# Table of Contents

## Introduction ............................................. 4
- Maximizing Ridership is Not NAFTA’s Only Goal . . 5
- Ridership or Coverage? .................................. 6
- Frequency is freedom ..................................... 7

## Assessing Ridership Potential ............... 8
- Effects of Land Use and Street Design ............. 9
- Density ...................................................... 10
  - Residential density .................................. 10
  - Job Density .............................................. 11
  - Activity Density ....................................... 12

## Assessing Coverage Needs ................. 13
- Poverty Density ....................................... 14
- Density by Race and Ethnicity ................ 15
- Senior Density ......................................... 16
- Youth Density .......................................... 17

## Recent Trends ........................................... 18
- Ridership, Revenue Hours and Productivity .......... 19
- Operating Costs ........................................ 20
- Funding Sources ........................................ 21
- Peer Comparison ......................................... 22
  - Investment and relevance ............................... 22
  - Cost to deliver service ................................ 22

## Transit Service Analysis ..................... 23
- Daily and Weekly Span of Fixed Route Service .... 25
- Fixed Route Ridership by Time of Day .............. 26
- Ridership by Route ........................................ 29
- Fixed Route Productivity ................................. 29
  - System-wide productivity ............................... 29
  - Route-by-route productivity ............................ 30
  - Productivity and frequency relate ..................... 31
  - Weekend productivity ................................... 32
- NAU Shuttle ................................................. 32
- Network Design ........................................... 33
  - Pulsing ...................................................... 33
  - Linearity .................................................... 33
- Paratransit Ridership .................................... 36
  - Productivity and cost ................................... 36

## Key Choice: How to Balance Ridership and Coverage Goals ................. 39
- Balancing Ridership and Coverage Goals ............ 40

## Alternatives ............................................. 41
- Conceptual Alternatives ................................ 42
- Descriptions of the Alternatives .................... 46
- Budget ......................................................... 46
- Service categories ......................................... 46
- Route numbering ........................................... 46
- High Ridership (High Frequency) Alternative .... 47
- High Coverage Alternative ............................... 48
- Comparing Coverage and Ridership Potential ........ 49
List of Figures

Introduction .................................................................................. 5
Figure 1: Illustration of the Ridership / Coverage Trade-off ........................................ 7
Figure 2: Map of NAIPTA’s Fixed Route Network, color-coded by frequency ............. 8
Assessing Ridership Potential ................................................................. 9
Figure 3: Illustration of the Ridership Recipe ...................................................... 10
Figure 4: Map of Residential Density .............................................................. 11
Figure 5: Map of Job Density ........................................................................ 12
Figure 6: Map of Activity Density ................................................................... 13
Assessing Coverage Needs ........................................................................... 14
Figure 7: Map Poverty Density ..................................................................... 15
Figure 8: Map of Residents by Race or Ethnicity ........................................................................ 16
Figure 9: Map of Senior Density ................................................................... 17
Figure 10: Map of Youth Density .................................................................. 18
Recent Trends ........................................................................................ 19
Figure 11: Graph of NAIPTA’s Annual Revenue Hours of Service, 2008-2015 ........ 20
Figure 12: Graph of NAIPTA’s Annual Boardings, 2008-2015 .......................... 20
Figure 13: Graph of NAIPTA’s Productivity, 2008-2015 ...................................... 20
Figure 14: Graph of NAIPTA’s Annual Operating Costs, 2008-2015 .................. 21
Figure 15: Graph of NAIPTA’s Operating Cost per Hour of Service, 2008-2015 ... 21
Figure 16: Graph of NAIPTA’s Operating Cost per Boarding, 2008-2015 ............ 21
Figure 17: Chart of NAIPTA’s Funding Sources for Fiscal Year 2016 .................. 22
Figure 18: Charts of Investment and Relevance in Flagstaff and Seven Peer Cities ... 23
Figure 19: Chart of Cost per Service Hour in Flagstaff and Seven Peer Cities ........ 23
Transit Service Analysis .......................................................................... 24
Figure 20: Map of NAIPTA’s Existing Fixed Route Transit Network as of October 2016 25
Figure 21: Diagram of Frequencies and Spans of NAIPTA Fixed Routes (as of January 2017) 26
Figure 22: Graphs of Boardings by Time of Day on Each NAIPTA Route ............... 27
Figure 23: Map of Average Daily Boardings per Stop ......................................... 28
Figure 24: Map of Average Daily Boardings per Stop, and Activity Density ........... 29
Figure 26: Chart of the Productivity of NAIPTA and Peer Transit Agencies’ Fixed Route Networks. ................................................................. 30
Figure 25: Table of Daily Revenue Hours and Boardings by Route and by Day of the Week ................................................................. 30
Figure 27: Graph of the System-Wide Productivities of Peer Agencies, 2010-2015 .......... 30
Figure 29: Chart of Routes’ Percentages of Weekday Ridership and Revenue Hours .................................................................................. 31
Figure 28: Table of NAIPTA’s Route-by-Route Productivities, October 2016 .......... 31
Figure 30: Scatterplot of Routes’ Productivity and Frequency from 20 U.S. Transit Networks .................................................................................. 32
Figure 31: Scatterplot of NAIPTA Routes’ Weekday Productivities and Frequencies .................................................................................. 32
Figure 32: Graph of NAIPTA Routes’ Productivities on Weekdays, Saturdays and Sundays .................................................................................. 33
Figure 33: Pulse Diagram .............................................................................. 34
Figure 34: Diagram of Direct, Circuitous and Deviating Routes .............................. 34
Figure 35: Excerpt of the Activity Density Map of Flagstaff (full map is shown on page 13) .................................................................................. 35
Figure 36: Street Map of Mesa and BASIS Area .................................................. 35
Figure 37: Graph of NAIPTA Fixed Route and Paratransit Productivity, 2008-2016 .................................................................................. 37
Figure 38: Map of Paratransit Pickups in November 2016 ..................................... 38
Figure 39: Map of Paratransit Trips in November 2016 ......................................... 39
Key Choice: How to Balance Ridership and Coverage Goals ............................... 40
Alternatives .......................................................................................... 42
Figure 40: The Spectrum of Choices .................................................................. 43
Figure 41: Small Map of the High Ridership (High Frequency) Alternative .................. 43
Figure 42: Small Map of the High Coverage Alternative ....................................... 43
Figure 43: Map of the High Ridership (High Frequency) Alternative ....................... 44
Figure 44: Map of the High Coverage Alternative ............................................... 45
Figure 45: Map of the Existing Network .......................................................... 46
List of Figures

Figure 46: Frequency and Span Table for the Existing Mountain Line Network .................. 47
Figure 47: Frequency and Span Table for the High Ridership Alternative ......................... 48
Figure 48: Frequency and Span Table for the High Coverage Alternative ....................... 49
Figure 49: Charts Comparing Coverage and Ridership Potential of the Alternatives .......... 50
Figure 50: Tables Reporting the Coverage and Ridership Potential of the Alternatives ........ 51
Introduction
Introduction

This report begins the development of a 5-Year Transit Plan for NAIPTA’s Mountain Line bus service.

The first part of this report is an assessment of the market for transit in Flagstaff. By “market” we are referring specifically to the demands for transit that result in high ridership relative to cost. This way of thinking about a transit market is similar to the way a private business thinks about its market for sales – how many potential customers there are, how useful they will find the product, and how well the product competes for their business.

High ridership serves a number of commonly-held values, like:

- Protecting the economy from the effects of congestion,
- Reducing pollution, and
- Reducing people’s transportation costs.

An assessment of transit ridership potential is contained in Chapter 2 starting on page 9.

In this report, we refer to transit services that are not operated with the goal of high ridership as having a coverage goal. Coverage goals reflect concerns about equity, and they also reflect social-service objectives, such as meeting the needs of people who are especially reliant on transit, whether due to age, disability, poverty or some other condition. Arguments for coverage services generally refer not to how many people need transit service but to the intensity of their need.

Transit coverage serves a set of commonly-held values, like:

- Giving all residents equal access to transit, no matter where they live,
- Providing transit service to certain groups of people, because of how intensely they need access or because of civil or legal entitlements, or
- Spending tax revenues close to where they were raised.

If the severity of a person’s need is a more important driver of where transit goes than the number of people who will be served, that reflects a coverage goal.

An assessment of coverage needs is contained in Chapter 3 starting on page 14.

Maximizing Ridership is Not NAIPTA’s Only Goal

If the Mountain Line system were designed only for maximum ridership, it would focus only on areas where there are many potential riders, and transit is useful for many of their trips. In other words, NAIPTA would be targeting a market where its product is competitive.

Yet maximizing ridership is not the only goal of public transit systems. While private transit companies may focus on profits, and therefore on exclusively high-ridership routes, public transit is almost always expected to meet other goals. In nearly every city, there is an expectation that transit service should be provided in some or all places regardless of the ridership it attracts.

Unlike governments, businesses are under no obligation to open storefronts in places where they would spend a lot of money to reach few potential customers, or where their products can’t compete. For example, McDonald’s is under no obligation to provide a drive-thru restaurant within 1/2 mile of every resident in Arizona. If it was, then thousands of houses in rural Arizona would need to have their own McDonald’s at the end of the driveway. The company would quickly go bankrupt, as a result of operating all those restaurants across the state for tiny numbers of customers.

People understand that in a low-density, rural place they will have to drive many miles to reach a McDonald’s, because McDonald’s will be located only in places with enough potential customers. We wouldn’t describe this situation as McDonald’s being unfair to people in rural areas; McDonald’s is just acting like a business. It has no coverage obligation, only a goal of maximizing profit.

Transit agencies are often accused of failing to maximize ridership, as if that were their only goal. But they are not private businesses, and as public agencies they are intentionally providing coverage services that they know will not generate much ridership. The elected officials who ultimately make public transit decisions hear their constituents say things like “We pay taxes too” and “If you cut this bus line, we will be stranded” and they decide that coverage of some low-ridership places is an important transit outcome.

Similarly, transit agencies are often accused of failing to maximize the coverage they provide across their service area. Mountain Line achieves relatively high ridership, for an agency of its size, but few people realize that this achievement trades-off against providing high coverage.
Introduction

Ridership or Coverage?

Most conversations about transit arrive, sooner or later, at a basic conflict between transit’s major goals: maximize ridership, or provide coverage?

Maximizing ridership serves a number of values, such as:

- Reducing driving, and with it pollution, carbon emissions, noise, parking requirements, and other negative impacts.
- Supporting compact urban development without an accompanying increase in auto traffic, congestion and parking demand.
- Reducing household transportation costs.
- Improving access to jobs for large numbers of workers.
- Reducing subsidy per passenger, since high ridership transit divides its operating costs over a larger number of passengers.

There are other goals for transit, that do not depend on high ridership:

- Providing access to transit to a large number of people or places. (Access can be valuable whether or not the transit is actually used.)
- Providing service close to those who pay for it (e.g. through taxes).
- Making sure that people with severe needs for transit (due to income, age or disability) have access, no matter where they live.

These two sets of goals can be thought of as “ridership goals” and “coverage goals.” Ridership goals are only achieved when ridership is high relative to cost. Coverage goals, on the other hand, are served through the presence and availability of transit, whether or not people ride it. It is important that we think clearly about the difference between ridership and coverage goals because, for simple mathematical reasons, they are in conflict. If a transit agency wants to do more of one, it must (within a fixed budget) do less of the other. This conflict is illustrated in the diagram at right.

In the town illustrated at right, the little dots are dwellings and commercial buildings and other land uses. The lines are roads. Most of the activity in the town is concentrated around a few roads, as in most towns. A transit agency pursuing only a ridership goal would run all of its buses on the streets where there are large numbers of people, walking to transit stops is easy, and where they can run straight routes that feel direct and fast to customers. This would result in a network like the one at bottom-left.

If the town were pursuing only a coverage goal, on the other hand, the transit agency would spread out services so that every street had some bus service, as in the network at bottom-right. As a result, all routes would be infrequent, even those on the main roads.

In these two scenarios, the town is using the same number of buses. These two networks cost the same amount to operate, but they deliver very different outcomes.

On a fixed budget, designing transit for ridership or coverage is a zero sum game. In the networks in Figure 1, each bus that the transit agency runs down a main road, to provide higher frequency service there, is not running on the neighborhood streets, providing coverage, and vice versa.

While an agency can pursue ridership and provide coverage within the same budget, the more it does of one, the less it does of the other.

