



AURORA

Bicycle and Pedestrian Master Plan

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February 17, 2012

Prepared by Toole Design Group



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SECTION 1: MASTER PLAN BACKGROUND AND PURPOSE

1.1 Introduction

In 1971, the City of Aurora developed the Aurora Bikeway System Map, which served as the framework for an on-street and off-street bicycle system. Two years later in 1973 an evaluation of the Aurora Bikeway System was conducted, and many of its findings are still applicable to present day Aurora.

Key findings of the 1973 Aurora Bikeway System Evaluation:

- The facilities and needs of the utilitarian cyclist were not being served;
- The facilities and needs of the recreational cyclist were being well served;
- The on-street bicycle network was under-developed;
- The most effective way for the city to encourage utilitarian bicycling was to implement an on-street bike network;
- The number of bicycle signs provided to inform the motorist and bicyclist of bicycle facilities was far below minimum standards; and
- Street intersections were major impediments to the safety of bicyclists.

The last city-wide update of the bicycle plan, including a map of existing and proposed facilities, was completed in 1998. In 2005, staff prepared, and city council adopted,

the Northwest Aurora Bicycle & Pedestrian Master Plan. Elements of both the 1998 and 2005 plans have been implemented and some facility improvements have been constructed. However, many other planned facility improvements have not been constructed. Most recently the City received a federal stimulus grant to install approximately six miles of striped bike lanes and two miles of shared lane markings. Although these improvements demonstrate progress, a recognizable deficiency still exists for on-street bicycle facilities, i.e. a comprehensive city-wide bicycle network. One challenge to developing such a network has been the lack of dedicated funding for the implementation of on-street bicycle facilities.

Off-street bicycle facilities (i.e. trails) have benefitted from the Arapahoe County Open Space Program funded by a quarter-of-a-penny sales and use tax. In the fall of 2011, voters approved extending the Open Space Program to 2023. Off-street bicycle and pedestrian facilities constructed with these funds have greatly increased recreation opportunities for the City's residents and provided a strong foundation for a continuous bicycle network in sectors of the City.

In 2010, the City of Aurora was awarded funding to develop the Bicycle and Pedestrian Master Plan through the Tri-County Health Department's Communities Putting Prevention to Work initiative (CPPW). The CPPW initiative is a grant program funded through the Centers for Disease Control and Prevention as part of the American Recovery and Reinvestment Act economic stimulus program.



In 2011, the city used a federal stimulus grant to stripe six miles of bike lanes.

While the focus of the Bicycle and Pedestrian Master Plan is to provide a coordinated vision for accommodating and encouraging bicycling as a viable transportation mode in the City, many of the Plan's recommendations also provide benefits to pedestrians. The Master Plan seeks to complement and extend the reach of the City's extensive and well-used trail network by further establishing a network of on-street bicycle facilities, so that Aurora residents may safely and conveniently bike throughout the City both for recreation and utilitarian trips such as shopping, commuting to work and school, and accessing transit.

The Master Plan:

- Provides a "roadmap" for City Council, as well as city staff, for collectively moving forward with implementing an on-street bicycle network in a cost effective way.
- Incorporates extensive public feedback, assisting elected officials and staff in understanding what citizens want to see developed.

- Builds upon previous plans and links together other ongoing efforts related to bicycling, including the City's extensive trail network, and efforts in neighboring jurisdictions.
- Provides an implementation schedule for a city-wide bicycle network to be incrementally implemented over time with a focus on early action and short-term projects that will provide the most benefit from a ridership perspective.
- Identifies planning-level costs, staffing needs, and funding strategies.
- Provides best practices on education, encouragement, and enforcement programs that promote safe riding.
- Establishes an evaluation framework that incorporates performance measures that can be used to gauge progress in Plan implementation and achieving "Bicycle Friendly Community" recognition from the League of American Bicyclists. Provide guidance on best practices for pedestrian wayfinding (included in Appendix D).



The Master Plan seeks to complement and extend the reach of the city's extensive trail network.

1.2 The Case for Funding Implementation of the Bicycle and Pedestrian Master Plan

Presently, a number of key trends are converging and resulting in a ground swell of national interest in promoting bicycling as a viable transportation mode. Many cities are facing challenges in terms of economic development, being able to repair and maintain infrastructure, addressing local and global environmental issues, and distributing basic services fairly. In addition, households are feeling the pressure of increasing fuel costs. There is great interest among citizens and stakeholders in pursuing development and transportation solutions that are more sustainable—meaning less costly to maintain over time, less polluting, and more equitable. More and more, the bicycle is being seen as a key component of sustainable transportation systems. These trends, as well as growing public demand for more transportation choices, and opportunities for integrating walking and biking into daily routines, point to the need for implementing this Master Plan.

Cities across the country are embracing the bicycle as a viable transportation mode, and a means to achieving multiple objectives, including economic development, maximizing transportation investments, improving public health, addressing transportation equity, and reducing environmental impacts.

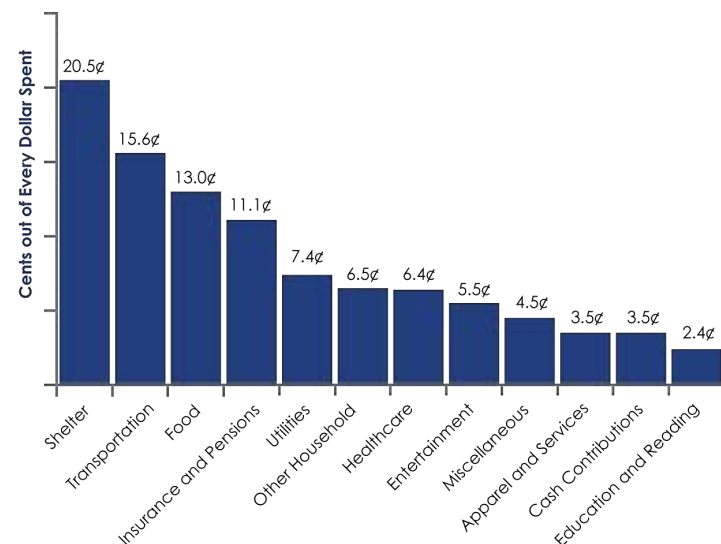
Economic Development

- In many industries, the competition for workers is on a global scale, and people are choosing employers not just on salary and traditional benefits, but on external criteria such as lifestyle and quality of life. Many employers are recognizing that their ability to recruit top employees depends significantly on local culture and amenities. Cities that are making investments to become more

walkable and bikeable are seeing dividends in the form of attracting new residents and employers.

- The Aurora-Denver area perennially makes top ten lists for places that offer a high quality of life. Most recently, the area ranked 8th among the top ten cities for young people.¹ Its ranking was mainly due to accessibility to the Rocky Mountains, but also the “green” image that Denver has cultivated, and the regional public transportation system were key factors. The City of Aurora should and can capture its fair share of young people, and the economic activity they generate, and supporting biking and walking is a key strategy for doing so.

How an Average Household Spends a Dollar



Source: BLS 2009 Notes: Shelter includes mortgages, taxes, maintenance, home insurance, and rent; Other Household includes housekeeping supplies, household furnishings, and equipment; Miscellaneous includes personal care products and services, alcohol, tobacco products, and other miscellaneous expenditures as found in Alliance for Biking & Walking, Bicycling and Walking in the United States: 2012 Benchmarking Report, Washington, DC, 2012.

¹ Sperling's Best Places featured on CNBC.com

- Aurora has also made the U.S. News “best places” list for retirement.² Maintaining health and staying physically active is a major concern for many retirees, and providing opportunities for this population to walk and bike safely and comfortably will further enhance Aurora’s ability to attract those looking for a great place to retire.
- According to the League of American Bicyclists, a motor vehicle is the second-highest household expense, after housing itself.³ The American Automobile Association estimates that Americans spend on average \$8,485 each year to own and operate a car. This number increases each year as gas prices continually increase. It is estimated that about \$7,000 of this leaves the local economy (through fuel purchase, insurance, etc) while about \$1,400 remains (through taxes, maintenance, registration, etc). Providing transportation choices can give households the option of owning fewer cars, thus freeing up more household money that can be spent in the local economy.
- Investing in bicycle and pedestrian infrastructure is a key strategy for revitalizing neighborhoods by improving access to businesses, making streets more attractive to a broader range of users, improving neighborhood livability by increasing social interaction and peoples’ perceptions of personal safety, as well as reducing vehicle congestion. The Master Plan’s recommendations along Montview Boulevard and other parts of Aurora directly support the City’s community development efforts (e.g. Original Aurora Renewal, Montview Community Plan)

² <http://money.usnews.com/money/retirement/best-places-to-retire/colorado/aurora>

³ Surface Transportation Policy Project. “Housing and Transportation,” Online, www.transact.org/library/factsheets/housing.asp#_ednref1, February 23, 2004

Maximizing Transportation Investments

- Dollar for dollar, bicycling is by far one of the cheapest transportation modes to support. Often bicycle facilities utilize existing roadway space, and only require relatively low-cost pavement markings and/or signage.
- The City of Aurora has already made substantial investments in its transportation infrastructure. Implementation of on-street bicycle facilities is a key strategy for maximizing the return of this investment. By increasing the percentage of miles traveled by bicycle, Aurora can improve the efficiency of its existing roadway system, and forego costly congestion management projects.
- A walking or bicycling trip may end at a destination such as work or shopping, or it can be part of a longer journey that involves transit. Pairing bicycle facility improvements with transit gives people more transportation choices and expands the reach of the transit system. Targeting the provision of safe and convenient bicycle facilities such as lanes, trails, and parking will increase the service radius of a transit stop or station, particularly in Aurora where distances between stops are great.

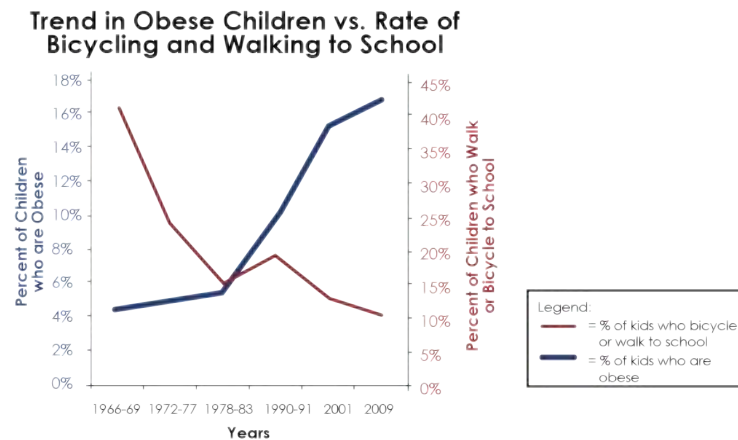
Health

- The Centers for Disease Control and Prevention recommends 150 minutes of moderate-intensity aerobic activity every week, which is equivalent to 10 minutes of brisk walking, 3 times a day, 5 days a week.⁴ Providing opportunities for people to integrate walking or biking into their daily routines can help them meet these guidelines and stay healthy and fit.
- The prevalence of obesity among children 6 to 11

⁴ Centers for Disease Control and Prevention, How Much Physical Activity do Adults Need?. <http://www.cdc.gov/physicalactivity/everyone/guidelines/adults.html> accessed 12/22/11

increased from 6.5 percent in 1980 to 19.6 percent in 2008, nationwide. The prevalence of obesity among adolescents aged 12 to 19 years increased from 5.0 percent to 18.1 percent.⁵

- Given that most elementary and middle schools in Aurora are located on low traffic volume collector and local streets, there is tremendous opportunity for increasing the number of children able to integrate physical activity into their daily routines by walking or biking to school by making relatively low-cost safety improvements.



CDC, NHANES, McDonald 2007, Ogden and Carroll, NHTS 2009 as found in Alliance for Biking & Walking, Bicycling and Walking in the United States: 2012 Benchmarking Report, Washington, DC, 2012

Environmental

- Aurora is a member of the Colorado Climate Action Plan and has identified a number of strategies to reduce its carbon footprint, including reducing vehicle miles traveled by promoting transportation alternatives.

⁵ Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007–2008. *JAMA* 2010;303(3):242–9.

- One-quarter of all trips people take in the United States are within a mile, or about a 20-minute walk, and half of all trips taken are within three miles, or a 20-minute bike ride. Yet for the vast majority—78 percent—of these shortest trips, people are using their cars. Replacing these car trips with bicycling and walking trips can greatly reduce harmful emissions associated with cold starts.

Equity

- Providing the community viable and affordable transportation choices that include transit, bicycling and walking is a key component of an equitable transportation system.

1.3 Implementation of the Master Plan Will Support Established Goals and Objectives

Council Goals and Objectives

Below are excerpts from Aurora City Council’s 2011 goals and objectives along with commentary about how implementation of the Bicycle and Pedestrian Master Plan supports these goals and objectives:

- “Ensure that every child and young person in Aurora will have access to the fundamental resources she or he needs to succeed.” Comment: Children and young people are very limited in their transportation options and therefore providing safe neighborhoods for walking and bicycling is critical to their being able to get around safely and succeed in the community.
- “Reduce travel time and reduce congestion and provide expanded multi-modal choices by securing improvements to the transportation system...”

Comment: Promotion of bicycling as a viable transportation alternative can reduce motor vehicle congestion and the need to invest in costly projects intended to increase roadway capacity.

- “Develop and maintain high-quality parks, recreational facilities/programs, libraries, natural areas, trails and open spaces.” Comment: The recommended on-street bicycle network complements the existing and proposed trail network, greatly expanding the reach of the trail system for both recreational and utilitarian bicycle trips.
- “Maintain high-quality, livable neighborhoods.” Comment: Provision of safe bicycling and walking facilities is a critical component of neighborhood livability.

The city should begin to discourage short-distance driving in [Town Center/Aurora Mall] and encourage walking or biking between shops.
- Aurora Resident

- “Provide appropriate stewardship of natural resources to ensure long-term sustainability for the city.” Comment: Promotion of bicycling through infrastructure investments reduces carbon emissions and maximizes investments made in roadways by being able to move more people in the same amount of roadway space.

Comprehensive Plan

The City’s Comprehensive Plan establishes a sustainability framework that is built around a vision for energy efficiency and conservation, renewable energy and economic growth. Providing transportation choices and a high quality

network of bicycle and pedestrian routes are mentioned as essential steps toward promoting sustainability within Aurora. The Comprehensive Plan specifically calls for:

- Updating the City’s existing bike and pedestrian plan to reflect current and future needs related to integration of bike and pedestrian facilities into the transportation network to ensure a **cohesive network of facilities for enhanced mobility, safety, and connectivity.**
- **Identifying, prioritizing, funding and implementing key bicycle and pedestrian improvements** needed to improve access to transit stations, major activity centers.
- **Identifying funding mechanisms** that support a broader range of convenient and sustainable travel choices including public transit and bicycle and walking routes.
- **Connecting neighborhoods to activity centers** with vehicular, bicycle and pedestrian connections.
- Developing a system to **identify and prioritize critical bicycle and pedestrian improvement needs** and recommend projects for inclusion in the City’s CIP and the DRCOG Transportation Improvement Program.
- Developing a plan for **improving pedestrian and bicycle safety and crossings of major streets** with an emphasis on providing signalized or improved crossings where significant pedestrian and bicycle facilities exist.
- Increasing the percentage of school-age children who have the opportunity to **walk or bicycle safely to school.**

The Comprehensive Plan also identifies specific actions for improving bicycle and pedestrian access within defined “strategic areas”:

- Continue to work to improve the streetscape design for **Montview Boulevard**. Consider the extension of the median treatment with an enhanced tree canopy, the removal of on-street parking, and the provision of bicycle lanes to and from the **Fitzsimons Campus**.
- Transportation improvements, including bicycle and pedestrian routes and amenities within **City Center**, and a pedestrian/bicycle crossing of I-225 at Jewell Avenue.
- Safety enhancements for pedestrians and cyclists at regular crossing intervals of **Parker Road**.
- Work to develop additional trail and bicycle route connections throughout the **Havana District/Lowry/Buckingham** area to support alternative modes of transportation and facilitate access to retail establishments.

Other Planning Initiatives

In addition to the Comprehensive Plan, the City has embarked on numerous other planning studies and initiatives that support the implementation of bicycle and pedestrian improvements, including:

- **Northwest Aurora Bicycle and Pedestrian Master Plan** – the Bicycle and Pedestrian Master Plan incorporates many of the recommendations in this Plan.
- **Fitzsimons Area Wide Multimodal Transportation**

Study – this study provides a detailed and comprehensive understanding of the multi-modal transportation needs surrounding the Fitzsimons medical campus. Many of its recommendations were integrated into the bicycle network recommendations in the Master Plan.

- **Northeast Area Transportation Study** – this study presents a network of new streets in the northeast portion of Aurora, most of which will include bicycle lanes, thus supporting many of the bicycle network recommendations in the Bicycle and Pedestrian Master Plan.
- **Southeast Area Transportation Study** – this study presents a network of new streets in the southeast portion of Aurora, most of which will include bicycle lanes, thus supporting many of the bicycle network recommendations in the Bicycle and Pedestrian Master Plan.
- **Station Area Planning** – station area plans identify bicycle circulation and access improvements, which have been integrated in the bicycle network recommended in the Bicycle and Pedestrian Master Plan.
- **Montview Community Plan** – this planning process envisions a vibrant Montview Boulevard transformed with activity and enhanced to better serve the neighborhood and improve the safety and efficiency of all transportation modes.
- **Safe Routes to School** – the City has partnered with Aurora Public Schools on several Safe Routes to School funding applications. Providing safer bicycling routes to schools is a major goal of the Bicycle and Pedestrian Master Plan.
- **1997 Parks and Open Space Framework Master Plan** – this long-range planning document guides and

I would like the city to be as concerned with pedestrians and riders as it is with moving traffic.
- Aurora Resident

supports initiatives geared toward the provision of parks, recreation, and open space resources. The document acknowledges the symbiotic relationship between those resources and the improvement of bicycle and pedestrian mobility, which is a principle embraced by this Plan.

Building and Zoning Code

- Sec. 146-1508. – Bicycle Parking – requires the number of bicycle parking spaces provided by non-residential uses to be equal to three percent of all required motor vehicle parking spaces. Allows for a reduction in number of required motor vehicle spaces with provision of additional bicycle parking. Specifies placement and design of bicycle parking.
- Sec. 146-1509. – Parking Area Design – requires safe and convenient movement for bicycles and pedestrians be provided throughout the proposed development and to and from surrounding areas, and connections to City’s off-road trail system to the extent reasonably feasible.
- Sec. 147-32(c)(2) of the City’s subdivision code, requires subdivisions to create an integrated system of lots, streets, trails, and infrastructure that provides for efficient movement of people, bicycles, and automobiles within the subdivision and to and from adjacent development.

1.4 Summary Analysis of Existing Plans and Policies

- For over 30 years the City has been planning for and promoting bicycling.
- Collectively, the goals and objectives in adopted plans are comprehensive and inclusive in supporting the development of a city-wide bicycle network that is connected and safe, and is a key component of a larger

multi-modal transportation system. Most notably:

- Ensure a cohesive network of facilities for enhanced mobility, safety, and connectivity.
- Identify and prioritize critical bicycle and pedestrian improvement needs.
- Funding and implementing of key bicycle and pedestrian improvements.
- Identifying funding mechanisms that support biking and walking routes.
- While there is substantial support in the City’s planning documents for implementing city-wide bicycle network improvements, and some progress has been made in installing bicycle facilities, a recognizable deficiency still exists for on-street bicycle facilities.
- National and regional trends point to the growing public demand for investments in alternative transportation systems that include connected, safe, and convenient bicycle and pedestrian networks.

Encourage businesses to add bicycle and pedestrian friendly facilities.

- Aurora Resident

SECTION 2: BICYCLE AND PEDESTRIAN MASTER PLAN AND NETWORK OVERVIEW

2.1 Master Plan Vision, Goals and Objectives

A draft vision was developed, along with a list of goals and objectives related to the Master Plan and walking and biking in general. The vision, goals and objectives were derived from the City's Comprehensive Plan, 2011 City Council Goals and Objectives, as well as best practices in bicycle planning. The vision, goals and objectives were presented to the public through the online survey, as well as at the first public open house. The public was asked to comment on the draft vision and rank the goals and objectives based on what they thought was most important for the Plan to address and achieve through implementation. The vision and top ranked goals and objectives are presented below. The Master Plan addresses each of the goals and objectives through bicycle network recommendations and an implementation strategy that includes policy-level actions and design-level guidelines and recommendations.

Master Plan Vision

The city will have a sustainable transportation network that offers a variety of multi-modal options and a high-quality network of bicycle and pedestrian routes that provides safe, comfortable and convenient access to transit, shopping, neighborhoods, recreation, and areas of employment.

Master Plan Goals and Objectives

Goal 1: Identify and prioritize key bicycle and pedestrian improvements.

Objective: Identify a comprehensive on-street/off-street interconnected bicycle network.

Objective: Increase number of trailheads connected to on-street bicycle facilities.

Objective: Improve accessibility for bicyclists and pedestrians to transit stations, community facilities, and activity centers.



The public was asked to rank draft goals and objectives for the Master Plan.

Objective: Increase the number of bike racks throughout the City.

Goal 2: Develop an Implementation Strategy

Objective: Identify funding sources and mechanisms that address highest priorities first.

Objective: Adopt a 5-year Capital Improvement Program for bicycle and pedestrian improvements.

Objective: Incorporate bicycle and pedestrian facility improvements into capital projects and annual programs.

Objective: Adopt a “Complete Streets” policy.

Goal 3: Improve safety for bicyclists and pedestrians through careful design and implementation of facilities.

Objective: Design all bicycle facilities utilizing the most current national standards, guidelines, and practices.

Objective: Educate City staff involved in planning, design, maintenance, and construction about best practices for addressing bicycle and pedestrian needs.

Objective: Develop a system for identifying and understanding the type and location of bicycle and pedestrian crashes so that safety issues may be addressed either through better design, education or enforcement.

Objective: Assess and identify existing facility deficiencies.

Goal 4: Promote active lifestyles and good health by encouraging bicycling and walking in the City.

Objective: Increase the number of people using bikes for recreation and utilitarian trips.

Objective: Increase the percentage of school-age children who are walking or bicycling to school.

Objective: Promote bicycling and walking through events, social marketing, and dissemination of information such as bike maps, biking and walking tips, and a comprehensive way-finding sign program.

Objective: Increase the number of businesses/ employers that are recognized as Bicycle Friendly Businesses by encouraging them to provide end-of-trip facilities such as bike parking, lockers, and showers.



Input on biking and walking conditions around schools was sought at Aurora Public School's "Coffee with Parents" meetings.

2.2 Stakeholder Outreach and Input

Public Input

The public was engaged throughout the Plan development process. Table 2.1 provides a summary of the public involvement strategies used, and how the input was used to shape the Plan. A compendium of public comments from the online survey, online interactive map, and public open houses can be found in Appendix A. The public was informed of the Master Plan, and the ways in which they could provide input via the City’s website, utility bill notices, email blasts, City newsletter, as well as media coverage, including an article in the Aurora Sentinel and Your Hub magazine.

City Staff Input

City staff from Planning and Development Services, Public Works, and Parks, Recreation and Open Space provided valuable input throughout the Plan development process. In addition to reviewing the draft bicycle network and accompanying design guidelines, representatives from each department met with the City’s consultant team on several occasions to discuss policies and practices related to accommodating bicycles on Aurora’s streets. Staff input helped shape the recommended bicycle network, as well as many of the Master Plan’s policy-level recommendations found in Section 3.

Table 2-1 Summary of Public Involvement Strategies

Strategy	Notification	Timeframe	Outcome
Online Survey	Utility bill, city website, email blast	July 1 – September 19, 2011	Comments were used to identify issues and needs, focus field work, and develop draft bicycle network
Interactive Map	Utility bill, city website, email blast, Aurora Sentinel Article	July 1 – September 19, 2011	Comments were used to identify issues and needs, focus field work, and develop draft bicycle network
Public Open House 1	Utility bill, city website, email blast	June 29, 2011	Attendees marked up study network maps and provided comments on issues and needs related to network development, prioritization, and Plan goals and objectives.
Meet with Bicycle Aurora	Email	August 10, 2011	Attendees provided insight on bicycling culture and infrastructural improvements that are needed to get more people biking.
Coffee with Parents	N/A – attended regularly scheduled monthly meeting	October/November 2011	City staff and the consultant team attended five ‘Coffee with Parents’ at Aurora Public Schools in Northwest Aurora in order to get input regarding walking/biking conditions from underrepresented populations
Public Open House 2	Utility bill, city website, email blast,	December 6, 2011	Attendees provided input on the draft bicycle network maps, implementation and prioritization, wayfinding and development of a bicycle facility map.



The public helped shape the Master Plan by commenting on maps of the city.

2.3 Development of the Recommended Bicycle Network

The Master Plan recommends a city-wide bicycle network, which was developed using citizen and stakeholder input, the latest standards in facility planning and design, and field analysis of constraints and opportunities throughout the City. The recommended bicycle network consists of 163 miles of on-street bicycle improvements ranging from signed routes to buffered bike lanes. Table 2.2 provides a summary of miles for each type of recommended bicycle facility.

Table 2-2 Summary of Recommended Bicycle Network

Facility Type	Mileage
Bike Lanes	70.26
Buffered Bike Lanes	4.15
Shared Lane Marking	16.55
Shared Roadway/Signed Route	14.05
Paved Shoulder	5.11
Bicycle Boulevard	19.72
Sidewalk Connector/ Side Path	26.12
Shared Use Path	0.85
Separated Bikeway	3.69
Further Study Needed	3.38
TOTAL	163.88

The following factors were considered in the development of the recommended bicycle network:

- Maximum one-mile spacing of bike facilities (it was found that half-mile spacing or less is achievable in most parts of the City)
- Review and consideration of baseline facilities
 - Planned bicycle facilities (1998 Bike Plan, Station Area Plans, Northwest Aurora Bicycle and Pedestrian Master Plan, Fitzsimons Area Multi-Modal Transportation Study).
 - Existing facilities.
- Routes that complete or connect to existing and planned bicycle facilities (including Denver).
 - Routes that connect to transit, including future RTD stations .



Extensive field analysis was conducted to inform bicycle network recommendations.

- Routes that connect schools (supporting Safe Routes to School efforts) and other community facilities such as recreation centers, parks, and libraries.
- Routes that connect major trails.
- Roadways that have existing excess capacity (e.g. peak-hour traffic volumes are significantly below what roadway can handle), which provide critical linkages.
- Roadways that provide parallel routes to arterials with high traffic volumes and connections to commercial and retail destinations.
- Attracting the “casual and less confident” rider (see explanation below).

The draft update to the AASHTO Guide for the Development of Bicycle Facilities¹ discusses the different ways in which to classify different types of bicycle riders, including comfort level, physical ability, and trip purpose. When planning

¹ Final approval and publication of the updated AASHTO Guide for the Development of Bicycle Facilities is expected in summer 2012.

and designing a bicycle network consideration should be given to the types of trips people are likely to take, e.g. utilitarian vs. recreational, but probably more important is the skill and comfort level of various types of riders. Those people that are willing to ride a bicycle are categorized into two primary groups: the experienced and confident, and the casual and less confident. It is the latter group that makes up the majority of the population, and includes a wide range of people: those who ride frequently for multiple purposes; those who enjoy bicycling occasionally but may only ride on paths or low-traffic streets in favorable conditions; those who ride for recreation, perhaps with children; and those for whom the bicycle is a necessary mode of transportation. In order for this group to regularly choose bicycling as a mode of transportation, a physical network of visible, convenient and well-designed bicycle facilities is needed. Table 2.3, taken from the AASHTO Guide, outlines the general characteristics of experienced versus casual bicyclists.



Children are among the “casual” or “less confident” bicyclists that need to be considered when planning and designing bicycle facilities.

Table 2-3 General Characteristics of Experienced Versus Casual Bicyclists

Experienced/Confident Riders	Casual/Less Confident Riders
Most are comfortable riding with vehicles on streets, and are able to negotiate streets like a motor vehicle, including using the full width of a narrow travel lane when appropriate and using left-turn lanes.	Prefer shared use paths, bike boulevards, or bike lanes along low-volume, low-speed streets.
While comfortable on most streets, some prefer on-street bike lanes, paved shoulders or shared use paths when available.	May have difficulty gauging traffic and may be unfamiliar with rules of the road as they pertain to bicyclists: may walk bike across intersections.
Prefer a more direct route.	May use less direct route to avoid arterials with heavy traffic volumes.
Avoid riding on sidewalks. Ride with the flow of traffic on streets.	If no on-street facility is available, may ride on sidewalks.
May ride at speeds up to 20 mph on flat ground, up to 45 mph on steep descents.	May ride at speeds around 8 to 12 mph.
May cycle longer distances.	Cycle shorter distances: 2 to 5 miles is a typical trip distance.

2.4 Bicycle Network Development: Challenges and Opportunities

The City of Aurora manages and maintains approximately 977 miles of roadways. The roadway network generally consists of local, collector and arterial streets. Each roadway type, as well as the pattern of development adjacent to the roadway, presents different challenges and opportunities in terms of developing a city-wide bicycle network that is safe, connected, and convenient.

The City of Aurora has been developed in stages, which is evident by looking at the variation in its street network. Northwest Aurora (Original Aurora) was developed in the early twentieth century when grid street patterns were favored. It is in this part of the City that a dense and direct bicycle network can most easily be achieved. Central Aurora (those areas west of I-225 and south of 6th Ave) was mostly built out in the mid-twentieth century when land developers began introducing more curvilinear streets, but, for the most part, maintained a network of connected streets. While there are some challenges in developing direct bicycle routes in these areas, a connected system is largely achievable. South and east Aurora (those areas east of I-225) were built later in the century when a development pattern built around a network of winding local streets and cul-de-sacs feeding a system of collector and arterial streets was in favor. It is in these parts of the City where there are the most challenges developing a dense and direct bicycle network.

In 1998 the City revised its street standards, and in 2001 adopted the E-470 Zone District Standards. The new street standards incorporated bike lanes into all collector streets and minor arterial streets, and the E-470 standards required connected off-street trail networks. Together these two ordinances made significant strides to better accommodate pedestrians and bicycles in the newly developing areas of the City.

Below is a summary of the challenges and opportunities associated with each roadway type. More detailed information on bicycle facility design is included in Appendix B.

Arterial Streets

Aurora's arterial streets are constructed on an approximate one mile grid and provide direct and efficient inter-neighborhood and regional access. With the exception of a few arterial segments, the recommended bicycle network generally does not include arterial streets due to the high traffic volumes and operating speeds of these roadways. In some cases, arterial streets provide the only direct connection between two recommended on-street facilities or trail access points. Where this is the case an off-street "sidewalk connector" has been recommended. In some very select cases where there is excess existing and future roadway capacity, rechannelization of the roadway (reducing number of vehicle travel lanes; also known as a 'road diet') has been recommended to accommodate high quality bicycle lanes.

Collector Streets

Most of the City's existing bicycle lanes have been installed on collector streets. Collector streets present many opportunities for accommodating bicyclists given their width, low to non-existent parking demand, low traffic volumes, and relative directness. Furthermore, the majority of schools within the city are accessed via collector streets, so there is tremendous opportunity for increasing the number of children walking and biking to school by making safety improvements to these roadways. It is anticipated that a large part of the recommended network can be implemented by adding striping to existing collector streets or as collector streets are overlaid.

Local Streets

The lower traffic volume and operational speeds of these streets make them particularly suitable and attractive to bicycling but the lack of connectivity, widespread use of cul-de-sacs and curvilinear pattern limit their usefulness in a bicycle network. In some cases multiple local street segments have been linked together to create a more or less continuous route that provides an alternative to a busy arterial street, or a connection to a major trail. Many of these parallel routes would be suitable as "neighborhood greenways" or "bicycle boulevards, which incorporate treatments such as traffic calming, bicycle advantage stop control, additional crossing treatments where they intersect arterials, and a robust system of pavement markings and signage.

The Trail Network

The City of Aurora has an extensive and well-used trail system consisting of several major regional trails such as the Westerly Creek Trail, Tollgate Creek Trail, and High Line Canal Trail, as well as numerous other trails that connect neighborhoods and parks. In addition, there are many miles of proposed trails that will greatly expand the off-street network once implemented. The trail system, in many ways, can function as the backbone of the bicycle network because for the recreational or casual bicyclist, trails are the preferred facility type. However, there has long been an identified need in Aurora to connect trails via on-street bicycle facilities so that the trail network can both be more easily accessed (without having to drive to

Bike trails are great, but need better connected street routes.

- Aurora Resident

a trail access point) and better serve those riders wanting more direct routes to destinations than the trail network provides. One of the primary objectives of this plan is to provide bicycle connections between neighborhoods and off-street trails by recommending a variety of facilities that safely accommodate basic as well as advanced cyclists.

There are multiple locations throughout the city where regional trail facilities intersect with roadways that have high vehicle volumes and speeds. Grade separation of these facilities, i.e. underpasses or overpasses, is being explored at several locations, and at least one such project is moving forward at Chambers Road and the High Line Canal Trail.

Overcoming Barriers

There are a number of barriers within the city that present challenges to bicyclists in terms of safety, comfort, and convenience. Most notable among these barriers is I-225, and to a lesser extent E-470 and I-70. There are a limited number of crossings of these highways, and these crossings are, for the most part, arterial roadways with high volumes of traffic and minimal space for accommodating bicyclists



A pedestrian/bicycle bridge will be constructed over I-225 at Florida Ave in conjunction with the planned Florida Ave light rail station.



I-225 is a major barrier to bicyclists traveling east-west, and existing overpasses such as Alameda Ave need improvement in order to safely accommodate bicyclists.

with safe and comfortable facilities. The following I-225 crossing improvements have been considered and included in the recommended bicycle network:

Non-motorized Crossings

- Florida Ave - A pedestrian/bicycle overpass at Florida Ave will improve east-west movement for bicyclists and pedestrians in the central part of the city, connecting the Medical Center with future light rail and commercial and residential uses east of I-225. This connection would tie into recommended bicycle facilities on Florida Ave and Potomac Ave. Timing of this facility depends on RTD's FasTracks system build-out.
- Jewell Ave - Another non-motorized overpass crossing is planned for Jewell Ave. This overpass would tie into recommended on-street bicycle facilities, and a proposed trail segment that would connect the Westerly Creek Trail to the Tollgate Creek Trail. It would also improve access to the Iliff light rail station for those people coming from west of the highway and north of Iliff Ave. Funding has not yet been identified for this facility.

