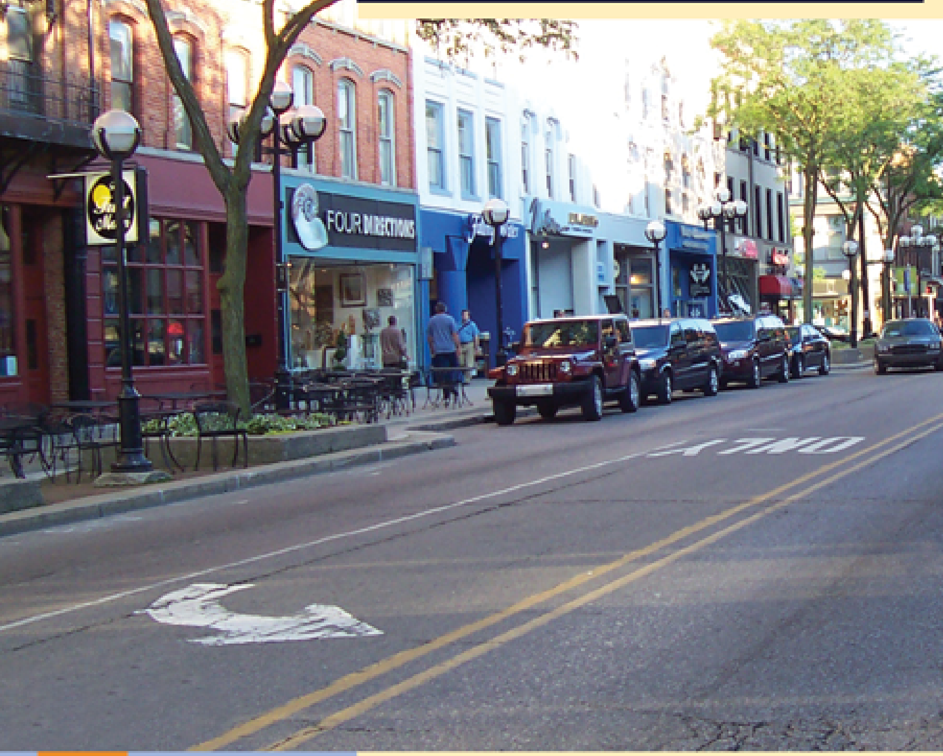
Ann Arbor Connector Feasibility Study

Final Report



February 21, 2011

Collaborating Agencies

City of Ann Arbor

Ann Arbor Transportation Authority

University of Michigan

Ann Arbor Downtown Development Authority

prepared by

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EXECUTIVE SUMMARY

Study Purpose and Need

The City of Ann Arbor, the Ann Arbor Transportation Authority (AATA), the Ann Arbor Downtown Development Authority (DDA) and the University of Michigan (U-M) have collaborated to conduct this feasibility study of advanced transit technologies to serve the transportation needs of the City and the University. Each of these agencies recognize that some type of advanced transit system could supplement the existing multi-modal transportation system in Ann Arbor, and also provide benefits such as economic stability, convenience, sustainability, more travel options and an improved overall quality of life. This feasibility study coordinated the mutual goals of the project team, and provided a basis for moving forward with additional transit improvements.

The purpose of this study is to determine the feasibility of advanced transit technologies to meet growing transportation demands by:

- Examining the technical and financial feasibility and public policy issues in implementing the latest advanced transit technologies
- Improving mobility and connectivity to and within the City of Ann Arbor and U-M by increasing the ease and efficiency of movement
- Accommodating forecasted economic growth and development while protecting and enhancing the quality of life and character of the community
- Improving intermodal connections to improve the accessibility of Ann Arbor to/from the surrounding communities
- Integrating trips to reduce travel time between destinations
- Appropriately matching transit technologies with travel demand
- Determining how to maximize advanced transit options to compliment Ann Arbor's goals related to succeeding as a walkable and livable community and reinforcing access to activity centers
- Increasing opportunities for economic development without widening roadways by improving transit along "signature" development corridors
- Avoiding the need for further investment of land and financial resources in new parking facilities
- Assessing the feasibility of a transit connection between commuter rail stations serving proposed north-south and east-west commuter rail lines
- Engaging and educating the public and stakeholders as part of the planning process

A number of factors contribute to the need for advanced transit in the City of Ann Arbor, including existing traffic congestion, anticipated growth, roadway system constraints, existing transit operations and the anticipated increase in transit service demand, the need for passengers to connect to new planned commuter rail services, and the desire for greater regional accessibility and more sustainable transportation options.

Several previous studies were reviewed to provide background for the current study, and contained a number of common themes, including a desire for sustainable transportation, support of non-motorized travel, reduction of greenhouse gas emissions, minimization of road expansion, and the increased use of transit. The need for consideration of advanced transit technologies for the city is supported by the results of these studies as well as current and projected conditions of the transportation system. The study process involved five components:

- Document the existing conditions
- Establish what is needed to accommodate growth and maintain quality of life in Ann Arbor, and estimate future conditions with respect to development and travel patterns
- Identify which transit technologies and types of service will best meet Ann Arbor's needs
- Evaluate the feasibility of each transit technology, including estimated cost and ridership
- Make recommendations for further action

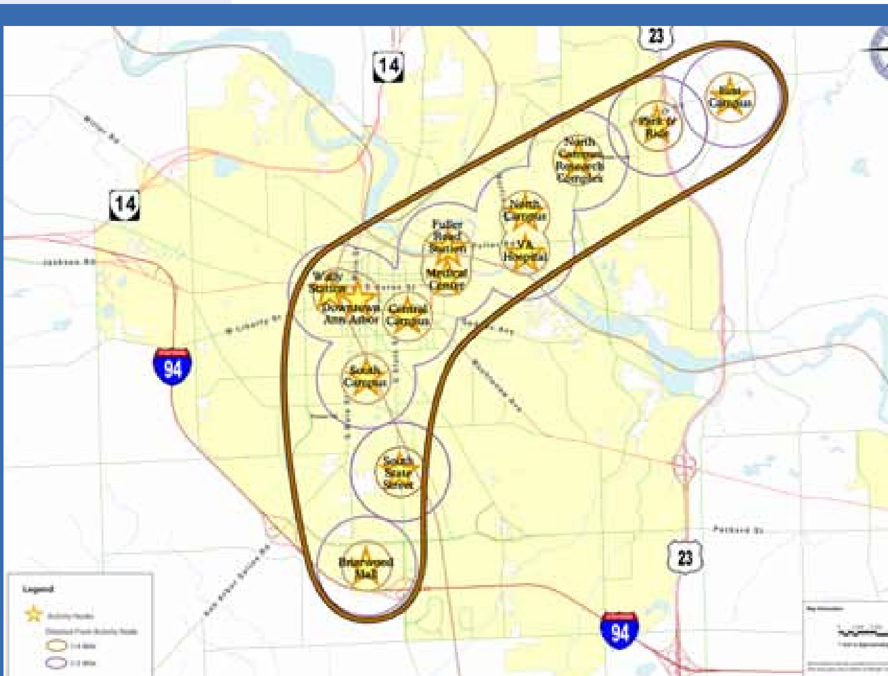


Figure ES-1: Study Area
Source: City of Ann Arbor, Michigan Center of Geographic Information, and URS Corportation

The study area forms a crescent shape which connects US-23 and I-94. The study area extends from the Northeast Corridor (near the US-23 / Plymouth Road interchange), through the East Medical Campus, Plymouth Road commercial center, North Campus, Medical Center Campus, Central Campus, downtown Ann Arbor, South Campus, and along the South Corridor and Briarwood Mall area (near the I-94 / South State Street interchange). A map of the project study area is shown in **Figure ES-1**.

A Study Management Committee (SMC) provided project oversight, direction, transportation modeling services and funding throughout all stages of the study, and was comprised of representatives from City of Ann Arbor, City of Ann Arbor Downtown Development Authority, Ann Arbor Transportation Authority, U-M and Washtenaw Area Transportation Study.

Existing and Future Travel

The study began with an examination of existing conditions, including existing and planned transit hubs and transit services available in the study area. This effort included a review of existing transit survey data, as well as collection of new transit data to estimate current transit ridership and help define existing transit operating characteristics. This information was used to develop the transit ridership forecast for 2035, which the study team used in determining which advanced transit technologies may be appropriate for Ann Arbor.

The forecasting approach first reviewed the patterns of travel within the study area. With this information, the extent to which various alternatives would address the study objectives could be estimated. The forecasting effort was a tool used to identify opportunities for improved transit connectivity/travel efficiency, to evaluate the travel demand for potential connections, and finally to appropriately match transit technologies with the travel demand in the corridor.

The Washtenaw Area Transportation Study (WATS) travel demand model was the primary tool used to evaluate the study area travel demand. The model uses residential, commercial and industrial development data, student activity, transit operations and the network of roads and streets that connect the area to estimate the amount of travel that occurs between activity centers. The WATS model was also used as the source for forecasts of future (2035) population and employment and resulting trip-making behavior. This information is updated every four to five years to reflect current trends and census data.

Once the model was calibrated and validated, the study team was able to obtain the following key observations for the current conditions (2010):

- 50,000 daily trips travel between Central Campus and North Campus
- 16,000 daily trips travel between Central Campus and the Medical Campus
- 5,000 daily trips travel between North Campus and the Medical Campus
- 10,000 daily trips travel between the Central Campus and South Campus
- 11,000 daily trips travel between Central Campus and downtown Ann Arbor

The current (2010) and forecasted 2035 orientations are relatively similar in pattern, even though 2035 represents growth in most origin-destination pairs. Key observations of the 2035 conditions include:

- 54,000 daily trips travel between Central Campus and North Campus
- 16,000 daily trips travel between Central Campus and the Medical Campus
- 6,000 daily trips travel between North Campus and the Medical Campus
- 10,400 daily trips travel between the Central Campus and South Campus
- 12,000 daily trips travel between Central Campus and downtown Ann Arbor

Alternative Transit Modes

A comprehensive set of advanced transit technologies were examined in this study, and case studies of how these technologies functioned in cities across the United States were performed to help determine if such technologies could also work well in Ann Arbor. Case studies included:

- BRT
  - Cleveland, OH - Healthline
  - Kansas City, KS - Metro Area Express (MAX)
- LRT
  - Charlotte, NC - LYNX Blue Line
  - Minneapolis, MN - Hiawatha Line
- Streetcar
  - Portland, OR - Portland Streetcar
  - Little Rock, AR - River Rail Streetcar Line
- AGT
  - Detroit, MI - Detroit People Mover
  - Indianapolis, IN - Clarian People Mover
- Personal Rapid Transit
  - Morgantown, WV - Personal Rapid Transit
  - London, England - ULTra
- Monorail
  - Las Vegas, NV - Monorail

- Double-Decker Bus
  - Las Vegas, NV - The Deuce
- Heavy Rail
  - Minneapolis, MN - Northstar Commuter Rail

After reviewing each of the case studies, the study team and the study management committee examined the pros and cons associated with each technology in terms of applicability and appropriateness for Ann Arbor. This analysis yielded a short list of technologies that the study team determined could best meet Ann Arbor's needs, which included LRT, BRT, standard bus, streetcar, AGT and monorail.

Connector Concepts

Transit improvements are comprised of a variety of different components including service concepts, route/alignment, surrounding land use, stations/stops and where and how each technology operates in relation to roads and traffic. The basic route for the advanced transit alternatives follows the study area corridor as shown in **Figure ES-1**, extending from the northeast area of the city through downtown and then to the south. Depending on the transit technology, a new guideway could be located in a number of physical configurations relative to the existing street system.

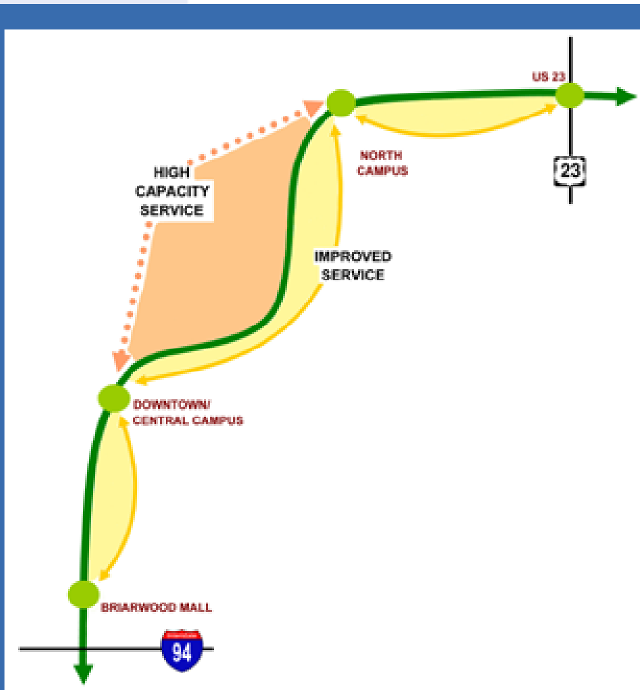


Figure ES-2: Demand by Corridor Segment
Source: URS Corporation

One of the critical factors defining transit operations is the need to accommodate peak period demand through the U-M campuses. The number of vehicles provided must have sufficient capacity to carry the passenger demand. For purposes of estimating operating characteristics in this feasibility study, a peak hourly one-way design capacity of 3,500 passengers was assumed. Accommodating these passengers is a function of the capacity of each transit vehicle, the number of vehicles per trip, and the headway or time between trips.

The peak passenger demand in the corridor exists primarily between the North Campus and the Central Campus as shown in **Figure ES-2**. The segments to the northeast and to the south have significantly less demand and could warrant a reduced level of passenger capacity. For this reason, alternative concepts involving more than one mode or operating plan were considered.

This analysis of passenger capacity by mode as well as compatibility between modes led to the identification of the six concept alternatives shown on **Figure ES-3** for more detailed study and evaluation.

Evaluation of Alternatives

Engineering and Environmental Constraints

This study area has a variety of features and constraints that must be considered in determining which type of transit technology may be the most appropriate for Ann Arbor. Many of these features are shown on **Figure ES-4**, and, depending on the selected alignment, could include the Huron River crossing, changes in topography, railroad crossings, intersections with major roadways, restricted available right-of-way in downtown Ann Arbor, access to the U-M Medical Center, the presence of historic districts, floodplains, parklands, golf courses and other features.

Connector Ridership

The transit technologies modeled included local bus service, Bus Rapid Transit (BRT), Light Rail Transit (LRT), and an elevated transit technology (such as Automated Guideway Transit (AGT) or monorail). The travel time estimated for each technology from one end of the Connector study area corridor to the other was:

- Baseline local bus: 36.1 minutes
- BRT: 31.4 minutes
- LRT: 30.6 minutes
- Elevated transit: 23.5 minutes

The model was also used to estimate 2035 Connector corridor ridership. For comparison purposes, ridership estimates were also developed for 2035 baseline conditions, assuming that the current bus system was maintained through the year 2035. Ridership estimates for the 2035 Baseline condition are also shown, generalized to represent bus ridership in the Connector corridor. A single forecast for the Connector improvement is provided as there was not a substantial difference in the segment ridership between any of the technology alternatives. Ridership estimates are shown in **Figure ES-5**.

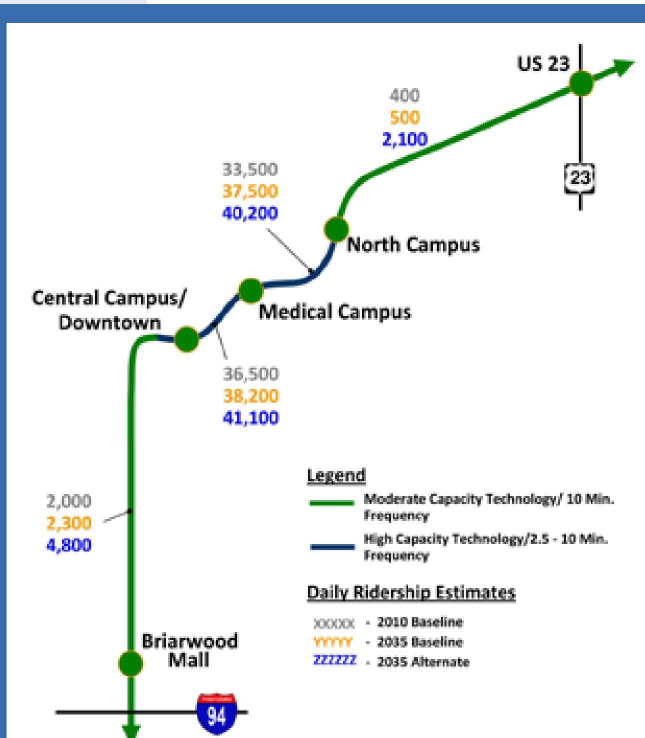
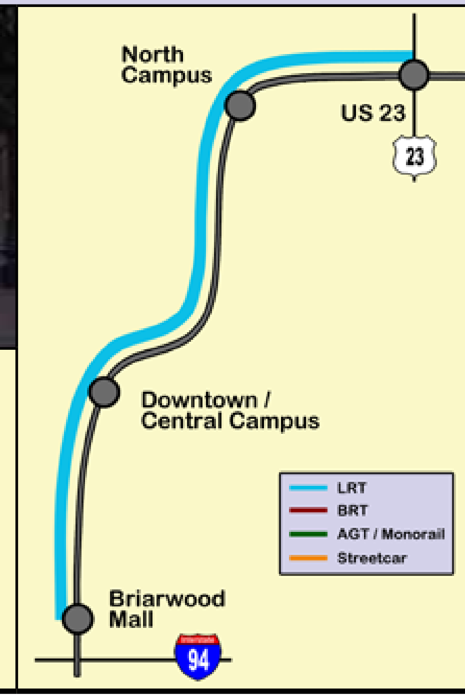


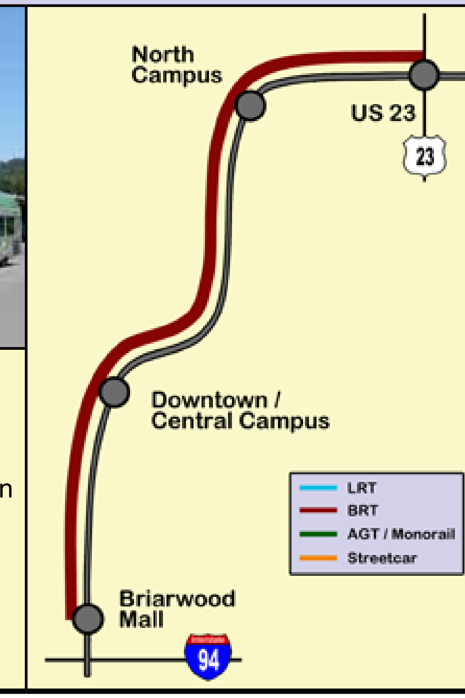
Figure ES-5: Forecasted Daily Transit Ridership
Source: WATS Travel Model and URS Corporation

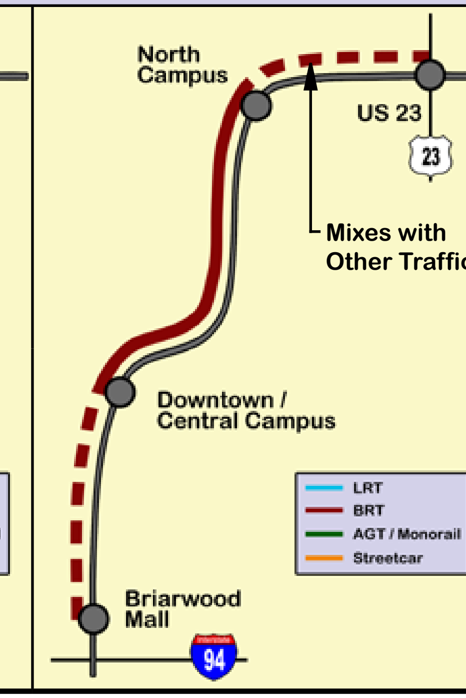
Light Rail Transit (LRT)



A multi-car train running each way on a single set of tracks through the study area.

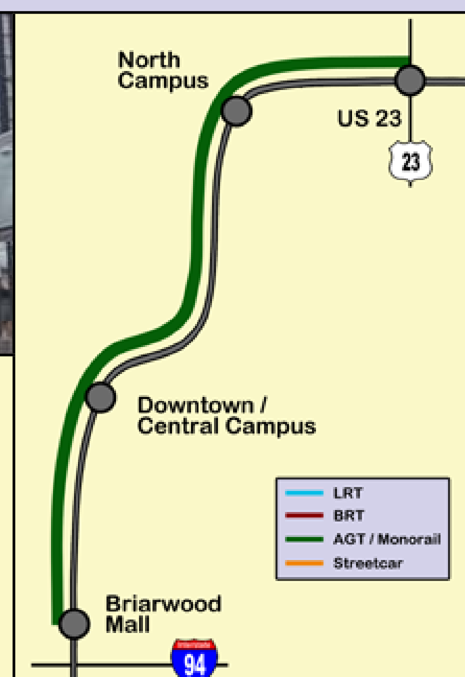
Bus Rapid Transit (BRT)





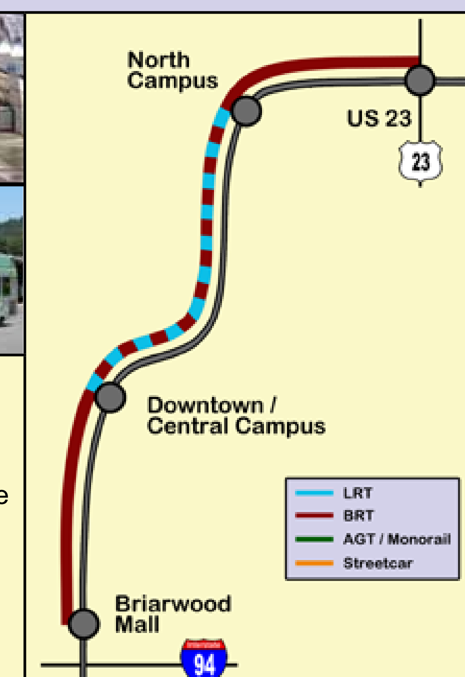
A high capacity bus running either on an exclusive guideway or with other traffic through the study area.

Elevated Technology
(Automated Guideway Transit or Monorail)



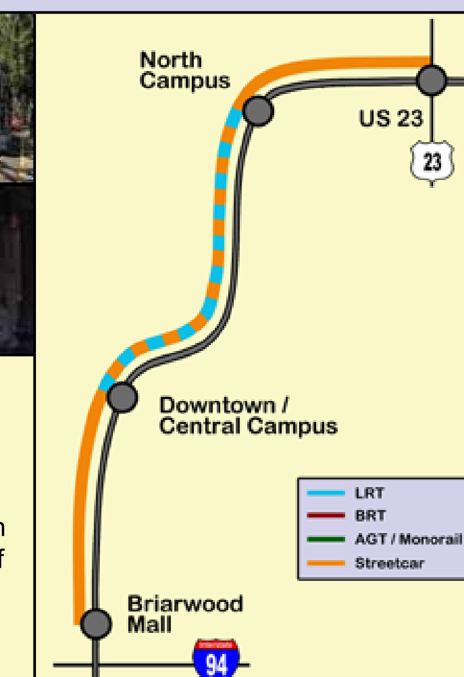
Vehicles running each way on an elevated guideway through the study area.

BRT Combined With LRT



A high capacity bus running through the entire study area on an exclusive guideway shared with LRT between the North and Central Campuses of the University of Michigan.

Streetcar Combined With LRT



A streetcar running through the entire study area on an exclusive guideway shared with LRT between the North and Central Campuses of the University of Michigan.

Figure ES-3: Transit Technology Alternatives
Source: URS Corporation

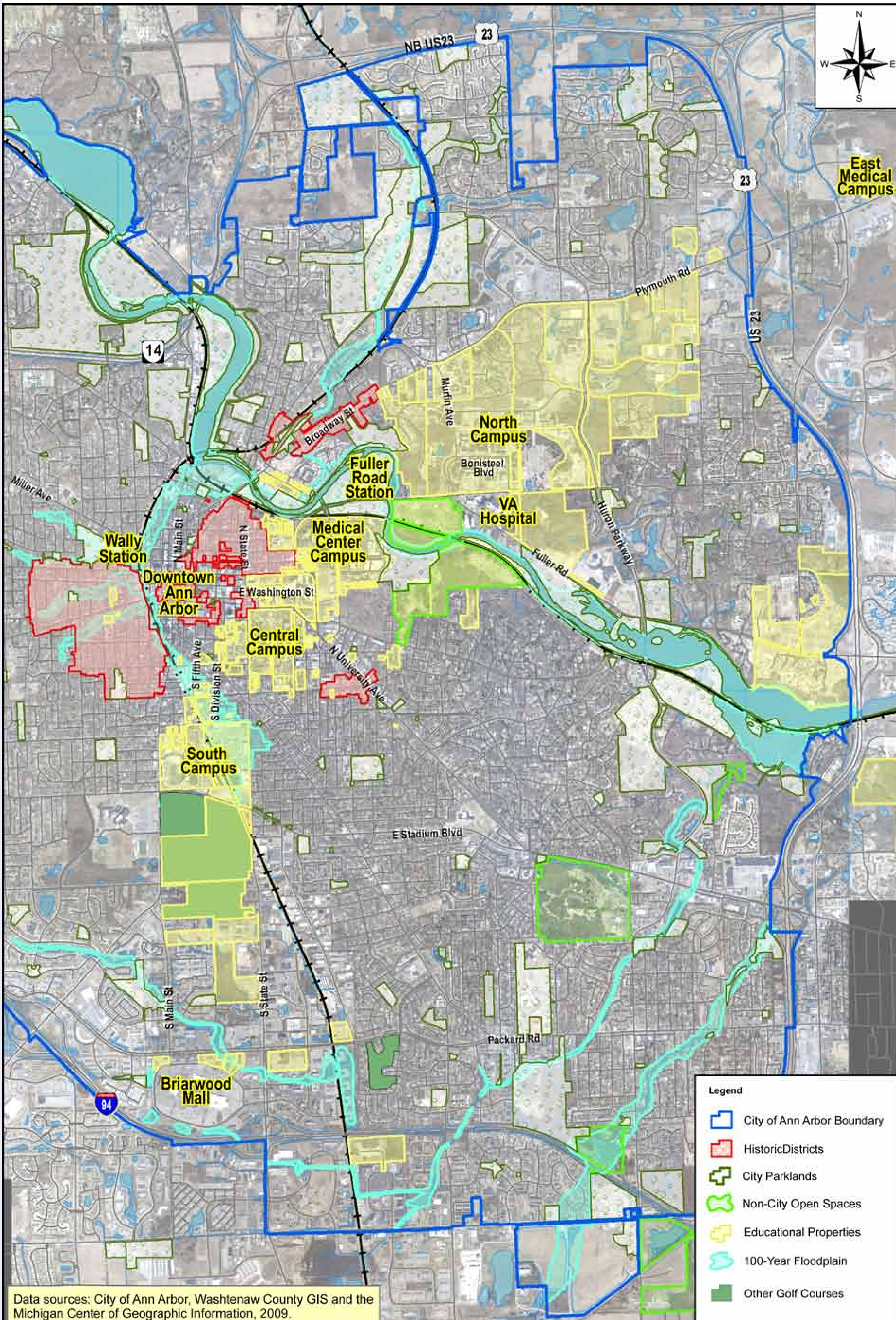


Figure ES-4: Engineering and Environmental Constraints
Source: URS Corporation

Cost Estimates

Estimates of capital project costs, shown in **Table ES-1**, and operating and maintenance (O & M) costs, shown in **Table ES-2**, were completed by URS Corporation for each of the alternatives recommended for further consideration, and are summarized in the tables below. As a specific alignment has not yet been defined for an advanced transit technology, the capital costs do not include right-of-way costs. These preliminary cost estimates are intended to show relative differences in cost between

	Total Estimate	Cost per Mile
Light Rail Transit (LRT)	$522 - $542 M	$61 - $64 M
Bus Rapid Transit (BRT) (end-to-end guideway)	$176 - $186 M	$21 - $22 M
BRT (guideway between North and Central Campus)	$130 - $140 M	$15 - $17 M
Elevated Technology (full guideway)	$1.7 - $1.9 B	$200 - $224 M
Elevated Technology - Core Segment Only	$350 - $400 M	
BRT + LRT	$312 - $322 M	$37 - $38 M
LRT + Streetcar	$490 - $500 M	$58 - $59 M

Table ES-1: Capital Project Cost Estimates (2010$)

Source: URS Corporation

	Total Incremental Connector O&M Costs ($2010)	New Circulator Bus O&M Costs ($2010)	Cost Savings (Eliminated + Modified Routes; $2010)	Net Change In O&M Costs ($2010)
Light Rail Transit (LRT)	$11.5 M	$2.5 M	-$4.5 M	$9.5 M
Bus Rapid Transit (BRT) (end-to-end guideway)	$5.8 M	$2.5 M	-$4.5 M	$3.8 M
BRT (guideway between North and Central Campus)	$6.6 M	$2.5 M	-$4.5 M	$4.6 M
Elevated Technology	$13.0 M	$2.5 M	-$4.5 M	$11.0 M
BRT + LRT	$7.6 M	$2.5 M	-$4.5 M	$5.6 M
LRT + Streetcar	$9.4 M	$2.5 M	-$4.5 M	$7.4 M

Table ES-2: Change in Operating and Maintenance Costs

Source: URS Corporation

each of the alternatives and are not meant to be indicative of the true cost of any system, as costs will be further refined during more detailed phases of future study.

Land Use Impacts

Fixed guideway transit investments have the potential to improve economic development opportunities and attract and retain jobs. Recent examples from around the U.S. have demonstrated that a transit investment can provide a boost to the local development market, particularly in urban environments that offer the potential for transit-supportive uses.

In addition to local interest in land use and development, the federal government has recently placed a greater emphasis on these and other "livability" factors when considering qualifying projects. Enacting land use and development policies that complement and support a transit investment will improve the case for receiving highly competitive grant funding. Fixed guideway transit investments also have the potential to contribute to liveable, walkable neighborhoods.

Table ES-3 summarizes some of the potential land use impacts for the alternatives being considered as part of the Ann Arbor Connector Feasibility Study.

Mode	Potential land use impacts
Local Bus	Impacts likely to be minimal. Little evidence to show that local bus service in a corridor has a significant impact on surrounding land uses other than apartment vacancy rates.
Bus Rapid Transit	Impacts are variable and dependent upon factors such as the level of investment in stations and service and coordination with local planning and development incentives. When the service is perceived as different from local bus service, presence of TOD impacts may increase.
Light Rail Transit	Documented land use impacts in major urban regions (Dallas, Denver, Charlotte, Minneapolis). TOD areas may be more distributed due to station spacing, although highly concentrated around station areas. Specific development types may depend on existing surrounding land use types.
Streetcar	Documented land use impacts, particularly when serving mixed-use downtown districts (Portland, Seattle). Streetcar projects are often built with economic development as a major goal, but are most suitable for short (<3 mile) high-density urban corridors.
Elevated / AGT	Very few new elevated transit corridors, making it difficult to gauge impact. Would be expected to provide similar potential to light-rail transit, but with less street-level activity as compared to an at-grade alternative.

Table ES-3: Summary of Potential Land Use Impact by Transit Mode Source: URS Corporation

Public Involvement

The Ann Arbor Connector Feasibility Study included a robust public involvement component. The goal of the public involvement process was to continue and extend the public involvement activities previously undertaken by the study sponsors both collectively and individually, by facilitating a dialogue that would inform the public about the different possible transit technologies that could improve accessibility and increase economic development.

The public involvement process used both traditional and non-traditional methods to convey the key messages of the project and to obtain input from the SMC, key stakeholders, and members of the public. Some common themes emerged from conversations with the project stakeholders and are summarized below:

- People are generally happy with the existing AATA bus service within the City of Ann Arbor.
- More public transportation connections are needed to communities outside of the City.
- There is a lot of support for the proposed Washtenaw and Livingston Line (WALLY) and the Ann Arbor – Detroit Regional Rail Project.
- There is a need for cleaner and “greener” transportation alternatives to driving single-occupancy vehicles.
- Expanded evening and weekend service is needed.
- There are a lot of concerns about funding for possible transit improvements.
- Improved transportation infrastructure has the potential to contribute to increased property values and provide the opportunity to add density in selected activity areas

A project website was created to allow interested parties to easily access project information at www.aaconnector.com. The study team also created three project newsletters to keep stakeholders informed about the study as it progressed. Paper copies of the newsletters were mailed to previous and current study participants. Copies were also placed on the project website and the websites of each of the SMC agencies, and sent electronically to participants who indicated a preference for receiving electronic copies.

The study team also held two public meetings, one on June 8, 2010, and one on November 15, 2010. These meetings provided an opportunity for members of the community to learn more about the project, to ask questions, and to provide the team with feedback on the study.

Findings and Recommendations

Is there a need for some type of alternative transit system in Ann Arbor?

Yes, there is a need for some type of advanced transit system to connect key destinations in the City of Ann Arbor and support a sustainable system of transportation and land use. The primary transportation needs to be addressed by an alternative transit system are:

- Accommodating existing and forecasted ridership
- Existing U-M bus system operating near capacity
- The lack of reliability and delay associated with buses operating in mixed traffic
- The need for more sustainable options to support long term transportation planning goals of the City, the University and the region.

Is an advanced transit system for Ann Arbor technically feasible?

While there are a number of physical and operational constraints that will need to be addressed to develop an advanced transit system that satisfies demand, it appears that there are technically feasible solutions available. Preliminary engineering analysis indicates that the physical constraints can be addressed recognizing that there will need to be tradeoffs between impacts, operations and cost. Future engineering design will need to develop cost effective solutions that minimize impacts to environmental resources.

Figure ES-6: Connector Service Concept
Source: URS Corporation

What type of advanced transit technology fits best in the community?

The type of advanced transit technology suitable for Ann Arbor is primarily dictated by passenger demand. Ridership analysis indicates that there are two distinct area types, the high demand core and the moderate demand shoulders. This concept is illustrated in **Figure ES-6**.

As noted previously, while the existing passenger demand is currently accommodated on standard buses, the system is currently operating at capacity during peak periods, in the segment between the North Campus and the Central Campus. In this high ridership core, a larger vehicle is required and it would be highly desirable to provide a dedicated right of way to enhance transit travel times and improve schedule reliability. A bus rapid transit, light rail transit or elevated system could provide the necessary passenger capacity through the high demand portion of the corridor.

While these same technologies could be applied in the moderate demand shoulders to the northeast and to the south, it would be desirable to adjust service levels and/or vehicle capacity in these lower demand portions of the corridor to better match forecast demand. In addition, the level of demand could be accommodated by a streetcar or by standard buses.

Could an advanced transit system be implemented incrementally?

Yes, elements of an advanced transit system could be added incrementally with the goals of improving transit travel times and reliability, adding capacity and improving quality of service.

What sources of funding could be used to build a Connector?

The capital cost of major new transit projects is typically funded from multiple sources. Funds can originate at the federal, state, or local level and can be supplemented with private sources. Funding can take the form of grants or a revenue stream that can be used to issue bonds. Funding might also be supplemented with in-kind contributions; for example donation of right of way.