Fortunately, this is not a binary choice: with any given budget, a community can decide how much to spend maximizing ridership, and how much to spend providing coverage in low-ridership places. All transit providers pick a point on the spectrum between maximizing these goals.

How to optimize and balance ridership and coverage goals is not a technical question; it is a question of values. It relates directly to the needs and desires of the community. With values questions, there is no single correct answer, and reasonable people may disagree about the optimal balance.

Imagine you are the transit planner for this fictional town. The dots scattered around the map are people and jobs; the streets shown are ones on which transit can be operated. The buses are the resources the town has to run transit.

Before you can plan transit routes, you must first decide what you want transit to do.

Figure 1: Illustration of the Ridership / Coverage Trade-off
In transit conversations there is often a great focus on where transit is provided, but less concern about when it is provided. The “when” of transit service is described as frequency (how many minutes between each bus) and span (how many hours a day, and days a week, it runs).

Low frequencies and short spans are one of the main ways that transit fails to be useful, because it means service is simply not there when the customer needs to travel.

Even though Google Maps or an app on a phone can be consulted for directions, frequent transit service is effective at attracting ridership because it has the simplicity of a road: you can use it anytime you need to. Frequent service allows someone to maintain a map of the transit system that is much like a road map, in that no schedule is needed to know how to go places whenever you want to.

Flagstaff currently has two transit routes at this “no-schedule-needed” level of frequency: Mountain Line’s Route 10 (which comes every 8-10 minutes, on days when NAU is in session) and NAU’s student shuttle (which comes every 4 minutes on those same days). An additional pair of routes come close to that frequency threshold. Routes 2 and 4 come every 20 minutes on weekdays.

Frequent service:
- Reduces waiting time (and thus overall travel time).
- Improves reliability for the customer, because if something happens to your bus, another one is always coming soon.
- Makes transit service more accessible, by reducing the need to consult a schedule.
- Increases capacity, moving more people with less crowding.

Many people assume that today, with real-time transit arrival information (like Mountain Line’s FLGride app) and smartphones, nobody needs to wait for a bus anymore, and frequency therefore doesn’t matter. If a bus only comes once an hour, that’s fine, because your phone will tell you when it is a few minutes away and you should start walking.

Despite all these new technologies, frequency still matters enormously, because:
- Waiting doesn’t just happen at the start of your ride, it also happens at the end. You may not need to leave the house much before your departure, but if your bus is infrequent and the schedule doesn’t happen to line up perfectly with your desired arrival time, you have to choose between being very early or too late. If you start work at 8:00 am but the bus passes your workplace at 8:10 am, you can be 50 minutes early or 10 minutes late, a frustrating choice.
- Many of the places we go don’t let us hang out until our bus’s arrival is imminent. We can easily do this when leaving home, but it is more awkward when leaving a restaurant or a workplace that is closing.

Real-time arrival information doesn’t make the bus more reliable. Your smartphone can tell you when your bus is arriving, but it cannot prevent your bus from having a problem and being severely delayed, or not showing up at all. Only frequency – which means that another bus is always coming soon – can offer this kind of reliability.

Frequency is freedom
2 Assessing Ridership Potential
Assessing Ridership Potential

Effects of Land Use and Street Design

Some people have the impression that transit’s success at attracting riders is within the control of the transit agency alone, but this is rarely the case. Land use, development, zoning, urban design, highways, railroads and street patterns have effects on transit’s usefulness and cost, and therefore on its ridership. For this reason, most cities coordinate their transit planning with their land use and transportation planning.

Land use, development and transportation planning are done by the City of Flagstaff and the Metropolitan Planning Organization (FMPO). These factors are not directly controlled by NAIP, but they impact ridership and the costs NAIP must bear to attract that ridership.

If a transit agency is designing for high ridership, it will naturally focus service on places where ridership potential is high and cost is low.

Four key factors are:

- **Density**: How many people (or jobs, or other activities) are within a given distance of each stop?
- **Walkability**: Can people near the stop actually reach the stop?
- **Linearity**: Can transit serve an area in straight paths, or must it make time-consuming deviations?
- **Proximity**: Are there long gaps between destinations and strong markets that transit must traverse?

A simple way to visualize the different ways they impact ridership and costs is to ask: “How far do we have to drive a bus to serve 100 people or jobs?” The lower this distance is, the higher the ridership potential of an area and the lower the cost.

These factors determine both the costs of providing transit in a particular place and how many people are likely to find the service useful. Density and walkability tell us about the overall ridership potential of the market: “Are there a lot of people around, and can they get to the transit stop?”

Linearity and proximity tell us about both ridership potential and cost: “Are we going to be able to serve the market with fast, direct lines, or will we have to run indirect or long routes, which cost more to operate (and cost riders time)?”

A transit provider can influence the level of ridership their services generate, within their fixed budget, by targeting corridors and places where the “Ridership Recipe” is in effect. However, they cannot directly control the urban form of the places they serve. Without dense, walkable places with connected streets, where demand is continuous along linear transit paths, a high level of transit service alone is unlikely to achieve high ridership. The transit agency can try to provide a level of transit service that is as useful as possible, but the built environment has the power to limit transit ridership regardless of service.

In the following pages, we look at the potential for high transit ridership in Flagstaff with these considerations in mind.
Density

The maps on this page and the following page show the densities of residents and jobs in Flagstaff.

In planning, people sometimes react strongly to the word “density” based on their emotional and cultural experiences. Yet density describes a simple geometric and geographic fact that matters enormously for transit – the number of people around any given transit stop.

Residential density

While not all trips start or end at home, nearly everybody makes at least one trip starting or ending at their place of residence on most days. Further, places with many households are also social destinations.

The map at right shows the density of residents within each Census block in Flagstaff.² We can observe that:

- There are a high density of residents at and around NAU campus, including on the other side of I-40.
- Places where people live in moderate or high densities are scattered across the city, rather than concentrated in certain parts of the municipality, and they are certainly not centralized in a traditional urban pattern. Referring back to the “Ridership Recipe,” Flagstaff residential development does not offer proximity.
- Places where people live in moderate or high densities are not arranged along a small set of common corridors. In terms of the “Ridership Recipe,” this would be described as a challenge for linearity – a transit route can either run in a straight line, or serve multiple dense residential areas, but it cannot do both.
- There are dense zones located along roads that are unsafe or unpleasant to cross (for example, Route 66/Highway 89). Per the “Ridership Recipe,” walkability requires that people be able to reach bus stops in both directions, which means crossing the road at least once. A transit stop on an uncrossable road cannot attract high ridership, even if it is in front of a very dense neighborhood.
- Residential density downtown is fairly low, though it is slightly higher in Southside. This is where the transit network converges, so downtown and Southside residents would have transit access to more of the city than residents anywhere else. Yet there are not very many people living at the center of the network, which also happens to be on of the most walkable places in the city.

² The data used for this map is the most recent available, but still does not reflect very recent developments in the Sawmill area. If it did include these developments, Sawmill would likely appear to be very dense with residents. This is also true of recent developments in Presidio and on the Mesa.
Job Density

Job density is an even better predictor of transit ridership than residential density. This is because it represents places people travel for work, but also places people go for services, shopping, culture, health care, and more. A person’s workplace may be, throughout the day, a destination for dozens or even hundreds of people.

The map at right shows the density of jobs in each Census block. The data used for this map is the most recent available, but still does not reflect very recent developments in the Sawmill area. If it did include these developments, Sawmill would likely be a long stretch of Huntington, and a long stretch of Route 66. In places, these jobs are located in the long island between the railroad and I-40, making them much farther than they appear from neighboring developments and from transit service passing by.

Employment is most concentrated downtown, and in and around NAU. Small pockets of large numbers of jobs are scattered on either side of Route 66, especially in Sunnyside and on Hospital Hill.

The most proximate and linear pattern in this map is the string of dark- and medium-blue Census blocks running from Hospital Hill in the north to NAU and Milton Road in the south.

There is low density employment and commercial development along a long stretch of Huntington, and a long stretch of Route 66. In places, these jobs are located in the long island between the railroad and I-40, making them much farther than they appear from neighboring developments and from transit service passing by.

Employment is most concentrated downtown, and in and around NAU. Small pockets of large numbers of jobs are scattered on either side of Route 66, especially in Sunnyside and on Hospital Hill.

The most proximate and linear pattern in this map is the string of dark- and medium-blue Census blocks running from Hospital Hill in the north to NAU and Milton Road in the south.

There is low density employment and commercial development along a long stretch of Huntington, and a long stretch of Route 66. In places, these jobs are located in the long island between the railroad and I-40, making them much farther than they appear from neighboring developments and from transit service passing by.

3. This map exhibits a common problem with job data, which is called “headquartering.” Some large private and public organizations, whose workers are actually distributed across a large area or multiple job sites, record all of their workers’ job sites as being at the headquarters. This is obviously the case for the very dark blue Census block in Forest Springs, which in reality contains only single-family homes, a middle school campus, and a Flagstaff Public Schools office. Yet every Public Schools employee is counted as though they worked at that Census block. Similarly, while there are a great many jobs in some of the dark blue areas between Route 66 and I-40, some of those Census blocks may also reflect the “headquartering” of private companies’ job data. Finally, jobs on NAU campus are likely more distributed across central campus than they appear.

4. The data used for this map is the most recent available, but still does not reflect very recent developments in the Sawmill area. If it did include these developments, Sawmill would likely appear to be at least moderately dense with jobs. There are also more jobs on the Mesa than suggested by this map, for the same reason.
Activity Density

Residential and job densities are combined into Activity Density in the map at right. This allows us to see how the total density of activities, the mix of uses, their proximity and their linearity could affect transit ridership across Flagstaff.

On this map, red represents residential density and blue represents job density. Shades of purple represent Census blocks with a mix of uses, but the highest-density mixed use blocks are shown in yellow.

We can observe that:

- The mix of uses is mostly high in a linear pattern from Hospital Hill through downtown and Southside, to the NAU campus and along Milton Road, with only a few gaps in activity.
- There is a mix of uses in Sunnyside.
- In between these two dense, mixed-use centers there is a mostly-empty space – the Mesa. Transit service connecting these centers has to traverse this distance. (Part of the mesa is slated for development, though not along the road that a bus would follow, as we discuss on page 36.)
- There is also a mix of uses along Route 66/Highway 89, though at low densities, over a very long distance, and generally only on one side of the highway or the other (but rarely both). However, densities are more intense near NAU, especially with recent developments at Sawmill.
- There are pockets of high-density housing that are far from any other dense development, especially south of I-40.

Though it is not one of the four major factors named in the Ridership Recipe, the mix of residential and job density along a corridor also affects how much ridership transit can achieve, relative to cost.

This is because a mix of uses tends to generate demand for transit in both directions, at many times of day. Transit lines serving purely residential neighborhoods tend to be used in only one direction – away from the residential neighborhood, towards jobs and services. This limits how much ridership the service can attract relative to its cost, because:

- If ridership is only high during the morning and evening rush hours, that means the transit agency must pay to run mostly-empty buses during the rest of the day (or must pay drivers to take awful split-shifts, which go from very early to very late, and must buy extra buses for those few hours of peak service each day).

Thus all-day and two-way demand, along an entire route, results in higher ridership relative to cost. All-day and two-way demand tends to arise on corridors that have mixtures of housing, retail, services and jobs.

Flagstaff’s major challenge in achieving higher transit ridership, relative to cost, will be this: there are very few long, linear corridors with proximate, continuous density and a mix of jobs and housing. The only two such corridors are one between Hospital Hill and the south end of Milton Road, and another along Route 66/Highway 89. The latter is fairly hostile to walking in most places.
3 Assessing Coverage Needs
Poverty Density

Transit is often tasked with providing affordable transportation for low-income people. When this is done in the absence of high ridership, it represents a type of coverage goal. Federal laws also protect low-income people from disparate transportation impacts, which can lead agencies to provide transit service in places where poverty is high even if it does not maximize ridership.

However, an examination of the distribution of poverty in Flagstaff arguably belongs in the preceding chapter, because people who are living in poverty can represent either a strong market for transit or a need for coverage service (regardless of ridership), depending on the built environment around them. Understanding where large numbers of low-income people live (and where they need to go) is thus important in terms of ridership goals and coverage goals.

A common misconception is that transit, especially all-day transit, is only useful to low-income people who cannot afford a car. This is a simplistic view on a complex matter. People at all points on the income spectrum make choices about how to travel, based on their personal evaluation of a set of factors including cost, travel time, safety and comfort.