- 13th Ave – Improving (i.e. widening) the existing non-motorized crossing at 13th Ave would greatly improve pedestrian and bicycle mobility in the northern part of the city. There is potential for this facility to be funded through the I-225 light rail FasTracks program.

Improving Existing Overpasses

Existing overpasses at Alameda Ave and Mississippi Ave have limited space for accommodating bicycles in a manner that would be safe and comfortable and attract ridership, and yet they are very important linkages in the recommended bicycle network. It is recommended that sidewalk connectors be developed along these roadways to connect on-street bicycle facilities on the east and west sides of the highway.

The existing sidewalk on the north side of the Mississippi Ave overpass is 8 to 10 feet wide, which may be adequate as a sidewalk where bikes are permitted provided that bicyclists are directed (through signage) to be mindful of, and yield to pedestrians. . On the south side of the street the sidewalk is only 6 feet wide, which is not adequate to safely accommodate both bicycles and pedestrians. The sidewalk on the north side of Alameda Ave overpass is 6 feet wide while the sidewalk on the south side is only 5 feet wide. The sidewalks on both these bridges could likely be widened by retrofitting the existing structure. Alternatively, a separate non-motorized overpass structure (similar to what was done at Yale Ave) could be built at (or near) one or both of these crossings, or between them e.g. at Exposition Ave. Both the bridge retrofit and separate non-motorized bridge solutions are quite costly, but could possibly be resolved in conjunction with light rail station area improvements. As an interim treatment for both bridges, a safety railing could be installed along the edge of the sidewalk, which would improve the safety and comfort of the facility for both

pedestrians and cyclists. Signage that indicates to cyclists that they should yield to pedestrians could also be installed at either end of the crossing. A much longer term solution is to include needed bicycle and pedestrian improvements in future bridge replacement/reconstruction.

Improving Existing Underpasses

Existing underpasses at Iliff Ave, and 6th Ave are, for the most part, of sufficient width for accommodating pedestrians and bicyclists, however these locations could use minor improvements such as safety railings along the edge of the sidewalk to separate pedestrians and cyclists from traffic. A larger issue is the approaches to these underpasses.

Approaches to highway underpasses and overpasses are just as critical as the crossing condition itself. Highway access ramps, and the large arterial intersections on either side of the interchange, can be quite challenging for pedestrians and cyclists. The city made improvements along Alameda Ave on the east side of I-225, including installing wide sidewalks, high visibility crosswalks, advanced stop bars, directional curb ramps and pedestrian countdown signals.



Making intersections more comfortable and safer for cyclists is critical to attracting casual and less confident riders.

Similar improvements should be made at all roadway and ramp crossings. In addition, pedestrian crossing warning signs should be used at uncontrolled access ramp slip lanes as appropriate. High quality, off-street connections, i.e. sidewalk connectors, should bring users through the interchange and connect them to the bicycle network on either side of the highway.

While a pedestrian underpass has been proposed to provide access to the Iliff light rail station, connections using street right-of-way should be maintained and enhanced where appropriate.

Intersections

The recommended bicycle network consists of numerous routes on collector and local streets that intersect arterial streets, and in many cases these arterial streets are true barriers for the casual/less confident cyclist. Where there are existing bicycle lanes, they have been dropped several hundred feet before the intersection. This practice creates confusion for bicyclists and motorists, makes cyclists feel unsafe, and results in low utilization of the bicycle lane facility. There are several design challenges and details related to turning movements, signal timing, and signal detection/activation at intersections that need to be addressed on a case by case basis throughout the network. It is critical to address these details if ridership numbers are to truly increase in the city. Appendix B provides several options for how a bicycle facility such as a bike lane can be brought to and through an intersection in a way that is safe and comfortable for bicyclists.

E. Montview Boulevard

E. Montview Blvd is an important arterial connector between Denver, the Stapleton area, and the Fitzsimons Campus. It serves as a gateway into the city of Aurora

and a main activity corridor for adjacent residential neighborhoods. It also provides access to the Westley Creek Trail and proposed Montview stop on the Regional Transportation District (RTD) I-225 Rail Line. Given the important role E. Montview Blvd. plays in the bicycle network as a connection between Denver and Aurora's most prominent employment center, this corridor was analyzed in detail to determine if it can be optimized for all transportation modes, and in turn, support the city's efforts to revitalize the areas within its vicinity.



Signs provide on-the-ground information that helps bicyclists understand and use the bicycle network.

Reducing the number of vehicle travel lanes from five to three, i.e. road diet, would provide an opportunity to greatly enhance pedestrian safety along the corridor, allow for the installation of a high quality bicycle facility (a buffered bike lane), and improve vehicle safety. There are a number of significant roadway capacity projects that will likely lessen traffic pressures on E Montview Blvd in the longer term. However, the construction phase of some of these projects will likely increase demand on Montview until the improvements have been completed. For this reason, no immediate action is recommended for Montview

Boulevard. The recommendations contained in Appendix C will serve as a guide to implementing bicycle and pedestrian improvements to Montview Boulevard once vehicle demand has more or less stabilized.

Furthermore, a road diet of E Montview Blvd could provide an opportunity to greatly enhance the aesthetic quality of the roadway, which would provide economic development and neighborhood livability benefits. While providing all these benefits, a road diet could serve as a relatively low-cost interim step to partial or whole reconstruction of the roadway, which should include widening of existing substandard sidewalks to a minimum six foot width, or wider where there are transit stops or other uses generating higher pedestrian volumes. The complete analysis of E Montview Blvd can be found in Appendix C.

2.5 Signing of the Bicycle Network

Wayfinding signs provide information about destinations, direction and distance to help bicyclists determine the best routes to take to major destinations. Signs provide on-the-ground information that helps bicyclists understand and use the on-street and trail network without the use of a map. Directional signs also provide additional messaging to motorists to expect bicycles on the roadway. The presence of signs encourages bicycling on designated corridors because users feel the signs will direct them to the best route for getting to their destination. Signs may also be used to direct bicyclists around barriers.

Wayfinding is an important component of establishing the recommended bicycle network. Wayfinding signs may be used alone, e.g., signed route, or in combination with other treatments such as pavement markings (e.g. bike lanes and shared lane markings). The installation of signing and other bicycle network improvements do not need to occur

at the same time. For example, for some lower speed/lower volume roadways installation of wayfinding signage may precede the striping of bike lanes, and in this sense, could be used as an interim step toward implementing additional recommended treatments. The recommended network consists of several signed routes that have no pavement markings, and over time, the city may find it makes sense to add additional signed routes to the network. The decision to develop a signed route versus installing a bike lane or shared lane marking may be based on the following criteria:

- Alternate routes parallel, and within close proximity (less than a half mile) to a route with bicycle facilities.
- Lower volume streets.
- Spur routes, or routes that may span a relatively short distance and terminate at a specific destination or loop back into the main route.

I believe that the most important objective should be working immediately with existing infrastructure to apply an approach that contemplates bicyclists, pedestrians and mobility devices.

- Aurora Resident

Guidance for establishing a comprehensive wayfinding system based on the latest Manual on Uniform Traffic Control Devices (MUTCD) standards, and American Association of State Highway Transportation Officials (AASHTO) guidelines, and best practices are provided in Appendix D.

SECTION 3: IMPLEMENTATION AND FUNDING

Implementation of the Master Plan and the bicycle network will require a collaborative effort between a variety of City departments and agencies and several outside entities. It will result from careful planning and project integration, as well as a comprehensive funding strategy that involves local, state, and federal sources. This section provides a discussion of how the Master Plan will be implemented and the necessary steps the city needs to take in order to realize the vision, goals, and objectives of the Master Plan.

3.1 Strategies for Bicycle Network Implementation

Implementation of the Master Plan will occur over time using a number of different strategies. Foremost, implementation will hinge upon the city's commitment to accommodating bicycle and pedestrian improvements in all transportation projects and programs when feasible. Such "routine accommodation" is how most bicycle and pedestrian facilities are constructed throughout the U.S. In some cases, this is cost neutral, in other cases, additional funding will be needed. In almost all cases, this approach will be less costly than independent bicycle and pedestrian projects. Dedicated funding and staff resources is also an important factor in successful implementation, particularly in terms of funding those medium and higher cost projects that will not be implemented as a part of larger projects. In order to provide safe and functional bicycle facilities that encourage multi-modal choices, dedicated minimum annual funding levels must be set aside that ensure implementation of the

plan. Implementation will also depend upon other factors such as the pace of new development, unique opportunities associated with regional projects such as light rail expansion, funding available at the state and federal levels, and the amount of support and demand that is generated by the public. Below is a discussion of the primary implementation strategies that will be used for building the bicycle network recommended in this Plan. The city's Bicycle Facility Design Guidelines and Appendix B provide detailed guidance for how roadways should be designed to provide high quality bicycle facilities.

Retrofitting Existing Roadways

Most of the bicycle network will be implemented by retrofitting existing roadways. In some cases this may



Many of Aurora's streets can be retrofitted to accommodate bicycle facilities. Here vehicle lane widths have been reduced to accommodate bike lanes.

only involve adding signage or pavement markings e.g., bike lanes, shared lane markings, to the existing roadway without having to make any other changes. In other cases, it may involve narrowing a travel lane, removing parking on one side of the street, reducing the number of vehicle travel lanes, or installing traffic calming treatments. Improving intersections to better accommodate bicyclists will also be a major part of many retrofitting projects.

Lane Diet

Some streets in the recommended bicycle network have travel lanes that can be narrowed to provide additional space for on-road bicycle facilities. Travel lanes can be narrowed during repaving projects or by grinding out existing markings and replacing them with new markings as part of a stand-alone project. New research indicates that narrower lanes can reduce speeds without increasing crash rates (see Appendix B).



Lane widths can be reduced to provide space for bike lanes. Here the center turn lane and vehicle travel lane widths have been reduced to accommodate bike lanes."

Road Diet

There are some streets on the recommended bicycle network where space for bicycle lanes or other on-road bicycle facilities could be provided by removing existing travel lanes or center turn lanes, i.e. road diet. In addition allowing for the installation of a high quality bicycle facility, this treatment reduces bicycle and pedestrian crossing distance and exposure to vehicular traffic, and has been shown to improve motor vehicle flow and reduce rear-end and left-turning crashes when used in the appropriate locations. An engineering and policy analysis that addresses, at a minimum, both vehicle and bicycle/ pedestrian level of service, pedestrian safety, signal level of service, vehicle volumes and speeds, vehicle classification, and parking demand, should be conducted to evaluate the impact of removing travel lanes on all modes. Appendix B provides more detail on the factors to be considered when designing for road diet.

Consolidate On-Street Parking to One Side of the Street

Consolidating on-street parking to one side of the street provides additional space for bicycle lanes. This action is recommended in a limited number of cases where significant excess parking capacity exists (on- and off-street) and where it does not cause too many people to have to cross the road to reach their parked cars. Land use analysis and parking studies are critical factors to consider when making a determination on which side of the road to eliminate parking.

Traffic Calming

The Master Plan recommends a number of bicycle boulevards on local streets, which will typically require traffic calming treatments to slow motor vehicle speeds and make bicycling conditions more comfortable. These treatments may include mini traffic circles, chicanes, raised

crosswalks, speed humps, or other measures. Appendix B provides more information on traffic calming in the context of bicycle boulevards.

Paved Shoulder Rehabilitation or Construction

Paved shoulders provide space on the outside of travel lanes for bicycle and pedestrian use. Shoulders also improve safety for motor vehicles and prevent pavement damage at the edge of the travel lanes. There are a limited number of roadways within the recommended bicycle network where paved shoulders are recommended. These roadways are mostly in the eastern sector of the city.

New Construction and Reconstruction of Roadways and Bridges

Future growth and development is anticipated in northeast and southeast Aurora. As these areas are built out, the city will reconstruct existing roadways and build new roadways per the Southeast Area Transportation Study and Northeast Area Transportation Study. These studies show that the majority of new and reconstructed roadways will accommodate bicycles either with bicycle lanes (in the



Bicyclists should be encouraged to ride with the direction of traffic when riding on sidewalk connectors (sidepaths).

case of minor arterials and collectors) or 10-foot detached sidewalks on both sides of the roadway (in the case of major arterials) per the city's Roadway Design and Construction Specifications. The 10-foot detached sidewalk standard meets minimum AASHTO standards for sidepaths. Given that wrong-way riding is a major cause of bicycle crashes, it is recommended in corridors that are part of the bicycle network that the city proactively encourage bicyclists using the sidewalk to ride with the direction of traffic. Signage and/or pavement markings along the sidewalk can assist in directing cyclists. In areas with higher pedestrian volumes, designating space for bicyclists on the sidewalk using striping should be considered. Enforcement may also be necessary.

Bridges play a key role in the bicycle network, providing access over major barriers such as highways. When bridges are constructed or rehabilitated they all should accommodate bicyclists with high quality facilities that maximize comfort and safety. When federal money is used in bridge construction or rehabilitation, Federal law (23 U.S.C. Section 217) states that *"In any case where a highway bridge deck being replaced or rehabilitated with Federal financial participation is located on a highway on which bicycles are permitted to operate at each end of such bridge, and the Secretary determines that the safe accommodation of bicycles can be provided at reasonable cost as part of such replacement or rehabilitation, then such bridge shall be so replaced or rehabilitated as to provide such safe accommodations."*

3.2 Action Plan

Below is a list of implementation objectives and actions related to staffing, inter-departmental coordination and project integration, funding strategies, and maintenance. Each of these actions should be pursued as the City moves forward with implementing the Master Plan.

1. Institutionalize Master Plan Recommendations by Improving Inter-Departmental Coordination and Processes

Integrating bicycle considerations into policies and processes is referred to as “institutionalization.” Institutionalization of bicycling means bringing bicycle needs into the City’s mission and corporate culture. It requires internal work by staff and coordination among departments to make changes to policies, plans, and processes that guide the City and its decision makers.

Project design, prioritization, budgeting, and maintenance of the bicycle network are responsibilities that cross departmental lines. Coordination among departments is critical for ensuring there are no missed opportunities as road and trail projects are planned, designed and implemented. Key departments, and divisions within departments, that should be involved in project coordination include:

- Planning and Development Services
 - Transportation Planning
 - Economic Development and Urban Renewal
 - Development Review
- Public Works
 - Engineering Services
 - Traffic Engineering
 - Public Improvement Inspections
 - Streets and Traffic Operations
- Parks, Recreation and Open Space

Other city departments that may need to be involved on a project-by-project basis include:

- Aurora Water
- Aurora Fire Department
- Aurora Police Department

Action 1.1: Expand the functional responsibility of the inter-departmental coordination team

The responsibilities of the inter-departmental team, with representatives from Planning and Development Services, various divisions within Public Works, and PROS should be expanded. The City’s Bicycle/Pedestrian Coordinator plays a key role in convening and facilitating the coordination team. In addition to its current responsibilities, this team should also meet quarterly or semi-annually to:

- Review upcoming capital projects and street overlay projects to ensure integration of bicycle improvement recommendations included in the Master Plan.
- Adjust the schedule of when projects are implemented based on achieving multiple objectives, including implementation of high priority bicycle improvements and pedestrian safety improvements.
- Identify funding needs (cost estimates) for incorporating recommended bicycle improvements into capital projects and annual programs, including maintenance.

In addition to meeting, or instead of meeting regularly, this group could engage in an electronic review process of upcoming roadway projects, providing input via email at the 30%, 60%, and 90% design levels.

Action 1.2: Establish a formal inter-departmental project integration process

Departments and divisions within the city should consult the Master Plan when working on projects. In addition to establishing a formal inter-departmental team to oversee implementation of the Master Plan, it is also important to modify existing projects scoping, design, and implementation processes to ensure that recommendations in this Master Plan are automatically integrated into all applicable capital projects. The coordination team mentioned in Action 1.1 should play a key role in identifying the necessary steps toward achieving an effective project integration process.

2. Consider the Regional Context When Planning and Designing New Bicycle Facilities

Action 2.1: Coordinate with and Engage Other Agencies and Organizations Where Necessary to Implement the Master Plan.

Successful implementation of the Master Plan, and related programs, will require coordination between the city and other agencies and organizations. The roles of key partners are summarized below:

- Regional Transportation District (RTD) – bicycle access to stations and stops, bicycle parking and storage at stations, bus stop placement, and bicycle-on-transit counts.
- Tri-County Health Department (TCHD) – bicycle safety education and promotion, promotion of walking and biking, grant funding partner.
- Advocacy Organizations – bicycle education and encouragement, evaluation of plan implementation.

- Denver Regional Council of Governments (DRCOG) – regional transportation planning (including non-motorized), administration of federal and state funding for grant funding projects, regional bike maps, travel behavior inventories, bicycle promotion.
- Colorado Department of Transportation (CDOT) – funding partner, owner of right-of-way where some bicycle facilities recommended in the Master Plan are located.
- City of Denver – owns portions of streets bordering or meeting the city of Aurora, implementing its own bicycle and pedestrian master plan.
- City of Centennial - owns portions of streets bordering or meeting the city of Aurora, implementing its own bicycle master plan.
- Arapahoe County - owns portions of streets bordering or meeting the city of Aurora, administers the Open Space Program.

3. Provide the Necessary Staff Expertise and Commitment to Implement the Master Plan

The Master Plan envisions a city-wide bicycle network being developed over the next 20 years. The implementation of this network will require dedicated staff time to oversee project coordination and integration, project design, administer education and encouragement programs, conduct public outreach, and monitor progress. In addition to the bike/pedestrian coordinator in Planning & Development services, it is critical that the bicycle/pedestrian program include staff within the Public Works Department of the Master Plan, including project design. Having engineering staff directly involved in bicycle facility design and integration has proven to be an important and effective strategy in jurisdictions

that have successfully implemented their bicycle and pedestrian master plans.

Action 3.1: The city should dedicate a minimum one half FTE within Planning and Development Services to coordinate implementation of the Master Plan.

The bicycle/pedestrian coordinator position is instrumental in ensuring that Master Plan recommendations are followed through on, convening and coordinating the interdepartmental team (see Actions 1.1 and 1.2), coordinating with outside agencies and organizations, initiating and/or partnering with other entities to provide education and encouragement programs, and identifying and pursuing funding opportunities.

Action 3.2: The city should dedicate a minimum one half FTE within Public Works to manage project implementation including the design of projects involving bicycle and pedestrian facilities.

Whether it is a relatively simple striping plan or a more complex intersection design, Public Works staff time is required to design bicycle facilities, or to manage and review designs made by on-call contractors.

Make alternative transportation an integral part of life in Aurora.

- Aurora Resident

4. Pursue a Multi- Pronged Funding Strategy

Funding for Master Plan implementation and related programs will come from a variety of sources, including the General Fund, as well as regional, state, and federal funds and grants related to transportation and even non-transportation programs. The city may also want to consider a voter-approved bond or levy aimed specifically at making investments in transportation infrastructure, which would include bicycle and pedestrian improvements. Public-private partnerships may also be instrumental in implementing certain segments of the network. More and more cities are adopting policies that set spending targets for bicycling and walking ranging from \$1 million to \$500 million.¹ More cities are also dedicating annual city budget funds to walking and biking improvements and maintenance, which range from a \$200,000 to \$15 million with a median of \$1.6 million.²

Action 4.1: Adopt a policy that sets a spending target for biking and walking improvements and establish minimum annual funding for plan implementation and facility maintenance.

The City of Aurora should set a spending target for biking and walking improvements and establish minimum funding amounts per year for plan implementation and facility maintenance. Appendix F provides planning-level cost estimates, which can be used to establish minimum annual budgeting for bicycle improvements and a target for overall spending. Appendix G provides descriptions of available funding sources for bicycle planning and plan implementation.

¹ According to 2012 Alliance for Biking and Walking Benchmarking Report, thirteen cities (Albuquerque, Austin, Cleveland, Colorado Springs, Columbus, Fresno, Honolulu, Las Vegas, Louisville, Nashville, Phoenix, Portland, and Washington D.C.) have spending target policies. Albuquerque and Washington D.C. reported a target equal to 5% of total transportation budget.

² Alliance for Biking and Walking 2012 Benchmarking Report.

Action 4.2: Dedicate funding for high-priority bicycle project planning and implementation, as well as spot bicycle improvements.

In order to begin building a functional and connected bicycle network that serves key destinations it will be important to implement the high-priority early action and short-term projects identified in section 3.3 below. Dedicating a portion of the General Fund, or securing other funding sources early on in the implementation process will be a critical step toward increasing ridership and building momentum for further implementation of the Master Plan.

Action 4.3: Evaluate departmental budgets and increase and/or reallocate funds for implementation of recommended bicycle facilities.

A significant portion of the recommended bicycle network will be implemented as part of larger roadway projects, i.e. pavement overlay or roadway reconstruction. Meetings with representatives from Planning, Public Works, and Parks, Recreation, and Open Space (PROS) revealed that a major challenge in implementing the Master Plan is how departmental budgets are structured. In some cases incorporating bicycle facilities into a roadway project takes additional Public Works staff resources during the design phase, and funding to make necessary roadway modifications, particularly at intersections. Individual departmental budgets should be evaluated to determine what additional funding is needed to plan, design, and implement bicycle improvements. Additional funding from the General Fund should be allocated to both implement high-priority bicycle projects, and establish a reliable funding source that can be used for spot improvements.

Action 4.4: Pursue a variety of grant funding opportunities.

In addition to making departmental budget modifications, the city should continue to pursue outside funding sources at the regional, state, and federal levels. Appendix G contains a list of potential funding sources that should be tracked by the city on a continual basis.

Action 4.5: Establish an internal funding mechanism such as a grant match reserve fund that makes it possible for the city to have matching funds available to take advantage of state and federal grants.

A grant match reserve fund could be established as part of the annual budgeting for Plan implementation by setting aside a certain percentage (e.g., 5 percent) of dedicated bicycle improvement funds. Annual interest from the match reserve fund could be used to implement bicycle facility maintenance improvements.

If establishing a match reserve fund is not feasible, then the city should consider other mechanisms that would allow for matching funds to be readily available to ensure that appropriate grant opportunities requiring a local match can be pursued.

Action 4.6: Forge funding partnerships.

Leveraging funds with those of other agencies and departments will strengthen implementation efforts. As appropriate, public-private partnerships with private organizations should be pursued as a way to leverage funds.

5. Improve Safety and Consistency Through Design and Data Analysis.

Action 5.1: Build the capacity of city staff to plan, design, and implement bicycle facilities through trainings on bicycle planning and facility design.

Trainings may include attending conferences such as Pro-Walk/Pro-Bike, courses offered through professional organizations such as ITE, APBP, and FHWA, as well as formal and informal sessions delivered by the Pedestrian and Bicycle Coordinator and/or consultants with an expertise in bicycle and pedestrian planning and engineering. Periodic training may focus on specific topics of importance, such as intersection design, innovative design treatments, facility design transitions, and maintenance practices.

Action 5.2: Update the city's *Bicycle Facility Design Guidelines* based on the latest *AASHTO Guide for the Development of Bicycle Facilities* and 2009 MUTCD Standards.

Representatives from multiple city departments worked to develop the *Bicycle Facility Design Guidelines*, and these guidelines are fairly comprehensive. However, since the development of these guidelines the state of practice for bicycle facility design has continued to evolve. Appendix B supplements the city's *Bicycle Facility Design Guidelines* and identifies where these guidelines should be revised or added to based on the latest *AASHTO Guide for the Development of Bicycle Facilities* and current MUTCD, and best practices.

Action 5.3: Develop a system for identifying and understanding the type, pattern and location of bicycle crashes so that safety issues may be addressed either through better design, maintenance, education or enforcement.

Many bicycle crashes are undocumented because they are single bike crashes that do not require a police report, or because police are never called to the scene of the accident. In those cases where police are called to a scene of an accident involving a bicycle, it is important for all accident details to be noted regardless of who was at fault. Police reports that do involve bicycles should be compiled on an annual basis and made available to the bike/pedestrian coordinator so that locations and corridors with a high rate of crashes can be identified and any roadway design or maintenance issues can be resolved through the interdepartmental coordination team.

It is recommended the city investigate options for coordinating local hospital injury data into a crash database for bicyclists to improve the quality of the bicycle crash reporting system.

Action 5.4: Develop a system for using on-going counts of bicycle activity to extrapolate average annual daily bicycle traffic (AADBT) and average daily bicycle traffic (ADBT) for corridors and areas of the city.

The development of average daily bicycle traffic volumes for corridors and areas of the city will allow the determination of crash rates for bicyclists and to track facility usage. Both of these are identified performance measures. All on-going traffic counts conducted should include the counting of bicyclists. It is recommended that trail counters be installed on major regional trails to provide data useful for trail corridors, as well as to provide data useful for determining seasonal, daily, or hourly adjustment factors. Initially the lack of data may require the city be divided into "bicyclist catchment" areas which over time can be further subdivided as additional data is collected. Refer to the National Bicycle and Pedestrian Documentation

Project for additional information about conducting bicycle counts and establishing adjustment factors.

Ultimately the ability to determine crash rates and/or diagnose accident patterns/commonality will help the city to objectively target safety improvements. Relying strictly on total crashes may not result in the highest need location being prioritized.

6. Engineer Bicycle Facilities which Support and Encourage Bicycling

The quality of provided bicycle facilities has a direct impact on the experience of the bicyclists and will therefore have a tremendous influence on the ability of the facility to sustain use or to attract increased use. Well maintained and high quality facilities have been demonstrated to attract higher levels of users than poorly maintained or low quality facilities. Likewise, interconnected systems with minimal gaps or interruptions are essential.

Research has documented the quality of the bicyclist's experience and comfort is directly related to their space (i.e. width of bicycle lane or trail), separation from adjacent passing traffic, speed and volume of adjacent traffic, as well as the composition of the traffic (cars/trucks on roadways, people/bikes on trails). This research has resulted in the incorporation of bicycle level (quality) of service³ into the Highway Capacity Manual which accounts for the experience and comfort of the bicyclist operating on the roadway. For example, while a level of service of "D" for a motorist

³ Bicycle Level of Service is an evaluation of bicyclist perceived safety and comfort with respect to motor vehicle traffic while traveling in a roadway corridor. It has been incorporated into the 2010 Highway Capacity Manual. The research is more highly developed for midblock segments than for intersection nodes.



The width of a bike lane impacts the bicyclist's experience and comfort and is a major determining factor of whether or not people will use it.

indicates the roadway is operating at an efficient balance (capacity relative to delay); a level of service of "D" indicates a bicyclist is experiencing poor comfort on the facility. The motorist is relatively comfortable and secure in their vehicle as they are isolated from noise, weather, and are minimally physically engaged in the effort of driving. Their experiences with the bicyclists are typically limited to a perception of increased delay if they find themselves operating behind a bicyclist. This is the opposite for the bicyclist who is very sensitive to motor vehicle speed, volume, composition (trucks, buses, cars) and space due to their inherent exposure and vulnerability. This is a critical distinction which explains why the two levels of service are not directly comparable and why bicycle level of service is very sensitive to the separation of the bicyclist from motorized traffic. The bicyclist is a "vulnerable" roadway user in comparison to the motorists as they are likely to be injured or killed in a collision with a motorist while the motorists will likely not be.

A similar quality of service exists⁴ for trails where bicyclists of varying degrees of experience are frequently operating in mixed use with pedestrians, joggers, rollerbladers, and dog walkers. Speed differentials and group behavior dynamics (pedestrians and bicyclists) affect the available operating space of the bicyclist potentially limiting their ability to move at normal desired operating speeds.

The quality (level) of service concept for bicyclists is relatively new compared to vehicle level of service concepts. As such, it is important to note that there are limitations to the existing models which the designer needs to take into consideration. It is anticipated that extensive research will be forthcoming to improve the reliability of the measurements now that the concept has been validated and incorporated into the Highway Capacity Manual and AASHTO Guidelines.

Action 6.1: Develop a desired minimum bicycle level of service goal for on-road and off-road projects.

It is recommended a minimum level of service score of C or better be provided for on-road segments and level of service of B or better for off-road segments. Refer to the 2010 Highway Capacity Manual for more details on level of service for bicyclists.

Action 6.2: Incorporate the evaluation of bicycle level (quality) of service into all projects.

With the incorporation of bicycle level of service into the Highway Capacity Manual, all new traffic models will be capable of determining this score. This scoring will allow for an objective comparison of alternatives during concept development or preliminary engineering stages for proposed modifications or improvements to the

⁴ Chapter 23. Highway Capacity Manual. 2010.

transportation network. It may be necessary to provide training to staff to implement this recommendation.

Action 6.3: Utilize engineering strategies which maximize the safety and comfort of the most vulnerable (non-motorized) roadway users at roadway intersections.

A fundamental strategy for increasing bicycling rates, is to improve the experience and safety of bicycling on the roadway network. Nationally, historic crash statistics demonstrate the vast majority of crashes occur within intersections. Improvements for the comfort and safety of bicyclists on street segments with bicycle facilities should be extended through the functional area of intersections rather than terminating prior to the intersection. It is preferable to develop separate right turn lanes to the right of through bicycle lanes where space allows. At signalized intersections signal operations should consider the bicyclists both in actuating the signal and in having sufficient time to clear the intersection safely. At non-signalized intersections, consideration should be given to implementing engineering strategies which reduce crossing delay and improve comfort and safety for the bicyclists.

The provision of bicycle crossing enhancements at intersections can be obtained by the following engineering methods:

- Providing a bicycle facility (bicycle lanes, cycle track, etc) through the functional area of the intersection.
- Adding or improving bicycle detection/activation.
- Adjusting signal timing to provide sufficient time to cross.
- Providing crossing enhancements such as medians, active warning devices, or signals.

Additional discussion regarding approaches to intersection design for bicyclists is provided in Appendix B, and a case study example of how a typical Aurora intersection may be modified to better accommodate bicyclists is provided in Appendix J.

Action 6.4: Utilize engineering strategies which maximize the safety and comfort of the most vulnerable (non-motorized) roadway users on roadway segments.

On low speed urban streets (defined as posted less than 45 mph per AASHTO), the space available within the street cross section should maximize the space provided to the bicyclists via wider shoulders, travel lanes, or bicycle lanes, or be utilized to create additional separation from adjacent traffic in the form of buffered bicycle lanes or cycle tracks. Safety research has shown on low speed urban streets, additional width provided to motorists has zero to minimal value while extra width provided to bicyclists provides extensive benefits (see Appendix B for details). This extra width can be obtained by the following engineering methods:

- Narrowing parking lanes
- Narrowing travel lanes
- Narrowing medians
- Removing travel lanes
- Removing parking
- Widening roadways

Additional discussion regarding lane widths is provided in Appendix B.

Action 6.5: Evaluate new bicycle facility treatments.

The City should evaluate emerging bicycle facility treatments for their potential effectiveness. These facilities can be implemented as pilot projects with pre-determined bench marks established to measure the effectiveness. Potential facilities which should be considered include:

- Bicycle boxes
- Bicycle signals
- Passive bicycle detection
- Cycle tracks
- Colored bicycle lanes
- Enhanced trail crossings (Rapid Flash Beacons)
- Modified pedestrian hybrid beacons (addition of bicycle signals/symbols)

Additional discussion regarding potential new bicycle facility treatments is provided in Appendix B.



Colored pavement within a bicycle lane increases the visibility of the facility, identifies potential areas of conflict, and reinforces priority to bicyclists in conflict areas such as turn lanes.

7. Incorporate Bicycle Facilities into Existing Maintenance Programs

The City will establish a bicycle network maintenance strategy that includes full integration of bicycle facilities into routine roadway maintenance, considers weather and seasonal issues, and explores opportunities to utilize volunteers to assist with some maintenance tasks.

Action 7.1: Establish a system such as an on-line form or telephone hotline that allows citizens to make maintenance requests.

Establishing (or modifying the City's existing citizen comment/feedback form and system) a maintenance request system that automatically stores requests in a database would allow the City to identify where spot maintenance is needed and to set maintenance priorities.

Action 7.2: Encourage bicycle organizations and other community groups to assist with minor maintenance activities.

The City will work with bicycle organizations, community groups, civic organizations, and businesses to provide periodic upkeep along trail corridors and certain bicycle facilities such as facilities on bridges that may be more difficult to maintain using standard equipment.

8. Provide Bicycle Education and Encouragement Programs Through Partnerships

The bicycle network is designed to provide safe and convenient access for bicyclists to travel to destinations throughout Aurora. Like facilities for other transportation modes, this network of bicycle facilities must be used appropriately to be effective. For example, bicycle facilities are designed under the assumption that bicyclists ride the

correct direction on streets and stop at red traffic signals. It is also assumed that motorists yield to bicyclists when turning and do not drive or park in designated bicycle lanes.

Action 8.1: Promote bicycle and pedestrian education and encouragement in Aurora through partnerships with other agencies and community organizations.

The City will work with a number of partners, including Bicycle Aurora, Bicycle Colorado, DRCOG and others to offer bicycle education and encouragement programs. Appendix G provides examples of existing and potential education and encouragement programs.

Action 8.2: Develop and distribute an Aurora Bicycle Facilities Map

As the bicycle network is developed it will be important to ensure that bicyclists are aware of new routing options. The Facilities map can be distributed in paper form, be posted online as a PDF document, and may also be used as the basis for a web-based bicycle route-finding system.



Educating youth about bicycle control and safe riding establishes good life long bicycling habits.

9. Monitor Progress of Plan Implementation

Action 9.1: Establish performance measures.

Performance measures are used to determine progress being made toward Master Plan implementation. The most useful performance measures are quantifiable and trackable over time. As a starting point the City may want to establish the performance measures listed in Table 3.1. Additional performance measures may be added as data and resources become available.