The funding plan for a major transit investment typically evolves over time. Initially, funding is required for the planning and design phases of a project. As the project becomes more defined, a capital funding plan is developed and the project is incorporated into the regional transportation funding process administered by the regional planning agency (Washtenaw Area Transportation Study – WATS).

Based on the ridership forecasts developed as part of this study, it appears that the Connector could qualify for New Start or Small Start funding from the Federal Transit Administration (FTA). This program could provide up to 50% of the capital cost of a fixed-guideway Connector.

Who would operate a Connector?

The question of who would be responsible for the operation of a Connector is just one element of the issue of governance. In addition to operations, decisions need to be made to address the agency that might receive federal or state grants, the agency that would be responsible for constructing the system, and the agency that would be responsible for system administration and financial performance.

Considerations in the issue of governance of a Connector include the specific mode and route selected, service area, the sources of funding for capital and operations, procurement and implementation methodology, and administration costs and capabilities. The governance plan for a major transit investment typically evolves over time as these other considerations are addressed.

What are the next steps that need to be completed to move the project toward implementation?

If the community determines that it wants to proceed with development of a Connector, it is recommended that the FTA New Starts Project Development Process be initiated. This would assure that the project would be eligible for FTA New Starts funding. The New Starts Project Development Process would commence with the preparation of an Alternatives Analysis (AA).

The AA is intended to develop more detailed information regarding benefits, costs and impacts of alternative actions which can be used by the community to select a locally preferred alternative (LPA). The LPA could then be incorporated into the region's long range transportation plan. The AA will need to evaluate a range of potential transit investments and will require significant community involvement in the decision making process.

What are the primary considerations in locating a specific Connector alignment?

One of the products of the AA process would be a more defined route alignment and analysis of alternatives. Some of the key factors that would be considered in defining a specific route alignment would be:

- Station Locations
- Right of Way Availability
- Service Area
- Huron River Crossing
- Topography
- Railroad Crossings
- Maintenance Facility

INTRODUCTION

The City of Ann Arbor, the Ann Arbor Transportation Authority (AATA), the Ann Arbor Downtown Development Authority (DDA) and U-M collaborated to conduct this feasibility study of advanced transit technologies to serve the transportation needs of the City and the University. Each of these agencies recognize that some type of advanced transit system could supplement the existing multi-modal transportation system in Ann Arbor, and provide benefits such as economic stability, convenience, sustainability, more travel options and an improved overall quality of life. This feasibility study will coordinate the mutual goals of the project team, and provide a basis for moving forward with additional transit improvements.

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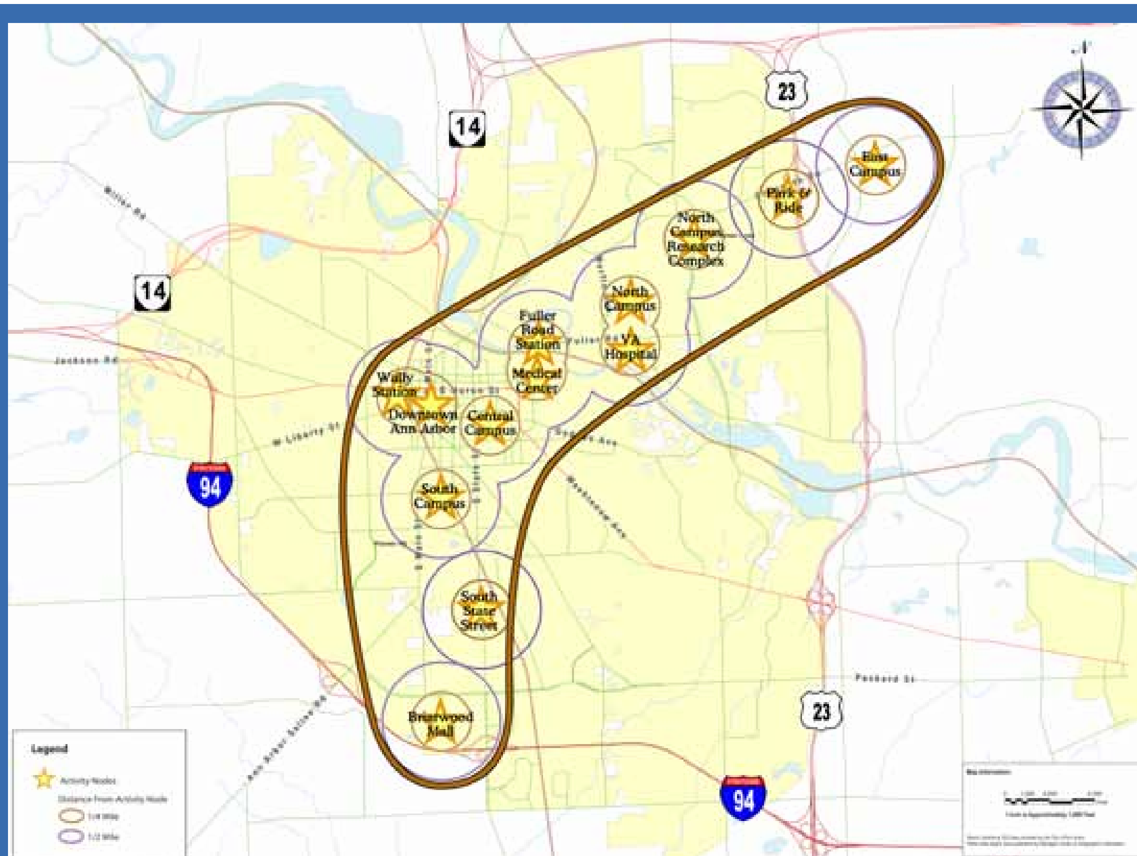

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- Improving mobility and connectivity to and within the City of Ann Arbor and U-M by increasing the ease and efficiency of movement
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- Engaging and educating the public and stakeholders as part of the planning process

Several previous studies were reviewed to provide background for the current study. The need for consideration of advanced transit technologies for the city is supported by the results of these studies as well as current and projected conditions of the transportation system. Most recently, the need for consideration of advanced transit technologies was identified in the May 2009 City of Ann Arbor Transportation Master Plan Update (TMPU). This report identified a number of "signature transit corridors", including the Plymouth-Fuller and State Street corridors, where high capacity transit was recommended, as shown by the corridors highlighted in red in **Figure 2-2**.

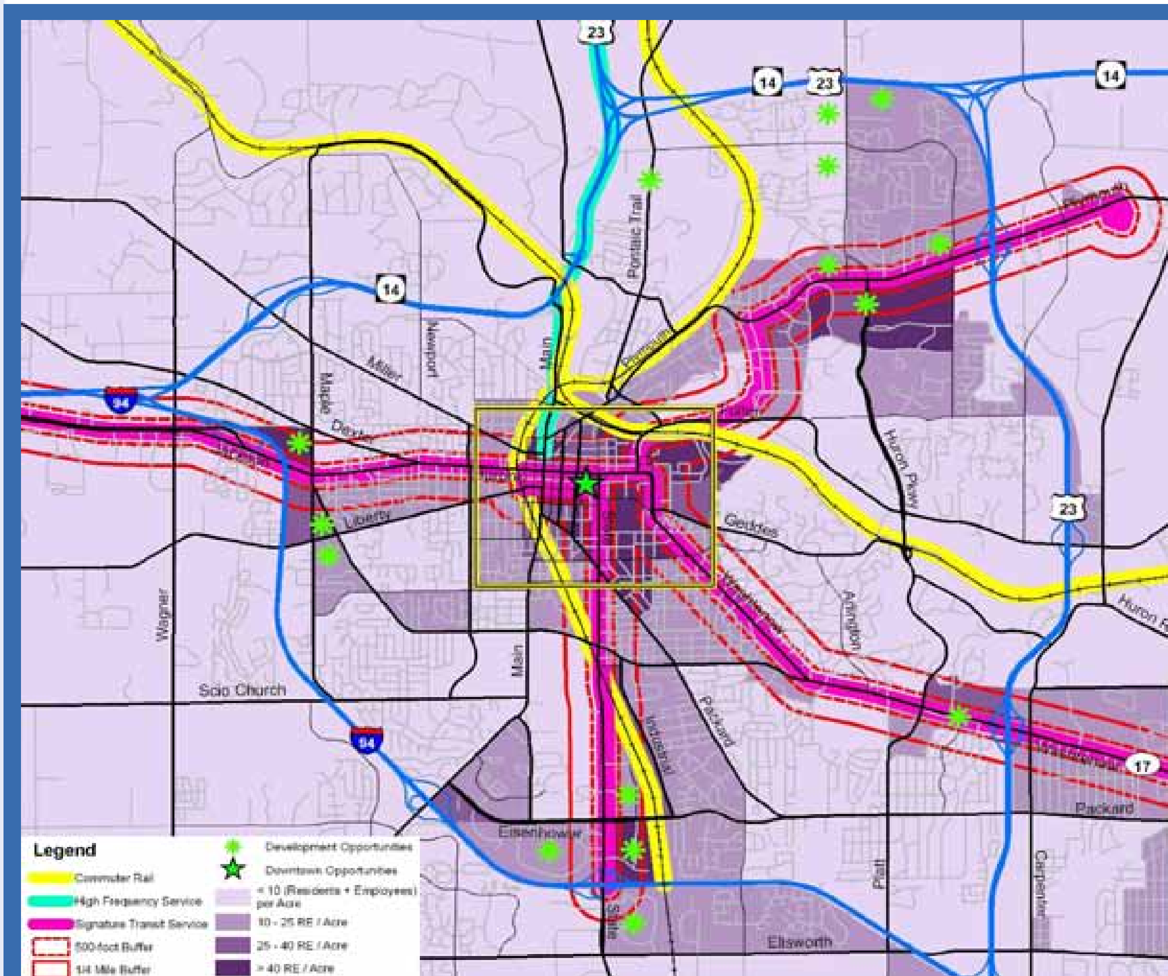


Figure 2-2: Signature Transit Corridors
Source: The CIty of Ann Arbor Transportation Master Plan, Update April 2009

The U-M North Campus Master Plan also identified a potential high capacity transit route through the North Campus, as shown in **Figure 2-3**. It was not the intent of the study to provide greater specificity of the corridor location.

Transit has been a part of Ann Arbor for more than a century, beginning with the electric streetcars which ran in Ann Arbor from 1890 to 1925. There were two streetcar lines: one carrying passengers around the downtown and U-M Central Campus area, and an "interurban" line running between Ypsilanti and Ann Arbor, as shown in **Figure 2-4**. The interurban line brought passengers to the edge of the city, where they could walk a short distance to board the local electric streetcars that would take them to destinations within the city. This desire to increase the ease and efficiency of movement throughout the Ann Arbor area is one that still endures today. It is interesting to note that the crescent shape of the current study area mimics the original transit service lines.

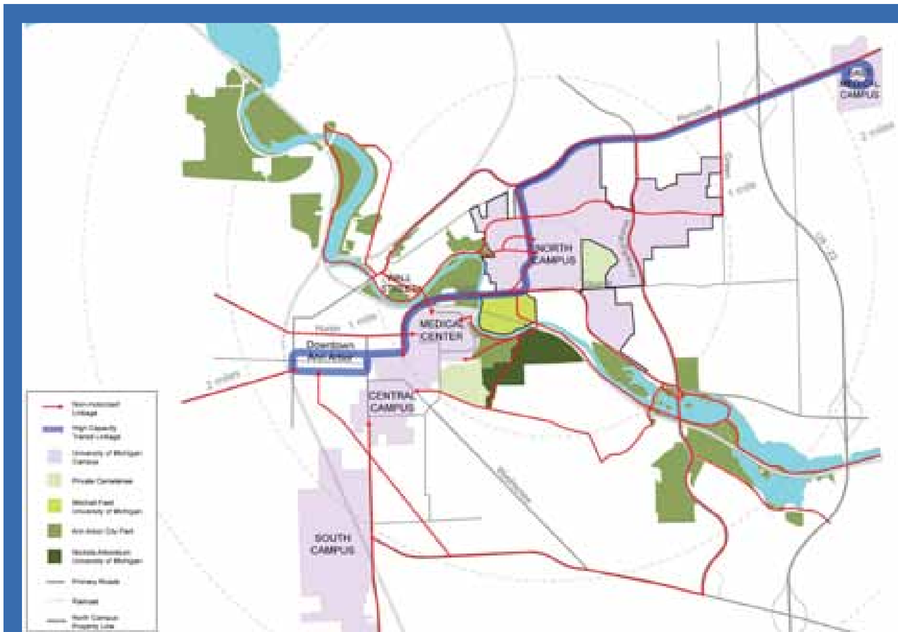


Figure 2-3: Potential High Capacity Route Included in the 2008 U-M North Campus Master Plan

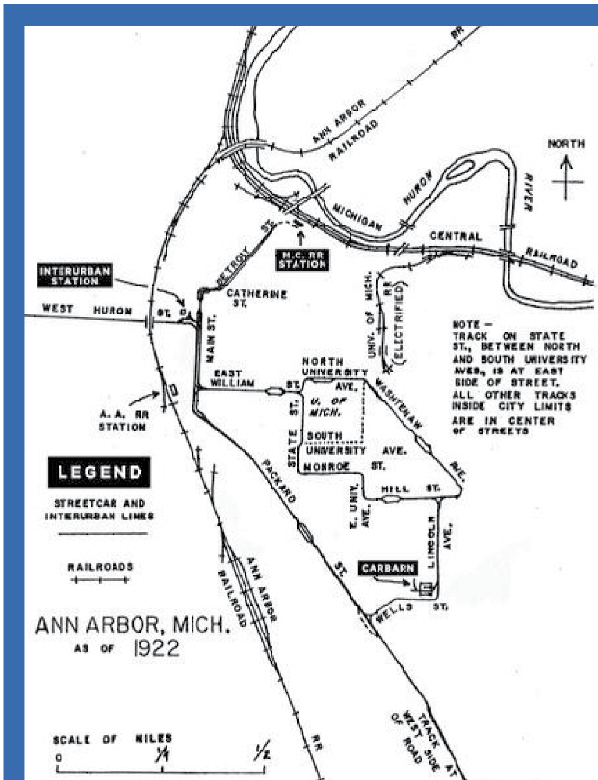


Figure 2-4: Ann Arbor Streetcar and Rail Lines, 1922
Source: Bentley Historical Library

Transportation Needs

A number of factors contribute to the need for advanced transit in the City of Ann Arbor:

- **Existing Traffic Congestion** – The TMPU identified existing traffic congestion along a number of corridors including Fuller Road and State Street.
- **Roadway Capacity Constraints** – Although the existing road experience congestion, significant roadway widening is not consistent with the goals of the TMPU.
- **Forecasted Employment Growth** - Between 2010 and 2035, the City of Ann Arbor is forecast to gain 18,800 employees (SEMCOG) - a 15.2% increase. This growth will add to the level of congestion already observed on the road system. By 2035, the Southeast Michigan Region will gain almost 191,000 employees (SEMCOG, 2010) – a 7% increase. In addition, the City of Ann Arbor will continue diversifying its workforce with 53% of the growth in higher education and healthcare. This growth has the potential to add additional congestion to the road system. Transit improvements can help to offset any impacts these actions may have on the transportation infrastructure, while encouraging more economic growth and activity in the Ann Arbor area by making it easy for people to travel throughout the City.
- **Transit System Operations** – Both AATA and U-M bus routes operate on city streets and experience the same level of delay caused by traffic congestion. As traffic congestion continues to increase, bus transit travel times can be expected to increase and reliability of service will diminish.
- **Transit Service Demand** –Between 2003 and 2008 ridership on AATA and U-M buses increased by over 38% to over 12 million passenger trips annually. Increased transit capacity will be needed to accommodate growing demand. Approximately 18% of the buses operating between the North and Central Campus are over 75% full (counting both seated and standing capacity) and, during peak periods (class changes), buses are full and people are often left waiting for the next buses to arrive at the busiest stops. A key question to be addressed in the feasibility study is whether it is possible to accommodate future transit travel using an all-bus system or whether it is reasonable to implement a higher capacity, advanced technology.
- **Transit Demand Between Activity Centers**– There is significant travel demand between U-M campuses, and between the Central Campus and Downtown Ann Arbor. The highest travel demand volume exists between the North Campus and Central Campus, representing an estimated 50,000 person trips per day.
- **Transportation System Management (TSM) and Transportation Demand Management (TDM)** – In the 1970s, the Ann Arbor Transportation Master Plan identified the need for implementation of TSM and TDM strategies, most

of which have been implemented throughout the study area. The 2009 TMPU identifies the continuing need for transportation improvements that can be implemented without expanding the existing roadway system. Recommended TSM measures include access management, queue jump lanes and traffic signal optimization. The TMPU also recommended a variety of TDM measures, including improved transit service, transit oriented development, bicycle and pedestrian improvements and park and ride expansion to accommodate future travel demand.

- **Coordination of Local Transit Service and Planned Commuter Rail Service** – Implementation of the WALLY (Washtenaw and Livingston Line) and the Ann Arbor to Detroit commuter rail lines will bring people into the City who will need local public transit service to reach their final destinations. Commuter service will focus travel demand to a few station locations and it will be critical to the success of the commuter service to have the local service capacity to accommodate the peaks. These systems are discussed in more detail later in this report.

- **Regional Accessibility** – The U-M, downtown businesses and office parks are significant contributors to the regional economy and could benefit from greater regional and local access.

- **Sustainability** – All of the project partners promote green transportation improvements. The City of Ann Arbor maintains a list of environmental indicators, many of which are transportation related. The U-M Office of Sustainability, in cooperation with the Graham Environmental Sustainability Institute, is working to advance sustainability at the University by connecting operational efforts to research and learning opportunities.

  To promote and advance sustainability, any recommended transportation improvements will be carried out in accordance with the six livability principles established by the U.S. Department of Transportation's Partnership for Sustainable Communities:

  1. Provide more transportation choices
  2. Promote equitable, affordable housing
  3. Enhance economic competitiveness
  4. Support existing communities
  5. Coordinate policies and leverage investment
  6. Value communities and neighborhoods

- **Air Quality** - In 2009, the U.S. Environmental Protection Agency announced that Southeast Michigan has been officially designated as an ozone "attainment/

maintenance" area. The region had previously been designated as "marginal nonattainment", but thanks to the implementation of the Ozone Attainment Strategy, Southeast Michigan is now in compliance. The seven-county SEMCOG region remains designated as "nonattainment" for both the annual and 24-hour PM2.5 national ambient air quality standards. Therefore, any recommended transportation improvements must not worsen air quality or delay the timely attainment of national air quality standards. As shown in **Figure 2-5**, switching from vehicle trips to transit trips has the potential to significantly reduce greenhouse gas emissions, and to improve air quality.

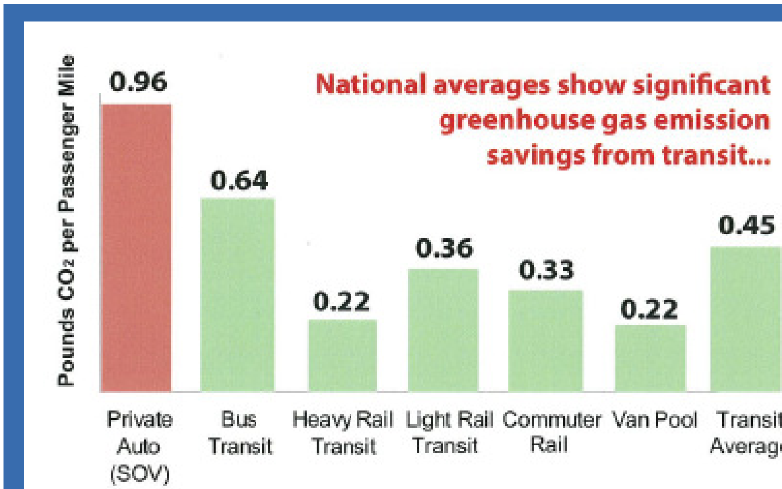


Figure 2-5: Greenhouse Gas Emission by Mode

Source: Public Transportation's Role in Responding to Climate Change, U.S. DOT, FTA, January 2010

The project partners believe that an advanced transit system could provide a number of benefits to area residents and the community as a whole. **Table 2-1** summarizes some of these possible benefits.

The study process involved five components:

- Document the existing conditions
- Establish what is needed to accommodate growth and maintain quality of life in Ann Arbor, and estimate future conditions with respect to development and travel patterns
- Identify which transit technologies and types of service will best meet Ann Arbor's needs
- Evaluate the feasibility of each transit technology
- Make recommendations for further action

Related Studies

The feasibility of improved transportation options has been the subject of a number of previous studies. The following studies were reviewed to provide background information and context for this study:

- City of Ann Arbor 2009 Transportation Plan Update
- 2035 Long Range Plan for Washtenaw County – September 2009
- Direction 2035: Regional Transportation Plan for Southeast Michigan – 2009
- Washtenaw Livingston Rail Line (WALLY) Technical Review – June 2008
- University of Michigan North Campus Master Plan Update – Summer 2008
- Ann Arbor Transit System Development Report – January 2007
- City of Ann Arbor Non-motorized Transportation Plan 2007
- Ann Arbor Downtown Development Authority Ann Arbor Downtown Parking Study (Phase I and II) – 2007
- Ann Arbor – Downtown Detroit Detailed Screening of Alternatives – July 2007
- Transit Plan for Washtenaw County – December 2007
- City of Ann Arbor Northeast Area Plan 2006
- City of Ann Arbor Parks & Recreation Open Space Plan 2006 – 2011
- Recommended Vision & Policy Framework for Downtown Ann Arbor: Downtown Development Strategies Project – February 2006
- Western Washtenaw Regional Coordination Transit Study Report – June 2006
- Non-motorized Plan for Washtenaw County – June 2006
- University of Michigan Medical Center and East Medical Campus Master Plan Update – June 2005
- 2030 Long Range Transportation Plan of Washtenaw County 2004
- The University of Michigan Campus Plan Phase I Overview – April 1998
- City of Ann Arbor Central Area Plan – December 1992
- Ann Arbor Downtown Plan – July 1988

These previous studies by the City, County, AATA, DDA, U-M and WATS have identified common themes, as shown in **Figure 2-6** that have led to this study.

Figure 2-6 Common Study Themes
Source: URS Corporation

Table 2-1: Potential Benefits of Implementing an Advanced Transit System

Type of Benefit		Personal Benefit	Community Benefit
Fuel/Oil Consumption	Full buses are six times more fuel efficient than vehicles with one occupant; the fuel efficiency of a fully occupied rail car is 15 times greater than that of the typical commuter's vehicles.[1]	Taking transit helps save you money on fuel and vehicle maintenance.	Less dependence on foreign oil keeps more money in Michigan's economy and increases national security.
Sustainable Energy	Not only are transit vehicles more fuel efficient than single occupant vehicles, they also offer the opportunity to use renewable and sustainable sources of electrical power such as biodiesel, hydro, solar or wind generated.	Greater use of sustainable energy can reduce pollution and improve water and air quality, resulting in a cleaner environment for all outdoor activities.	Greater reliance on sustainable sources of energy means fewer toxic emissions, a smaller carbon footprint and less harm to the environment. Assists the City efforts towards meeting its Green Energy Challenge of 20% community-wide renewable energy use by 2015.
Air Quality	For each mile traveled, fewer pollutants are emitted by transit vehicles than by a single-passenger automobile (Buses emit 80% less CO than a car; rail, almost none).[2] On average, light rail systems produce 62% less and bus transit produces 33% less greenhouse gas emissions per passenger mile than an average single-occupancy vehicle.[3]	Cleaner air means fewer illnesses due to allergens and asthma, resulting in reduced healthcare costs. Small changes today can spur greater changes in the future.	Fewer toxic emissions mean less harm to the environment, making Ann Arbor and the region a more desirable place to live and work.
Out of Pocket Costs	When people use transit instead of a more costly alternative (personal vehicle or taxi) they save money on transportation.[4] The cost of owning and operating a car is $5,000 to $10,000 per year depending on the type of vehicle and amount of travel.[6]	Choosing transit instead of driving means a lower share of income spent on transportation.	Increased disposable income provides families and singles the ability to spend on needs and wants other than transportation, leading to increased economic vitality.
Travel Time	Advanced transit systems can be designed to reduce travel times compared to driving alone. Modern, high capacity transit vehicles have multiple boarding doors and level boarding platforms to reduce passenger load and unload times, and provide convenient and quick wheelchair access. People using transit take cars off the road and can reduce congestion and delay.	Spending less time commuting gives you more time and freedom to do other things.	Increased use of transit reduces traffic congestion and travel delay for everyone, making it easier to travel throughout the city.
Personal Time	Users of advanced transit systems have more predictable travel time than drivers along congested roadways. They can also use the time in the transit system to text, talk, read, make friends and work while travelling.	Riding transit frees your time to take care of personal details and eliminates the stress associated with driving in rush hour traffic	Fewer people driving means less congestion and fewer crashes on the roadways. Reducing the number of drivers using handheld devices can decrease the number of crashes and amount of community resources invested in responding to crashes. Transit users are less stressed when they arrive at work, making them more productive workers.
Quality of Service	An advanced transit system can provide a quieter, smoother ride, less crowding, improved reliability and on-time performance.	A dependable and reliable advanced transit system ensures that you can get to your destination on time and enjoy a more pleasant, comfortable commute.	An attractive, comfortable and reliable advanced transit system encourages more people to use it, resulting in fewer vehicles on the road and all of the benefits associated with less driving.
Parking	Businesses in transit-intensive areas save on land required for parking and its associated costs.1 With approximately 19,000 new jobs forecast for the Ann Arbor area by 2035, an advanced transit system can help to forego the need to construct new parking facilities to accommodate these new employees.	Choosing transit instead of driving eliminates the need to hunt for parking, and saves you money by avoiding parking fees. Transit provides an alternative to a second or third family vehicle, or to bringing a vehicle to campus.	Reduced demand for parking means that land can be used for other things, such as green space or new businesses. Fewer paved surfaces can also reduces the amount of runoff causing flooding and the amount of vehicle pollutants found in rainwater runoff such as oil and gasoline, improving area water quality.

Table 2-1: Potential Benefits of Implementing an Advanced Transit System

Type of Benefit		Personal Benefit	Community Benefit
Healthier Life Style	Taking public transit is associated with walking 8.3 more minutes per day on average. Additional walking associated with public transit could save $5,500 per person in present value by reducing obesity-related medical costs.[5]	Increasing the amount of walking you do each day can improve your health and fitness and reduce your current and future healthcare costs.	Reduced healthcare costs reduce the burden on the healthcare system and on the employers and taxpayers who fund it.
Employment Benefits	Transit provides greater access to employment and expands the labor pool, enhancing employee recruitment. Transit also promotes employee reliability, decreases absenteeism and turnover and improves productivity.	Access to a reliable source of transportation can allow people to apply for jobs at companies they may not have been able to reach before.	Access to a larger pool of applicants means the best workers can be hired, leading to an increase in prosperity for Ann Arbor businesses, attracting more businesses to the area.
Transit Oriented Development/ Economic Vitality	A number of cities have experienced significant new economic development adjacent to new fixed guideway transit lines. Portland, OR experienced over $2.8 billion in new investment within three blocks of the streetcar line. It is estimated that $3.3 billion in new development has occurred adjacent to the Healthline BRT corridor in Cleveland, OH.[8] In Minneapolis, the Hiawatha LRT line is estimated to have generated $1.6 billion in building activity.	Transit that is easy to use improves business district access and attracts more businesses to the area. This provides more variety in the types of restaurants, shops and other businesses that are available, creating new jobs, a more vibrant community, and increased property values.	Community support in master plans, zoning and urban design initiatives create an environment that favor a high quality transit investment stimulates new economic development. A "cool" and fun transit system encourages system use to visit shops and restaurants generating more money for businesses. A more robust economy means greater prosperity and stability for Ann Arbor, and increased property values mean a greater tax base.
Low-cost Mobility / Access	Transit facilitates access to essential needs including jobs, school and medical services.	Particularly for those with low income, disabilities or no access to a car, transit is essential for access.	Greater access to jobs, education, healthy food, and medical care for all Ann Arbor residents means an increased overall standard of living.
Safety	The National Safety Council estimates that riding the bus is over 170 times safer than automobile travel.	Increased safety provides peace of mind, improved health due to reduced injuries, and a more relaxed stress free commute.	Increased safety results in less lost productivity, reduced costs for health care, and reduced property damage resulting from vehicular crashes.
Affordable Housing	The true cost of housing is based on both housing and transportation costs, and is considered affordable if it is 45% or less of household income. In 2008, approximately 27% of the neighborhoods in Washtenaw County spent greater than 50% of their income on housing and transportation costs combined.[7]	Improved and expanded transit extends the area of affordable housing. Spending less on transportation costs by using transit means more disposable income for housing.	More affordable housing makes Ann Arbor a more desirable place to live.
Tax Base	Maintaining a healthy economy in the region means maintaining employment. Proximity to transit stations enhances and stabilizes property values, keeping buildings fully leased.	A healthy regional economy means that you have easy access to the types of employment, education, services and businesses that you prefer.	A fully leased business district and low residential vacancy rates provides increased revenues to support Ann Arbor public services.

1. Port Authority of Allegheny County, 2010.
2. Center for Transportation Excellence
3. USDOT, Federal Transit Administration, Public Transportation's Role in Responding to Climate Change, January 2010
4. Michigan Department of Transportation, Economic and Community Benefits of Local Bus Transit Service, HDR Decision Economics, July, 2010.
5. Prev Med. 2008 Jan;46(1):14-21. Epub 2007 Oct 18. Public transit, obesity, and medical costs: assessing the magnitudes.
6. AAA (2008), Your Driving Costs 2008, American Automobile Association
7. Center for Neighborhood Technology website (http://www.cnt.org), October 2010.
8. The Plain Dealer, Cleveland, Ohio, Cleveland's Euclid Corridor Project Has Paved the Way to Economic Development, Monday, November 30, 2009.

In addition to reviewing previous studies, the study team also examined two commuter rail studies that are currently underway. These projects will provide regional rail connections between Ann Arbor and other parts of Southeast Michigan while using existing rails and tracks. The first is the Ann Arbor – Detroit Regional Rail Project, which will provide regional rail service in the Ann Arbor – Detroit corridor. The second project is the Washtenaw and Livingston Line, or WALLY, which is a proposed north-south commuter rail service between Ann Arbor and Howell. The name WALLY is short for the Washtenaw and Livingston Line. The end-points for the service (Ann Arbor and Howell) are located in Washtenaw and Livingston counties, as shown in **Figure 2-7**.

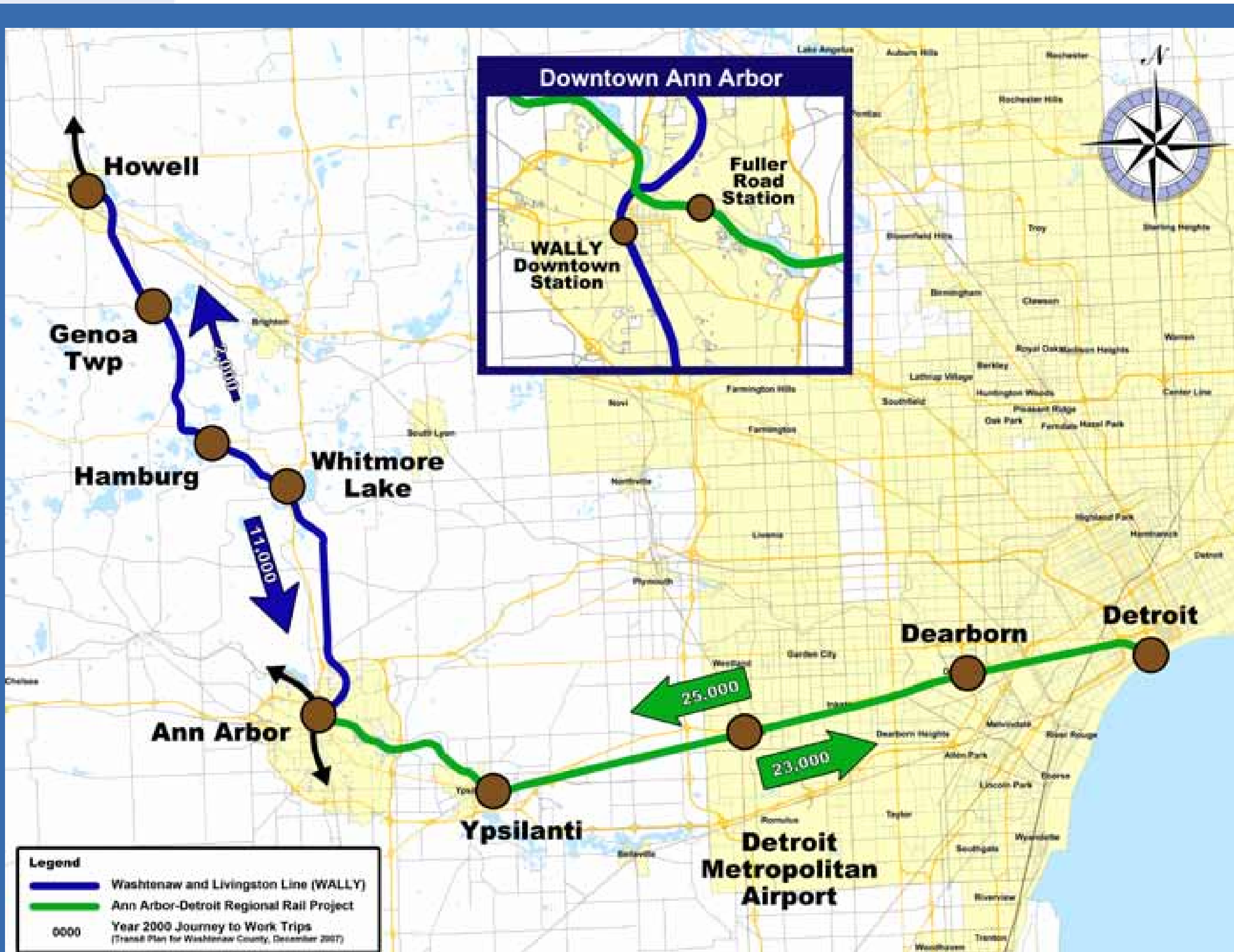


Figure 2-7: Planned Commuter Rail Service
Source: Washtenaw Livingston Rail Line (WALLY) Technical Review, June 2008, and Ann Arbor - Downtown Detroit Detailed Screening of Alternatives, July 2007

In March 2010, U-M sponsored a Transportation Technology Forum to explore and advance input to the Connector study. The panel discussion included representatives from the following companies and transit systems:

- Doppelmayer is a firm that specializes in aerial cable car systems
- Clarian Health People Mover is an automated people mover system connecting facilities at Clarian Health Systems in Indianapolis, IN
- Minneapolis Light Rail is a 11.5 mile light rail line that commenced operations in 2004
- The University of West Virginia has an automated guideway transit system that has been in service since the 1970s
- UniModal Transport Solutions Inc. is a firm developing a personal rapid transit system
- Bombardier is an international firm that manufactures a number of transit vehicles including light rail cars, streetcars, and people mover systems
- The Healthline Corridor in Cleveland is a bus rapid transit system that opened in 2008

EXISTING AND FUTURE TRANSPORTATION CONDITIONS

Existing Transit Service

Transit Centers

The AATA Blake Transit Center (BTC) is the primary transit hub serving Ann Arbor today. It is located in downtown Ann Arbor, between Fourth and Fifth Avenues, north of William Street. More than 5,000 people each weekday travel on an AATA bus to the BTC. The improved Central Campus Transit Center, located on North University between Fletcher and Church streets, opened in September 2010 and serves as a transit hub for the Ann Arbor and U-M communities.

