The economic boom after World War II allowed most families to own a car resulting in a new surge of families moving out of the cities into newly developed suburban communities. These communities required residents to drive to services and stores. Most of these communities consisted of single-family houses with yards, creating homogeneous neighborhoods of middle-class families. These new neighborhoods enabled homeowners to have more land and living space than they could afford in the city center, a trend that continues until today. The suburbs grew five times faster than the central cities in the 1950s, more than four times faster in the 1960s, and nearly five times faster in the 1970s (Beauregard 2006, 35).

Suburbs did not follow the same pattern as the cities they grew around—they lacked the mix of residential, commercial, and civic buildings found in cities. In many suburbs, local governments adopted zoning ordinances separating different types of development into different physical spaces. Businesses have followed residents into the suburbs, but because of zoning regulations, they have remained segregated from housing, creating the need for transportation in order to complete the tasks of daily living, such as grocery shopping, going to medical appointments, and banking.

The increase in population in the suburbs covers all age ranges. In the United States the percentage of seniors living in the suburbs increased from 39% in 1980 to 46% in the mid-1990s. As seniors get older, the proportion living alone and the proportion

having a disability have both increased creating barriers to transportation (Wasafi,

Levinson, and El-Geneidy 2007, 4). Because low-density land use patterns in these areas

lead to greater reliance on the automobile and complicate the provision of alternate

transportation services, this trend compounds the issue of transportation for the elderly

and people with disabilities.

<u>Changes in Population</u>

A second factor that is contributing to the need of better transportation systems is

the changes that are taking place with the composition of the general population. In

virtually every industrialized nation, increasing life expectancy and declining birth rates

are resulting in aging of the population as a whole. Twelve percent of the total

population was age sixty-five and over in 2002, and this percentage is only expected to

increase. It is projected by the year 2030 the percentage of people age sixty-five and

over will increase to 20% (U.S. Census Bureau, 2006). At the current rate of growth, by

2025, Montana will have the third largest percentage of people over age 65, trailing only

Florida and West Virginia (U.S. Census Bureau, 1996). It is also projected that Missoula

County will see a 53.5% increase in the 65 and older population between the years 2000

and 2030 (Census & Economic Information Center, 2008).

In the U.S. both men and women are likely to live beyond the time that they can

drive safely, as much as six years for men and about ten for women (Foley et al. 2002,

1284-1289). When they can no longer drive safely, they will lose the independence of

the personal automobile and become dependent on alternative transportation. If trends

continue, the necessity of a comprehensive transportation system, with both public and

private providers, is only going to become more pronounced in the future. As previously

noted, as the population grows older, the percentage of disabilities for the elderly also

increases. These disabilities include reduced vision, poor memory, and increased

difficulties in performing daily living activities (Foley et al. 2002; Bailey 2004).

Currently, approximately 18% of the U.S. population has some sort of disability and

11.5% has a severe disability[1] (U.S. Census Bureau, 2006). The increase of disabilities in

the population as it ages will put an additional burden on the existing public and private

transportation systems and force communities to provide more options for accessible

transportation.

<div align="center">

Importance of Accessible Transportation for People
with Disabilities and the Elderly
</div>

Accessible transportation can change a person's life from one of isolation and

dependency to one of social integration and independence. Travel has always

contributed to Americans' enjoyment of their lives and leisure. When transportation does

not work well, it can be a source of great personal frustration and economic loss. People

who are unable to fully use the existing transportation systems may experience reduced

access to opportunities for employment, health care, education, shopping, recreation, and

social and cultural events (U.S. Department of Transportation 2000, 3-11). People with

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[1]

Adults aged 15 and over were classified as having a severe disability if they used a wheelchair or had used another special aid for 6 months or longer, were unable to perform one or more functional activities or needed assistance with an activity of daily living or an instrumental activity of daily living, were prevented from working at a job or doing housework, or had a selected condition including autism, cerebral palsy, Alzheimer's disease, senility or dementia, or mental retardation (U.S. Census Bureau, 1994).

disabilities do not want sympathy; their main goal is to live as independently as possible and to be integrated into the mainstream of society. People with disabilities need to have the opportunity to realize their potential in a fully supportive environment (Gilderbloom and Rosentraub 1990, Iezzoni et al. 2006).

Lack of adequate transportation has been found to adversely affect people with disabilities and the elderly in many areas of their lives (Crudden, Sansing, and Butler 2005, Iezzoni, Killeen, and O'Day 2006, Schopp, et al. 2007, Bailey 2004). Access to alternative transportation systems is considered to be crucial for the elderly to minimize social isolation, maintain social interaction, visit community and social services, and access healthcare (Cvitkovich & Wister 2001, 810). It is not a stretch of the imagination to realize that this statement is also true for people with disabilities.

Transportation services are a vital component of any comprehensive medical care program. More available transportation services encourage greater use of preventive medical care by seniors, keeping people mobile and independent in their own homes, and reducing overall health costs to society (Burkhardt 2006, 32). However for people with disabilities and the elderly, obtaining reliable transportation can be problematic when it comes to procuring appropriate health care. In a focus group study with people with disabilities conducted in Massachusetts, in almost all the focus groups, individuals cited transportation problems as a barrier to accessing healthcare. This study also found that patients with Medicaid, which pays for local public transportation to medical appointments, are frequently picked up or dropped off a couple of hours early or late. Therefore, many riders must book their pick-up hours early to ensure they do not miss

their appointments, which transforms a medical visit into a whole-day affair (Drainoni et al. 2006, Iezzoni et al. 2006). Besides time delays, the eligibility requirements for publicly funded transportation for persons with disabilities prevented some individuals from accessing these services at all. Blind and deaf individuals noted that Medicaid did not consider their disabilities to be medical conditions and therefore would not pay for the use of transportation services (Drainoni et al. 2006, 106-107).

For some elderly, an additional problem for obtaining transportation for medical services is the cost of transportation services. While Medicaid funds transportation to medical and health-related services for low-income, and elderly or disabled persons who qualify, Medicare, the federal health program designed to provide medical insurance for all persons sixty-five and older, only provides emergency medical transportation when using an ambulance. According to one study, reduced mobility translates into 15% fewer trips to the doctor for non-driving older people (Bailey 2004, 4). Another study revealed that having transportation is an important enabling factor for health care utilization. This study found that if an individual is unable to drive themselves to health care appointments, having friends or family available to drive them significantly increased the number of chronic health care visits. The use of public transportation also increased the number of chronic health care visits by an average of four visits per year (Arcury et al. 2005, 35). If appropriate transportation was readily available, perhaps more elderly and people with disabilities would be able to receive the medical care they need.

Quality of life is another factor that can be affected by lack of adequate transportation. Many people with disabilities and the elderly find that they are unable to

participate in many of the social activities they would like to because they are unable to get to them. Inadequate transportation was found to be one of the barriers with greatest impact that affects social participation and life satisfaction in a study of people with traumatic brain injury (Whiteneck et al. 2006, 196). Transportation was the second most important environmental barrier, after the natural environment itself, that limited people with spinal cord injuries in participating in activities, therefore reducing life satisfaction (Whiteneck et al. 2004, 1797). When an individual is dependent on others for transportation, the extent he or she can interact with the environment is greatly restricted, which adversely influences quality of life (Joseph and Fuller 1991).

Forty-five percent of seniors in focus groups in a study in Minnesota also indicated that there were places that they were unable to get to because of transportation difficulties. This included both places they needed to go, such as appointments, and also places they wanted to for social and leisure purposes (Wasfi, Levinson, and El-Geneidy 1997, 11). In another focus group study with seniors in California, Florida, and Michigan, the seniors cited problems getting to what might be categorized as "non-essential" or "fun" trips." These trips included events at night, visiting the sick, visiting museums, going to senior centers, participating in volunteer work, attending church services and meetings, and attending cultural events (Kerschner and Aizenberg, 1999, Part V:25). One study found that reduced mobility for non-driving older people resulted in 65% fewer trips for social, family, and religious purposes (Surface Transportation Policy 2004). The results of a survey conducted in Oregon showed that 41% of individuals with mobility impairments, which included all ages of people, would

like to make more trips in their community but are prevented from doing so because they do not have transportation (Oregon Department of Transportation 1999).

People with disabilities who are not elderly, often have the added concern of finding transportation to their place of employment. A study on post-injury factors that affect occupational performance found that lack of transportation or even just less access to transportation contributed to worse outcomes in the area of employment (Devitt et al., 2006). Schopp and his coauthors (2007) found that nearly half of the participants in their study of individuals with spinal cord injuries living in the community reported that physical barriers and transportation limited their access to employment. Another study found that persons with mobility disorders were most dependent on others for activities related to household tasks and transportation, whereas it was easier for these individuals to acquire independence in their work tasks (Andren and Grimby 2004, 270). These findings show that in many cases a person with disabilities is unemployed or under-employed not because they cannot perform a job, but because they cannot get to a place of employment due to lack of appropriate transportation.

<div align="center">Meeting Transportation Needs</div>

City bus systems are among the most common services that one thinks of when considering transportation. However, in smaller cities, if there is a bus system available, the service can be fairly limited in terms of times of day it operates and areas covered. City bus systems also are not able to provide additional assistance to passengers in reaching their destinations after they disembark the vehicle. Originally, many city bus systems had an alternative service known as paratransit for people with disabilities who

were unable to use the fixed-route bus system. This service used accessible vehicles to provide transportation. In 1990, Congress passed the Americans with Disabilities Act (ADA), which protects persons with disabilities from discrimination in employment, provision of public services and accommodations, and transportation. One of the main effects of the ADA is that paratransit is no longer to be used as a substitute for fixed-route service. Under the ADA, fixed-route service must be made available to the disabled; paratransit is to be provided only when fixed-route transit does not meet a customer's needs or is inappropriate to the situation. Moreover, paratransit eligibility is no longer based on a person's disability but on whether or not the person has the ability to use the fixed-route system (U.S. Department of Transportation 2000, 5-11). The result of this legislation has been that now the majority of city buses are ADA accessible, with powerlifts and wheelchair securements.

However, buses and other fixed-route transportation and their paratransit components are only one type of transportation option that may be available in a community. A second option is to have family or friends provide transportation. While it is often assumed that older adults have children nearby and will receive transportation assistance from them, this is often not the case. Even when people have children in the area, they may not (and often cannot) depend on them to provide transportation because the children are busy at work and/or the parents do not want to be a burden (Kerschner and Aizenberg 1999, Part V:5). Often this same expectation that family and friends will provide transportation for people with disabilities exists with the same results. People in wheelchairs are also at an additional disadvantage in this scenario since most people do

not have vehicles that can accommodate wheelchairs. This leads to many non-driving seniors and disabled people dependent on the third option of public and community-based transportation services. However, many communities do not offer these services, and even where they are available, older adults may be unable to use them because of the physical conditions that forced them to give up driving in the first place.

Furthermore, many elderly people want transportation services to also be "senior-friendly." Extensive research conducted in California arrived at five principles of senior-friendly transportation: availability, accessibility, acceptability, affordability, and adaptability (Kerschner and Harris 2007, 4). Seniors want flexible, door-to-door transportation service that responds to the needs that they may have on a particular trip. They also want to be able to have access to services on less than a twenty-four hour notice and want to be able to travel more hours of the day and days of the week than many public transit authorities currently offer (Sterns, Burkhardt, and Eberhard 2003, 11). Additionally, results from a survey by the Oregon Department of Transportation (1999) indicated that respondents of all ages rated the most important transportation service elements as the safe operation of the vehicle, the availability of personnel who are knowledgeable about special needs, procedures to safely secure a wheelchair, the availability of wheelchair accessible vehicles, and the ease of access to the transit location.

Meeting these senior and disability friendly requirements can be difficult for public transit, paratransit, nonprofit organizations that provide transportation, and privately owned transportation agencies. Normally, the design of these services is not

conducive to the special needs of the disabled or elderly population. Although many of the transportation services may include helping passengers into and out of vehicles, they do not go as far as offering door-to-door services, door-through-door assistance or the escort of passengers from the vehicle to their destination. Costs for paid staff, vehicles, equipment, and insurance can dramatically limit the ability of a transportation service to do more than provide fixed-route or curb-to-curb service (Kerschner and Harris 2007, 4). Additionally, lack of funding and the distance to destinations often can be restrictive factors for transportation agencies which cause them to limit the services they offer to a single purpose, limit which people are eligible for the service, or limit availability to certain days of the week or hours of the day.

However, research indicates that communities need a range of transportation services throughout the day to help older adults remain independent and socially integrated as their functional capabilities change and as they drive less or cease driving altogether (Sterns et al. 2003, 14). The idea of the need for a range of transportation services can be extended to people with disabilities. Historical assumptions about the role of conventional fixed-route public transport need to be questioned, and opportunities for more flexible forms of transport should be investigated both in terms of technology and the service providers (Alsnih and Hensher 2003, 912).

There have been several programs established by the federal government to address the problem of inadequate local transportation. For example, the Federal Transit Administration makes funds available to each state to administer their Elderly Individuals and Individuals with Disabilities programs, the Job Access Reverse Commute programs,

and the New Freedom programs. For agencies and organizations to qualify for funding, they must demonstrate that the projects they want to implement comply with the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU 2005). This Act requires projects selected for funding under the federal programs be "derived from a locally developed, coordinated public transit-human service transportation plan" and that the plan be "developed through a process that includes representatives of public, private, and nonprofit transportation and human service providers and participation by members of the public." In addition, the agencies and organizations seeking funding must demonstrate that they coordinate and collaborate with other agencies that provide local transportation. Funding can be very competitive, and if an agency or organization can demonstrate that it has met the requirements of SAFETEA_LU, its chances of obtaining additional federal funding are vastly improved.

<div align="center">Types of Transportation Services</div>

Every transportation service delivery system has two main components, a spatial component and a temporal component. The spatial component corresponds to the route or routes that the transportation service offers, and the temporal component is the type of schedule that is available for the service. Both of these components can occur along a continuum of flexibility, from fixed to very flexible. A framework that describes four different types of transportation services along this continuum that are typically available has been developed (Burkhardt, et al. 1995, 16). The four types of transportation services are described below.

Fixed-route, fixed-schedule: this category is usually associated with traditional bus service. The route is always the same with scheduled stops at specific locations.

Fixed-route, flexible-schedule: this service travels along the same route and stops at particular locations, but does not adhere to a strict schedule. An example of this is commonly seen in tourist areas where buses travel a loop of popular sites and there may be an estimated time between buses, but there is no set schedule of when buses arrive or depart.

Flexible-route, fixed-schedule: this type of service usually follows a general route, but time is allowed between stops so that the vehicle can detour off the route to either pick up or drop off passengers who are located within a certain distance of the route.

Flexible-route, flexible-schedule: this type of service is also known as demand-responsive service. The route is variable as is the schedule in this instance. For this type of service, the rider usually calls a provider to schedule a pick up at the riders' location and then transportation is provided to their destination. Although this may be the most convenient for the riders, the transportation usually has to be arranged at least twenty-four to forty-eight hours in advance, making spontaneous trips nearly impossible.

<u>Geography and Disability</u>

The area of disabilities as it relates to the field of geography has been relatively neglected until fairly recently (Gleeson, 1999a, Butler & Hester, 2000, Park, et al, 1998, Hansen and Philo, 2006). Some geographers have labeled the lack of addressing disability in the field of geography as "ableism" or "disabilism" (Gleeson, 1999a, 130).

Ableism (or disabilism) refers to ideas, practices, institutions and social relations that presume ablebodiedness, and by so doing; categorize persons with disabilities as marginalized, oppressed, and largely invisible "others" (Chouinard 1997, 380).

Of course, there have been a few exceptions to the overall scarcity of studying disability in relation to geography. For example, beginning in the early 1970s the pioneering work of Reg Golledge, a geographer, focused on the needs and social experiences of people with disabilities (Gleeson 1999a, 1). Furthermore, in the field of medical geography there has been considerable study regarding the spread of certain diseases, which oftentimes have symptoms that are disabling, across space and time. In the 1960s, geographers began to study various aspects of mental health, such as the spatial distributions of mental illnesses and the location dynamics of mental-health facilities. In the 1980s, a movement to integrate people from institutions back into communities took hold, and new areas of research emerged in the mental health fields. Many geographers began examining what happened to the residents of these facilities after they left the institutions and the attitudes of communities toward these individuals (Park, Redford, and Vicker's 1998, 217-223).