Action 9.2: Establish baseline data needs and data collection methods that can be used to measure success of the Master Plan.

Establishing and using performance measures to monitor Master Plan implementation is contingent upon developing baseline data and collecting data on a periodic basis such as once a year or every two years. Data collection will entail coordinating with transportation agencies, the police department, and other relevant organizations that currently generate data, or would be the logical entity for collecting data related to the performance measures shown in Table 3.1.

Ensure that low-income and other disadvantaged populations (ethnic and communities of color) have equitable access to active transportation options.

- Aurora Resident

Action 9.3: Establish mechanisms for ongoing community input and accountability.

Implementation of the Master Plan will be a dynamic process with priorities changing over time as factors such as community input and funding availability are taken into consideration. Community input should continue to be sought after the Master Plan is finalized and throughout the implementation phase. The ideas and experiences of bicyclists and other roadway users, such as their experience with installed facilities, spot maintenance issues, behaviors of roadway users, and other improvements they would like to see implemented, should be used to continually shape the Master Plan. Community input may be elicited using several mechanisms, including a telephone hotline or web-based comment form, having open houses annually or every other year, and establishing a Bicycle Advisory Board or some other group such as Bicycle Aurora that functions as an intermediary between the City and the bicycling community. Bicycle Aurora has agreed to provide an annual “report card” that highlights accomplishments and ongoing efforts related to Master Plan implementation.

Table 3-1 Performance Measures

Performance Measure	Baseline Measurement	Performance Target	Data Collection Frequency
Number of bicyclists observed at counting locations	To be counted in 2012	Double the number of bicyclists counted by 2017, quadruple by 2022	Every 2 years; use volunteers and/or interns
Crash Rate: the number of reported on-road bicycle crashes compared to the total number of bicyclists observed during the on-road bicycle counts collected every other year	To be calculated by 2013, begin collecting crash data in 2012 (focus on reported crashes, hospital reports and other data as time and funding allows)	Reduce the bicycle crash rate by half by 2022	Every year
Number of bicycle racks installed	To be counted in 2012 (racks in public right-of-way, and as part of new private development projects)	Increase to a minimum of 50 per year (not including transit stations)	Annually
Miles of on-street bicycle network complete	Number of miles of existing bicycle facilities	Install a minimum of 15 miles of bicycle network annually. Complete network by 2027	Annually
Number of trail access points connected by on-street bicycle facilities	Number of trail access points currently connected by on-street facilities	Increase to a minimum of 2 per year	Annually
Achieve Bicycle-Friendly Community recognition (see http://www.bikeleague.org/programs/bicyclefriendlyamerica/communities/ for more information)	N/A	2017 (submit application) If unsuccessful, then address gaps and reapply in 2019	N/A

3.3 Implementation Schedule and Phasing

The implementation timeline for individual segments of the recommended bicycle network will vary depending on a number of factors, including available funding, the potential to piggy-back bicycle improvements on other capital improvement and street maintenance projects, and opportunities that arise through regional projects to name a few. Despite the fact that many bicycle improvements will result from an opportunistic approach, it is important to identify and implement improvements that will establish a foundational network that is functional and connects to major destinations as a starting point for building ridership. The improvements that are necessary to establish a functional foundational network are the Early Action (1 to 3 year) and Short-term (4 to 6 year) projects identified in Tables 3.2 and 3.3 and in Figure 3.1. Map 2, which accompanies this Master Plan shows these projects in more detail. It should be noted that there are several funded, and soon-to-be constructed (within the 1-3 year timeframe) projects that will have a significant impact on the existing bicycle and pedestrian network. These projects include approximately 2.8 miles of improvements around the Peoria/Smith, Nine Mile rail stations, and bicycle improvements on 40th Ave in the vicinity of Airport Blvd. These projects are shown on Maps 1 and 2 as “funded/in design” and are important components of the bicycle and pedestrian network that will be coming on line within the short-term.

All other bicycle network recommendations are shown on the bicycle network map and are considered to be long-term (7+ years) projects. It should be noted that this implementation schedule is not static, and may change as segments of the network are completed and new opportunities or demands come to light.

Phasing

A foundational bicycle network that begins to truly build ridership can be established at a relatively low cost considering that many of the network recommendations could be implemented in phases.

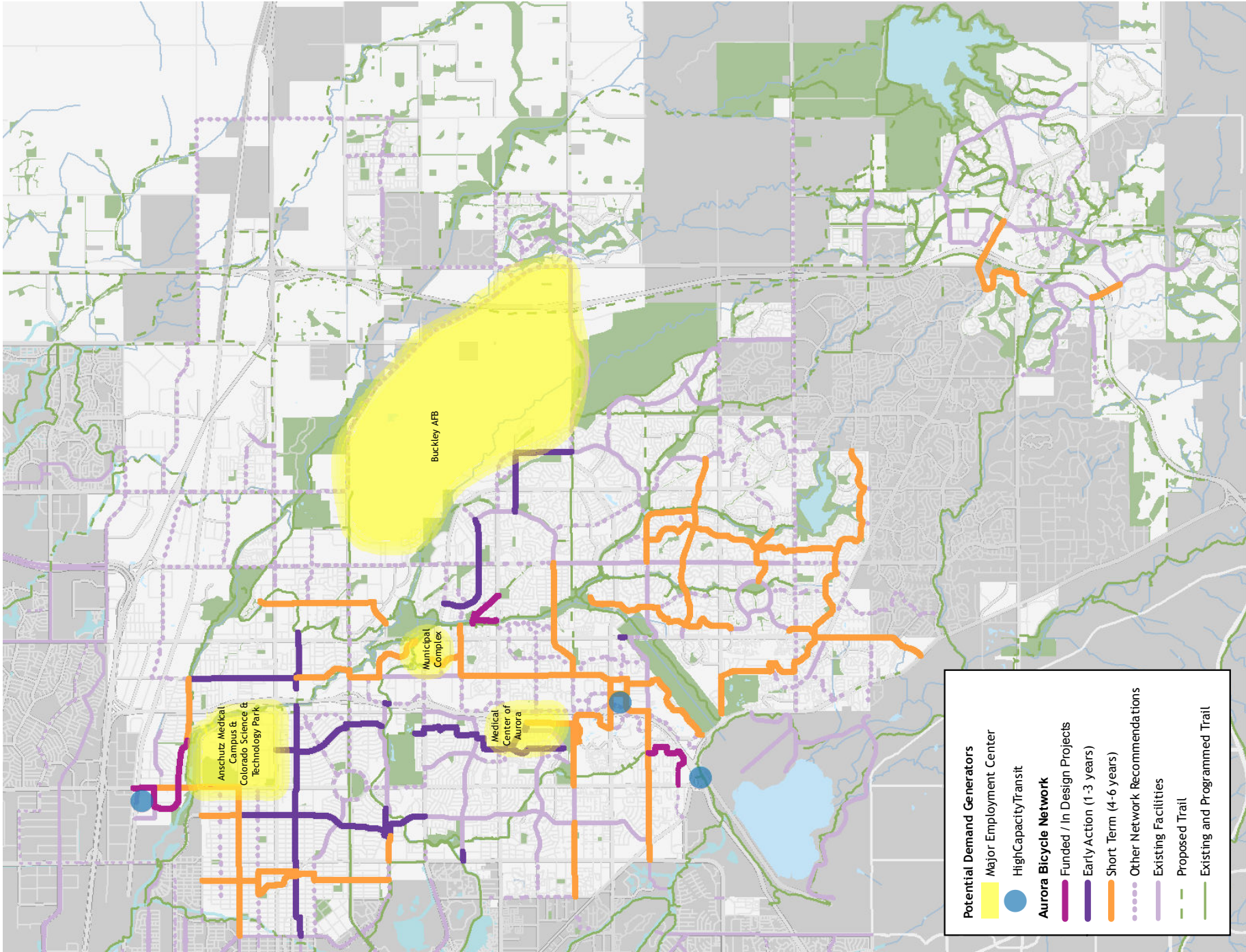
The following examples illustrate a phased strategy:

- Routes on lower volume local or collector streets could be established using relatively low cost signage first, and then, as funding becomes available, or opportunities arise, such routes could be treated with pavement markings.
- For bicycle boulevards, signage and/or pavement markings could be installed first, and higher costs traffic calming treatments could be installed over time.
- Separated bikeways in the vicinity of planned light rail stations may first be established as bike lanes or buffered bike lanes, but over time, as light rail station areas are built out, they might be upgraded to facilities that are truly separated from vehicle travel lanes.”

Regardless of how various routes are phased it will be important to improve major arterial intersections so that bicyclists are safely and comfortably accommodated through the intersection. Foregoing these kinds of improvements will likely result in low ridership and a low return on investment for the entire system.

Phasing may also occur along a corridor. For example, one segment of a corridor may be more important than another because it directly connects to other bicycle network segments and serves destinations that are likely to generate higher ridership. In such cases it would make economic sense to implement the segment that will generate the most ridership first, and complete the remainder of the corridor over time.

Figure 3-1 Early Action and Short-term Project Recommendations



I would like a climate of respect for those who do not drive a car everywhere.

- Aurora Resident

Early Action Projects (1 to 3 years)

Approximately 16.08 miles of Early Action projects have been identified. Early Action projects (Tables 3.2 and 3.3) are focused on establishing a foundational network that provides access to key destinations, provides continuity, and begins to build momentum for further developing the bicycle network. For the most part, Early Action projects are expected to provide a high return on investment in terms of ridership. The Early Action projects listed below (in no particular order) were identified using prioritization criteria established through the stakeholder process, as well as best practices in bicycle network planning. Prioritization criteria include providing:

- Access to major employment areas
- Access to high capacity transit
- Access through significant barriers
- Parallel routes to high traffic streets
- Connections to trail access points
- Access to multiple community facilities such as schools, parks, community/recreation centers

Early Action projects are primarily focused in the west and north portions of the City because it is in those areas where the prioritization criteria are best met. Ensuring that all parts of the City receive bicycle improvements

will be another important consideration as the City moves forward with implementation of the Master Plan

Early Action projects are profiled below and shown in Figure 3.1 and Map 2, which accompanies this Master Plan. It should be noted that other projects recommended in the Master Plan that are not identified as Early Action projects should be pursued whenever the opportunity arises e.g., when a street is overlaid or reconstructed.

Table 3-2 Early Action Segment Improvements

Project Name: E 12 th /13 th Ave (Yosemite to High Line Canal Trail)		
Project Description: Conduct preliminary planning and neighborhood outreach for developing a bicycle boulevard, including signing, pavement markings, bicycle advantage stop control, arterial crossing improvements. Final design and implementation timeframe will depend on neighborhood acceptance, traffic analysis, and modification of City's current traffic calming approach.		
Routing Criteria		Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none"> Within 3 blocks of Anschutz Medical Campus & Colorado Science & Technology Park Denver 	<ul style="list-style-type: none"> Relative Cost: Planning = Low, Design/Construction=Medium Arterial crossings at Peoria and Potomac need improvements Project phasing may include signing, adding markings, establishing bike advantage, traffic calming Provides opportunity to develop high quality, high profile project with very high potential ridership
Links High Capacity Transit	<ul style="list-style-type: none"> 13th Ave light rail station (proposed) 	
Links Multiple Community Facilities	<ul style="list-style-type: none"> 8 schools within 2 blocks 2 libraries within 2 blocks 	
Links to Trail Access Point	<ul style="list-style-type: none"> High Line Canal Trail Westerly Creek Trail (proposed) Toll Gate Creek Greenway (proposed) 	
Addresses Significant Barriers	<ul style="list-style-type: none"> None, but upgrading existing foot bridge over Toll Gate Creek and paving connection to The Meadows (east of I-225) would greatly improve quality of route 	
Provides Parallel Route to High Traffic Street	<ul style="list-style-type: none"> Colfax Ave (0.25 miles) 	

Project Name: Moline St (Montview to Alameda, includes short segments of E 4th Way, N Lima St, and E 1st Ave)

Project Description: Add shared lane markings and signage, E 1st Ave and Moline between E 1st Ave and Alameda to have bike lanes - Install shared lane markings where there are existing traffic circles and medians.

Routing Criteria		Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none"> Within 6 blocks of Anschutz Medical Campus & Colorado Science & Technology Park 	<ul style="list-style-type: none"> Relative Cost: Low Bringing bicycle facility up to and through intersection at arterials Provides continuous north-south route connecting south Aurora to north Aurora
Links High Capacity Transit	<ul style="list-style-type: none"> Not directly 	
Links Multiple Community Facilities	<ul style="list-style-type: none"> 4 schools within 2 blocks 6 additional schools when connected to existing bike lanes on S Moline St/S Lima St Expo Recreation Center 	
Links to Trail Access Point	<ul style="list-style-type: none"> 6th Ave Trail High Line Canal Trail Westerly Creek Trail 	
Addresses Significant Barriers	<ul style="list-style-type: none"> None 	
Provides Parallel Route to High Traffic Street	<ul style="list-style-type: none"> Peoria St Havana St 	

Project Name: Potomac Bypass

Project Description: Preliminary planning and neighborhood outreach to develop a bicycle boulevard generally running parallel to Potomac Street between Aurora Medical Center and Anschutz Medical Campus and Colorado Science and Technology Park, and incorporating numerous street segments, and one proposed trail segment (adjacent to Aurora Hills Golf Course) between S Wheeling Way and N Ursula St. Bicycle boulevard treatments would include signing, pavement markings, bicycle advantage stop control, and arterial street crossing improvements. Final design and implementation timeframe will depend on neighborhood acceptance, traffic analysis, and modification of City’s current traffic calming approach.

Routing Criteria		Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none"> Anschutz Medical Campus & Colorado Science & Technology Park Aurora Medical Center 	<ul style="list-style-type: none"> Relative Cost: Planning = Low, Design/Construction=Medium Widen existing trail (S Ursula St) on east side of Aurora Hills Golf Course Crossing at S Xapary St/ E Alameda needs to be improved with signal and/ or crossing island Utilize 8’ sidewalk on north side of E Alameda (between S Xapary St and S Ursula St) or investigate using private driveway associated with churches on north side of Alameda (connects to E Cedar Ave trail stub)
Links High Capacity Transit	<ul style="list-style-type: none"> Not directly 	
Links Multiple Community Facilities	<ul style="list-style-type: none"> 4 schools within 2 blocks Bicentennial Arts Center 3 parks 	
Links to Trail Access Point	<ul style="list-style-type: none"> 6th Ave Trail High Line Canal Trail 	
Addresses Significant Barriers	<ul style="list-style-type: none"> None 	
Provides Parallel Route to High Traffic Street	<ul style="list-style-type: none"> Potomac St (0.25 miles) 	

Project Name: E Mexico Ave (Toll Gate Creek Trail to S Buckley)

Project Description: Rechannelize roadway, i.e. road diet from 4 lanes to 3 (including center turn lane) and extend existing bike lanes that stop east of S Buckley St to Toll Gate Creek Trail.

Routing Criteria		Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none"> Enhances connection to Buckley AFB 	<ul style="list-style-type: none"> Relative Cost: Low Provides opportunity to install high quality bicycle facility Likely to have traffic calming benefits Likely to reduce potential for crashes, particularly rear-ending
Links High Capacity Transit	<ul style="list-style-type: none"> Not directly 	
Links Multiple Community Facilities	<ul style="list-style-type: none"> 1 school within 2 blocks Connects neighborhood to large open space system 	
Links to Trail Access Point	<ul style="list-style-type: none"> Toll Gate Creek Trail 	
Addresses Significant Barriers	<ul style="list-style-type: none"> None 	
Provides Parallel Route to High Traffic Street	<ul style="list-style-type: none"> None 	

Project Name: S Kalispell Way/E Kentucky Ave

Project Description: Install bike lanes on S Kalispell Way/E Kentucky Ave from E Alameda Pkwy to S Uravan St. This project should include wayfinding signage directing users between Toll Gate Creek Trail and S Kalispell Way along north side of E Alameda.

Routing Criteria		Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none"> Buckley AFB 	<ul style="list-style-type: none"> Relative Cost: Low Stripe 7-foot parking lane to provide a 6-foot bike lane (west of Buckley) Buffered bike lane east of Buckley)
Links High Capacity Transit	<ul style="list-style-type: none"> None 	
Links Multiple Community Facilities	<ul style="list-style-type: none"> 1 school Multiple parks 	
Links to Trail Access Point	<ul style="list-style-type: none"> Toll Gate Creek Trail 	
Addresses Significant Barriers	<ul style="list-style-type: none"> No 	
Provides Parallel Route to High Traffic Street	<ul style="list-style-type: none"> E Alameda Pkwy (0.50 miles) 	

Project Name: E Louisiana Ave (From S Uravan St to S Dunkirk St)

Project Description: Add bike lanes and improve transitions (crossing) to the East Tollgate Creek Trail.

Routing Criteria		Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none"> Buckley AFB 	<ul style="list-style-type: none"> Relative Cost: Low Crossing of E Mississippi Ave at Buckley AFB entrance should be improved to include marked crosswalk on east side of intersection in order to discourage wrong way riding. Alternatively, a high visibility crosswalk should be installed on north side of intersection. Sidewalk on south side of E Mississippi Ave should be improved per AASHTO standards of sidepaths, i.e. include a 5-foot buffer or safety railing.
Links High Capacity Transit	<ul style="list-style-type: none"> None 	
Links Multiple Community Facilities	<ul style="list-style-type: none"> 2 parks 	
Links to Trail Access Point	<ul style="list-style-type: none"> Yes 	
Addresses Significant Barriers	<ul style="list-style-type: none"> No 	
Provides Parallel Route to High Traffic Street	<ul style="list-style-type: none"> Mississippi Ave (0.25 miles) 	

Project Name: S Dunkirk St (from E Louisiana Way to E Jewell Ave)

Project Description: Add bike lanes by rechannelizing roadway, i.e. road diet, from 5-lane to 3-lane

Routing Criteria		Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none">▪ Buckley AFB	<ul style="list-style-type: none">▪ Relative Cost: Low▪ Improves access to Buckley AFB▪ Provides opportunity to install high quality bicycle facility▪ Likely to have traffic calming benefits▪ Likely to reduce potential for crashes, particularly rear-ending
Links High Capacity Transit	<ul style="list-style-type: none">▪ None	
Links Multiple Community Facilities	<ul style="list-style-type: none">▪ None	
Links to Trail Access Point	<ul style="list-style-type: none">▪ Powerline Trail	
Addresses Significant Barriers	<ul style="list-style-type: none">▪ None	
Provides Parallel Route to High Traffic Street	<ul style="list-style-type: none">▪ Tower Rd (0.50 miles)	

Addressing Key Network Gaps

In addition to the above routes, there are several Early Action projects that were identified because they address short gaps in the existing network, and therefore would provide considerable benefit in terms of overall network connectivity. These are listed below:

Table 3-3 Early Action Network Gap Improvements

Project Name: E Exposition Ave Extension
Project Description: Extend existing EB bicycle lane facility to S Havana St and WB bicycle lane from Havana St
Considerations
<ul style="list-style-type: none"> ▪ Relative Cost: Low ▪ Consider one of several options: <ul style="list-style-type: none"> ▪ Shared right-turn lane ▪ Reduce width of EB vehicle lane and shift WB vehicle lanes to accommodate WB bicycle lane up to intersection ▪ Widen sidewalk on north side of Exposition and use signage and pavement markings to transition users
Project Name: S Garrell Rd (From Aurora Pkwy to E Dry Creek Rd)
Project Description: Extend existing bicycle lanes up to and through Aurora Pkwy intersection and across E-470 overpass)
Considerations
<ul style="list-style-type: none"> ▪ Relative Cost: Low ▪ Requires restriping portions of roadway and modifications to the signalized intersection at Aurora Parkway ▪ Detached sidewalk on south side between off-ramp and Aurora Pkwy sufficient for SB users ▪ Transitions/crossings at access ramp will need special treatments to make evident to motorists

Project Name: S Abilene St (E 2nd Ave to High Line Canal Trail)

Project Description: Improve crossing of S Abilene St and access to High Line Canal Trail

Considerations

- Relative Cost: Low
- Improves safety of on-street/off-street transition
- Consider one of several options:
 - Improve sidewalk connection on east side of S Abilene and encourage users coming from E 2nd Ave and High Line Canal Trail to utilize connector and cross roadway at crosswalk, or
 - Install median with left turn pocket across from trail access point for bicyclists heading south,.
 - Install left turn pocket at intersection to connect northbound bicyclists to crosswalk which connects to sidewalk on south side of E 2nd Ave.
 - Create a hook space for northbound cyclists to pull off to right from bike lane and get in position for crossing at crosswalk to sidewalk on south side of E 2nd Ave

Project Name: E 2nd Ave/ High Line Canal Crossing (S Moline St to E 1st Ave over High Line Canal)

Project Description: Install shared lane markings and/or signage on E 2nd Ave, bridge over High Line Canal and short off-street connection to E 1st Ave. (see Appendix E for more details)

Considerations

- Relative Cost: Medium
- Greatly improves neighborhood connectivity
- Property acquisition or easement negotiation required

Short-term Projects (4 to 6 years)

Approximately 45.34 miles of short-term projects have been identified. Short-term projects will further fill out the bicycle network, with more facilities east of I-225 connecting high capacity transit stations as they come online, linking more trail access points and community facilities, and providing additional parallel routes to high traffic corridors. Short-term projects are shown on Figure 3.1 and Map 2, which accompanies this Master Plan.

Longer-Term Projects (7 + years)

Longer-term projects are all projects labeled as “Other Network Recommendations” on Map 2. It is expected that as the bicycle network is developed, new private development occurs, and the planned I-225 light rail corridor is further built out, bicycle improvement priorities will become more apparent. Similar prioritization criteria should continue to be applied when identifying these longer-term improvements.

3.4 Costs of Implementation

Dollar for dollar, bicycling is by far one of the cheapest transportation modes to support. Striped bicycle lanes cost between \$25,000 and \$50,000 per mile (depending on level of design required and other factors such as how it is being implemented, e.g. stand alone project or as part of a larger roadway project) while other treatments such as signage and shared lane markings cost even less per mile. In most cases bicycle facilities can be installed within existing roadways without affecting vehicle capacity, thus maximizing the roadway’s ability to move people and goods. Table 3.4 below provides planning level cost estimates by bicycle facility type and the total cost of implementing the recommended bicycle network in current dollar figures. Cost calculations and assumptions are provided in Appendix F.

Table 3-4 Planning-level Cost Estimates

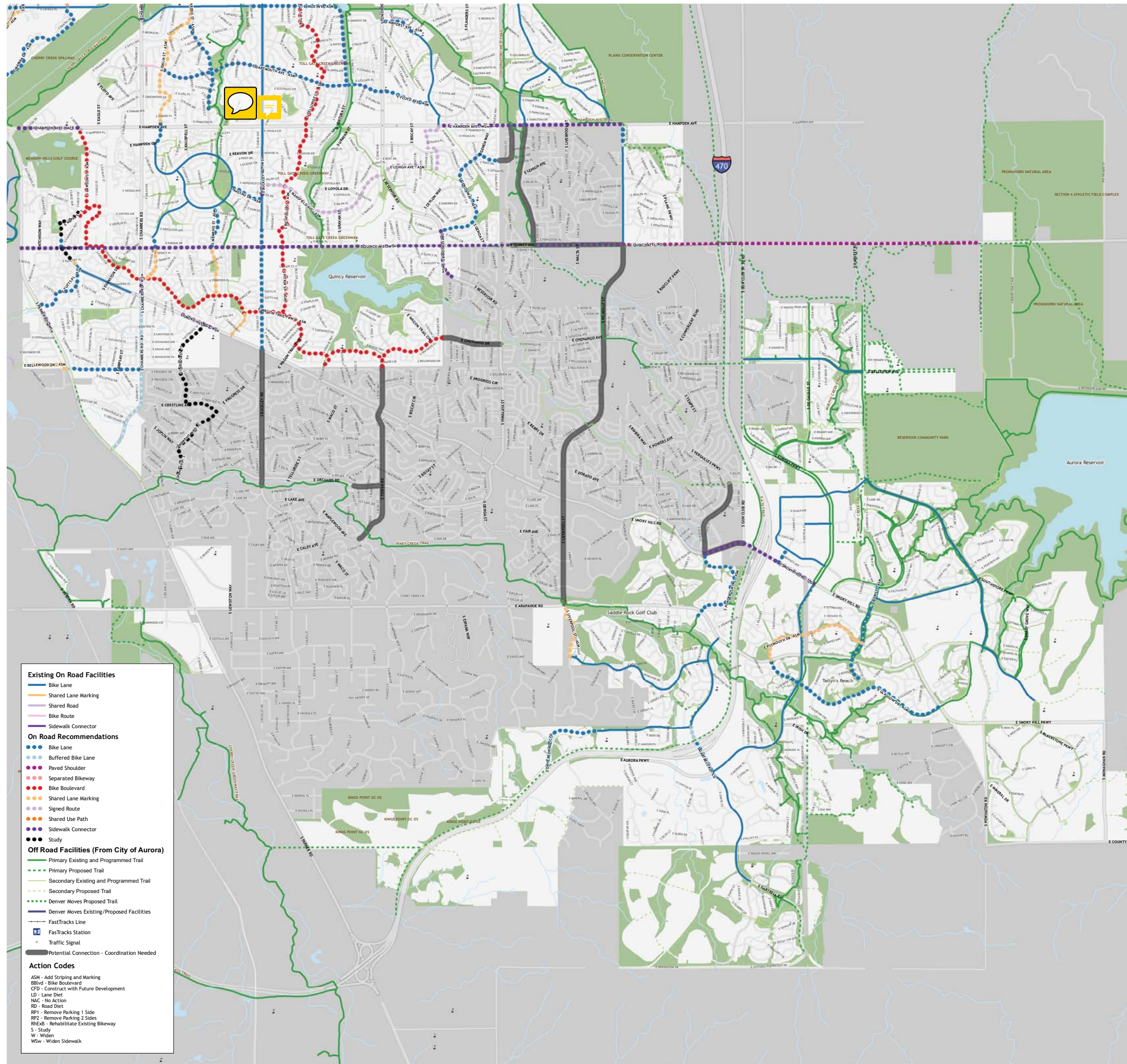
Facility Type	Miles	Total Cost
Bike lanes*	70.26	\$1,833,786
Buffered bike lanes*	4.15	\$159,318
Shared lane markings*	16.55	\$339,275
Separated bikeway	3.03	\$2,035,463
Widened sidewalk connector	26.12	\$4,725,108
Shared use pathway	0.85	\$394,655
Bicycle boulevard	19.72	\$1,815,817
Paved shoulder	5.11	\$1,349,040
Signed bike route	14.05	\$23,885
TOTAL	159.84	\$12,676,347

*Striping of parking lane is assumed for cost calculation. Cumulative costs for these facilities will likely be lower given that many streets do not have parking lanes.

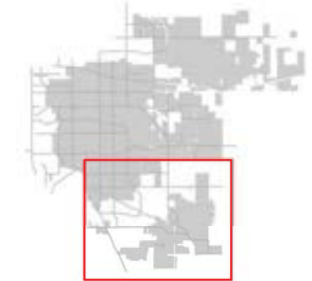


Aurora Bicycle & Pedestrian Master Plan

Map 1
Recommended Bicycle Network



- Existing On Road Facilities**
- Bike Lane
 - Shared Lane Marking
 - Shared Road
 - Bike Route
 - Sidewalk Connector
- On Road Recommendations**
- Bike Lane
 - Buffered Bike Lane
 - Paved Shoulder
 - Separated Bikeway
 - Bike Boulevard
 - Shared Lane Marking
 - Signed Route
 - Shared Use Path
 - Sidewalk Connector
 - Study
- Off Road Facilities (From City of Aurora)**
- Primary Existing and Programmed Trail
 - Primary Proposed Trail
 - Secondary Existing and Programmed Trail
 - Secondary Proposed Trail
 - Denver Moves Proposed Trail
 - Denver Moves Existing/Proposed Facilities
 - FastTracks Line
 - FastTracks Station
 - Traffic Signal
 - Potential Connection - Coordination Needed
- Action Codes**
- ASW - Add Striping and Marking
 - BSW - Bike Boulevard
 - CFD - Construct with Future Development
 - LD - Lane Diet
 - NAC - No Action
 - RD - Road Diet
 - RP1 - Remove Parking 1 Side
 - RP2 - Remove Parking 2 Sides
 - RHEX - Rehabilitate Existing Bikeway
 - S - Study
 - W - Widen
 - WSW - Widen Sidewalk



February 17 2012

Coordinate System: State Plane
Colorado Central Feet - NAD 1983



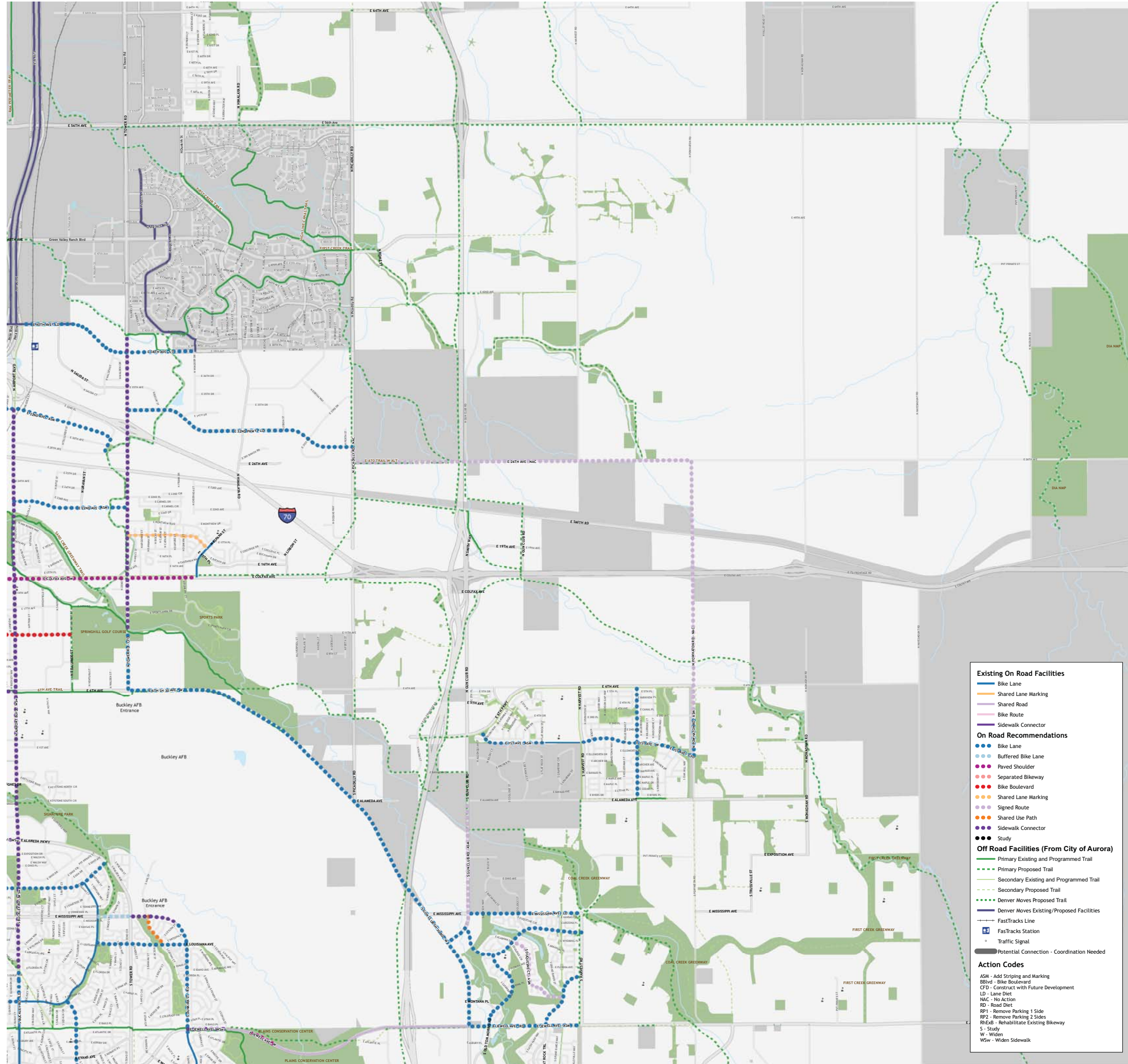
The following projects are shown as "existing" on the map because they are funded and will be constructed in the near future in conjunction with RTD light rail station improvements/ construction.