It is certainly true is that people with fewer resources have an incentive to spend less on transportation. The more carefully a person must manage their money, the more attractive transit’s value proposition may be. However, this doesn’t mean that lower-income people will automatically choose transit because it’s the cheapest option. The service available to them must be useful and reliable for the kinds of trips they need to make. Nor does it mean that a person further up the income spectrum will not use the same transit services as low-income people, if they find those services sufficiently useful.

The map at right shows the density of people living in poverty in each Census block in Flagstaff. There appears to be a correlation between the density of low-income residents and the density of all residents (the latter shown in the map on page 11).

This correlation means that the far-flung dense developments we noted on page 11 are also where large numbers of low-income people reside. This development pattern sets up the conflict between transit’s competing goals, of achieving high ridership relative to cost, on the one hand, and making sure low-income people have access to service, on the other hand. When low-income people live far away from other activities and developments, and reaching them with transit requires circuitous routes through mostly empty space, the service will be expensive relative to the ridership it achieves, and will therefore be justified by a coverage (rather than ridership) goal.

5. There are places in Flagstaff where the percentage of residents who are low-income is quite high, but those places do not appear on this map because densities are so low that they actually represent a very small number of people. Because those low-density (nearly rural) places tend to have very large Census block areas, they would appear enormous on this map, overwhelming the data that represents much larger numbers of people living in urban-sized Census blocks.
Density by Race and Ethnicity

Federal civil rights law protects people from discrimination in the provision of transit service on the basis of their race or ethnicity. It is important to understand where large numbers of non-white people live, so that service changes can be evaluated in light of impacts to those people.

While information about someone’s income tells us something about their potential interest in riding transit, information about ethnicity or race do not (except to the extent that race or ethnicity correlate with income, and in certain cases they do). However, avoiding placing disproportionate burdens on non-white people through transportation decisions is essential to the transit planning process.

The overall pattern of density of minority residents, shown in the map at right, resembles the pattern of density of all residents in the city.

The largest and densest areas home to minority residents are near NAU, in Sunnyside and West Village, as well as in the Census blocks containing large apartment complexes (e.g. Country Club, Christmas Tree Estates, Tablerock) and manufactured homes (e.g. Sunnyside, Smokerise Valley, Lynch).

This information about where non-white people live is helpful not only for assessing coverage needs and civil rights, but also for thinking about where people’s involvement in this 5-Year Plan process might be hampered by language or cultural barriers.

6. There are places in Flagstaff where the percentage of residents who are non-white is high, but those places do not appear on this map because densities are so low that they actually represent a very small number of people. Because those low-density (often rural) places tend to have very large Census block areas, they would appear enormous on this map, overwhelming the data that represents much larger numbers of people living in urban-sized Census blocks.
Senior Density
One of the major drivers of transit coverage is the need for mobility among people who cannot drive. This need is particularly acute among seniors, many of whom cannot or choose not to drive themselves.

The map at right shows the density of senior residents of each Census block in Flagstaff. From this map, we can observe that many of the neighborhoods that are dense overall are also home to many seniors, especially in Sunnyside, downtown, Southside, and along Highway 89.

There are three housing complexes specifically for seniors in Flagstaff: Sandstone Highlands on High Country Trail, Flagstaff Senior Meadows on the Mesa, and The Peaks off of Highway 180.

There are also areas that are revealed on this map as being home to many seniors, that do not stand out on other maps of residential density – in particular along Lockett and Fort Valley Roads. In general, seniors’ residences are scattered all over the city, even more so than low-income or minority residents.

7. The need for transit is particularly acute among people with physical or cognitive disabilities. However, data on the residential locations of people with disabilities is closely-guarded, to protect such people from victimization, and for that reason we can not produce a similar map for people with disabilities.
Youth Density

Just as transit coverage can meet the needs of seniors who cannot or choose not to drive, transit coverage can also meet the needs of children and teenagers who are too young to drive.

The map at right shows the density of residents under the age of 18 in each Census block in Flagstaff.

Again, the pattern of youth density is similar to the pattern of overall residential density in the city, with a few exceptions. However, the neighborhoods around NAU do not show up as important in this map, because they are so dominated by housing for NAU students.

We can observe a greater scattering of young people all over the city than we do in the previous map showing the density of senior people. Moderate densities of children can be seen south of I-40, in neighborhoods that do not appear shaded at all in the map of residential density (on page 11).

The map also shows where schools are located. School symbols differentiate among elementary, middle and high schools, because the typical difference in size relates to the difference in potential ridership or need for transportation at those schools. The symbols also differentiate between charter and public schools. This distinction is relevant to NAIPTA’s transit planning because public schools in Flagstaff currently pay for student transportation (school buses) but charter schools do not. As a result, charter schools rely more on NAIPTA service for student transportation, though all large schools likely generate transit ridership on nearby routes.

Figure 10: Map of Youth Density
4 Recent Trends
Recent Trends

In this chapter, we review basic metrics for NAIPTA and how they have changed since 2008.

Ridership, Revenue Hours and Productivity

Since 2008, NAIPTA has grown its fixed route service offering substantially, from 45,000 annual revenue hours in FY2008 to about 64,000 in FY2015.

A “revenue hour” is an industry term for a single hour of a bus and driver in “revenue service,” accepting fare revenue and accepting passengers. Because so much of transit’s operating cost relates to human labor, and humans are generally compensated based on their time, the bulk of transit operating cost arises from hours of service (rather than distance, or the size of vehicles, or other factors).

Thus “revenue hours” describes the sheer quantity of transit service provided, without consideration for how much it costs the agency to deliver each hour of service.

The revenue hours of service required for any given route will increase if:
- The length of the route increases.
- The frequency of the route increases.
- The span (hours of operation) of the route increases.

The graphs below show data for “Fixed Route Service” (Mountain Line) and “Demand Response Service” (Mountain Lift) separately.

A “fixed route” is a route that serves fixed stops, on a schedule. Unlike a fixed route, dial-a-ride is a “demand responsive” service, responding to individual requests for rides to and from unique places, and unique times. (Paratransit, which NAIPTA brands as “Mountain Lift,” is simply a demand responsive service offered exclusively to people with disabilities. Paratransit is required by law within 3/4 mile of any fixed route.)

NAIPTA’s big investment in fixed route service has resulted in a big increase in ridership – in fact, the increase in ridership was out of proportion to the increase in service quantity. While revenue hours of service were increased by just 19% between 2008 and 2015, ridership increased by 89% over its 2008 levels! This increase appears in the violet line in the chart below.

The big increase in ridership between 2008 and 2015, with only a modest increase in revenue hours of service, means that NAIPTA’s fixed route productivity improved in this period.

Productivity is a transit industry term for what lay-people might call “efficiency.” If ridership is an outcome people care about, then ridership relative to cost describes how “productive” an agency is towards that outcome.

In 2008, an average of 22 people boarded NAIPTA’s fixed route buses per hour; in 2015, an average of 30 people boarded per hour. For people who care about ridership, and therefore about ridership relative to cost, this is an excellent return on NAIPTA’s investment in more service.

During the same period, the quantity of paratransit service provided and the amount of paratransit ridership achieved (shown in teal in the charts below) stayed relatively flat.

The productivity of paratransit, and of any demand responsive service, has a very low upper limit, simply because of the laws of time and space. Any vehicle that is transporting multiple individuals to and from unique origins and unique destinations will struggle to serve more than 3-4 people per hour. This will be true whether the demand responsive service is dial-a-ride, paratransit, or private jitney services like taxis, Uber or Lyft.
Operating Costs

Since NAIPTA has increased its service level over the past decade, its total expenditure on fixed route operations has increased as well. The shapes of the lines in Figure 14, below, are very similar to the shapes of the lines in Figure 11 on the previous page. The more service NAIPTA supplied, the greater its operating cost each year.

While the quantity of service supplied is a huge driver of operating cost, another factor is the cost of providing each revenue hour of service. If wages, benefits, administration, fuel, insurance, and other costs of doing business go up, then an agency will have to pay more to deliver each revenue hour of service.

To differentiate between rising costs that represent and investment in more service, and rising costs that reflect higher costs of doing business, we look at operating cost per revenue hour. The chart in Figure 15 shows how NAIPTA’s costs to provide an hour of fixed route service or paratransit has changed over time.

NAIPTA has managed to keep the costs of providing fixed route service fairly flat over a period in which many other agencies are experiencing cost increases (often related to wages and health insurance costs). Some agencies are in the unfortunate position of providing fewer hours of service with the same total operating budget, due to rising costs. NAIPTA has thus far avoided that situation.

Taken together, the productivity of a service and the cost of providing that service govern the cost of serving each passenger. For example, NAIPTA’s costs of providing a revenue hour of fixed route service have stayed flat, while the productivity of fixed route service has increased (as more people ride per hour). As a result, NAIPTA’s cost per boarding on fixed routes has decreased.

Meanwhile, the cost to provide an hour of paratransit service is a little higher than the cost to provide fixed route services, and has increased slightly since 2008. Paratransit gets many fewer boardings per hour (and always will). As a result, the cost per paratransit boarding is much higher than the cost per fixed route boarding, and has grown slightly over its 2008 level.

It is essential to keep in mind that cost per rider is governed by productivity, not only by operating cost, because this is so often misunderstood in debates about whether Uber and Lyft and new dial-a-ride services are “more efficient” than “traditional” transit.

Private jitney or dial-a-ride services like UberPool and LyftLine can have a much lower operating cost per hour, largely because their drivers and other staff are paid so much less. But the ceiling on their potential productivity is very low, just like the ceiling on paratransit’s productivity, simply because of the rules of time and space. In very few situations can demand response services be more productive than fixed routes, because they simply cannot get anywhere near as many passengers through the door per hour.
Funding Sources

Like many small transit agencies, NAIPTA is funded by multiple local partners, to a large degree by federal grants, and barely at all by fares and other fees for service. The chart below illustrates NAIPTA’s sources of operating funds for the 2016 fiscal year.

About 45% of NAIPTA’s 2016 operating funds came from a City sales tax, and 5% from NAU. Federal operating grants made up 37% of revenues. Fares made up 8% of revenues, and other fees for service brought in 1%. Revenues from ADOT (which are passed through from Federal sources) made up 4%.

Figure 17: Chart of NAIPTA’s Funding Sources for Fiscal Year 2016
Peer Comparison

To get a sense of how some other cities’ transit services compare to Flagstaff and NAIPTA, we have compiled a short set of indicators from the National Transit Database looking at other similarly-sized cities in comparable situations.

The performance of NAIPTA’s individual routes will be evaluated in comparison to one another (starting on page 29). For performance of the entire system, and as an aide in thinking about Flagstaff’s particular transit choices, it helps to compare NAIPTA to peer transit providers.

Obviously no place precisely replicates Flagstaff’s economic, demographic and geographic conditions, so a group of peers provides a range rather than a prescriptive target.

With the exception of Santa Fe, New Mexico, each of these peer cities is home to a major public university (though the university in San Luis Obispo is smaller than the others). Some of these universities buy transit passes for their students and staff, and offer them for sale at steep discounts. This is not the case in Flagstaff – instead, NAU directly-compensates NAIPTA for fares on Route 10, and all NAU students and staff are allowed to ride Route 10 for free.

Investment and relevance

The charts at right in Figure 18 show how much a region is investing in transit service (at top) and how relevant transit is to the life of the community (at bottom). There is a certain amount of “pay for what you get” appearing in these two charts: the more service an agency puts on the street, the more boardings it is likely to attract.

NAIPTA makes the fourth-highest service investment per capita among this peer group, but receives the third-highest number of boardings per capita. In addition, the two agencies with higher boardings per capita (Davis and Eugene) operate all transit in their cities, including service on the university campuses. In contrast, in Flagstaff NAIPTA and NAU split transit service and transit ridership between them. Last year, the NAU shuttle achieved 58 boardings per hour, whereas Mountain Line achieved 29.6 boardings per hour. When the two systems numbers are combined, Flagstaff’s performance in terms of relevance is even closer to that of Eugene and Davis, though its level of investment per capita rises as well.