Plans are underway for a complete reconstruction of the BTC. This project, funded by state and federal grants, involves demolition of the existing BTC and construction of a new transit center on the same site.

There are also plans to build two new transportation facilities. The first facility, known as the Fuller Road Station, is planned to be a multi-modal transportation facility which is sponsored by the City of Ann Arbor. It will include a five-level, 977-space parking structure on the south side of Fuller Road along the Chicago-Detroit high speed rail line, east of East Medical Center Drive. The site will also include a 44-space surface parking lot, 17 motorcycle parking spaces and 103 bicycle parking spaces, and five bus bays. The Fuller Road Station could also become a stop along the Ann Arbor to Detroit commuter rail line, as well as the site of a relocated Amtrak station. A second facility, an off-street transportation transfer facility on Washetnaw Avenue near US-23, is also currently in the planning stages.

In addition, there are preliminary plans underway for a WALLY Downtown Station to serve the proposed WALLY commuter rail line. One of the goals of the Ann Arbor Connector Feasibility Study is to provide convenient connections between the commuter rail stations and activity centers in the City.

AATA Bus Service

According to the National Transit Database 2008 data, AATA:

- Carries more than 22,000 passengers every weekday
- Operates 61 buses during peak periods
- Has seen a 44% increase in ridership over the past 5 years.

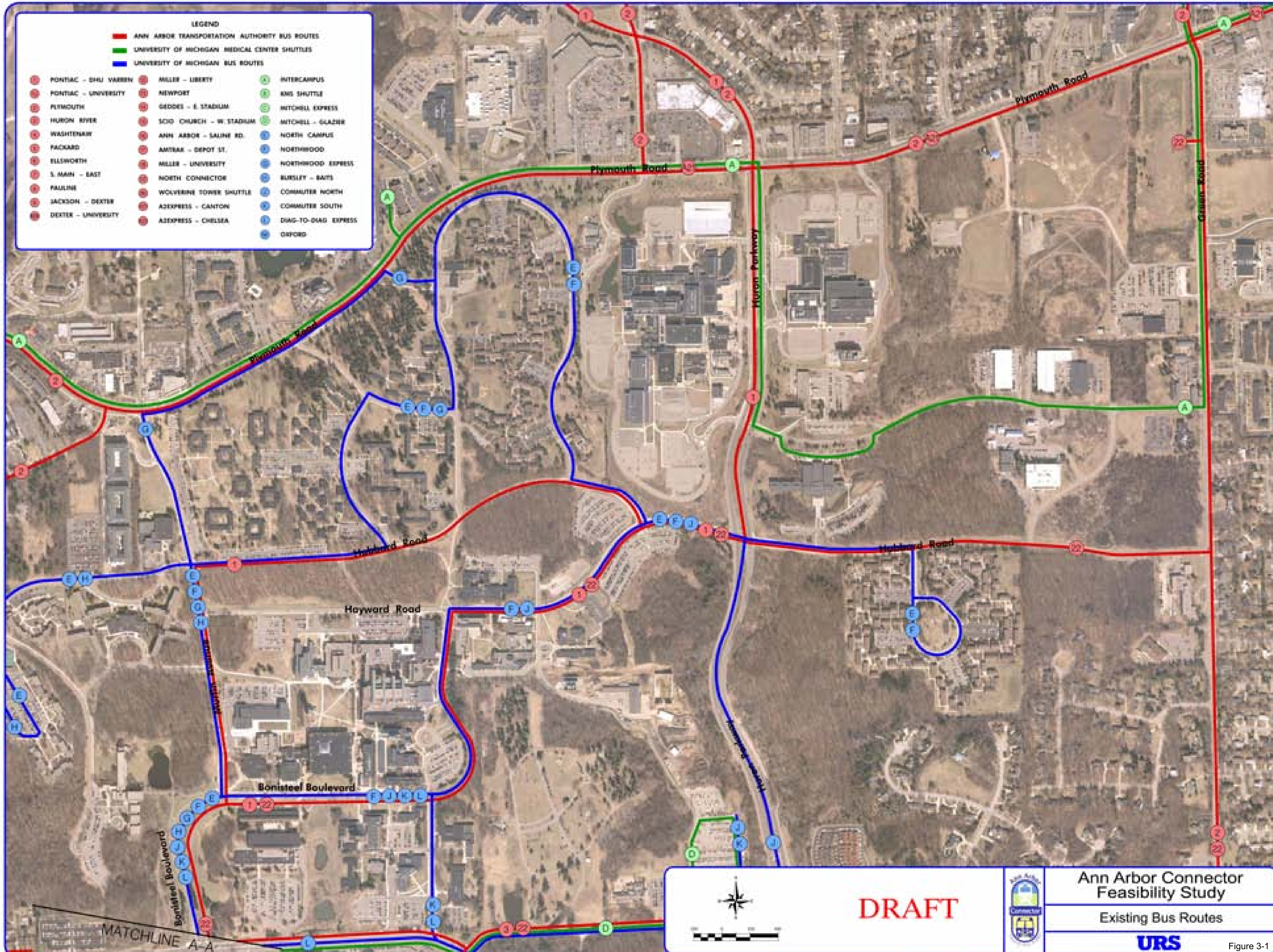
AATA currently provides service along 25 different routes. Similar to most transit systems, the majority of riders use relatively few of the routes. Half of the riders travel on one of five routes, while only 10% of customers ride on the 11 lowest volume routes. **Table 3-1** provides the AATA ridership by route.

A number of AATA, U-M and U-M Medical Center transit routes currently serve passengers throughout the study area, as shown in **Figures 3-1, 3-2, and 3-3**.

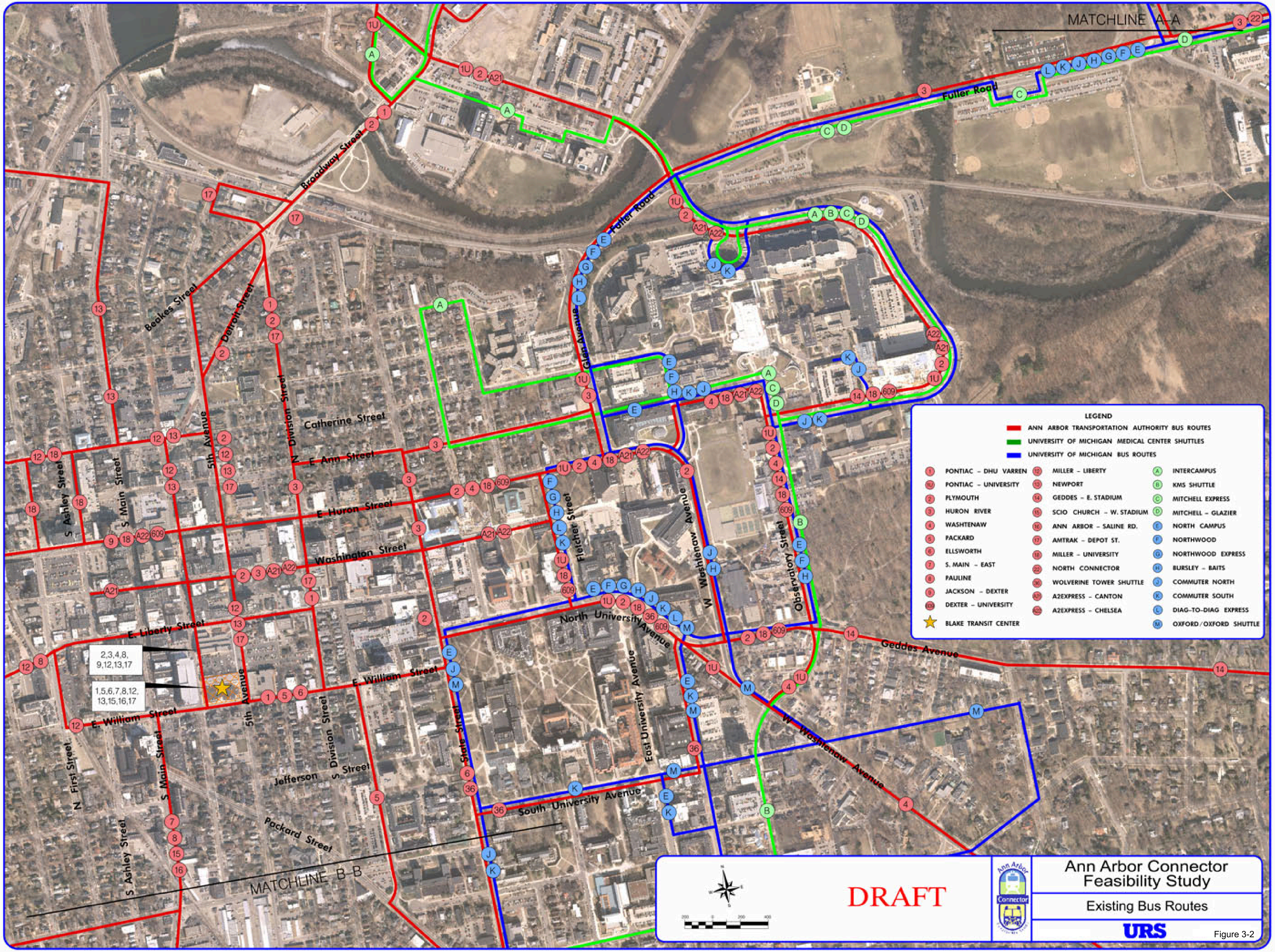
Ridership: Customer Boardings Per Time Period								
Route	Route Name	AM Peak	Midday	PM Peak	Night	Weekday Total	Saturday	Sunday
1	Pontiac-Dhu Varren	118	303	153	116	690	153	136
1U	Pontiac University	25	-	22	-	47	-	-
2	Plymouth	441	928	448	317	2,134	331	221
3	Huron River	157	494	245	52	948	-	-
4	Washtenaw	506	894	688	504	2,592	842	524
5	Packard	396	897	500	289	2,082	237	209
6	Ellsworth	364	890	532	271	2,057	996	472
7	S. Main-East	180	413	227	127	947	247	141
8	Pauline	105	259	182	117	663	164	103
9	Jackson – Dexter	93	270	160	113	636	241	135
9U	Jackson - University	70	-	74	-	144	-	-
10	Ypsilanti - Northeast	65	161	89	86	401	27	-
11	Ypsilanti - South	45	121	61	73	300	24	-
12A/B	Miller - Liberty	144	382	241	158	925	298	306
12UL	Liberty - University	25	43	21	-	89	-	-
12UM	Miller - University	45	41	66	-	152	-	-
13	Newport	40	62	54	15	171	-	-
14	Geddes -E. Stadium	93	115	141	10	359	-	
15	Scio Church -W Stadium	40	74	57	56	227	82	99
16	Ann Arbor – Saline Rd	78	197	118	79	472	220	173
20	Ypsilanti: Grove - Ecorse	73	181	92	46	392	-	-
22	North-South Connector	101	286	171	84	642	215	-
33	EMU Shuttle	30	262	104	79	476	-	-
36	Wolverine Tower Shuttle	415	835	479	182	1,911	-	-
60	LINK	130	514	252	226	1,122	-	-
	Total	3,779	8,623	5,177	3,000	20,579	4,077	2,519

Table 3-1: AATA Ridership by Route

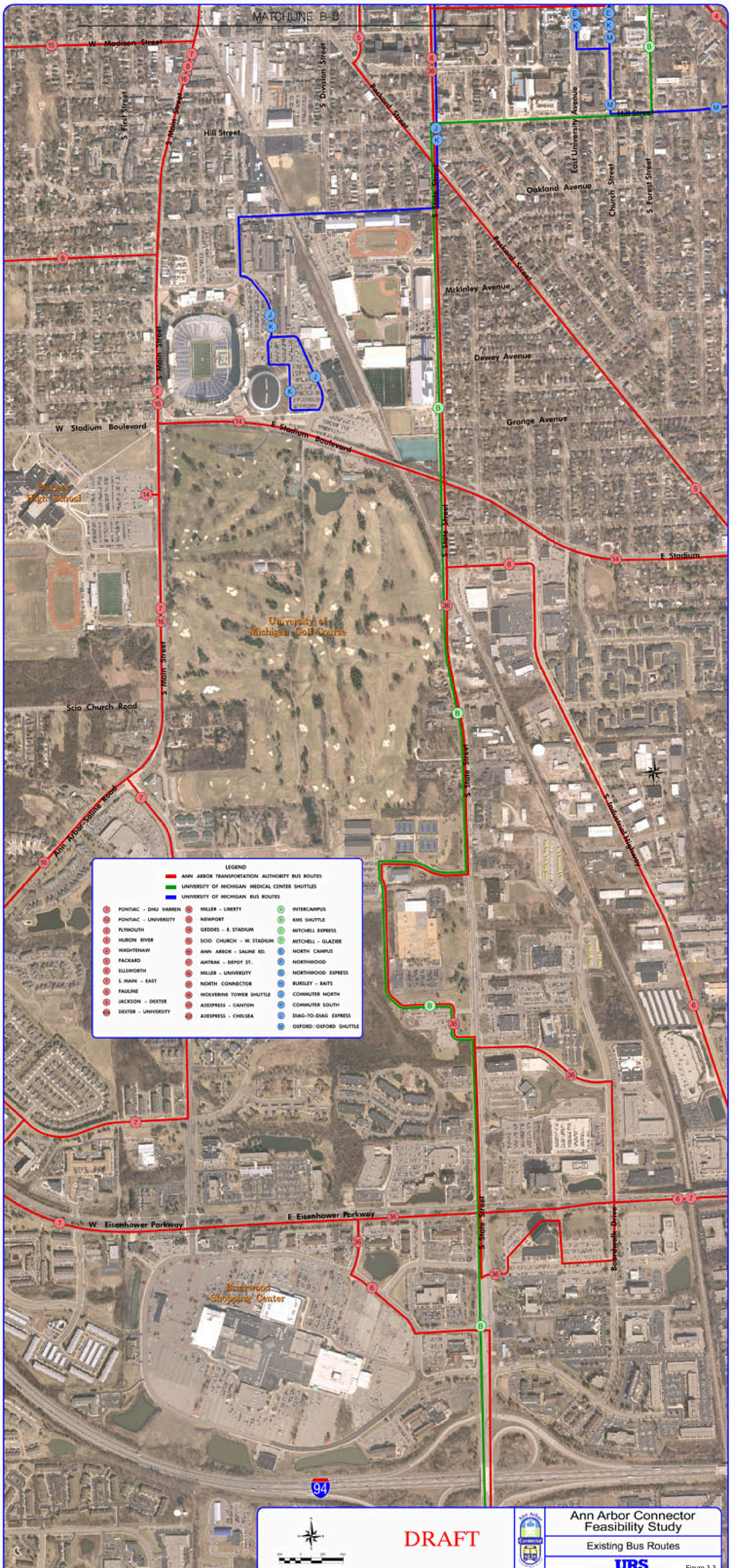
Source: Ann Arbor Transit Authority. Ann Arbor Transit System Development Report. 2007 ed. S-4.



LEGEND
ANN ARBOR TRANSPORTATION AUTHORITY BUS ROUTES
UNIVERSITY OF MICHIGAN MEDICAL CENTER SHUTTLES
UNIVERSITY OF MICHIGAN BUS ROUTES
PONTIAC - DHU VARREN
PONTIAC - UNIVERSITY
PLYMOUTH
HURON RIVER
WASHTENAW
PACKARD
ELLSWORTH
S. MAIN - EAST
PAULINE
JACKSON - DEXTER
DEXTER - UNIVERSITY
MILLER - LIBERTY
NEWPORT
GEDDES - E. STADIUM
SCIO CHURCH - W. STADIUM
ANN ARBOR - SALINE RD.
AMTRAK - DEPOT ST.
MILLER - UNIVERSITY
NORTH CONNECTOR
WOLVERINE TOWER SHUTTLE
A2EXPRESS - CANTON
A2EXPRESS - CHELSEA
INTERCAMPUS
KMS SHUTTLE
MITCHELL EXPRESS
MITCHELL - GLAZIER
NORTH CAMPUS
NORTHWOOD
NORTHWOOD EXPRESS
BURSLEY - BAITS
COMMUTER NORTH
COMMUTER SOUTH
DIAG-TO-DIAG EXPRESS
OXFORD
Plymouth Road
Huron Parkway
Green Road
Hubbard Road
Hayward Road
Bonisteel Boulevard
MATCHLINE A-A
DRAFT
Ann Arbor Connector Feasibility Study
Existing Bus Routes
URS
Figure 3-1



MATCHLINE A-A
Fuller Road
Broadway Street
Beakes Street
Detroit Street
N. Division Street
5th Avenue
S Main Street
S Ashley Street
Catherine Street
E. Ann Street
E. Huron Street
Washington Street
E. Liberty Street
E. William Street
Glen Avenue
Fletcher Street
North University Avenue
W. Washtenaw Avenue
Observatory Street
Geddes Avenue
East University Avenue
State Street
South University Avenue
Washtenaw Avenue
Jefferson Street
S Division Street
Packard Street
N. First Street
S Main Street
S Ashley Street
MATCHLINE B-B
2,3,4,8, 9,12,13,17
1,5,6,7,8,12, 13,15,16,17
LEGEND
ANN ARBOR TRANSPORTATION AUTHORITY BUS ROUTES
UNIVERSITY OF MICHIGAN MEDICAL CENTER SHUTTLES
UNIVERSITY OF MICHIGAN BUS ROUTES
PONTIAC - DHU VARREN
PONTIAC - UNIVERSITY
PLYMOUTH
HURON RIVER
WASHTENAW
PACKARD
ELLSWORTH
S. MAIN - EAST
PAULINE
JACKSON - DEXTER
DEXTER - UNIVERSITY
BLAKE TRANSIT CENTER
MILLER - LIBERTY
NEWPORT
GEDDES - E. STADIUM
SCIO CHURCH - W. STADIUM
ANN ARBOR - SALINE RD.
AMTRAK - DEPOT ST.
MILLER - UNIVERSITY
NORTH CONNECTOR
WOLVERINE TOWER SHUTTLE
A2EXPRESS - CANTON
A2EXPRESS - CHELSEA
INTERCAMPUS
KMS SHUTTLE
MITCHELL EXPRESS
MITCHELL - GLAZIER
NORTH CAMPUS
NORTHWOOD
NORTHWOOD EXPRESS
BURSLEY - BAITS
COMMUTER NORTH
COMMUTER SOUTH
DIAG-TO-DIAG EXPRESS
OXFORD / OXFORD SHUTTLE
DRAFT
Ann Arbor Connector Feasibility Study
Existing Bus Routes
URS
Figure 3-2


MATCHLINE B-B
W Madison Street
S First Street
S Main Street
Hill Street
S Division Street
Packard Street
East University Avenue
Church Street
S Forest Street
Oakland Avenue
S State Street
Mckinley Avenue
Dewey Avenue
Grange Avenue
W Stadium Boulevard
E Stadium Boulevard
E Stadium
Pioneer High School
University of Michigan Golf Course
Scio Church Road
Ann Arbor-Saline Road
S Industrial Highway
W Eisenhower Parkway
E Eisenhower Parkway
Boardwalk Drive
Briarwood Shopping Center
94
LEGEND
ANN ARBOR TRANSPORTATION AUTHORITY BUS ROUTES
UNIVERSITY OF MICHIGAN MEDICAL CENTER SHUTTLES
UNIVERSITY OF MICHIGAN BUS ROUTES
PONTIAC – DHU VARREN
PONTIAC – UNIVERSITY
PLYMOUTH
HURON RIVER
WASHTENAW
PACKARD
ELLSWORTH
S. MAIN – EAST
PAULINE
JACKSON – DEXTER
DEXTER – UNIVERSITY
MILLER – LIBERTY
NEWPORT
GEDDES – E. STADIUM
SCIO CHURCH – W. STADIUM
ANN ARBOR – SALINE RD.
AMTRAK – DEPOT ST.
MILLER – UNIVERSITY
NORTH CONNECTOR
WOLVERINE TOWER SHUTTLE
A2EXPRESS – CANTON
A2EXPRESS – CHELSEA
INTERCAMPUS
KMS SHUTTLE
MITCHELL EXPRESS
MITCHELL – GLAZIER
NORTH CAMPUS
NORTHWOOD
NORTHWOOD EXPRESS
BURSLEY – BAITS
COMMUTER NORTH
COMMUTER SOUTH
DIAG-TO-DIAG EXPRESS
OXFORD / OXFORD SHUTTLE
DRAFT
Ann Arbor Connector Feasibility Study
Existing Bus Routes
URS
Figure 3-3

U-M Bus Service

According to the National Transit Database 2008 data, U-M Parking and Transportation Services:

- Carries more than 22,000 passengers every weekday
- Operates 34 buses during peak periods
- Has seen a 31% increase in ridership over the last 5 years

The U-M provides bus service throughout the five campuses (Central, North, South, East Medical Campus, and Medical Center Campus). The highest transit activity occurs by a wide margin between the Central Campus and North Campus, which are the primary academic / research and residential campuses. A large number of students, faculty, and staff travel between the academic campuses on a regular basis to attend class or for other purposes.

URS collected transit data between the Central Campus Transit Center (CCTC, formerly known as CC Little) and Pierpont Commons on the North Campus. The data collection was intended to help validate the transit assumptions made as part of the travel demand forecast modeling task. Due to the particularly high level of transit activity and the unique ridership characteristics associated with intra-campus travel this additional validation of the regional model adds to the credibility of the overall modeling process and results. Detailed information resulting from this data collection effort is located in **Appendix A**.

There are other options for transportation between the North and Central Campus which were not quantified as part of the data collection effort. The cumulative number of users by these options is expected to be much lower than the U-M bus users for the reasons noted below. Other options include:

- Vehicle - parking availability on the Central Campus and North Campus is limited and requires a permit or parking meter payment.
- AATA Route 2 - service is not geared to U-M student transportation, and few students are expected to use this option.
- Bicycle - Glen Avenue has narrow lanes and high volumes of bus traffic, and the sidewalks are narrow.
- Walk - the distance between campuses is nearly two miles, so pedestrian trips are likely to be minimal.

Class Schedule

The standard, 50-minute class periods are staggered by 30 minutes between the campuses to accommodate student travel between campuses. The typical class schedule on the Central Campus starts at 10 minutes past the hour and concludes on the hour, while the typical class schedule on the North Campus starts at 40 minutes past the hour and concludes on the half-hour. The goal of the U-M transit system is to accommodate the transportation needs of students departing a class on one campus and attending a class on the other campus within the 30-minute window.

Bus Routes

As shown in **Figures 3-1, 3-2, and 3-3**, there are five bus routes that connect the primary transit centers on each campus: the CCTC on Central Campus, and Pierpont Commons on North Campus. Two routes are express routes which minimize the route length and travel time between the campuses. The other three routes serve the Central Campus residential halls and the Medical Center Campus located between the transit centers, which require slightly longer routes and travel times. On the five bus routes, there are 8 or 9 signals along each route, and the average number of mid-route bus stops is four in each direction.

Data Collection

URS collected data associated with the five bus routes to capture the transit characteristics between the CCTC and Pierpont Commons. The data collection took place during typical fall season conditions on dry days. Data collection occurred on Tuesday through Thursday, September 21-23, 2010 while the U-M was in session, and included the following tasks:

- Bus occupancy estimates as buses arrived and departed the CCTC and Pierpont Commons. These estimates incorporate approximately 560 observations conducted between 7 AM and 6 PM.
- Bus travel time measurements between the CCTC and the Pierpont Transit Center, including the delay associated with traffic signals and the dwell time associated with mid-route bus stops. The bus travel time estimates are based on 30 bus trips conducted between 8 AM and 5 PM.
- Bus board and deboard activity at mid-route bus stops. The estimates based on boarding and deboarding activity are based on 30 bus trips conducted between 8 AM and 5 PM.
- Bus dwell time measurements that included boarding, deboarding, and bus dwell time at the CCTC and Pierpont Commons. The estimates are based on approximately 280 measurements conducted between 9 AM and 4 PM.

System Capacity

Using the data collected in the field and U-M bus schedule information, the distribution of buses was estimated by each hour over the entire day. There was an average of 60 bus trips between the campuses each hour between 8 AM and 5 PM, and the total number of bus trips (both directions) on a weekday was 872. The U-M uses a mix of buses that either seat 35 passengers with standing room for an additional 45 passengers, or seat 45 passengers with standing room for an additional 35 passengers.

Bus Occupancy

The overall average occupancy of the buses throughout the day was 35 riders. The percentage of buses arriving or departing the CCTC that exceeded 60 riders was 14%, and the percentage of buses arriving or departing Pierpont Commons that exceeded 60 riders was 23%. The bus loading time necessary for the bus to exceed 60 riders became much more significant as the bus occupancy approached the bus "crush" capacity (80 riders).

Bus Travel Times

The average bus travel time in one direction was measured to be 9.7 minutes, with a range of 7 to 13 minutes. On average, 63% of the travel time represented a moving bus, 28% was traffic signal delay, and 9% was bus dwell time at mid-route bus stops. The bus dwell times at CCTC and Pierpont Commons were not included in the travel time measurements.

Transit Ridership

The total number of daily riders who used the U-M bus routes between CCTC and Pierpont Commons was estimated to be 30,700. The number of riders that remained on the bus for entire route between CCTC and Pierpont Commons was estimated to be 12,200, or 40% of the total number of riders. The remaining riders boarded or deboarded at the mid-route bus stops associated with the Medical Center Campus, dormitories, and academic buildings.

Bus Dwell Times

The CCTC has staging space for buses to dwell for a period of time before they are filled or have met their scheduled departure time, and so a number of buses are typically waiting at the transit center prior to the conclusion of the hourly class period. As a result, the average bus dwell time at the CCTC was found to be 77 seconds. The buses at Pierpont Commons typically do not wait for more passengers to fill the bus, but rather leave after the immediate demand for boarding is complete. As a result, the average bus dwell time at Pierpont Commons was found to be 31 seconds.

Peak Ridership Conditions

As a result of the hourly class changes and the interaction between the two campuses, there are transit ridership surges within each hour. The peak 15-minute surges are most prevalent at the CCTC between the hour and 15 minutes past the hour, and at Pierpont Commons between the half-hour and 45 minutes past the hour. Over the day, the most significant transit ridership peaks occurred in the morning at 10 AM and in the afternoon at 4 PM, with a peak 15-minute demand of approximately 800 passengers. The transit ridership during the peak 15 minutes creates an hourly ridership rate that exceeds the average hourly ridership rate by approximately 65%. The U-M provides additional buses to adequately service the ridership surges. When the buses fill during the surge periods, students will often need to wait for the next bus, which usually arrives within a short period of time.

Traffic and Transit Ridership Volume Comparison

The five bus routes all use Fuller Road between East Medical Center Drive and Bonisteel Boulevard. The average daily traffic (ADT) volumes on Fuller Road between East Medical Center Drive and Bonisteel Boulevard is 24,700 vehicles, based on traffic data collected in September 2009. The estimated bus ridership on the same section of Fuller Road is 30,500, which indicates that the number of vehicle passengers and the number of transit rides are comparable. A similar relationship exists between the number of vehicle passengers and transit rides on Glen Avenue.

Socioeconomics

An important factor in deciding whether an enhanced transit service investment is warranted is the extent the alternate service will benefit the Ann Arbor area. Key benefit measures include the number of people expected to use the new service, the travel time savings, and the ease or comfort of the trip relative to the current AATA and U-M bus services. The potential for a transit service/technology change to provide a benefit when measured using any of the listed criteria, is highly dependent on the location, density and intensity of residential, commercial, educational and industrial activity center relative to the improvement corridor. A corridor improvement that complements travel desire lines established by development patterns and mixes has the potential to yield substantial benefit. On the other hand, there is little or no potential for benefit to be derived by implementing the same technology or service concept in a corridor where it does not complement the development patterns.

The diversity and breadth in development types within the Connector study area and in areas within the region that feed travel activity into the corridor influence the transit alternatives analysis in a number of ways, including:

- The U-M is a large and diverse activity center that generates over 700,000 person trip ends per day across auto, pedestrian, bicycle and transit modes (Source: WATS travel model).
- Multiple U-M campuses that are integrated in educational, research, residential, patient care and athletic activities create very high levels of travel between them.
- Developing perimeter park-and-ride lots served by both AATA and U-M routes and replacing more central surface parking creates opportunities for higher capacity transit modes
- The U-M Medical Campus draws a large number of trips from an extensive portion of the region for a broad array of purposes including patient trips, visitor trips, research activities, staff and physician work trips and education trips.

Each of these influencing factors has been characterized through assessment of current and future (2035) socioeconomic data.

Current (2010) Socioeconomic Data

Ann Arbor is in a somewhat unique situation relative to most other metropolitan areas in the state in that it is covered by two overlapping planning organizations. The Southeast Michigan Council of Governments (SEMCOG) is the Metropolitan Planning Organization and is responsible for transportation planning in the seven county area that covers Livingston County, Macomb County, Monroe County, Oakland County, St. Clair County, Washtenaw County, and Wayne County. The Washtenaw Area Transportation Study (WATS) also has responsibility for administering the transportation planning efforts for Washtenaw County. Both organizations have collaborated on collecting and analyzing socioeconomic data for the region, including:

- Population
- Households by income and size
- Employment divided in a range of classifications
- Students enrolled at U-M

Within the region, socioeconomic data is aggregated from individual parcels to traffic analysis zones (TAZs) that represent aggregated census blocks. This information is used as input variables to the travel model for generating and distributing travel within the region. SEMCOG has primary responsibility, with input from WATS and individual jurisdictions, for developing the regional database of socioeconomic data. **Table 3-2** documents the current (2010) socioeconomic data for the Connector study area, Ann Arbor, Washtenaw County and the SEMCOG region.

	2010		2035		'10 to '35 Change Absolute		'10 to '35 Change Percentage	
Area Description	Households	Employment	Households	Employment	Households	Employment	Households	Employment
Connector Study Area	23,800	See Note 1	25,000	See Note 1	1,200	12,600	5.0%	
Ann Arbor	48,200	See Note 1	49,800	See Note 1	1,600	14,300	3.3%	
Washtenaw County	140,300	243,600	157,300	285,900	17,000	42,300	12.1%	17.4%
SEMCOG Region	1,930,000	2,586,700	2,100,000	2,777,300	170,000	190,600	8.8%	7.4%

Table 3-2: Regional Socioeconomic Statistics (2010 and 2035)

Notes: 1 - Employment data for selected TAZs is not distributed by SEMCOG to maintain confidentiality of specific employer data. Only increment is available for distribution.

Connector Study area employment growth represents 38% of the county increment of growth and Ann Arbor growth represents 43% of county.

Source: SEMCOG

Important to the Connector study assessment is documentation at the TAZ level of the distribution of data in each of the variable categories. **Figures 3-4 and 3-5** display the current estimates of households and employment by TAZ, which are two of the most critical measures of regional development. Note that in selected TAZs the employment data has been suppressed to retain confidentiality of information for individual employers that may represent the vast majority of the employment in a specific TAZ.

2035 Socioeconomic Data

The change in the number of trips in the study area between the 2010 base year and the 2035 horizon year is highly influenced by the level of development anticipated to occur immediately within and immediately adjacent to the corridor and in areas in the region that feed the corridor. SEMCOG is responsible for developing the county control totals and TAZ forecasts of 2035 population, households, and employment by sector and for providing the framework for distribution within the region. This information is updated every four to five years to reflect current trends and census data. This information is used by WATS as a key input into the county-based travel model to determine the change in the number of trips and the trip distribution, which is the source for the forecasted travel demand information the Connector study. **Figures 3-6 through 3-7** display the forecasted level of household and employment activity in each of the TAZs within and adjacent to the study area.

Figures 3-8 and 3-9 display by TAZ the locations in the region where households and employment are anticipated to change in the period between 2010 and 2035.

<u>Existing and Future Travel</u>

Overview

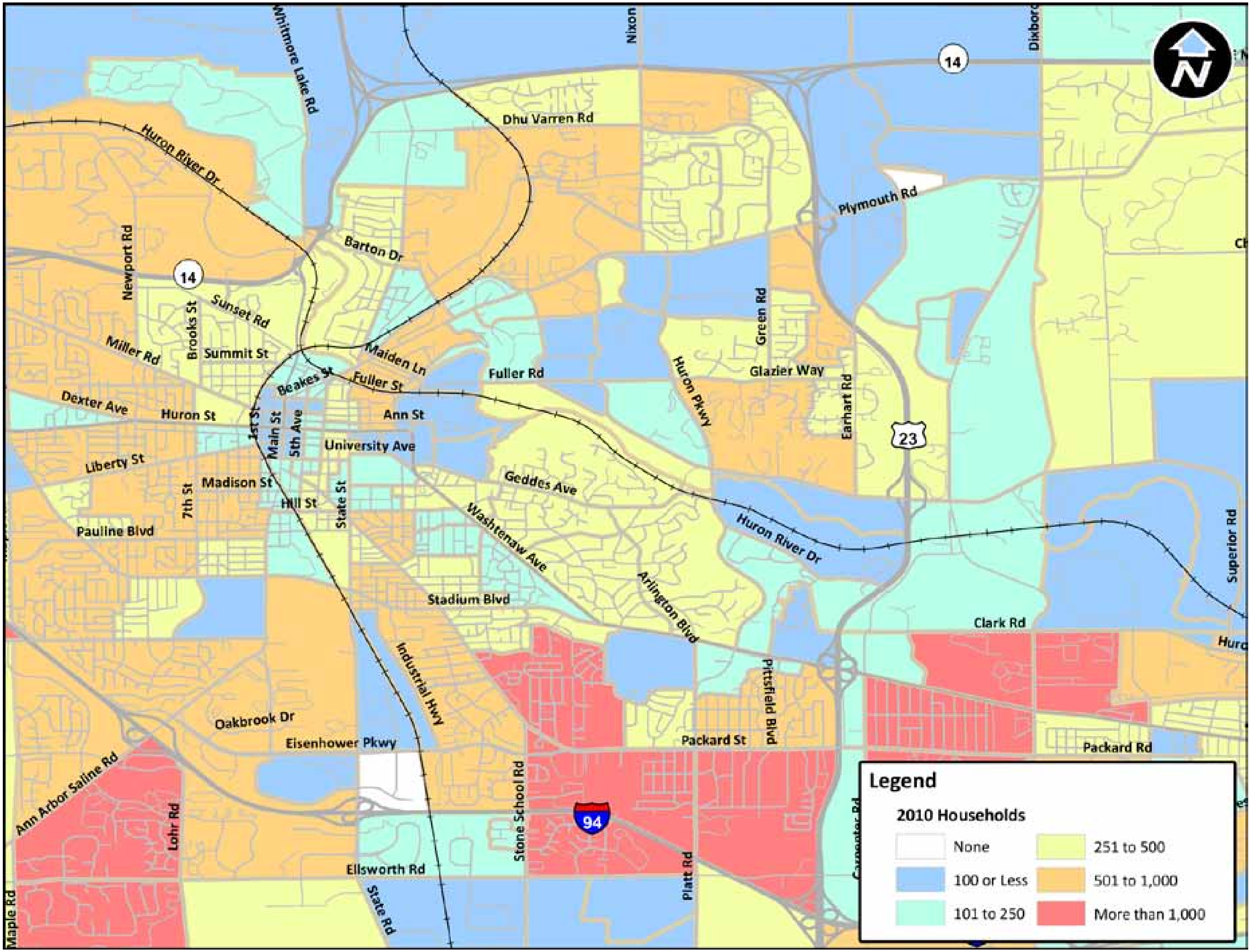
The objectives of the Connector study forecasting effort were to:

1) Identify a baseline level of trip making within the study area to establish the market.