- S Ursula St
- N Moline St
- E 33rd St
- N Nome St
- E 30th Ave



Aurora Bicycle & Pedestrian Master Plan

Map 1 Recommended Bicycle Network



Existing On Road Facilities

- Bike Lane
- Shared Lane Marking
- Shared Road
- Bike Route
- Sidewalk Connector

On Road Recommendations

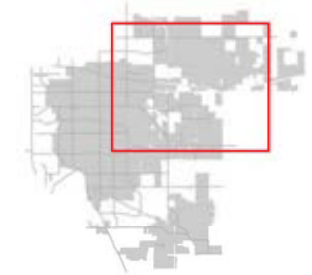
- Bike Lane
- Buffered Bike Lane
- Paved Shoulder
- Separated Bikeway
- Bike Boulevard
- Shared Lane Marking
- Signed Route
- Shared Use Path
- Sidewalk Connector
- Study

Off Road Facilities (From City of Aurora)

- Primary Existing and Programmed Trail
- Primary Proposed Trail
- Secondary Existing and Programmed Trail
- Secondary Proposed Trail
- Denver Moves Proposed Trail
- Denver Moves Existing/Proposed Facilities
- FastTracks Line
- FastTracks Station
- Traffic Signal
- Potential Connection - Coordination Needed

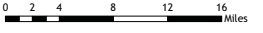
Action Codes

- ASM - Add Striping and Marking
- BBW - Bike Boulevard
- CFD - Construct with Future Development
- LD - Lane Diet
- NAC - No Action
- RD - Road Diet
- RP1 - Remove Parking 1 Side
- RP2 - Remove Parking 2 Sides
- RH-EB - Rehabilitate Existing Bikeway
- S - Study
- W - Widen
- WSW - Widen Sidewalk



February 17 2012

Coordinate System: State Plane
Colorado Central Feet - NAD 1983



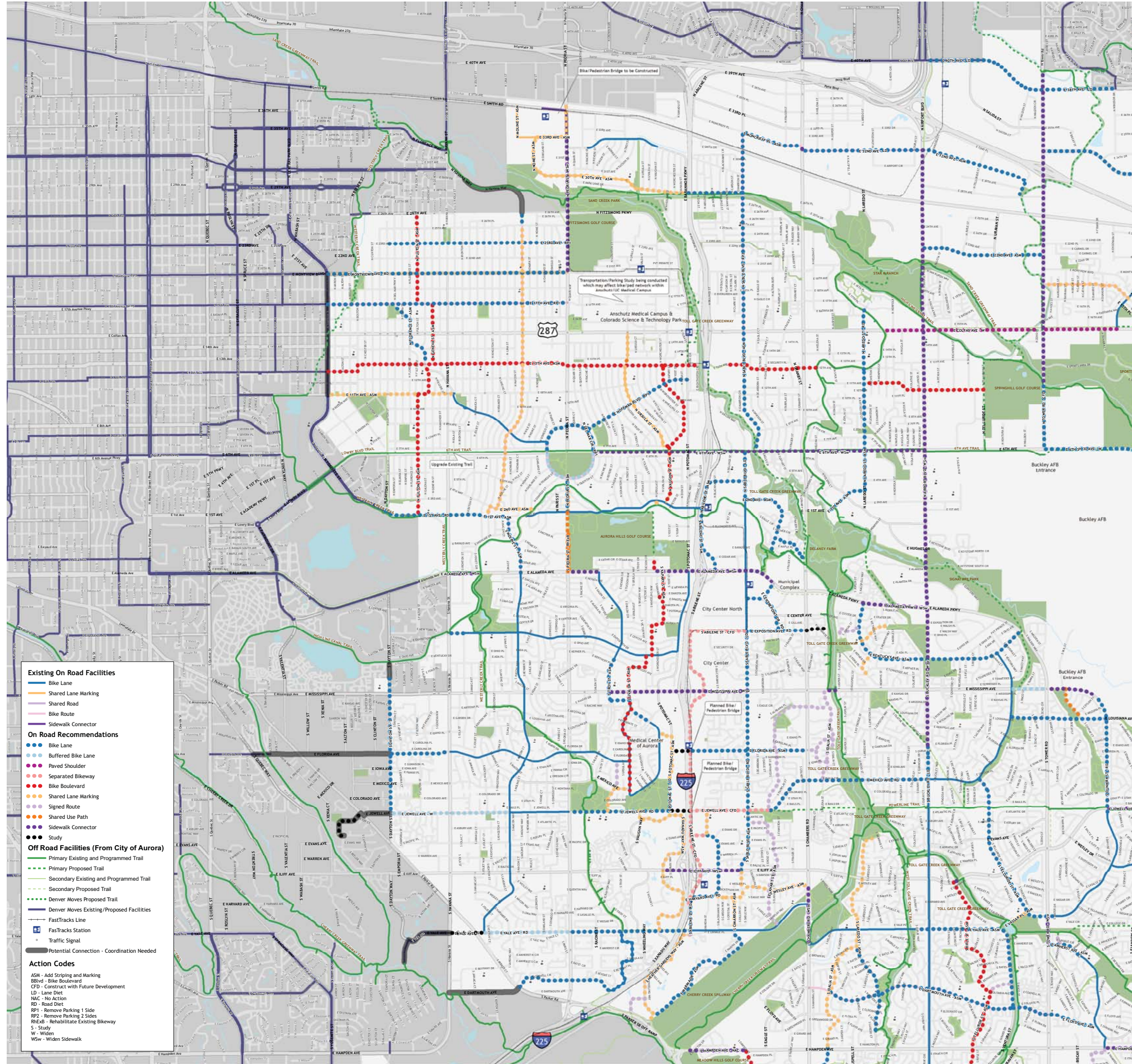
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Aurora Bicycle & Pedestrian Master Plan

Map 1 Recommended Bicycle Network



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 - Shared Lane Marking
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 - Bike Route
 - Sidewalk Connector
- On Road Recommendations**
- Bike Lane
 - Buffered Bike Lane
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 - Separated Bikeway
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 - BSld - Bike Boulevard
 - CFD - Construct with Future Development
 - LD - Lane Diet
 - NAC - No Action
 - RD - Road Diet
 - RP1 - Remove Parking 1 Side
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AURORA

Bicycle and Pedestrian Master Plan APPENDICES

Appendix A: Summary of Public and Stakeholder Outreach and Involvement

Section 2 of the Master Plan document provides a summary of stakeholder outreach and input strategies used in the Master Plan development process. This appendix provides more detail on these strategies and the results in terms of comments and suggestions that helped shape the Master Plan.

A.1 Public Open Houses

Two public open houses were held at critical stages in the Master Plan development process in order to inform the public about the Master Plan and its objectives, as well as receive input that was used to shape the Plan. The city's Communications Department prepared press releases for both open houses, which was picked up by the Aurora Sentinel and local news. In addition to putting the open house notices on its website, the city also sent notices to the following entities and organizations:

- All 368 neighborhood organizations,
- CU Medical Center and Children's Hospital employees at Fitzsimons,
- Tri-County Health Department for dissemination to their contact lists,
- Bicycle Aurora (posted on website and emailed to members)
- Bike Denver,
- Aurora Chamber of Commerce (posted on website and emailed to members)
- Aurora Public Schools (noticed all staff, parents, and students)

In addition, the first open house was announced at the final Montview Neighborhood Plan meeting where approximately 60 people were in attendance. The second public open house was announced at the five "Coffee with Parents" meetings held at public schools in northwest Aurora and attended by the Master Plan project team.

PUBLIC OPEN HOUSE # 1

The first open house was held on June 29, 2010, and had about 65 attendees from the public. In addition to informing attendees about the Master Plan purpose and objectives, they were given the opportunity to:

- Prioritize goals and objectives for the Plan
- Provide ideas for future bike routes
- Identify barriers to bicycling and walking
- Submit ideas for what should be included in the Plan

PUBLIC OPEN HOUSE # 2

The second open house was held on December 6, 2011 and had 62 attendees despite incimate weather. In addition to receiving an update on the Master Plan status, participants of this open house were given the opportunity to:

- Get an update on Master Plan development and next steps
- View and comment on the draft Bicycle Network and identify implementation priorities
- Give input on the development of a bicycle facilities map
- View examples of wayfinding signage

Below is a summary of written comments (unedited) received at the two public open houses.

General Facility Requests
Increased shared lane markings throughout the city on major high traffic roads.
Connectivity Requests
Better access between AMC and ACRAA (Aurora Center for Active Adults). ACAA is located at the SEC of West Del Mar Circle & 6 th Avenue.
The absence of a connection between the Westerly Creek Trail and Cherry Creek Trail and reservoir is a major oversight and ought to be corrected.
Need a trail connection between Norfolk Glen and Stark Ranch/Morrison Nature Center. Need to complete the High Line Canal trail from 6 th Ave, past Springhill, all the to Green Valley Ranch at 38 th Ave. Need to make a connection between Mission Viejo Park to Cherry Ck. Park entrance at Quincy Rd/Parker Road that goes thru the neighborhoods.
Regional connectivity.
Specific Facility Requests
I would like to see more underpasses along the high line canal trail.
The bike/pedestrian access along Peoria to Nine Mile Station is very limited, often dangerous. Sidewalk needs to be widened, better marked, intersections made safer.
My interest: Continue bike trail/ designation in Heather Gardens – per discussion w/ Jay Pierce.
Peoria South of Illif ha no sidewalk on the west side and the other sidewalk is narrow. This is a direct route to nine mile station. Also the Highline needs more underpasses for bikes and peds to eliminate crossings wh/ is potential for accidents and underpasses make for a much more efficient ride.
A very interesting talk. I find these days with all the traffic you have to drive to an area to bike riding,
Bike racks west side of Municipal Bldg. Funding for APS and CCSD for racks at main (admin) bldgs
Shoulder on Quincy out to the reservoir.
Paint bike lanes on Yale east of Buckley.
Can Alameda become a sharrow?
Design Issues
When a trail crosses a street in the middle of the block, is it possible to etch the street name at the edge of the trail? Very often, if the bike trail is winding, I'll come to a street, and I don't know where I am.
Please provide signage at any intersection of trails or routes with other streets.
Bike/ped crossing and traffic signals – time allowed for crossing is inadequate. The time it takes for signal to change is too long.
Wayfinding signs are needed badly. Glad to see this will be addressed.
I am a major cyclist but today I would like to advocate for people with disabilities. I would like you to consider and design for people with reduced or no vision, wheelchair bound, mobility impaired, cognitive impairment, etc. Please refer to the "Public Rights-of-Way Accessibility Guidelines." Let's work to remove barriers to people with disabilities. If we design for the weakest and most vulnerable people, we design for all.

Areas we should consider when designing for people with disabilities-

- connected sidewalks
- curb cuts
- transition corners that lead to distant transition corner
- bike lanes for wheel chairs when no sidewalk available
- wayfinding for all – deaf, blind, sighted
- paths with edges
- accessible pedestrian signal buttons – audible , vibrotactile
- consider bikes, peds and people with disabilities when designing round-about
- Bus stops should be accessible. No stops on stones, rocks, grass.

Some barriers to remove for accessibility

- snow – enforce snow removal
- transition ramps with lips
- lack of curb cuts
- Blocked sidewalks (construction crews often block sidewalks with road work signs)

Spray paint the name of the street at bike/street intersections.

Spray paint street names on sidewalk where it intersects the street.

We are looking at these issues in CABC – Our recommendations include better cooler signage on all bike routes. Need to make it exciting to bike and walk in Aurora.

Maintenance Issues

While new infrastructure is fantastic and needed, I hope the plan will address maintenance of existing trails, e.g., cleaning up debris – especially glass. It's a problem on The High Line.

Improvements to existing trails should be a priority. There are several areas that have not seen improvements in several years. I talked with one person that was in charge of funds (lottery money) that I thought was supposed to pay for trails and open space. I told her about the trail that crosses under both Mississippi and Alabama and a portion of the trail just before you get to the top which crosses over the trail is in deplorable condition. She then informed me that those funds have been spoken for for months in advance for other projects. She also told me that portion of the trail has never been addressed in the past, and that there was no future for that section of the trail.

Enforce snow removal

Perhaps the street sweeper follow the mow crowd in an effort to clear the goatheads.

An improvement plan needs to be adopted and funded to maintain/repair existing trails and lanes.

Safety and Culture

Many bike routes now (namely Buckley Rd) are way too dangerous and should not be “routes.”

High Line canal to Peoria; going around Del Mar Pkwy and crossing 6th Ave to get on Del Mar bike lane is scary. Can light or something heap w/that immediate left onto Del Mar north of 6th Ave?

Safe Routes to School

Schools near trails-invite kids w/parents to council mtg.

- Buckley AFB
- Community College of Aurora
- Fitz-CUAS

Encouragement

Would like ability to have an assigned locker if you pledge to bike to work __ days per month, so I don't need to tote a towel, dress clothes, dress shoes, toiletries, curling iron, blow dryer, etc., etc. on my bike.

Education

Small group & individual education/ tours/ programs

Implementation/Partnerships

Get realtor and sponsorship/support—trail access sells houses.

Establish links with bicycle shops.

Can you work with the Parks/Rec/Open Space Dept on this?

Plan Development
Incorporate bike and ped plan into Seats & Neats (Southeast & Northeast Area Transportation Study)
Coordinate Highline working group with this effort.
It would be good to get people with disabilities involved in this process.
An improvement plan needs to be adopted and funded to maintain/repair existing trails and lanes.
Look forward to frequent communications. Email doesn't need a stamp.
Thank You; Appreciation
Many good ideas and I am glad to see there is a lot of North South connection routes being added.
I like that you're also looking at pedestrian wayfinding.
I hope the City of Aurora recognizes the value of bike/ped accommodation and accepts the recommendations and guidance the Plan provides. Thanks for doing this.
Amazing set up. Quite impressed with the layout, printings, and organization.
Thanks to fleet for plowing the paths in the winter.
Excellent get-together. Great idea.
Planning firm looks good. Please ensure you are serious about the plan & get rid of old school attitudes.
Excellent presentation – Feels like a good start.

COFFEE WITH PARENTS

Given that populations living in northwest Aurora are predominant walkers and bikers, and that residents from this part of the city were generally not represented at either of the public open houses, the planning team sought input from these residents by attending Coffee with Parents meetings at five Aurora public schools in the area:

- Fulton Elementary
- Fletcher Elementary
- Crawford Elementary
- Jamaica Elementary
- Paris Elementary

Input received at these meetings was primarily focused on pedestrian issues and the need to improve specific segments of sidewalk or intersections. A summary of these comments is provided below.

General Facility Requests
They wondered when the new red crosswalks (Denver's) would be implemented. They thought cars avoided stopping in them at red lights. [Fletcher]
Street names are hard to see because of the poor lighting. San Antonio was mentioned to have painted the names in the street. [Fletcher]
Sidewalks are too narrow [Fulton]
Speed bumps (or speed tables) requested on roads surrounding the school. Parent sad cars travel fast down the alley behind the school. [Fulton]
Specific Facility Requests
The traffic light at 16th & Dayton does not allow enough time for children to pass through the intersection. [Crawford]
Crawford Elementary School needs more bike parking; there are only eight spaces for bikes. Also, the school needs to provide parking for skateboards and scooters. [Crawford]

The walk phase of the traffic signal at 16th & Florence is too short for children. [Crawford]
16th or 17th Avenue needs a bike lane. [Crawford]
A four-way stop sign is needed at 16th Avenue and Chester Street. [Crawford]
The neighbors would like a traffic signal at Colfax and Beeler. [Crawford]
They inquired about speed bumps (speed tables) along 23rd and 25th near the school to control the speeding vehicles. [Fletcher]
Requested a left turn signal from Colfax to Havana. [Fletcher]
4 way stop on 23rd and Moline is ignored. A light is requested. [Fletcher]
Street trees were requested for a property at Jamaica and Montview [Fletcher]
Requested that the midblock light and crossing at the school moved to either street corner. Traffic exiting the Hanover alley do not see people in the crosswalk (a lighted stop sign requested). [Fletcher]
Bike lane connection from 4th and Havana area to Highline Canal is requested [Fulton]
Crosswalk requested to the park [Fulton]
Crosswalk at front door along Fulton requested [Fulton]
A crosswalk and stop sign was requested at the Delmar and Jamaica intersection. [Jamaica]
Restrooms were requested at city parks (no location given). [Jamaica]
Traffic speeds along 16th Avenue are excessive. Can we get more traffic control during the times when children walk to and from school? [Paris]
The traffic light at Oswego and Montview takes too long to change. I see children get impatient and cross on “red” if they have to wait too long. [Paris]
16th and Oswego is very difficult to cross at times due to very high traffic volumes. Parents would like to see a 4-way stop installed at this location. [Paris]
Maintenance Issues
On snow days too many sidewalks do not get cleared; especially near the school. [Crawford]
Tree branches near the intersection of 17th & Florence block the traffic signals and cars passing through the intersection cannot see the traffic lights. [Crawford]
The pedestrian-activated walk button at 16th & Dayton does not work. [Crawford]
On snow days too many sidewalks do not get cleared; especially near the school. [Fletcher]
Flashing light on 8th and Peoria is not working [Fulton]
Broken bottles and trash often exist on Hanover [Fulton]
Parents would like to know what number they call to report people that get their sidewalks cleared in time. [Paris]
Safety and Culture
At 16th & Havana, semi trucks parked along the NWC of the intersection block sight lines for pedestrians. [Crawford]
Vehicles travel too fast on 17th Avenue; speed control measures are needed. [Crawford]
Sidewalks in NW Aurora are too narrow. [Crawford]
Sidewalks are very narrow [Fletcher]
No sidewalks exist to Bluff Lake (the Chain link fence between north side 25th properties and the vacant land along 26th has been cut to gain access to Stapleton (Bluff Lake access and sidewalks) [Fletcher]
Sidewalks do not exist along the park behind the school [Fulton]
Fulton currently has 4-5 vision impaired students. (accommodations to walk are nonexistent) [Fulton]
Sidewalks are too narrow. [Jamaica]
Many parents ride RTD to 8th and Havana stop and walk the children from there. There is no stop sign at 8th and Jamaica. They have both morning and afternoon sessions (3 peak traffic times). [Jamaica]
Very few marked crossings on Delmar and vehicles travel very fast along Delmar [Jamaica]
Poor street lighting in the area [Jamaica]
There is a lot of double parking when parents are picking up children at the end of the day. [Paris]
Safe Routes to School—General Issues

Crawford Elementary needs to have bike donations for children. [Crawford]
The neighboring Head Start school contributes to the traffic as well [Jamaica]
Parking along 17th Avenue is a problem if you want to visit the school. We believe Fitzsimons employees park in the area making it difficult for parents to park close to Paris Elementary. [Paris]
Parents would like to see if bicycle donations could be made. Donations should be in pairs: one bike for a parent and one for the child. [Paris]
Education
Parents would like to see driver education PSA's regarding the need to drive safely around school zones. [Paris]
Enforcement
No enforcement of parking rules in school parking lot results in congestion [Fulton]
Middle School children harass elementary school children walking home from school. [Crawford]
Implementation
The construction along Havana was poorly communicated to the parents and has left dirt and mud along the sidewalks. They would like information on the completion date. [Fletcher]

MEETING WITH BICYCLE AURORA

Bicycle Aurora is the primary bicycle advocacy group in Aurora. Its members are knowledgeable about bicycling conditions throughout the city. The planning team met with Bicycle Aurora on June 30, 2010 to seek their input on both general and specific issues related to biking, including facility design and biking culture in the city. The group provided valuable input and ideas for what the Master Plan should focus on.

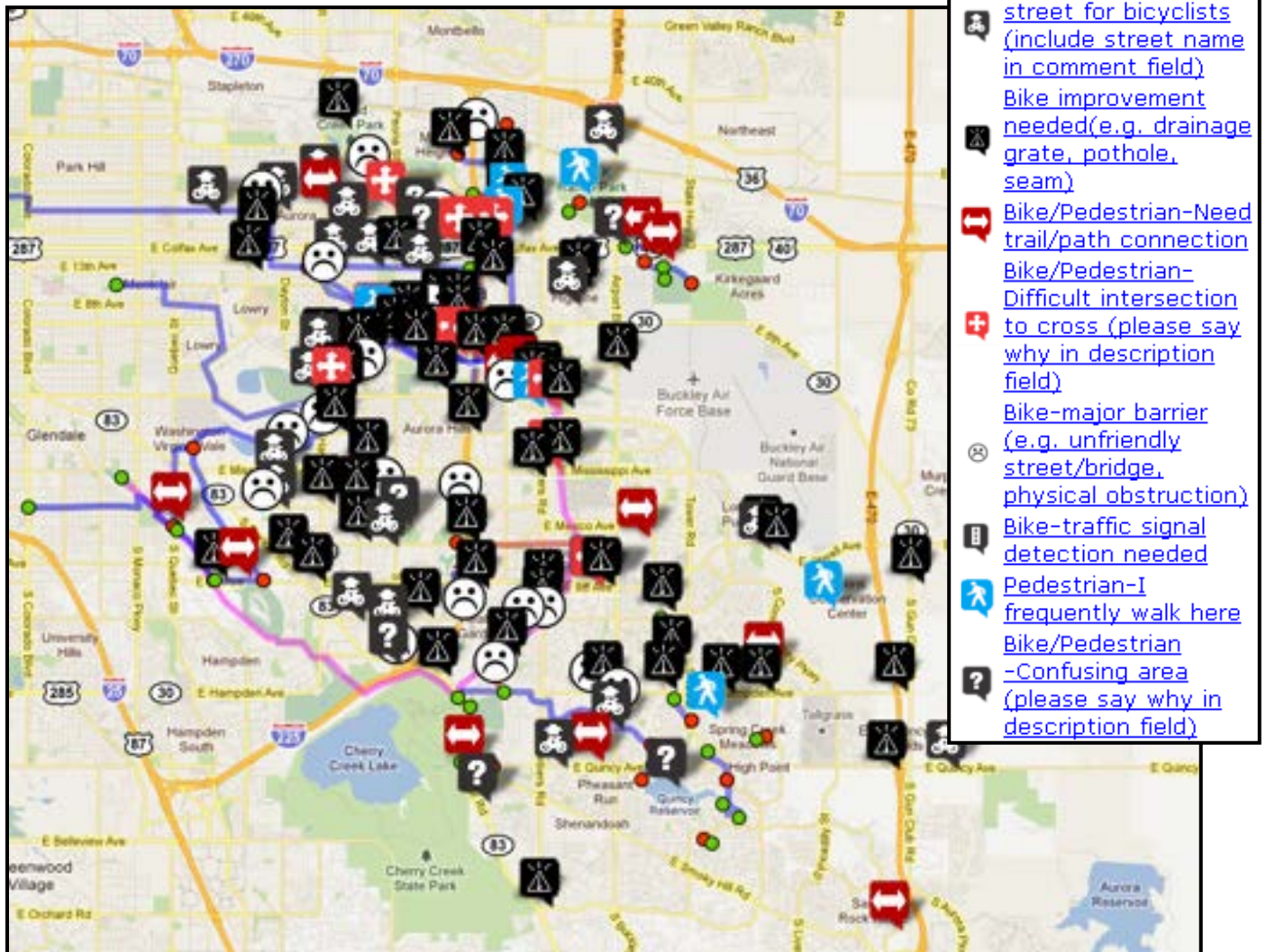
A.2 Interactive Mapping Results

Members of the public were encouraged to indicate preferred routes and areas where improvements are needed for bicycling in the city by adding markers, paths, and descriptive comments to an interactive map. Between July 1, 2011 and September 19th 2011, the map was viewed 481 times, and 149 markers and 34 paths were added. Table 1 below shows a ranking of the category areas placed by map users. Figure 1 shows a screen shot of the online mapping tool with the markers and paths added by the public.

Table 1: Interactive Map Category and Number of Markers

Ranking	Category	# of Markers
1	Bike improvement needed (e.g. drainage grate, pothole, seam)	65
2	Bike-Important street for bicyclists (include street name in comment field)	20
3	Bike-major barrier (e.g. unfriendly street/bridge, physical obstruction)	20
4	Bike/Pedestrian-Difficult intersection to cross (please say why in description field)	13
5	Bike/Pedestrian-Need trail/path connection	12
6	Pedestrian-I frequently walk here	9
7	Bike/Pedestrian -Confusing area (please say why in description field)	7
8	Bike-traffic signal detection needed	2

Figure 1: Screen shot of the Interactive Map



The TDG team downloaded the points, paths and comments received through the online mapping tool for analysis. The findings are included below:

AREAS OF HIGHEST COMMENT CONCENTRATION

- Aurora Plaza and Del Mar Park
- Intersection of 287/East Colfax Avenue and Interstate 225/Route 40
- Along East 2nd Avenue (between Del Mar Circle and North Sable Boulevard)
- Along East 6th Avenue (between Del Mar Circle and Sable Boulevard)

OTHER AREAS OF NOTABLE COMMENT CONCENTRATION

- Along Sable Boulevard (between East 6th Avenue and East Smith Road)
- Intersection of E Iliff Avenue and the Toll Gate Creek Trail
- South Chambers Road (between East Yale Avenue and E Iliff Avenue)
- East Florida Ave (between South Parker Road and South Peoria Street)

- East Jewel Ave (between South Parker Road and Horseshoe Park)
- Intersection of East Mississippi Avenue and trail access (west of Rocky Ridge Park)
- Along the High Line Canal Trail
- East and West Intersections of High Line Canal Trail and East Alameda Parkway
- Along East 1st Avenue (between Fulton Street and High Line Canal Trail)
- Along East 13th Avenue (between Del Mar Parkway and Freedom Park)

The input received through the interactive map helped to focus field work efforts and identify opportunities and issues that were invaluable to defining the draft bicycle network. In particular, the input was helpful in identifying streets that people use to bike (or streets that they would use if some improvements were made), and locations where spot improvements could be made that would greatly improve the bicycle network.

A.3 Online Survey Results

An online survey was used to identify public attitudes and perceptions about bicycling, major barriers to bicycling, what aspects of the existing bicycle currently work or don't work, and identify specific locations or streets needing improvement. Information from the survey will be used to inform the program, policy, and bicycle network recommendations that are included in the Plan. The survey was available online from July 1, 2011 through September 19th, 2011. The survey was publicized through City of Aurora website, Bicycle Aurora website, Aurora Public Utility bill statements, local media coverage, and email blasts. It is important to note that this survey was self-selected; therefore the results are not statistically significant.

One hundred and five (105) surveys were started and 76 were completed, representing a 72.4% response rate. The most frequently cited concerns expressed by survey respondents regarding walking and biking in the City include:

- Bicycle lanes are too few, and are not interconnected
- Difficult intersection/road crossings
- High traffic volumes
- Unsafe driver behavior (including traveling at high speeds)

Demographic information was collected as part of an optional section of the survey. Approximately one fifth of the respondents skipped this section. Based on the responses received on optional questions, it can be concluded that the survey response was well-balanced in terms of age and gender. A small minority of the respondents indicated that they have mobility impairments.

A summary of survey response highlights is provided below. Following the highlights are summary tables and charts illustrating the results of each survey question in the order that they appeared in the online survey form. Write-in responses to questions are included with the tables and chart.

HIGHLIGHTS

- A total of 105 respondents completed the survey.
- The survey created two tracks for the respondents; those who have bicycled in the city within the last year and those who have not.
 - The majority of respondents have bicycled in the City of Aurora within the last year. (76, 72.4%)
 - Of those who have not bicycled in the City of Aurora in the past year (29, 26.6%), the two most common reasons for not bicycling included "I don't own a bicycle" and "I don't feel safe riding a bicycle in traffic" (11, 40.7% each).
 - Other common reasons for not bicycling in the City of Aurora included
 - There are too many barriers to biking (high traffic speeds, dangerous intersections, etc.) (10, 37.0%).
 - Bicycle lanes are too few, and are not interconnected (8, 29.6%)
 - None of the following reasons for not bicycling in the City were chosen by respondents
 - My school is located too far from my home (0).
 - My school does not offer shower/locker facilities (0).
 - Insufficient bicycle parking at school (0).

- It is possible that schools are providing all of the facilities needed to comfortably bicycle in the City. Another explanation may be that this survey did not attract many student respondents.
- Of those that do bicycle in the City, respondents were asked about the types of bicycle trips that they take and how often. Respondents could choose any number of responses.
 - The most common trip that the respondents take is for exercise or personal fitness (66). Half of these trips are made three or more times per week (33).
 - The second most popular trip types are made for fun/leisure (57).
 - Other common responses included biking to work (49), biking for shopping/errands (42) or for visiting family and friends (42).
 - The least common trips are made to school (23).
- Respondents were asked what they like most about bicycling in Aurora. Respondents could choose up to three responses.
 - The most common response was the off-road network or bike trails (45).
 - Followed closely behind was agreeable weather (37).
 - Good feelings about helping the environment ranked third (31).
 - The least popular response was related to driver behavior; motorists respect bicyclists on the roadway (2).
- Respondents were asked to rank five types of bicycle facilities that they prefer to use when riding a bicycle.
 - The most popular response was trails/paths (69). Nearly all of the respondents who chose trails/paths ranked it as their number one preferred facility (52).
 - Designated striped bicycle lanes were also a popular choice (65). Most of these respondents ranked bike lanes as their second choice (43).
 - The least favorite facility type amongst the respondents was vehicle travel lanes (with the flow of traffic) (46). Nearly all of the respondents that marked this choice ranked this facility type at number five (31).
- Respondents were asked what factors make it difficult to bicycle in Aurora and neighboring areas. The respondents were asked to rank their respondents from one to four, one being the most important factor.
 - Similar to previous responses, the most commonly selected factor was bicycle lanes are too few and not interconnected (47). Half of these respondents ranked this as the most important factor.
 - The second most common factor was crossing busy streets (37). Nearly all of these respondents included this factor within their top three.
 - The third most common factor chosen was not feeling safe riding a bicycle around cars and trucks (34).
 - Similar to previous responses, the answer choices relating to school ranked very low. A lack of shower and locker facilities was not chosen as a factor at all.

- Using general terms, respondents were asked what areas in the City are most in need of improvements for bicyclists. Respondents were asked to identify how much improvement is needed at these locations.
 - The most common general location chosen was along the length of major streets ((e.g., Montview Blvd, Quincy Ave, Chambers Rd) (66). Nearly all of the respondents indicated that these types of streets are in need of substantial improvement.
 - The second area most in need of improvements was crossing highways (e.g., I-225, 6th Ave, Parker Rd, Havana St) (65). The majority of these respondents indicated that these locations are in need of at least some improvement.
 - Other common responses included
 - At trail access points (61)
 - Trails (61)
 - Near retail/shopping centers (60)
 - The area of the city west and north of I-225 (59)
- Respondents were asked about their walking trips in the City of Aurora. They were asked to identify which trips they make by walking and how often those trips are made.
 - Most of the respondents walk for exercise or personal fitness (66) or leisure (62). Most of these trips are made weekly if not more often.
 - Respondents also walk to complete errands (40). Over half of these trips are made weekly if not more often.
 - Walking to work was amongst the least common responses (12).
 - Four respondents indicated that they walk to school.
- Respondents were asked to identify the top four factors that make it difficult or unpleasant to walk in the City.
 - The most common factor among the respondents was drivers not stopping for pedestrians in crosswalks (32). Most of the respondents ranked this as the most important factor.
 - “Fast vehicle speeds” was chosen by 28 of the respondents. Of those respondents 17 ranked in the top two.
 - Likewise, heavy traffic was the third most popular answer (23).
 - Among the respondents, the least important factors were
 - Mobility impairments (poor health, use of wheelchair or other walking aid) (1)
 - Lack of facilities for people with disabilities (such as curb ramps) (1)
- Respondents were asked a series of questions related to the draft plan. The first question asked if they agreed with the draft vision of the plan.
 - Two-thirds of the respondents agree with the draft vision (78, 74%). Over half of the respondents strongly agree with the draft vision (51, 56%)
- The respondents who indicated that they disagreed with the draft vision were asked how they would modify the draft. Common themes among the write-in responses included
 - Clarify the word “sustainable” or replace it with a more intuitive word
 - Focus on health, fitness and recreation purposes

- Focus on mode shift
- Respondents were asked to rank the importance of each of the six goals included in the draft plan.
 - The three highest ranking goals (in order) were:
 - Improve safety for bicyclists and pedestrians through careful design and implementation of facilities.
 - Identify and prioritize key bicycle and pedestrian improvements.
 - Promote active lifestyles and good health by encouraging bicycling and walking in the city.
 - Developing an implementation strategy was the goal that received the lowest ranking among the respondents.
- Respondents were asked to write-in any goals that they would like to add to the plan. Common themes among the write-in responses included:
 - Promote social and economic equity
 - Increase opportunities to combine walking/biking trips with transit
- Respondents were asked to rank the objectives associated with each goal. The tables included below shows how each objective was ranked by the respondents.
 - Overall the respondents highly rank objectives that either increase or improve bicycle or pedestrian facilities in the City.
 - Education and enforcement programs are also ranked highly.
 - Generally speaking, objectives that focus on policies or administrative tasks are not ranked as highly as those that are facility-focused.

Goal 1: Promote active lifestyles and good health by encouraging bicycling and walking in the City.

Ranking	Objective	Count
1	Objective 1.2 Increase number of trailheads connected to on-street bicycle facilities	78
2	Objective 1.3: Increase the percentage of school-age children who have the opportunity to walk or bicycle to school.	69
2	Objective 1.4: Promote bicycling and walking through events, social marketing, and dissemination of information such as bike maps, biking and walking tips, and a comprehensive way-finding sign program.	69
3	Objective 1.1: Increase the number of people bicycling by 50% by 2022	58

Goal 2: Improve safety for bicyclists and pedestrians through careful design and implementation of facilities.

Ranking	Objective	Count
1	Objective 2.2: Design all bicycle facilities utilizing the most current national standards, guidelines, and practices.	81
2	Objective 2. 1: Reduce the rate of bicycle crashes by 50 percent by 2022.	76

Goal 3: Improve safety for bicyclists and pedestrians through education and enforcement programs.

Ranking	Objective	Count
1	Objective 3.3: Educate city staff involved in planning, design, maintenance, and construction about best practices for addressing bicycle and pedestrian needs.	75
1	Objective 3.5: Develop a system for identifying and understanding the type and location of bicycle and pedestrian crashes so that safety issues may be addressed either through better design, education or enforcement.	75
2	Objective 3.1: Coordinate with the school districts, and the Police and Fire Departments to develop and implement school safety programs for bicycling and walking to school.	74
3	Objective 3.4: Increase enforcement, taking a balanced approach that improves the behaviors of both motorists and bicyclists and reduces crashes.	71
4	Objective 3.2: Develop bilingual educational materials and announcements to raise awareness of behaviors that reduce the incidence of bicycle and pedestrian and motor vehicle accidents.	50

Goal 4: Identify and prioritize key bicycle and pedestrian improvements.

Ranking	Objective	Count
1	Objective 4.1: Identify a comprehensive on-street/off-street interconnected bicycle network	81
2	Objective 4.4: Improve accessibility for bicyclists and pedestrians around barriers such as intersections, freeways, and a discontinuous street network.	80
3	Objective 4.3: Assess and identify existing facility deficiencies.	79
4	Objective 4.2: Identify and recommend bicycle facilities for the bicycle network (i.e. bike lanes, shared lane markings etc.)	75
5	Objective 4.5: Improve accessibility for bicyclists and pedestrians to transit stations and neighborhood activity centers.	71
6	Objective 4.6: Design a way-finding sign program to facilitate and encourage pedestrian and bicycle mobility and access to facilities and services.	70
7	Objective 4.7: Coordinate with neighboring jurisdictions to promote regional bike facility continuity.	60

Goal 5: Develop an implementation strategy.