Cost to deliver service

The chart below shows how much the same seven peer transit agencies spent on fixed route operations (including administration and overhead), per revenue hour of service provided in 2015.7

NAIPTA is in the middle of the range in terms of how affordably it provides fixed route service. Davis, California, is able to provide service at an extremely low rate because it employs student drivers, and thus its wage and benefits costs are low. Eugene, Oregon, has high labor costs partly because of state pension costs, and partly because Eugene’s data includes BRT operations. BRT is more expensive to administer and operate than local bus service, though it contributes to transit’s high ridership, relevance and productivity in Eugene.
5 Transit Service Analysis
Transit Service Analysis

The map at right shows the Mountain Line fixed route system as operated in 2016, as well as NAU’s campus shuttle service. Each route is color-coded according to its frequency.

NAIPTA’s most frequent service is offered on Route 10, between downtown and Woodland Village. Route 10 comes every 8-10 minutes on weekdays when NAU is in session, and every 20 minutes on weekdays when NAU is on break.

NAU operates its own high-frequency shuttle within campus. This shuttle comes every 4 minutes during school days, and every 30 minutes on other days.

Routes 2 and 4 also offer relatively frequent service, with buses coming every 20 minutes on weekdays.

The tables on the following page show the frequency offered by each of these routes, throughout each day, and over different types of days throughout the year.

9. Before January 2017, Route 10 offered frequent service between NAU and Woodland Village. A branch of Route 10 served Sawmill, thereby dividing the frequency of Route 10 north of campus. That branch has been eliminated, so that trips from anywhere to anywhere on Route 10 can be made with a very short wait. We have maintained the old Sawmill branch on this map as a reference for readers as they look at boardings that were counted in 2016, shown on later pages.

Figure 20: Map of NAIPTA’s Existing Fixed Route Transit Network as of October 2016

**Figure 20: Map of NAIPTA’s Existing Fixed Route Transit Network as of October 2016**

- **Weekday Daytime Frequencies**
  - every 8 minutes during school year, every 20 minutes other weekdays
  - every 20 minutes on school days only
  - every 20 minutes
  - every 30 minutes
  - every 60 minutes
  - school deviation

- **NAU shuttle, students only,** every 4 min on school days, every 30 min on other days

- **Downtown Connection Center**
  - Routes make timed connections downtown and at the Mall, so that connections require only short waits.

<table>
<thead>
<tr>
<th>Route</th>
<th>Weekday Daytime Frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>every 8 minutes during school year, every 20 minutes other weekdays</td>
</tr>
<tr>
<td></td>
<td>every 20 minutes on school days only</td>
</tr>
<tr>
<td></td>
<td>every 20 minutes</td>
</tr>
<tr>
<td></td>
<td>every 30 minutes</td>
</tr>
<tr>
<td></td>
<td>every 60 minutes</td>
</tr>
<tr>
<td></td>
<td>school deviation</td>
</tr>
<tr>
<td></td>
<td>NAU shuttle, students only, every 4 min on school days, every 30 min on other days</td>
</tr>
<tr>
<td></td>
<td>Downtown Connection Center</td>
</tr>
<tr>
<td></td>
<td>Routes make timed connections downtown and at the Mall, so that connections require only short waits.</td>
</tr>
</tbody>
</table>
Transit Service Analysis

Daily and Weekly Span of Fixed Route Service

Frequency is one aspect of this “when” question, but another critical aspect is span. The span of a service is how many hours each day it operates, and how many days each week.

The charts at right show the approximate frequency and span of each NAIPTA fixed route.

The frequency of Route 10 differs between weekdays when NAU is in session (shown at top) and when NAU is on break (second from top). It also differs between weekends when NAU is in session (third from top) and weekends when NAU is on break (at bottom).

Other routes’ frequencies and spans stay the same regardless of the NAU academic calendar, but do vary between weekdays and weekends. Every route offers a lower frequency and shorter daily span of service on weekends.

The transportation profession has long been focused on the weekday peaks, because those are the times when our roads are most congested. Yet people need to travel at all times of day and week, and if a transportation option is only available at certain times, many people will not be able to rely on it.

Service workers tend to work from very early in the morning to midday, or from midday to late at night, and the service industry peaks on weekends. People who hold two jobs may need to commute to both of them on a single day, leaving home early and returning late. And of course anyone taking an evening class, pursuing a hobby, going to worship, or staying late at work to finish a report needs a bus ride home outside of the traditional 8-to-5 workday.

As of the 2010 Census, 29% of U.S. workers did not work a traditional weekday, daytime schedule. Add to this population anyone who is employed part-time, studying, retired, or not working, and we can imagine the proportion of Flagstaff residents whose essential travel needs go far beyond the morning and evening weekday peaks.

Buses running late at night, and very early in the morning, will always be much emptier than those running during the day. Yet the presence of those late buses is, in many transit systems, supporting higher productivity during the day.

This sometimes becomes clear when an agency cuts the last bus trip of the day, because few people ride it. Measured alone, the last trip of the day is the least productive.

Very soon, however, the bus trip that is now the last of the day (and was the second-to-last, before they cut the last trip) becomes equally unproductive. No responsible person will plan their daily schedule, or their life, around the last bus of the day. The last bus is a sort of insurance policy, there if people need it, and it always looks unproductive when it is evaluated on its own.

Late night trips also tend to support afternoon ridership, because people who work or study in the second half of the day head out in the afternoon and come back home at night. If the bus isn’t there for them to return home at night, then they have a powerful incentive to get a car or find some other way to make their round-trip commute. For this reason, it is common for transit agencies to find that, when nighttime service is cut, afternoon ridership drops.

It is rarely a good idea to measure the productivity of a route or a network by time of day, with an eye towards cutting trips and thereby increasing productivity. The ridership on a route is almost always arising from the day-long and week-long level of service.

Agencies often link frequency and span of service to “service brands.” A service brand tells the public something about a service’s usefulness, and frequency and span are key to usefulness. For example, in many cities there are “Frequent” or “Core” service brands. Routes branded this way are known to come frequently and be available for more of each day and week than other service brands. These branded routes also operate as a network, and running all of the branded routes equally late maintains the connections between them.
Transit Service Analysis

The colorful table on the previous page shows that frequency and span are well-connected in NAIPTA’s fixed route services. The higher a route’s frequency, the more likely it is to be running when someone needs it, in the evening or on the weekend. In general, spans are fairly short, ending before restaurants close on weekday evenings, and far before most service industry shifts end on Saturdays and Sundays.

Fixed Route Ridership by Time of Day

The daily patterns of ridership on NAIPTA routes are very different among different routes. The set of charts at right shows the average total boardings during each hour of the day, for each route. This data was taken from a week in November 2016 in which there were no holidays or other major disruptions, so it gives us a fairly reliable picture of the “shape” of daily demand.

Few of Mountain Line’s six routes display a traditional “8-to-5” peaked ridership pattern. Instead, we see that six routes show a pronounced “7-to-3” pattern, which is normally associated with school bell times. (See Routes 2, 3, 5, 7 and 66.) The most “peaked” service is Route 5, which has extremely low boardings at any other time of day besides 8 am and 3 pm.

Routes 4, 7, 14 and 60 have a fairly flat daily demand pattern, with ridership steadily increasing until a peak at 3 or 4 pm. Routes 4 and 14 serve Coconino Community College and NAU, and colleges and universities typically generate all-day demand.

Meanwhile, Route 10 has very high ridership that is sustained for most of the day, peaks in the mid-morning, and is still far higher than on any other route in the early evening. This is consistent with the type of demand that is typically shown around big universities, where students start their school days at many different times, depending on when their first class begins. (Travel demand around NAU is very different on Tuesdays and Thursdays than on Mondays, Wednesdays and Fridays, due to class schedules. This chart only shows the average condition of all weekdays.)

The only routes that show high demand during the traditional evening rush hour (with sustained high ridership through the 5 pm hour) are Routes 2, 10 and 66. Even so, demand earlier in the afternoon on each of those routes dwarfs evening demand.

Fixed Route Ridership by Stop

The map on the next page shows the average weekday boardings at each bus stop in Flagstaff. Each dot represents the combined total boardings from every route that serves that bus stop.

The greatest number of high-ridership stops are found along Route 10 between downtown, NAU and Woodlands Village.

The map in Figure 24 on page 29 overlays the ridership by stop data on the activity density map shown earlier.

From this combined map we can see a correlation between the density of residences and jobs in an area, and the size of the boardings dots there. In dense places with transit service, many of the dots are large. In low-density places, most of the dots are small. The few larger dots that are in low-density areas are associated with schools, such as Coconino Community College, BASIS and the Flagstaff Arts & Leadership Academy. This combined map makes clear why the first ingredient in the Ridership Recipe (illustrated on page 9) is density.
Figure 23: Map of Average Daily Boardings per Stop
This map does not show boardings on the NAU shuttle.

**Flagstaff Transit Ridership**
Ridership combines the average daily boardings at stops in the Mountain Line network for weekday service in October 2016.

- Downtown Connection Center
- Boardings per day
  - 1-10
  - 11-25
  - 26-75
  - 76-150
  - 151-500
  - greater than 500

Data Source: NAIPTA, October 2016.

Flagstaff

<table>
<thead>
<tr>
<th>Boardings per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10</td>
</tr>
<tr>
<td>11-25</td>
</tr>
<tr>
<td>26-75</td>
</tr>
<tr>
<td>76-150</td>
</tr>
<tr>
<td>151-500</td>
</tr>
<tr>
<td>greater than 500</td>
</tr>
</tbody>
</table>

**Outside Flagstaff**

- Railroad
- Boardings per day
  - 1-10
  - 11-25
  - 26-75
  - 76-150
  - 151-500
  - greater than 500

Data Source: NAIPTA, October 2016.
Activity Density (combined population and employment) indicates the total level of daily activity in an area, as most trips begin or end at a residence, workplace, or commercial establishment.

Data Sources: 2014 LEHD, 2009-2014 American Community Survey 5-year Summary File, 2010 Census

Figure 24: Map of Average Daily Boardings per Stop, and Activity Density

This map does not show boardings on the NAU shuttle.
Ridership by Route

The table at right reports the total number of boardings attracted by each Mountain Line route (in October 2016) and also the number of revenue hours of service NAIPTA supplied to each route. Boardings and revenue hours are split out by weekdays, Saturdays and Sundays.

Fixed Route Productivity

People who value the environmental, business or development benefits of transit highly will talk about ridership as the key to meeting their goals. However, because their transit agency is operating under a fixed budget, the measure they should be tracking is not sheer ridership but ridership per unit of cost. They would not be satisfied simply by a large dot on the boardings map on page 28, or a big number in the Average Daily Boardings column in the table at right, until they knew what it cost the transit agency to achieve. By measuring ridership relative to cost – productivity – can we evaluate how well a route, or an entire network, is maximizing its potential ridership.

Recall that productivity is measured as boardings per revenue hour of service.

\[
\text{Productivity} = \frac{\text{Ridership}}{\text{Cost}} = \frac{\text{Boardings}}{\text{Revenue hour}}
\]

Productivity strictly a measure of achievement towards a ridership goal. Services that are designed to provide coverage, regardless of ridership, will likely have low productivity. This does not mean that these services are failing or that the transit agency should cut them. It just means that their service is not being spent to maximize ridership.

System-wide productivity

The average productivity of the entire NAIPTA fixed route network in 2015 was 29.6 boardings per hour. NAIPTA’s productivity is compared to peer agencies’ in the chart in Figure 25 at right.

Most of the peer agencies in this list serve enormous state universities. The exceptions are Santa Fe and San Luis Obispo (the latter is home to a small state university). NAIPTA’s productivity in 2015 was higher than that of Santa Fe, San Luis Obispo and Missoula, but lower than in Iowa City, Bloomington-Normal, Eugene and Davis.

The universities in Eugene and Davis do not have their own shuttle systems, unlike in the other university towns on this list. This may contribute to the very high productivity achieved by the Davis and Eugene transit agencies, since all ridership is on the public systems, rather than being divided between the public and university transit systems as it is in Flagstaff, Bloomington-Normal, Iowa City, Missoula and San Luis Obispo.

The unique agreements made between universities and transit agencies regarding discounts, free rides or prepaid transit passes for students can have a big effect on how much ridership a transit network attracts relative to its cost. Students are particularly price-sensitive, so being given a free fare (or at least a fare that was pre-paid through student fees) can cause a big increase in ridership.

Recall that NAIPTA’s fixed route productivity grew significantly between 2008 and 2015 (as shown in the graph on page 20). While the bar chart in Figure 25 shows a snapshot of 2015, the graph in Figure 26 shows how these peer agencies’ fixed route productivities have changed since 2010. The overall trend is, on average, flat, with some agencies experiencing a modest increase and others a modest decrease.