It was not until the early 1990's that disability and the socio-spatial aspects associated with disability began to be addressed in earnest by geographers in a variety of subfields of geography (Hansen and Philo 2007; Park, Radford and Vickers 1998). In the area of human geography, the concept of how disabled people maneuver through and relate to their environment and in turn are then viewed by society has been explored by a number of geographers.

The book, *Mind and Body Spaces* (Butler and Parr, 1999), is a collection of writings from social scientists, the majority being geographers. The chapters highlight new research on bodily impairments, mental health, and social attitudes that increase the stigma of having a disability. For example two chapters address the interaction of geography and disability and its affect on employment (Dyck 1999; Hall 1999). Another chapter examines the question of whether technology can overcome the accessibility problems people face living in the modern city (Gleeson 1999b, 98-118). A discussion on the aspects of the social and spatial environment that contribute to either the inclusion or exclusion of individuals with mental ill health is presented (Milligan 1999, 221-239). Finally affordable housing for people with disabilities and the theoretical debates about social justice and decision-making processes surrounding the creation of a housing project are also studied (Gathorne-Hardy 1999, 240-255).

In his book, *Geographies of Disability* (1999a), Brendon Gleeson explores the relationship between space and disability. He argues that the topic is important for at least two reasons: first, space and related concepts such as mobility and accessibility, are profoundly important to how having a disability affects a person's life; and second this relationship has been given relatively little attention the past by most western social scientists including those in urban planning, geography, and architecture.

In the area of economics, Gleeson (1999a,) postulates that the capitalistic society, which emphasizes productivity above all else, actively excludes people with disabilities not only socially but also through the physical environment of the work place. Other geographers have studied how the inability to get to the work place and the problems of

negotiating obstacles within the workplace, in addition to the attitude of employers, has led to a higher rate of unemployment for people with disabilities and to a disproportionate number of people with disabilities in lower skilled, lower paying jobs (Gleeson 1999a, 129-152).

Finally, it is probably most surprising that in the area of urban planning, where access and mobility are integral concepts, disability has largely been ignored until the last two decades. Now, many geographers and urban planners are examining how the built environment actively discriminates against people with disabilities in a way that seems to attempt to exclude them from society. Ideas about identity and place underlie the emergence of a variety of urban studies concerned with the spatialities of disability (Irmie 2001, 232). This is a small but growing area of scholarship is documenting the diverse way in which disabled people's lives are influenced by the intersection between their bodies and broader socio-institutional attitudes and practices. The works of Irmie, Matthews, and Vujakovic, regarding how barriers to inclusion are clearly evident in the urban environment, are examples of this research (Kitchin 1998, 346-347). For example, some barriers that have made many spaces "no go" areas for people with disabilities include the design of buildings with stairs instead of ramps, cash machines being placed too high, and places linked by inaccessible public transportation.

GIS and Disability

GIS is a tool that geographers can use to add to the small but growing body of research in the field of disabilities and geography. Models for finding the best routes for people with disabilities to traverse the physical environment is one way GIS is being used

(Matthews et al. 2003, Sobek and Miller 2006). Additionally, urban planners can use the models built by GIS as tools to aid in their decision making and planning by making visible the barriers that exist for wheelchair users and for other people with differing physical abilities that may affect their mobility.

Another use of GIS has been to assess the location of employment services for people with disabilities (Metzler and Giordano 2007, 88-97). In this study it was found that areas with high numbers of unemployed people with disabilities are geographically under-served by both Vocational Rehabilitation offices and One-Stop service centers. When employment centers are not located near the highest population concentrations of people with disabilities, it increases the need for accessible transportation for people with disabilities to reach these services.

GIS is also being used to improve emergency management and disaster response for people with disabilities by providing the ability to spatially coordinate resources from separate systems, such as ADA accessible vehicles funded under Section 5310 of the Federal Transit Act, emergency shelters, and the Center for Independent Living offices in the area impacted by hurricane Katrina (Enders and Brandt 2007, 223-229).

<div align="center">Summary</div>

Research regarding transportation and disabilities illustrates the importance of adequate transportation options for people with disabilities and the elderly for an improved quality of life in a variety of areas including health, employment, socialization, and overall satisfaction with life. The ability of the government and private businesses to provide these options have been complicated by the prominent settlement pattern in the

United States known as urban sprawl. As the U.S. population ages, the demand for additional transportation options has increased and this demand is predicted to continue to grow in the futures.

Historically, geographers have not sufficiently addressed disability as in the field of geography; however this is changing as research in the field of geography as it pertains to disability continues to grow. Research in the field of GIS and disabilities, through still fairly limited, has also seen growth in the last few years. GIS is a tool that can be used to improve the lives of those with disabilities in the area of transportation. It can also be used to impact many other aspects of their lives, and is a field that deserves continued research.

CHAPTER 3
Methods

The city of Missoula and the surrounding communities was chosen as the pilot

study area for this thesis for a number of reasons. First since, I reside in the community, I

am knowledgeable about the area and it was convenient for interviewing the agencies

that participated in the project. Second Missoula is one of the three cities in Montana to

have a public transit system along with other accessible transportation options. Most

cities and towns in Montana that do have accessible transportation have only one or two

options making it fairly easy to determine if the transportation option(s) are meeting the

need of the communities. However, since Missoula is the second largest city in Montana

and has several different accessible options it becomes more difficult to assess if the

transportation options are truly meeting the population's need. Another reason is the

projected increase in the elderly population in Montana. As I noted in previous chapter,

at the current rate of growth, by 2025, Montana will have the third largest percentage of

people over age 65, trailing only Florida and West Virginia (U.S. Census Bureau, 1996)

and Missoula County will see a 53.5% increase in the 65 years of age and older

population between the years 2000 and 2030 (Census & Economic Information Center,

2008).

In order to assess a community's accessible transportation using GIS, it is

essential to gather as much information as possible about who provides this type of

transportation and what their services entail. For the purposes of this thesis, I determined

that the most effective and efficient way to capture this information was to interview the

agencies that provide accessible transportation in the study area. This chapter describes

the methods I used to identify and interview agencies that provide accessible

transportation options. Once the information was gathered, it was necessary to compile it

in an organized fashion into an ArcGIS geodatabase in order to create maps and spatially

analyze the data. Finally a method that uses spatial analysis to categorize locations in the

study area from low to high that may benefit from additional accessible transportation

options is described.

<u>Identifying Accessible Transportation Options in the Study Area</u>

Five agencies provide accessible transportation services to the general public in

Missoula and the surrounding area (Table 2). These agencies were identified through

Internet searches and by calling agencies that provide their customers information

regarding transportation such as the Missoula Aging Services and local hospitals. The

term "general public" means that anyone can use the transportation service as long as

they fit the eligibility criteria for that services. In other words, the service is not limited

to clients of a particular agency or residents of a particular facility.

Although many assisted living facilities, nursing home, and group homes provide

transportation services for their clients, these agencies were not included in this study

since their services often do not have set schedules or hours of operations. Instead the

services are tied to their clients' circumstances and needs. In addition, there is a taxi

company that provides services in Missoula. This business was not included in this study

since it does not provide accessible transportation; however, it is a viable transportation

option for the many elderly individuals and people with disabilities that do not need

accessible transportation.

Table 2. Accessible transportation agencies in the study area

Agency Name	Agency Type
Mountain Line	Public transit bus system and paratransit
Community Needs Van Service (CNVS)	Nonprofit agency
Medicab	Private medical transportation service and private transportation for wheelchair users
Opportunity Resources, Inc (ORI)	Nonprofit agency
Associated Students of The University of Montana (ASUM)	University funded bus shuttle service

Each agency that participated in the project was first contacted by telephone. During this initial contact the project was described to the person who answered the call, who was then asked to identify the specific individual who was most knowledgeable about their accessible transportation services to be contacted regarding being interviewed for the project. A letter that described the project in greater detail was sent to the person recommended for the interview and a second telephone call was made to set up the first interview time. The potential interviewees were informed at this time that a second interview would occur after the maps had been completed in order to verify their accuracy and functionality.

<div align="center">Initial Interviews</div>

A semi-structured interview style was used to gather knowledge about the transportation services provided by the agencies. This style involved using a predetermined set of questions created for the interview. However, the order the questions were asked varied. For example, if an answer given to one of the questions

naturally lends itself to another question that was to be asked later on, then the order could be changed. Also I asked follow-up questions to clarify confusing answers and to ensure that the questions were fully answered.

The questions were organized in a pyramid structure to encourage rapport with the interviewee. A pyramid structure refers to the concept that the interview starts with easy-to-answer questions about a topic, which allows the informant to become accustomed to the interview and interviewer. More abstract and open-ended questions were asked toward the end (Dunn 2005, 86). For this thesis, the interview questions were ordered to first cover the factual information about the location, eligibility criteria, and times of services and then progressed to the topics that involved expressing opinion about the adequacy of transportation services in the area and about the agency's collaboration and coordination with other agencies that provide transportation services. The following table contains the questions that were asked in the initial interview and the purpose for each question (Table 3). I recorded the answers in writing as they were given.

Before asking questions the last two sets of questions, sets seven and eight, I gave the interviewee the definition of coordination and collaboration for this project. Coordination is when an agency structured or changed their services to address unmet needs in the community or made referrals for consumers to more appropriate services. Collaboration referred to working together with other agencies to develop a plan that would improve accessible transportation services in the community. Two of the agencies interviewed, Mountain Line and Medicab, offer two separate services. Therefore, during

the interviews with each of these agencies the first five sets of questions were asked

twice, once for each service that agency provides.

Table 3. Questions for the initial interview

Interview Questions	Purpose of Questions
1. Who are your transportation services intended for? 　　a. Is there an eligibility criterion for consumers to use your services?	These questions were aimed at determining who is eligible for this particular transportation service.
2. Can consumers use you transportation services for any reason or is you service limited to a specific purpose? 　　a. What purposes qualify?	These questions were asked to determine if transportation services are only available for limited purposes.
3. Describe the area that you provide transportation services to? 　　a. What is the greatest distance you will travel? 　　b. Have you ever turned someone down for transportation because they are not in your service area or wanted to travel outside of your service area? If yes, where did they live or want to go?	The answers to these questions were used to help ascertain the areas in which the transportation service is available in order to establish service area boundaries for each agency's map.
4. When are your services available? 　　a. Days of the week? 　　b. Hours of the day?	This set of questions was asked to find out the hours and days of operation for each of the transportation services.
5. Do your services cost? 　　a. What are the rates? 　　b. Are these rates the same for everyone and if not how are rates determined?	These questions were used to determine cost associated with using the each transportation service.
6. Do you believe the transportation services are adequate for people with disabilities and the elderly in Missoula? 　　a. If no, why not? 　　b. How could they be improved?	This set of questions was asked to find out if interviewee believed that transportation services are adequate for the Missoula area and if there was room for improvement in either number of options available or times that services are offered.

7. Have you have coordinated your services with other service providers in the Missoula area (for example in the times you provide services)?
    a. If yes, please describe what you did. If no, please explain why not?
    b. Do you think you might try to coordinate your services in the future?
	These questions address the issue of whether agency representatives are aware of other transportation options available and if they have tailored their services in a way to compliment other transportation services.

8. Have you ever collaborated with other service providers in order to improve services in Missoula or to apply for funding?
    a. If yes, please describe what you did. If no, please explain why not.
    b. Do you think collaboration would be something you would be willing to participate in if the opportunity arose in the future?
	This set of questions was designed to elicit details of ways the different agencies have worked together in order to create a mutual plan that would provide more efficient and effective use of assets in the overall accessible transportation options for the study area.

9. Do you think a maps like the ones I am proposing to create for this project will be useful for you in future planning?
    a. Why or Why not?
    b. Do you think this information will be helpful in coordinating services?
    c. Do you think this information will be helpful in collaborating with other agencies in order to improve services?
	This set of questions was used to evaluate perceived usefulness of a spatial approach in evaluating transportation.

10. Do you have any questions for me regarding this project?	This question was asked to address any concerns the interviewee may have about the project.
11. Do you know of any other transportation providers I should contact to interview?	This question was used to ensure that all the pertinent transportation agencies were included in the study.

<u>Data Preparation</u>

Once the interviews were completed, the results were organized and compiled.

The information about the different variables associated with transportation was then

analyzed using GIS. This study employs ESRI's ArcGIS 9.2, in which the spatial data

and the attribute data are saved into files known as feature classes. In previous versions of ArcGIS the spatial and attribute data files were called shapefiles, which can easily be converted to feature classes. The feature classes are then organized into a geodatabase. The advantages of the geodatabase for a project such as this one includes the ability to store a rich collection of spatial data in a centralized location, apply sophisticated rules and relationships to the data, and maintain integrity of spatial data with a consistent, accurate database. The GIS geodatabase for this project was composed of feature classes that make up a base map of the study area with the identifiable features of roads and rivers and then data gathered for this project was added as additional feature classes.

The Missoula City GIS Department had spatial data available for three of the five agencies: CNVS, ORI, and Mountain Line. The data for CNVS and ORI were in the form of polygon shapefiles that depicted the boundary of the area within which each agency provides transportation. There was a line shapefile of the Mountain Line bus routes. The Mountain Line Paratransit service boundaries use a combination of the Urban Transportation District (UTD) and the Mountain Line bus routes to determine their areas of service and a polygon shapefiles the Urban Transportation District was also available. Finally the medical transportation service provided by Medicab uses the city limit boundary to determine the areas to which they provide service, which was also obtained as a polygon shapefile from the Missoula City GIS Department. Though I was able to find shapefiles to base most of the service areas on, from information gathered during the interviews all of these map layers needed to be modified to more accurately display current service boundaries.

Before editing the shapefiles in ArcGIS, I created a geodatabase to house all the data that would be used in mapping for this project. The shapefiles were then imported as feature classes into the geodatabase. Since there was no data files currently available for the ASUM shuttle routes, a new line feature class of the routes was created.

The route line feature class was used as the base for creating the polygon feature class for the service area of the Mountain Line bus system. Edits to this file included deleting the trolley route since the trolley is not ADA accessible and dissolving the several lines that made up each route into single features.

Mountain Line and ASUM Transportation consider their service area boundaries to cover one-quarter mile on either side of the established bus routes. This distance has been determined to be the maximum that the majority of people will travel to use public transit (The Federal Transit Administration, TCRP Report 16, 1996). Therefore, if a rider's departure point is within one-quarter mile of a bus route and his or her destination is also within one-quarter mile of the bus route, then the bus service is a legitimate transportation option. Therefore, a polygon feature class was created using buffer analyses to create polygon features that encompass all areas within a distance of one-quarter mile on each side of the bus route line feature class. I performed same process on the ASUM route feature class.

The Mountain Line Paratransit service area covers a three-quarters mile buffer around all the bus routes plus any location within the Missoula Urban Transportation District (UTD) boundary. I used the merge function in ArcGIS to combine the Missoula UTD polygon and a new buffer polygon of all location three-quarters mile of a from the

Mountain Line bus routes into a single, new, output feature class depicting the Mountain Line Paratransit service area.

Using the information collected in the interview, a polygon feature class for the service area of Medicab was also created. Medicab bases its medical transportation option's service area on Missoula's city limits. Since Missoula city limits consist of several polygons, a new polygon feature class was created that encompassed all the city limit polygons, which was designated as the Medicab's Medicaid transportation service area. Medicab's wheelchair user transportation service is offered in seven western Montana counties. Therefore, the service area boundary for their wheelchair user transportation service consisted of merging the seven county boundaries into a single feature class. I obtained the original shapefile of Montana counties from the Natural Resource Information System web site at http://nris.mt.gov/gis/.