2) Develop estimates of the ridership associated with each of the advanced transit technologies in the study corridor.

The forecasting approach first reviewed the patterns of travel within the study area. With this information, the extent to which various alternatives would address the study objectives could be estimated. The forecasting effort was a tool used to identify opportunities for improved transit connectivity/travel efficiency, to evaluate the travel demand for potential connections, and finally to appropriately match transit technologies with the travel demand in the corridor.

The WATS travel demand model was the primary tool used to evaluate the study area travel demand. The model uses residential, commercial and industrial development data, student activity, transit operations and the network of roads and streets that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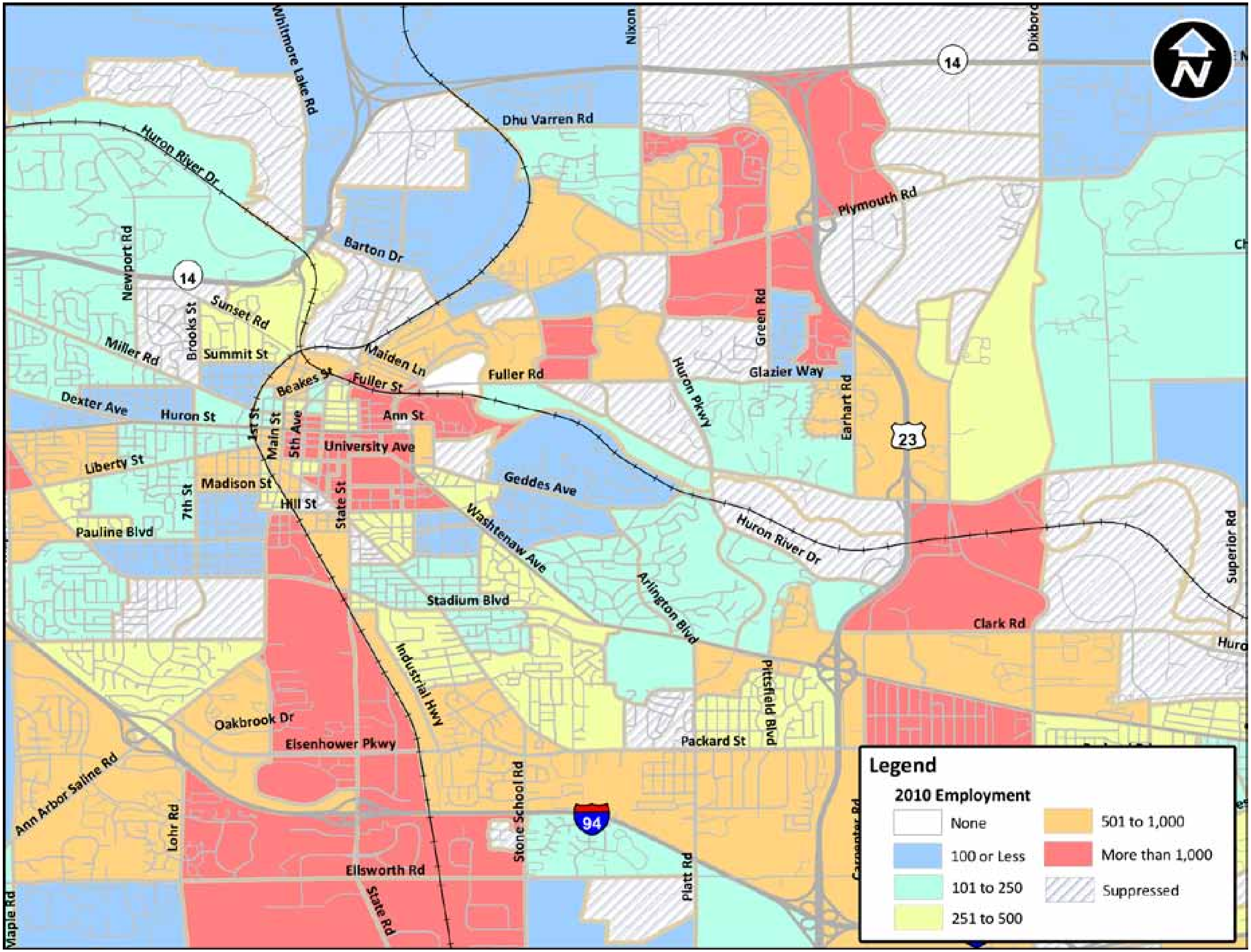
2010 Households
None
100 or Less
101 to 250
251 to 500
501 to 1,000
More than 1,000
Huron River Dr
Whitmore Lake Rd
Nixon
Dixboro
Dhu Varren Rd
Plymouth Rd
Barton Dr
Newport Rd
Sunset Rd
Miller Rd
Brooks St
Summit St
Maiden Ln
Fuller Rd
Fuller St
Beakes St
Green Rd
Glazier Way
Huron Pkwy
Earhart Rd
Dexter Ave
Huron St
Ann St
1st St
Main St
5th Ave
University Ave
Liberty St
Madison St
7th St
Hill St
State St
Geddes Ave
Washtenaw Ave
Pauline Blvd
Arlington Blvd
Stadium Blvd
Superior Rd
Clark Rd
Industrial Hwy
Pittsfield Blvd
Oakbrook Dr
Eisenhower Pkwy
Packard St
Packard Rd
Ann Arbor Saline Rd
Lohr Rd
Stone School Rd
Platt Rd
Ellsworth Rd
State Rd
Maple Rd
14
23
94

Source: WATS



Legend
2010 Employment
None
100 or Less
101 to 250
251 to 500
501 to 1,000
More than 1,000
Suppressed
Whitmore Lake Rd
Nixon
Dixboro
Dhu Varren Rd
Huron River Dr
Barton Dr
Plymouth Rd
Newport Rd
Sunset Rd
Miller Rd
Brooks St
Summit St
Maiden Ln
Fuller Rd
Green Rd
Glazier Way
Huron Pkwy
Earhart Rd
Beakes St
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Ann St
1st St
Main St
5th Ave
University Ave
Liberty St
Madison St
7th St
Hill St
State St
Geddes Ave
Washtenaw Ave
Pauline Blvd
Arlington Blvd
Stadium Blvd
Clark Rd
Superior Rd
Industrial Hwy
Pittsfield Blvd
Oakbrook Dr
Eisenhower Pkwy
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Ann Arbor Saline Rd
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Stone School Rd
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Platt Rd
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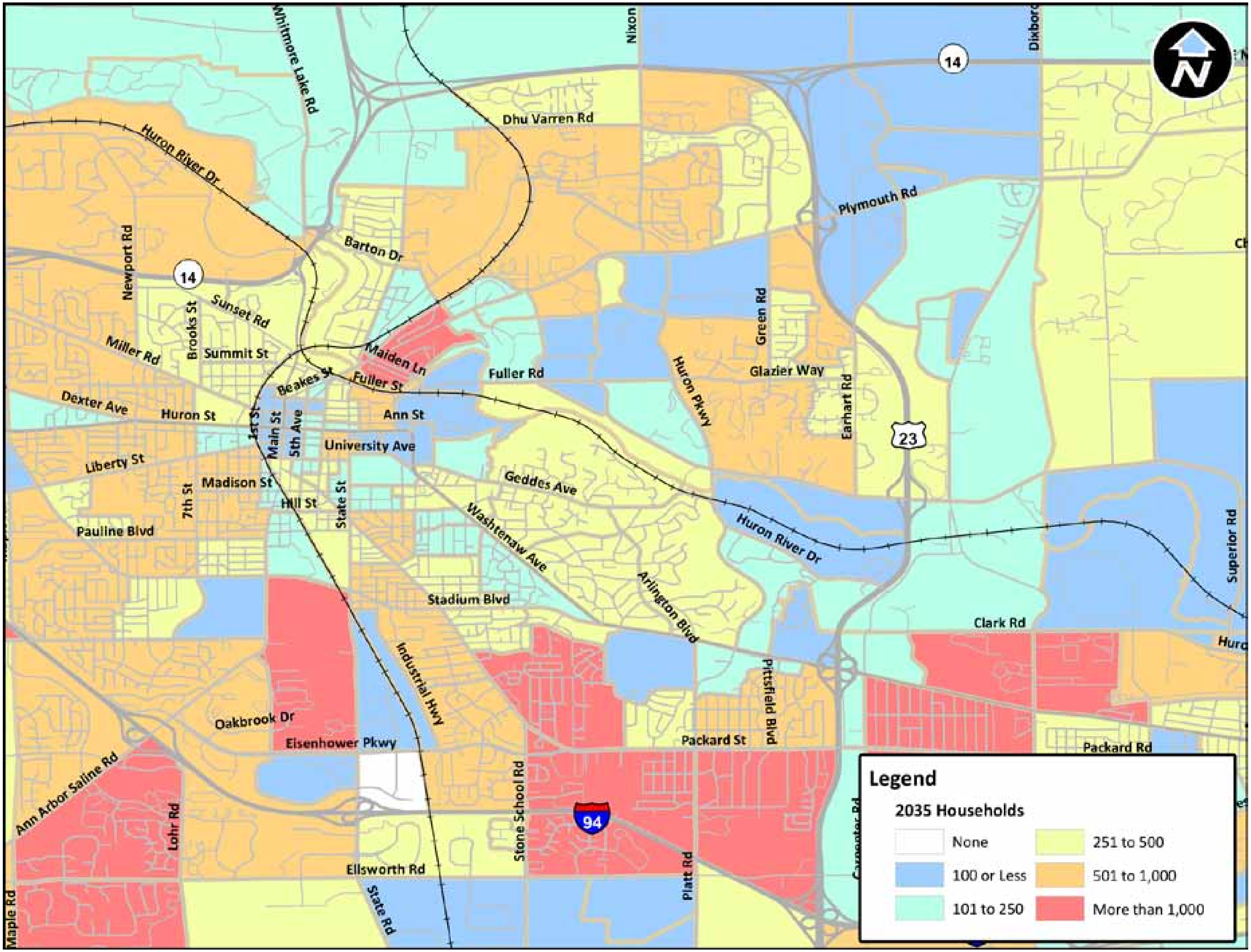
Source: WATS


Legend
2035 Households
None
100 or Less
101 to 250
251 to 500
501 to 1,000
More than 1,000
N
14
23
94
Whitmore Lake Rd
Nixon
Dixboro
Dhu Varren Rd
Huron River Dr
Plymouth Rd
Barton Dr
Newport Rd
Sunset Rd
Brooks St
Summit St
Miller Rd
Green Rd
Maiden Ln
Fuller Rd
Fuller St
Beakes St
Glazier Way
Huron Pkwy
Earhart Rd
Dexter Ave
Huron St
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5th Ave
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Madison St
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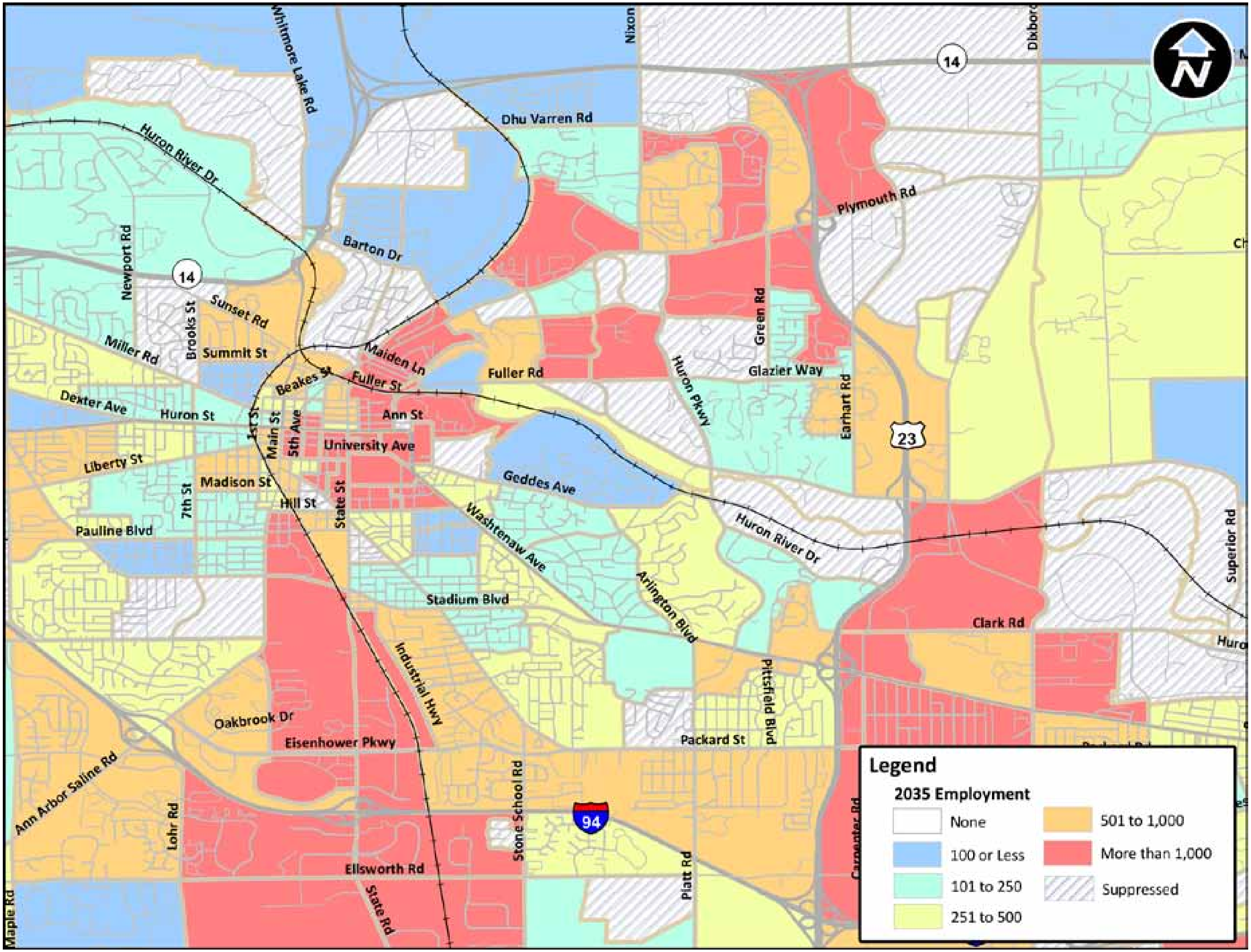
Source: WATS


Legend
2035 Employment
None
100 or Less
101 to 250
251 to 500
501 to 1,000
More than 1,000
Suppressed
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Plymouth Rd
Barton Dr
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Earhart Rd
Huron Pkwy
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Carpenter Rd
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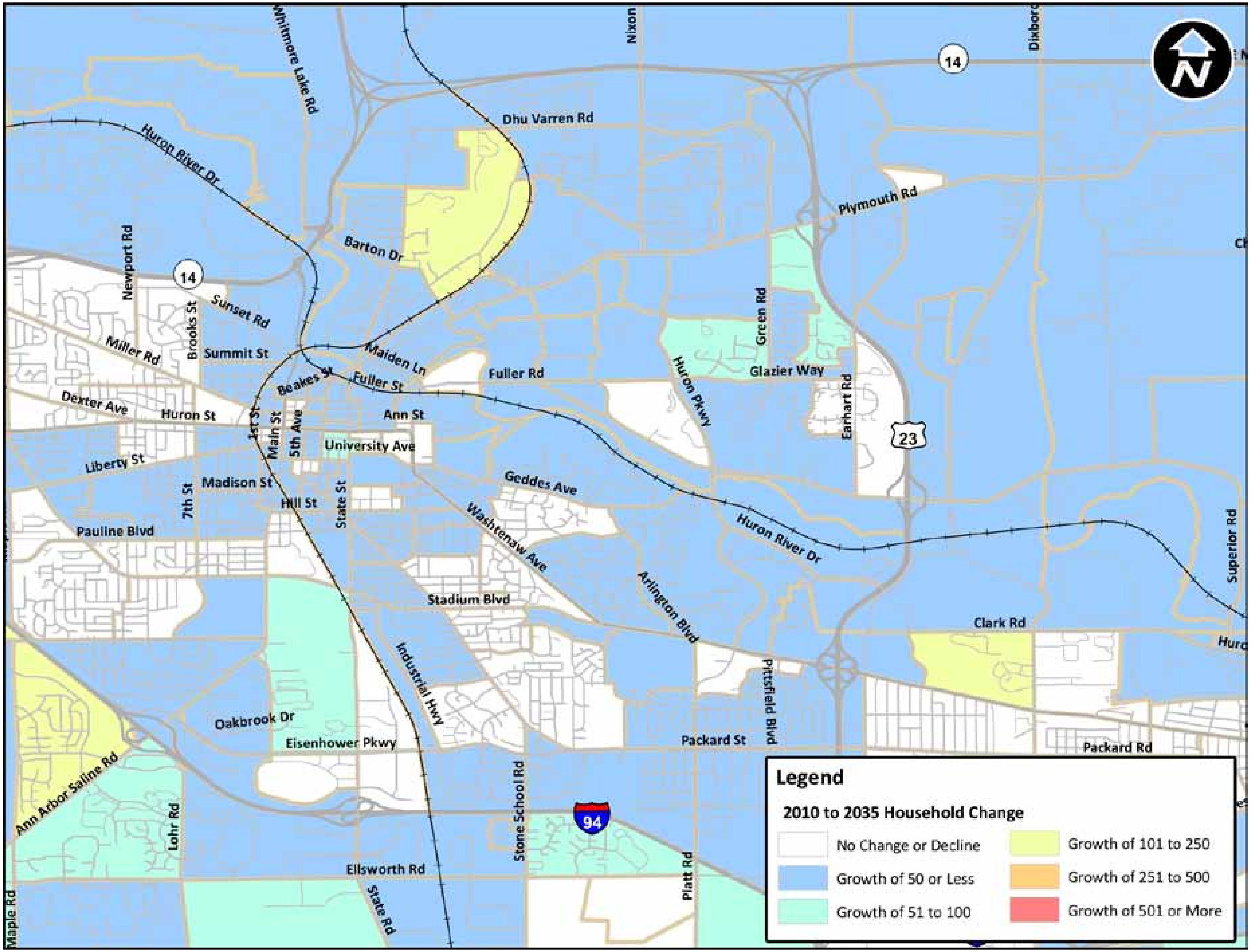
Source: WATS


Dhu Varren Rd
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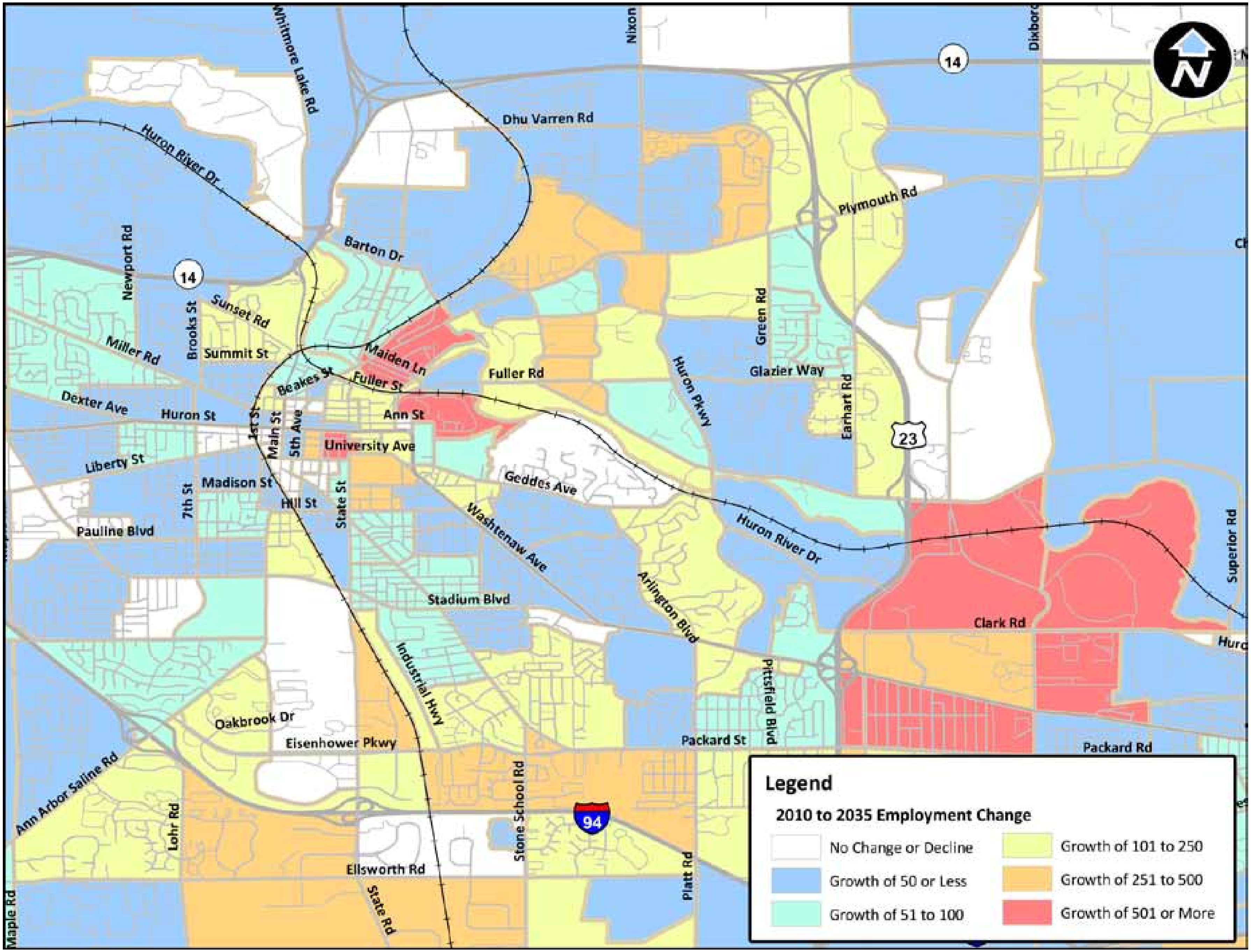
Packard Rd
Ann Arbor Saline Rd
Lohr Rd
Stone School Rd
94
Ellsworth Rd
State Rd
Platt Rd
Maple Rd
Legend
2010 to 2035 Household Change
No Change or Decline
Growth of 50 or Less
Growth of 51 to 100
Growth of 101 to 250
Growth of 251 to 500
Growth of 501 or More

Source: WATS



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Stadium Blvd
Arlington Blvd
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Eisenhower Pkwy
Packard St
Packard Rd
Ann Arbor Saline Rd
Lohr Rd
Stone School Rd
94
Ellsworth Rd
State Rd
Platt Rd
Maple Rd
Legend
2010 to 2035 Employment Change
No Change or Decline
Growth of 50 or Less
Growth of 51 to 100
Growth of 101 to 250
Growth of 251 to 500
Growth of 501 or More

Source: WATS

connect the area to estimate the amount of travel that occurs between activity centers.

The WATS Travel Demand Model is a standard tool used for travel demand forecasting. It employs an accepted and proven methodology that is used in cities throughout the country but incorporates the unique street network, transit system, and socioeconomic characteristics of the Ann Arbor region.

The WATS modeling process follows the traditional four-step process shown in **Figure 3-10**.

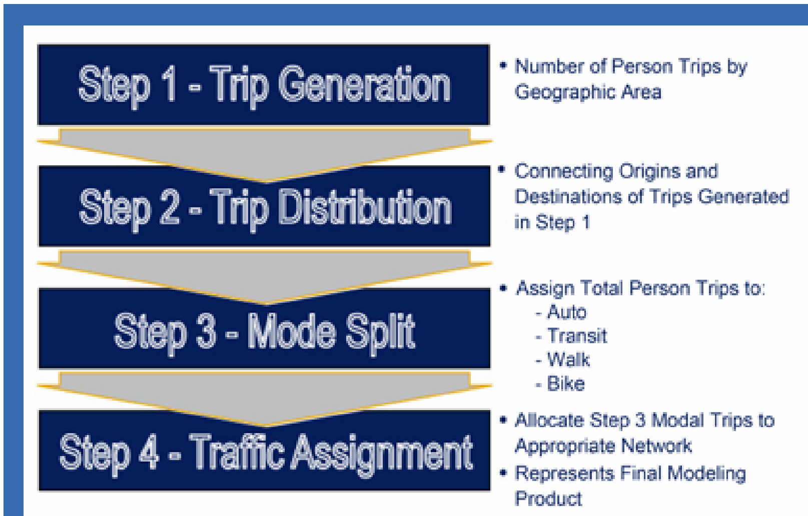

Figure 3-10: WATS Modeling Process
Source: WATS

The county-wide model divides the region into 427 smaller geographic areas (traffic analysis zones – TAZ) which are the basis for trip origins and destinations. While the study area covers a small geographic portion of the entire county, it does constitute a sizable portion of the trip making activity in the county and the model reflects that fact as the study area constitutes approximately 80 of the County's TAZs.

Aggregation of TAZs to Activity Areas

The study area comprising over 50 percent of the city of Ann Arbor's population included the following activity centers:

- I-94/State Street Research Park
- Airport Boulevard Area
- Briarwood Mall

- Wolverine Tower Area Development
- South Campus
- Downtown Ann Arbor
- Central Campus
- Medical Center Campus
- Lower Town
- VA Hospital
- North Campus
- Plymouth / Huron Parkway Commercial Area
- Dominos Farms
- East Campus Medical

The activity centers were basic geographic units used in the forecasting effort, and are illustrated in **Figure 3-11**. The study area activity centers were constructed based on the WATS travel model TAZ structure, so that model input/output could be used to represent each activity center.

Review of Available Transit Survey Data

Two recent travel surveys were available for the study team to review: an on-board transit survey from AATA, and boarding / alighting counts of U-M transit routes. The survey data provided valuable information on where and when transit activity was occurring in the corridor, and a summary of each survey is provided below:

- **AATA Survey**: The AATA survey data was collected from an on-board survey administered from October 1 - 10, 2009. The survey database includes information on where each of the surveyed trips began and ended, many of which were geocoded with latitude / longitude information. There were 3,307 surveyed responses provided, and 1,606 (49 percent) of the survey records had complete origin and destination information. These 1,606 complete geocoded responses were the basis for our estimates of daily AATA travel patterns within the study area.
- **U-M Transit**: The U-M transit data was collected during the 2007-08 school year, and includes data collect from hundreds of bus trips that occurred at different times of the day on most of the University routes. The information collected for each surveyed bus trip included the route name, date, starting time of bus trip, passengers getting on at each bus stop and passengers getting off at each bus stop. The U-M transit survey allowed us to estimate the time distribution of when people were using the buses for each route and to estimate how many people were using the buses at each stop, by route.

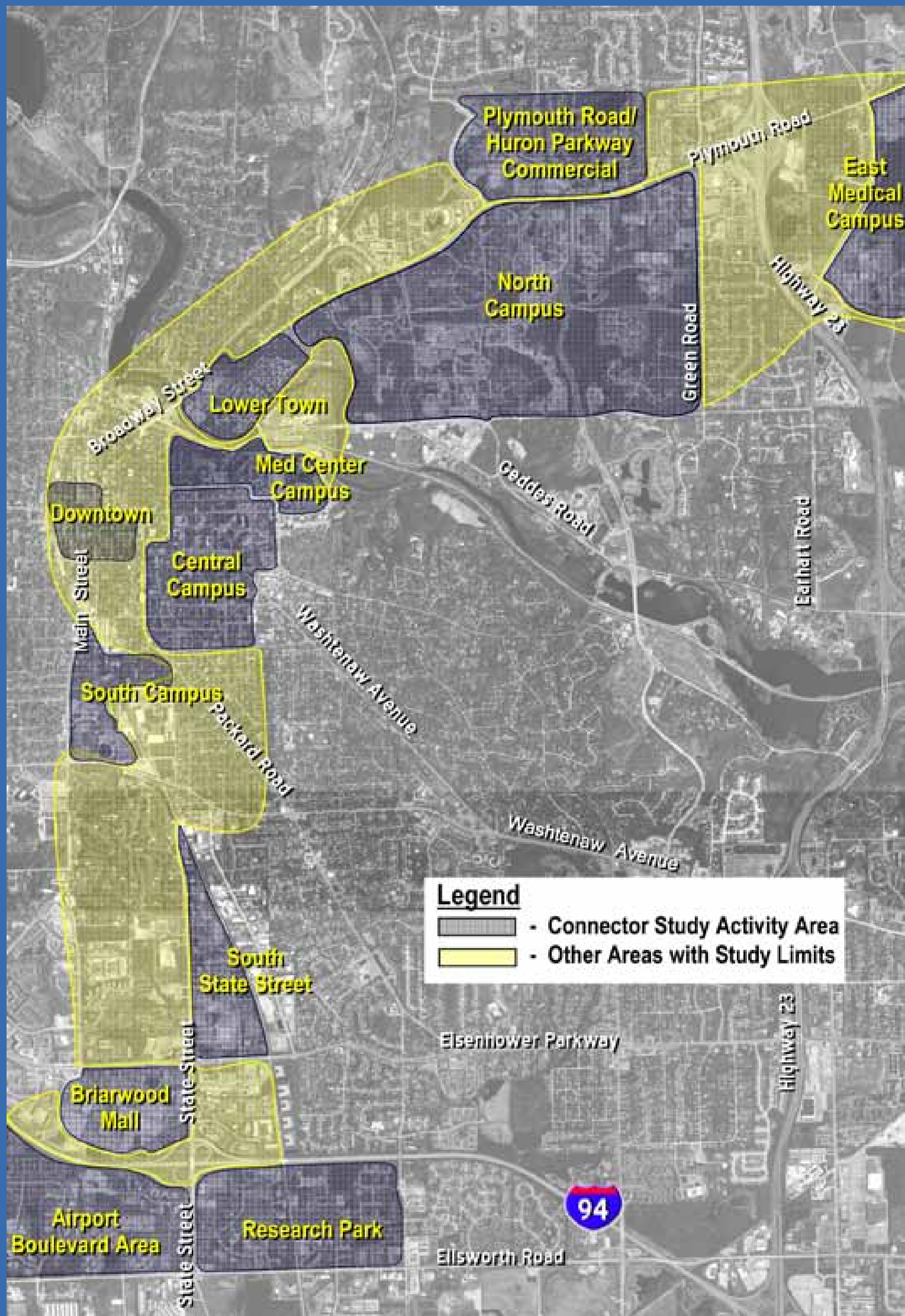

Figure 3-11: Activity Centers
Source: URS Corporation

The available AATA and U-M travel surveys were supplemented with the additional data collection that summarized bus service characteristics between the North Campus and Central Campus, as noted in the previous section. The combined dataset from these three surveys provided a solid foundation of observed transit ridership for the study area, and was an important starting point for applying and evaluating the various technology alternatives using the WATS travel model.

Candidate Trips

While one of the key goals of the feasibility study is to determine whether there are viable means of better serving transit trips in the corridor, the larger goal is to identify whether introducing higher capacity and more reliable transit service would result in travel, economic and environmental benefits for the community as a whole. In assessing the broader community, those persons presently using non-transit means or electing to not make a desired trip are added to the evaluation equation. In the study the universe of potential travelers are referred to as candidate trips. Candidate trips represent the entire pool of persons that desire to travel within and, in selected cases, through the study area from which transit riders are gleaned. Candidates would select transit only in the case where they are provided a travel time or travel cost benefit over the alternative modes or over not electing to make the trip.

The universe of candidate trips was established through the combination of information gathered through the surveys of current services for both AATA and U-M and from information in the WATS regional travel demand model. **Figure 3-12** displays the general orientation of trips between the study area activity centers. The current (2010) and forecasted 2035 orientations are relatively similar in pattern, even though 2035 represents growth in most origin-destination pairs.

Key observations for the current conditions are listed below:

- 50,000 daily trips travel between Central Campus and North Campus
- 16,000 daily trips travel between Central Campus and the Medical Campus
- 5,000 daily trips travel between North Campus and the Medical Campus
- 10,000 daily trips travel between the Central Campus and South Campus
- 11,000 daily trips travel between Central Campus and downtown Ann Arbor

The population and employment forecasts contained in the WATS model for 2035 show an increase in overall travel, but the travel patterns for candidate trips are not anticipated to change dramatically from today. Within the study area the total number of trips with origins/destinations is forecasted to increase by approximately eight percent. Trips to and from the university activity areas are forecasted to increase from about four percent (Central Campus) to over 14 percent (North Campus). Even though travel in the study area is highly influenced by activities at the university, the much smaller

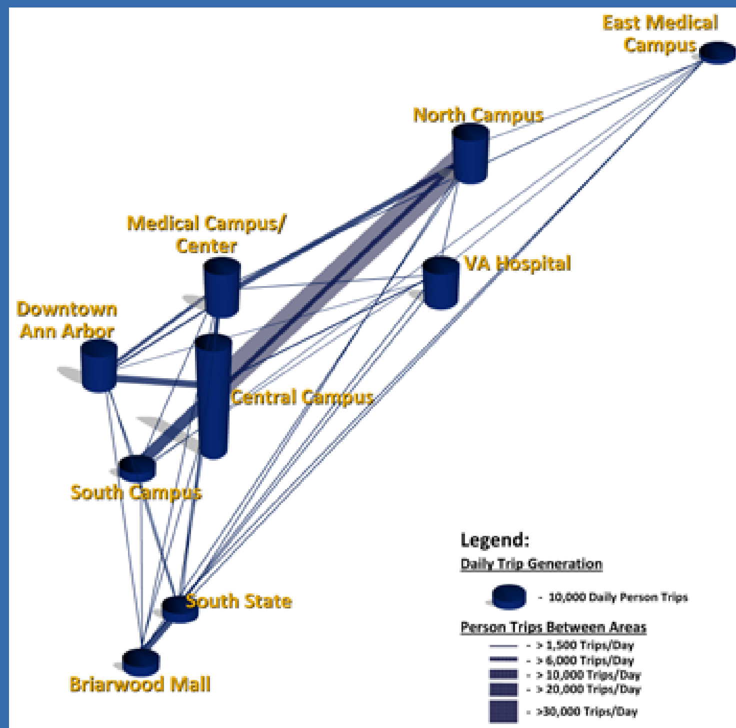

Figure 3-12: Orientation of Candidate Trips Between Key Activity Areas (2010 and 2035)
Source: URS Corporation

increment of growth outside the university zones moderates the overall growth level reported for the study area. Key observations of the 2035 conditions include:

- 54,000 daily trips travel between Central Campus and North Campus
- 16,000 daily trips travel between Central Campus and the Medical Campus
- 6,000 daily trips travel between North Campus and the Medical Campus
- 10,400 daily trips travel between the Central Campus and South Campus
- 12,000 daily trips travel between Central Campus and downtown Ann Arbor

Estimating the Transit Market

The WATS model is a multimodal application that can aid in forecasting:

- The number of people traveling between two locations
- The number of autos traveling between two locations
- The number of transit passengers traveling between two locations

- The number of people walking between two locations
- The number of people biking between two locations

The mode choice step of the model estimates the probability that any given trip would use any of the range, or a combination, of modes. The transit assignment portion of the model was used to estimate the level of ridership that each transit route would carry, based on the level of transit activity predicted by mode choice.