NAIPTA experienced a net increase in fixed route productivity over the same period, especially between 2011 and 2013. (Data for NAIPTA is shown in a thick black line in the graph.) However, in a ranking by system-wide productivity, Mountain Line’s position among these peers would not have changed from 2010 to 2015.
Route-by-route productivity

Recall that the revenue hours provided on any particular route, and to any particular stop, will relate to the length of the route, its frequency and its daily and weekly span. Changing any of these factors for a transit route will affect the denominator of the productivity ratio described on the previous page.

The table in Figure 27 reports the average daily revenue hours of service on each route, and the average daily boardings it attracted. The latter divided by the former gives us productivity - boardings per revenue hour.

The table in Figure 28 shows NAIPTA’s fixed routes, sorted from the most to the least productive (on weekdays).

Even though Route 10/10a required the most revenue hours (because of its high frequency) it still achieved the highest productivity, of 80.4 boardings per hour (on weekdays). This is extremely high productivity, and even for frequent routes serving large university campuses it is very high. (NAU’s shuttle achieves 58 boardings per hour, which is already quite high.)

In October 2016, Routes 10 & 10a attracted nearly as many boardings per day as the rest of the Mountain Line routes, combined. The network’s productivity is 37.9 boardings per hour on weekdays. If we remove Routes 10 & 10a, the productivity of the rest of the network on weekdays is just 24.2.

On weekends, Route 10 & 10a are much less productive than on weekdays (though still the most productive routes in the network). Weekend productivity of the entire network is 25.4; without counting Route 10 & 10a, it would be 20.6.

Route 10 ridership is vastly lower during school breaks. Total boardings on all routes were 41% in July of what they were in October last year. That seasonality is mostly attributable to Route 10, which got just 6% as much ridership in July as it did in October.

The degree of seasonality in other routes’ ridership varies, from July representing 49% of October boardings (in the case of Route 5) to July representing 91% of October boardings (in the case of Route 66). Route 66 has the least seasonal variation and also, as we describe in subsequent pages, the least variation by day of the week.

This table makes clear that the other frequent and long-span routes are not necessarily the most productive. Routes 2 and 4, despite offering a bus every 20 minutes, achieve lower ridership relative to their cost than do Routes 7, 14 and 66.

Figure 27: Table of Daily Revenue Hours and Boardings by Route and by Day of the Week

<table>
<thead>
<tr>
<th>Average Daily Revenue Hours of Service (October 2016)</th>
<th>Average Daily Boardings (October 2016)</th>
<th>Productivity (Boardings per Revenue Hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route</td>
<td>Weekday Saturday</td>
<td>Sunday</td>
</tr>
<tr>
<td>2</td>
<td>45</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>29</td>
<td>13</td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>28</td>
<td>13</td>
</tr>
<tr>
<td>14</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>66</td>
<td>29</td>
<td>14</td>
</tr>
<tr>
<td>10 &amp; 10a</td>
<td>61</td>
<td>25</td>
</tr>
</tbody>
</table>

Figure 28: Table of NAIPTA’s Route-by-Route Productivities, October 2016

<table>
<thead>
<tr>
<th>Weekday Frequencies (NAU in session)</th>
<th>Weekend Frequencies (NAU in session)</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route</td>
<td>Day</td>
<td>Evening</td>
</tr>
<tr>
<td>10 &amp; 10a</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>14</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>66</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

Averages for all routes: 37.9, 27.7, 23.0, 31.7
However, a caveat must be given for Routes 2 and 5, which had recent increases in frequency.

In 2015, Routes 2 and 66 offered the same frequencies of service. NAIPTA increased the frequency of Route 2 from every 30 minutes to every 20 minutes on weekdays. The immediate, and predictable, effect was a decrease in productivity, as the same amount of ridership was divided over a larger number of revenue hours.

Ridership on Route 2 has been growing in response to the increased frequency, but has not yet reached a level at which Route 2 would be as productive as it was before the increase in frequency. The transit industry norm is to wait 2-3 years before deciding whether a new service meets productivity expectations.

Similarly, weekend service on Route 5 was only introduced in August of 2016, and so it is too early to evaluate its productivity against the weekend productivities of routes that have had weekend service for years.

Finally, by examining the productivities reported in the tables on the previous page, for Saturdays and Sundays, we can see that Routes 3 and 66 are attracting more riders per hour on Saturdays or Sundays, when they offer less service and when travel demand is generally lower.

Another way to look at route-by-route ridership is by comparing it to total revenue hours invested in each route. (The revenue hours cost of each route tracks with its frequency, but also with its daily and weekly span of service, and its length.)

The bar chart in Figure 29 shows the percentage of NAIPTA’s fixed route revenue hours (in black) and ridership (in grey) for each route. All routes require a greater proportion of revenue hours than they return in ridership, except for Route 10. (Route 66 comes very close to returning as much ridership as the service it uses.) These chart illustrates just how crucial Route 10’s ridership is to the overall ridership performance of NAIPTA.

![Figure 29: Chart of Routes’ Percentages of Weekday Ridership and Revenue Hours](image-url)
Productivity and frequency relate

In examining transit systems in cities around the world, we have found a general correlation between transit route frequency and productivity. The chart in Figure 31 shows individual routes from 20 U.S. transit networks, each plotted according to its midday frequency and its total average productivity.

There is a clear curve detectable, up and to the left. More frequent services tend to have higher productivity (ridership per revenue hour), even though providing high frequency requires spending more revenue hours. On average, high frequency routes are getting more riders through the doors of each bus than low-frequency routes. (There are, as always, some interesting outliers – high frequency routes with extremely low productivity, and vice versa.)

Frequent service is a categorically different transit offering than infrequent service, because it offers a level of freedom, spontaneity and reliability that many people require. This is why transit planners often find that increasing the frequency of a very productive route causes the ridership to increase disproportionately. In other words, the result is not only an increase in the route’s total ridership, but also in the ridership attracted relative to the route’s cost. Deploying frequent service just anywhere will not necessarily lead to higher productivity. But when frequent service is available to people in a suitably dense, walkable environment, high ridership is a common result.

The frequencies and productivities of NAIPTA fixed routes are shown in a similar scatterplot, in Figure 31. The shape of this scatterplot is generally consistent with the national data above it, but as with the national data there are some interesting outliers. Routes 2 and 4, despite having higher frequency (and longer spans) than Routes 14, 66, 7 and 3, are no more productive. However, as noted in the previous section, there hasn’t been enough time since a recent frequency increase on Route 2 for its ridership to reach its full potential.

10 This report offers an intuitive explanation of how and why frequency would affect ridership, on page 8. The scatterplot on this page offers a visual case that there is currently a relationship between frequency and productivity, in US transit networks; the correlation shown in this scatterplot is in fact statistically significant. In addition, abundant research has shown a relationship between frequency and, when it is deployed in certain places and in a connected network, high ridership. For example, “[Metro areas] whose transit agencies provided more frequent service experienced increased ridership,” report Thompson and Brown in Explaining Variation in Transit Ridership in U.S. Metropolitan Areas between 1990 and 2000, Transportation Research Record (2006) 1986.1. “Improved frequency and span of service...consistently had the strongest influence on increased ridership,” write Stewart et. al in Ridership Response to Incremental Bus Rapid Transit Upgrades in North America, Transportation Research Record (2015) 2538.
Weekend productivity

The table on Figure 28 on page 31 shows that the Mountain Line network is most productive on weekdays, though Routes 3 and 66 have their highest productivity on weekend days.

It is not unusual for Saturdays to be more productive than weekdays, at least not on certain routes. Transit planning in the U.S. has been focused on the 8-to-5 commute for many decades, even as our economy has shifted away from the industrial and white-collar work that generates that demand pattern, and towards a service economy that runs all day, every day, and especially on weekends.

Routes 66 and 3 are both more productive on Saturdays than on weekdays. Route 66 is also slightly more productive on Sundays than on weekdays. Both routes connect downtown and the university to the Mall, and their weekend productivity may relate to the retail establishments they serve. Route 2 shares these same endpoints, and its Saturday productivity is just barely lower than its weekday productivity.

At the start of this report, we described the different types of outcomes that people tend to look for from their transit system. Some outcomes arise from high ridership, while others arise from transit’s availability, whether or not it achieves high ridership. Both types of outcomes can be served by weekend service. Sometimes weekend service achieves high ridership, because:

- Anyone in a service industry job is nearly guaranteed to work on the weekends, especially Saturdays, which are “all-hands-on-deck” for stores, restaurants and entertainment industries.
- Students and young people, who are in school on weekdays but don’t have access to a car, tend to do their socializing and errand-running on weekends. (Adults do the same, but are more likely to do it by car.)
- Other commute and school-focused services (like Route 10’s high frequency on NAU school days, and the NAU shuttle) aren’t running on weekends, so ridership may shift to other lines.

At the same time, the simple availability of service on the weekends can be valuable, even if it doesn’t achieve high ridership. Weekend service allows low-income people to reach retail jobs; working people who do not have cars to access services; and gives people with few options in how they get around a degree of freedom and autonomy on weekends. Serving these values may be important to NAIPTA across its entire system, or on certain routes.

A current limitation of Mountain Line’s weekend service is its short span.
Network Design

Understanding the performance of NAIPTA’s current service requires looking not only route-by-route but also at how the routes work together as a network. A single route can only ever connect people to the places along it, but when routes are designed as part of a network, people can access a great deal of their city with just a single transfer.

Flagstaff presents some acute challenges to the design of transit routes and a network, mostly related to \textit{linearity} and \textit{proximity}. (Their importance as part of the Ridership Recipe is illustrated on page \pageref{fig:ridership-recipe}.) To put it simply, while Flagstaff has a number of neighborhoods that could generate high transit demand, it is impossible to connect them with a single route without making that route indirect and circuitous. Yet transit planning in Flagstaff has, for the past few years, been focused on solving this very puzzle – on stringing the city’s pearls onto a single strand. It may be that the path to abundant, useful transit in Flagstaff requires shifting focus away from developing one excellent route and towards developing an excellent network.

Pulsing

The NAIPTA fixed route network uses pulses to connect services to one another, so that passengers have a reliably short wait to transfer.

To offer a pulse, an agency must design its routes to be a certain length of time-efficient as can be reasonably expected. The NAIPTA fixed route network uses pulses to connect services to one another, so that passengers have a reliably short wait to transfer.

A pulse is an excellent way to create a network out of a set of routes, because it makes transfers less onerous and risky than they would be if they happened at random. This is especially important for low-frequency routes. If two 60-minute routes cross someplace in the city, and someone wants to transfer between them, their average wait will be 1/2 of the frequency, i.e. 30 minutes. (Sometimes they will get lucky, and wait 1 minute; sometimes they will get unlucky, and just miss their connection, and wait 59 minutes. On average, they will wait 30 minutes.) This amount of waiting time, and degree of variability in trip time, is intolerable to most people, so hardly anyone will rely on such a connection.

Instead, if the transit agency designs the network so that those two 60-minute routes pulse together at a Connection Center, people’s wait at the connection point will be reliably just a few minutes long. Many more people will be willing to transfer between low-frequency routes if the connection is quick and reliable. There is a cost to pulsing, however. First, the routes must be designed so that they can make a round trip in the right amount of time to get back to the pulse with all of the other routes. This makes it hard for NAIPTA to lengthen a route just a tiny bit in response to requests. It also means that any reduction in the speed of the bus can be threatening to the pulse, since that bus may not be able to do its round trip in the required amount of time.

Second, the routes must be given enough spare time to protect them against all of the unpredictable delays that happen on the roads. If two 60-minute routes are meant to pulse together, and one of them is often late and misses the rendezvous, then the transferring passengers face waits even worse than if the routes were connecting at random – they may often be waiting 55 minutes! The spare time added to schedules to protect against delays is called “recovery time,” and it is essential for the reliability of a pulse. The regular delays caused by train traffic in Flagstaff (and congestion on Milton Road) require that NAIPTA add extra recovery time to schedules. Recovery time, and time sitting at the pulse, cost money even though they don’t represent extra distance or service, and this is one of the costs of pulsing.

Currently, each Mountain Line route spends between 3% and 18% of its revenue hours pulsing at the Downtown Connection Center or at the Flagstaff Mall. Another 10% of each route’s operating time is set aside for recovery, to protect against the unpredictable delays that arise in any transportation system.