Once all the service area feature classes were created, data that I collected from each agency through the initial interviews was added to their tables as attribute information for each of the polygons. This was accomplished by creating new fields in each of the tables for this data. The new fields were named **cost**, **eligibility**, **type_of_service**, **purpose**, **start_time**, **end_time**, and **days**. The **cost** field contained either the cost of the transportation in dollars or in the case of Medicab's medical transportation option it contained the word 'Medicaid' since this is how one pays for this service. The **eligibility** field contained one of four variables: disabled, elderly, disabled_elderly, and wheelchair_user. The **type_of_service** field indicated the type of assistance offered to riders. The variables entered into this field were curb-to-curb or door-to-door. The **purpose** field addressed transportation uses; there were two possible

variables—any or medical. The **start_time** field contained the time the transportation

started its daily operation and the **end_time** field contained the time of day that the daily

operations ended. Military time was used in order to differentiate between morning and

afternoon hours. The **days** field contained one of the four variables: weekdays,

weekdays_Saturday, Wednesday, and Sunday.

<div align="center">Analyzing Transportation Options Density</div>

For this thesis, the number of transportation options at a particular location is

referred to as the transportation density for that location. I created a transportation

density map to show the number of agencies that provide services across the study area

for Monday through Friday. This map consists of connecting polygons that cover the

entire study area which illustrate the number of transportation options available in every

location.

The first step in creating the density map was to determine which feature classes

to include. In this case, since ORI only provides transportation on Sunday, its feature

class was not included. However, the other four agencies provide services Monday

through Friday, so the six feature classes related to their service options were included.

Next all feature classes needed to have only one polygon feature that encompassed the

agency's entire service area. The feature classes for the Medicab medical transportation

service, the Medicab wheelchair transportation service, CNVS, and the Mountain Line

Paratransit services all consisted of a single feature. However, this was not the case for

the Mountain Line Bus routes and the ASUM shuttle routes. To create a single feature

the Dissolve tool was used to combine the features of the Mountain Line bus route

buffers into a single feature in a new feature class; the same was done with the ASUM

shuttle route buffers. The Union tool was used to combine all concerned agencies'

feature classes. The Union tool computes a geometric intersection of the polygons in all

the feature classes that are input into the tool, and it creates new polygons based on these

intersections. All polygons created in the union were written to a new output feature

class containing the attributes from the input features which they overlap (Figure 1).

When the Union tool creates the new output feature class it adds a new field to its data

table for each feature class that was input into the

union. These new fields are automatically named

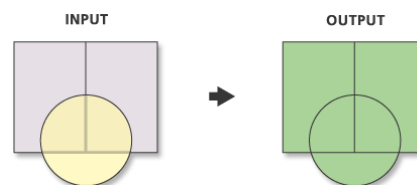**FID_name** (name being the name of a feature

class in the union).

Figure 1. Union tool.

Therefore, for this project six new fields were created in the output file. Each of

the new polygons was assigned an attribute of **-1** if the new polygon was not located in

the service area of a particular agency or a **1** if the new polygon was located in an area

that is served by the agency. In order to create the density map, the number of agencies

that provide services in each of the polygons that were created needed to be summed.

This was accomplished by editing the output feature class table by replacing all the **–1**

entries to **0**. Then a new short integer field called **density** was added and the field

calculator was used to sum the fields that contained a **0** or **1** for each polygon. The

number indicates the number of transportation options for each polygon in this

transportation density feature class created in the union. Using this feature class, a

thematic map that shows the density of transportation options across the study area was

created.

Analyzing Availability of Services by Time of Day

The number of services available at certain locations is only a small part of analyzing transportation as a whole. If services are only available a limited number of hours a day or certain days a week, this information is essential in determining if there is adequate transportation available. Therefore, the hours of services the agencies operated daily, Mondays through Friday, were spatially analyzed using the **start_time**, **end_time** and **days** attribute for each agency feature class. Maps were not created for weekends since only Mountain Line provides services on Saturday and only ORI provides services on Sunday, so their service area maps can also to show where services are provided during the hours they operate on those days.

From the data gathered in the interviews, I discovered that the start and end times provided by the different agencies varied. The earliest transportation services start was at 6:00 A.M. All the agencies provide services between 8:00 A.M. and 5:00 P.M. But then once again, the times when agencies stop providing services for the day varied up until 8:00 P.M., after which no services were offered. Therefore a series of maps that show the locations where transportation is available throughout the day for Monday to Friday was created for each hour from 6:00 A.M. until 8 A.M. A single map was built for 8:00 A.M. until 5:00 P.M., and then additional maps were built for each hour from 5:00 P.M. until 8:00 P.M.

To determine the services that provided transportation for a particular time of day, I used the Select by Attribute GIS tool. By creating an expression, for example **[start_time] < 6** all the agencies that begin service at or before 6:00 A.M. were selected. The selected features were then exported as a new feature class and displayed on a map.

This same expression, with only the hour being changed, was used to create the feature classes that showed changes during the morning hours of services. To find the differences in the times services ended the Select by Attribute tool was used with the expressions **[end_time] < x**, where x was the hour the services ended. Once again, all the selected features were exported as a new feature class. Viewing these maps as a series makes it apparent which locations have transportation available at different times of day.

Analyzing the Spatiality of Cost, Eligibility, Purpose of Trip, and Type of Services

In addition to the number of transportation options and the times transportation is available, there are other factors that affect whether a person can or will use a transportation service. These include, 1) can the person afford the service, 2) is the person eligible to use the service, 3) is the service limited to particular purposes and 4) is additional assistance available that may be needed in order to use the service. As previously noted data was collected on these factors and the information was entered in the data tables for the different accessible transportation service options as the attributes of cost, eligibility, type_of_service, and purpose.

It is possible to isolate and map each of these attributes thematically, using the dissolved feature class files for each agency that were created when building the transportation density map as the input files. Since the number of services that are provide on weekends and weekdays are different, once again only the services available on Monday through Friday were evaluated for this project. However the data to create

maps for the weekend days is available and maps showing this information could be made if desired.

For the first step for this process, I used the Merge tool to combine the six relevant feature class files. This tool combines input features from multiple feature classes of the same type, into a single, new output feature class. This merge created a single feature class file that contained the polygons for each of the accessible transportation options in the study area. By changing how the attributes are symbolized in ArcGIS, maps that illustrate different attributes of transportation services across locations where transportation is available were built. To accomplish this, the polygons with the same attributes in the field of interest were grouped into categories. A unique symbol, in this case a unique color, was then used to classify that attribute. Since there are overlapping polygons with different attribute values, when appropriate for the map the symbols were made transparent so that all attribute values for a particular location could be seen. For this project, separate maps showing cost of services, type of services, purposes for which the services can be used, and eligibility of services across the study area were created.

<div align="center">Determining Areas of Need</div>

In order to analyze the areas of greatest need for more accessible transportation options in the study area, data regarding percentage of people with disabilities and the elderly at the block group level was collected from the U.S. Census Bureau. The data regarding disabilities is contained in the Census 2000 Summary File 3 and the data regarding ages of the populations is in the Census 2000 Summary File 1. A block group

is a subdivision of a census tract. It consists of all the blocks within a census tract that have been assigned the same beginning number. It would have been preferred to have data at the block level, but the block group is the smallest geographic unit for which the Census Bureau tabulates disability information. The spatial data for the block groups in the study area was also available from the U.S. Census Bureau in the form of a polygon shapefile that I imported into the geodatabase as a feature class. The disability and elderly population data were joined to the block group feature class tables and two maps were created. The first map shows the levels of priority for additional accessible transportation options when considering people with disabilities and the second map shows the levels of priority for additional accessible transportation options when considering the elderly.

To create the first map, the features were classified into groups of high, medium, and low percentages of people with disabilities using the Quantile method of choropleth map classification, so that one third of the data was in each group. The Quantile method places the same number of data values in each class. There is a potential problem with this method in that it sometimes causes similar data to be placed in different classes or it places very different values in the same class.

Another classification method called Natural Breaks (Jenks) was also considered. This method determines class boundaries by algorithms that seek statistically significant groupings within the data. When compared to the Quantile method the classification divisions for the Natural Breaks (Jenks) method were within one percentage point when looking at the disability populations. However, with the elderly population there were

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two block groups with a fairly high percentage of elderly people compared with the rest

of the block groups. This caused the Natural Breaks methods to create a large difference

in the number of features each classification contained. This made comparison of the two

different data sets difficult using the Natural Breaks (Jenks) method. A comparison of the

division of the percentages between the two methods is illustrated in Table 4.

Table 4. Comparison of percentage classifications between the Quantile and Natural Breaks (Jenks) methods

	Percent Disability		Percent Elderly	
	Quantile	Natural Breaks	Quantile	Natural Breaks
Low	1.8-10.7	1.8-9.6	1.6-6.8	1.6-10.4
Medium	10.8-14.4	9.7-15.4	6.9-11.7	10.5-21.1
High	14.5-23.8	15.4-23.8	11.8-34.4	21.2-34.4

Once the data was classified the appropriate values of high, medium, and low for

each polygon needed to be added to the table in a new field, which was named

disability_level. Next the data regarding the number of transportation options at all

locations throughout the study area found when the transportation density feature class

was created was classified into levels of high, medium, or low. Since the range of

transportation options varies from one to six they could easily be divided into three

categories of five to six options being classified as a high number of options, three to four

options as a medium number of options, and one to two options as low number of

options. A new field named **transportation_level** was created and the values of either

high, medium, and low were entered for each feature in the feature class table. By

analyzing the spatial characteristics of the population data feature class and the

transportation options density feature class using the Union tool in ArcGIS, all locations

in the study area could be placed into one of nine categories (Table 5).

Table 5. Level of transportation needs matrix

Percentage of People with Disabilities/Percentage of people over 65 years of age	Number of Transportation Options		
	High	Medium	Low
High	High-High	High-Medium	High-Low
Medium	Medium-High	Medium-Medium	Medium-Low
Low	Low-High	Low-Medium	Low-Low

This same process was performed a second time, this time classifying the

population data for the percentage of people over the age of sixty-five as high, medium,

or low for each block group polygon and once again using the transportation density

feature class as the second input file. The new field created was called **elderly_level**.

The final step of the process was to create the maps that show the areas that

would most benefit from additional transportation options according to the information

available. It would be reasonable to assume that the areas that have a higher percentage

of people with disabilities and/or people with disabilities and the elderly with the lowest

number of transportation options would benefit most from additional accessible

transportation options. Therefore I grouped the nine categories into three new categories

of high, medium, and low. In the high category the classes of percentage of people with

disabilities and/or the elderly were rated ordinally higher than the class of the number of

transportation options. In the medium category the classes were equal and in the low

category the classes of the number of transportation options were rated higher than the

class of percentage of people with disabilities and/or the elderly (Table 6).

Table 6. Category groups for determining areas that would most benefit

High	Medium	Low
Low Options-Medium Percent	Low Options-Low Percent	Medium Options-Low Percent
Low Options-High Percent	Medium Options-Medium Percent	High Options-Low Percent
Medium Options-High Percent	High Options-High Percent	High Options-Medium Percent

In addition to the polygons which show the levels of priority of all locations, I

added another feature class map layer to both of the maps. This map layer consisted of

the block group boundaries, with a graduated symbol placed in the center that illustrates

the differences in the disabled population size on the first map and the elderly population

size on the second map for each block group. Once again I used the Quantile method to

divide the block groups into three equal categories and then used small, medium, and

large circles to illustrate the size of the disabled or elderly population size within the

block groups.

Finally, I created a third map that combined the priority level layer for additional

accessible transportation created based on people with disabilities and the priority level

layer created for people over 65 years of age by using the Union tool. From the new

polygon feature class that was created I was able to employ the Select by Attribute tool

using the expression [EldLevel] = High AND [disLevel] = High, to select the polygons

that were both a high priority for people with disabilities and the elderly. This data I then

exported as a new feature class. Next I used the expression [EldLevel] = Low AND

[disLevel] = Low the polygons to select the polygons that were both a low priority for people with disabilities and the elderly. The remaining polygons were then classified as mixed priority.

<div align="center">Second Interview</div>

After the maps were created, a second interview was conducted with each of the agencies regarding the accuracy of the maps and their perceived usefulness. To begin the interview, all the maps created were shown to the interviewee one at a time and the purpose of each map was described. For example, when showed the map regarding cost of services, the interviewee was told, "This map shows costs of the least expensive transportation option for locations across the study area." After the interviewee had reviewed all the maps, the following questions were asked regarding the entire set of maps and the responses were recorded by hand (Table 7). After the second interview was complete, the information that was gathered was compiled.

Table 7. Questions asked in the second interview

Questions	Purpose
4. Do you believe the maps accurately portray accessible transportation options in Missoula and the surrounding area? a. Why or why not?	These questions were asked to determine if the accessible transportation service areas created for the maps were correct.
5. Do you think the maps are easy to understand? a. Why or why not?	These questions were asked to assess if the information given on the map was easy to understand.
6. Are the maps visually appealing? a. Why or why not?	These questions address if the "look" of the map was appealing.
7. Is the information provided on the maps useful to your agency? Please explain.	This question assesses whether the maps provide any useful or new information to the agency regarding transportation.

8. Is there any other information that you think should be included on the maps?	This question addresses if the interviewee has suggestions for other information that could be included on the maps.
9. How might you use these maps when attempting to improve transportation services for people with disabilities or the elderly?	This question looks at the functionality of the maps for agencies in looking at ways to improve their services.
10. Do you think the maps are useful in coordinating services with other agencies? a. Why or why not?	These questions address the concept of how these maps may be used in coordinating services between agencies.
11. Do you think the maps would be useful in collaborating with other agencies? a.Why or why not?	These questions address the idea of if these maps may help in creating a transportation plan in conjunctions with other agencies.
12. Do you think the maps would be useful in applying for future funding to improve transportation services in Missoula? a. Why or why not?	These questions look at whether the interviewee believes that these maps would provide useful information to strengthen proposals when applying for funding.
13. Would the information provided by the maps be useful for other communities in assessing their accessible transportation options? Please explain.	This question address whether the interviewee thinks the type of data presented on the maps would be useful for other communities in assessing their accessible transportation services.
14. Is there anything you would change on the maps?	This question was asked as a second check on accuracy and to see if the interviewee had any suggestions for improving the maps.

The methods developed allowed me to meet the objectives of identifying and interviewing the appropriate agencies for the study and in using this information to create a set of maps that display the spatial extent of accessible transportation options in the Missoula, MT area. By interviewing the involved agencies a second time, the effectiveness of the methods to produce accurate maps and the functionality of the maps created could be evaluated. The following chapter describes in detail the results of the

interviews and the information that can be gleamed from the maps regarding accessible

transportation in the study area.

CHAPTER 4
Results

This chapter presents the information gathered from the interviews with each of the agencies that were identified as providing accessible transportation in the study area along with the maps of each of the agencies' service areas that were created as a result of this information. In addition, the maps that I created to capture the spatial aspect of each of the variables associated with transportation of where, when, who, why and how much that were defined in Chapter One are presented. The information that each map portrays is described and the significance to providing information regarding the variables of transportation is discussed.

Initial Interview Results

Mountain Line

The Missoula Urban Transportation District was created in June 1976, and public buses began providing service on three routes using four buses in December 1977. Within five months, Mountain Line added six more routes and ten new buses were placed into service. In October of 1978, service to East Missoula and Bonner was added. In December of 1991, Mountain Line added two paratransit buses to the fleet, providing the first accessible bus service in Missoula. In January 2001, the Missoula bus system (except for a downtown circulator trolley) became 100% Americans with Disabilities Act accessible when four new accessible buses were placed in service.