As the WATS model addresses all modes and can estimate the number of people making trips between any two locations, it can be used to establish the potential market from which transit trips across the range of technologies can be quantified. The market represents the total number of person trips between or within any of the activity centers in the Connector corridor for the base year (2010) or the forecast year (2035). These total trips within the market area are also referred to as candidate trips. Riders for the proposed transit alternatives were selected from the candidate trips and represent those trips/travelers that would derive:

- A higher level of access to service
- A shorter travel time than other competing alternatives
- A similar or lower wait time between vehicles relative to other modes

The ridership modeling efforts began by providing the study team and public a general overview of the potential transit market that exists in the study area. This initial travel market analysis was completed to identify the approximate size of various travel markets and identify key origins and destinations. This analysis focused on providing:

- Estimates of the total size of the study area market and how major origin-destination patterns differ in each specific alignment
- A comparison of transit competitiveness versus the automobile for the different transit technologies and alignments. This effort included reviews of how current and projected highway congestion is likely to affect transit attractiveness
- How differences in the different transit technology / alignment level of service are likely to affect the projected transit ridership

Particular focus was paid to the U-M campuses for the purposes of this review. As the U-M campus accounted for a relatively large portion of the study corridor trips, a rigorous review of the model assumptions and results for the U-M campuses was completed.

The intra-campus trip table was scrutinized by city, WATS and university staff, looking at available data and using firsthand knowledge of on-the-ground conditions and available survey data. The review looked at both the number of trips made between campuses and at the mode share of those trips. As shown in **Table 3-3**, the revisions increased the modeled number of trips made between the North and Central Campuses and reduced the number of trips made to/from the South Campus.

The intra-campus trip table review considered all modes of travel between the campuses, as most intra-U-M travelers were candidates to use an enhanced transit system. The revised intra-campus trip table reflected in **Table 3-3** was relatively consistent with the level of trip exchanges observed in the study survey data collection effort.

Original 2010 All Mode Daily Model Trips			
From / To	South Campus	Central Campus	North Campus
South Campus		16,600	39,500
Central Campus	16,600		10,300
North Campus	39,500	10,300	
Revised / Final 2010 All Mode Daily Trips			
From / To	South Campus	Central Campus	North Campus
South Campus		5,300	1,900
Central Campus	5,100		25,200
North Campus	1,900	26,000	

Table 3-3: Person Trip Adjustments
Source: WATS

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ALTERNATIVE TRANSIT MODES

A comprehensive set of alternative advanced transit options were considered as a part of this study. Case studies of these technologies in cities across the United States were prepared to help determine if such technologies could also work well in Ann Arbor. The following pages summarize the existing systems that were researched in detail for applicability to this study.

After reviewing each of the case studies, the study team and the study management committee examined the pros and cons associated with each technology in terms of applicability and appropriateness for Ann Arbor. **Table 4-1** summarizes the findings associated with each of the technologies that was considered.

Bus Rapid Transit

Cleveland, OH Regional Transit Authority Healthline

- 21 articulated buses running along a 6.8 mile corridor with 58 stations/stops
- Buses run in dedicated lanes separate from other traffic through the most congested portions of the corridor and are given priority at traffic signals
- Buses share lanes with other traffic along the remainder of the corridor
- Features off-board fare collection for faster service
- Provides 24-hour service, 7 days per week
- Service frequency is every 5 minutes during rush hours, every 10-15 minutes throughout the day, and every 30 minutes during late night/early morning

Passengers pay fares on the platform for quick and easy boarding

Some stations serve both Eastbound and Westbound travel, with dedicated BRT lanes on each side of the platform

Healthline station amenities

Healthline uses articulated buses for greater passenger capacity

Bus Rapid Transit

Kansas City, KS Metro Area Express (MAX)

- 13 buses running along a 6 mile route with 40 stations/stops
- Buses run in dedicated lanes separate from other traffic for 3.75 miles of the route for a faster ride
- Majority of route uses on-street parking lane for BRT operations during peak hours
- Special traffic signalization holds a green light longer to keep buses on schedule
- Stations feature real-time arrival signs
- Service frequency is every 10 minutes during peak times, and every 15-30 minutes most other times

Bicycles are welcome on MAX!

MAX service runs 7 days a week, from 5:30 a.m. to midnight

18-foot station markers are well-lit at night, making them easy to find

MAX runs in a dedicated bus lane beside other traffic

Light Rail Transit

Charlotte, NC LYNX Blue Line

- 20 vehicles running on 9.6 miles of track with 15 stations/stops
- Service is available every 10 minutes during weekday rush hours and every 15 minutes during non-peak hours, with 20-30 minute service available on weekends
- Powered by an overhead catenary system
- Heritage streetcars operate as the Charlotte Trolley along a portion of the route in tandem with the modern light rail vehicles on weekends
- An 11-mile extension is currently in the planning stages
- Seven of the 15 LYNX stations are park and ride locations

Audio announcements broadcast the destination of approaching trains

Passengers pay fares on the platform for quick and easy boarding

The LYNX Blue Line is the only light rail system in the United States that runs through a Convention Center

Stations feature passenger canopies for protection during poor weather conditions

Light Rail Transit

Minneapolis, MN Hiawatha Line

- 27 vehicles running on 12.3 miles of track with 19 stations/stops
- Powered by an overhead catenary system
- Top speed: 55 mph, with a general service speed of 40 mph or less
- 46 Metro Transit bus routes connect to 14 rail stations with timed transfers
- NexTrip technology provides real-time departure information
- Vehicles depart stations every 10-15 minutes throughout the day, 7 days per week, with 5-10 minute frequencies during rush hours
- First opened in 2004; by 2006 the Hiawatha Line had already exceeded its 2020 weekday ridership goal

Stations and vehicles are fully ADA complaints with level boarding and four wheelchair locations per vehicle

Elevated grade separations and a tunnel into the airport provide travel time advantages

A Hiawatha train typically consists of two cars coupled together

The Hiawatha Line provides Minnesota Vikings and Twins fans a low-cost alternative to driving to the game

Streetcar

Portland Streetcar

- 11 vehicles running on 4 miles of single track with 42 stations/stops
- Single streetcars operate in lanes shared with other traffic at a maximum speed of 30 mph
- Powered by an overhead catenary system
- Vehicles depart stations every 15 minutes most of the day
- No fares charged for passengers traveling within the Free Rail Zone
- Uses Nextbus technology to provide real-time arrival information
- A 3.3-mile extension is currently under construction; expected to open to the public in 2012

Low floor vehicles make boarding easier

Tickets purchased for the streetcar may be used on the Tri Met MAX light rail, bus and commuter rail services and vice versa

Streetcar station amenities. Tickets may be purchased on the station platform or onboard the streetcar

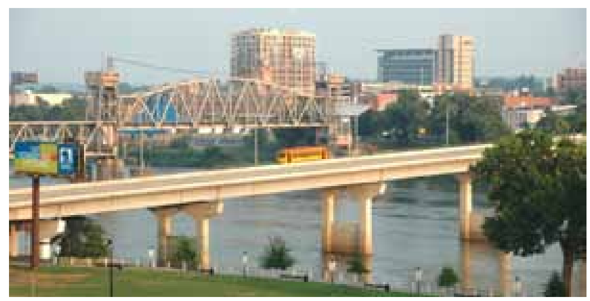
Streetcars operate in lanes shared with other traffic, eliminating the need for additional right-of-way

Streetcar

Little Rock River Rail Streetcar Line

- First opened in 2004 with 2.5 miles of single track
- Extension completed in 2007 increased system to 3.4 miles of single track and 14 stations/stops
- Operates as a heritage streetcar system using 5 replica vintage electric vehicles in lanes shared with other traffic
- Vehicles depart stations every 15–30 minutes depending on route and time of day
- Powered by an overhead catenary system
- Corporate sponsors are invited to purchase naming rights for the overall system, individual streetcars or station stops

Streetcar service can spur transit oriented development



The streetcar line crosses the Arkansas River, joining the communities of Little Rock and North Little Rock

The design of the Little Rock River Rail streetcars is modeled after the Birney streetcars used in Little Rock until 1947

Automated Guideway Transit

Detroit, MI Detroit People Mover

- Opened to the public in 1987
- 12 vehicles operating in two-car pairs along a 2.9-mile route with 13 stations/ stops in downtown Detroit
- Vehicle maximum speed: 56 mph
- Service is provided as a one-way loop
- End-to-end travel time is approximately 15 minutes
- When service first began, vehicles traveled counterclockwise around the loop
- At the completion of renovations in 2008, vehicles began traveling clockwise around the loop, reducing the end-to-end travel time by 26 seconds

Eight of the 13 People Mover stations are integrated into buildings

The People Mover connects government buildings, sports arenas, exhibition centers, hotels and commercial, banking and retail districts in downtown Detroit

The Detroit People Mover is designed to accommodate up to 15 million riders a year. In 2008, it served over 2 million riders

Automated Guideway Transit

Indianapolis, IN Clarian People Mover

- Two three-car trains operating along a 1.4 mile dual track with three stations/stops
- Connects Methodist Hospital of Indianapolis, Indiana University Hospital and the James Whitcomb Riley Hospital for Children
- Vehicle maximum speed: 30 mph
- Average speed: 17 mph
- End-to-end travel time is approximately 5 minutes
- Provides 24 hour service, with trains departing every six minutes
- The Clarian People Mover is the only private transportation system in the United States to run above public roads

Each train can accommodate up to 81 passengers as well as patients on gurneys

Clarian People Mover service is free and open to the public

The Clarian People Mover uses two separate parallel elevated guideways, both of which operate in both directions

The concrete rails of the guideway are designed with a gap between them to combat winter snow accumulation

Personal Rapid Transit

Morgantown, WV Personal Rapid Transit

- Began operation in 1975
- 73 driverless vehicles operating along an 8.65-mile track with 5 stations/stops
- Connects three Morgantown campuses of West Virginia University and the downtown area
- Vehicles are powered by electric rails
- Each vehicle can hold up to 20 passengers; for this reason, some believe this is truly a "Group Rapid Transit" system instead of Personal Rapid Transit
- System operates in three modes:
    - Demand mode – used during off-peak hours. When a passenger wishes to use the system, a call button is pressed at the station and a vehicle automatically arrives to transport them to the selected destination.
    - Schedule mode – used during peak hours. Vehicles are operated on fixed routes of known demand, and do not respond dynamically to passenger requests.
    - Circulation mode – used during low-demand periods. A small number of vehicles are operated that stop at every station, similar to a bus service.
- During the 2006 fiscal year, the Morgantown PRT system broke down a total of 259 times.[1]

[1]*Gregory, Kathryn (2007-01-30). "PRT System to Receive 1.6 Million a Year". The Daily Athenaeum, January 30, 2007.*

Vehicles are powered by electrified rails on one or both sides of the guideway. Vehicles steer slightly toward whichever side is powered so they can stay in firm electrical contact with the rails

Though portions of the track are at-grade or underground, 65% of the system is built on elevated bridges and viaducts

When a vehicle approaches a station, it can either continue forward and bypass the station or the wheels can turn and follow the electrified rails into the station

All vehicles are handicapped-accessible, and can travel at speeds up to 30 mph

Personal Rapid Transit

London, England ULTra

- Located at Heathrow Airport, Terminal 5; currently in testing phase
- Presently running 18 driverless vehicles (called "pods") along a 2.4 mile track
- Each pod can accommodate 4 – 6 passengers
- Pods are powered by rechargeable on-board batteries
- Passengers select a destination using an interactive touch screen at the station and a pod automatically takes passengers directly to their selected destination
- Maximum speed: 25 mph
- If successful, the system will be expanded to as many as 450 pods with stations/stops at all five airport terminals and the surrounding parking lots and hotels

Employee parking lot PRT station at Terminal 5

PRT station inside Terminal 5. Passengers use interactive kiosks with touch screens to pay fares and select their destination

While parked at the station, pods make contact with metal plates that allow the vehicle to recharge while waiting for passengers

Lightweight pods allow the guideway support structures (shown above) to be much smaller than those constructed for typical roadways, which can reduce the visual impact

Monorail

Las Vegas, NV Monorail

- Nine four-car trains run along an elevated 3. 9 mile route with seven stations/stops that connect hotels and attractions along the Las Vegas Strip
- Journey from one end to the other takes 15 minutes
- For the majority of the day, trains arrive every 5-6 minutes
- Trains run on rubber tires along a concrete guideway
- Maximum speed is 50 mph
- The Las Vegas Monorail Company is currently in the planning phases of a proposed extension to the McCarran International Airport

Northbound and Southbound trains travel along parallel guideways

Monorail guideway in front of the Las Vegas Hilton lobby. At it's highest point, the guideway stands 60 feet above street level

Kiosks provide visitors with information about each stop along the route

Stations are spacious enough to accomodate large numbers of passengers during events such as conventions

Double-Decker Bus

Las Vegas, NV The Deuce

- Regional Transportation Commission (RTC) Transit began operating The Deuce in 2005
- 130 diesel-powered double-decker buses serve seven routes in the Las Vegas area
- The Deuce On The Strip is the name used to designate the route that primarily serves tourists
- Provides 24-hour service
- RTC Transit is one of six transit agencies that operate double-decker buses in the United States for fixed-route services

A $7 one-day pass allows passengers to ride The Deuce as many times as they like

Each bus provides seating for 80 passengers, with 27 seats on the lower deck and 53 on the upper deck

The Deuce shares stops with the RTC bus rapid transit system

Stops feature shaded ramadas and transit system information

Heavy Rail

Minneapolis, MN Northstar Commuter Rail

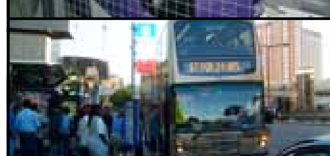
- The Northstar Corridor is an 82-mile transportation corridor that runs along Highway 10 from the St. Cloud area to downtown Minneapolis. It is one of the fastest growing corridors in Minnesota and the nation.
- In service since November 2009, the Northstar Commuter Rail operates along a 40-mile route between downtown Minneapolis and Big Lake, with connecting coach bus service between Big Lake and St. Cloud
- As demand for commuter rail service grows, the Northstar Corridor Development Authority plans to extend commuter rail service between Big Lake and St. Cloud
- Northstar trains make six trips to downtown Minneapolis and six return trips each weekday, and three trips in each direction on Saturday and Sundays
- Tickets are purchased from ticket machines at each station, and fares are determined according to a fare zone schedule
- Bicycles are welcome on all Northstar trains

Train schedules are set to provide service during peak commuting times, as well as weekend and some special event service

Typical weekday operation requires five trains, each consisting of one push-pull locomotive and three or four bi-level coaches.

Once in downtown Minneapolis, commuters can walk upstairs to the Hiawatha Line light rail or take a bus into neighboring St. Paul and other areas

Modes that Warrant Further Study			
	**Light Rail Transit**	A moderate to high capacity transit system operating two to three car trains in semi-exclusive right-of-way with power provided by overhead wires.	Light Rail Transit can provide adequate passenger capacity and is appropriate for an urban environment with short, frequent stops.
	**Bus Rapid Transit**	An integrated system of facilities, services, and amenities that collectively improves the speed, reliability and identity of bus transit. Generally operates at least partially in exclusive right-of-way with frequent service.	Bus Rapid Transit can provide adequate passenger capacity and is appropriate for an urban environment with short, frequent stops.
	**Automated Guideway Transit**	A moderate to low capacity transit system that generally operates on an elevated guideway over a limited distance. Vehicles are automated and generally operate on a fixed headway throughout the day.	Automated Guideway Transit systems have proven operational systems, can provide the necessary passenger capacity, and is compatibale with Ann Arbor's urban environment.
	**Monorail**	A system of guided transit vehicles operating on a single elevated rail or beam.	Monorails have proven operational systems, can provide the necessary passenger capacity, and is compatibale with Ann Arbor's urban environment.
	**Bus**	Standard buses generally operate in mixed flow on city streets.	Standard bus service is meeting the current transit demand in Ann Arbor and is appropriate, but is operating near - or at- capacity.
	**Streetcar**	Generally operates as a single car in mixed flow on city streets with power provided by overhead wires. Generally intended for shorter trips with frequent stops.	Streetcars can provide adequate passenger capacity with frequent service, and is appropriate for an urban environment with short, frequent stops.

Modes that Were Considered But are Not Recommended			
	**Personal Rapid Transit**	A type of Automated Guideway Transit designed to make a non-stop journey to a selected destination. Service is on demand, and passengers travel in small vehicles (or "pods") designed to seat four to six people.	- Does not provide sufficient capacity for estimated demand - Unproven technology - first system in the world has just been built in London; not yet open to the public - Significant uncertainty about cost, passenger capacity and feasibility of implementation - Could be applicable for circulation radiating from stations
	**Double-Decker Bus**	Buses with two stories or "decks" that generally operate in mixed flow on city streets.	Boarding and alighting times are not consistent with high demand station loadings
	**Heavy Rail**	A railway system with the capacity to handle a heavy volume of passengers. It is characterized by high-speed, passenger rail cars running in an exclusive right-of-way, and can operate on existing freight rail tracks.	- Existing railroad rights-of-way do not serve the major activity centers in Ann Arbor - Heavy passenger rail technology is not appropriate for urban service with frequent stops
	**Diesel Multiple Unit**	A type of heavy rail train consisting of self-contained cars, each of which has its own engine and the ability to operate as an individual unit.	- Existing railroad rights-of-way do not serve the major activity centers in Ann Arbor - Heavy passenger rail technology is not appropriate for urban service with frequent stops - Only one producer of Diesel Multiple Units in the United States (U.S. Railcar); lack of competitive bidding could drive costs up

CONNECTOR CONCEPTS

Transit improvements can be comprised of a variety of different components. Therefore, a number of different factors must be considered when developing possible transit improvement concepts. The transit system components considered as a part of this study are shown in **Table 5-1**.

Service Concepts	Route Changes / Enhancements	Stations / Stops
• Hours • Frequency • Fare Collection	• New Routes - Using Existing Streets - New Guideways • Changes to existing routes to support new service	• Multimodal connections • Locations • Amenities

Table 5-1: Transit System Components
Source: URS Corporation

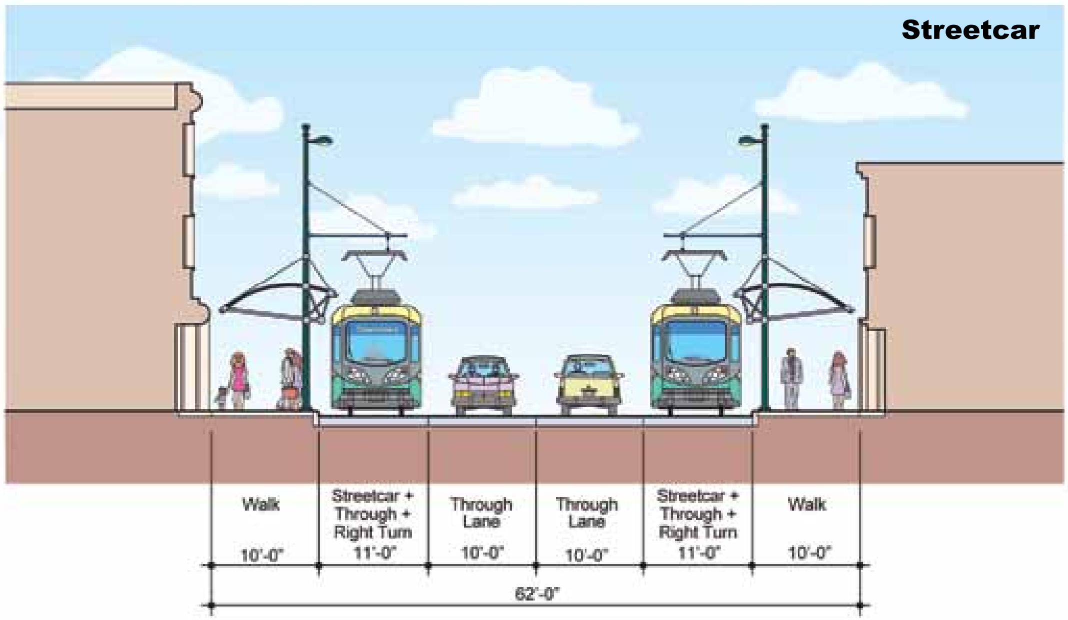
The various forms of transit technologies can be classified by where and how they operate in relation to roads and traffic:

Mixed Flow Transit: Transit vehicles share travel lanes with autos and other non-transit vehicles. Existing AATA bus operations are one example of mixed flow transit; trolleys and streetcars are other technologies that can operate in mixed flow. Mixed flow transit does not require any new right-of-way and is generally the least costly type of transit, but it also does not provide a significant travel time advantage. See **Figure 5-1** for illustrations.

Exclusive At-Grade Transit: Transit vehicles operate in their own travel lanes, separate from autos and other non-transit vehicles. Bus rapid transit (BRT) and light rail transit (LRT) are examples of transit that can commonly operate in an exclusive right-of-way. Exclusive at-grade transit requires new right-of-way (typically 30-50 ft.), but it can provide a significant travel time advantage because it is not subject to conflicts with other, non-transit traffic. See **Figure 5-2** for illustrations.

Exclusive Grade-Separated Transit: Transit vehicles, such as monorail, LRT, automated guideway transit (AGT), and personal rapid transit (PRT), operate on an elevated track. The guideway requires 10 feet of right-of-way for support columns that are spaced approximately every 50 to 100 feet, and 16+ feet of clearance under the track to accommodate surface traffic. Exclusive grade-separated transit can provide a significant travel time advantage, because it is not subject to conflicts with other, non-transit traffic. See **Figure 5-3** for illustrations.

The basic route for the advanced transit alternatives follows the study area corridor as



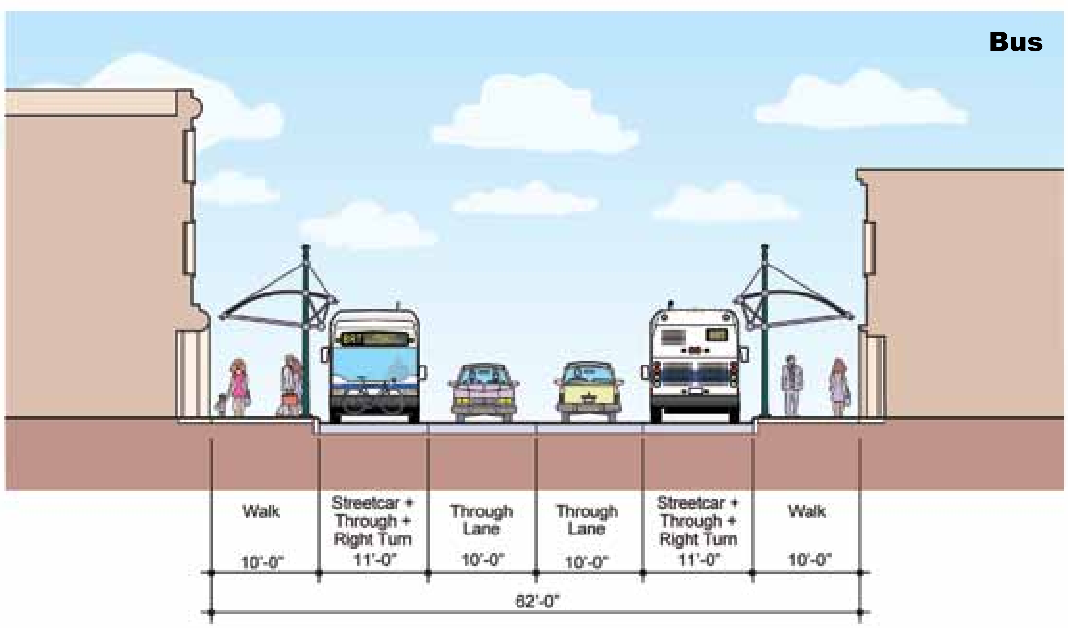


Figure 5-1: Mixed Flow Transit Typical Sections
Source: URS Corporation

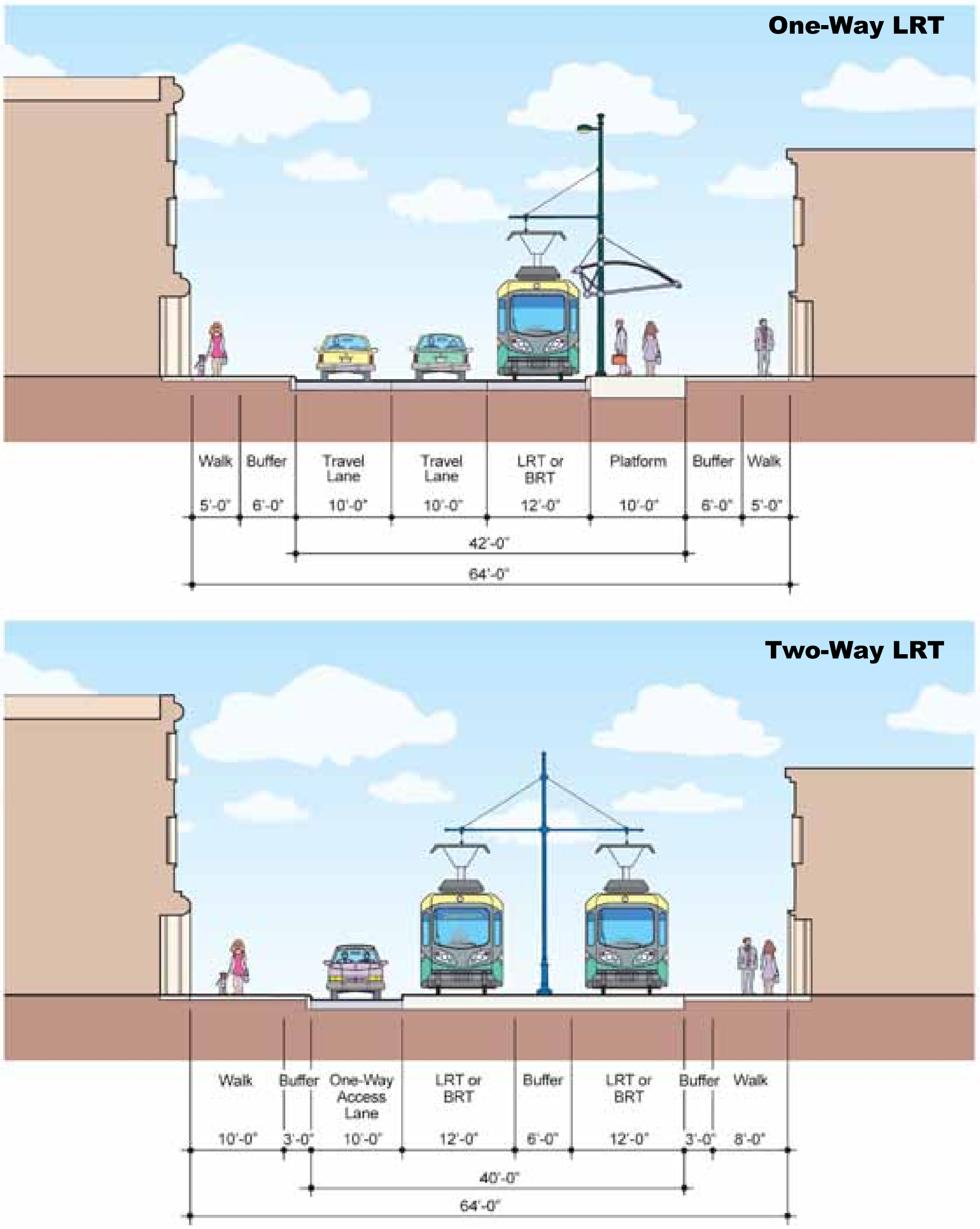
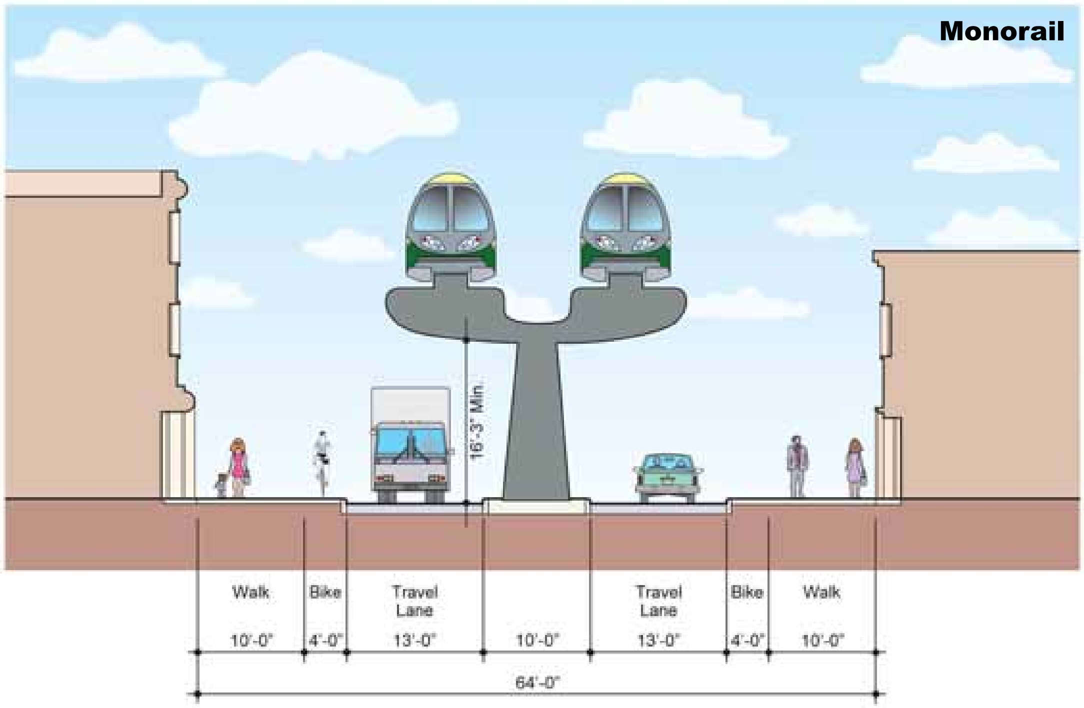


Figure 5-2: Exclusive At-Grade Transit Typical Sections
Source: URS Corporation



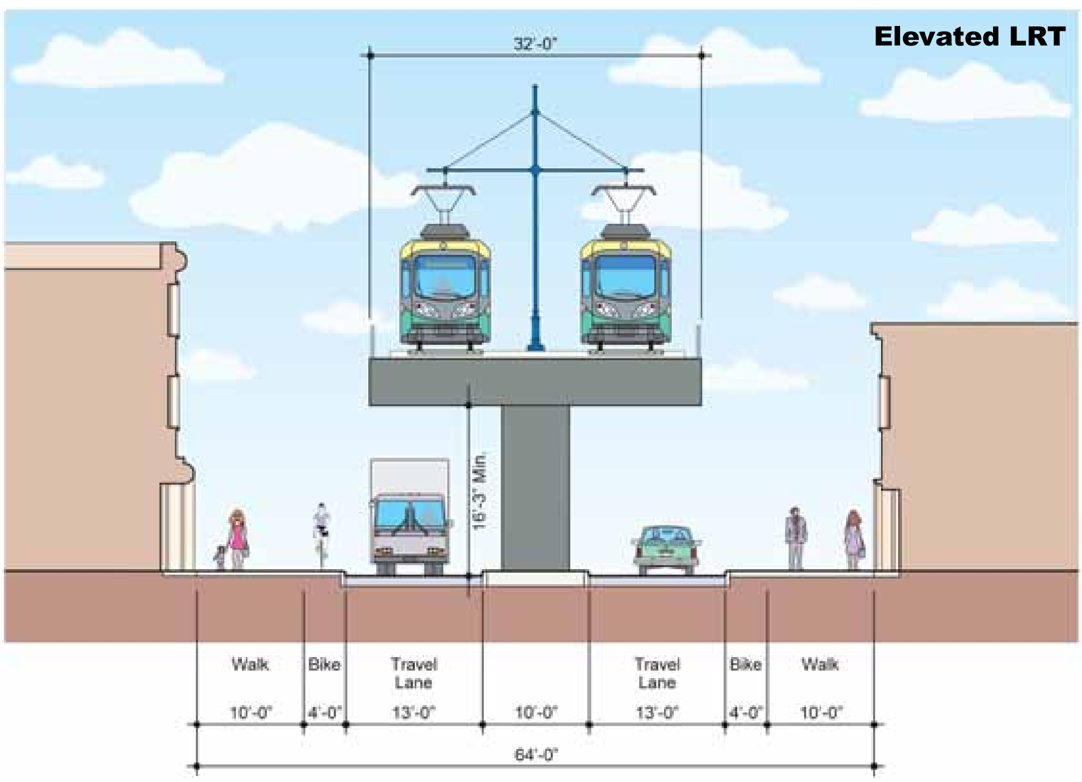


Figure 5-3: Exclusive Grade-Separated Transit Typical Sections
Source: URS Corporation

shown in **Figure 5-4**, extending from the northeast area of the city through downtown and then to the south. The general alignment begins in the vicinity of the U-M East Medical Campus, proceeds west to the US 23 Park & Ride and the Plymouth Road commercial center, and then continues west and south to the U-M North Campus, past the VA Medical Center, continuing west past the Fuller Road Station and the U-M Medical Center. Then, the alignment is routed southwest passing the U-M Central Campus with stops in downtown Ann Arbor and at the WALLY transfer station (once the location of this station has been determined). Turning south again, the alignment would have additional stops at the U-M South Campus, near Michigan Stadium and along the South State Street corridor, and continue past the I-94 Park & Ride, before terminating in the vicinity of Briarwood Shopping Center. As noted above, depending on the transit technology, a new guideway could be located in a number of physical configurations relative to the existing street system. This study was based on a generalized Connector route. If the study concludes with a positive finding of feasibility, more detailed route alignment studies will be required.