These are normal ratios of recovery time and pulsing time relative to total revenue hours, for a small transit system that relies on pulses. Given the degree of variability imposed by freight train traffic we believe it is time-efficient as can be reasonably expected.

Linearity

High-ridership transit is almost always linear, in that it provides a reasonably direct path between places large numbers of people want to go. Development patterns in Flagstaff force a difficult choice for transit planners, a choice between serving dense places and providing direct, linear service.

This challenge arises for a few reasons:

- Flagstaff is extremely divided by freeways and highways. Places that are close to one another “as the crow flies” are miles apart because they are on opposite sides of a freeway or highway.
- Flagstaff is also divided by the railroad, in similar ways.
- Highways and roads that are difficult or impossible to cross on foot (such as Route 66 or Forest) create demands for bus routes to deviate off the highway, to a location that people can safely access. This deviation is great for the people who board there, but frustrating for anyone riding through and expensive for NAIPTA.
- Two of the densest, most walkable parts of the city (downtown and Sunnyside) both developed perpendicular to Route 66 and the railroad. There is permanent open space in between them [on the mesa], and partly due to topography there is no street connectivity between them. Thus these two places are very difficult to connect with a single route that is neither circuitous nor traversing low-density low-ridership places.
- Most importantly, dense developments are scattered around Flagstaff away from major roads. (This is understandable, because who wants to live near a noisy, unwalkable road?) The result is that many dense places are not on the way to other places. Getting transit service to these places requires deviating in a way that feels indirect to through-riders and costs NAIPTA more revenue hours.

Figure 33: Pulse Diagram
The linearity challenge has been particularly acute in NAIPTA’s planning for high-capacity transit. The city’s four biggest activity centers (NAU, downtown, Sunnyside and the Flagstaff Mall) cannot all be served by a single high-capacity line that feels reasonably direct between them.

A route that directly connects NAU, downtown and the Mall, via Route 66, misses the densest part of Sunnyside (and Hospital Hill). A route that connects NAU, downtown, the hospital and Sunnyside is a very slow and circuitous way for anyone to get to the Mall.

In addition, there is a great deal of transit demand on either side of Milton Road (to the west, there is student housing; to the east, NAU campus). Because Milton Road is so hostile to walking, there must be a single high-capacity line that feels reasonably direct between them.

Recent and future development on the mesa, and the operation of Forest Ave, offer another example of circuitousness that is caused by land use and street design. Today, Route 2 goes on Forest Ave between Hospital Hill and Sunnyside. In the morning and afternoon, when school gets out, it deviates onto Gemini/Pine Cliff Road and makes a long loop past the BASIS school. There is no signal at the intersection of Pine Cliff and Forest, because the car speeds on Forest are too high. Because there is no signal there, a bus cannot turn left from Pine Cliff onto Forest, and people cannot safely cross Forest on foot.

These development and street design decisions put Mountain Line in a bind:

- They can operate on Forest, and people have to walk all the way down to Turquoise to get to a bus stop, and that is a long way from BASIS and development.
- Or they can operate on Pine Cliff-Gemini, and Route 2 has to do an extra loop’s worth of driving on each round trip, because of the lack of a signal (for left turns out of the development) at Pine Cliff and Forest.

The first option means the service is barely accessible to new development. The second means NAIPTA spends valuable resources (and customers’ time) driving in a circle.
Circuitous or deviating routes are not inherently wrong. They depress ridership (and increase cost) compared to linear routes, and thus they worsen the conflict between ridership goals and coverage goals. People who want to maximize transit ridership, but also want to provide safe and proximate access to people living or working in hard-to-reach places, will have a much harder time balancing those competing goals when providing coverage requires circuitous, low-ridership and expensive routing.

In an urban environment in which it is impossible to reach large numbers of riders without deviations from a straight path, the high-ridership strategy in the short-term may involve circuitousness. The high-ridership strategy for the long term, however, is to grow the city along straight and walkable roads, so that the densest and most important places for transit to serve are “on the way.”
Paratransit Ridership

NAIPTA provides paratransit, a dial-a-ride service that complements the fixed-route network, for people with disabilities that prevent them from using fixed routes. It is called “Mountain Lift.”

Paratransit is required to complement fixed routes, by federal regulations, based on the Americans with Disabilities Act (for which reason it is often called “ADA Paratransit”). Paratransit must be provided for travel between any locations that are within 3/4 mile (as the crow flies) of a fixed route, during the same hours and days as the fixed routes.

In November 2016, Mountain Lift served 122 unique customers. The average customer would have made an average of 9.3 trips during the month. Trips are short: the average is 23 minutes long, even though some trips necessarily require passengers to ride along en route to the origins or destinations of other passengers.

The map on the following page shows all of the paratransit pickups (at people’s origins and destinations) provided in November 2016. The largest dot is at the Montoya Senior Center, on Thorpe Road. Other large dots can be seen at the Kacha Square Shopping Center on Route 66 (where Quality Connections, a day program for adults with disabilities, is located); at the east end of Commerce Drive in the Industrial Park (where Lou Corp, a similar program, is located); and at Sandstone Highlands senior apartments on High Country Trail.

The map on page 40 shows all of the paratransit trips taken in November 2016. Each green line represents a trip (a particular origin-destination pair). The thicker the line, the more times this trip was taken in the month. The trip may have been taken by a single person, or by multiple people.

Places that appear as large dots, on the previous page, appear here as having many lines going to them from many different places. However, this map also makes visible trips that are taken by small numbers of people (causing only a small dot on the previous map) but often throughout the month.

Productivity and cost

Over the past decade, NAIPTA has been able to achieve between 2.5 and 3.5 paratransit boardings per revenue hour. This productivity is in the normal range for a small, low-density city with very poor street connectivity. (Low densities and poor street connectivity increase the amount of driving a paratransit vehicle must make to get from place to place.)

In 2016, the operating cost per paratransit boarding was $41.15 (as shown in the chart on Figure 16 on page 21). Operating cost per boarding relates directly to productivity, i.e. how many passengers an hour’s worth of service is divided across. The graph showing fixed route and demand response productivity is repeated from earlier in this report, below.

With fixed routes, services can become more productive (and therefore costs per passenger lower) with the only consequence for riders being occasional crowding on the bus. In contrast, with demand response services (including paratransit, general public dial-a-ride, and other shared rides) higher productivity and lower cost generally come at the expense of convenience.

Increasing productivity on a demand-response service means that the transit provider is getting more people to share vehicles. In general, this is done in one of three ways: by asking passengers to walk and wait in easier-to-reach places (as “point” dial-a-ride services do, and as even UberPool and LyftLine do); by asking passengers to travel at a different time; or by making passengers ride along as the vehicle picks up or drops off other people. These can present an inconvenience or an impossibility to paratransit riders.

Mountain Lift is a requirement, not a discretionary service, and so NAIPTA’s ability to increase its productivity is limited. The most productive paratransit services in the country struggle to reach 4 boardings per hour. The low ceiling on paratransit’s productivity is not so much about who is riding the service, as it is about what all demand responsive services do, and how little of it they can physically do per hour.

Productivity (Boardings per Revenue Hour), 2008-15

In 2016, the operating cost per paratransit boarding was $41.15 (as shown in the chart on Figure 16 on page 21). Operating cost per boarding relates directly to productivity, i.e. how many passengers an hour’s worth of service is divided across. The graph showing fixed route and demand response productivity is repeated from earlier in this report, below.

With fixed routes, services can become more productive (and therefore costs per passenger lower) with the only consequence for riders being occasional crowding on the bus. In contrast, with demand response services (including paratransit, general public dial-a-ride, and other shared rides) higher productivity and lower cost generally come at the expense of convenience.

Increasing productivity on a demand-response service means that the transit provider is getting more people to share vehicles. In general, this is done in one of three ways: by asking passengers to walk and wait in easier-to-reach places (as “point” dial-a-ride services do, and as even UberPool and LyftLine do); by asking passengers to travel at a different time; or by making passengers ride along as the vehicle picks up or drops off other people. These can present an inconvenience or an impossibility to paratransit riders.

Mountain Lift is a requirement, not a discretionary service, and so NAIPTA’s ability to increase its productivity is limited. The most productive paratransit services in the country struggle to reach 4 boardings per hour. The low ceiling on paratransit’s productivity is not so much about who is riding the service, as it is about what all demand responsive services do, and how little of it they can physically do per hour.
Figure 38: Map of Paratransit Pickups in November 2016

This map shows all paratransit pick-ups made in the month of November 2016.

Data Source: NAIPTA, November 2016

Legend:
- 1 - 10
- 11 - 30
- 31 - 70
- 71 - 150
- Greater than 150

Downtown Connection Center
railroad
outside Flagstaff

02/28/2017
Figure 39: Map of Paratransit Trips in November 2016

This map shows each one-way paratransit trip as a line. Trips taken more frequently appear as thicker lines. All trips taken in November 2016 are pictured.

Monthly Trips

- 1 trip
- 2 - 5 trips
- 6 - 15 trips
- 16 - 30 trips
- Greater than 30 trips

Data Source: NAIPTA, November 2016

Legend:
- Downtown Connection Center
- railroad
- outside Flagstaff
Key Choice: How to Balance Ridership and Coverage Goals
As Flagstaff plans for the near and distant future, the city faces a key choice about the overall goals of its transit system. This is not a choice to which there is a technically-correct answer. This choice relates to Flagstaff’s values, and why the city has transit service to begin with.

This choice is being presented to stakeholders, the public and decision-makers in the spring of 2017. Their input will guide the recommendations made by this consulting team in the 5-Year Transit Plan.

Balancing Ridership and Coverage Goals

The most fundamental choice before Flagstaff and NAIPTA concerns transit ridership: How important is maximizing ridership, relative to other potential transit goals?

Many people expect transit to serve various goals that arise from high ridership, such as:

• Reducing congestion and pollution.
• Reducing household transportation costs.
• Helping businesses attract workers and customers.
• Supporting the development of dense and walkable places.

On the other hand, people also expect transit to achieve some non-ridership goals. These types of goals are served even when ridership is low. They include:

• Providing lifeline access to critical services, as insurance against immobility.
• Providing mobility for people with severe needs, and people who cannot use a car, no matter where they live.
• Ensuring that every part of a city gets its fair share of transit service.

We describe the first set of goals as “ridership goals,” since they are accomplished (to varying degrees) through high ridership. We describe the second set as “coverage goals,” since they are accomplished through the coverage of an area, the sheer availability of transit, even if ridership is low.

No transit agency focuses solely on either of these types of goals. Most transit agencies have routes that generate a lot of ridership very efficiently, and others which don’t draw as much ridership but which have an important social purpose.

The choice between high ridership and high coverage is not binary. Every agency balances these goals in a particular way. In this planning process, we will encourage transit stakeholders to think of this as a sliding scale that the community can help to set. What percentage of NAIPTA’s operating budget should be spent pursuing maximum ridership? And what percentage should be set aside for services with predictably low ridership, that are important in service of other goals?

This trade-off can also be described as higher frequencies vs. wider coverage.

In pursuit of high ridership, NAIPTA will concentrates some of its service into frequent routes in places with the most people and activities. Yet the more service is concentrated into a few routes, the less service is available to spread out and cover all of Flagstaff. Thus, in designing its transit network, NAIPTA must trade-off higher frequency routes against wider geographic coverage.

How to balance ridership (or frequency) and coverage is not a technical question. Rather, it is a question that relates to the values and needs of a community.

We estimate that about 65% of the existing NAIPTA fixed-route transit network is designed as it would be if maximizing ridership were its only goal. The other 35% is deployed in places with predictably low-ridership, where it serves other, non-ridership purposes.

This may be the right balance for Flagstaff in the future, or the community may wish for a shift in emphasis, with more of the transit budget spent pursuing one or the other of these goals. The direction of that shift, and how fast NAIPTA should make such a shift, are both questions for stakeholders, the public and decision-makers to discuss as part of this 5-Year Transit Plan.

Guidance from the public on this choice can be helpful to NAIPTA not only as the agency continues to hone its current services, but also in any conversations that arise about how the transit network should grow in the future.
Alternatives
For this 5-Year Plan, NAIPTA’s intention is to follow these principles:

- Service design will be “zero-based,” meaning that history, habit and recent plans will not limit what is possible.
- The public will be engaged in setting the direction for the plan, giving input that is quantifiable and actionable.
- Multiple potential service models and networks will be compared to one another, using measurable outcomes.