Ray Hoff, the Operations Supervisor, was interviewed regarding the Mountain Line Bus and paratransit services. Mountain Line's bus service and paratransit service runs Monday through Friday from 6:15 A.M. to 8:00 P.M. and on Saturday from 9:30 A.M. to 6:00 P.M. (Map 2). There is no service on Sundays or on holidays. Fares for the

buses are $0.85 per one-way trip. Discounted fares of $0.35 are available to people with disabilities and senior citizens over the age of 60 with proof of eligibility. A buffer of one-quarter mile on either side of the bus routes was created as the Mountain Line bus service area since this is known to be typical distant a user will traverse to access a bus. There is no eligibility criterion for the bus service, and it can be used for any purpose.
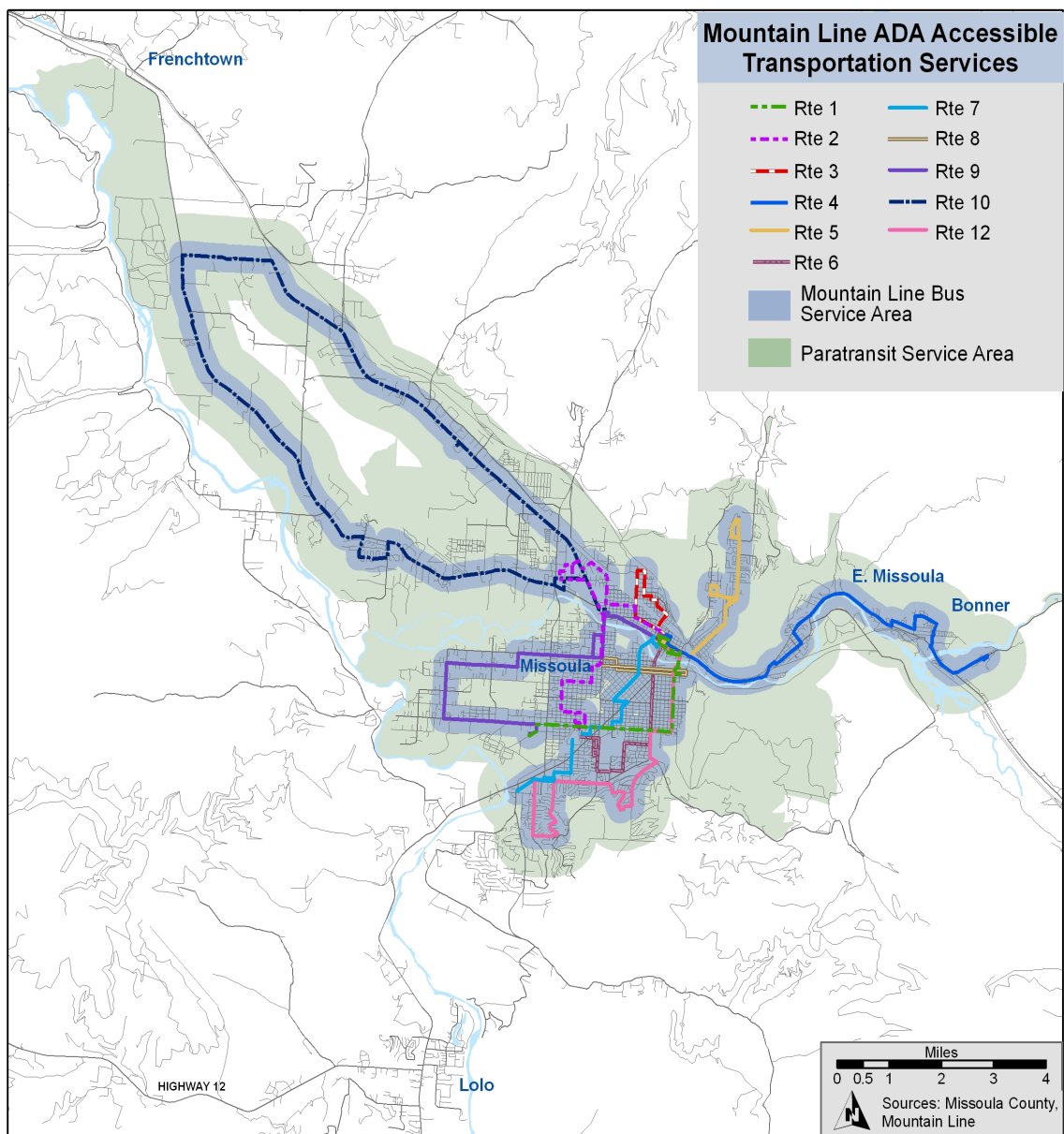

Map 2. Mountain Line routes and service areas

Mountain Line paratransit services provide equivalent curb-to-curb transportation services for eligible persons with disabilities within a three-quarters mile distance from the Mountain Line bus routes. In addition, it provides services anywhere else within the Missoula Urban Transportation District. Passengers who are unable to board, ride, or disembark a Mountain Line bus due to a disability can apply to Mountain Line for paratransit services. To qualify for this service, a completed application form and a Healthcare Professional Verification describing how the applicant's disability prevents him or her from using the accessible fixed bus route services must be turned into the Mountain Line office in order to determine eligibility. It is important to note that Mountain Line drivers provide very limited assistance to riders. Drivers are not required to leave the curbside to assist riders to or from the bus, but will assist riders from the curbside onto the lift or through the door of the bus. They will see that passengers are secured appropriately and will assist riders in disembarking from the bus to the curb.

Community Needs Van Service (CNVS)

CNVS provides transportation to seniors 60 years and over and to adults with a disability (Map 3). CNVS was started in order to provide transportation to those individuals who are ineligible for the locally funded paratransit system run by the Mountain Line. This service is coordinated by the Missoula Ravalli Transportation Management Association (MR TMA), a nonprofit agency that develops comprehensive transportation alternatives to reduce traffic and parking congestion, protect our environment, and improve our quality of life. Lyn Hellegaard, Director of Community Affairs was interviewed for this thesis. The MR TMA partnered with Community
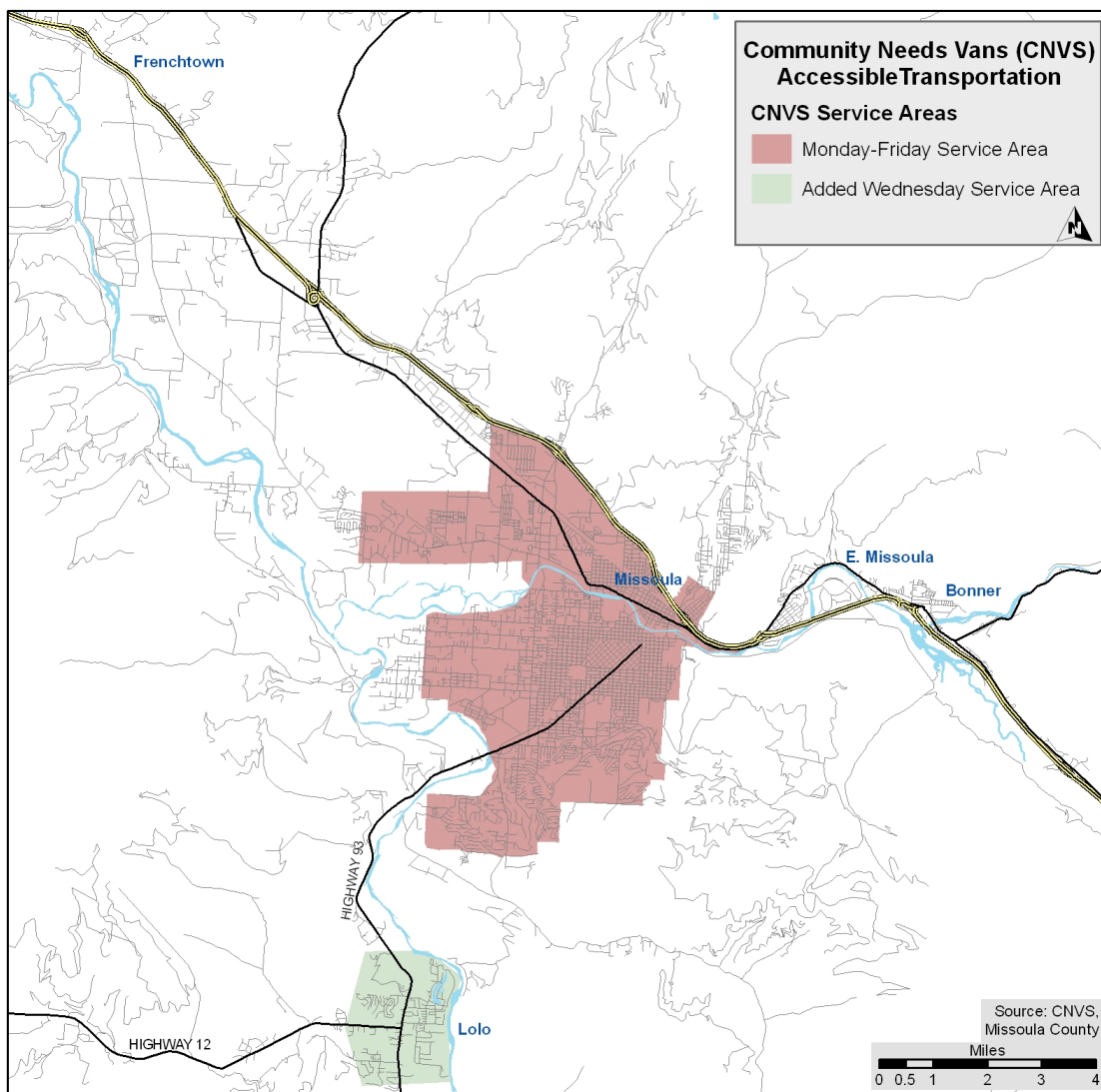
Map 3. CNVS service area

Medical Center (CMC), a local hospital, to use its accessible wheelchair bus to better

provide services and eventually took over all of CMC transportation vans and services, in

addition to their own services. CNVS provides door-to-door service. This service can be

for any purpose the client desires including medical appointments, shopping, personal

care appointments, and recreation/leisure activities. When first requesting service, new

customers need to complete a form to determine eligibility with the Transportation

Coordinator. Services are offered Monday through Friday from 8:30 A.M. to 4:30 P.M.

On Wednesday, an additional route to Lolo is also available from 9:00 A.M. to 3:00 P.M. A ride needs to be scheduled forty-eight hours in advance and costs $1.00 each way. The service to Lolo costs $5.00 round trip, and if additional rides within Missoula are required, a $1.00 fee is charged for each leg of the trip.

Medicab

Brian Parks and Peggy Metivier, who are the co-owners of Medicab, were interviewed for this project. Medicab is a private transportation service that provides door-to-door transportation for people who have Medicaid for non-emergency medical appointments within the Missoula city limits (Map 4). Medicab also provides an accessible taxi service for people who use a wheelchair for non-medical reasons; non-wheelchair users are not eligible for the taxi service. The cost for the taxi service is $12.00 one way for a trip within the Missoula city limits and an additional $2.00 per mile for locations outside the city limits. Medicab provides this accessible taxi service across nine counties in Western Montana (Ravalli, Sanders, Lake, Silver Bow, Deer Lodge, Granite, Missoula, Mineral, and Flathead).

Group rates are available for longer trips for two or more passengers. However, Medicab does not have vehicles located outside of Missoula, so if the request for transportation is not cost effective, its owner can refuse to provide the service. To reserve transportation that will be paid for by Medicaid, the State of Montana requires passengers to give a 24-hour notice by calling the Medicaid Transportation Hotline. For non-Medicaid passengers, Medicab will try to accommodate same day calls. Medicab provides services from 6:00 A.M. to 6:00 P.M., Monday through Friday. Medicab will
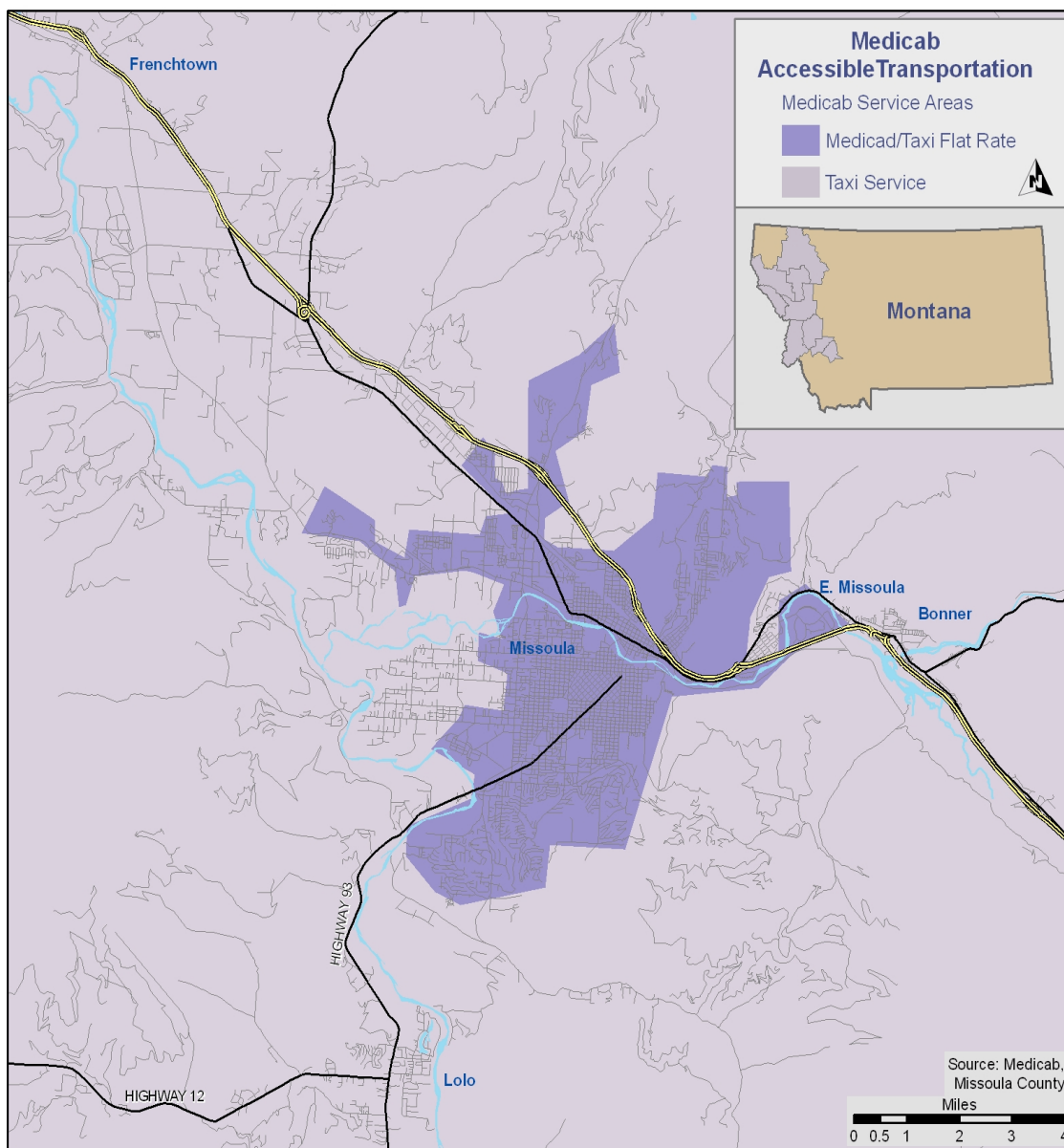
Map 4. Medicab services areas

sometimes provide services outside their normal operating hours for people who use

wheelchairs if arranged ahead of time.