Ranking	Objective	Count
1	Objective 5.3: Identify funding sources and mechanisms that address highest priorities first.	76
2	Objective 5.6: Incorporate bicycle and pedestrian facility improvements into capital projects and annual programs.	75
3	Objective 5.5: Adopt a 5-year Capital Improvement Program (CIP) for bike and pedestrian improvements.	68
4	Objective 5.4: Establish an accountability process that includes specific performance measures and targeted timeframes.	62
5	Objective 5.1: Adopt a Complete Streets policy.	59
5	Objective 5.2: Adopt a policy for “routine accommodation” of bicycle and pedestrian facilities.	59

Goal 6: Recognize the provision of high quality bicycle and pedestrian facilities as an integral component to achieving economic, environmental and social sustainability.

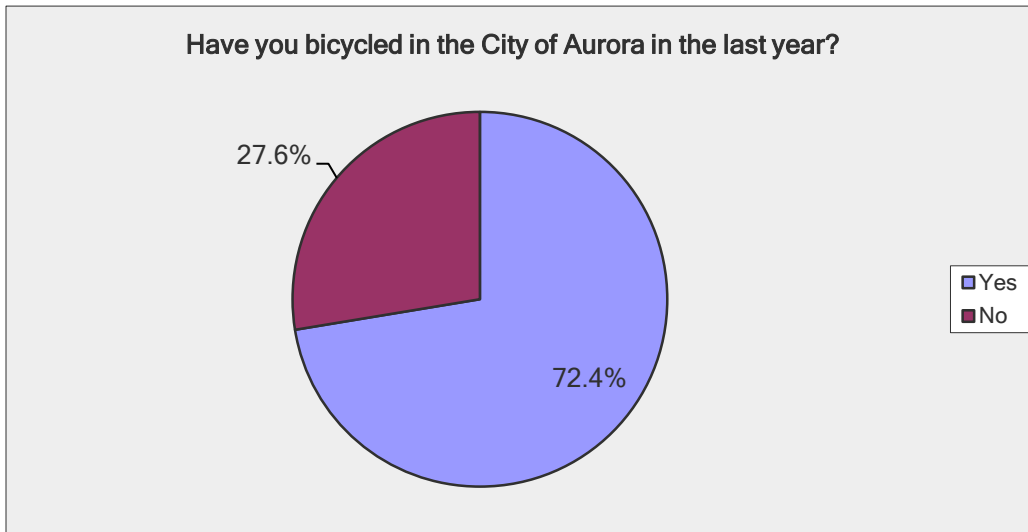
Ranking	Objective	Count
1	Objective 6.4: Implement bicycle and pedestrian improvements in an equitable manner.	71
2	Objective 6.1: Increase the number of businesses/employers that are recognized as Bicycle Friendly Businesses by encouraging them to provide end-of-trip facilities such as bike parking, lockers, and showers.	69
2	Objective 6.2: Increase the number of bike racks throughout the City.	69
3	Objective 6.5: Increase the number of Bicycle Friendly businesses.	62
4	Objective 6.3: Decrease the number of Vehicle Miles Traveled and associated Greenhouse Gas Emissions.	58

- Respondents were asked to provide demographic information.
 - One fifth of the respondents skipped this section.
 - Most of the respondents are between the ages of 25 and 64 (85.5%)
 - The respondents are nearly balanced on gender.
 - Male 46, 54.3%
 - Female 38, 45.2%
 - Very few of the respondents indicated that they have a mobility impairment (5, 6.1%)

Full Survey Results

Full survey results, including graphs and write-in responses for each question, are provided below.

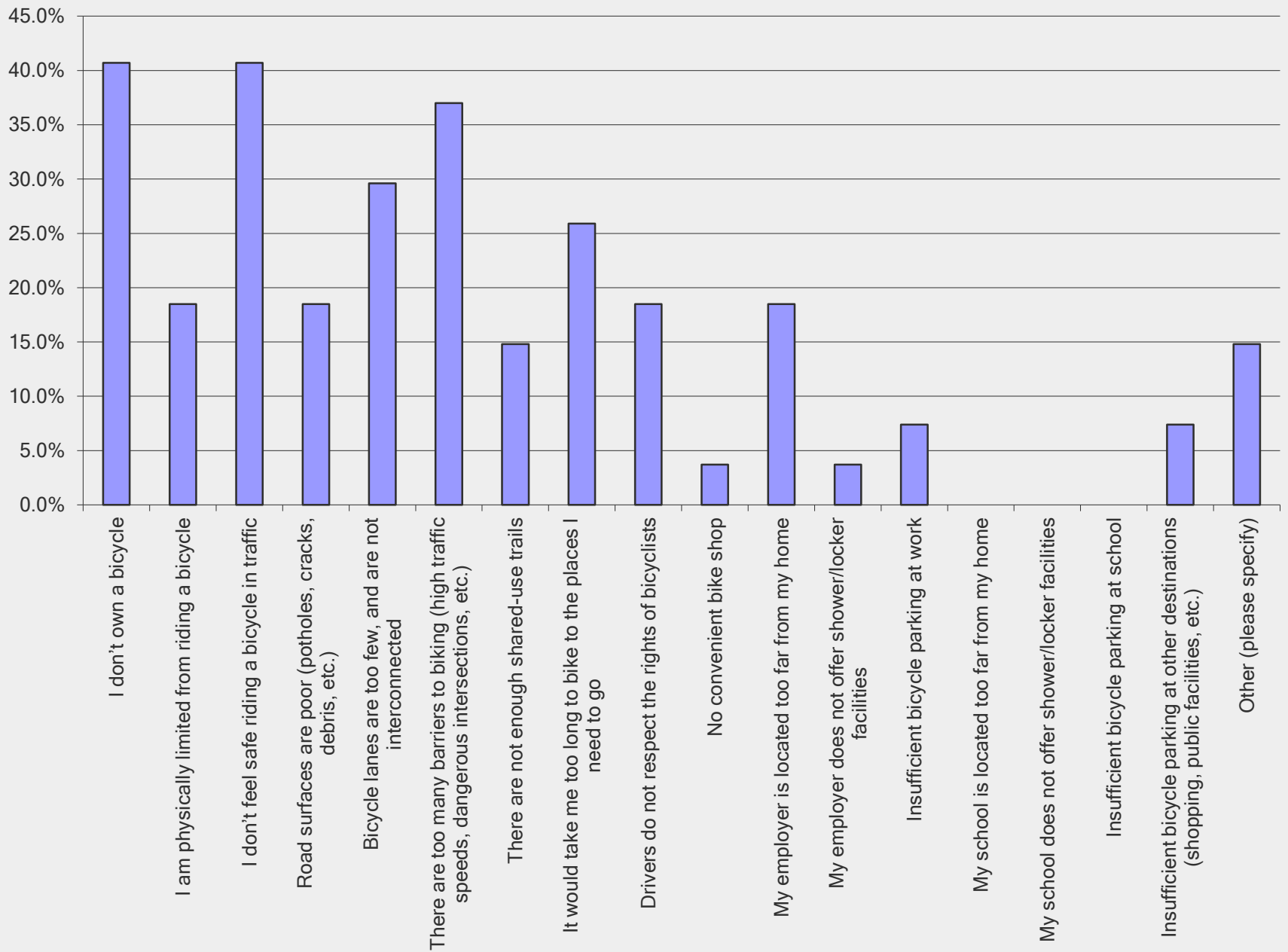
Q1: Have you bicycled in the City of Aurora in the last year? Respondents who chose “yes” skipped to question 3.



Q2: If you have NOT BICYCLED in the last year, which factors MOST prevented you from doing so? (Choose all that apply). After completing this question, respondents skipped to question 8.

(see graph next page)

If you have NOT BICYCLED in the last year, which factors MOST prevented you from doing so? (Choose all that apply)

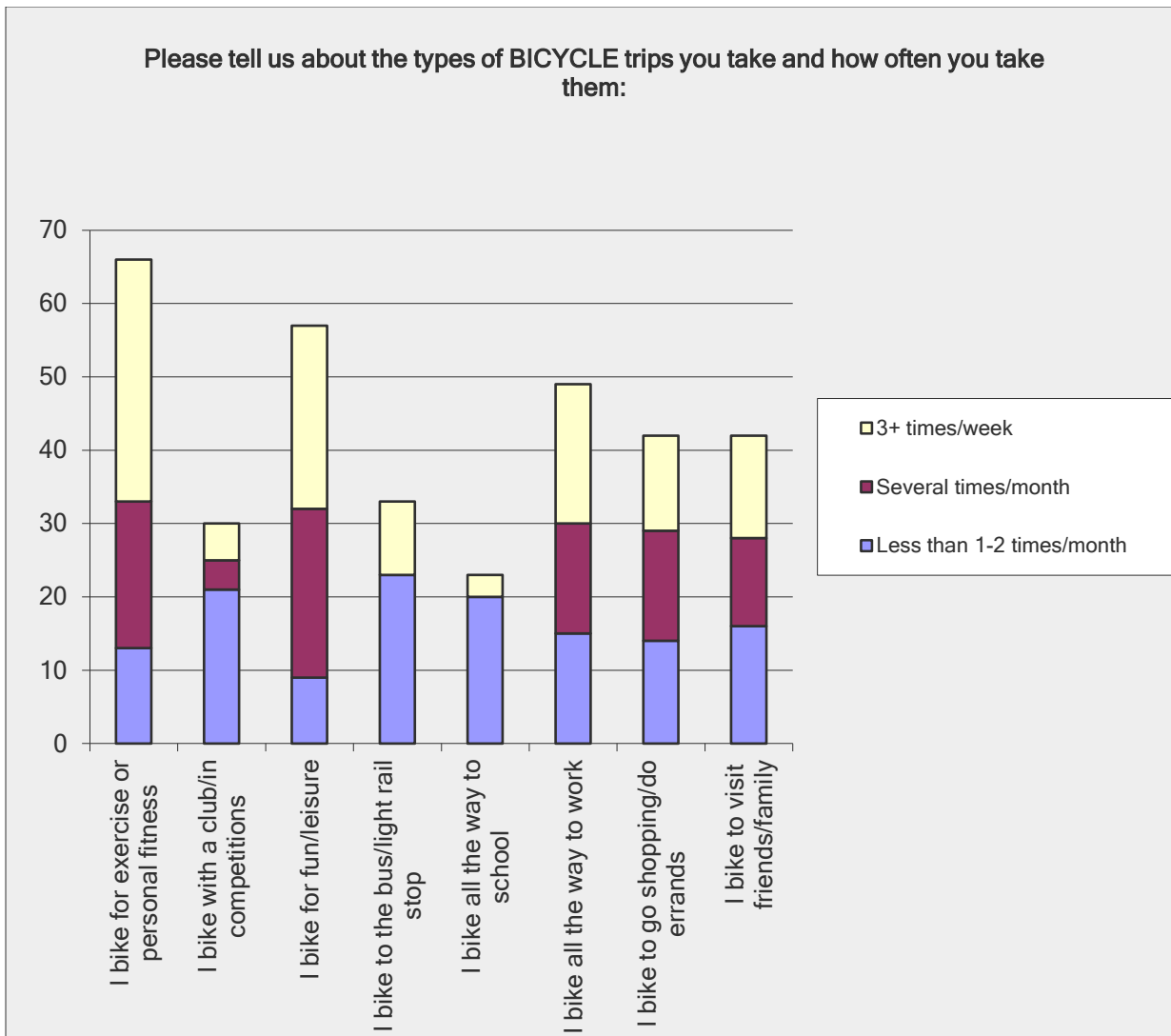


“Other” Write-in response for Q2:

Number	Other (please specify)
1	Bike not in working order (I keep procrastinating)
2	Not air conditioned; no radio; not comfortable; all the reasons I like my car.
3	Prefer traveling by car
4	I don't live in Aurora

Please tell us about the types of BICYCLE trips you take and how often you take them:

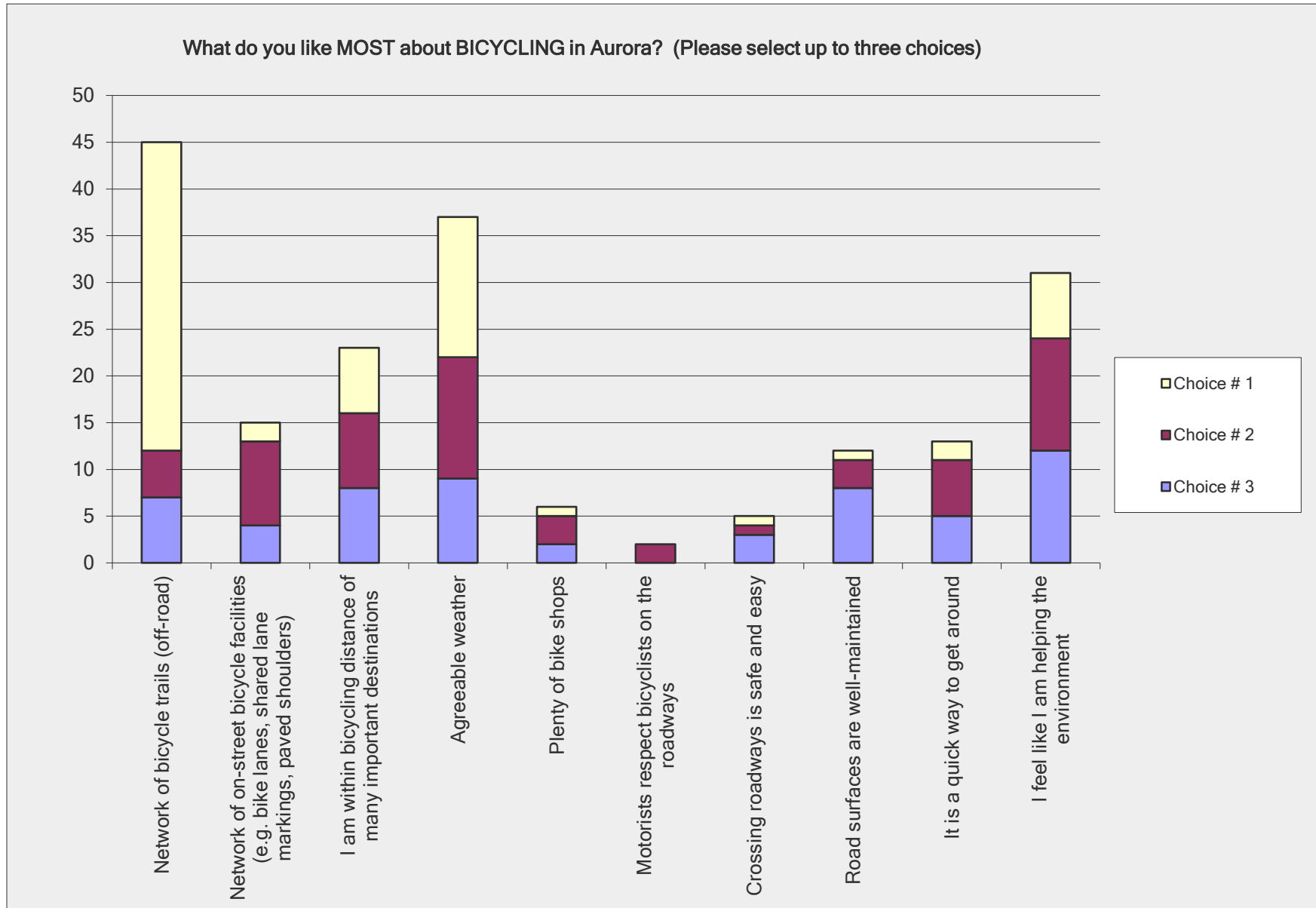
Q3: Please tell us about the types of BICYCLE trips you take and how often you take them



“Other” Write-in responses for Q3:

Number	Other (please specify)
1	I love to bike downtown on both the roads and trails
2	I try to drive only on weekends, when necessary.
3	I bike home from work (8 miles to NE Denver) few times a month
4	I bike for training

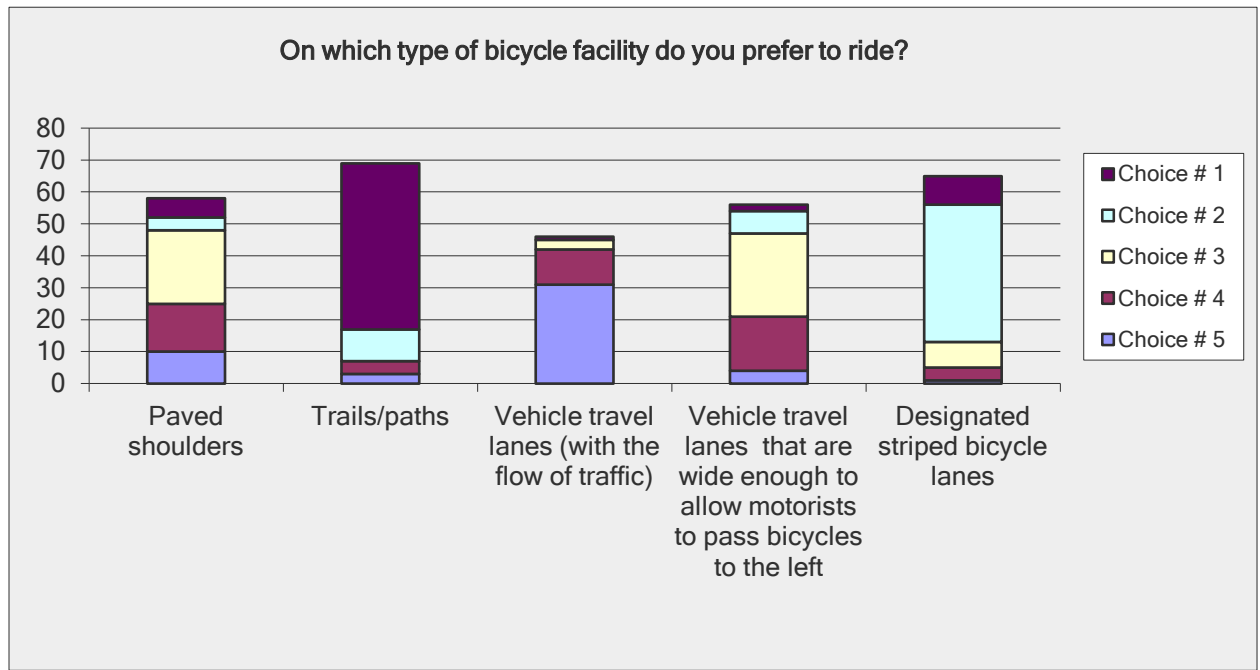
Q4: What do you like MOST about BICYCLING in Aurora? (Please select up to three choices)



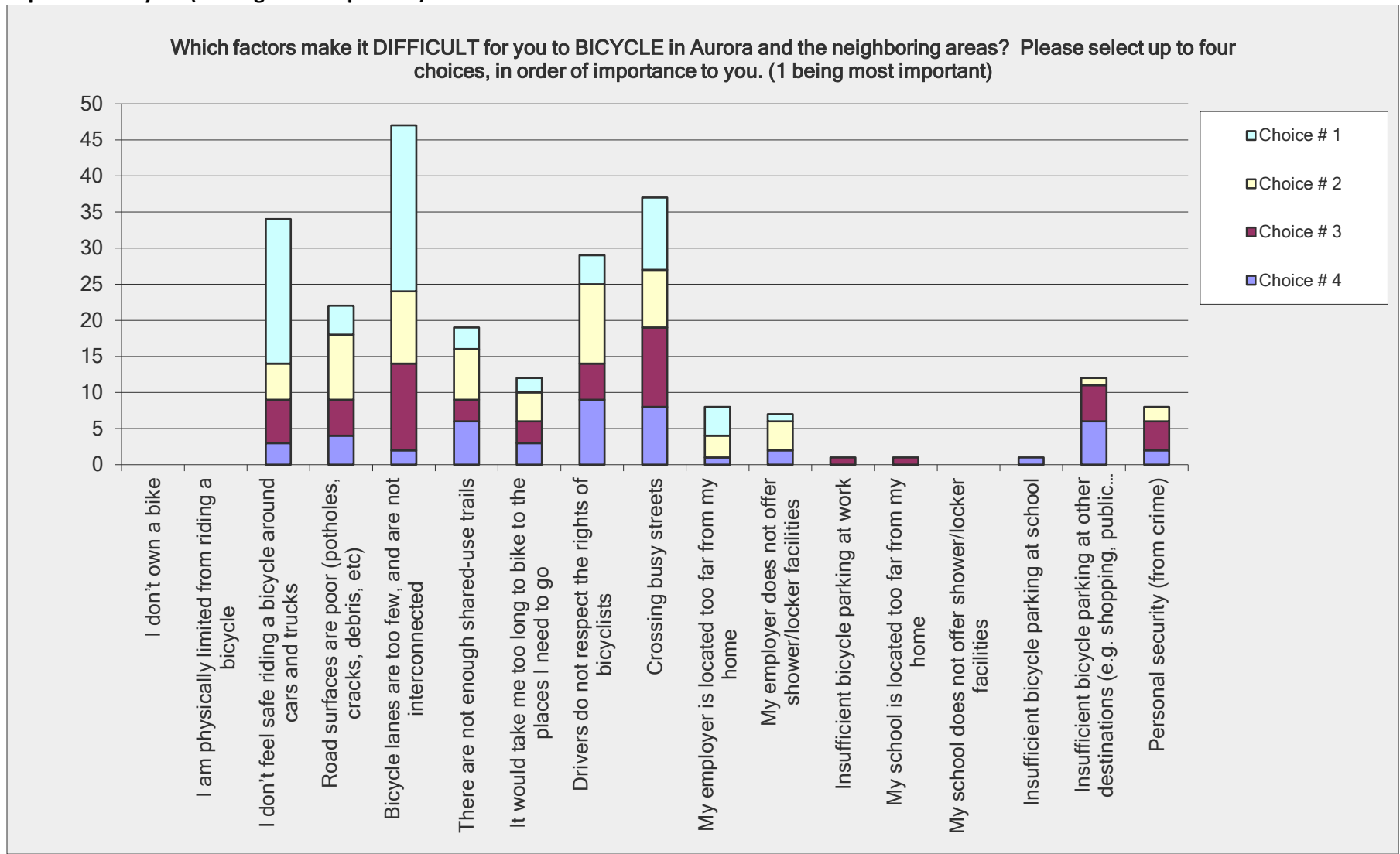
“Other” Write-in responses for Q4:

Number	Other (please specify)
1	Physical Fitness. Bike network and road shoulders are lousy.
2	Bike trails are great. Need better connected street routes
3	Good Family Time and exercise
4	Exercise
5	Choice #2 Saving money on gas
6	I do not like to bike in Aurora, and only do because my girlfriend lives here. The bike paths do not connect and there are few bike lanes on the street. We ride Smokey Hill or Quincey to the Reservoir and it is very very dangerous.
7	scenic and through parks

Q5: On which type of bicycle facility do you prefer to ride?



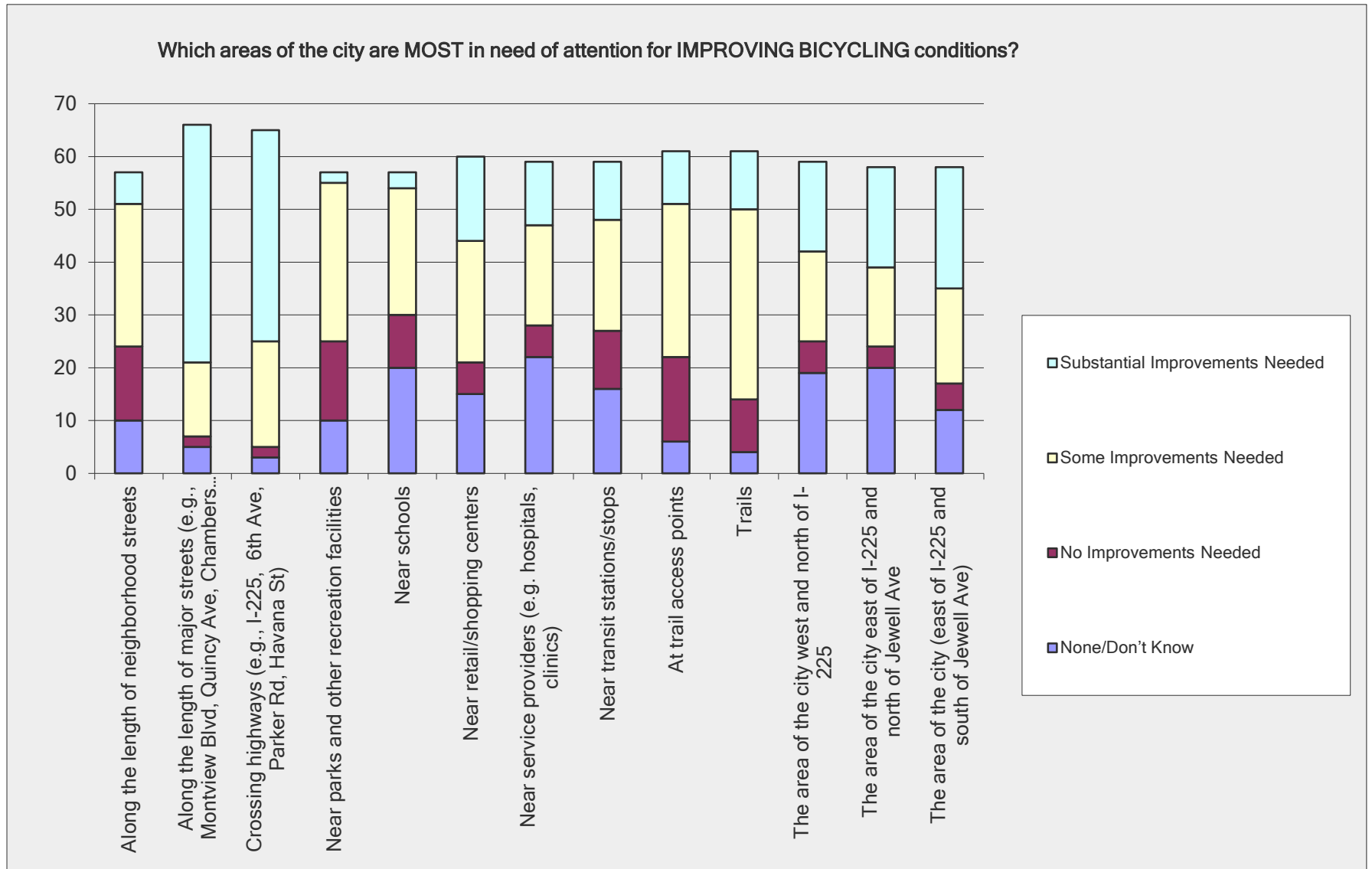
Q6: Which factors make it DIFFICULT for you to BICYCLE in Aurora and the neighboring areas? Please select up to four choices, in order of importance to you. (1 being most important)



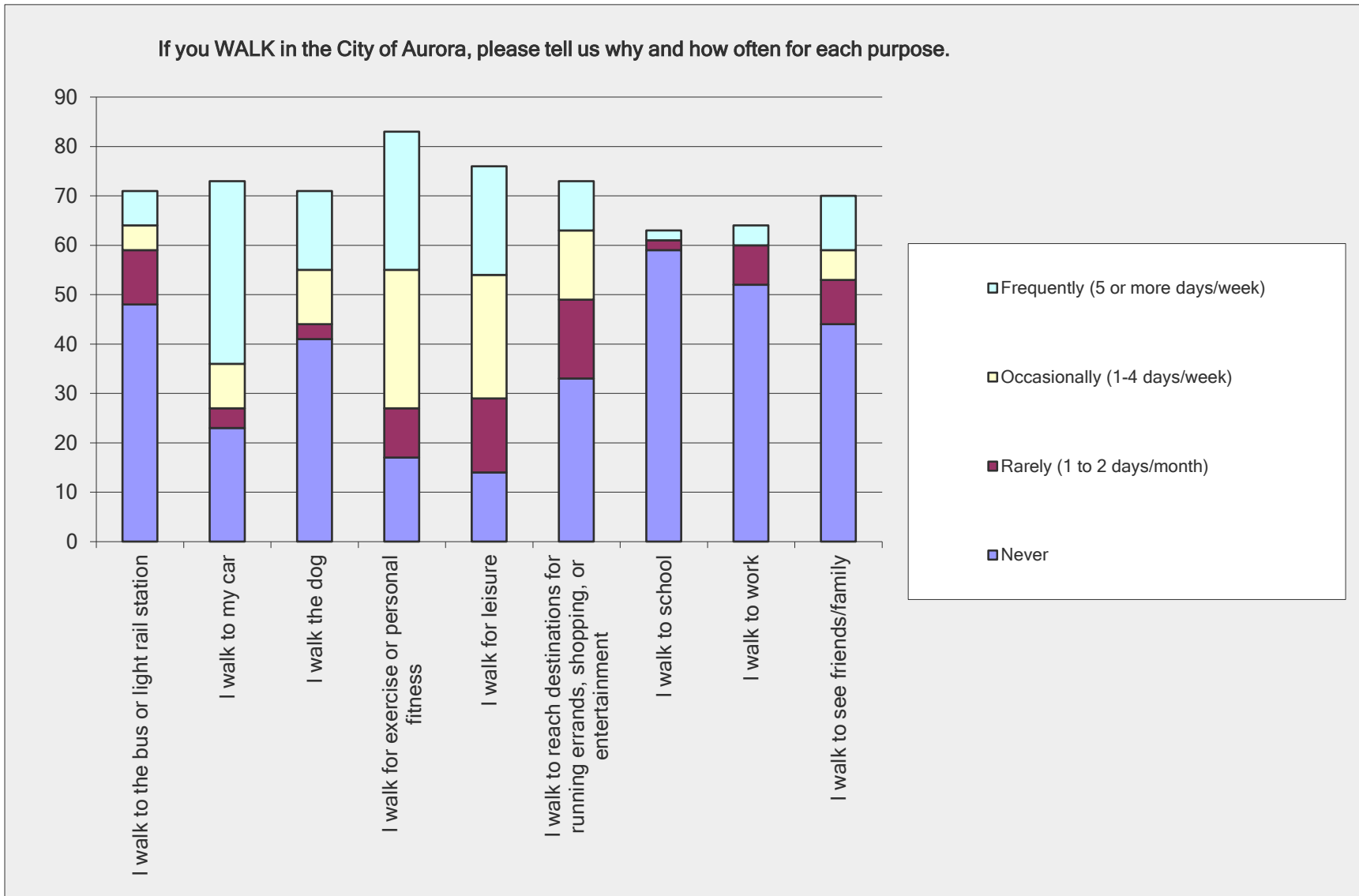
“Other” Write-in Responses for Q6

Number	Other (please specify)
1	Major Aurora thoroughfares have too much traffic and no bike lanes or wide shoulders
2	I have a daughter who I must transport to and from daycare.
3	There is gravel in the bike lanes, street sweepers need to clean them
4	Aurora loves cars and does not seem to welcome bicycles. One need only travel through the city to experience the frustrating trail/road crossings with light activation buttons way out of convenient reach, disparate wait times, no logical relation of light timing with motorized vehicle traffic flow, unnecessarily long waits at traffic lights, the dirty sidewalks, lack of bike lanes, etc.
5	Too much to carry on a bike;

Q7: Which areas of the city are MOST in need of attention for IMPROVING BICYCLING conditions?



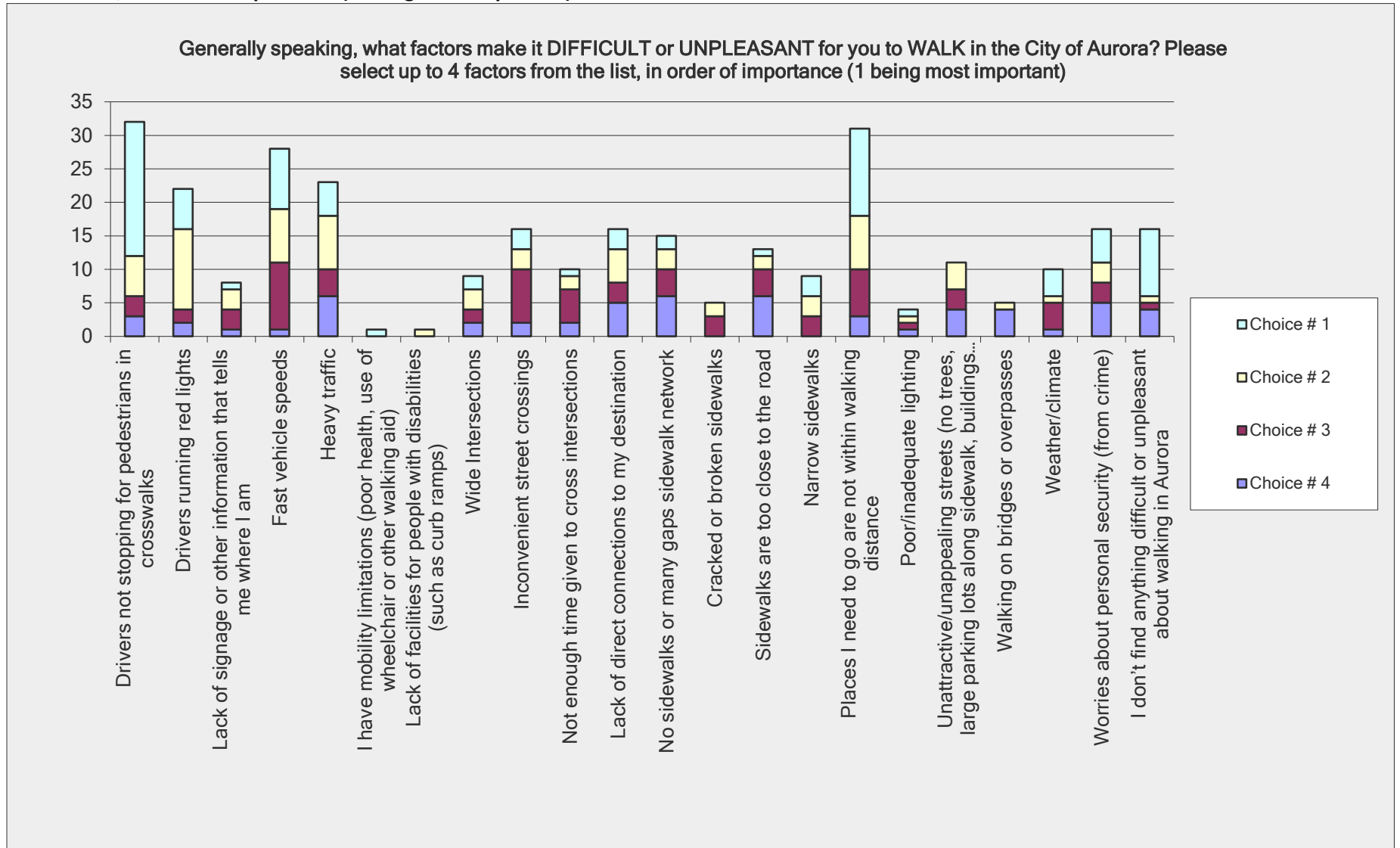
Q8: If you WALK in the City of Aurora, please tell us why and how often for each purpose.