In keeping with that approach, we have developed a pair of alternative networks, in order to engage the public, transit stakeholders and decision-makers in high-level goal setting for NAIPTA over the next five years. The alternatives, and their potential outcomes, are described in this chapter.

Conceptual Alternatives

The trade-off between high ridership (or high frequency) and wide geographic coverage can be hard to imagine, and hard to make. Most people value both ridership outcomes and coverage outcomes, so deciding how to trade them off against one another is difficult, and even painful.

Most people will naturally say that they want more frequency in their transit network, and also that they want more coverage of their city. Within a fixed budget, both are not possible. By asking people to react to these Conceptual Alternatives, we will learn not only what people want, but also what they are willing to give up in order to get it.

These Alternatives are not proposals. They are designed to be different enough from one another, and from the existing NAIPTA network, to help people envision the spectrum between them. In the spring of 2017, stakeholders, the public and decision-makers will be asked to react to these Alternatives, and to point out where on the spectrum they think the Mountain Line network should be.

The High Ridership Alternative could also be called the “High Frequency” Alternative. The High Coverage Alternative could also be called the “Low Frequency” Alternative. This is clear from a glance at the two Alternative maps, shown small and side-by-side, to the right.

- The High Ridership map shows multiple red (frequent) lines, but...
- ...fewer routes, covering fewer places, and no green (low-frequency) lines at all.
- The High Coverage map shows more routes, covering more places, and a number of green (low-frequency) lines, but...
- ...just two red (frequent) lines, and they are frequent only on certain days.

The triangle above illustrates how these two Alternatives relate to the existing Mountain Line network. As people think about their own reactions to the Alternatives, and what kind of direction they would like to see NAIPTA pursue, they can locate their opinion on this triangle.

The triangle shows two different axes, representing two separable choices:

- What degree of change from the existing network is desirable, or tolerable, for people?
- In which direction should NAIPTA pursue change (if any): Towards higher coverage, or towards higher ridership and frequency?
Alternatives

Figure 43: Map of the High Ridership (High Frequency) Alternative

**Conceptual Alternative**

**High Ridership**

**Weekday Daytime Frequencies**
- Every 7.5 minutes during school year, every 15 minutes other weekdays
- Every 15 minutes
- Every 30 minutes
- School deviation

- NAU shuttle, students only, every 4 min. on school days, every 30 min. on other days

Downtown Connection Center

Routes with 30-min. frequency make timed connections downtown and at the Mall, so that connections require only short waits.

This is not a proposal. It is one of two conceptual alternatives.

How is this Alternative different from the High Coverage Alternative?

- This Alternative concentrates service into fewer routes, and as a consequence it offers better frequencies and longer spans.
- However, also as a consequence, less of the city is covered with transit service.
- On weekdays when NAU is in session, Route 10 offers higher frequency for more hours than it does in the High Coverage Alternative.
Alternatives

Figure 44: Map of the High Coverage Alternative

Conceptual Alternative

High Coverage

Weekday Daytime Frequencies

- every 10 minutes during school year, every 20 minutes other weekdays
- every 15 minutes
- every 30 minutes
- every 60 minutes
- school deviation
- NAU shuttle, students only, every 4 min. on school days, every 30 min. on other days

Routes with 30- and 60-min. frequency make timed connections downtown and at the Mall, so that connections require only short waits.

This is not a proposal. It is one of two conceptual alternatives.

How is this Alternative different from the High Ridership Alternative?

- This Alternative spreads service out to cover more of the city.
- However, as a consequence, all routes run less frequently and for fewer hours.
- On weekdays when NAU is in session, Route 10 offers high frequency for only 9 hours of the day.
### Alternatives

**Figure 45: Map of the Existing Network**

---

**Existing Network**

**Weekday Daytime Frequencies**

- **NAU shuttle, students only, every 4 min on school days, every 30 min on other days**
- **NAU**
- **CC Downtown Connection Center**
- **Routes make timed connections downtown and at the Mall, so that connections require only short waits.**

- **Mountain Line**
  - **Existing Network**
  - **School deviation**
  - **Routes make timed connections downtown and at the Mall, so that connections require only short waits.**

- **Starting in January 2017, the 10a branch of Route 10 no longer exists. Instead, Route 10 offers ten minute frequency from Woodlands Village all the way into downtown.**

---

**Natural Area**

- **Outside Flagstaff**

---

**03/01/2017**

---

**Figure 45: Map of the Existing Network**

---

**ALTERNATIVES**

---

**JARRETT WALKER + ASSOCIATES**

---

**NAIPTA 5-Year Transit Plan**

---

**Transit Choices Report**

---

**47**
Alternatives

Descriptions of the Alternatives

On the following pages, we describe the main characteristics of the Alternatives, in particular how they differ from one another, and from the existing network.

For ease of reference, a table describing the frequency and span of existing routes is shown at right.

Budget

These Alternatives were designed to use the same budget, which is approximately equal to NAIPTA’s 2018 budget for fixed route service. No additional funding for transit is assumed.

The operating budget for these Alternatives would be about 77,000 revenue hours per year. In 2018, this would cost about $6.3 million.

These Alternatives would also fit within NAIPTA’s expected fleet limitations in 2018. The High Ridership Alternative would require 16 vehicles, and the High Coverage Alternative would require 17 vehicles (not including spares).

Service categories

We have made an effort to use one set of service categories across both of the Alternatives, so that differences in frequency and span are easier to notice. This means that a line of a given color offers the same frequency and span as other lines of the same color, within and between the Alternatives.

The one exception is Route 2, which offers longer spans of service each day than other routes in the same category, in both Alternatives, in order to match the existing late-night service on Route 2.

The frequencies and spans of service on each route in the Alternatives, and in the existing network, are shown in colorful tables on this page and the following pages. The hours of service represented in these tables are approximate, rounded to the nearest hour.

Both of the Alternatives assume more consistent frequencies from day to day than are provided by the existing system. In the Alternatives, a route that comes every 15 minutes on a weekday also comes every 15 minutes on the weekend; the same is true of other frequencies. (The only exception is Route 10, which has very high frequencies targeted at peak student demand.) In contrast, in the existing network, only some routes maintain their weekday frequencies on the weekends (see the colorful table at right).

Route numbering

Some of the routes in these Alternative are very similar to existing routes, and their numbers have been kept the same. Others are completely new, or are sufficiently different that they have been given new numbers to avoid confusion.

11. The fleet requirements nor the operating budget mentioned above do not include the costs of the NAU shuttle, which is shown on these maps only for ease of reference. The NAU shuttle is planned, funded and managed by the University, and no changes to it are being contemplated as part of this plan.
In this Alternative, about 85% of the budget would be spent pursuing maximum ridership, and just 15% spent covering places where ridership relative to cost is likely to be low. (In comparison, about 65% of the existing Mountain Line budget is spent pursuing maximum ridership.) This Alternative represents a shift in spending priorities, away from coverage and towards maximizing ridership.

As described earlier in this report, Flagstaff’s geography presents a difficult puzzle for the design of transit services. Downtown and the Flagstaff Mall are major centers of activity, and it would make sense for them to anchor the ends of east-west routes. 4th Street, in Sunnyside, is another center of activity, with the density, mix of uses and walkability that typically results in high ridership. However, it is impossible for a single route to connect downtown, 4th Street and the Mall without becoming circuitous and indirect. Thus NAIPTA may always have to run one route that connects downtown and the Mall via a more direct path. Service will then be divided among multiple routes operating at a frequency worse than 20 minutes; “pulse” service will be needed between the shortline and the longline, making Mountain Line budget is spent pursuing maximum ridership.) This Alternative represents a shift in spending priorities, away from coverage and towards maximizing ridership.

In the High Ridership Alternative, this puzzle and challenge is dealt with as follows:

- A frequent Route 7 serves Sunnyside, via Huntington.
- Route 66 makes the fastest and most direct connection between downtown and the Mall.
- Route 2 makes a less direct connection between downtown and the Mall, via Cedar Avenue.
- In this way, downtown and southside both have direct connections to the Mall, via different paths. The most frequent service is designed so that it can travel along 4th Street in Sunnyside, rather than passing by the edge of Sunnyside.

Route 2 would have a frequent “shortline” between the Connection Center and the hospital, and a less frequent “longline” that continues on to Flagstaff Mall on Route 2’s existing path. No transfer would be needed between the shortline and the longline, but people traveling to the Mall from downtown would need to wait for every-other bus, since half of the buses would turn around at the hospital and return to the Connection Center.

Route 7 would follow a similar path as today. However, it would no longer go west of the Connection Center. Its frequency would be much higher than today, especially on weekends.

Route 66 would be as it is today, except that it would have higher frequency on weekends, and would no longer serve Christmas Tree Estates.

Instead of one-way Routes 4 and 14, with their different frequencies and different directions, this Alternative would have a single Route 4, running in both directions, every 30 minutes.

Route 10 would be more frequent than it is today on weekends and days when NAU is out of session. Its route would be largely the same.

Routes 3 and 5 would not exist in the High Ridership Alternative.

All routes operating at a frequency worse than 20 minutes would “pulse” at the Downtown Connection Center, so that people can make reliably quick transfers between them.

In the High Ridership Alternative, there are fewer routes, but each route has higher frequency than today, and than in the High Coverage Alternative.

Frequent service would be targeted at the densest, most walkable, and most proximate areas of the city: Woodlands Village, NAU, southside, downtown, Historic Highway 66, Sunnyside and the Flagstaff Mall.

Figure 47: Frequency and Span Table for the High Ridership Alternative

<table>
<thead>
<tr>
<th>Color</th>
<th>Frequency</th>
<th>Route</th>
<th>Highest Frequency</th>
<th>Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5 - 10 min</td>
<td>15 min</td>
<td>2s</td>
<td>15 min</td>
<td>5</td>
</tr>
<tr>
<td>15 min</td>
<td>2L</td>
<td>15 min</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>20 min</td>
<td>4</td>
<td>30 min</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>30 min</td>
<td>7</td>
<td>15 min</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>40 min</td>
<td>10</td>
<td>7.5 min</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>60 min</td>
<td>66</td>
<td>30 min</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Color</th>
<th>Frequency</th>
<th>Route</th>
<th>Highest Frequency</th>
<th>Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5 - 10 min</td>
<td>15 min</td>
<td>2s</td>
<td>15 min</td>
<td>5</td>
</tr>
<tr>
<td>15 min</td>
<td>2L</td>
<td>30 min</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>20 min</td>
<td>4</td>
<td>30 min</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>30 min</td>
<td>7</td>
<td>15 min</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>40 min</td>
<td>10</td>
<td>7.5 min</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>60 min</td>
<td>66</td>
<td>30 min</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Color</th>
<th>Frequency</th>
<th>Route</th>
<th>Highest Frequency</th>
<th>Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5 - 10 min</td>
<td>15 min</td>
<td>2s</td>
<td>15 min</td>
<td>5</td>
</tr>
<tr>
<td>15 min</td>
<td>2L</td>
<td>30 min</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>20 min</td>
<td>4</td>
<td>30 min</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>30 min</td>
<td>7</td>
<td>15 min</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>40 min</td>
<td>10</td>
<td>7.5 min</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>60 min</td>
<td>66</td>
<td>30 min</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Color</th>
<th>Frequency</th>
<th>Route</th>
<th>Highest Frequency</th>
<th>Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5 - 10 min</td>
<td>15 min</td>
<td>2s</td>
<td>15 min</td>
<td>5</td>
</tr>
<tr>
<td>15 min</td>
<td>2L</td>
<td>30 min</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>20 min</td>
<td>4</td>
<td>30 min</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>30 min</td>
<td>7</td>
<td>15 min</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>40 min</td>
<td>10</td>
<td>7.5 min</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>60 min</td>
<td>66</td>
<td>30 min</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Color</th>
<th>Frequency</th>
<th>Route</th>
<th>Highest Frequency</th>
<th>Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5 - 10 min</td>
<td>15 min</td>
<td>2s</td>
<td>15 min</td>
<td>5</td>
</tr>
<tr>
<td>15 min</td>
<td>2L</td>
<td>30 min</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>20 min</td>
<td>4</td>
<td>30 min</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>30 min</td>
<td>7</td>
<td>15 min</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>40 min</td>
<td>10</td>
<td>7.5 min</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>60 min</td>
<td>66</td>
<td>30 min</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>
Altenatives

High Coverage Alternative
In the High Coverage Alternative, about 55% of the operating budget is spent pursuing maximum ridership, and 45% is spent providing coverage in areas where ridership is likely to be low relative to the cost of serving it. (In comparison, about 65% of the existing Mountain Line budget is spent pursuing maximum ridership.) This Alternative represents a small shift in spending priorities away from maximum ridership and towards greater coverage.