Opportunity Resources, Inc. (ORI)

     Josh Kendrick, who heads up the transportation department of ORI, was

interviewed regarding the transportation services rendered. ORI is a nonprofit

organization that provides a variety of supports to people with disabilities including work opportunities, housing, case management, recreation activities, and transportation. In addition to providing transportation twenty-four hours a day, seven days a week to the people who use ORI services, on Sundays ORI provides transportation as a public service to elderly individuals or people with disabilities who do not receive any of their other services (Map 5). The Sunday transportation service runs from 8:00 A.M. to 5:00 P.M.
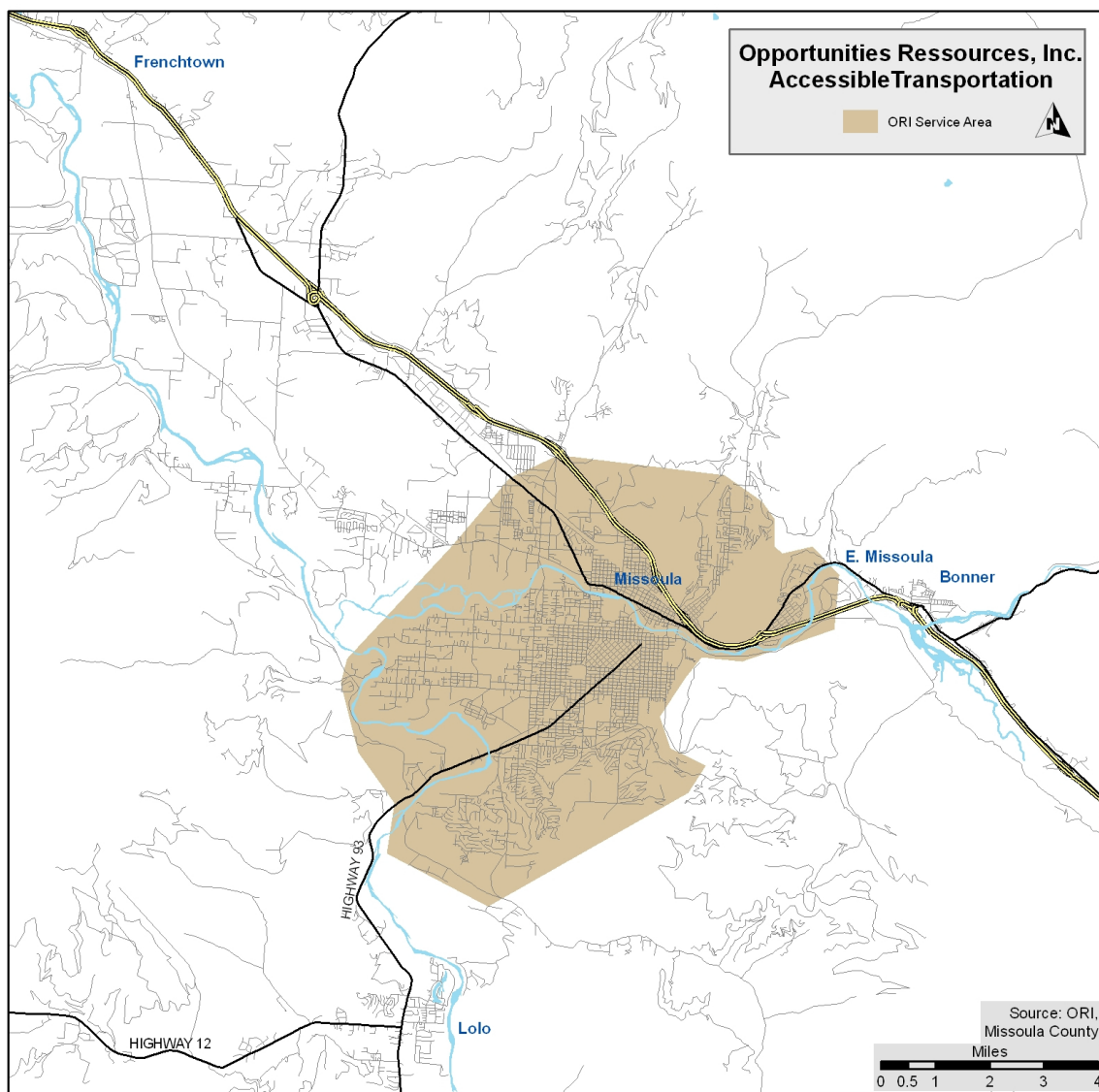
Map 5. ORI service area

and is available for any purpose. There is no cost to the riders for ORI transportation services, but donations are accepted. ORI currently has the capacity to provide approximately twenty rides on a Sunday but hopes to obtain additional funding to add another bus, doubling their capacity.

Associated Students of the University of Montana (ASUM)

Nancy Wilson, director of ASUM transportation was interviewed for this project. ASUM provides a shuttle service during the academic year with ADA accessible buses, called UM Park n' Ride, with two different routes (Map 6). The South shuttle provides transportation from the University of Montana's Lewis and Clark Village which is located about one mile south of campus and the East shuttle provides transportation from a parking area on East Broadway approximately one mile north east from campus to the University of Montana campus. These shuttles are free and open to the general public. Service runs from 7:25 A.M. until 6:15 P.M., Monday through Friday. ASUM contracts with Mountain Line to provide transportation through their paratransit service for registered students with disabilities who for some reason cannot use the shuttle due to a disability. ASUM also provides a shuttle called U-Dash for registered students from campus to downtown Missoula, with accessible buses that run Monday through Thursday from 7:00 P.M. until 11:55 P.M. and on Friday and Saturday from 7:00 P.M. until 2:25 A.M.
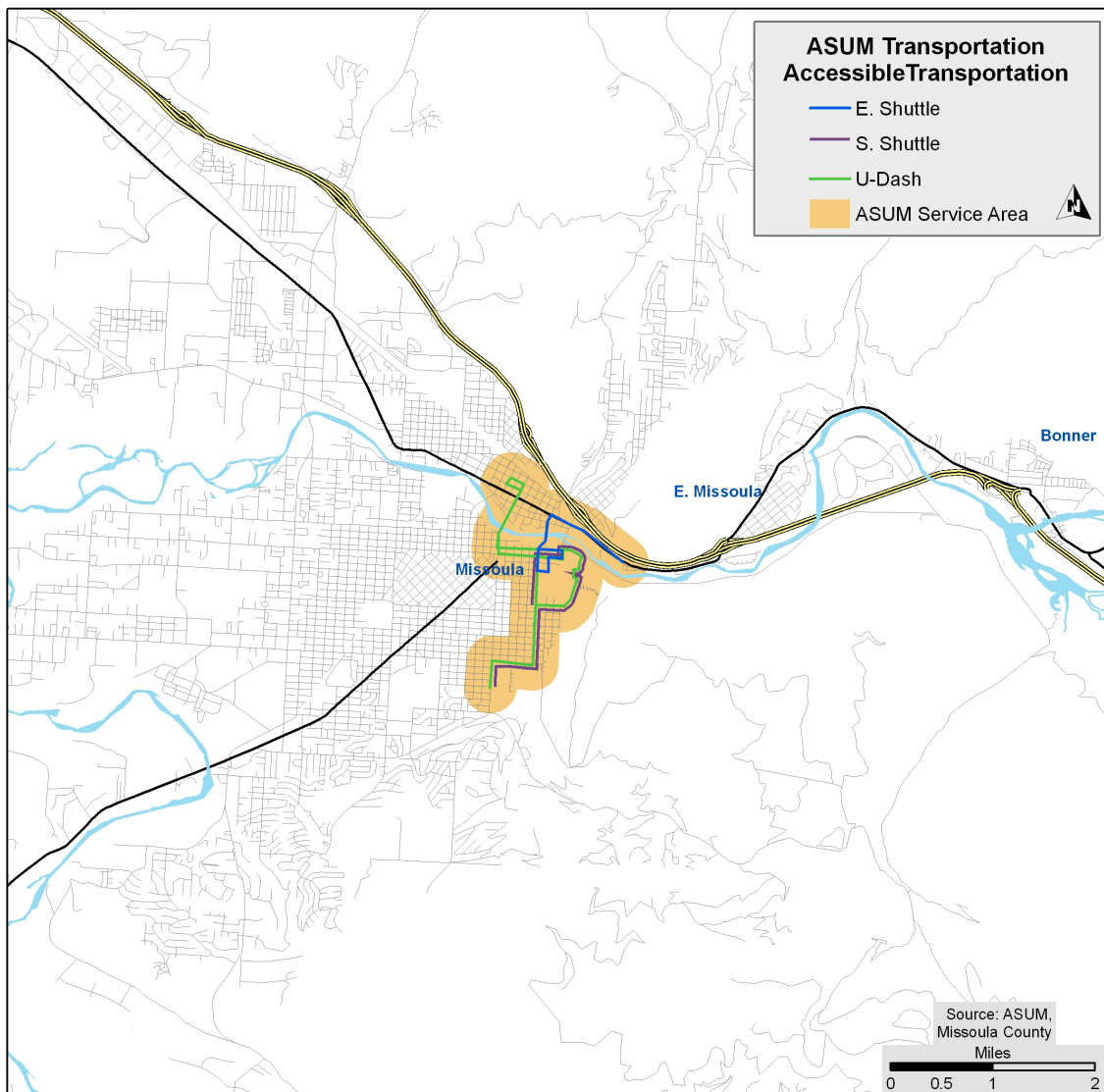
Map 6. ASUM service area.

As stated earlier, the maps of each of the agencies' service areas only present a partial picture of accessible transportation in the study area. In addition to the variable of where, the other variables of who, when, why, and how much must also be considered. Therefore, maps addressing each of these variables are presented below.

Accessible Transportation Maps

The next map shows the density of transportation options Monday through Friday for the study area (Map 7). In this map, Mountain Line's bus service and paratransit services are shown as separate transportation options since the areas of coverage and eligibility criteria are different. Medicab's medical transportation service is also shown separately from its wheelchair taxi service, given that the eligibility criteria,
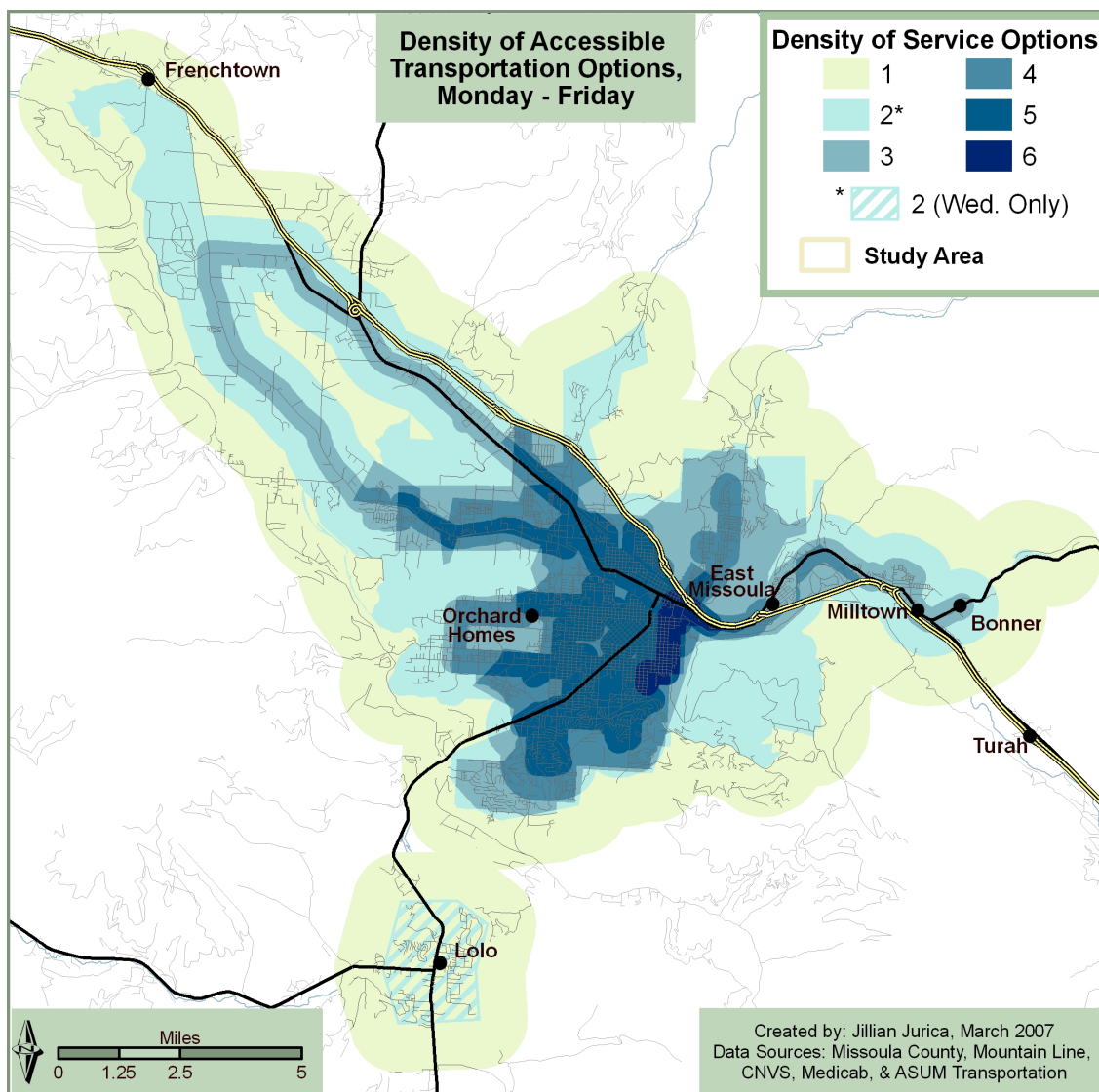

Map7. Number of accessible transportation options throughout the study area.

costs, and service areas are different. The density map shows that the number of agencies that provide transportation decreases from central Missoula as one moves toward the outskirts of the city. There are few if any transportation services in or to the small towns and communities within a few miles of Missoula, even though many people living in these areas commute to Missoula for work and many people also use Missoula as their main medical services and shopping center. This map may be useful when agency managers that are considering expanding services or changing its service areas. Using the map they can see which areas of Missoula have fewer transportation options and therefore could benefit from additional options.

Although transportation options vary between weekdays and weekends, it was not necessary to create separate maps for Saturday and Sunday because on Saturdays, Mountain Line public transit and paratransit are the only transportation options and on Sundays, ORI is the only transportation option. Therefore, their service area maps can serve as the density maps for these days (Map 2 and Map 5).

The next series of maps show the changes in transportation options over a typical weekday (Maps 8-14). All of the agencies vary in the times they begin and end services throughout a day. Therefore, it is important to determine if there are times during the day when transportation is adequate and if there are times when services are limited and/or insufficient, even in those areas covered by a transportation service. The maps also show the service boundaries of each of the agencies providing services at the hours shown on the maps. This gives the map viewer an idea of the number of accessible transportation options that are available across locations for the times indicated.

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These maps show by the hour how transportation options vary throughout a typical weekday. The series begins when services start in the morning and continues throughout a twenty-hour period. There is a map that shows services from 6:00 A.M. - to 7:00 A.M. (Map 8), a map that shows services from 7:00 A.M. to 8:00 A.M. (Map 9), a map of services from 8:00 A.M. until 5:00 P.M. (Map 10), a map for services from 5:00 P.M. to 6:00 P.M. (Map 11), a map from 6:00 P.M. to 7:00 P.M. (Map 12), a map from 7:00 P.M. to 8:00 P.M. (Map 13), and finally a map that shows the lack of any services from 8:00 P.M. until 6:00 A.M. the following morning (Map 14).
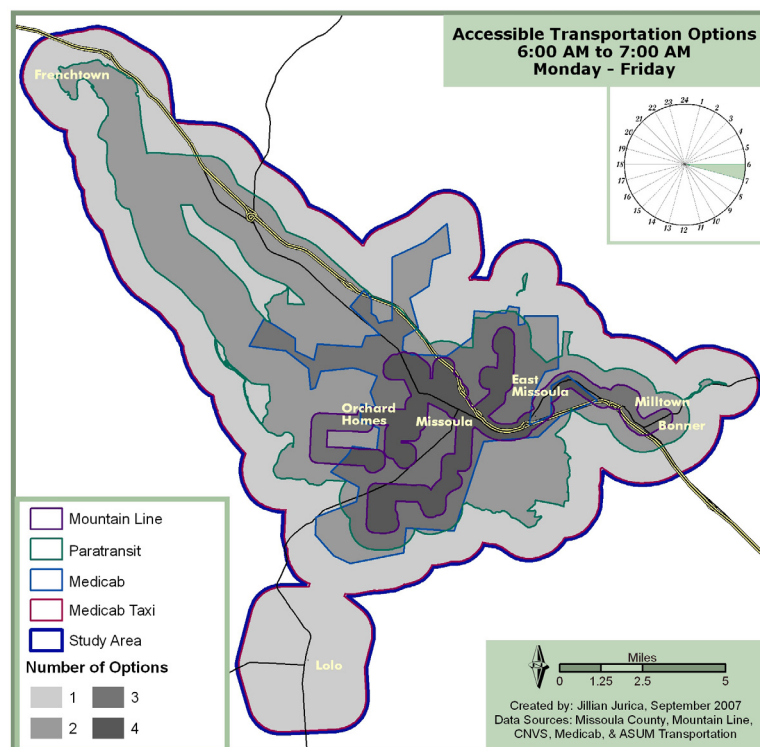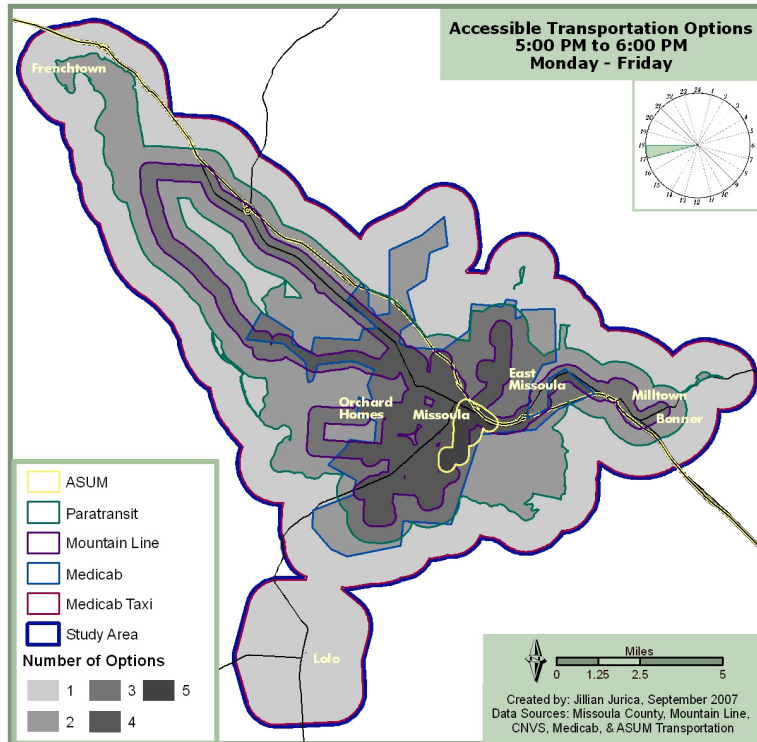