“Other” Write-in Responses for Q8

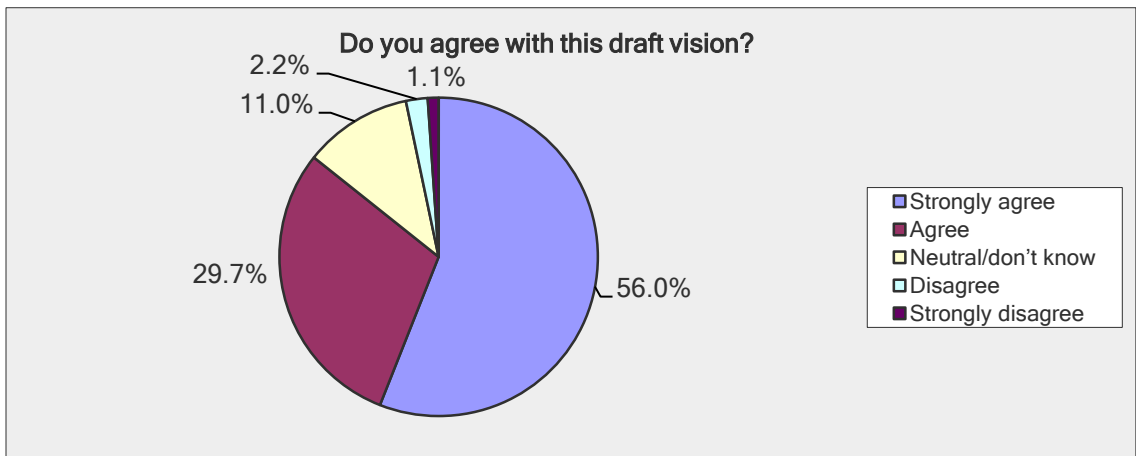
Number	Other (please specify)
1	I run around Aurora
2	I bicycle to exercise
3	I don't live in Aurora
4	I run for training

Q9: Generally speaking, what factors make it DIFFICULT or UNPLEASANT for you to WALK in the City of Aurora? Please select up to 4 factors from the list, in order of importance (1 being most important)



Number	Other (please specify)
1	Snow removal lacking (in season) -- plows pile on sidewalks
2	don't have time
3	Why walk when I can drive?
4	I live near E470 and Gartrell, and us Piney Creek trail
5	Prefer traveling by car
6	Lack of snow removal on sidewalks and bus stops

Q10: Do you agree with this draft vision?

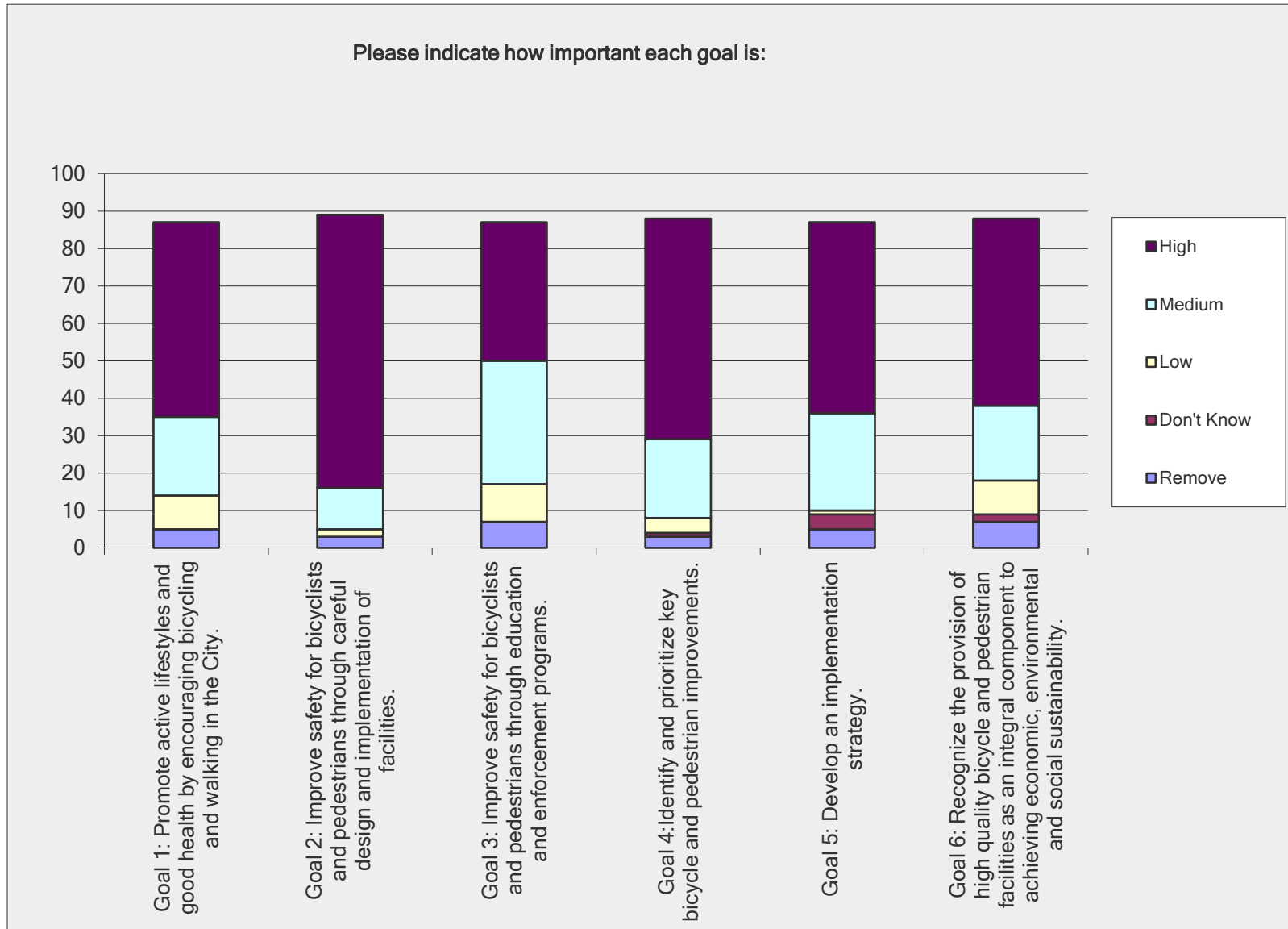


Q11: How would you modify the draft vision?

Number	Response Text
1	An accessible and well-connected active transportation network that offers a variety of safe, comfortable and convenient multi-modal options, including a high-quality network of bicycle and pedestrian routes providing access to transit, shopping, neighborhoods, recreation, and areas of employment for all residents of Aurora (including low-income residents).
2	Put it into plain English.
3	I think citizens' health should be a consideration as well.
4	A sustainable, high quality transportation network of bicycle and pedestrian routes that provides safe, comfortable and convenient access to transit, shopping, neighborhoods, recreation, and areas of employment.
5	The word sustainable is indicative of a fad that tends to be expensive. Right now, it is the wrong time to be putting together schemes to increase taxes. It is best to simply take care of what we have until the economy improves.
6	I mainly bike from Home (Murphy Creek at Gun Club and Jewell) to Work (8th and Colorado) and for personal fitness on the weekends. I am not so concerned with access to transit, shopping, etc. I am very concerned with wider shoulders (Gun Club and 6th it is about 2" wide at times), wider roads that allow safer riding, more well paved trails like the network of that is in Parker and goes past Park Meadows all the way West and also North into Denver. A similar trail to connect from Parker heading North past Southlands mall and continuing North up to Buckley would be FANTASTIC and keep us much safer. Option would be to have a wide shoulder or bike lane on Gun Club from Southlands up toward Buckley (turns into 6th) and also Gun Club near Cross Creek neighborhood. There are a lot of new neighborhoods in the East Aurora area but the road system hasn't kept up. Pave some of the back roads better (finish paving Jewell well past E-470 so we can get to Aurora reservoir without going on busy Gun Club with no shoulder.
7	Delete it.
8	The current draft appears to focus on "getting to places". I mostly use the highline canal trail in Aurora for running, and there are many more trail users who primarily use the trail for exercise (not for going anywhere in particular). I would like the vision to also include exercise, since the needs for people exercising and those for people going places are not entirely the same.
9	add - for all people, including those with disabilities.
10	Additional progress linking the excellent network of multi-use trails with service providers is needed. For instance, it is difficult and dangerous to get from the bike path to the Town Center/Aurora Mall complex. The city should begin designing efforts to discourage short-distance driving in such areas and encourage walking or biking between shops. The Town Center complex north of Alameda is an excellent example of how the city missed the opportunity to encourage walking between shops - it is dangerous, uncomfortable, and annoying to get from Target to any of the stores in the south side of that development.
11	There should be connecting bike paths to ALL city parks. When new parks are established it seems bike paths to these new parks are limited to immediate neighborhoods only.
12	I would also like to see the trail continued on East around E-470 from Parker Rd to give Aurora residents access to bike paths heading West around E-470 and C-470. This will also allow riders from C-470 to access locations and activities in Aurora.

- 13 maintenance and funding responsibility is not identified
- 14 Safe and efficient access (rather than safe, comfortable and convenient). Work on the route to the airport. Airport Rd. is less than ideal. Access through the city should also be a goal, though perhaps a lesser goal in the big picture.
- 15 It is uninspiring for a Bike and Pedestrian Plan. If you are serious about increasing bike and pedestrian options and increasing these types of mode share in the city these option need priority over cars. If you want an uninspired business as usual plan leave it how it is.
- 16 Remove "sustainable", as this is a meaningless political buzzword. Identify purpose: is this the city's forced goal or the public's request?
- 17 Interconnected! Too many trails and sidewalks end abruptly in random areas, even on major roads such as Chambers or Parker Rd.
- 18 Make alternative transportation an integral part of life in Aurora.
- 19 Study areas with the most bike/walking traffic and provide safety signs curb ramps etc.
- 20 Need to ensure people understand what you mean by sustainable. Are you intending the term to mean lasting long term or do you mean for it to be environmentally sustainable, meaning it minimizes the impacts to the environment?
- 21 I think the grant moneys should be used by Aurora and not to hire "experts" from out of state to do surveys etc. and should be spent in areas where usage merits not all over the city where no one walks or bikes.
- 22 I think it's perfect!

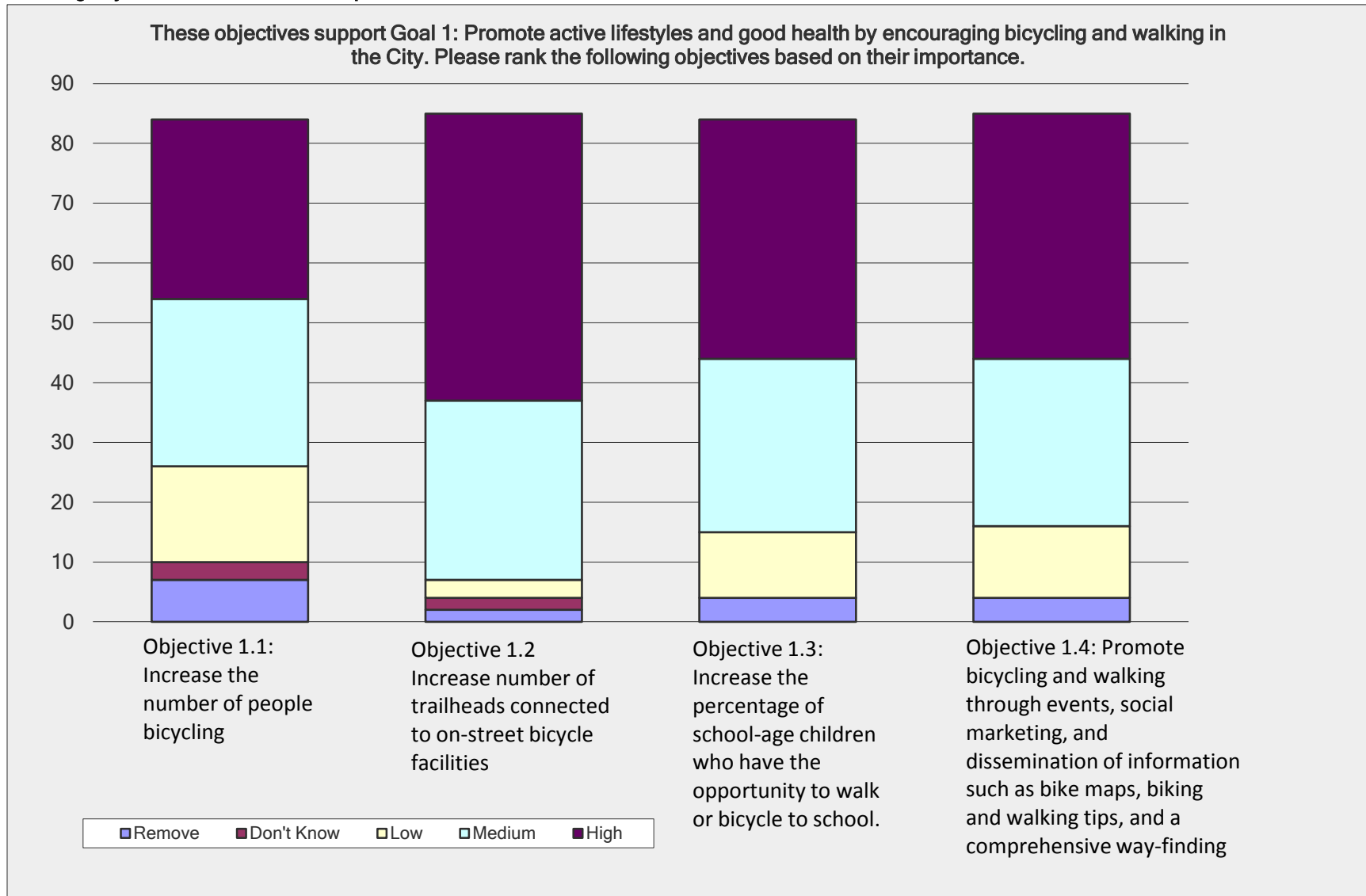
Q12: Please indicate how important each goal is:



Q13: What if any goals would you add to the above list?

Number	Response Text
1	Ensuring that low-income and other disadvantage populations (ethnic and communities of color) have equitable access to active transportation options.
2	Bring B-cycle to Aurora
3	A licensing program that teaches traffic laws, such as stopping at stop signs and red lights when cycling. Combine Goal 2 and Goal 3 to read as follows: improve safety for bicyclists and pedestrians through careful design and implementation of facilities, education and enforcement programs. Encourage businesses to add bicycle and pedestrian-friendly facilities. Aurora should be prepared to offer tax rebates or incentives to businesses who support biking and walking. Aurora should participate in, or encourage participation in, bicycle advocacy programs such as People for Bikes (www.peopleforbikes.org). Aurora should attract or sponsor cycling events. Perhaps Aurora should bid for a stage of the 2012 USA Pro Cycling
4	Challenge Recognize the private property and freedom of citizens to choose their own methods of transportation instead of forcing them into a government preferred transportation system.
5	As I mentioned before, linking existing paths to provider/shopping areas is key. Right now it is difficult to get from paths to popular destinations such as movie theaters, the Town Center, and hospitals.
6	1. Bring Aurora into the 21st Century -- Encourage bicycling and walking in the city: Promote active and healthy lifestyles; Promote economic, environmental and social sustainability.
7	2. Improve safety for pedestrians, bicyclists and users of mobility devices by requiring that safety, education and enforcement exist in all planning, design and implementation efforts.
8	Develop a transit system that give preference to bike and pedestrians over car and other single occupant vehicles
9	Respond to public desires, not force an ideological goal on the public.
10	I would like the city to be as concerned with pedestrians and riders as it is with moving traffic. Clearing the streets of snow (which is essential) impedes foot traffic. I would like a climate of respect for those who do not drive a car everywhere.
11	incentive program for those who bike/walk to work each week.
12	people should be responsible for their own healthy lifestyles and we do not need to spend a lot of money on more paths and bureauqucyThere are enough paths already

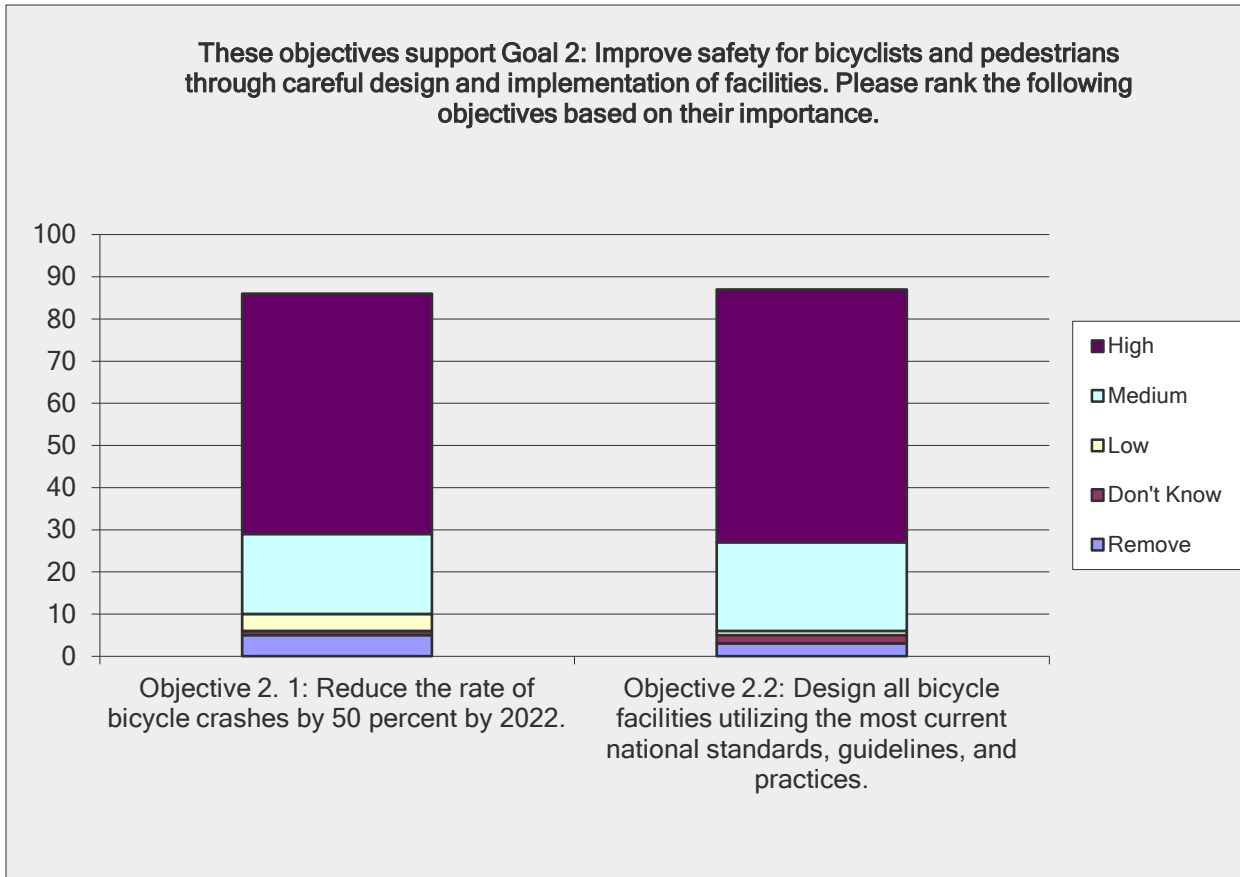
Q14: These objectives support Goal 1: Promote active lifestyles and good health by encouraging bicycling and walking in the City. Please rank the following objectives based on their importance.



“Other” Write-in Responses for Q14:

Number	Other please specify)
1	Make safer bicycle lanes - SEPARATE - parallel to roadways
2	1.1 is too long (2022)
3	Improve trails, shoulders and bike paths will automatically improve utilization - we will feel safer and they would be more accessible.
4	Discourage driving by costly parking, etc. at events in Objective 1.4
5	1.1 Increase what number by 50% and bicycling for what? 1.2 What is an on-street bicycle facility? 1.3 Would like to see a more specific number or actual percentage increase target here. 1.4 Need a baseline and measurement component here.
6	Our family has used the Aurora bike map several times this year. Thank You for publishing.

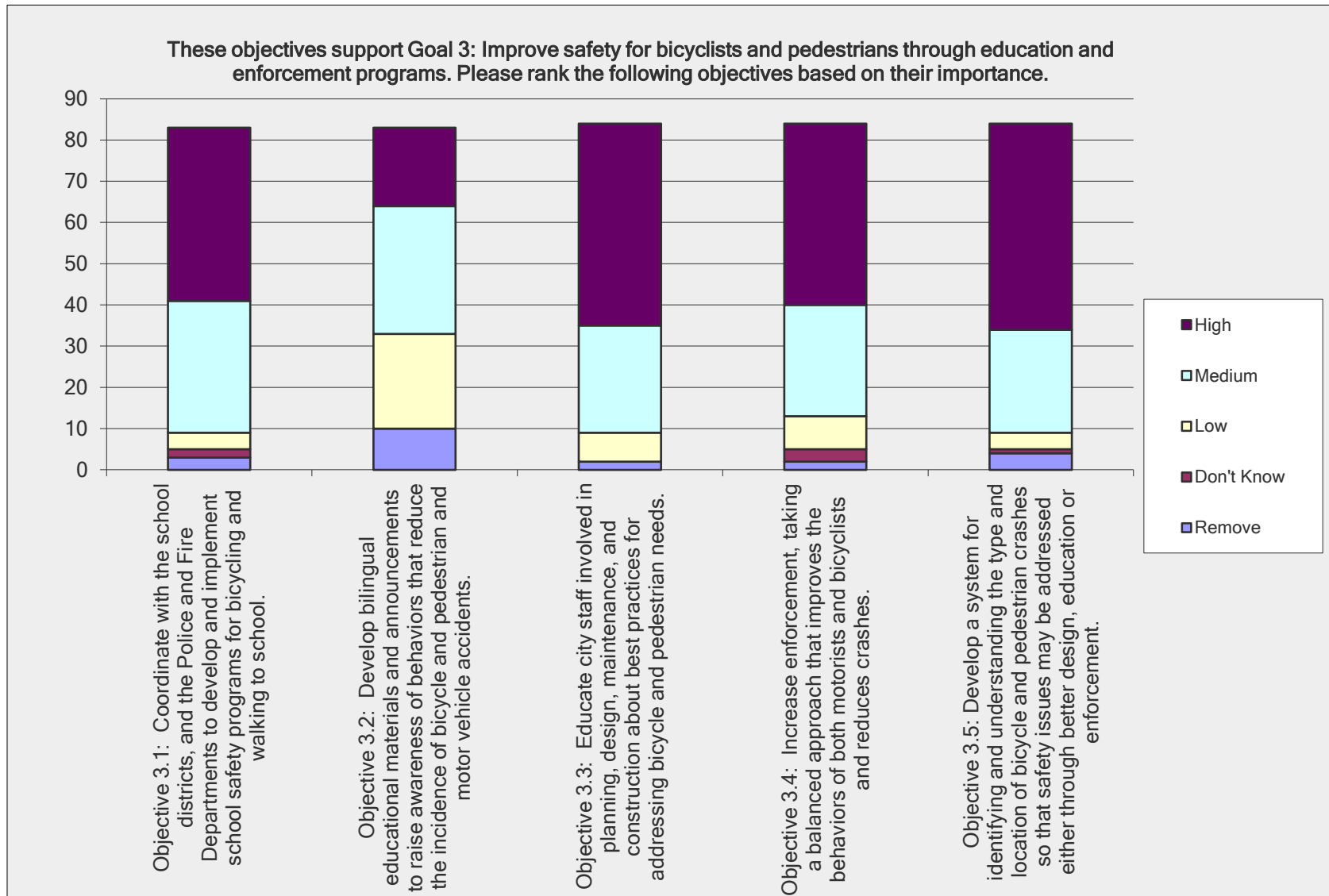
Q15: These objectives support Goal 2: Improve safety for bicyclists and pedestrians through careful design and implementation of facilities. Please rank the following objectives based on their importance.



“Other” Write-in Responses for Q15:

Number	Other (please specify)
1	Prove a cost benefit analysis to taxpayers prior to introducing the plan. 2.1 and 1.1 (previous page) -- Why different years for different objectives? If we increase bicycling by 50% by 2022, why shoot for 2027 for 50% reduction in crashes? Per capita crashes or total crashes? 2.2 Still don't know what a bicycle facility is... but I think we should
2	use most current standards. Might want to identify source of standards... make many more designated lanes and paths instead of sharrows to increase the likelihood of women and children using the bike and
3	trail network (http://www.streetsblog.org/2011/07/13/to-close-the-gender-gap-separate-cyclists-from-cars/)
4	Connect existing trails and sidewalks for continuity. Increase the number of facilities, including on-street bike lanes, street calming measures, traffic signs/signals, etc. Ensure that debris
5	on bike/ped paths is cleaned up regularly.
6	increase vehicle operator education

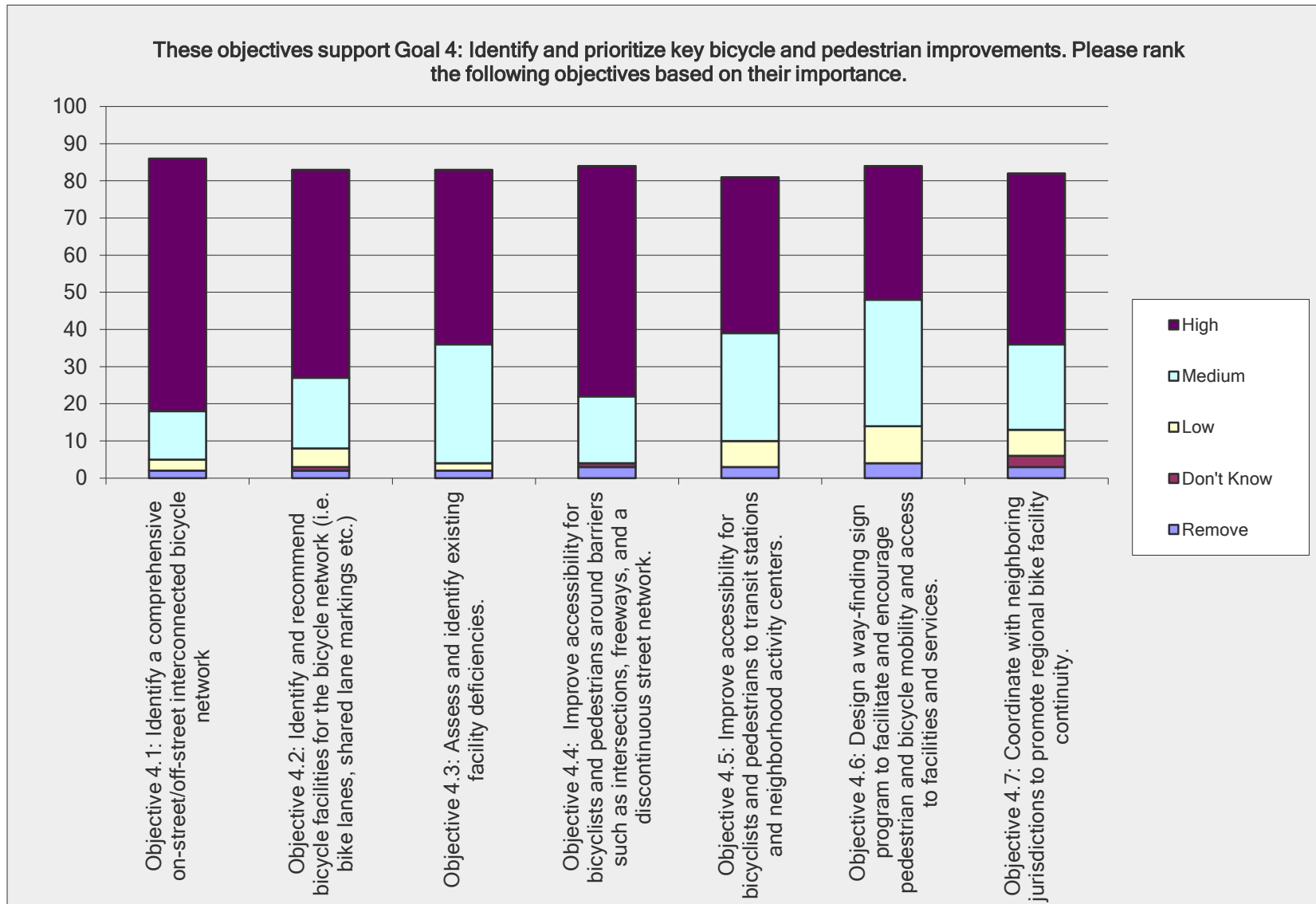
Q16: These objectives support Goal 3: Improve safety for bicyclists and pedestrians through education and enforcement programs. Please rank the following objectives based on their importance.



“Other” Write-in Responses for Q16:

Number	Other (please specify)
1	3.3 I have to think this could go a long way toward improving the bicycle/pedestrian experience. Who sets the timing on the traffic lights?
2	this is America. we speak English. NO BILINGUAL ANYTHING
3	Follow Idaho and Utah on progressive bike laws that give preference to cyclists instead of cars
4	Encourage bicyclists to observe the rules of the road.
5	while bilingual is good. Citizens should be able to read English to pass drivers tests to be able to read road signs, the same applies to bike signs

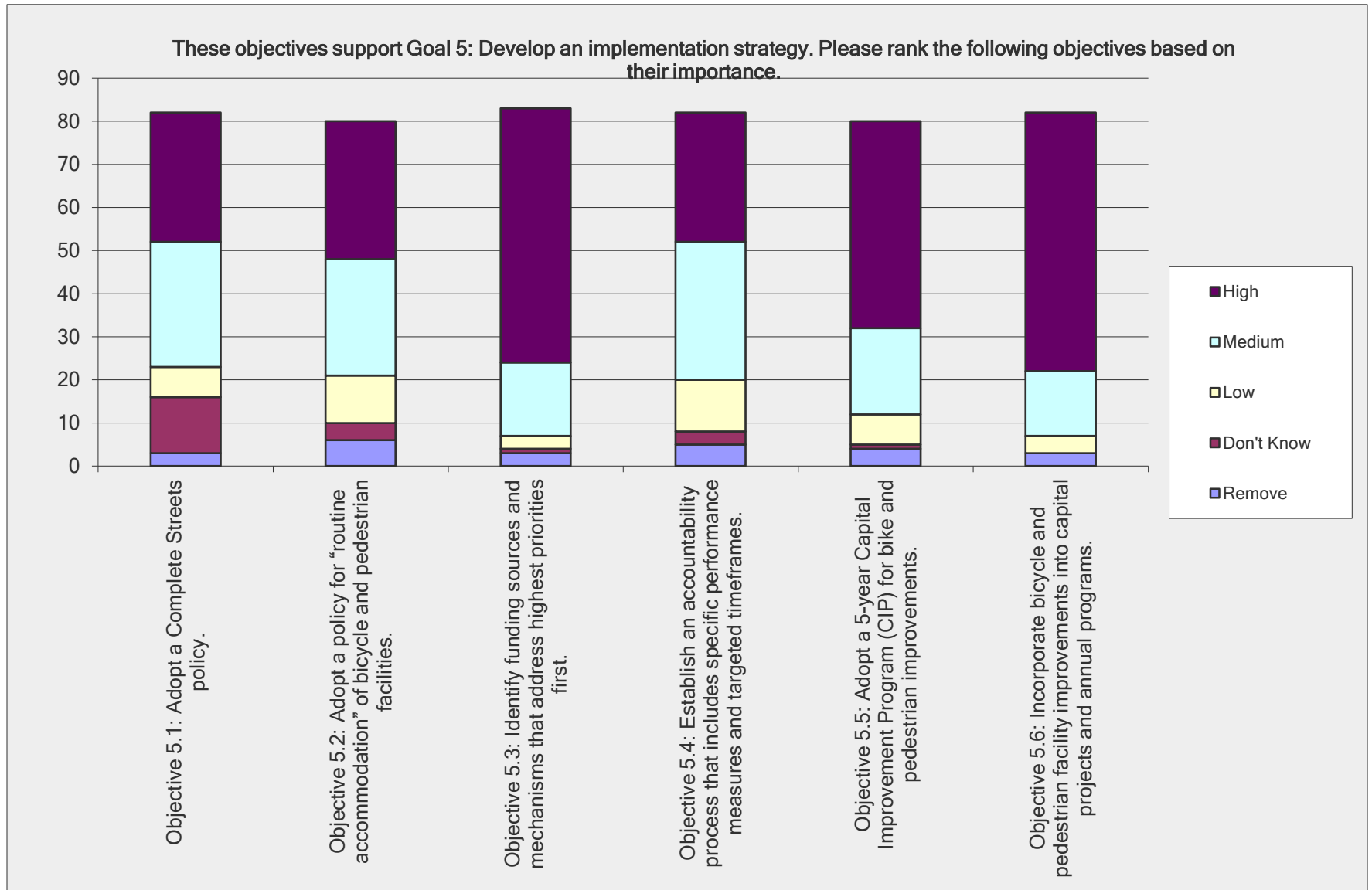
Q17: These objectives support Goal 4: Identify and prioritize key bicycle and pedestrian improvements. Please rank the following objectives based on their importance.