For purposes of this feasibility study, a limited stop transit service was assumed with stations located in the vicinity of high activity land uses as described in **Table 5-2**.

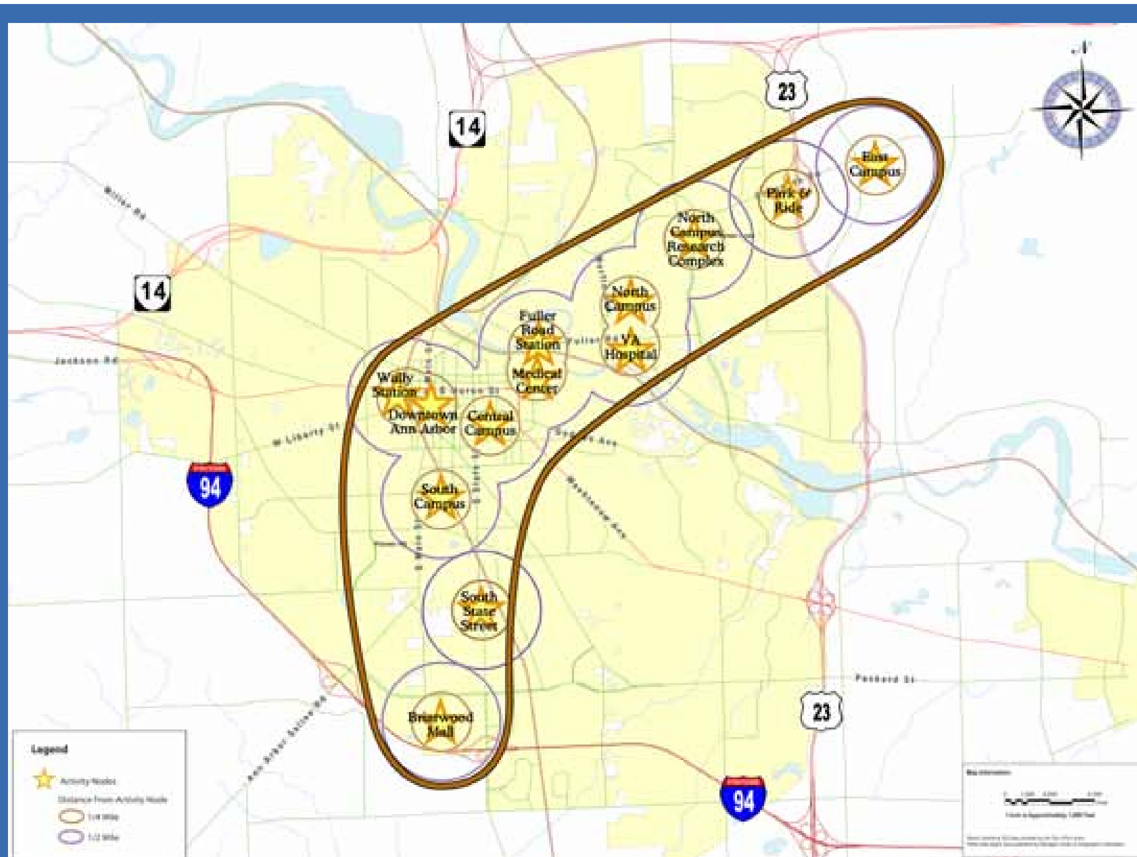


Figure 5-4: Study Area
Source: City of Ann Arbor, Michigan Center of Geographic Information, and URS Corportation

Proposed Stations/Stops	Distances	
	Distance From Previous Station (Traveling North to South, miles)	Distance From North End of Alignment (miles)
U-M East Medical Campus	0.0	0.0
US 23 Park & Ride	0.9	0.9
U-M North Campus Research Complex	0.8	1.7
U-M North Campus Northwoods	0.9	2.6
U-M North Campus Commons	0.5	3.1
VA Medical Center	0.3	3.4
U-M Medical Campus	0.8	4.2
U-M Central Campus	0.6	4.8
Downtown Ann Arbor	0.5	5.3
WALLY Transfer Station	0.3	5.6
U-M South Campus	0.7	6.3
South Stadium	1.0	7.3
Briarwood Shopping Center	0.7	8.5
I-94 Park & Ride	0.5	7.8

Table 5-2: Station / Stop Locations
Source: URS Corporation

One of the critical factors defining transit operations is the need to accommodate peak period demand through the U-M campuses. The number of vehicles provided must have sufficient capacity to carry the passenger demand. As noted previously, counts of existing riders between campuses yielded a peak 15-minute demand of approximately 800 riders on 20 buses. This demand can be expected to increase in the future in response to both improved transit service and growth in the corridor. For purposes of estimating operating characteristics in this feasibility study, a peak hourly one-way design capacity of 3,500 passengers was recommended.

Accommodating these passengers is a function of the capacity of each transit vehicle, the number of vehicles per train, and the headway or time between trains. **Table 5-3** shows hourly capacity for a number of alternative modes and operating headways. The green shaded cells in the table identify the modal combinations that meet the design capacity of 3,500 passengers per hour. The yellow shaded cells do not provide sufficient passenger capacity.

As shown in **Table 5-3**, the various modal alternatives incorporate assumptions about vehicle characteristics. The BRT mode is assumed to consist of articulated, 60-foot buses. The Streetcar mode is assumed to be a 70-foot long vehicle operating as a single car. Light Rail is assumed to consist of 90-foot long cars operating in 2 to 3 car trains. The elevated technologies, APM and Monorail, are assumed to operate in 4-car trains. If a positive feasibility finding is made the specific size and configuration of vehicles will need to be further evaluated.

As shown in the table, standard buses do not meet the recommended peak design capacity. Articulated buses or streetcars could meet the design capacity but would need to operate on headways of 2 minutes. A 2-car LRT, 4-car APM or 4-car monorail would provide the necessary capacity with 5-minute headways. A 3-car LRT would provide the necessary capacity with 10-minute headways.

	Standard Bus	Articulated Bus / BRT	Single Car Streetcar	2-Car LRT	3-Car LRT	4-Car APM	4-Car Monorail
Vehicle Length (Feet)	40	60	70	180	270	168	165
Passenger Capacity	80	120	120	400	600	412	356
Headway (Minutes)	1.5	2	2	2	2	2	2
Vehicles Per hour	40	30	30	30	30	30	30
Peak Hour passengers	3,200	3,600	3,600	12,000	18,000	12,360	10,680
Headway (Minutes)	4	4	4	4	4	4	4
Vehicles Per hour	15	15	15	15	15	15	15
Peak Hour passengers	1,200	1,800	1,800	6,000	9,000	6,180	5,340
Headway (Minutes)	5	5	5	5	5	5	5
Vehicles Per hour	12	12	12	12	12	12	12
Peak Hour passengers	960	1,440	1,440	4,800	7,200	4,944	4,272
Headway (Minutes)	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Vehicles Per hour	8	8	8	8	8	8	8
Peak Hour passengers	640	960	960	3,200	4,800	3,296	2,848
Headway (Minutes)	10	10	10	10	10	10	10
Vehicles Per hour	6	6	6	6	6	6	6
Peak Hour passengers	480	720	720	2,400	3,600	2,472	2,136

Table 5-3: Potential Peak Hour Capacity of Alternative Transit Modes
Source: URS Corporation

The peak passenger demand in the corridor exists primarily between the North Campus and the Central Campus as shown in **Figure 5-5**. The segments to the northeast and to the south have significantly less demand and could warrant a reduced level of passenger capacity. For this reason, alternative concepts involving more than one mode or operating plan were considered.

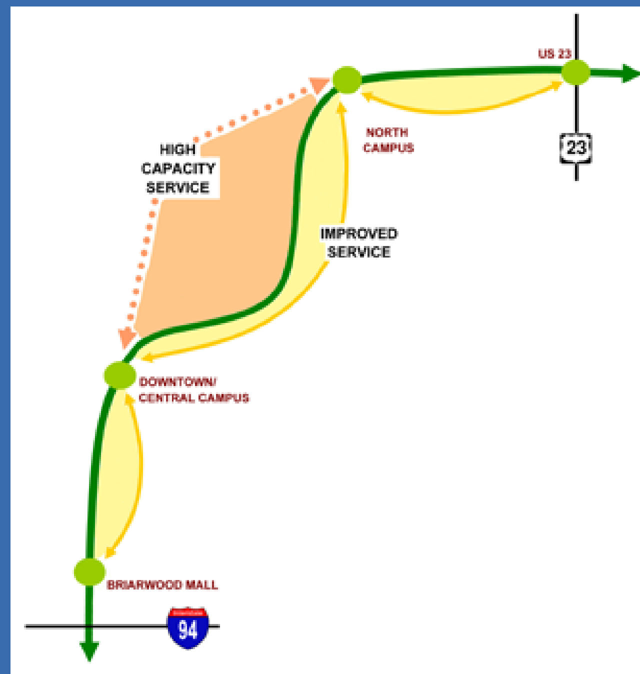


Figure 5-5: Demand by Corridor Segment
Source: URS Corporation

These dual mode alternatives would conceptually share a guideway in the center, the high capacity portion of the corridor. **Figure 5-6** identifies which modal alternatives would be compatible with each other. For example, it would be possible to develop a LRT line between the North Campus and Central Campus and a streetcar line that extends the entire length of the corridor and uses the same guideway as the LRT through the center portion of the corridor. Similarly, a BRT line connecting the campuses could be used by standards buses providing improved service the entire length of the corridor.

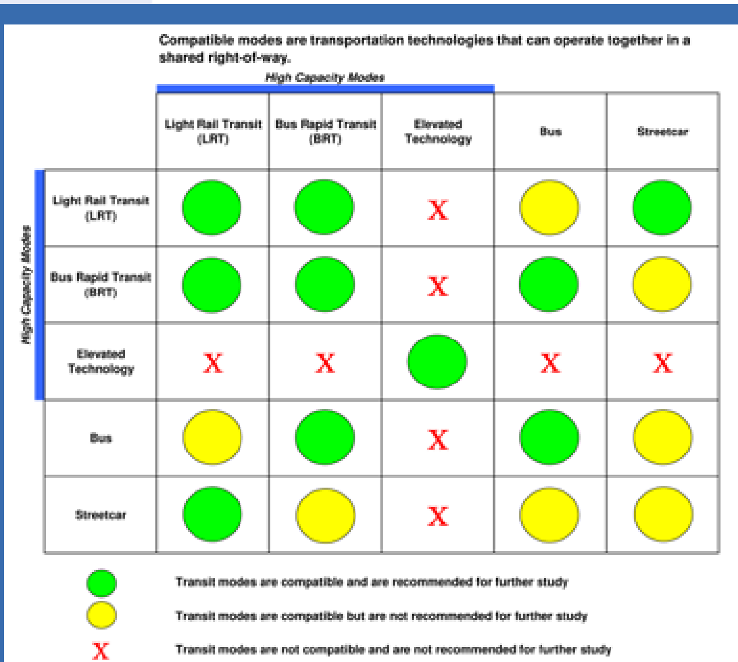


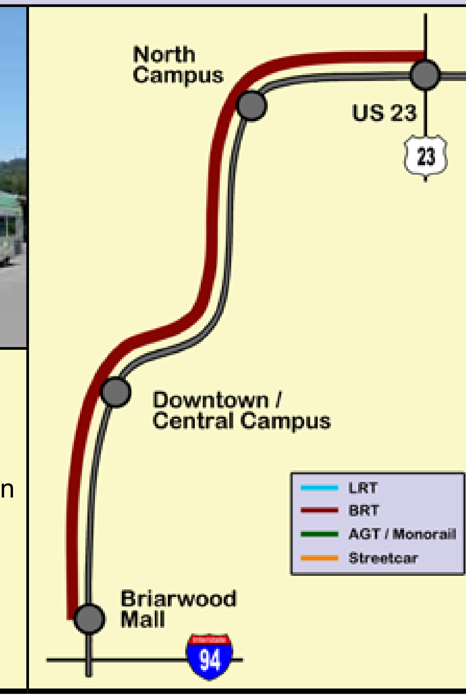
Figure 5-6: Transit Compatibility
Source: URS Corporation

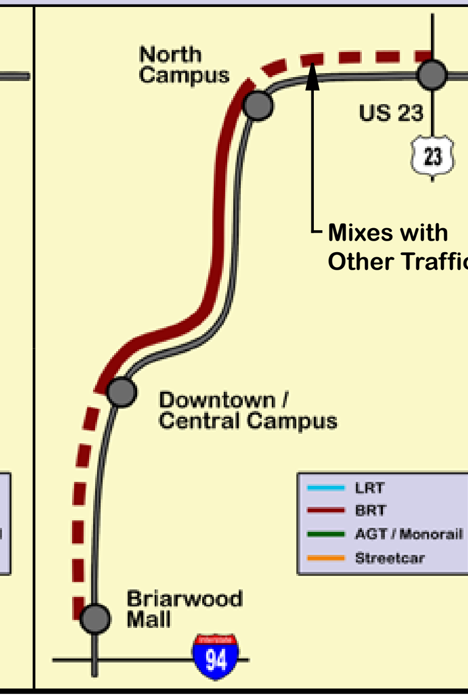
This analysis of passenger capacity by mode as well as compatibility between modes led to the identification of the six concept alternatives shown on **Figure 5-7** for more detailed study and evaluation.

Light Rail Transit (LRT)

A multi-car train running each way on a single set of tracks through the study area.

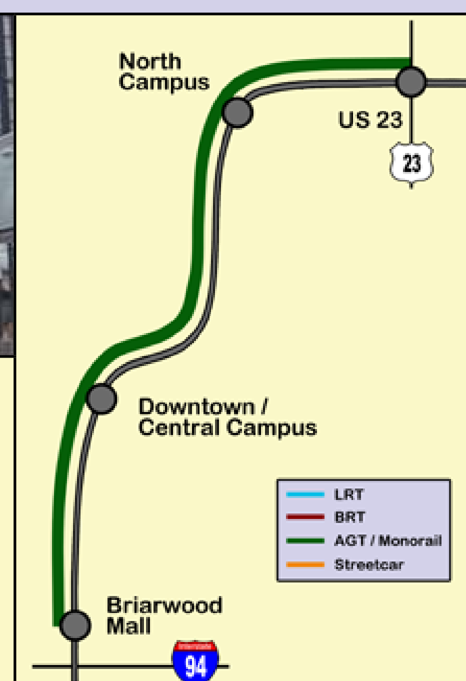
Bus Rapid Transit (BRT)





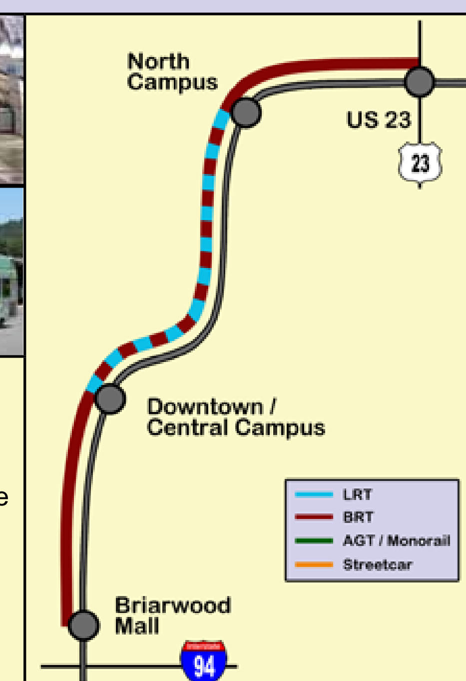
A high capacity bus running either on an exclusive guideway or with other traffic through the study area.

Elevated Technology
(Automated Guideway Transit or Monorail)



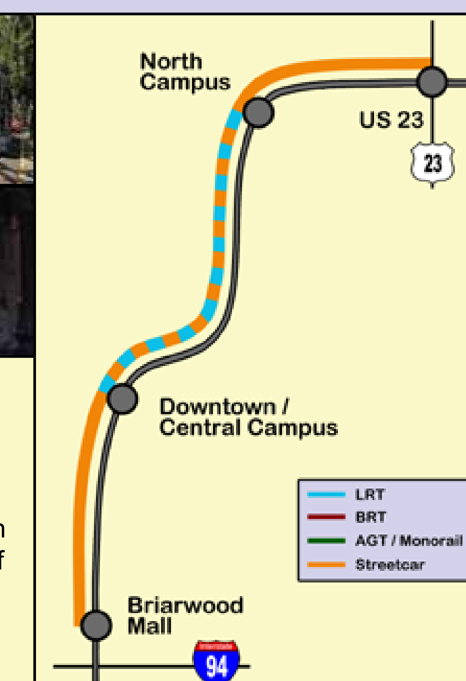
Vehicles running each way on an elevated guideway through the study area.

BRT Combined With LRT



A high capacity bus running through the entire study area on an exclusive guideway shared with LRT between the North and Central Campuses of the University of Michigan.

Streetcar Combined With LRT



A streetcar running through the entire study area on an exclusive guideway shared with LRT between the North and Central Campuses of the University of Michigan.

Figure 5-7: Transit Technology Alternatives
Source: URS Corporation

Changes to Existing Transit Service

One of the goals of the Ann Arbor Connector Feasibility Study is to improve mobility and connectivity within the City of Ann Arbor by increasing the efficiency of movement. Part of this task involves evaluating the existing U-M and AATA bus routes to determine the best way these routes can interface with the proposed Connector transit service. In some cases, this may require modification or elimination of certain routes to eliminate duplicative service and feed the new transit service. Changes to existing bus transit services need to be defined for the following purposes:

- Ridership Forecasts – The travel model transit network will be refined to incorporate these changes. The travel model is sensitive to both the proximity and frequency of transit service.
- Cost Estimation – Part of the intent of the Connector would be to more efficiently serve transit markets with high demand. The net operating cost of the Connector service needs to reflect both the cost of the Connector operations and the cost of the bus service eliminated or modified.

A basic service assumption is that the Fuller Road Station will provide a convenient pedestrian connection to the U-M Medical Center and will serve as the main transit/pedestrian interface to the Medical Center. Concept plans for the station include a pedestrian bridge between the station and the Medical Center.

The following U-M bus routes have been identified for possible elimination, as the North-Central campus connection provided by these routes would be replaced by the Connector service:

- Mitchell Express
- North Campus
- Northwood
- Northwood Express
- Bursley-Baits
- Diag-to-Diag Express

The North Campus and internal circulation function provided by these routes would instead be provided by two proposed north campus shuttle routes operating on 10 minute headways, the Northwood Shuttle and the Baits/Stone Shuttle, shown in **Figure 5-8**. These routes would provide connections to activity centers throughout north campus and to the new Connector transit service.

The Northwood Shuttle is a modification of the existing U-M Northwood bus route. This modified route begins at the corner of Bonisteel Boulevard and Murfin Avenue, follows

Murfin Avenue north, and turns east on Hubbard Road. The route heads north following Cram Circle to Bishop Avenue east, Beal Avenue north and McIntyre Street south to Hubbard Road. Continuing east on Hubbard Road, the route turns south and west along Hayward Street, south along Beal Avenue, and then west on Bonisteel Boulevard, ending at Murfin Avenue.

The Baits/Stone Shuttle is a modification of the existing U-M North Campus bus route. This modified route begins at Baits Housing 1, and follows Hubbard drive north and east before turning south on Murfin Avenue. The route turns east on Bonisteel Boulevard, south on Beal Avenue, and then heads east on Fuller Road/Glazier Way. At Huron Parkway the route turns north, heads east on Hubbard Road, and then turns south on Stone Road. At this point, the route follows the Stone Road loop and continues along the reverse path back to Baits Housing 1.

Modifications are recommended for the following AATA bus routes:

- Route 7: S. Main – East
- A2Express – Canton

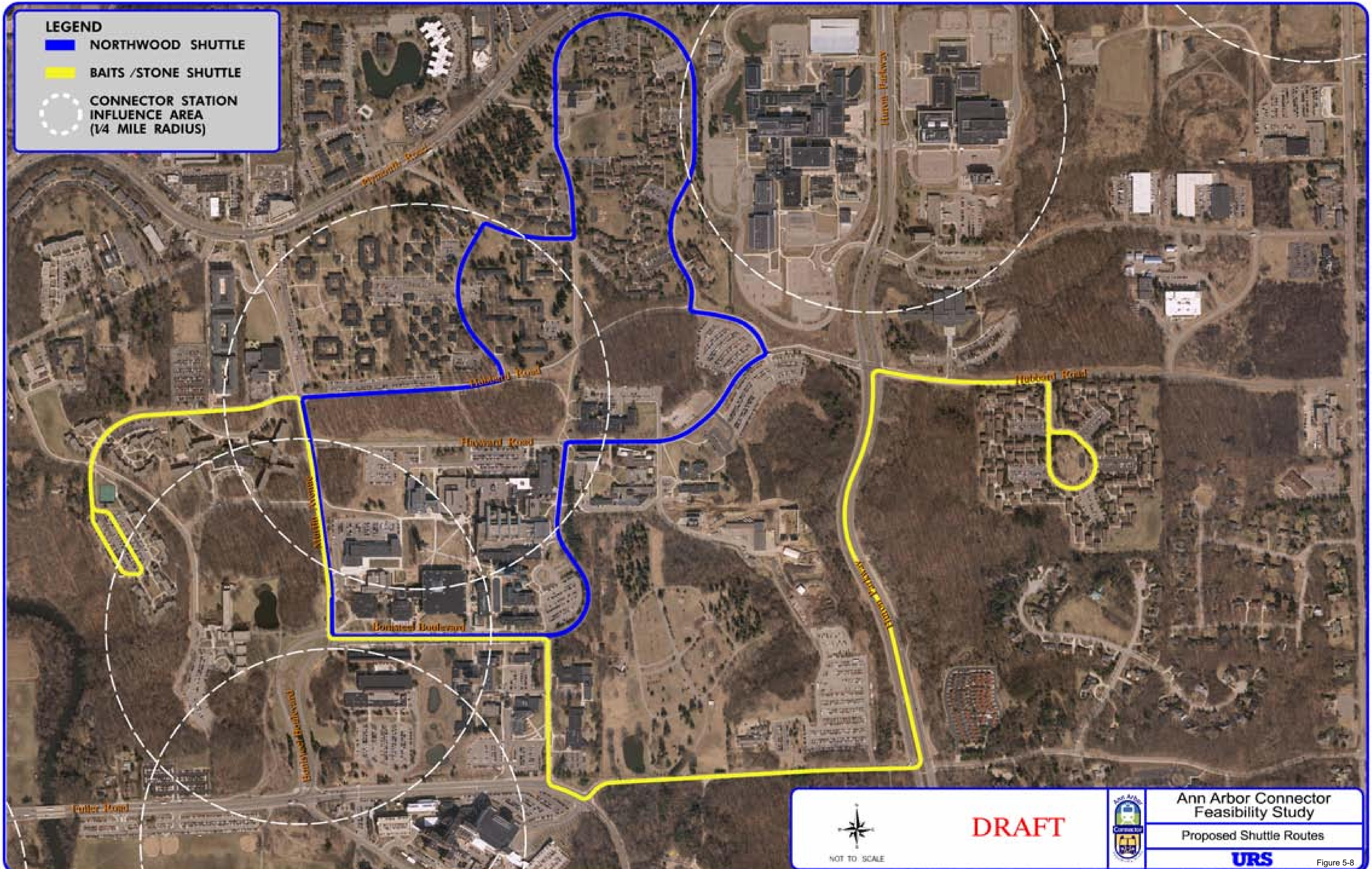
Route 7: S. Main – East currently provides service between Washtenaw Community College and the Blake Transit Center, with service to Glencoe Hills Apartments, County Service Center, Arborland, Buhr Park, Homestead Commons, Malletts Creek Library, Wolverine Tower, Briarwood Mall, Cranbrook Tower, Pioneer High School Park & Ride and Michigan Stadium. It is recommended that this route be modified to provide service only between Washtenaw Community College and Briarwood Mall. The portion of the existing route between Briarwood Mall and Blake Transit Center would be adequately served by the new Connector transit route.

A2 Express – Canton currently provides commuter service between Canton, MI and Washington & Ashley in downtown Ann Arbor, with stops at the U-M Medical Center Cancer Center, Main Entrance, Mott Entrance and Cardiovascular Center, Washington & Fletcher and Washington & Division. It is recommended that this route be modified to provide service between Canton, MI and the intersection of Plymouth Road & Green Road, where it will connect to the new Connector transit route.

Modifications are also recommended for the following U-M bus routes:

- Commuter North
- Commuter South

It is recommended that the portions of the Commuter North & South routes north of the Central Campus Transit Center be eliminated, as these areas would be adequately served by the new Connector transit route. However, the portions of these routes that are south of the Central Campus Transit Center should be retained, as elimination of Commuter North & South service in this area would result in a reduced level of transit service in the corridor and have an impact on system ridership.



LEGEND
NORTHWOOD SHUTTLE
BAITS /STONE SHUTTLE
CONNECTOR STATION INFLUENCE AREA (1/4 MILE RADIUS)
Plymouth Road
Hubbard Road
Hayward Road
Murfin Avenue
Bonisteel Boulevard
Huron Parkway
Fuller Road
NOT TO SCALE
DRAFT
Ann Arbor Connector Feasibility Study
Proposed Shuttle Routes
URS
Figure 5-8

EVALUATION OF ALTERNATIVES

The alternative service and technology concepts defined in the previous section were examined and analyzed to estimate physical cost and operating characteristics, as described below.

Engineering and Environmental Challenges

This study area has a variety of features and challenges that must be considered in determining which type of transit technology may be the most appropriate for Ann Arbor. Many of these features are shown on **Figure 6-1**, and, depending on the selected alignment, could include:

Huron River Crossing – a transit system that accommodates passengers traveling from the US-23 park and ride or U-M North Campus area to the Medical Center, Central Campus, Downtown or Briarwood areas must cross the Huron River. This may be done using an existing bridge (Fuller Road, Norfolk Southern Railroad), or by constructing a new bridge to accommodate the transit system.

Topography – Some portions of the study area feature steep grades, which would need to be considered when constructing any type of guideway for a new transit system. This could require re-grading of certain locations or building the guideway on a structure, which can increase construction costs.

Railroad Crossings – If a rail-based transit technology is selected and the guideway path will cross existing railroad tracks, the new guideway must be grade-separated from the existing tracks. The guideway would need to be built on a structure that allows adequate clearance for existing rail traffic to pass underneath, and use grades no steeper than what is appropriate for the selected transit technology.

Major Roadway Crossings – There are a number of major roadways within the study area, including Plymouth Road, Huron Parkway, Fuller Road, Huron Street and others. If the new transit alignment intersects a major roadway, it may be necessary to install a new traffic signal, modify an existing signal, or provide grade separation between the existing roadway and the new transit guideway to ensure efficient traffic operations.

Right-of-Way in Downtown Ann Arbor – If the a new transit system alignment passes through downtown Ann Arbor at-grade, it will be necessary to use the right-of-way currently occupied by existing city streets to avoid impacts to businesses and residences adjacent to the alignment. This will result in the loss of parking or vehicular capacity along these city streets and could impact driveway access.

Access to the U-M Medical Center – The buildings that comprise the Medical Center campus are very close together, making it difficult for a transit system to operate within the complex. Therefore, it is likely that a new transit system would include a Medical Center access point somewhere at the periphery of the campus.

Historic Districts – Several historic districts exist throughout the study area that should be taken into consideration during detailed design. Any potential impacts to historic districts that would result from the implementation of a new transit system would need to be documented and reviewed with the appropriate agencies.

Floodplains, Parklands and Golf Courses – As shown on **Figure 6-1**, 100-year floodplains exist adjacent to the Huron River and extend through the south campus area along the existing railroad right-of-way. These floodplains will be a consideration during future phases of planning and design, as well as the presence of parklands and golf courses within the study area.

Connector Ridership

The WATS travel model was applied to estimate the ridership effects / sensitivity of various changes in transit service provided in the corridor. The transit component of the WATS model was not validated on the individual route or subarea level, but performed relatively well when routes were grouped to compare modeled and observed bus usage. Thus, the travel model output was used as a means to estimate the relative changes in transit service demand across the various alternatives. Prior to establishing a methodology for evaluating the alternatives in the WATS model, the study team reviewed the model documentation, discussed the study modeling approach with WATS staff, and worked with WATS staff to test various approaches to modeling the alternatives that the study team was going to be reviewing.

The general approach, displayed in **Figure 6-2**, for modeling alternatives was for the study team to make the necessary coding adjustments to the WATS model files and

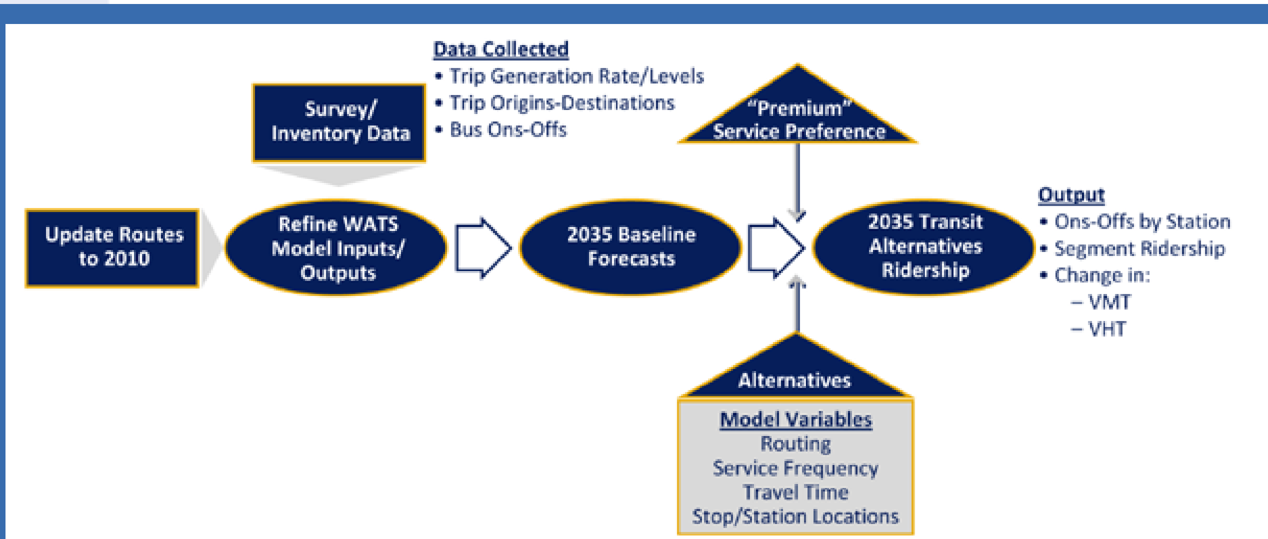


Figure 6-2: Transit Forecasting Approach
Source: URS Corporation

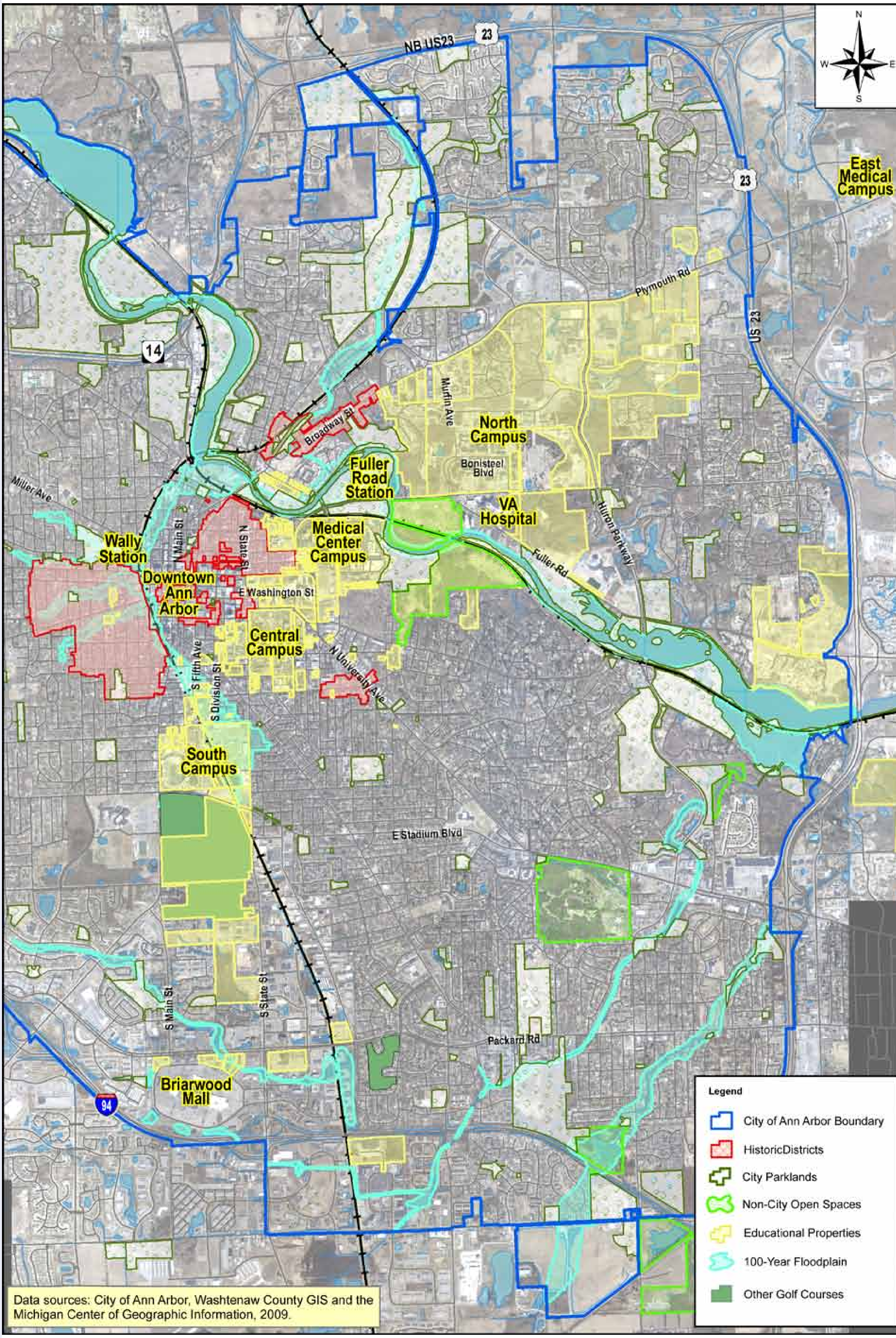


Figure 6-1: Engineering and Environmental Constraints
Source: URS Corporation

then provide the appropriate input files for all alternatives to WATS staff for them to run. The alternatives that were modeled, and the operating assumptions of each, are provided in **Table 6-1**.