In the High Coverage Alternative, there are many more routes than in the High Ridership Alternative, and more routes than NAIPTA offers today. However, spreading transit service far means spreading it thin. As a result, the frequencies and spans of all routes are much lower than in the High Ridership Alternative, and somewhat lower than they are today, even on the highest ridership routes.

By looking at the frequency table at right, and comparing it to the High Ridership Alternative, and most routes today, it is still not possible to cover everywhere within the budget.

A new Route 8 would connect downtown and the airport, once per hour, via Milton Road.

A new Route 9 would serve west Historic Route 66, once per hour.

Route 5 would be replaced by a new Route 6, which goes directly from Fort Valley Road to downtown. Thorpe Park would be served by a separate Route 11, which would have its ends at the Downtown Connection Center and the hospital. Both routes would come once per hour. (Splitting the Thorpe Park loop off of Route 5 is only possible because Route 9, on west Highway 66, takes so little time to drive out and back, that in the other half of the hour it can run Route 11 through Thorpe Park, and still make the “pulse” at the Connection Center. If Route 9 did not exist, Thorpe Park would need to be served by Route 5, as it is today.)

Routes 2, 4, 7 and 66 would come every 30 minutes.

Route 10 would offer high frequency only during NAU class times, to avoid crowding.

As in the High Ridership Alternative, Routes 4 and 14 would be combined into a single bidirectional Route 4, which would come every 30 minutes.

Unlike in the High Ridership Alternative, Route 66 would still serve Christmas Tree Estates.

**Figure 48: Frequency and Span Table for the High Coverage Alternative**

<table>
<thead>
<tr>
<th>Route</th>
<th>Highest Frequency</th>
<th>Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>30 min</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>30 min</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>30 min</td>
<td>16</td>
</tr>
<tr>
<td>6</td>
<td>60 min</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>30 min</td>
<td>16</td>
</tr>
<tr>
<td>8</td>
<td>60 min</td>
<td>14</td>
</tr>
<tr>
<td>9</td>
<td>60 min</td>
<td>14</td>
</tr>
<tr>
<td>10</td>
<td>10 min</td>
<td>17</td>
</tr>
<tr>
<td>11</td>
<td>60 min</td>
<td>14</td>
</tr>
<tr>
<td>66</td>
<td>30 min</td>
<td>16</td>
</tr>
</tbody>
</table>

**NAU Weekdays (182 per year)**

<table>
<thead>
<tr>
<th>Route</th>
<th>Highest Frequency</th>
<th>Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>30 min</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>60 min</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>30 min</td>
<td>16</td>
</tr>
<tr>
<td>6</td>
<td>60 min</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>30 min</td>
<td>16</td>
</tr>
<tr>
<td>8</td>
<td>60 min</td>
<td>14</td>
</tr>
<tr>
<td>9</td>
<td>60 min</td>
<td>14</td>
</tr>
<tr>
<td>10</td>
<td>20 min</td>
<td>17</td>
</tr>
<tr>
<td>11</td>
<td>60 min</td>
<td>14</td>
</tr>
<tr>
<td>66</td>
<td>30 min</td>
<td>16</td>
</tr>
</tbody>
</table>

**Break Weekdays (72 per year)**

<table>
<thead>
<tr>
<th>Route</th>
<th>Highest Frequency</th>
<th>Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>30 min</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>60 min</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>30 min</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>60 min</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>30 min</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>60 min</td>
<td>12</td>
</tr>
<tr>
<td>9</td>
<td>60 min</td>
<td>12</td>
</tr>
<tr>
<td>10</td>
<td>20 min</td>
<td>14</td>
</tr>
<tr>
<td>11</td>
<td>60 min</td>
<td>12</td>
</tr>
<tr>
<td>66</td>
<td>30 min</td>
<td>13</td>
</tr>
</tbody>
</table>

**Weekends (110 per year)**

<table>
<thead>
<tr>
<th>Route</th>
<th>Highest Frequency</th>
<th>Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>30 min</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>60 min</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>30 min</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>60 min</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>30 min</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>60 min</td>
<td>12</td>
</tr>
<tr>
<td>9</td>
<td>60 min</td>
<td>12</td>
</tr>
<tr>
<td>10</td>
<td>20 min</td>
<td>14</td>
</tr>
<tr>
<td>11</td>
<td>60 min</td>
<td>12</td>
</tr>
<tr>
<td>66</td>
<td>30 min</td>
<td>13</td>
</tr>
</tbody>
</table>
Comparing Coverage and Ridership Potential

By simply comparing the maps on the previous pages, it is clear that the High Ridership network would cover less of the City of Flagstaff, and the High Coverage network would cover more. But how many residents and jobs does that geographic coverage represent?

The charts at right illustrate how the Alternatives would change the number of residents and jobs that have access to any service (no matter how useful) and to frequent service.

Predictably, the High Ridership Alternative gets service (of any frequency) close to fewer residents and jobs (49% of residents, and 73% of jobs) than do the existing and High Coverage networks. (These numbers are reported in a table on the next page.)

In exchange, however, the High Ridership Alternative gets frequent service within 1/4 mile of many more residents (32%) than do the other two networks (20%). It also gets frequent service within 1/4 mile of vastly more jobs (57%) than do the other two networks (25%). It does this by concentrating service into fewer routes, in places where residents and jobs are also concentrated.

Access to frequent service is a good estimate of potential ridership. While frequency alone is not enough to cause high ridership, frequency deployed along direct routes, in places that are dense, walkable and proximate to one other, does tend to lead to high ridership, and to lower operating costs, and thus to high productivity.

Note, however, that the “frequent service” offered by Route 10 in these Alternatives is not equal.

- In the High Coverage Alternative, Route 10 comes every 10 minutes during school hours, on days when NAU is in session. On other days, and on weekends, it comes every 20 minutes.
- In the High Ridership Alternative, Route 10 comes every 7.5 minutes on days when NAU is in session, for more than just school hours, and on other days it comes every 15 minutes.

12 Access is defined as being within 1/4 mile, by air, from a bus stop. It is standard practice in such measurements to use either a 1/4 or 1/2 mile buffer, but when measuring “as the crow flies” the more conservative measure is 1/4 mile. Mountain Line’s bus stops are fairly widely spaced; a person could be near the road on which a route runs but not necessarily be 1/4 mile from the closest bus stop. Any measurement of distance “as the crow flies” will tend to over-count access in places where there are barriers to walking. In general, some people will walk further than 1/4 mile to service, and other people will not or cannot walk even 1/4 mile. On average, people walk further to more frequent service or faster service, because sometimes by walking to such service they can get the shortest transit travel time.

Figure 49: Charts Comparing Coverage and Ridership Potential of the Alternatives

Residents with Access to Transit within 1/4 mile of a Mountain Line or NAU stop in Flagstaff.

<table>
<thead>
<tr>
<th>Frequent Service: Every 7.5-15 min.</th>
<th>All Day Service: Every 20-60 min.</th>
<th>No access within 1/4 mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10,000</td>
<td>20,000</td>
</tr>
<tr>
<td>30,000</td>
<td>40,000</td>
<td></td>
</tr>
<tr>
<td>50,000</td>
<td>60,000</td>
<td></td>
</tr>
</tbody>
</table>

High Ridership

High Coverage

Existing

Total residents: 68,000

Jobs Accessible by Transit within 1/4 mile of a Mountain Line or NAU stop in Flagstaff.

<table>
<thead>
<tr>
<th>Frequent Service: Every 7.5-15 min.</th>
<th>All Day Service: Every 20-60 min.</th>
<th>No access within 1/4 mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10,000</td>
<td>20,000</td>
</tr>
<tr>
<td>30,000</td>
<td>40,000</td>
<td></td>
</tr>
<tr>
<td>50,000</td>
<td>60,000</td>
<td></td>
</tr>
</tbody>
</table>

High Ridership

High Coverage

Existing

Total jobs: 37,000
Alternatives

These two versions of Route 10 offer different levels of service, but are treated the same — as “frequent” service — in this analysis (for which we picked, as the moment in time to measure, midday on a weekday when NAU is in session, a distinction that matters for Route 10 alone).

The tables at right report the numbers underlying the chart on the previous page.13

More jobs are covered by transit than are residents, in all three of these networks. In the existing network, about 86% of jobs in the city are within 1/4 mile of some service (this would remain the same in the High Coverage Alternative, and would decrease in the High Ridership Alternative). Jobs are very centralized around downtown, the University and the historic highways, whereas residential development is mostly low-density and dispersed. Of course, for people to access their jobs, their residences must also be close to transit service.

The High Coverage Alternative covers only a few more jobs than the existing network, because there are so few jobs near the main roads on which Routes 8 and 9 travel.

The High Coverage Alternative would get service within 1/4 mile of at least 2,000 more residents than does the existing network. The new coverage provided is on Historic Route 66, east of Thompson Street, and on High Country Trail and Pulliam Drive, between Lake Mary Road and the airport.

This may be an underestimate of the residential coverage added in the High Coverage Alternative, because some of the developments along Historic Route 66 are too recent to be captured in the Census data used for this analysis. Also, some of the denser housing near the new Route 9, on Historic Route 66, is more than 1/4 mile away from the highway.

However, service provided by the new Route 9 on Historic Route 66 would be accessible to people in only one direction, unless they are willing to cross the highway on foot. The nearest pedestrian crossing is at Woodlands Village Road. (This raises a question of whether coverage provided by Route 7 at Thompson Street, today, is really accessible either, though it is counted as such in this analysis.)

No doubt a handful of people would be willing to run across Historic Route 66 in order to access the bus stop on the other side, but for all other residents Route 9 would only be useful for a one-way trip, in-bound or out-bound, at least until pedestrian improvements are made to the highway. This is but one example of the type of barrier to access that is not captured by the results of this high-level coverage analysis. Less severe examples of such pedestrian crossing barriers can be found on the Mesa, on Highway 89, on Butler Avenue, on Country Club Drive and in other places.

Thus while 1/4 mile is an appropriate distance to use for this measurement (especially given how dark the city is at night), in most parts of Flagstaff people must walk longer distances to access service, thanks to a combination of poor street connectivity, scattered development, widely-spaced bus stops, freeway- and railroad-related barriers, and missing pedestrian crossings.

---

<table>
<thead>
<tr>
<th>Jobs with access to…</th>
<th>All Day Service</th>
<th>Frequent Service</th>
<th>No access within 1/4 mile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Every 20-60 min.)</td>
<td>(Every 7.5-15 min.)</td>
<td></td>
</tr>
<tr>
<td>High Ridership Alternative</td>
<td>27,265</td>
<td>21,284</td>
<td>9,858</td>
</tr>
<tr>
<td>High Coverage Alternative</td>
<td>31,980</td>
<td>9,405</td>
<td>25%</td>
</tr>
<tr>
<td>Existing Network (including NAU shuttle)</td>
<td>31,886</td>
<td>9,432</td>
<td>25%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Residents with access to…</th>
<th>All Day Service</th>
<th>Frequent Service</th>
<th>No access within 1/4 mile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Every 20-60 min.)</td>
<td>(Every 7.5-15 min.)</td>
<td></td>
</tr>
<tr>
<td>High Ridership Alternative</td>
<td>32,941</td>
<td>21,497</td>
<td>34,653</td>
</tr>
<tr>
<td>High Coverage Alternative</td>
<td>45,271</td>
<td>13,356</td>
<td>22,323</td>
</tr>
<tr>
<td>Existing Network (including NAU shuttle)</td>
<td>43,726</td>
<td>13,318</td>
<td>23,868</td>
</tr>
</tbody>
</table>

Figure 50: Tables Reporting the Coverage and Ridership Potential of the Alternatives

13 Percentages are based on an estimated residential population of 68,000 and job count of 37,000 within the City of Flagstaff. Data for this analysis is from the 2014 and 2010 Census sources, the same used for the maps of job density (shown on page 12) and residential density (shown on page 15). As described for those maps, jobs data is susceptible to “headquartering,” which will cause an overestimate of jobs coverage in some places, and an underestimate in other places. The net effect of headquarters on the total measurements of jobs coverage reported here is unknown.