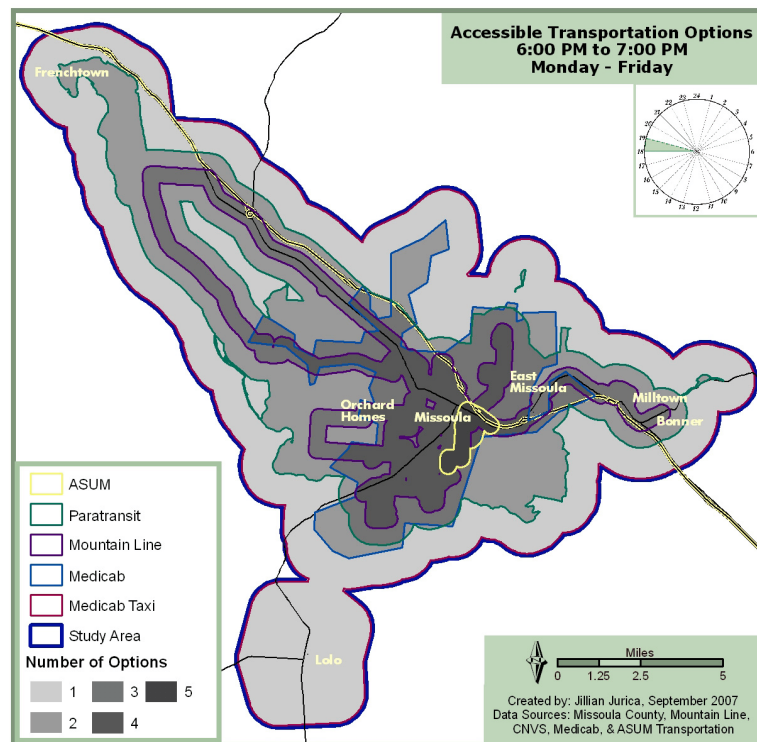**Map 8. Accessible transportation 6 A.M. to 7 A.M.**
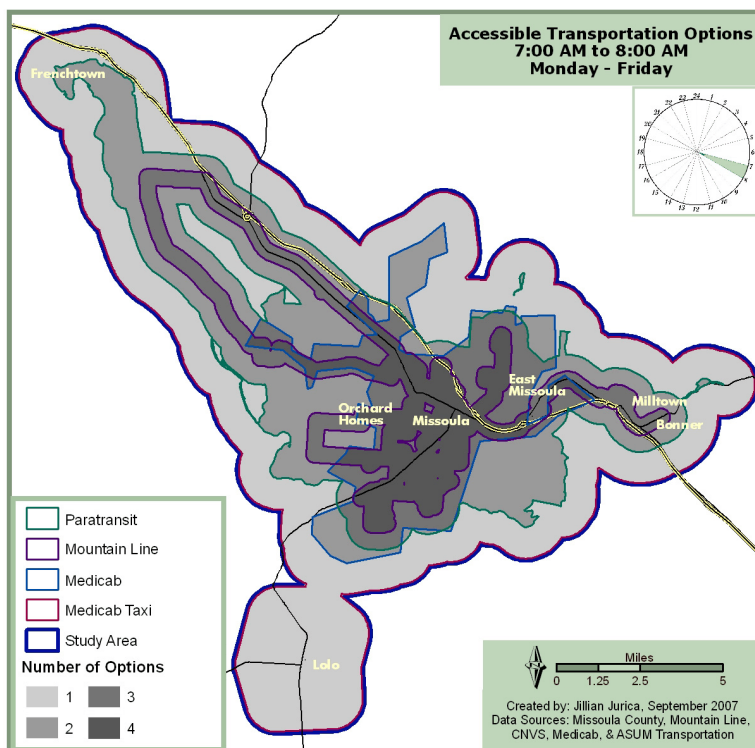
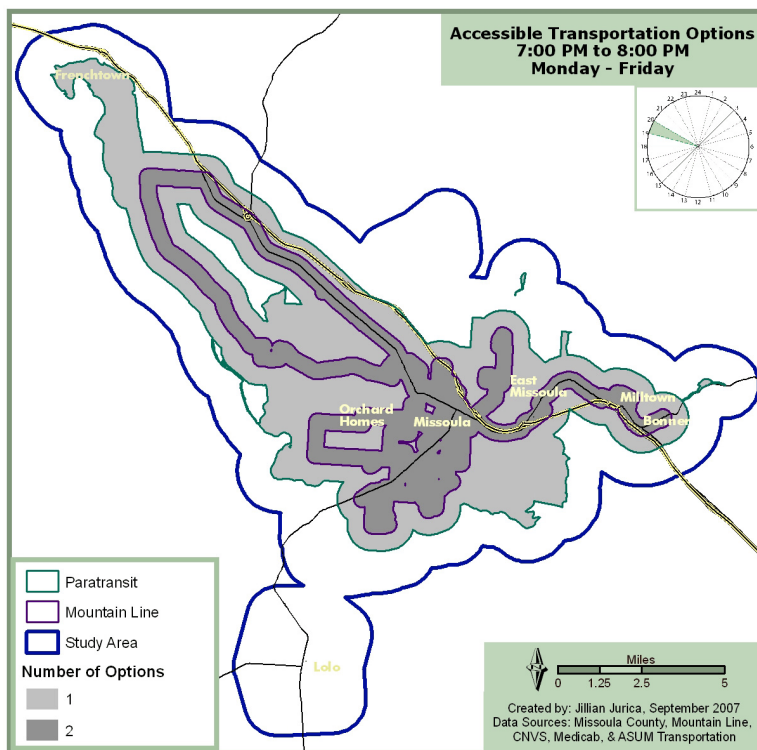**Map 9. Accessible transportation 7 A.M. to 8 A.M.**
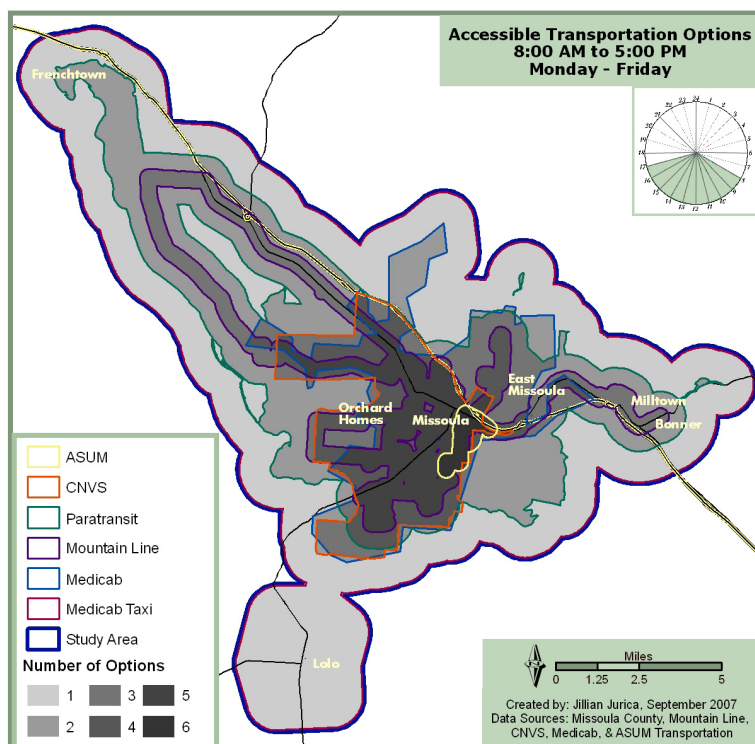
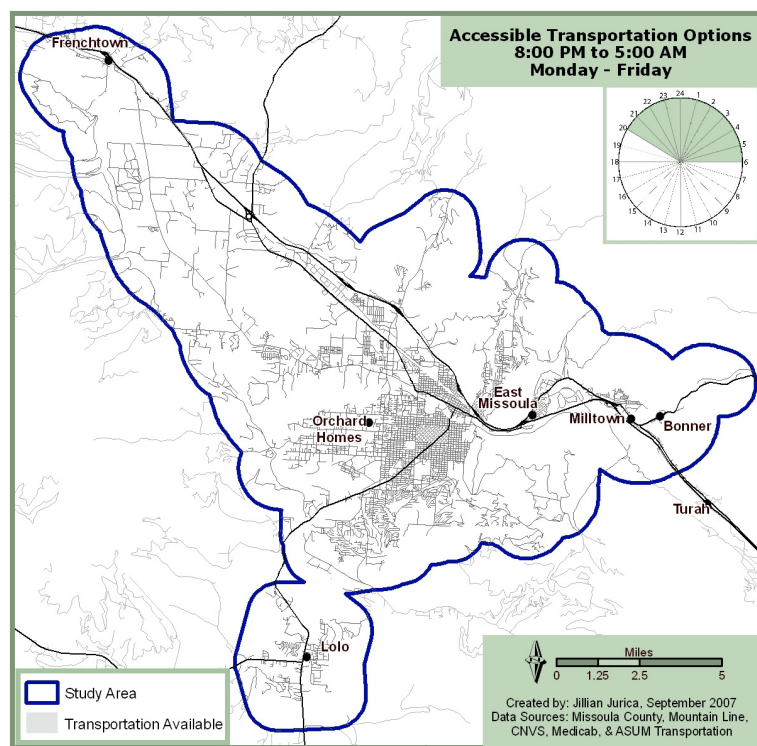**Map 10. Accessible transportation 8 A.M. to 5 P.M.**

Map 11. Accessible transportation 5 P.M. to 6 P.M.

Map 12. Accessible transportation 6 P.M. to 7 P.M.

Map 13. Accessible transportation 7 P.M. to 8 P.M.

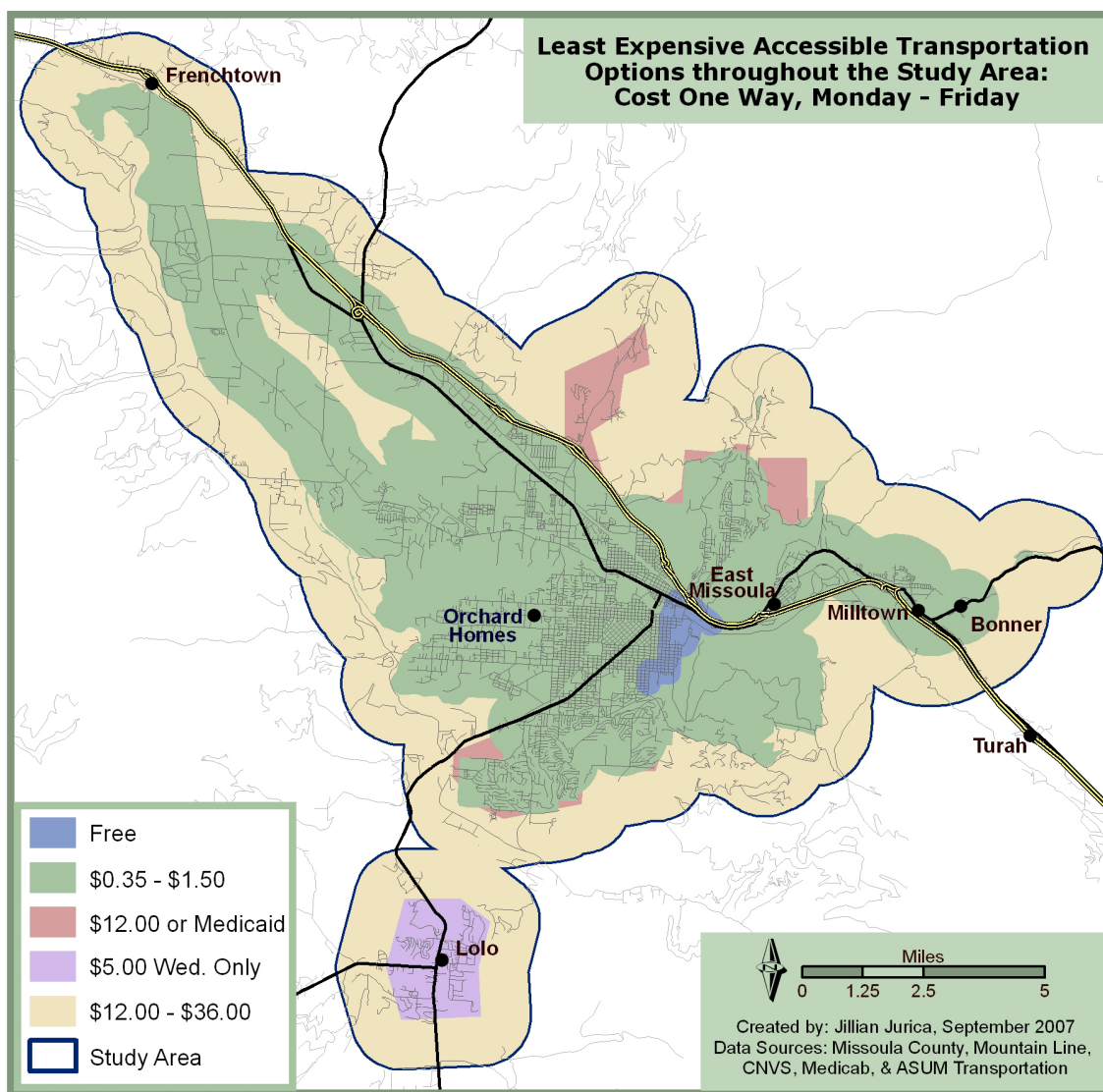**Map 14. Accessible transportation 8 P.M. to 8 A.M.**

As can be seen in this series of maps, some type of accessible transportation is available from six in the morning eight in the evening. Though at first this may seem adequate, it is important to remember that many recreational and leisure activities occur in the evenings. These maps show that the person using accessible transportation has to be dropped off at home before 8:00 P.M., so they could not attend an event that began before 8:00 P.M. but lasted later than 8:00 P.M., or even until 8 P.M. In addition, many workdays no longer follow the nine to five norms. Shift work is becoming more commonplace and transportation to and from work is needed late in the evenings, very early in the mornings, and on weekends for many people, including those with disabilities. There is one exception in Missoula regarding transportation in the evenings and that is for registered students at the University of Montana who can take an accessible bus from the University to downtown Missoula, Monday through Saturday nights. As a result, students with disabilities who need accessible transportation can enjoy the same nightlife as any other college student, if they wish.