Forecasting with the WATS Model

The study team and WATS staff worked through the following modeling process for developing the Alternatives Ridership forecasts:

- The first step was to establish an updated "baseline" existing conditions transit system. Several bus route changes had been implemented since the WATS model and its transit route file were established in 2008. The transit route file was updated to reflect the current bus route conditions in Ann Arbor, including the following changes:
  - Adding the Plymouth Road / US 23 Park and Ride (PNR) to the model
  - Extending AATA Routes 2A and 2B to reflect the service provided to the Plymouth Road park and ride
  - Splitting the AATA Route 8 service to reflect the current service, via both Pauline and Liberty Streets
  - Adding AATA Route 17 "Depot to Amtrak" service
  - Eliminating AATA "Link" route, which is no longer in service
  - Adding U-M Oxford route
  - Adding U-M Diag-to-Diag route
  - Adjusting service headways on several AATA and U-M routes to reflect current service levels
- The next step was to run the WATS travel model for both the 2010 and 2035 planning years with the updated baseline transit route file in place. A review of the 2010 baseline transit model results reflects a model snapshot of transit usage today. A comparison of these two baseline scenarios reflects the "natural growth" in corridor transit ridership due to forecasted changes in study area population and employment between 2010 and 2035.
- Once the baseline transit route model file was established, alternative-specific route files were developed for each Connector alternative. A generalized Connector alignment was used in the model runs, and some variations on the Connector corridor were run to get a general pattern of ridership in the corridor. WATS staff ran each alternative-specific set of input files developed by the study team. The alternative-specific characteristics that were adjusted for each alternative included:

Table 6-1: Operating Assumptions for Each Alternative
Source: URS Corporation

	Alternative	Guideway	Service Frequency
	**Light Rail Transit (LRT)**	Full Guideway for all 8.5 miles.	5 minute headways between North Campus and Central Campus; 10 minute headways East Campus to North Campus and Central Campus to Briarwood.
	**Bus Rapid Transit (BRT)**	Full Guideway for all 8.5 miles.	2 minute headways between North Campus and Central Campus; 10 minute headways East Campus to North Campus and Central Campus to Briarwood.
	**Bus Rapid Transit (BRT)**	Partial; 1.5 mile guideway implemented between U-M North Campus Commons and U-M Central Campus.	2 minute headways between North Campus and Central Campus; 10 minute headways East Campus to North Campus and Central Campus to Briarwood.
	**Elevated Technology (Monorail or Automated Guideway Technology (AGT)**	Full Guideway for all 8.5 miles.	5 minute headways between North Campus and Central Campus; 10 minute headways East Campus to North Campus and Central Campus to Briarwood.
	**BRT + LRT**	Full Guideway for all 8.5 miles; BRT operates on exclusive guideway for entire alignment. BRT shares guideway with LRT along 1.5 miles of guideway between North Cam-pus and Central Campus.	5 minute LRT headways; 10 minute BRT headways.
	**LRT + Streetcar**	Partial; 1.5 mile guideway implemented between U-M North Campus Commons and U-M Central Campus.	5 minute LRT headways; 10 minute Streetcar headways

  - Each alternative's travel times were based on estimates of technology-specific station-to-station travel times, compared to observed existing bus route travel times in the studied corridor. As documented in more detail below, the travel times were coded to be appropriate in model terms, so that they reflected the relative differences between alternatives in the model, not necessarily the absolute travel times between point A and point B. This was important, as the model estimates transit travel times in a manner that best fits observed travel times region-wide, and are not necessarily corridor or route-specific.
  - Service frequencies were coded to reflect the anticipated service headways for each alternative.
  - Transit stop locations were located along the connector corridor to reflect the approximate station locations identified in the conceptual travel time tables. In the model environment, stops were placed in locations that took advantage of connections to existing transit stops, transit routes, park and ride facilities and reasonable accessibility to adjacent TAZs.
  - Modeled stop accessibility was enhanced for the added Connector stations, so that there were appropriate opportunities for drive and walk access to stations.
  - Those alternatives that include a dedicated transit guideway were provided a transit-only set of highway links in the WATS roadway linefile so that alternative-specific travel times, independent of roadway congestion, could be modeled.

- As travel model output was received from WATS staff, the study team processed and analyzed it. The goal of these analyses was to compare the results of each alternative relative to each another, and to the baseline scenario. The starting point for the ridership forecast development was the observed / surveyed ridership information. Thus, the observed trip interchanges were the starting point for each alternative's ridership / service use, and each was adjusted according to the model-estimated ridership sensitivity to alternative-specific travel times and service frequencies.

Alternative Travel Times

The transit component of the WATS model was validated to reflect the current local fixed-route bus transit services offered in Washtenaw County. The model currently has two transit modes: AATA bus and U-M bus. The travel model estimates transit travel times for these two modes based on two variables from the input highway network: the route distance traveled and automobile travel time along the route corridor. Route distance is more heavily weighted than corridor automobile travel time in the model's travel time estimation methodology, so that estimated transit travel time is relatively consistent even in higher-speed corridors. Given the fact that the current transit services in Ann Arbor are local bus services with frequent stops, heavily weighting distance in travel time estimates makes sense, and provided a relatively good fit with observed route travel times when the model was validated in 2008.

The majority of advance transit technologies being considered for the Ann Arbor Connector study are not local bus services. The WATS model has the built in capability to expand its mode choice and transit assignment portions to accommodate advanced transit technologies, but the survey data and observed patterns are not present in Ann Arbor to provide a valid basis for doing so. Thus, the study team decided to model the premium bus services within the model's existing local bus model, but adjust the approach to estimating each alternative / technology's corridor travel times. The study team worked with WATS staff and WATS' model consultant to adjust the model script to allow transit travel speeds that were technology / alternative specific. Study team staff estimated and entered these travel speeds in relative model terms to the current on-street bus routes. The travel time estimated for each technology from one end of the corridor to the other was:

- Baseline Local Bus: 36.1 minutes
- Bus Rapid Transit (BRT): 31.4 minutes
- Light-Rail Transit (LRT): 30.6 minutes
- Elevated Transit: 23.5 minutes

Premium Service Ridership Bias

Our forecasting methodology used the WATS travel model to simulate an advanced transit technology (BRT / LRT / Streetcar / Elevated Transit) using parameters intended to reflect local bus service. While the modeling effort used the appropriate travel times and service frequencies reflecting the advanced transit service, there is a documented "mode bias factor" associated with a premium transit service that is not currently reflected in the WATS model environment. This means that advanced transit services that have amenities such as dedicated guideways, upgraded stations, premium transit vehicles and line-specific branding typically draw significant ridership increases compared to traditional bus lines that provide the same service frequencies and travel times. TCRP Report 118, Bus Rapid Transit Practitioner's Guide, provides a methodology for converting the descriptive service elements into ridership enhancements. Based on the assumed elements likely to be incorporated into the advanced technology alternatives, it was estimated that selected model-derived Connector area-to-area interchanges could be increased by approximately 21 percent to reflect the advanced transit service bias.

The advanced transit service bias factor was only applied to the forecasted origin-destination ridership for areas with access to the premium Connector service and located outside the university campuses. It has been assumed that users along the Connector route between South Campus, Central Campus and North Campus represent a relatively captive market that would be much more impacted by the reduced travel time and not the service "premiums". This assumption is based on the belief that transit is already the most viable option for the majority of the inter-campus trips, as parking costs and limited supply make auto travel difficult for most campus locations, and walking between campuses takes much longer than the convenient / frequent bus service already available.

Ridership Estimation Results

Station-to-station ridership estimates were developed for the range of technologies based on the process described above. Bus rapid transit technology was used to develop the travel forecasts provided in this document, but it should be noted that the ridership associated with the various premium modes along the Connector corridor was not particularly sensitive to the individual technology selected. The 2035 Connector corridor ridership results are documented in **Figure 6-3**. For comparison purposes, ridership estimates were also developed for 2035 baseline conditions, assuming that the current bus system was maintained through the year 2035. Ridership estimates for the 2035 Baseline condition are also shown, generalized to represent bus ridership in the Connector corridor. A single forecast for the Connector improvement is provided as there was not a substantial difference in the segment ridership between any of the technology alternatives.

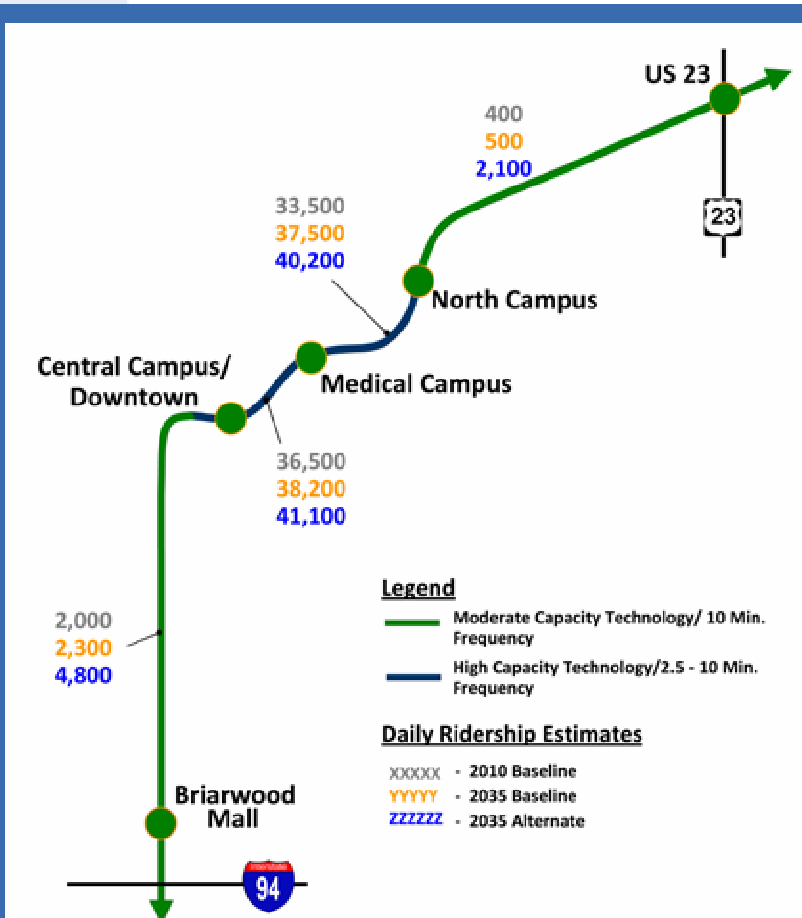


Figure 6-3: Forecasted Daily Transit Ridership
Source: WATS Travel Model and URS Corporation

A profile of the station-to-station ridership is displayed in **Figure 6-4**. The station-to-station ridership profile provides additional detail on the number of people getting on and/or off at each station and the number of riders on-board between stations. From the profile the

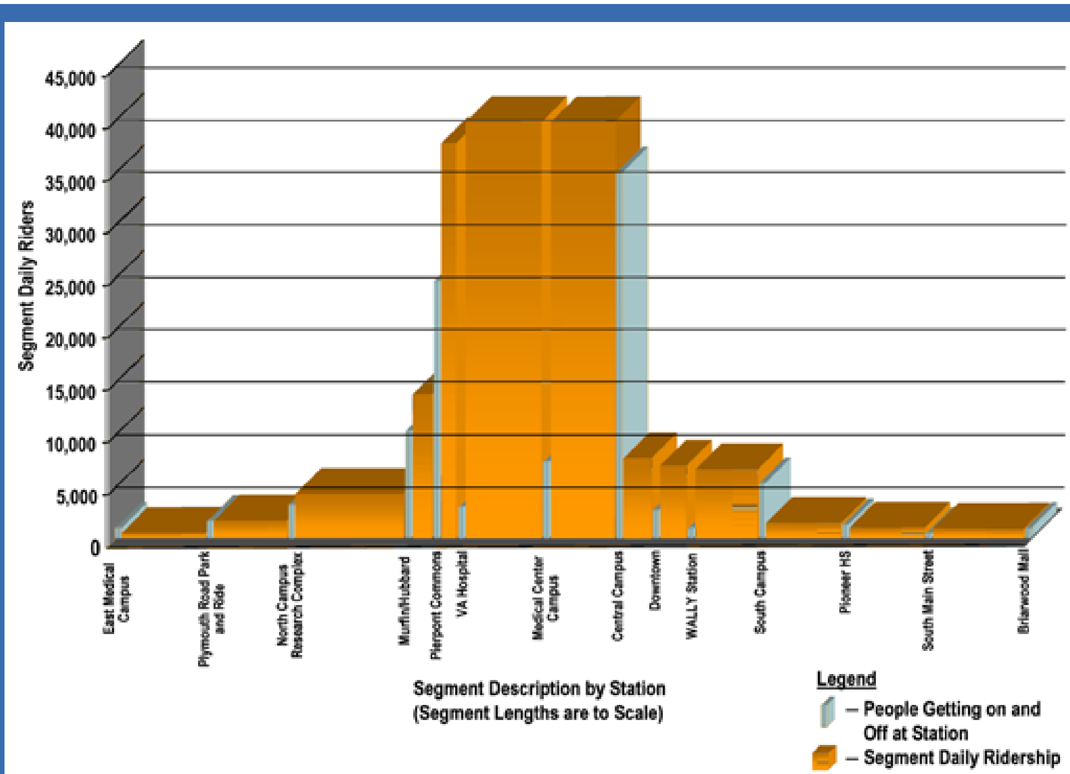


Figure 6-4: 2035 Station-to-Station Rider Load Profile
Source: WATS Travel Model and URS Corporation

following can be observed:

- The Central Campus Station would be the most active with approximately 35,000 people getting on and/or off on a daily basis (forecast year 2035).
- The Pierpont Commons Station on the North Campus would be the next most active station with approximately 25,000 people getting on and/or off.
- A station at Murfin/Hubbard that would serve the North Campus residence halls and parking areas would generate approximately 10,000 ons and offs in 2035.
- Segment ridership between Pierpont Commons and Central Campus is forecasted to be the highest of the entire corridor, carrying 37,000 to 40,000 people per day.
- Outside the portion of the corridor between the North Campus and Central Campus ridership would be much lower than in the core between the primary campuses. Outside the core, the highest segment volume for the 2035 horizon ranges from 7,000 to 10,000 riders per day. Many of the segments outside downtown and the campus, ridership forecasts for 2035 range from 3,000 riders to less than 1,000 per day.

This feasibility study evaluated a generalized corridor that connected the various activity areas across the study area. No specific corridor was selected as a preferred alignment for this study. However, based on evaluations of focusing the improvements on various improved transit corridors, and replacing some redundant local bus routes with that service, there is the potential for some isolated areas of reduced service levels with a Connector concept. This is particularly true on the North and Central campuses, which currently have inter-campus routes that serve various sectors of each campus. For instance, an alignment that focuses on serving the North Campus residential buildings and Pierpont commons along Hubbard Road and Murfin Avenue would potentially provide reduced access to system users in the southeastern part of the North Campus. Similarly, a Connector line that runs along the north side of Central Campus might not provide as much intra-campus connectivity as current bus routes such as the Commuter Route. Thus, while there would likely be improved point-to-point service with a premium Connector transit service, those areas not adjacent to Connector stations could potentially have reduced transit accessibility.

Roadway Systems Operations

Implementation of an advanced transit technology in the Connector corridor has the potential to increase transit use in the corridor. A portion of the change in transit system ridership would come from a mode shift from auto trips to transit trips. The mode shift would be connected to the combination of reduced travel time and improvement in the reliability of a specific time relative to the auto mode. Reduction in the total number of autos assigned to the network, associated with the forecasted mode shift to a higher end transit service, would improve the quality of traffic operations along key corridors. **Table 6-2** highlights the 2035 Baseline and 2035 Connector macroscale travel statistics for the Ann Arbor area. Findings observed through the table information are:

- Implementation of the Connector service would reduce the overall vehicle miles of travel in the region by approximately 0.6 percent.

Descriptor	Period/Alternative					
	2010	2035		Change		
		Baseline	Alternative 2	‘10 to ‘35 Base	‘10 to ‘35 Alt 2	‘35 Base to ‘35 Alt 2
Vehicle Miles of Travel	2,367,234	2,544,048	2,528,497	7.5%	6.8%	-0.6%
Congested Vehicle Miles of Travel	690,368	1,072,049	1,055,738	55.3%	52.9%	-1.5%
Percent of VMT in Congested Conditions	29.2%	42.1%	41.8%	44.5%	43.2%	-0.9%
Vehicle Hours of Travel (Freeflow)	64,843	69,560	69,024	7.3%	6.4%	-0.8%
Vehicle Hours of Travel (include Congestion)	76,202	88,156	86,976	15.7%	14.1%	-1.3%
Congested Vehicle Hours	11,359	18,596	17,952	63.7%	58.0%	-3.5%

Table 6-2: Regional Travel Statistics (2010 and 2035)
Source: WATS Travel Model and URS Corporation

- Implementation of the Connector service would reduce the overall vehicle hours of travel by approximately 1.3 percent.
- The Connector service has the potential to reduce the congested travel by approximately 17,000 vehicle miles per day and over 600 vehicle hours per day.

Capital Cost Estimates

Preliminary capital cost estimates were completed for each of the alternatives retained for further consideration. The following elements were considered in each of the estimates, as applicable:

- Civil construction
- Guideway
- Freight Rail Reconstruction
- Structures
- Stations
- Park and ride
- Fare collection
- Maintenance facility
- Traction power
- Signal system
- Communications
- Vehicles
- Utility relocation
- Professional services
- Contingency

Right-of-way costs were not considered for the purposes of this study. While each alternative has unique features, the civil construction, guideway, structures and vehicle elements were the primary cost drivers for these estimates. A detailed description of the methodology used to derive the capital cost estimates is located in **Appendix B**.

The preliminary capital cost estimates are shown in the **Table 6-3**, in 2010 dollars. Detailed cost estimates for each of the alternatives are located in **Appendix C**. These preliminary cost estimates are intended to show relative differences in cost between each of the alternatives and are not meant to be indicative of the true cost of any system, as costs will be further refined during more detailed phases of future study.

Operating and Maintenance Costs

- Operating and maintenance (O&M) costs are a key component in determining the overall cost of a new transit system. To estimate these costs, the study team developed a model of operating costs for each transit technology that related operating cost line items (per 2008 National Transit Database data) to independent variables specific to each technology as noted in **Table 6-4**.

The following assumptions were used in estimating these costs for each of the alternatives:

	Total Estimate	Cost per Mile
Light Rail Transit (LRT)	$522 - $542 M	$61 - $64 M
Bus Rapid Transit (BRT) (end-to-end guideway)	$176 - $186 M	$21 - $22 M
BRT (guideway between North and Central Campus)	$130 - $140 M	$15 - $17 M
Elevated Technology (full guideway)	$1.7 - $1.9 B	$200 - $224 M
Elevated Technology - Core Segment Only	$350 - $400 M	
BRT + LRT	$312 - $322 M	$37 - $38 M
LRT + Streetcar	$490 - $500 M	$58 - $59 M

Table 6-3: Capital Project Cost Estimates (2010$)
Source: URS Corporation

	Variables
LRT	Number of vehicles running during peak times
	Annual revenue train-hours
	Annual revenue car-miles
	Directional route-miles
	Number of passenger stations
	Number of vehicle maintenance yards
BRT	Number of buses running during peak times
	Annual revenue vehicle-hours
	Annual revenue vehicle-miles
	Number of new bus garages (assumed to be zero)
Elevated Technology (based on LRT model)	Number of vehicles running during peak times
	Annual revenue train-hours
	Annual revenue car-miles
	Directional route-miles
	Number of passenger stations
	Number of vehicle maintenance yards
Streetcar	Number of vehicles running during peak times
	Annual revenue train-hours
	Annual revenue car-miles
	Directional route-miles
	Number of passenger stations
	Number of vehicle maintenance yards

Table 6-4: Operating and Maintenance Costs Variables
Source: URS Corporation

- LRT costs were based on the Metro Transit LRT in Twin Cities, MN
- Streetcar costs were based on costs for Metro Transit and systems in Memphis and Tampa
- Bus costs were based on AATA & U-M National Transit Database statistics
- 3% inflation rate

All costs were escalated to 2010 dollars.

The proposed changes to existing transit service, as shown in **Table 6-5**, were also considered when determining the net change in O&M costs resulting from the implementation of an advanced transit technology. This included the additional costs resulting from the implementation of new Circulator bus service and the cost savings generated by the modification or elimination of existing routes that would be adequately served by the new transit service.

To determine the cost savings generated by modifying or eliminating existing service, the annual vehicle miles traveled along each section of eliminated bus service was multiplied by the cost per revenue bus mile identified by the National Transit Database. A cost of $6.18 was used for changes to U-M routes, and $8.08 for changes to AATA routes. The cost of the two proposed new circulator routes was estimated by multiplying the estimated annual vehicle miles traveled for each of the routes by the U-M cost per revenue bus-mile of $6.18. **Table 6-6** summarizes the costs associated with the proposed bus service changes.

Net operating costs are:

- O & M costs for Connector service
- Less O & M costs for eliminated bus service
- Plus O & M costs for proposed Circulator service

	Bus Operating Cost (2008)	Annual Bus Revenue Miles	Annual Bus Revenue Hours	$ per Bus Revenue Mile	$ per Bus Revenue Hour
AATA**	$19.0 M	2.35 M	185,000	$8.08	$102.49
U-M	$5.9 M	953,000	101,000	$6.18	$58.32
Total:	$24.9 M	3.3 M	286,000	$7.55	$87.06

Table 6-5: Existing Operating and Maintenance Costs

*Source: 2008 National Transit Database
** AATA operations also include $4.7 M for Demand Response service

Cost Savings on Eliminated Routes							
	Mitchell Express	North Campus	Northwood	Northwood Express	Bursley-Baits	Diag-to-Diag Express	TOTAL COST SAVINGS
U-M Cost per Revenue Bus-Mile: $6.18	$142,030	$321,655	$772,831	$515,219	$824,594	$161,365	$2,737,694

Cost Savings on Modified Routes					
	AATA Route 7: S. Main - East	AATA A2Express - Canton	U-M Commuter North	U-M Commuter South	TOTAL COST SAVINGS
AATA Cost per Revenue Bus-Mile: $8.08 U-M Cost per Revenue Bus-Mile: $6.18	$452,754	$77,120	$681,639	$578,933	$1,790,446

Cost of Proposed New Routes			
	Northwood Shuttle	Baits/Stone Shuttle	TOTAL COST
U-M Cost per Revenue Bus-Mile: $6.18	$1,198,723	$1,289,390	$2,488,113

Total Cost Savings Realized from Route Adjustments		
Cost Savings (Eliminated + Modified Routes)	Cost of Proposed New Routes	TOTAL COST SAVINGS
$4,528,140	$2,488,113	$2,040,028

Table 6-6: Net Cost of Route Adjustments
Source: URS Corporation

Table 6-7 summarizes the net change in O&M costs for each alternative.

Land Use and Economic Development

Impacts to land use and development are an important factor to consider when analyzing potential transit investments in a corridor. Recent examples from around

	Total Incremental Connector O&M Costs ($2010)	New Circulator Bus O&M Costs ($2010)	Cost Savings (Eliminated + Modified Routes; $2010)	Net Change In O&M Costs ($2010)
Light Rail Transit (LRT)	$11.5 M	$2.5 M	-$4.5 M	$9.5 M
Bus Rapid Transit (BRT) (end-to-end guideway)	$5.8 M	$2.5 M	-$4.5 M	$3.8 M
BRT (guideway between North and Central Campus)	$6.6 M	$2.5 M	-$4.5 M	$4.6 M
Elevated Technology	$13.0 M	$2.5 M	-$4.5 M	$11.0 M
BRT + LRT	$7.6 M	$2.5 M	-$4.5 M	$5.6 M
LRT + Streetcar	$9.4 M	$2.5 M	-$4.5 M	$7.4 M

Table 6-7: Change in Operating and Maintenance Costs
Source: URS Corporation

the U.S. have demonstrated that a transit investment can provide a boost to the local development market, particularly in urban environments that offer the potential for transit-supportive uses.

In addition to local interest in land use and development, the federal government has recently placed a greater emphasis on these and other “livability” factors when considering qualifying projects. Enacting land use and development policies that complement and support a transit investment will improve the case for receiving highly competitive grant funding.

Potential Impacts of Transit

Transit investments in a corridor have the potential to impact land uses and economic development in two interrelated ways:

- ***Property value***: Like other transportation investments, transit improves the accessibility and thus the attractiveness of property. Numerous studies have shown an increase in property values near to rapid transit stations, particularly for transit-supportive land uses such as residences, retail/entertainment businesses, and office buildings.
- ***Adapted/intensified land uses***: Fixed-route transit allows for the development of dense transit-oriented development (TOD) districts and corridors that could not otherwise be created. These are increasingly attractive living environments for the demographic groups (i.e., young professionals and empty nesters) that are understood to drive regional economic growth.

It is important to note that while the above impacts are potential results, the relationship between transit and development is complex and interdependent, with numerous other intervening factors contributing to end results, including land use policies, local market conditions, geography, environmental issues, development types, etc., as discussed later in this section.

Impacts by Transit Mode

The level of impact may also vary depending on the mode of transit. Rapid transit service along a fixed route provides a permanent asset to a corridor that sends a positive signal to the development community. By contrast, development of additional local and/or express bus service along the corridor may help meet the transportation needs of existing corridor residents and employees, but is unlikely to provide the impetus for a significant change in land use or economic development patterns or trends. In addition, higher-density, mixed-use development types are less likely to gain development approval or generate buyer demand required for financial feasibility without the presence of fixed-route service.

Most of the established research on the land use impacts of transit is related to light-rail and streetcar investments, and thus these modes have more well-documented economic development impacts in urban areas across the United States. A few examples include:

- In ***Minneapolis***, the 12-mile Hiawatha Light Rail connects downtown Minneapolis with the regional airport. Even though there was not a coordinated planning effort along the corridor when it was built, developer interest in the station areas motivated the City to conduct station area planning and rezoning at numerous stations. Through March 2009, more than 7,500 housing units have been built in the corridor, significantly surpassing initial estimates for development trends.

- In ***Charlotte***, the 9-mile Lynx Blue Line Light Rail was planned as a way to focus development within this regional corridor, and has successfully driven increases in property value and development. For the period between 2005 and 2011, CATS has counted / projected the creation of 265 acres zoned for TOD, 7,581 housing units, 180 affordable housing units, and more than 625,000 square feet of commercial space, contributing to a total of $1.87 billion in private investment along the Blue Line. Charlotte is also planning a 1.5-mile streetcar line serving the downtown that is not yet fully built, but is already driving redevelopment of major parcels as mixed-use urban infill.
- In ***Seattle***, the South Lake Union Streetcar line is a 1.3-mile service that has successfully helped in efforts to redevelop the South Lake Union neighborhood as a high-density, mixed-use area. As a result of this investment, major bio-tech industry employers have located within the neighborhood, including the University of Washington, Fred Hutchinson Cancer Research Center, Seattle Biomedical Research Institute, and Group Health Cooperative. The residential construction activity has supported infill retail and commercial development, including the construction of a Whole Foods grocery store, Flying Fish restaurant, and Pan Pacific Hotel.

Seattle, WA South Lake Union Streetcar
Source: www.MinnPost.com

A high-amenity BRT service (with dedicated lanes, limited stations with shelters, etc.) may have similar development impacts to light rail and streetcar, although there are fewer demonstrated case studies “proving” this effect. While a relative few regions have made investments in full-scale BRT in an urban corridor, several North American examples have begun to demonstrate that BRT can have a similar impact to rail-based rapid transit (as more regions begin to implement BRT as a cost-effective transit solution, the body of research around impacts from this mode will grow). These examples suggest that BRT system does not automatically lead to development impacts, but must be part of a comprehensive strategy linking the investment to property value appreciation and changing land use patterns.

- In ***Cleveland***, the seven-mile HealthLine (Euclid Corridor) BRT project began operating in 2008. Its construction has been attributed as a major factor leading to redevelopment of this urban corridor, which has experienced 7.9 million square feet of new commercial development and 5,400 new residential units in the past few years. Importantly, the City combined its investment in full-scale BRT (including dedicated running ways and full stations integrated into the surrounding streetscape) with planning for complementary urban scale development. A portion of the new development has been by quasi-public institutions including the Cleveland Clinic, Cleveland State University and Case Western Reserve University.

Cleveland HealthLine in University Circle
Source: Goddard Rocket

- In ***Eugene***, home of the University of Oregon, the four-mile Emerald Express BRT began operating in 2007. There was no significant planning for transit-supportive land uses in the corridor, although the level of service was high, with a dedicated lane and limited stations with shelters. Spin-off developments have been minimal in the corridor, even though local realtors do attribute increased interest in adjacent property to the construction of the EmX line. This impact has spurred the City encourage higher density development as it works on the next phase of the project (the Gateway extension – due to open in 2011). In anticipation of this service, a 13-acre parcel adjacent to the line recently sold for $5.8 million, and there is also a major new healthcare complex that is being integrated with the route design.

- In ***Pittsburgh***, the region has a long history of dedicated busways used to provide rapid transit service including the Martin Luther King, Jr. East Busway, a 9-mile corridor opened in 1983. A recently completed study on the residential property values found that, similar to many rail-station studies, property value decreases as the distance from a bus rapid transit station increases. In fact, the study quantified a price difference of nearly $10,000 for a property 100 feet away from a station as compared to 1,000 feet away. This was one of the first complete studies of the impact of bus rapid transit stations on property values.

Based on current knowledge about the land use impacts of transit by mode, **Table 6-8** summarizes some of the potential land use impacts for the alternatives being considered as part of the Ann Arbor Connector Feasibility Study.

Mode	Potential land use impacts
Local Bus	Impacts likely to be minimal. Little evidence to show that local bus service in a corridor has a significant impact on surrounding land uses other than apartment vacancy rates.
Bus Rapid Transit	Impacts are variable and dependent upon factors such as the level of investment in stations and service and coordination with local planning and development incentives. When the service is perceived as different from local bus service, presence of TOD impacts may increase.
Light Rail Transit	Documented land use impacts in major urban regions (Dallas, Denver, Charlotte, Minneapolis). TOD areas may be more distributed due to station spacing, although highly concentrated around station areas. Specific development types may depend on existing surrounding land use types.
Streetcar	Documented land use impacts, particularly when serving mixed-use downtown districts (Portland, Seattle). Streetcar projects are often built with economic development as a major goal, but are most suitable for short (<3 mile) high-density urban corridors.
Elevated / AGT	Very few new elevated transit corridors, making it difficult to gauge impact. Would be expected to provide similar potential to light-rail transit, but with less street-level activity as compared to an at-grade alternative.

Table 6-8: Summary of Potential Land Use Impact by Transit Mode
Source: URS Corporation

Other Factors Influencing Land Use

While the creation of a major new transit investment in the corridor offers the opportunity for significant land use impacts, there are a variety of other factors that will influence the potential for transit-oriented development. Research from the Federal Transit Administration (FTA) has identified five primary factors which can be assessed to help predict the potential for economic development related in areas adjacent to transit. These are:

1. ***The developability of land in station areas***: The extent to which additional development could be physically located within a station area, usually due to the presence of vacant or underutilized opportunity sites.

2. ***Land use plans and policies encouraging transit-supportive development***: The extent to which high-density, mixed-use land uses are permitted or encouraged near transit.

3. ***The economic climate for development***: The health of the local regional economy and its ability to support new growth adjacent to transit. That is, transit may complement or focus existing development demand in a region, but is not likely to generate new development demand in a poor economic environment.

4. ***The accessibility benefits of the project***: The extent to which the transit line is a valuable transportation resource that provides accessibility and mobility to the corridor. This suggests that a transit project must first serve a viable transportation need before it can be considered to offer economic development benefits. It also speaks to the importance of pedestrian accessibility in and around the transit asset.

5. ***The permanence and scale of the transit investment***: Case study research demonstrates a stronger correlation between fixed-guideway projects and land use impacts.

As noted above, existing economic trends as well as local planning and policy initiatives will have a major impact on whether transit-supportive development can occur. Having complementary land use policies in place will also make the project much more viable when it comes to obtaining funding from the federal government.

Land Use Impacts in the Ann Arbor Corridor

The potential for land use impacts in the corridor under study would be dependent on not only the particular transit mode suggested but also the existing land uses, opportunity sites, and planning guidance within each particular station area along the corridor. It will also be dependent on the attractiveness of the transit as a transportation resource, as a line with high ridership will be significantly more likely to spur economic activity in the corridor than one with less.

As a potential project is refined and studied, it would be advisable for the City and other interested stakeholders to analyze the potential for impacts along the corridor so that the alternative can be designed with positive land use impacts in mind, and also so that land use plans and policies can be aligned with opportunities for redevelopment.

This would involve looking at each potential station site in the corridor to determine the development potentials within a ¼-mile of the station (where most of the potential for higher-density transit-oriented development would be likely to occur) and ½-mile of the station area (the area where property values are most likely to be impacted). Prior to the design of a fixed-guideway transit service in the corridor, the City should evaluate the block-by-block opportunities located around each proposed station area, and ensure that existing policies and incentives would allow the positive impact to occur.

PUBLIC INVOLVEMENT

Goals, Objectives and Desired Outcomes

The goal of the public involvement process is to continue and extend the public involvement activities previously undertaken by the sponsors both collectively and individually. The process facilitates a dialogue that will inform the public about the different possible transit technologies that could improve accessibility and increase economic development. The development of the Ann Arbor Transportation Plan included a thorough public involvement process which included three public meetings, three newsletters and website access for project information and collection of comments. In addition, the City of Ann Arbor, Ann Arbor DDA and AATA each held public meetings as a part of the funding approval process for this feasibility study. All public involvement activities comply with FTA guidelines.

Study Participants

A successful public involvement process relies on the ability to engage the public in a meaningful way. The objective of the public involvement process used both traditional and non-traditional methods to convey the key messages of the project and to obtain input from the public and key stakeholders.

The following describes the project participants.

Study Management Committee (SMC) – Members of the SMC include the following:

- City of Ann Arbor – Represented by Eli Cooper
- City of Ann Arbor Downtown Development Authority – Represented by Roger Hewitt & Susan Pollay
- Ann Arbor Transportation Authority – Represented by Chris White, Michael Ford, Dawn Gabay
- University of Michigan – Represented by Sue Gott, Bitsy Lamb and Steve Dolen
- Washtenaw Area Transportation Study – Represented by Terri Blackmore

The SMC provided project oversight, direction, transportation modeling services and funding. Regular monthly meetings were held with the consultant to review and approve deliverables prior to publication.

Stakeholders – The 2009 Ann Arbor Transportation Plan list of stakeholders was the starting point for identifying stakeholders who needed to be actively involved in the project. Members included groups and their representatives who had or may have had a direct impact on or benefit from the study. The group of stakeholders expanded as the project progressed with participants added primarily after the public meetings. The potential stakeholders are listed in **Appendix D**.

Public at Large – Persons without a direct affiliation with a generally recognized organization were invited to participate in the study through on-going access to web-based information, newsletters and two public workshops. Attendance sheets at the public meetings were used to expand the list of stakeholders.

Key Messages

The key messages conveyed throughout the process centered on the need to educate the public and stakeholders about advanced transit technologies while addressing the technical, financial and political feasibility of implementing transit improvements. The timing of this project was significant, as the City of Ann Arbor and U-M were developing future land use plans that will incorporate transit options and the Ann Arbor Transportation Authority initiated a Transit Master Plan project.

Educating stakeholders and the public about alternative transportation modes and their applicability to future growth scenarios continued throughout the project. Initial messages focused on education and familiarity with other cities where these innovative transit systems exist.