“Other” Write-in Responses for Q17:

Number	Other (please specify)
1	Identify the City’s low-income neighborhoods (and communities of color) and identify improvements for these communities, so they don’t have to rely so much on a car
2	Bring B-cycle to Aurora
3	4.1 How will this be measured/disseminated? 4.2 Still don't know what bicycle facilities are (tire repair kits? drinking fountains? lockers?). 4.3 Assuming here that facility deficiencies refer to bicycle network?
4	Sharrows on Montvies was a terrible idea. There is plenty of room for a dedicated bike lane. This city have poor bike connectivity on north south streets.

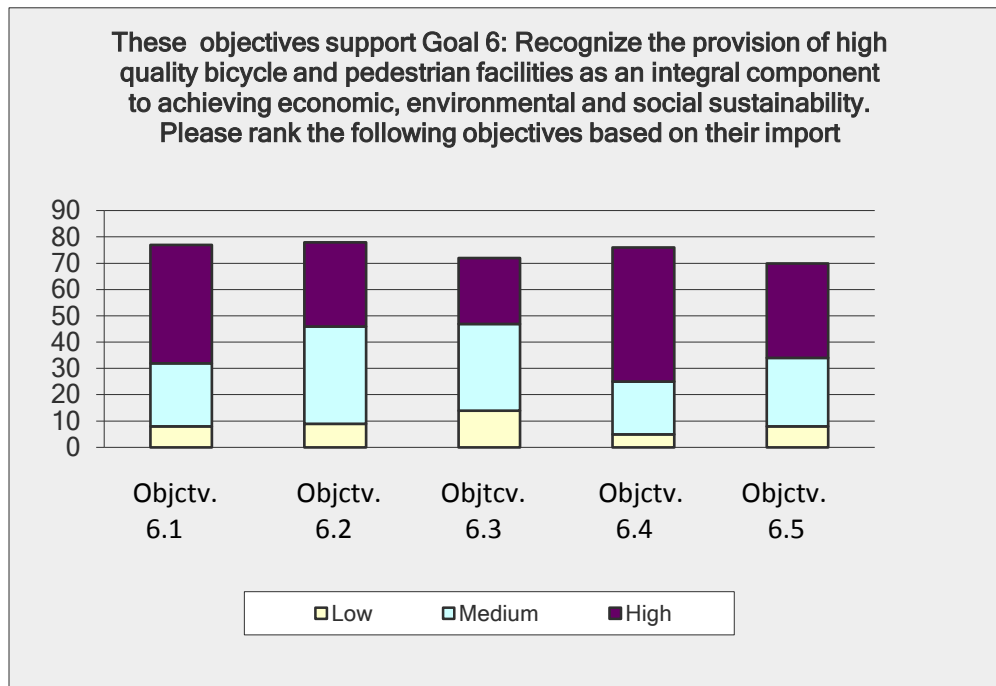
Q18: These objectives support Goal 5: Develop an implementation strategy. Please rank the following objectives based on their importance.



“Other” Write-in Responses for Q18:

Number	Other (please specify)
1	5.1 No idea what this means. 5.2 Assuming this means accommodations for bicycles are routinely incorporated into plans and implementation of those plans. 5.3 Establish priorities based on community needs and fund highest ones first. 5.4 Accountability for what? Funding? Priority setting? General strategy? 5.6 Assume this refers to bike lanes associated with roads, etc. Don't know what an annual program is...
2	Fund your bike capital improvements as much as your road CIP better economic investment (http://www.peri.umass.edu/236/hash/64a34bab6a183a2fc06fdc212875a3ad/publication/467/)

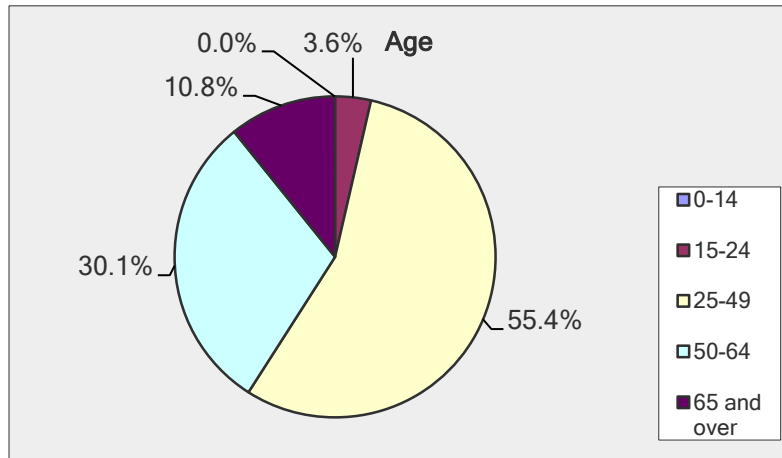
Q19: These objectives support Goal 6: Recognize the provision of high quality bicycle and pedestrian facilities as an integral component to achieving economic, environmental and social sustainability. Please rank the following objectives based on their importance.



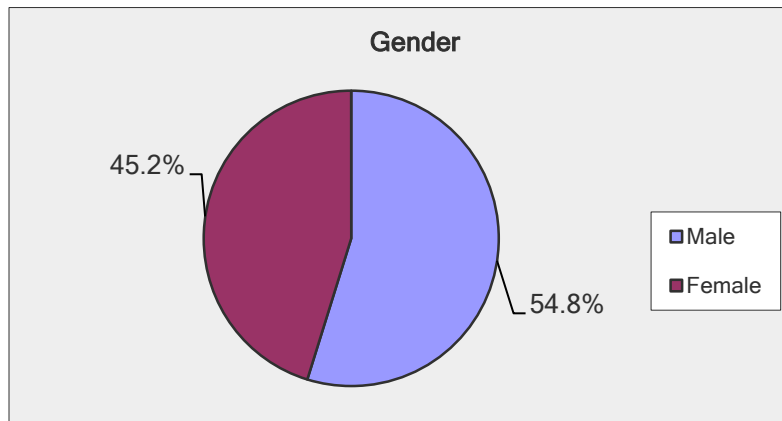
“Other” Write-in Responses for Q19:

Number	Other (please specify)
1	increase water fountains
2	Support liberty The city needs to gets its own house in order first and foremost. I believe the most important objective should be working immediately with existing infrastructure to apply an approach to transportation that contemplates bicyclists, pedestrians and mobility devices. Change light timers so they are all consistent and the time spent waiting can be reduced without interfering unnecessarily with motorized vehicle traffic flow. The city should be "Bicycle Friendly" and set the pace for the businesses residing therein. 6.2 On city property? Where? How? 6.3 How do we measure this? 6.5 Can we remove bicycle unfriendly businesses? Give tax breaks to the most
3	friendly? ;-)
4	Objective 6.3, while important, does not fit here. This is not an objective, but look at Fort Collins and how bike friendly they are. Almost every street has a bike lane and the city is bike
5	friendly.
6	6.5 seems to be the same as 6.1

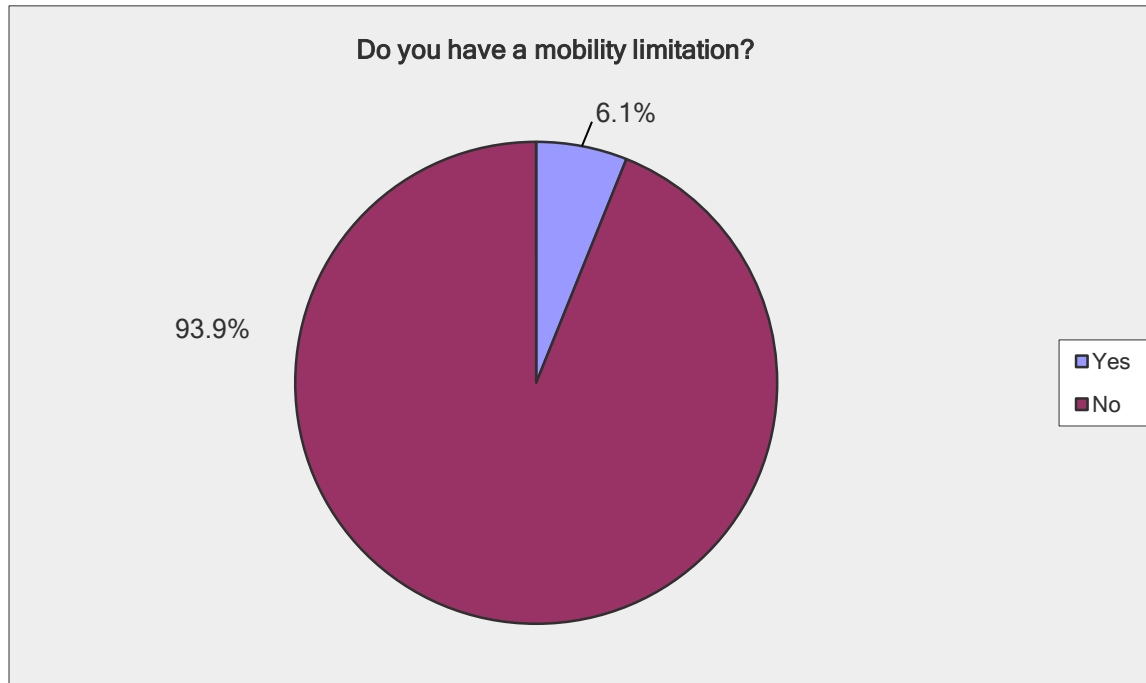
Q20: Age



Q21: Gender



Q22: Do you have a mobility limitation?



Appendix B: Aurora Bicycle Facility Design Approach

This appendix provides an overview of the guidelines and standards applicable to designing bicycle facilities in Aurora with suggested modifications to existing City of Aurora design guidelines and standards. Discussion is focused on treatments and strategies which are likely to be required to develop a high quality bicycle network that attracts ridership.

B.1 National Guidelines and Standards

The AASHTO Guide for the Development of Bicycle Facilities provides design and construction guidelines, and operation and maintenance recommendations for bicycle facilities. The 1999 Guide has been revised, and the new edition is undergoing final balloting by the AASHTO subcommittee on design, and has an expected release in summer 2012. The MUTCD 2009 edition provides standards for signs, signals, and pavement markings in the United States. These latest guidelines and standards provide clarity and additional guidance for on-street bicycle facilities, addressing many of the issues and questions on which the previous guidance was silent. Following these standards and guidelines will allow local agencies to move forward with confidence that what they are doing is consistent with the latest thinking on safely accommodating bicycles. Furthermore, it is important for all departments and agencies involved in implementing this Plan to follow the latest standards and guidelines to ensure that facilities throughout the network are designed in a uniform manner.

Guide to the Development of Bicycle Facilities. AASHTO

AASHTO is a not-for-profit, nonpartisan association representing state highway and transportation departments. It publishes a variety of planning and design guides, including the 1999 AASHTO Guide for the Development of Bicycle Facilities, and the recent update to that guide, which is expected to be published in summer 2012. This guide provides planning and design guidance for on- and off-street bicycle facilities. It is not intended to set absolute standards, but rather to present sound guidelines that will be valuable in attaining good design sensitive to the needs of both bicyclists and other roadway users. The provisions in the Guide are consistent with and similar to normal roadway engineering practices. Signs, signals, and pavement markings for bicycle facilities should be used in conjunction with the MUTCD.

Key provisions in the AASHTO Guide for the Development of Bicycle Facilities include:

- Bicycle planning, including types of planning processes, technical analysis tools, and integrating bicycle facilities with transit
- Bicycle operation and safety, including traffic principles for bicyclists and causes of bicycle crashes
- Design of on-road facilities
- Design of shared-use paths
- Bicycle parking facilities
- Maintenance and operations

Manual on Uniform Traffic Control Devices (MUTCD), 2009

The 2009 MUTCD is a document issued by the Federal Highway Administration (FHWA) of the U.S. Department of Transportation (USDOT) to specify the standards by which traffic signs, road surface markings, and signals are designed, installed, and used. These specifications include the shapes, colors, fonts, sizes, etc., used in road markings and signs. In the United States, all traffic control devices must generally conform to these standards. The manual is used by state and local agencies and private design and construction firms to ensure that the traffic control devices they use conform to the national standard. While some state agencies have developed their own sets of standards, including their own MUTCDs, they must substantially conform to the federal MUTCD, and must be approved by the FHWA. CDOT uses the national MUTCD in accordance with the Colorado Supplement to the Federal Manual on Uniform Traffic Control Devices 2009, Adopted December 15, 2011. The National Committee on Uniform Traffic Control Devices (NCUTCD) advises the FHWA on additions, revisions, and changes to the MUTCD.

Key provisions of the MUTCD related to bicycling include:

- Bicycle-related regulatory and warning signs
- Bicycle destination guide and route signs
- Pavement markings such as bike lane symbols and striping
- Trail signs

Significant changes in 2009 edition (from the 2003 Edition) include:

- New shared-lane pavement markings
- Bicycle lane regulatory signs no longer required
- Type 3 object markers for shared-use paths
- New bicycle destination guide and route signs
- New mode-specific guide signs for shared-use paths

The bicycle technical committee of the NCUTCD is currently developing and evaluating research and proposals for the following items:

- Bicycle signals
- Bicycle boxes
- Applications of the Rectangular Rapid Flashing Beacon to Trail Crossings
- Modifications to the Pedestrian Hybrid Beacon to accommodate bicyclists
- Combined right turn lane/bike lanes
- Barrier separated lanes/cycle tracks

Additional information can be found here: <http://www.ncutcdbtc.org/>

B.2 State Guidelines and Standards

CDOT

http://www.coloradodot.info/library/traffic/traffic-manuals-guidelines/fed-state-co-traffic-manuals/mutcd/MUTCD_2003_Colorado_Supplement.pdf

B.4 Local Guidelines and Standards

City of Aurora

Bicycle Facility Guidelines

The City of Aurora Bicycle Facility Guidelines were developed by city staff and contain specifications and designs for on-street bike routes, on-street bike lanes, bicycle-related signs, and intersections of shared use paths with public and private streets. They are based on information provided from the following sources:

1. Manual on Uniform Traffic Control Devices (MUTCD), 2003 edition;
1. Guide for the Development of Bicycle Facilities, American Association of State Highway and Transportation Officials' (AASHTO), 1999;
2. A Policy on Geometric Design of Highways and Streets, AASHTO, 2004;
3. Model Traffic Code for Colorado, Colorado Department of Transportation, 1995;
4. Implementing Bicycle Improvements at the Local Level, Publication No. FHWA-98- 105, Federal Highway Administration, 1998;
5. Bicycle Facility Design Reference Manual, Publication No. FHWA-NHI-02-065, Federal Highway Administration, October 2004;
6. Accessible Rights of Way: A Design Manual, U.S. Access Board, 1999, and
7. Chicago Bike Lane Design Manual, 2002.

These Guidelines are fairly comprehensive, however, in some cases, they require updating. This Appendix focuses on the newest standards, guidelines, and best practices in bicycle facility design, which should be used to update the city's existing Guidelines.

City of Aurora Roadway Specifications

The city's roadway specifications were last updated in 2010 and include standards for all roadway types, including standards that were developed for urban centers and transit-oriented development (TOD) zones. Specifications apply to all new and reconstructed roadways.

B.5 Design Strategies for Achieving High Quality Facilities for Vulnerable Roadway Users

To effectively design for the bicyclist, it is important to understand key differences between traveling in a vehicle versus on the bicycle. While the operation of a bicycle is consistent with a vehicle, the operating characteristics and user experience are dramatically different. The motorist operates within a protected, crashworthy shell which is insulated and protected from the outdoor environment. The motor vehicle is capable of rapid acceleration and can maintain constant rates of speed, with suspension systems capable of moving the vehicle over surface irregularities relatively smoothly. The bicycle and the bicyclist's function and experience traveling in relatively the opposite manner. In mixed traffic, the bicyclist is particularly sensitive to traffic noise and pollution (generated by the motorized vehicles), speed and acceleration differentials, and poor surface conditions which can create crash hazards and result in increased exposure to injury or death in the event of a crash. Compared to other roadway users, bicyclists (and pedestrians) are the most vulnerable users in the transportation system. Bicyclists also enjoy a number of significant advantages over the motorists in that they operate with greater freedom of movement, are less likely to be distracted while operating the bicycle and are more aware of their surroundings by being in the open environment.

Preference surveys and research studies have found widespread support and interest for bicycling with strong preferences given to the provision of high quality bikeways which provide the following elements:

- Separation from high volumes of fast-moving automobiles,
- Maneuverability within the bikeway to operate safely, and
- Space for cyclists to ride together in a social manner, side-by-side.

These qualities are routinely provided on trails, and are increasingly provided on streets through the provision of bicycle lanes, cycle tracks or the implementation of bicycle boulevards. The quality of provided bicycle facilities has a direct impact on the experience of the bicyclists and will therefore have a tremendous influence on the ability of the facility to sustain use, or to attract increased use. Well-maintained and high quality facilities have been demonstrated to attract higher levels of use than poorly maintained or low quality facilities. Likewise, interconnected systems with minimal gaps or interruptions are essential to a functioning bicycle system that supports and attracts high use as evidenced in cities such as Denver, Boulder, Austin, Minneapolis, Portland, Seattle, and Washington, DC.

Quality of Service Strategy

Research shows that bicyclists consider a wide variety of factors when assessing their quality of service, which focus on their comfort using a facility. For this reason, the 2010 release of the Highway Capacity Manual (HCM) include "Traveler Perception" methods in addition to the traditional performance measures (e.g. average delay, travel speed) to determine Level of Service for users. The 2010 HCM

includes a methodology for bicycle level of service¹, which also considers basic descriptors of the urban street character to determine the overall quality of bicyclist experiences on the roadway. Factors that affect bicycle level of service include space provided (i.e. width of bicycle lane), separation or buffer from adjacent traffic, speed and volume of adjacent traffic and traffic composition (cars/trucks on roadways). While a motor vehicle level of service of “D” indicates the roadway is operating at an acceptable level (capacity relative to delay); a bicycle level of service of “D” indicates a bicyclist is experiencing poor comfort on the facility. As previously discussed, the motorist is relatively comfortable and secure in their vehicle as they are isolated from noise, weather, and are minimally physically engaged in the effort of driving. Their direct experiences with the bicyclists are typically limited to a perception of increased delay if they find themselves operating behind a bicyclist. This is the opposite for the bicyclist who is very sensitive to motor vehicle speed, volume, composition (trucks, buses, cars) and space due to their inherent exposure and vulnerability. This is a critical distinction which explains why the two levels of service are not directly comparable and why bicycle level of service is very sensitive to motorized traffic characteristics and separation/space.

The concept of level of service for bicyclists is relatively new compared to that of vehicle level of service concepts. As such, it is important to note that there are limitations to the existing models which the designer should become familiar. It is anticipated that extensive research will be forthcoming to improve the reliability of the measurements now that the concept has been validated and incorporated into the Highway Capacity Manual and AASHTO Guidelines.

An example of Bicycle Level of Service for an Urban Street Link² is provided in the table below comparing theoretical retrofit cross sections for a typical 2 lane collector street. This example illustrates the value of a combination of narrower vehicle lanes and wider bicycle lanes in creating a more comfortable bicycling environment.

Example: Existing 2-Lane Collector Street Retrofit with Parking³

Road Width	Travel Lane Width	Bicycle Lane Width	Parking Lane Width w/Gutter	Resulting Bicycle Level of Service (LOS Score)
50	13	5	7	C (2.79)
50	12	5	8	C (2.61)
50	11	6	8	B (2.43)
50	10	7	8	B (2.23) ⁴

¹ Bicycle Level of Service is an evaluation of bicyclist perceived safety and comfort with respect to motor vehicle traffic while traveling in a roadway corridor. It has been incorporated into the 2010 Highway Capacity Manual. The research is more highly developed for midblock segments than for intersection nodes.

² The 2010 HCM also provides methods for calculating Level of Service for a bicycle at Signalized Intersections (Chapter 18), Urban Street Segment (Chapter 17) and Urban Street Facilities (Chapter 16).

³ The following assumptions apply to the roadway operating characteristics: 2 travel lanes, 10,000 ADT, 30 mph, 100% parking occupancy, good pavement (score 4.0 out of 5.0), 50% directional split of traffic with 2% heavy vehicles.

⁴ Unfortunately the bicycle level of service model is not likely to give an accurate score for a 7-foot bicycle lane as there were not 7-foot bicycle lanes to evaluate during development of the model. It is our assessment based on experience that this width would result in a LOS of “A”.

46	11	5	7	C (3.11)
46	10	5	8	C (2.95)
46	10	6	7	C (2.95)

An example of Bicycle Level of Service is provided in the table below comparing theoretical retrofit cross sections for a typical 6 lane arterial street. This example illustrates the value of a combination of narrower vehicle lanes and wider bicycle lanes in creating a more comfortable bicycling environment; however the ability to provide a high quality level of comfort is limited by the higher traffic speeds and volumes in the adjacent lanes.

Example: Existing 6-Lane Arterial Street Retrofit with No Parking⁵

Outside Travel Lane Width	Shoulder/Bicycle Lane Width to Left of Gutter Seam	Resulting Bicycle Level of Service (LOS Score)
16	0	D (4.29)
15	1	D (4.29)
14	2	D (4.29)
13	3	D (3.76)
12	4	D (3.57)
11	5	C (3.36)
10	6	C (3.15)
15	0	D (3.44)
10	5	D (3.57)

A similar quality of service exists⁶ for trails where bicyclists with varying levels of skill are frequently operating in mixed use with pedestrians, joggers, rollerbladers, and dog walkers. Speed differentials and group behavior dynamics (pedestrians and bicyclists) affect the available operating space of the bicyclist potentially limiting their ability to move at normal desired operating speeds.

There are also numerous safety and comfort benefits which can be provided to bicyclists by providing wider bicycle lanes. Wider bicycle lanes create space for bicyclists to pass other bicyclists with more comfort, create additional buffer space to parked vehicles (and opening doors), create additional maneuvering space to avoid surface defects or hazards, and allow bicyclists to operate side by side if desired to engage in conversation. The graphic below illustrates the comparative operating differences.

⁵ The following assumptions apply to the roadway operating characteristics: 6 travel lanes, 30,000 ADT, 45 mph, no parking occupancy, 2-foot gutter pan, good pavement (score 4.0 out of 5.0), 50% directional split of traffic with 6% heavy vehicles. The gutter pan does not count in the measurement of available space in this situation.

⁶ Chapter 23. Highway Capacity Manual. 2010.

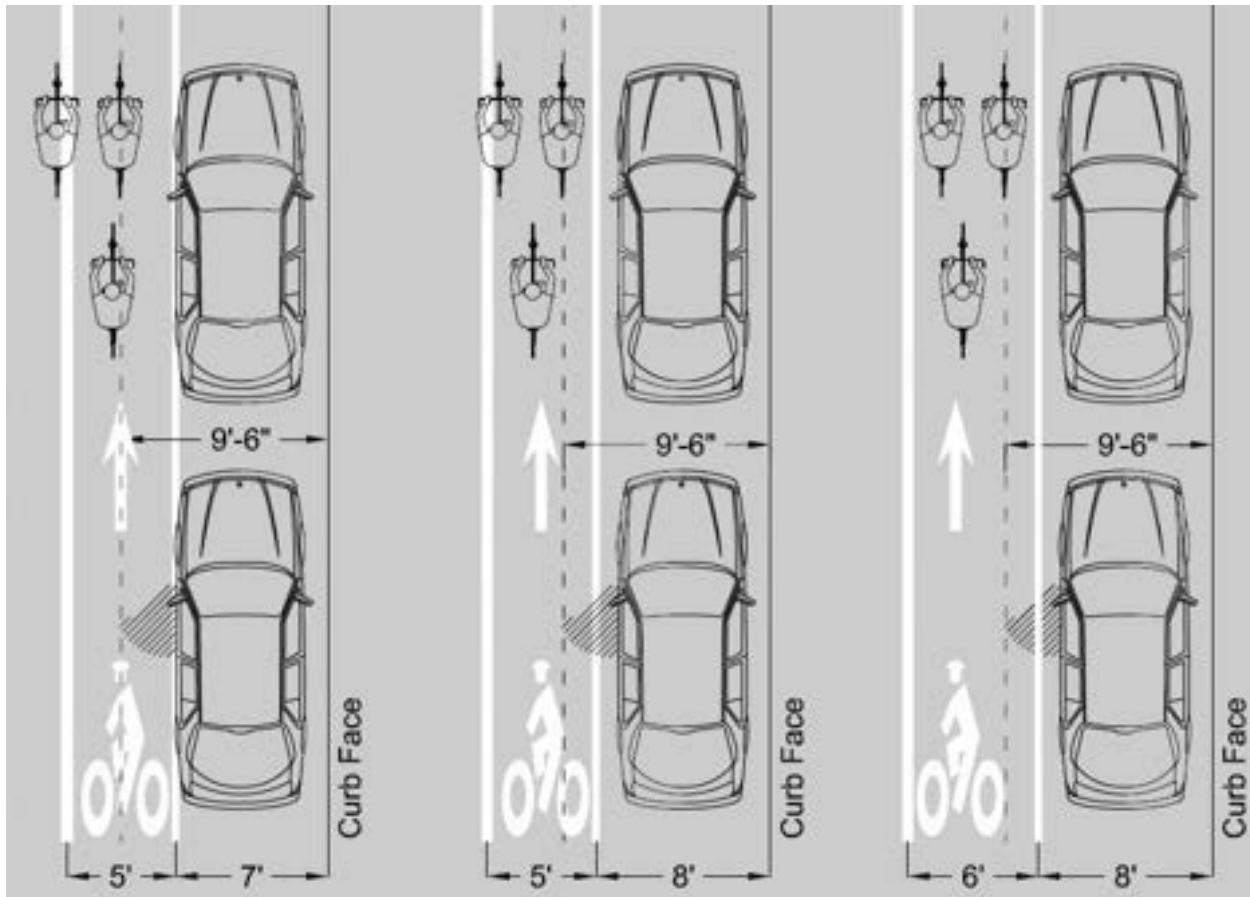


Figure 1: Comparative bicycle lane operating space

Recommendation: Establish bicycle quality of service goals for on-road bicycle lanes and off street trails. A minimum bike lane width of 6 feet should be the standard with exceptions allowing 5 feet in constrained circumstances.

Lane Width/Roadway Retrofitting Strategy for Street Segments

Travel lane widths were observed to vary from 10 feet to 15 feet throughout the City on all classifications of roadways. Collector Streets were unique in that some appeared to have “lanes” as wide as 25 feet when parking stripes are not provided and there is generally low parking demand⁷. For bicycle lanes or separated bikeways to be retrofitted onto some Aurora streets, existing travel lanes will have to be narrowed or the roadway will have to be widened. It is recommended the city consider providing wider bicycle lanes and narrower vehicle lanes in its cross sections that are only providing the AASHTO minimum, i.e. 5-feet, and when retrofitting existing roadways to create a more comfortable and safe experience for bicyclists. For example, existing 50-foot collector streets should be striped to provide 8 foot parking lanes, 6 foot bike lanes, and 11 foot travel lanes where space permits

⁷ It is now city policy to stripe collectors with parking, bicycle and travel lanes at the time they are dedicated to the city and the city is now embarking on an effort to mark collector streets already under city control.

(Approximate LOS =B). The city's current cross section for collector streets is 46 feet, which should be modified to include 7 foot parking lanes, 6 foot bike lanes, and 10 foot travel lanes(approximate LOS =C).

Travel lane narrowing is recommended as the primary retrofit method to implement the planned network, with road widening (or median narrowing) reserved only for truly constrained situations where lane narrowing is not advisable or feasible. Nationally, narrowing lanes to add capacity to roadways is a relatively common practice for local and state transportation agencies. Lane narrowing to add vehicle capacity is widely accepted as a cost effective congestion mitigation strategy, but historically narrowing lanes to add bicycle facilities has not been as accepted. From a traffic safety standpoint, congestion creates a justification for adjusting lane widths to improve safety (by reducing crashes caused by congestion), which a majority of transportation officials feel comfortable pursuing as a mitigation strategy. However, when it comes to narrowing lanes to add bicycle lanes, agencies are typically concerned that narrowing lanes will reduce safety for motorists, reduce capacity, or in some instances it is believed there is no demand for the bicycle facility to justify adjusting lane widths.

Providing additional width for the motorist has not proven to provide any safety benefit on low speed urban roadways⁸, whereas extra space provided to the parked vehicle and the bike lane reduces the potential for a hazardous crash between a bicyclist and an opening vehicle door and creates enough space where a bicyclist could pass another bicyclist without having to encroach into the adjacent travel lane. The resulting bicycle lane is more comfortable and is more likely to attract use.

The use of narrower travel lanes as a strategy for improving capacity and safety on urban arterials where posted speeds are 35 mph or lower are consistent with the 2011 AASHTO Green Book which states "lane width of 10 feet may be used in more constrained areas where truck and bus volumes are relatively low and speeds are less than 35 mph⁹". This is backed up by recent research¹⁰ focused on the safety of travel lane widths varying between 10 and 12 feet for motorists operating on arterial roadways with posted speeds of 45 mph or less. This research found lane width had no impact on safety or capacity under the majority of urban conditions. The study resulted in a virtual elimination of the capacity reduction formula in the 2010 Highway Capacity Manual related to lane widths as it found little difference between 10, 11 and 12 foot lanes.

The AASHTO Green Book is vague with regard to defining what percentage of truck and bus volume is "low" however there is guidance in research and pavement design guidelines that suggest 10% as a decision point¹¹.

⁸ Potts, Ingrid, Harwood, Douglas and Richard Karen, "Relationship of Lane Width to Safety for Urban and Suburban Arterials, TRB 2007 Annual Meeting

⁹ 2011 AASHTO Green Book, Urban Arterial Travel Lane Widths, page 7-29

¹⁰ Potts, Ingrid, Harwood, Douglas and Richard Karen, "Relationship of Lane Width to Safety for Urban and Suburban Arterials, TRB 2007 Annual Meeting

¹¹ TRB Special Report 214 – Designing Safer Roads, 1987. It is important to note this report documented research proving wider travel lanes increased safety, but this research was only based on rural, 2 lane highways.

It should also be noted that wider lane widths may encourage motorist speeding. Adding bike lanes to these streets where there is sufficient right-of-way can reduce speeding and increase safety in residential neighborhoods and near schools¹². In the past, the city has added bike lanes to some collector streets as a traffic calming measure.

Recommendation: On low speed urban streets (defined as less than 45 mph per AASHTO¹³), the space available within the street cross section should maximize the space provided to the bicyclists via wider travel lanes, wider shoulders, or bicycle lanes, or be utilized to create additional separation from adjacent traffic by utilizing buffered bicycle lanes or cycle tracks. The preference should be to provide separate operating space where feasible.

Parking Lane Strategies

On-street Parking Removal

On-street parking is permitted on limited arterial segments and along most collector and local streets in Aurora. Demand for on-street parking was observed adjacent to multi-family residential areas, parks, schools, and other community facilities where off-street parking is non-existent, restricted, or insufficient, and on local streets.



Back-in angle parking with bike lane

Reallocating the roadway by removing on-street parking on one or both sides of the street is one strategy for accommodating bicycle facilities, and is the recommended action for a number of segments within the bicycle network (shown bicycle network map). Parking removal is often done when bike lanes are desired, but there is insufficient roadway width and other strategies such as lane diets or road diets are not an option. Parking removal could be intermittent, e.g. at an intersection approach, or segment wide. The decision to remove on-street parking should be made only after a thorough analysis and stakeholder process. The stakeholder process should emphasize the benefits and trade-offs involved, and put neighborhood parking removal in the context of the whole bicycle network. The decision to remove parking on a stretch of roadway may hinge in part, on the resulting connectivity benefit to the bicycle network. If it provides limited facility continuity, it may not be prudent to remove the parking until such time as the larger connectivity challenges are resolved to ensure community support.

In addition to understanding neighborhood concerns, an analysis of adjacent land uses and observed parking utilization is necessary for determining where parking may be removed without having negative impacts to businesses and the neighborhood. For instance, parking removal is likely not an option where there are adjacent land uses such as neighborhood retail or residential uses that have insufficient off-

¹² Studies vary on the effectiveness of narrowing travel lanes as a speed reduction strategy. A majority of studies available for review generally find narrower lanes lower average speeds 3-5mph, but a small number of studies have also found no change or slight increases in speeds.

¹³ It is important to note AASHTO defines low speed urban streets as those with posted speeds less than 45 mph, however, it also recommends limiting the use of 10 foot lanes in urban areas to roadways with posted speeds of 35mph or less.

street parking. On the other hand, road segments where there are adjacent land uses that appear to have sufficient off-street parking (determined by field visits and analysis of aerial photography), or where the demand for on-street parking is likely to be low, are good candidates for parking removal. Initial analysis should be verified by a parking study that includes parking counts at several representative times, e.g. mid-week evening, weekend evening, and weekday lunch hour. If it is determined parking may be removed on one or both sides of a roadway, then the striping of all lanes should be modified in order to provide the most comfortable bicycle facility possible.

The safety of people having to cross the roadway in order to access their parked vehicle should also be considered in the decision to remove parking from one side of the street, and may be a determining factor for which side is best for parking removal.

Angled Parking Adjacent to Bike Lanes

The 1998 Aurora Bicycle Design Guidelines recommend that bicycle lanes not be installed on streets with diagonal or perpendicular parking. The AASHTO Guide for the Development of Bicycle Guide also discourages the installation of bike lanes adjacent to front-in diagonal parking. The update to the AASHTO Guide speaks to the benefits of back-in angle parking adjacent to bicycle lanes which can help:

- Improve sight lines between drivers and bicyclists
- Reduce door zone conflicts between parked cars and bicyclists that occurs with parallel parking
- Improve loading and unloading of motor vehicles
- Reduce driver and passenger exposure to travel lanes

Recommendation: Allow bicycle lanes to be marked adjacent to back-in-angled parking.