Also, the maps show that the farther one lives, works, or needs to travel away from central Missoula for any reason, transportation options decrease or become nonexistent in the earlier morning hours and in the evening hours.

The next series of maps spatially display additional issues that are important to consider when assessing transportation. For example, many senior citizens and people with disabilities live on a fixed income, therefore affordable transportation is critical. Four out of five of the agencies are able to provide transportation for under $3.00 per trip, since they receive funding from other sources to subsidize their transportation services.

Costs of transportation service are displayed in Map 15. Forty-six percent of the study

area has accessible transportation for under $1.50 per ride, and when looking at the map,

one can see by the streets that these locations are the more densely populated areas.

The next map displays the availability of transportation by eligibility criteria

(Map 16). There are five categories shown on the map: 1) person with a disability and/or

elderly, 2) person with a disability and/or elderly, Wednesday only, 3) person with a

Map 15. Cost one way of least expensive accessible transportation option
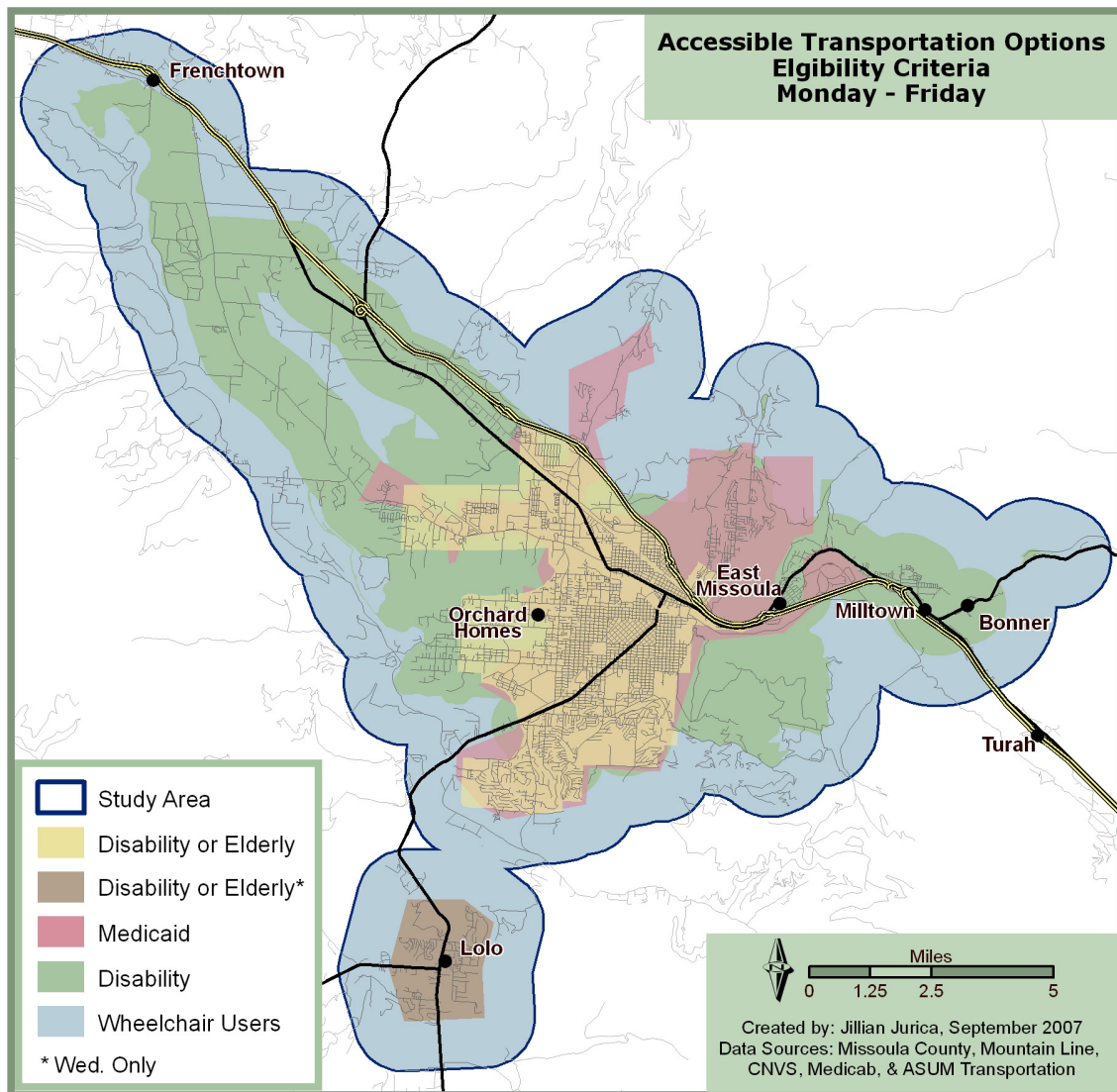
Map 16. Eligibility criteria for accessible transportation options.

disability only, 4) person has Medicaid, and 5) wheelchair user. If no eligibility criteria were required for an accessible transportation option, the option was not added to the map in order to make it more readable. As can been seen when looking at this map, areas of available accessible transportation do vary by eligibility. The availability of accessible transportation for the elderly has the smallest area. There is better coverage for people

with a disability, but it is important to note that paratransit is only available to those who are unable to use the fixed bus routes due to their disability.

The next map shows the type of assistance that is available with the different transportation options (Map 17). Since many elderly and people with disabilities need additional assistance either to reach a vehicle for transportation or to reach their final destination after disembarking from a vehicle, it is important to note when a transportation service offers this assistance. This map shows locations where door-to-
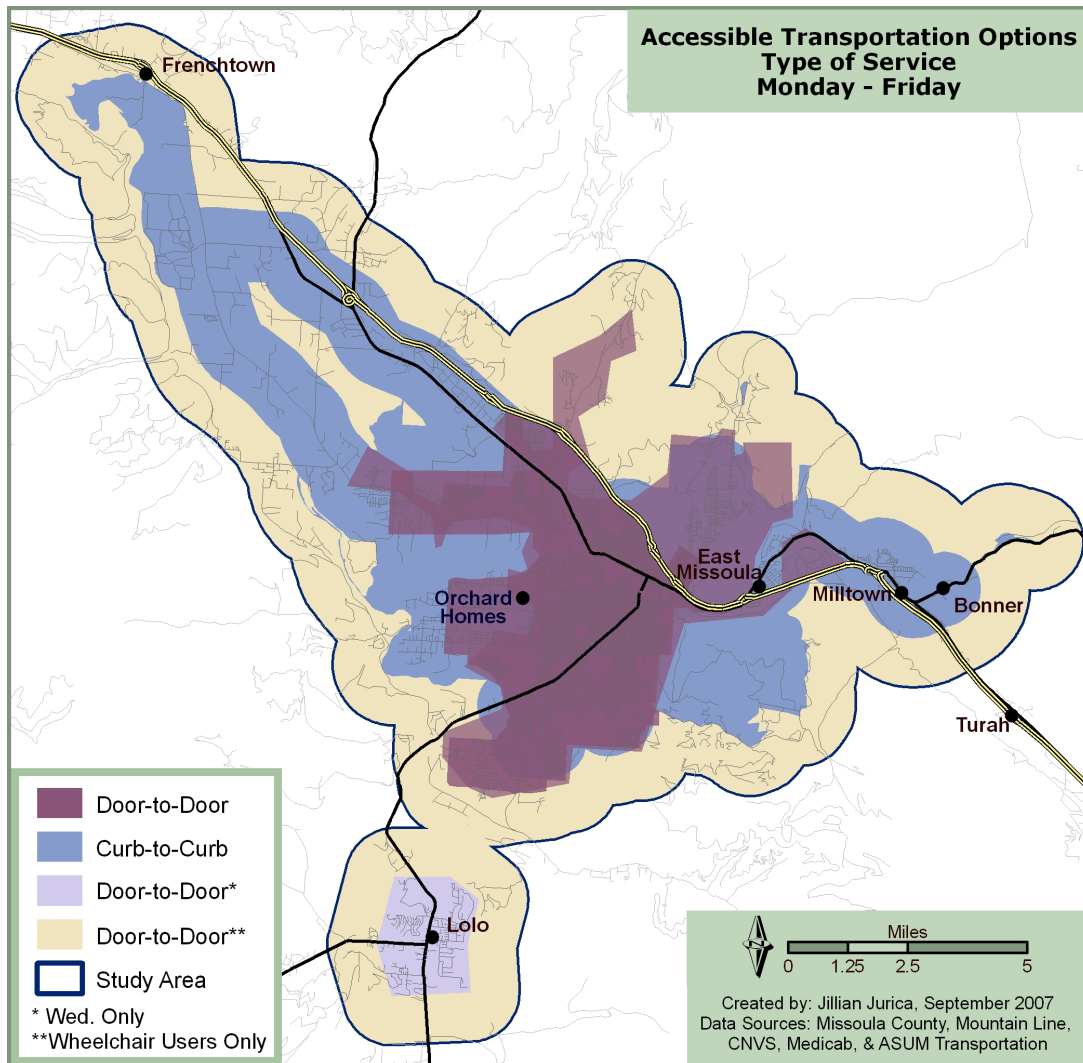

Map 17. Level of assistance available for accessible transportation options.

door service is available and where only curb-to-curb service is available. Once again the map shows that there are differences in coverage for these two different types of service. Though there is door-to-door service available for the entire service area it is only for wheelchair users. For elderly and other people with disabilities that need to door-to-door service the area it is available is much smaller.

The last map of the variables associated with accessible transportation created for this project illustrates for what purposes the available accessible transportation options can be used (Map 18). For six of the seven services provided there is no limit on the purposes for which the transportation can be used. Only Medicab limits its services to medical transportation that is reimbursed through medicaid. However, they do not limit the purposes for which people using wheelchair can use its taxi service.

The final three maps address the potential need of locations within the study area for additional accessible transportation options based on the percentage of people with disabilities and the percentage of the population over the age of sixty-five (Maps 19 - 21). In Maps 19 and 20, by employing spatial analysis techniques available in ArcGIS, all locations in the study area have been put into one of three priority levels of high, medium, or low. Additional information on the number of individuals in the disabled population and the population of people over 65 was added using graduated circles. This was done since it is possible that a block group may have a smaller population base as a whole and then if there are even just a few people with disabilities or people over 65 residing in that block group it could result in a larger percentage than in block groups that are more densely populated. In Map 21 where the information regarding the priority
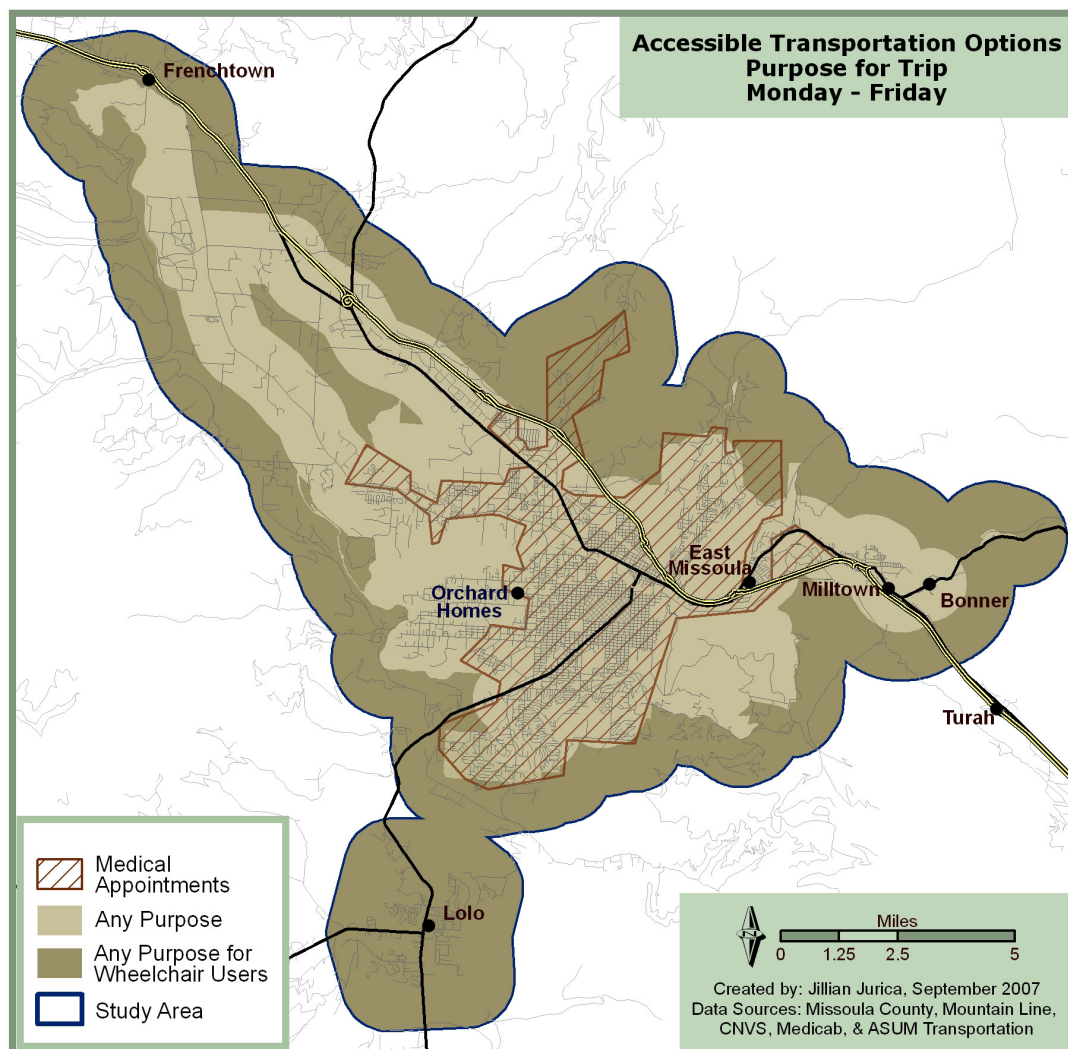
Map 18. Purpose for trips allowed across the study area

levels was combined for both people with disabilities and people over the age of 65, the

locations were classified into the groups of high priority, low priority and mixed priority.

The new high priority areas were high priority areas for both populations individually

and the new low priority areas were low priority areas for both populations individually.