One-on-One Interviews

In order to derive a sense of the issues and interests of key stakeholders, the consultant team and members of the SMC met individually with the following representative from the business community and public agencies.

- Michael Ford, Director AATA
- Michael Finney, President and CEO, Spark
- Carmine Palombo, SEMCOG Director of Transportation
- With Bob Guenzel, Washtenaw County
- Mike Martin, First Martin Development
- Mayor John Hieftje, Mayor, City of Ann Arbor
- Tim Hoeffner and Al Johnson, MDOT Office of High Speed Rail and Innovative Project Advancement
- Peter Allen, President, Peter Allen and Associates

RSVP Focus Groups

Two Focus Group sessions were held to obtain input and develop a dialogue between the SMC, the stakeholders and community representatives.

Focus Group Meeting #1 – Attendees

- Kari Martin, MDOT

- Rick Nau, URS
- Theresa Petko, URS
- Maura Thompson, Main Street Area Association
- Ray Dettler, U-M
- Clark Charnetski, Local Advisory Council
- Michael Benham, Ann Arbor Transportation Authority

Focus Group Meeting #2 – Attendees

- Rick Nau, URS
- Theresa Petko, URS
- Larry Deck, Ann Arbor Biking and Walking Coalition
- Evan Pratt, Ann Arbor Planning Commission
- Les Sipowski, City of Ann Arbor Traffic Engineer
- Marc Start, URS
- Tim Hoeffner, MDOT

Common themes emerged from these meetings and are summarized below:

- People are generally happy with the existing AATA bus service within the City of Ann Arbor.
- More public transportation connections are needed to communities outside of the City.
- There is a lot of support for the proposed Washtenaw and Livingston Line (WALLY) and the Ann Arbor – Detroit Regional Rail Project.
- There is a need for cleaner and "greener" transportation alternatives to driving single-occupancy vehicles.
- Expanded evening and weekend service is needed.
- There are a lot of concerns about funding for possible transit improvements.
- Improved transportation infrastructure has the potential to contribute to increased property values and provide the opportunity to add density without sprawl

Website

A project website (www.aaconnector.com) was kept up to date with information related to the public meetings and contained copies of the newsletters, public presentations, frequently asked questions. There was also an opportunity to submit questions. There were limited inquiries made to the site. The study partners also provided links to the website.

Newsletters

The three newsletters published and distributed tracked the study's progress from the project introduction and purpose, to initial findings and potential transit technologies available to the recommended transit technologies. In addition to mailing paper copies to previous and current study participants, the newsletter was placed on the projects website and the SMC websites. Copies were also sent electronically to participants who indicated a preference for receiving electronic copies. See **Appendix E** for copies of these newsletters.

Public Meetings

Public Meetings provide an opportunity to engage the general public and facilitate discussions. The Open House format used included a brief introductory presentation, question and answer period as well as an opportunity for the attendees to approach study team members directly to ask questions and discuss any concerns.

Open House Meeting #1

The first public information meeting for the Ann Arbor Connector Feasibility Study was held on June 8, 2010 from 6:30 p.m. to 8:30 p.m. in the Downtown Branch of the Ann Arbor District Library. The library hosted the meeting as part of its events program, thereby exposing the project to a broad public audience. The meeting was video taped as part of the events program and the video was made available through the library site. Additionally, the video was posted to the project website, and copies of the video recording of the meeting were available to the Study Management Committee to post on their individual agency websites.

This first public meeting served to introduce the project and its sponsors and to provide background and education of what transit technologies would be considered as part of the study. Large print boards were provided for the public to view with information on the study findings to-date. Comment cards distributed at the meeting were used to gauge the effectiveness of the presentations.

Nearly 50 people attended the meeting and 15 attendees completed comment cards. Press coverage occurred in the Ann Arbor Chronicle and the Transport Politic, which are electronic media publications. Comments from these electronic sources extended beyond the immediate Ann Arbor area and in some cases prompted comments from readers in France.

Comments obtained at and subsequent to the public meeting reflected similar themes to comments obtained during the One-on-One and RSVP Focus Group meetings. The feedback received showed public support for increased connectivity outside of the Ann

Arbor area, praise for the service provided by the existing systems, and the need for more integration between the AATA and U-M systems. Concerns about integrating public transit with bicycle travel were also expressed in the comments received after the meeting.

Comments obtained from responses to the electronic newspapers ranged from support of advanced transit technologies, to improving efficiency and encouraging economic development, to skepticism of the costs and responsibilities for paying for a system. Some commented about comparative transit experiences in other cities such as Cleveland, Ohio and Minneapolis, Minnesota and that perhaps a Bus Rapid Transit (BRT) would be appropriate for a city the size of Ann Arbor. Other concerns centered on the distribution of ridership between the U-M transit riders and the City of Ann Arbor riders. A complete summary of the public involvement component of Open House #1 is located in **Appendix F**.

Open House Meeting #2

The second open house meeting for the Ann Arbor Connector Feasibility Study was held on November 15, 2010 from 3:00pm to 8:00pm at the downtown Ann Arbor District Library. The public was invited to attend either of two sessions (3:30 p.m. to 5:30 p.m. or 6:30 p.m. to 8:00 p.m.). The City of Ann Arbor's Community Television Network (CTN) taped the first session and aired the meeting on December 3 through 5, 2010 and December 12, 2010. The meeting video is available online at http://a2govtv.pegcentral.comand for posting on the websites of the Study Management Committee and the project's website.

The second public meeting served to present the findings of the study to the public, answer questions relating to advanced transit technologies, and receive public input about the findings. A handout describing discussion points was distributed at the meeting and was used to gauge the effectiveness of the information presented.

Approximately 40 people attended the meeting and 11 people provided comments on the discussion point handout sheet. Two comments were made on the study's website prior to the second open house. Press coverage occurred in the Ann Arbor Journal and Concentrate, which are electronic media publications. No comments were made on either article.

Based on the comments received and made at the open house, the public generally agreed that the information presented explained the need for new service based on alternative transit technology through the greater Ann Arbor area, and that improved transit would be beneficial to the community. Further, comments emphasized that reducing automobile traffic and congestion as a priority, and indicated the need for a connection in the Plymouth Road/Downtown/State Street corridors. Concerns expressed centered around future routes for transit and what would happen with current transit systems. A complete summary of the public involvement component of the Open House is located in **Appendix F**.

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FINDINGS AND RECOMMENDATIONS

Is there a need for some type of alternative transit system in Ann Arbor?

Yes, there is a need for some type of advanced transit system to connect key destinations in the City of Ann Arbor and support a sustainable system of transportation and land use. As discussed in more detail below, the need for an advanced transit system is justified by the level of existing and forecasted ridership relative to the capacity of the existing bus service, the lack of reliability and delay associated with buses operating in mixed traffic, and the need for more sustainable options to support long term transportation planning goals of the City, the University and the region.

Existing and Forecast Ridership - There are currently over 30,000 transit trips per day between the North Campus and the Central Campus of the University of Michigan. These trips are all accommodated by the existing U-M bus system which provides approximately 870 bus trips per day between the campuses. Ridership on an advanced transit system is forecasted to exceed 40,000 trips per day in the segment between the North Campus and the Central Campus. This level of ridership is well within the range of what other cities have determined to be supportive of advanced transit technologies. As shown in **Table 8-1**, a number of other light rail lines in cities across the country have ridership similar to what is forecast for Ann Arbor.

Transit Line	Location	Average Weekday Ridership[1]
Hiawatha Light Rail	Minneapolis, MN	33,500
Valley Metro	Phoenix, AZ	39,200
Central Light Rail	Baltimore, MD	29,500
Houston METRORail	Houston, TX	34,600
Lynx Light Rail	Charlotte, NC	21,600
TRAX and FrontRunner Light Rail	Salt Lake City, UT	42,200

Table 8-1: Light Rail Transit Ridership of Major Cities

[1] American Public Transportation Association, Light Rail Transit Ridership Report, Second Quarter, 2010.

Capacity of Existing Buses - Approximately 18% of all U-M buses operating between the North and Central Campus are over 75% full counting both seated and standing capacity. During peak periods (class changes) buses are full, and people are often left waiting at the busiest stops. Given these current conditions, continuation of the existing conventional bus service is unlikely to support projected growth in transit ridership demand.

Long Term Planning Goals - Previous transportation planning studies for the city contain a number of common themes, including a desire for sustainable transportation, support of non-motorized travel, minimization of road expansion, and the increased use of transit. The need for consideration of advanced transit options for the city is supported by the results of these studies as well as current and projected conditions of the transportation system. Most recently, the need for consideration of advanced transit options was identified in the May 2009 Transportation Master Plan Update (TMPU). This report identified a number of "signature transit corridors", including the Plymouth-Fuller and State Street corridors, where high capacity transit should be considered.

Reliability and Delay – The bus travel time between North Campus and Central Campus varies between 7 and 13 minutes. Delay is caused by bus stop dwell time for passenger loading and unloading and traffic signals along the way. The current bus system operates on city streets and experiences the same congestion as other vehicular travel. As traffic congestion increases, bus transit travel times can be expected to increase and reliability of service will diminish. An advanced transit system on exclusive right-of-way, wholly or in part, would help to provide a transit travel time advantage and more reliable service.

Is an advanced transit system for Ann Arbor technically feasible?

While there are a number of physical and operational constraints that will need to be addressed to develop an advanced transit system that satisfies demand, it appears that there are technically feasible solutions available.

The most significant operational constraint is the demand associated with accommodating student class schedules. The demand for service between campuses has a significant short term peak, significantly higher than the average hourly demand. The existing bus service is structured directly in response to this demand peak. An advanced transit system operating plan needs to structure frequency of service and vehicle capacity to respond to peak demand. This will be an operational challenge but appears to be technically feasible.

The primary physical constraint is the crossing of the Huron River, along with the adjacent floodplains and parklands. There are also constraints associated with crossing or operating within existing street and railroad rights of way. The alignment for the advanced transit system needs to be designed to provide convenient and proximate access to activity centers. Conceptual engineering analysis indicates that the physical constraints can be addressed, but recognizes that there will need to be tradeoffs between impacts, operations and cost. Future engineering design will need to develop cost effective solutions that minimize impacts to environmental resources.

What type of advanced transit technology fits best in the community?

The type of advanced transit technology suitable for Ann Arbor is primarily dictated by passenger demand. Ridership analysis indicates that there are two distinct area types, the high demand core and the moderate demand shoulders. This concept is illustrated in **Figure 8-1**.

Figure 8-1: Connector Service Concept
Source: URS Corporation

As noted previously, while the existing passenger demand is currently accommodated on standard buses, the system is operating at capacity during peak periods in the segment between the North Campus and the Central Campus. In this high ridership core, a larger vehicle is required and it would be highly desirable to provide a dedicated right of way to enhance transit travel times and improve schedule reliability. A bus rapid transit, light rail transit or elevated system could provide the necessary passenger capacity through the high demand portion of the corridor.

While these same technologies could be applied in the moderate demand shoulders to the northeast and to the south, it would be desirable to adjust service levels and/or vehicle capacity in these lower demand portions of the corridor to better match forecast demand. In addition, the level of demand could be accommodated by a streetcar or by standard buses.

The elevated technologies considered could provide the passenger capacity required but at substantial cost. The construction and operation of an elevated transit technology would be significantly more expensive than either a light rail or BRT option. An elevated guideway would offer a marginal improvement in transit travel time over BRT or LRT but would also introduce a significant visual element into the environment.

Both BRT and LRT options would offer an opportunity to interline a lower capacity end to end service with the high capacity service through the high demand portion of the corridor. For example, if a BRT or LRT guideway were constructed between the North

Campus and the Central Campus and downtown, an end to end bus line could make use of the guideway through the core area. Similarly, if an LRT line were constructed between campuses, an end to end streetcar line could make use of the LRT tracks through campus. This interlining concept would provide the high capacity service in the core where the services overlap and the moderate capacity service in the shoulder areas.

Could an advanced transit system be implemented incrementally?

Yes, elements of an advanced transit system could be added incrementally with the goals of improving transit travel times and reliability, adding capacity and improving quality of service.

An incremental approach could start with a restructuring of UM bus service to establish line haul service between campus transit centers with connections to smaller, circulator buses operating within the campuses. The line haul Connector service could use larger buses with more passenger capacity. These larger buses could be phased in as the UM bus fleet requires replacement.

Providing traffic signal priority for transit vehicles could help to improve both bus travel times and schedule reliability. More detailed evaluation of transit travel time savings and impacts to other traffic is necessary to determine if transit signal priority (TSP) is worthwhile.

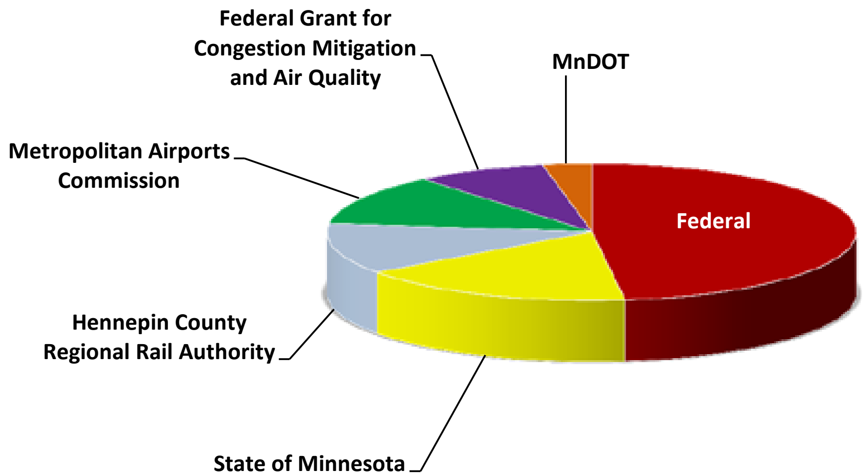
There may be opportunities to begin developing an exclusive guideway for bus operations incrementally. This process could start with construction of queue bypass lanes for use by transit vehicles at intersections. If developed in the context of a more detailed Connector plan, these bus bypass lanes could represent the first stages of development of a continuous fixed guideway.

A number of communities have considered opportunities to initially develop a fixed guideway for buses that could ultimately be converted into a rail transit system. This approach could keep initial capital costs low while developing and preserving a continuous right of way for a future rail system.

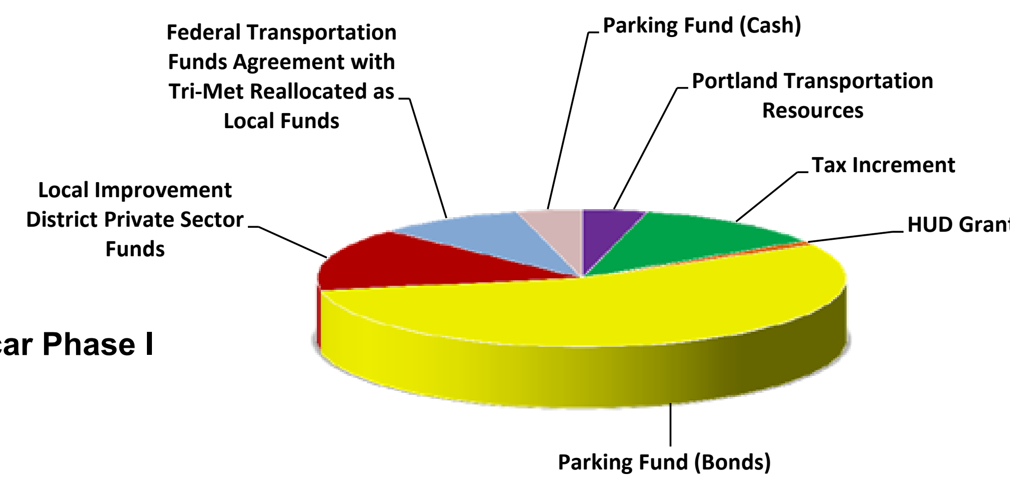
What sources of funding could be used to build a Connector?

The capital cost of major new transit projects is typically funded from multiple sources. Funds can originate at the federal, state, or local level and can be supplemented with private sources. Funding can take the form of grants or a revenue stream that can be used to issue bonds. Funding might also be supplemented with in-kind contributions, such as donation of right of way. **Figure 8-2** illustrates capital funding sources for three recent transit investments.

Hiawatha Light Rail
Minneapolis, MN



Portland Streetcar Phase I
Portland, OR



Euclid Corridor Healthline BRT
Cleveland, OH

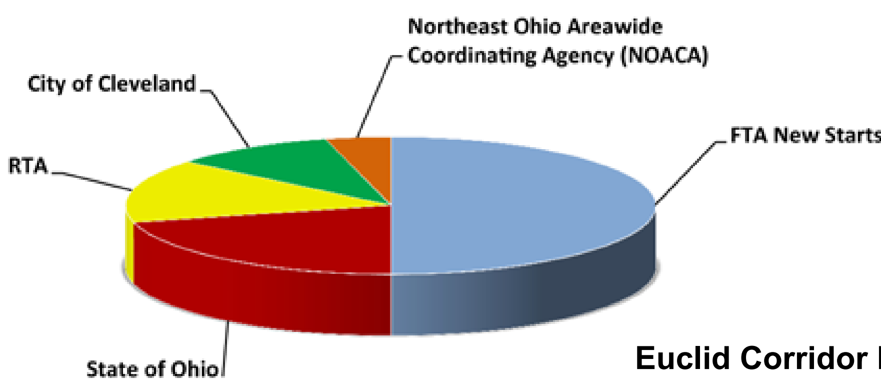


Figure 8-2: Capital Funding Examples
Source: URS Corporation

The funding plan for a major transit investment typically evolves over time. Initially, funding is required for the planning and design phases of a project. As the project becomes more defined, a capital funding plan is developed and the project is incorporated into the regional transportation funding process administered by the regional planning agency (Washtenaw Area Transportation Study – WATS). The regional transportation funding process includes the preparation of a Transportation Improvement Program (TIP) which is a programming document used to implement the goals, objectives, and projects in the Long Range Transportation Plan.

Described below are a number of sources of funding that have been used to fund transit investments in other cities. These sources and others should be investigated as potential sources of funds for the Ann Arbor Connector project.

Federal

FTA New Starts Program

The Federal Transit Administration (FTA) New Starts program has historically been the primary source of federal funding for the capital cost of a new fixed guideway transit system. There are three project classes identified in the New Starts program:

- New Starts - Projects with a capital cost in excess of $250 Million
- Small Starts - Projects with a capital cost between $25 and $250 Million
- Very Small Starts - Projects with a capital cost less than $25 Million

New Starts funding can generally be used to fund up to 50% of the capital cost of a qualifying project. In order to qualify, the project must be part of the adopted regional transportation plan, it must follow the New Starts Project Development Process, and it must satisfy New Start project evaluation criteria.

The New Starts Project Development Process consists of the following project phases:

- **Phase I – Alternatives Analysis** – An Alternatives Analysis (AA) evaluates mode and alignment options in a particular corridor and develops information regarding benefits, costs and impacts which can be used by the community to select a locally preferred alternative (LPA), which can then be adopted into the region's long-range transportation plan.
- **Phase II – Preliminary Engineering** - During the preliminary engineering (PE) phase the LPA is further refined and evaluated under the National Environmental Policy Act (NEPA). This requires assessment of a project's potential environmental effects generally in the form of an Environmental Impact Statement (EIS) or Environmental Assessment (EA). Preliminary engineering advances the project design and refines estimates of project costs, benefits, and impacts. The initial New Start project evaluation is conducted and reviewed by

FTA during the PE Phase.

- **Phase III – Final Design** - If FTA finds that the project satisfies the New Start evaluation criteria, FTA allows the project to proceed into final design. Final design is the last phase of project development and includes the preparation of final construction plans, detailed specifications and bid documents. During the Final Design process, the New Starts evaluation is refined and FTA determines if the project is eligible for a Full Funding Grant Agreement (FFGA).

New Starts projects are evaluated by the FTA throughout the project development process. Based on these evaluations, the FTA makes decisions about moving projects forward. The FTA evaluates the project according to the following measures:

- **Mobility Improvements** - measured by travel time benefits per project passenger mile, low-income households served, and employment near stations
- **Environmental Benefits** - measured by change in regional pollutant emissions, change in regional energy consumption, and EPA air quality designation
- **Cost Effectiveness** - measured as the cost per hour of travel time saved
- **Operating Efficiencies** - measured by system operating cost per passenger mile
- **Transit Supportive Land Use & Future Patterns** - measured by existing land use, transit supportive plans and policies and performance, and impacts of policies
- **Other** - includes a number of optional factors, including the projected economic impact of project.

Other Federal Grants Programs

<u>FTA Metropolitan & Statewide Planning Grants</u>

- Eligible recipients include State DOTs and Metropolitan Planning Organizations
- Funding must be used for planning activities that:
  - Support the economic vitality of the metropolitan area
  - Increase safety and security of the transportation system
  - Increase accessibility and mobility of people and freight
  - Protect and enhance the environment and promote energy conservation
  - Enhance the integration and connectivity of the transportation system, across and between modes

- Promote efficient system management and operation and
- Emphasize the preservation of the existing transportation system

- The federal share is not to exceed 80% of the cost of the project

FTA Urbanized Area Formula Program

- Eligible recipients are public bodies with the legal authority to receive and dispense federal funds
- Applies to incorporated areas with a population of 50,000 or more
- Eligible activities include:
  - Planning, engineering design and evaluation of transit projects and other technical transportation-related studies
  - Capital investments in bus and bus-related activities
  - Capital investments in new and existing fixed guideway systems
  - For urbanized areas with populations less than 200,000, operating assistance is an eligible expense
- Federal share can not exceed 80% of the net project cost

FTA Bus and Bus Related Equipment and Facilities Program

- Eligible recipients include states and local governments, public agencies, private companies engaged in public transportation and private non-profit organizations
- Provides funding for capital projects such as purchase of buses for fleet and service expansion, bus maintenance and administrative facilities, bus malls, transportation centers, intermodal terminals, park-and-ride stations, acquisition of replacement vehicles, bus rebuilds and preventive maintenance, passenger amenities and misc. equipment such as mobile radio units, fare boxes, computers, etc.
- Federal share of the eligible capital costs is 80 percent of the net capital project cost

FTA Alternatives Analysis Program Funds

- Provides financial assistance to applicants for the cost of evaluating project alternatives when at least one of the alternatives is a new fixed guideway system or extension to an existing fixed guideway system
- Funds can cover up to 80% of the project cost

- Eligible recipients include public agencies, local municipalities and public corporations, boards, and commissions established by state law

FHWA Congestion Mitigation and Air Quality (CMAQ) Program

- Funds transportation projects that will contribute to attainment or maintenance of the national ambient air quality standards for ozone, carbon monoxide and particulate matter and provide congestion relief
- Priority is on diesel engine retrofits and cost-effective emission reduction and congestion mitigation projects that also provide air quality benefits
- To be eligible for CMAQ funds, a project must be included in the MPO's current transportation plan
- Funds can be used for capital investment, operating assistance (3-year limit), and planning and project development activities
- State DOTs and MPOs are authorized to distribute the funds. The federal share for most eligible projects is generally not to exceed 80%.

FHWA Transportation, Community and System Preservation Program (TCSP)

- Federal share is up to 80%
- Funds may be used to:
  - Improve efficiency of the transportation system of the U.S.
  - Reduce the impacts of transportation on the environment
  - Reduce the need for costly future investments in public infrastructure
  - Provide efficient access to jobs, services and centers of trade
  - Examine community development patterns and identify strategies to encourage private sector development

FHWA Surface Transportation Program (STP)

- Provides flexible funding that may be used by states and local governments for projects on any Federal-aid highway, bridge projects on any public road, transit capital projects, and intracity and intercity bus terminals and facilities
- Funds are distributed by FHWA to the states, and are administered by the local transportation planning agency
- Federal share is up to 80%

USDOT Credit Enhancement (Transportation Infrastructure Finance and Innovation Act (TIFIA))

- Provides direct loans, loan guarantees and standby lines of credit for transportation projects
- To receive these benefits, the debt must be funded by tolls, user fees or dedicated revenues

Federal Discretionary Funds (Earmarks)

- This funding is requested by Members of Congress for specific projects in their districts
- The submission of earmark requests should be at least two years in advance of when funds are required

Other Federal Funds

The American Recovery and Reinvestment Act of 2009 ("ARRA") provided federal funding for a number of transit systems through special purpose grant programs administered by one or more federal agencies. For example, the TIGER (Transportation Investment Generating Economic Recovery) Discretionary Grant Program ("TIGER I") provided $63 million in funding for a modern streetcar system in Tucson and $25 million for the M1 Rail Project in Detroit. The Urban Circulator Grant program provided funding for transit projects in Dallas, Cincinnati and Portland.

State of Michigan

Many major transit projects rely on grants from the state legislature to fund a portion of the project capital costs. This funding, combined with local funds, provides a portion of the local match required for New Starts funding.

The Michigan Department of Transportation recently released its 2011-2015 Five Year Program, which estimates that $270.8 million will be available annually for passenger transportation programs such as local transit, intercity bus and intercity rail. These funds are primarily used by local transit agencies for operations. Revenues available for transit programs declined by 27 percent (inflation adjusted) over the last 10 years and with the current funding outlook, are not anticipated to recover.

Historically, state funding for projects like the connector project would come from the New Services Program, which is a discretionary program. This program is not funded at this time due to the limited revenue.

The Michigan Transportation Funding Task Force (November 10, 2008) published a report on the status of funding for transportation. The report specifically identifies the Woodward Avenue LRT project, BRT in Grand Rapids, high speed rail from Detroit to Chicago, the Ann Arbor to Detroit commuter rail project and the Ann Arbor to Howell commuter rail project. In addition to these projects, both the Ann Arbor Connector and the Michigan/Grand River Corridor in Lansing/East Lansing are all major transit initiatives that would benefit from increased state funding for transit.

During the 2010 legislative session the Michigan Legislature considered a bill that would have allowed the Michigan Department of Transportation to issue bonds up to $100 million to provide the match for federal funds for transit and high speed rail projects. The legislation failed to pass and it is uncertain whether new legislation will be introduced in 2011.

Local Funding

A variety of local revenue sources have been used to help finance either the capital or operating cost of transit system investments. A number of alternative local funding sources are discussed below.

Tax Increment Financing (TIF)

Tax Increment Financing (TIF) can be used to capture incremental tax revenues associated with increased property values adjacent to a transit system. The incremental tax revenue can be used to guarantee bonds for project construction. The concept underlying TIF financing is that the infrastructure investment paid for with the TIF is necessary to realize the incremental tax revenues. TIF "freezes" the property tax collected by all jurisdictions at the time a TIF district is created. As property within the district appreciates in value and higher taxes are generated, the incremental tax revenues over the frozen tax "base" creates a stream of revenue that is used to finance the issuance of bonds. The bonds typically can be used to finance capital expenditures but not operational costs.

Parking Revenue Bonds

Parking revenues represent a stream of funding that can be used to guarantee bonds for project construction. Incremental parking revenues can be generated either by raising parking fees or by expanding areas of parking control.

Local Improvement (Special Assessment) District

Both Portland and Seattle used special assessments in the funding of their streetcar projects. These onetime payments from property owners along the streetcar routes have been instrumental to the success of the project to date.

Fare Revenues

Currently, AATA recovers approximately 15% of total operating costs from the farebox. Generally, fixed guideway transit systems recover a higher percentage of operating costs because of improved operating efficiency (more passengers per vehicle).

Advertising and Sponsorship Revenues

Transit projects offer a wide variety of potential sources of advertising revenue. In Tampa, TECO Energy supported the project with a $1 million endowment for the right to name the entire line. Consideration has also been given to selling naming rights for each streetcar and each station. The Cleveland Clinic and University Hospitals paid $6.25 million over 25 years for the naming rights of the Healthline BRT system in Cleveland. Many transit systems sell vehicle 'wraps' to supplement advertising revenues

Property Tax

Currently, AATA receives approximately 44% of total operating costs from local sources which are primarily property taxes. Property tax revenues for transit could be increased by expanding the taxing district into Washtenaw County or by increasing tax rates.

Who would operate a Connector?

The question of who would be responsible for the operation of a Connector is just one element of the issue of governance. In addition to operations, decisions need to be made to address the agency that might receive federal or state grants, the agency that would be responsible for constructing the system, and the agency that would be responsible for system administration and financial performance. The governing agency should:

- Have fair and equitable representation from the communities, the public and agencies who support and use the system.
- Have the legal authority to receive and disburse federal and state grants.
- Have the legal authority to contract for professional services associated with the construction, management and operation of the system.
- Have an organizational structure which assures accountability for funding, operations and safety.
- Have the authority to regulate fares and determine schedules and routes.

Considerations in the issue of governance of a Connector include the specific mode and route selected, service area, the sources of funding for capital and operations, procurement and implementation methodology, and administration costs and capabilities. The governance plan for a major transit investment typically evolves over time as these other considerations are addressed.

What are the next steps that need to be completed to move the project toward implementation?

If the community determines that it wants to proceed with development of a Connector, it is recommended that the FTA New Starts Project Development Process be initiated. This would assure that the project would be eligible for FTA New Starts funding. As described previously, the New Starts Project Development Process would commence with the preparation of an Alternatives Analysis (AA).

The AA process would commence with an initial contact with the FTA to inform them that the study is being initiated and to provide documentation of purpose and need, goals and objectives and alternatives being considered. Much of the information required could be extracted from this report. This initial FTA coordination would provide FTA the opportunity to comment on technical and procedural issues as well as giving FTA staff an understanding of the project.

The AA is intended to develop more detailed information regarding benefits, costs and impacts of alternative actions, including an initial environmental review and mitigation plan, which can be used by the community to select a locally preferred alternative (LPA). The LPA could then be incorporated into the region's long range transportation plan. The AA will need to evaluate a range of potential transit investments and will require significant community involvement in the decision making process.

Following completion of the AA, the community, in conjunction with the FTA, would make a determination on the appropriate form of NEPA environmental review. Depending on the magnitude of the project and the scope of potential impacts, the NEPA review could consist of one of the following:

- Categorical Exclusion (CE) – Relatively minor actions, generally not involving fixed guideway construction that have little or no environmental impact and little or no public controversy.
- Environmental Assessment (EA) – An EA provides in-depth documentation of the environmental impacts of a proposed project. It is generally used when there are few alternatives and no significant public controversy.
- Environmental Impact Statement (EIS) – An EIS is prepared to clearly document the environmental effects of alternative actions. It is intended to be used as a decision making document for projects with more numerous alternatives, potentially significant environmental effects and/or significant public controversy and interest.

It is possible to combine the AA and NEPA processes. If there are a manageable number of relatively well defined alternatives, the AA can be incorporated into the NEPA process. However, based on the level of definition provided in this initial feasibility study, it is recommended that an independent AA process be conducted and used to better define the physical characteristics of a preferred action.

As noted above, the AA process needs to be coordinated with the FTA. The evaluation criteria used in the AA process will include some of the critical measures used in the New Starts evaluation process, including environmental criteria. Thus, at the conclusion of the AA process, there will be a preliminary assessment of how well the Connector project satisfies the New Starts criteria.

If the community decides to proceed, what are the primary considerations in locating a specific Connector alignment?

Station Locations – Careful consideration needs to be given to the location of stations. Station locations are likely to be a major factor in defining the Connector alignment. Stations need to be located to provide convenient pedestrian access between the station and major trip generators. Station sites are often considered as redevelopment nodes and therefore need to be sited consistent with city land use plans. Stations are a very visible part of the system and station siting requires careful community consideration.

Right of Way Availability – Throughout the corridor, public rights of way are limited. Locating the Connector alignment within public rights of way could displace on-street parking or reduce vehicle capacity. A Connector alignment needs to be developed that minimizes impacts to businesses and residences adjacent to the alignment.

Southern Alignment – In the southern portion of the study area, there are two distinct alignment options; Main Street or State Street. The Main Street alignment could potentially serve Pioneer High School and moderately high density housing located along Main Street between Pioneer High School and Briarwood Mall. The State Street alignment could serve the developing area located east of State in the vicinity of Stimson, the existing park and ride lot, and the office towers located along State Street near Eisenhower. Both of these alignment options have merit and require further consideration of ridership and potential future land use development. The selection of a southern alignment would also be influenced by the location of a crossing to the south side of I-94 and a potential extension into Pittsfield Township.

Crossing of US 23– At the northeast end of the Connector corridor is the interchange of US 23 and Plymouth Road. Crossing US 23 could add a significant structure to the cost of the project. The cost of this new structure would need to be considered in relation to the potential for additional ridership generated by the East Medical Campus and/or Domino Farms area.

Crossing of I-94 –At the south end of the Connector corridor is the interchange of I-94 and State Street. Crossing I-94 could add a significant structure to the cost of the project. The cost of this new structure would need to be considered in relation to the potential for additional ridership generated by serving Pittsfield Township.

Huron River Crossing – The Connector could cross the Huron River using an existing bridge or a new bridge. A new bridge would add a significant structure to the cost of the project and would also generate significant environmental concerns. The need for a new river crossing will depend on the Connector technology, horizontal and vertical alignment, and the use and condition of existing structures. Use of an existing bridge would need to be evaluated to determine if widening, additional structural support or any other modifications would be necessary to accommodate new transit traffic, which could also increase project costs.

Topography – Some portions of the study area feature steep grades, which need to be considered when designing any type of guideway for a new transit system. This could require re-grading of certain locations or building the guideway on a structure, which can increase construction costs.

Railroad Crossings – The Connector will likely need to cross both the east-west and north-south railroads through Ann Arbor. A rail-based transit technology would require a grade-separation from the existing tracks. The guideway would need to be built on a structure that allows adequate clearance for existing rail traffic to pass underneath, and use grades no steeper than what is appropriate for the selected transit technology.

Maintenance Facility - A rail-based transit technology would require a maintenance facility along or near the Connector alignment. This facility would need to provide both a yard for vehicle storage and a building for vehicle maintenance. Because it functions as the base for operations, the location of the maintenance facility has an impact on annual operating costs.

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Appendices

Refer to Included CD

Appendix A: U-M Bus Service Data

Appendix A-1: U-M Transit and City Traffic Signal Characteristics Summary

Appendix A-2: U-M Transit Daily Service Characteristics on a Typical Weekday

Appendix B: Capital Cost Assumptions

Appendix C: Preliminary Capital Cost Estimates

Appendix C-1: Light Rail Transit

Appendix C-2: Bus Rapid Transit (end-to-end exclusive guideway)

Appendix C-3: Bus Rapid Transit (partial exclusive guideway)

Appendix C-4: Elevated Technology

Appendix C-5: TDM/TSM

Appendix C-6: Combination Bus Rapid Transit + Light Rail Transit

Appendix C-7: Combination Light Rail Transit + Streetcar

Appendix D: Ann Arbor Connector Feasibility Study Stakeholders

Appendix E: Newsletters

Appendix E-1: Newsletter #1

Appendix E-2: Newsletter #2

Appendix E-3: Newsletter #3

Appendix F: Open Houses

Appendix F-1: Detailed Summary of Open House Meeting #1

Appendix F-2: Detailed Summary of Open House Meeting #2

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