The mixed priority areas are where there was a different level of priority for each of the

populations. It is important to note that these maps do not necessarily indicate that there

are areas of Missoula that transportation options are sufficient. That determination is

beyond the scope of this thesis. Map 19 illustrates the number of accessible

transportation options to the percent of people with disabilities and shows that within the

study area there are some areas with a higher percentage of people with disabilities that

also have a lower number of accessible transportation options available, indicating the

potential need for additional transportation options. This map also shows that in most of

the block groups that have their centroid in the study and have areas that are considered a

high priority, the number of disabled people living is 265 or greater. Map 20 illustrates

the number of accessible transportation options to the percent of people over sixty-five

and similarly shows that within the study area there are areas that have a higher

percentages of people over sixty-five and have a lower number of accessible
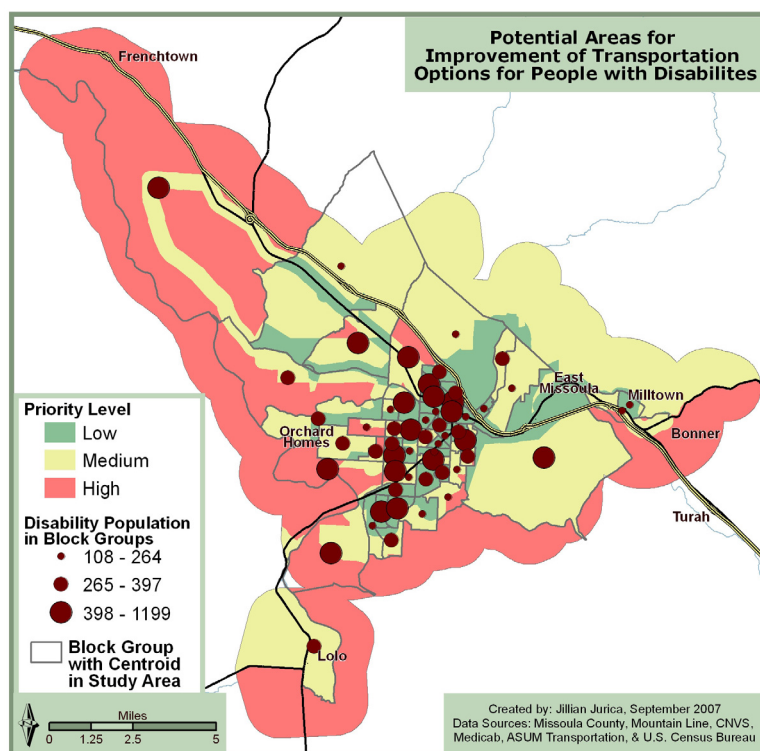
Map 19. Areas that may benefit from additional accessible transportation option based on the disability population
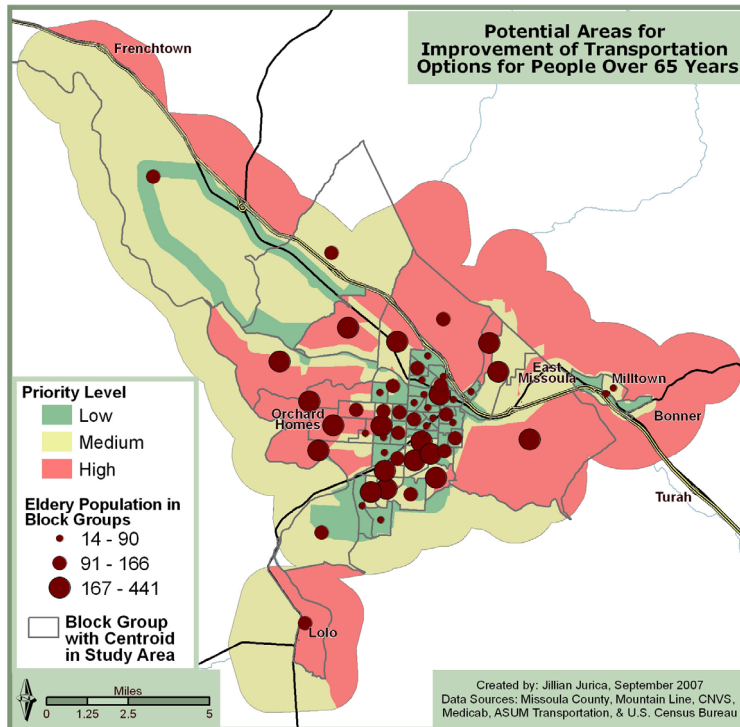
Map 20. Areas that may benefit from additional accessible transportation options based on people over 65 years of age.
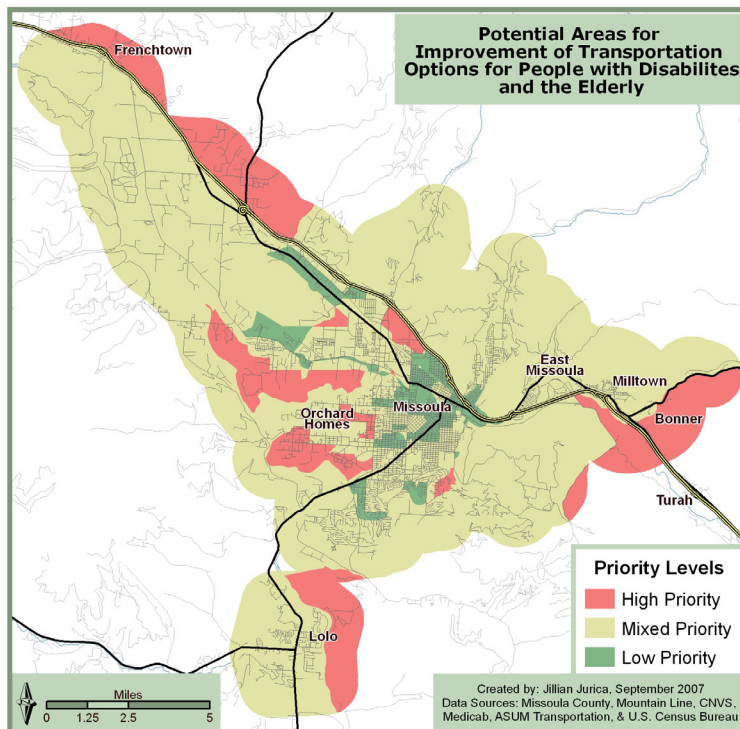
Map 21. Areas that may benefit from additional accessible transportation options based on people with disabilities plus people over 65 years of age.

transportation options. This map also shows that in most of the block groups that have

their centroid in the study and have areas that are considered a high priority, the number

of elderly people living is 91 or greater. Map 21, is the combination of the information in

Maps 19 and 20. This map shows that there are areas that are a high priority for both

people with disabilities and the elderly for additional accessible transportation options.

There are also areas that are low priorities when both these populations are taken into

account. However the majority of the study area has mixed priority levels when both

populations are considered. Therefore, when agencies are able to either expand their

services or want to better coordinate their services to provide more comprehensive

coverage they can use these maps to determine the best course of action. By providing

this information both on separate maps that address each population individually and then

together agencies that want to focus on one segment of the population can then tailor

there services to that population, while agencies that want to address both populations

can also use this information to do so.

<div align="center">Usefulness of the maps for Agencies and for Coordination
and Collaboration between Agencies</div>

The results of the questions regarding coordination of transportation services and

collaboration between agencies from both the first and second interviews are summarized

in Table 8. This data shows that four out of five of the agency representatives

interviewed felt that transportation services are not adequate in Missoula. The fifth

interviewee thought that even though there are many options for accessible

transportation, the public may not be aware of the options and therefore may not be

taking advantage of them. When the interviewees were asked about how transportation

services could be improved, they suggested later hours for services in the evenings, more

options, longer service hours on weekends, and additional routes.

Table 8. First and second interview results summary

Questions	Number of Agencies that answered yes	Number of Agencies that answered no
Are transportation services adequate in Missoula?	1	4
Do you coordinate your services with other transportation agencies?	5	0
Would the maps help your agency coordinate services with other transportation agencies?	4	1
Do you collaborate with other transportation agencies?	5	0
Would the maps help your agency improve your transportation services?	3	2
Would the maps help your agency apply for future funding?	3	2
Are the maps visually appealing?	5	0
Are the maps easy to understand?	4	1
Would maps like these be useful for similar communities in assessing transportation options?	5	0

All interviewees responded that they coordinated their services with each other,

either through referrals or through the scheduling of their services. For example,

Mountain Line coordinates its bus stop times with the ASUM shuttles. Four out of five

of the agency representatives said these maps would be useful for them in coordinating

their services with other transportation agencies by being able to use the information

provided when making referrals. For referral purposes it was suggested that a map listing

contact information for all the agencies would be a very useful tool.

All agency representatives also responded that their agency collaborates with other agencies regarding transportation services. Four out of five of the agencies interviewed are members of the Specialized Transportation Advisory Committee (STAY), which meets monthly to discuss transportation issues in Missoula. The representatives from these four agencies all responded that the information provided in these maps may be useful for future planning in these meetings. All interviewees stated that these maps would probably be useful in identifying gaps in services. Two of the interviewees stated that the maps are useful by making agencies more aware of the services provided by other agencies.

Three out of five of the agency representatives responded that the maps would be useful for their agency in determining how services could be improved and in coordinating with other agencies. The two interviewees that did not think the maps would be useful to them stated that they did think that other transportation agencies would probably find them useful. All the agency representatives responded that the maps either would be useful to people who need or use accessible transportation. Ways the interviewees suggested they may be useful were for users to be able to see which agencies serve the area they live and by cutting down on the number of calls a user may need to make to obtain accessible transportation for a trip.

Three out of five of the interviewees felt the maps may be useful when applying for funding. One interviewee stated that if the maps were added to grant applications they could help illustrate why more transportation is needed.

All agency representatives said the maps were visually appealing and four out of five agencies said they were easy to understand. The agency representative that did not think the maps were easy to understand was concerned that since the transportation service areas and service hours were always changing, the maps could not be kept up-to-date and accurate. Additionally, since the series of maps that showed the changes of the services available throughout the day show changes by the hour and some of the services start or end at different time during an hour, the agency representative felt the information was not as accurate as it could be in a text format.

Finally all agency representatives answered that they thought that a mapping project like this one would be useful or probably would be useful for other communities that had multiple transportation providers similar to Missoula.

The information gathered from the agencies and the resulting maps I created give agencies a new way to appreciate and evaluate accessible transportation options across the study area which previously was unavailable to the agencies and the community. Instead of focusing solely on whether there is or is not an accessible transportation option available for people with disabilities and the elderly at a particular location a more complete picture of options is presented. This is extremely important since not all available options fit with every individual's specific needs.

CHAPTER 5
Summary and Conclusions

The purpose of this thesis was to create a method to assess the current accessible transportation for a community using GIS. The maps created for this project just scratch the surface of what is possible with how GIS can be used in determining the adequacy of accessible transportation. The procedure used in creating the maps involved interviewing representatives from agencies that provide accessible transportation and then using GIS to spatially display the information gathered from these interviews to give an overall idea of accessible transportation throughout the study area.

The literature reviewed in Chapter 2 underscores the importance of having access to transportation for people with disabilities to live a more healthy and fulfilling life. Also, the increase of urban sprawl and the changes in the population towards an older society on average only accentuate the need for more transportation options, especially accessible transportation options. Although the area of disabilities has not been a focus in the fields of geography and GIS, in recent years this trend is changing as more geographers are studying how the physical environment can impact how people with disabilities live and are perceived by others. More recently, research in using GIS to assist people with disabilities find accessible routes of travel and in the planning of these routes for developers is being conducted. This study adds to this body of work by demonstrating another way GIS can be used in the field of geography and disability. This study shows how GIS can be used to assess accessible transportation in a community in hopes of helping agencies to improve their services, if necessary, by providing more comprehensive services to a community.

Chapter 3, Methods, describes the steps taken to complete this project. The design of the interview questions and the process for the interviews with the five agencies that provide accessible transportation in the study area were detailed. Two of the agencies provide two different services, therefore a total of seven accessible transportation options were examined in this thesis. In the interviews the agency representatives were asked about the accessible transportation services their agency provides, as well as, their coordination and collaboration with other agencies that provide accessible transportation. A method for using the collected data to create an accessible transportation density map, which displays the number of transportation options over locations across the entire study area was described, as well as, a method for creating a series of maps that display the changes in transportation throughout a typical weekday. In addition, steps were described to display the attribute information gathered and compiled into the feature class data tables on maps that address cost of services, eligibility criteria, type of assistance available, and the purpose for which the services can be used. Finally a method using population data from the U.S. Census Bureau in conjunction with the density of transportation options to find the locations in the study area where improvement or expansions of services may be necessary was developed. These methods typically involved employing the spatial analysis tools available in ArcGIS that intersect, merge or join polygons keeping their identifying information intact.

Chapter 4, Results, presents the interview results and the resulting maps that display information regarding the accessible transportation options. The accessible

transportation density map illustrates that as one moves away from central Missoula, the number of accessible transportation options decreases. The series of maps that depict transportation options over the course of a twenty-four hour weekday period also indicate that the further a rider is located from central Missoula, the fewer the number of options that person will have especially during early morning and early evening hours and, with the exception of University of Montana students, after 8:00 P.M. there are no accessible transportation options available in the study area. The information gathered indicates that there are limited options for transportation on the weekend, especially on Sunday when there is only one option with limited capacity. The maps that show the information regarding the variables of who, why, what, and how much also illustrate that there are not comparable accessible transportation options throughout the entire study area. For example, there are areas where there are only curb-to-curb options for anyone who does not use a wheelchair, and many individuals with disability and the elderly may require additional assistance getting into or out of their house and in reaching there final destination after disembarking from the vehicle. There are also areas where costs for transportation services may be prohibitive to some individuals.

Conclusions

The conclusions of this thesis will be discussed focusing on the strengths and weaknesses of the methodology and how it relates to using GIS to assess accessible transportation. One of the strengths is in the flexibility of the GIS once data has been gathered and compiled into to feature classes and attribute tables. Thus, with the information gathered and compiled into the feature classes and tables, the maps created

for this thesis are only a small number of possible maps that could be created. For example, instead of looking at one variable such as cost of a trip in a map, different combinations of the variables for a service could be mapped together, such as cost and eligibility, or eligibility and type of service provided. Additionally, if weekends were of a concern for a community more than weekdays, then similar maps could be created for those days of the week. The ability to create maps to focus on specific concerns of a community regarding accessible transportation is a great benefit of using GIS in this way. An additional strength of the methodology is the ability to visually see where all the different agencies' services are provided and to learn information about the different variables associated with the services. It is much easier for the riders to be able to see if an accessible transportation option is available where they need to be picked up and where they need to be dropped off using a map than to trying to figure out this information by reading about service coverage areas. Also by using the maps, it may be possible for a rider to combine different accessible transportation options to travel to and from areas to which no single transportation agency provides services.

Finally this information may be important for people with disabilities and the elderly to make decisions about where they want to live if accessible transportation is a concern for them. These maps can help them decide which areas of Missoula provide them with the best options for accessible transportation options that will meet their needs. The idea of choosing a place to live based on the available transportation options is one of the adaptive strategies suggested for the elderly in maintaining mobility (Sterns, et al., 2003).

The agency representatives interviewed for this project were all interested in having a map that shows all the service areas of the agencies together along with the basic information about the services and contact information to help them with referring consumers to the appropriate agency if they cannot provide the necessary transportation themselves. This map could be created using the agency feature classes that were developed combined with the information gathered for this project.

A potential weakness of the method was brought to the author's attention by one of the interviewees. They expressed the fact that they are constantly adjusting their transportation services to meet the needs of their focus population, which would cause the maps to lose accuracy in a short time. Without having someone who is charged with the task of periodically gathering information about changes in services of all the agencies and then updating the associated feature classes the maps may become quickly outdated and no longer a useful tool for assessment. However, GIS data can be updated with minimal time and effort in a scenario such as ths one, especially since at this time there are only seven accessible transportation options involved. GIS is particularly amenable to projects that require constant updating. Many editing tools are available making it easy to edit boundaries in service areas for an agency. When this is done, the accompanying attribute information automatically stays with the updated polygons. Other tools such as Select by Attribute make it easy to select for editing particular features whose attributes have changed. Updated maps can then be produced as needed by simply following the steps laid out in this project.

Finally this project has only focused on gathering information from the agencies that provide transportation services. For a community to accurately access the adequacy of their transportation system, the users of the different services need to be included in the discussion. Information contributed by users regarding the different transportation options could be entered as attribute information in the data tables for each agency feature class and then this information could be used in the spatial analysis. It would also be interesting to add ride capacity information for each of the agencies involved as an attribute, to see how that may relate to some of the other attributes.

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APPENDIX A

<u>Agency Request for Interview Letter</u>

Agency Representative
Agency Name
Agency Address

Dear Agency Representative,

I am a graduate student in the Geography Department at the University of Montana and am also employed at the Rural Institute on Disabilities. For my thesis I plan to map the accessible transportation options in Missoula and the surrounding area. I then hope to discover how the maps and the information they portray would be useful for agencies that provide accessible transportation. In order to complete this thesis, I received a stipend from Easter Seals Project Action.

The first step of this project is to gather data regarding accessible transportation for people with disabilities and the elderly. Therefore, I would like to interview you or someone at your agency about the transportation services you provide. I will be gathering data about when services are available, where services are provided, who is eligible for your services, and how much services cost. I will also be gathering data regarding your coordination or collaboration with other agencies in the Missoula community that provide transportation services.

The gathered data will then be used to create maps using GIS that illustrate accessible transportation options in Missoula. After the maps are created I would like to show them to you and then interview you a second time to see if you believe the maps accurately displays Missoula's transportation options and if it is easy to understand. Also I will ask question about if the maps would be a useful tool for you to use in evaluating your services and in make future decision about your services.

I will be contacting you in the next week to see if you would be willing to participate in this project and if we could set up at time for me to interview you. The interview will take approximately one hour to complete. If you have any questions or concerns, you can contact me at xxx-xxxx.

Sincerely,

Jillian Jurica
Graduate Student
Department of Geography
University of Montana