Gutter Strategies for Constrained Cross Sections

The provision of a curb with a 2-foot gutter is standard on collector and arterial streets in Aurora. The use of a 2-foot gutter can have a dramatic impact on the quality of the bicycle facility at locations where parking is non-existent or prohibited. For locations where the gutter is not flush with the adjacent travel lane, or where there is a gap in the seam, the gutter can become a hazardous condition, and more operating space to the left of the gutter seam should be provided. The AASHTO Bicycle Guide recommends a minimum of 4 feet (5 feet preferred) of smooth operating space to the left of a 2-foot gutter (6-7 foot bicycle lane) and allows for this clear space to be as narrow as 3 feet in constrained situations (5 foot bicycle lane). Minimum operating space



Example of existing bicycle facility with approximately 2-feet of space left of the gutter seam resulting in a condition where there is an 11' travel lane, and 4' bike lane on Smoky Hill Road.

accounts for the width of the bicycle, and a minimal amount of shy distance on either side to allow for the natural side-to-side movement that varies with speed, wind, and bicyclist proficiency. The city's Bicycle Facility Design Guidelines calls for 6-foot bike lanes, which includes the 2-foot gutter pan on 4-lane collectors where parking is prohibited. On arterials, the guidelines call for a 5-foot bike lane that does not include the adjacent 2-foot gutter pan, however this condition was not observed on any of the arterials where bicycle lanes have been installed. The arterials seemed to consist of a 2-3 foot shoulder adjacent to the gutter pan as seen on Smoky Hill Road and Buckley Road.

Recommendation: As roadways are reconstructed within limited right-of-way it is recommended that the gutter be narrowed to 1-foot or eliminated to maximize the width and usefulness of the bikeway where it is desired to provide bicycle lanes. While the gutter provides some nominal benefit for carrying some stormwater flows outside of the asphalt, the constrained space results in a potentially hazardous condition for the bicyclist should the gutter seam be uneven. Allowing stormwater to flow along the edge of the bike lane may have some minor effects on asphalt quality but periodic spot repairs are in most cases more cost effective than roadway widening. Travel lanes should also be narrowed to the greatest extent feasible in these situations. If narrowing vehicle travel lanes or improving or removing the gutter is found to be infeasible, then existing bicycle facilities on Buckley Rd and Smoky Hill Rd, and anywhere else this condition exists, should be removed with consideration provided to adding shared lane markings where route connectivity is important¹⁴.

Lane Width/Roadway Retrofitting Strategy for Intersections

A fundamental strategy for increasing bicycling rates is to improve the experience and safety of bicycling on the roadway network. Nationally, historic crash statistics demonstrate the vast majority of crashes

¹⁴ As noted throughout the document, it would be preferable to improve the bike lanes on these arterials in lieu of removing them for shared lane markings.

occur within intersections. While every intersection differs in terms of vehicle volumes, number of lanes, required turning movements, etc., there are a number of options that should be considered for bringing bicycle facilities up to and through an intersection. Appendix J contains an example design of the Iliff Avenue and Sable Boulevard intersection that would allow for carrying bicycle facilities through the intersection. Additional description of intersection roadway crossing treatments is provided further below in section B.6.

Recommendation: To improve the comfort and safety of bicyclists it is recommended that street segment bicycle facilities be extended through the functional area of intersections instead of terminating prior to the intersection. It is preferable to develop separate right turn lanes to the right of through bicycle lanes where space allows. At signalized intersections signal operations should consider the bicyclists both in actuating the signal and in having sufficient time to clear the intersection safely. At non-signalized intersections, consideration should be given to implementing engineering strategies which reduce crossing delay and improve comfort and safety for the bicyclists.

B.4 Recommended Bicycle Facilities by Street Type

Principal Arterials

The City of Aurora prefers to not install bicycle lanes on arterial streets, opting to provide off street accommodations via the provision of sidepaths on one or both sides of the street. There are a few limited circumstances where bike lanes have been recommended on arterial streets to close network gaps.

Retrofits of Existing

See discussions on lane width and gutter strategies above.

Current Standards

The city's current standard for 4-lane arterials (with center median) provides 12-foot travel lanes, 14-foot median, and 7-foot bike lanes. It is recommended that a 4-lane arterial cross section that includes narrower travel lanes (11 feet) and a narrower median (12 feet) be developed for those situations where it is desirable to have a buffered bike lane. The 6-lane arterial does not include on-street bicycle facilities, but includes a 10-foot detached sidewalk with an 11-foot buffer on both sides of the roadway. This standard meets minimum AASHTO standards for sidepaths, however it is recommended that, in corridors that are part of the bicycle network, bicyclists using the sidewalk should ride with the direction. Signage and/or pavement markings along the sidewalk can assist in directing cyclists. In areas with higher pedestrian volumes, designating space for bicyclists on the sidewalk using striping should be considered.

Collector Streets

Retrofits of Existing (50 foot cross section)

The city has installed the majority of existing bike lanes on collector streets. The roadway cross section has been striped with 7 foot parking lanes, 5 foot bicycle lanes, and 13 foot travel lanes. As mentioned above under the discussion about level of service, these roadways should be reconfigured to maximize

the operating space for bicyclists. The recommended cross section for a 50-foot collector street is 8 foot parking lanes, a 6 foot bike lanes and 11 foot travel lanes.

Current Standard (46 foot cross section)

For 46 feet wide collectors (the city’s current standard for new roadways) it is recommended that 11-foot travel lanes be reduced to 10-foot travel lanes to provide for 6-foot bike lanes. Other collector street cross sections, i.e. 4-lane and alternative 2-lane, provide 6-foot bike lanes.

Local/Residential Streets

For the most part local streets are suitable and attractive for bicycling given their low traffic volumes and operating speeds. However many local streets throughout the city were constructed with minimal connectivity and directness in order to minimize through traffic, and therefore, their usefulness in the bicycle network is limited. In some cases local streets have been incorporated into the recommended bicycle network by linking together segments to form a continuous route that serves as a parallel route to a busy arterial street or link between trails. It may be desirable to incorporate “neighborhood greenway” or “bicycle boulevard” type treatments such as traffic calming, bicycle advantage stop control, i.e. orienting stop control to cross streets, additional crossing treatments where these routes intersect arterial streets, and a robust system of pavement markings and/or signage along these routes. More information on Bicycle Boulevard treatments is provided below.

Retrofits of Existing

Because of the low traffic volumes and operating speeds on local streets these roadways require minimal improvements. Local streets that are part of the bicycle network should have shared lane markings or wayfinding signage, or both. Local streets that are part of a bicycle boulevard may have additional treatments such as traffic calming.

Current Standards

Current cross sections for local streets include roadway widths ranging from 30 to 40 feet with parking on both sides and travel lane widths ranging from 8 to 13 feet. These cross sections can all provide a comfortable experience for the bicyclists with minimal improvements such as shared lane markings and/or wayfinding signage due to the generally low traffic volumes.

B.6 Bicycle Facility Treatments

The following treatments are not referenced explicitly in the current City of Aurora Bicycle Facility Guidelines. It is recommended these treatments be incorporated into the guidelines.

Buffered Bicycle Lanes

A buffered bike lane is a bike lane that is separated from a travel lane or parking lane by a space of 3 to 6 feet. The lane is always one-way and is buffered by cross-hatched pavement marking, and if used, a sign for the exclusive use of bicyclists. The space between cross-hatching is flexible, but typically varies between 5 and 25 feet. Consider discontinuing cross-hatching through areas where motor vehicles may cross such as at driveway entrances and bus stops. All other guidelines and considerations that apply to bike lanes described above, also apply to buffered bike lanes. The MUTCD guidelines allow buffered bike lanes per the buffered preferential lanes found in section 3D-01.

Buffers may be used to:

- Provide additional space between parked cars and the bicycle lane to help bicyclists avoid the door zone.
- Buffer bicyclist from the motor vehicle travel lane.

Shared Lane Markings

A Shared Lane Marking is a pavement symbol consisting of a bicycle with two chevron markings above it that is placed in the roadway lane indicating that motorists should expect to see and share the lane with bicycles, and indicating the legal and appropriate line of travel for a bicyclist. Unlike bicycle lanes, they do not designate a particular part of the roadway for the exclusive use of bicyclists.

The following guidelines supplement the 2009 MUTCD and the *AASHTO Guide for the Development of Bicycle Facilities*. They are not design standards, and should not be used as such. Application of guidance provided in this document requires the use of engineering judgment when installing shared lane markings.

The revised 2009 Edition of the MUTCD includes new provisions for installing Shared Lane Markings. The following is taken directly from the 2009 Edition of the MUTCD.

The Shared Lane Marking shown in Figure 2 may be used to:

- Assist bicyclists with lateral positioning in a shared lane with on-street parallel parking in order to reduce the chance of a bicyclist's impacting the open door of a parked vehicle,
- Assist bicyclists with lateral positioning in lanes that are too narrow for a motor vehicle and a bicycle to travel side by side within the same traffic lane,
- Alert road users of the lateral location bicyclists are likely to occupy within the traveled way,
- Encourage safe passing of bicyclists by motorists, and
- Reduce the incidence of wrong-way bicycling

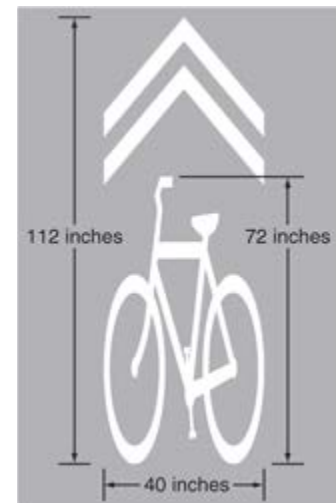


Figure 2: Shared Lane Marking Source: MUTCD, 2009 edition.

Shared Lane Marking Placement

In general, Shared Lane Markings are installed on streets where there is not enough space for bicycle lanes, or there is no desire for a bicycle lane. When bike lanes are desired but space limitations exist, a bike lane can be installed on one side of the street (the up-hill side of the street to provide dedicated space for slower, hill climbing bicyclists) and Shared Lane Markings on the downhill side. Flat streets should either have Shared Lane Markings installed on both sides (no bicycle lane) or have the bicycle lane installed on the side with the highest anticipated bicycle use (engineering judgment required). Shared Lane Markings may be the first choice (even if there is room for a bicycle lane) on some downhill sections.

Consideration for Shared Lane Marking Placement within a Travel Lane

The placement of shared lane markings will require engineering judgment as lane widths, quantity of lanes, operating speeds, and presence of parking will vary from street to street. In particular, the width of the shared travel lane and the number of available travel lanes impact typical operating behavior of motorists and bicyclists. Travel lanes with widths less than 13 feet will require motorists to partially or fully change lanes to pass bicyclists. Travel lanes of 13 feet or greater generally allow motorists to pass bicyclists with minimal or no encroachment into adjacent travel lanes (allowing 3 feet of horizontal separation between the motorist and bicyclist).

Generally, the center of shared lane markings should be located a minimum of 11 feet from the curb or edge of roadway at locations where parking is permitted adjacent to the travel lane. Generally, the center of shared lane markings should be located a minimum of 4 feet from the curb or edge of roadway at locations where parking is prohibited.

It may be appropriate to move the shared lane marking towards the center of the travel lane (exceeding the MUTCD minimums) if engineering judgment determine that this placement will enhance the safety of the bicyclist operating within the travel lane. The shared lane marking may be moved towards the center of the lane regardless of whether it is adjacent to parking or not. In most cases, it will be a combination of two or more of the following factors which will indicate that consideration should be given to moving the Shared Lane Marking towards the center of the travel lane:

- Travel lane is less than 12 feet in width
- Speed of traffic
- Number of travel lanes (it may be desirable to place the shared lane marking towards the center of a narrower outside travel lane when a center turn lane is present or when there are multiple travel lanes in the same direction)
- Grade of roadway and expected bicyclist speed (center lane placement often works well when going downhill on streets with grade and higher bicycle speeds)
- Volume of traffic (may or may not be an issue – speed, grade, and number of lanes are more important)

Situations Where Travel Lanes Are Less than or Equal to 12 Feet in Width

Shared lane markings should be placed in the center of the travel lane where travel lanes are less than 12 feet to encourage bicyclists to occupy the full lane and not ride too close to parked vehicles or the edge of the roadway. A BIKES MAY USE FULL LANE (R4-11) sign may be used to supplement the marking. Travel lanes of this dimension are too narrow for sharing side by side with vehicles.

Situations Where Travel Lanes Are Between 12 Feet and 13 Feet in Width

Where travel lanes are 12-13 feet in width, the travel lane can appear shareable to roadway users if bicyclists operate on the right side of the lane resulting in unsafe passing maneuvers. It may be desirable to place the marking in the center, or close to the center of the lane to discourage these behaviors. A BIKES MAY USE FULL LANE (R4-11) sign may be used to supplement the marking.

Situations Where Travel Lanes Are Greater than or Equal to 13 Feet in Width

Where travel lanes are 13 feet or wider, motorists will generally be able to pass bicyclists within the same lane or will only need to slightly encroach on adjacent lanes to pass bicyclists. The Shared Lane Marking should generally be located in the right portion of the lane (per the MUTCD minimum requirements) with exceptions for locations adjacent to parking where it is desirable to encourage riding further from parked vehicles. A Share the Road sign (W11-1 AND W16-1P) may be used to supplement the marking.

Shared lane markings should generally be used on arterial and non-arterial roadways with motor vehicle speeds 35 mph or less. Research has shown placing the marking in the center of travel lanes wider than 13 feet will likely result in poor compliance by bicyclists who will travel in the right portion of the lane which may undermine the effectiveness of shared lane markings in narrower lanes.

Considerations for Parking Lane Line Placement

Where there are no parking restrictions, the Shared Lane Marking should be placed in conjunction with a 4 inch solid or dotted white parking lane stripe (2 foot line with 4 foot gaps). The dotted line should be used through uncontrolled intersections where there is no arterial traffic control and where there are parking restrictions, including bus stops. The intent is to reinforce parking restrictions and to provide a continuous visual cue for the bicyclist to track along. The parking lane line will be located 7 to 8 feet from the face of the curb or roadway edge. Generally, a narrower parking lane is desirable to encourage motorists to keep the vehicle as close to the edge of the roadway as possible to maximize the available travel lane width, which will improve the bicyclist's level of comfort on the roadway.

Considerations for Symbol Placement Frequency

Shared Lane Markings should be placed at the far side of an uncontrolled intersection, at both sides of an arterial intersection with traffic control, and at mid-block locations where block faces are more than 250 feet long.

When placing mid-block Shared Lane markings, they should be placed in such a manner that the first Shared Lane marking a bicyclist or motorist would come upon would be the Shared Lane marking in their direction of travel. The Shared Lane markings should be offset from each other 20 feet from the tip of the leading (top) chevron to tip of leading (top) chevron.

Where there are mid-block marked crosswalks, the tip of the chevron should be placed 25 feet beyond the far side of the marked crosswalk.

Considerations for Shared Lane Marking Placement –Streets without Centerline

Shared Lane Marking installation on local streets or streets without a centerline should generally follow the guidelines mentioned above. However, no parking lane stripes should be installed. Utilizing the marking on non-arterial streets may require that the Shared Lane Markings be offset at intersections to prevent the symbols from overlapping. The tips of the leading (top) chevrons should be separated by at least 10 feet.

Paved Shoulders

Paved shoulders provide space on the outside of travel lanes for bicycle and pedestrian use. Examples of roadways where paved shoulders are recommended are state routes such as Colfax Ave and E Jewell Ave. Paved shoulders should be a minimum of 4 feet without the curb; 5-foot minimum with a curb. Additional shoulder width is desirable on roadways with high motor vehicle traffic volumes, high vehicular speeds, or a high percentage of trucks, buses, and recreational vehicles. It is important to note that at intersections, additional symbols, signage, arrows, or short sections of bike lanes may be needed to provide direction to bicyclists and reduce potential conflicts between bicyclists and turning cars.

Agencies can evaluate narrowing travel lanes within AASHTO Green Book guidelines to allow pavement to be reallocated to the paved shoulder. On some roadways without curbs, such as Quincy Ave east of S Picadilly St, paved shoulders can provide important bicycle connections. Paved shoulders also improve safety for motor vehicles and prevent pavement damage at the edge of the travel lanes.

In some areas such as along E Jewell Ave in the vicinity of the Plains Conservation Center shoulders may function as a parking lane. In areas where there are low occupancy rates of parking, the shoulder can function as bikeable space the majority of the time. In these instances, there is no need to provide an additional dedicated bicycle facility, and bicyclists should proceed with caution when overtaking parked vehicles. It should be noted that this situation should be regularly re-evaluated. If on-street parking occupancy rates increase, shared lane markings may be added to provide location specific guidance to bicyclists and motorists. If parking demand remains low, the shoulder should be targeted for conversion to a bicycle lane.

Separated Bikeway

Light rail station area plans call for “protected bikeways” around several planned stations, and defines these as “bicycle travelways that are physically separated from automobile and pedestrian traffic.” The recommended network shows these facilities as “separated bikeways” rather than “protected” because the latter is proving to be somewhat controversial given its implication of protection. Separated bikeways can be one way for bicycles on each side of a two-way road, or two-way, and installed on one or both sides of the road. Separated bikeways provide cyclists with a higher level of comfort relative to motor vehicle traffic, and are typically used on large multi-lane arterials where higher vehicle speeds exist. They may also be appropriate on high-volume but low-speed streets such as in a commercial downtown. A separated bikeway (often referred to as cycle tracks) is a bicycle facility that is physically separated from both the roadway and the sidewalk. Furthermore, a separated bikeway can be constructed at the roadway level or the sidewalk level.

Separated bikeway at the roadway level - uses roadway space and must be separated from motor vehicle traffic. Separation methods include curbs, raised concrete medians, bollards, on-street parking, large planting pots/boxes, landscaped buffers (trees and lawn) or other methods.

Separated bikeway at the sidewalk level – uses space adjacent to the road and must be separated from pedestrian traffic. Separation methods include different surface treatments, street lighting, plants, etc.

Sidewalk Connectors/Sidepaths

A sidepath is a one or two-way shared use path that parallels a roadway. In many cases making connections between trail access points, or between on-street facilities and a trail access point, is best accomplished through short sidepath segments, particularly where a dedicated right-of-way is not available. This is particularly true where the most direct connection between two trails or a trail and on-street bicycle facility is within an arterial corridor, where it is not possible or desired to have on-street bicycle facilities. Functionally, sidepaths are similar to what the city currently refers to as sidewalk connectors, and for this reason the term sidewalk connector is used for the recommended bicycle network. However, where sidewalk connectors are recommended in the Master Plan, it is assumed they would be designed to meet AASHTO sidepath guidelines. AASHTO guidelines recommend sidepaths be a minimum of 10 feet in width, with a minimum distance of 5 feet between the path and the roadway curb. Where the separation is less than 5 feet, a physical barrier or railing should be provided between the path and the roadway. The forthcoming AASHTO Guide for the Development of Bicycle Facilities provides a lengthy discussion of the design considerations associated with sidepaths.

B.7 Transitions Between Different Bicycle Facility Types

At locations where bike lanes terminate to become shared lanes it may be desirable to provide a transition to a marked shared lane for a brief distance, even if it is not desirable to mark a continuous shared lane for the remainder of the roadway. The placement of the shared lane marking should conform to guidance provided above. It is recommended that a SHARE THE ROAD sign (W11-1 and W16-1P) be used for shared lane situations where the lane is wider than 13 feet and BIKES MAY USE FULL LANE (R4-11) signs be used for narrower lane widths. The taper terminating the bike lane should also conform to the MUTCD (Figure 3B-14, 2009 MUTCD) shown here in Figure 3.

Trail System and the On-Street Bicycle Network Transition

It is often necessary to use different bicycle facilities to provide bicycle access within

Appendix B – Bicycle Facility Design Appro

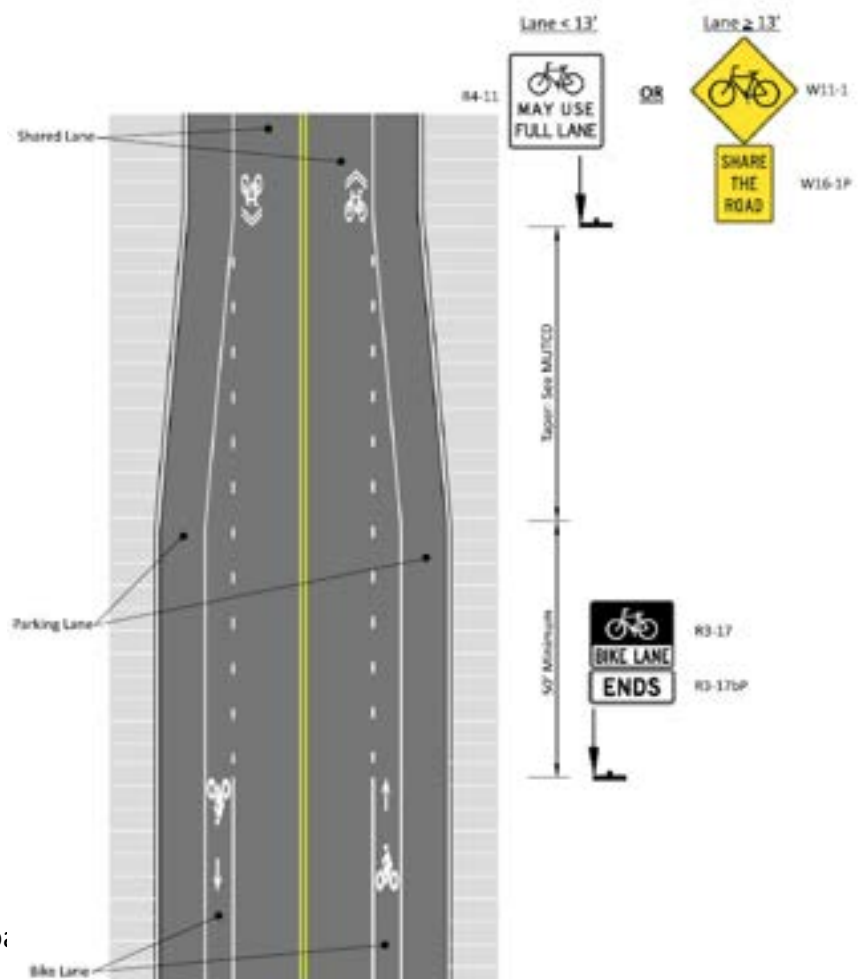


Figure 3: Transition from bike lane to shared lane marking

the same roadway corridor due to existing roadway conditions, surrounding land uses, available right-of-way, and other characteristics. Where this condition occurs, it is important to provide transitions between different facilities. These transitions can be made safer and more understandable for bicyclists and motorists with appropriate and consistent treatments such as spot directional signs, warning signs, pavement markings, curb cuts, etc. Transitions should be provided as a part of the bicycle facility design process. Where possible, provide additional space where trails intersect roadways, particularly at signalized locations where multiple trail users are likely to be waiting to cross the street. Curb ramps at trail crossings and other on-street access points should be assessed and widened where they are narrower than the trail width and/or where the volume of trail users is high.

Where a shared use path crosses or terminates at an existing road, it is important to transition the path into the system of on-street bicycle facilities and sidewalks. Care should be taken to properly design the terminus to transition the bicycle traffic into a safe merging of intersecting facilities. Appropriate signing is necessary to warn and direct both bicyclists and motorists regarding these transition areas. Each roadway crossing is also an access point, and should, therefore be designed to facilitate movements of path users who either enter the path from the road, or plan to exit the path and use the roadway.

B.8 Intersection and Roadway Crossing Treatments

This section provides guidance for intersection and mid-block crossing treatments, some of which is not in the AASHTO Guide or the MUTCD.

Crossings at Major Intersections

Improvements along bicycle boulevards, collector streets, or local streets for bicycling are of limited utility if cyclists cannot safely *and* comfortably cross major roadways. Intersection improvements on bicycle boulevards enhance cyclist safety by eliminating or raising awareness of potential areas of conflict between motorists and cyclists, and by reducing the delay cyclists experience at traditional intersections where no accommodations have been made for cyclists.

The positioning of the bicyclists, particularly longer bikes or bikes with trailers, and crossing times are important considerations for designing a crossing that can get cyclists across a busy roadway safely and comfortably. There are a number of intersection treatments available that can aid cyclists in crossing busy intersections including signalization, crossing islands, high visibility crosswalks, and flashing warning beacons.

Many arterial streets are challenging to cross, particularly during peak travel periods. In order to make it possible for bicyclists to travel throughout Aurora, there must be safe places to cross major streets. The section below describes the types of treatments that are recommended to help bicyclists cross these major roadways. Selection of the appropriate roadway crossing treatment depends on a number of factors:

- Roadway width/number of lanes
- Motor vehicle traffic volumes
- Motor vehicle speed

- Sight-distance
- On-street parking
- Presence of traffic signals at the intersection or at nearby intersections
- Satisfaction of necessary and relevant traffic warrants

Contrasting Green Color Pavement

The use of contrasting green color is used primarily to highlight areas with a potential for bicycle-vehicle conflicts, such as intersections or merge areas where turning vehicles must cross a through bike lane. Generally, color has been applied to sections of bike lanes that previously had been delineated by dotted white lines. Examples of the use of color are shown in Figures 4 and 5. Providing clear pathway of travel guidance for bicyclists across wide intersections and at transition areas between shared-use

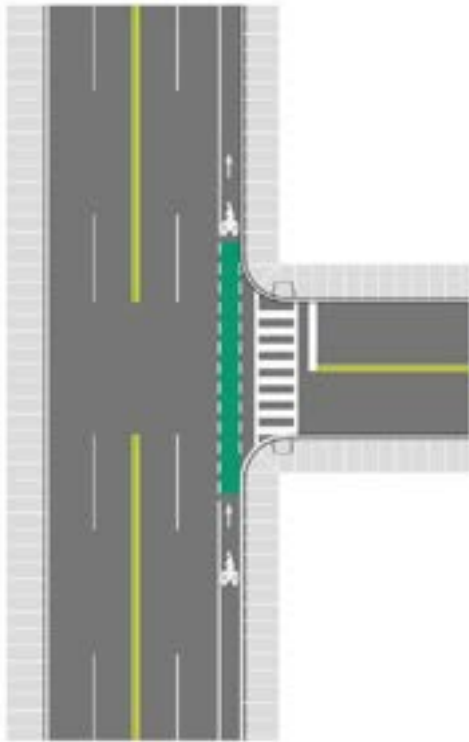


Figure 4: Green Bike Lane Through Intersection

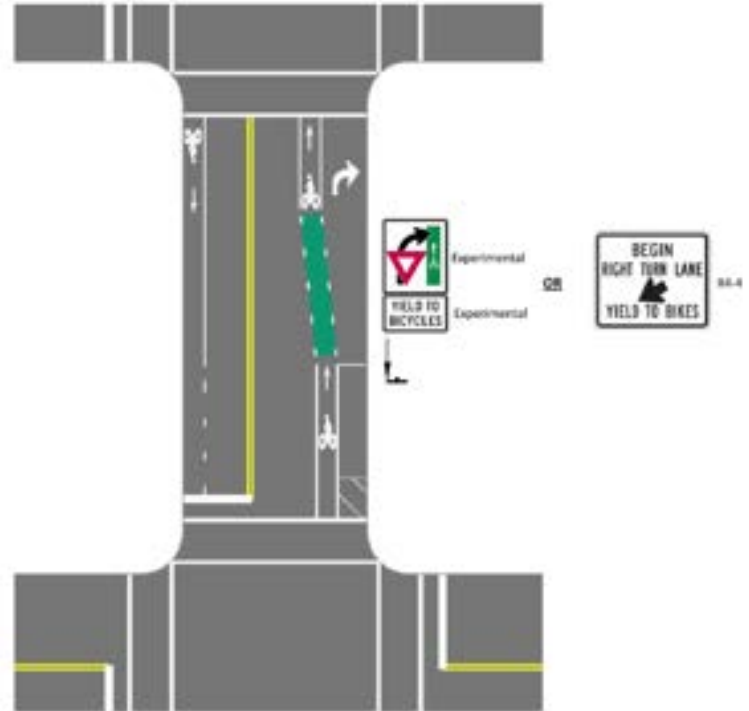


Figure 5: Green Bike Used to Cross Right-turn Lane

pathways and on-street facilities can aid in bicyclist comfort and alert motor vehicles about where to expect cyclists in the roadway.

MUTCD Status: The use of contrasting color was issued Interim Approval status by FHWA on April 15, 2011. The use of contrasting green color has been shown through experimentation to increase awareness of bicyclist but has thus far not been shown to reduce crash rates in conflict areas.

Design guidance and application from the interim approval state:

- The color green is designated as the color for bicycle facilities. The material used for green color can be paint, colored asphalt or concrete, other marking materials with the proper chromaticity and slip resistance
- Green pavement marking may be used within a bicycle lane or within an extension of a bicycle lane to enhance the conspicuity of the lane or extension

- If a pair of dotted lines is used to extend a bicycle lane across an intersection or driveway, or a ramp, green colored pavement may be installed between these lines as a supplement to the lines

Signals

Signalized intersections allow bicyclists to cross arterial streets without needing to select a gap in moving traffic. Traffic signals make it easier to cross the street, though it is important to make improvements to reduce conflicts between bicyclists and turning vehicles. All new signals shall meet MUTCD warrants. It is important to note that bicyclists may be counted as pedestrians or vehicles. It is recommended that the warrant should be checked with bicycles counted as vehicles and then as pedestrians to determine the potential need from both perspectives in cases where warrant satisfaction is borderline.

Bicycle Signals

Bicycle signals potentially provide clearer direction to bicyclists crossing signalized intersections that they may enter an intersection. At locations (typically trail crossings) where it is expected cyclists should follow pedestrian signals, under present law and timing practices, bicyclists are only “legal” when they enter the crosswalk during the solid WALK portion of the signal which is significantly shorter than the provided walk+clearance time resulting in bicyclists disobeying the flashing don’t walk portion of the cycle which can lead to them being caught in the intersection during the change interval. Providing bicycle signals allows for a longer display of green as compared to the walk, which significantly improves the compliance with the traffic control. Further, the MUTCD states explicitly that pedestrian signals are for the “exclusive use of pedestrians”. Bicycle signals can be designed to call a green signal phase through the use of loop detectors (or other passive detection such as video or radar) or push button. Bicycle signal heads and a separate bicycle signal phase should be considered at intersections and trail crossings with very high volumes of cyclists or locations where it is desirable to provide separate phasing for the bicyclists.



Bicycle Signal

Presently the MUTCD has no provision for bicycle signals; however bicycle signals are under experimentation in many jurisdictions and are being actively investigated by the National Committee for inclusion into the MUTCD. The use of bicycle signal heads would require permission to experiment from FHWA.

Rectangular Rapid Flashing Beacons

Rectangular rapid flashing beacons (RRFB) are installed at unsignalized street crossings or mid-block crossing to assist pedestrians and bicyclists in crossing the street. Rectangular rapid flashing beacons have proven to be effective devices at uncontrolled intersections for increasing motorist yielding rates and reducing pedestrian-vehicle crashes at crosswalk locations. The rapid flashing beacon device consists of a pair of rectangular, yellow LED beacons that employ a stutter-flash pattern similar to that used on emergency vehicles. The beacons are often mounted below a standard pedestrian crossing

warning sign and above the arrow plaque. The beacons are pedestrian activated (pushbutton or passive detection) and placed on both sides of the street. If a median exists at the crossing location, a third and fourth beacon may be placed in the median, which, studies show, significantly increases motorist yield rates. Advanced pedestrian warning signs can also be used with the rapid flashing beacon. If traffic volumes are too high, or there are too many lanes (generally more than 4 travel lanes), a pedestrian hybrid beacon or full signal may be warranted. Research has shown higher motorist yielding rates for RRFBs versus standard flashing beacons; since these devices have been granted interim approval by FHWA, they are not included in the 2009 MUTCD due to late approval status, however, request to study is not required with interim approval to install these devices. A written request must be submitted to the FHWA to participate in the Interim Approval.

Pedestrian Hybrid Beacons (a.k.a: HAWK Signal - High Intensity Activated Crosswalk)

This signal is intended to allow pedestrians and bicyclists to stop traffic to cross high volume arterial streets. The signal may be used in lieu of a full signal that meets any of the 9 warrants in the MUTCD as well as at locations which do not meet traffic signal warrants where it is necessary to provide assistance to cross a high volume arterial. The MUTCD provides suggested minimum volumes of 20 pedestrians or cyclists an hour for major arterial crossings (excess of 2,000 vehicles/hour). It is recommended that this signal be considered for all arterial crossings in the bicycle network and for trail crossings if other engineering measures prove inadequate to create safe crossings. Pushbuttons should be "hot" (respond immediately), be placed in convenient locations for bicyclists, and abide by other ADA standards. Passive signal activation, such as video or infrared may also be considered. While this type of signal is intended for pedestrians, it would be beneficial to retrofit it as the City of Portland, Oregon has with bicycle detection and bicycle signal heads on major cycling networks to provide adequate guidance. Depending upon the detection design, the city may have the option to provide different clearance intervals for bicyclists and pedestrians. The provision of bicycle signal heads would require permission to experiment from FHWA.



Curbside Push Button For Cyclist



Bicycle and Pedestrian Signals



HAWK Signal Across Arterial with Bike/Ped Crossing Warning Sign

Signal Timing

It was observed that the majority of collector and local street crossings of arterials required actuation. Existing detection systems are not set to explicitly detect bicyclists. Based on email discussions with

staff, the minimum green time provided for crossing arterials is typically 5-6 seconds with extension time provided as motor vehicles are detected. Yellow and red times totaling 4-6 seconds is provided at each location to allow a motor vehicle to clear the intersection. Should a bicyclist attempt to cross one of the city's 7 lane arterials (approximately 90 feet), they may not clear the intersection within the time provided. Section 9D.02 of the 2009 MUTCD states: "On bikeways, signal timing and actuation shall be reviewed and adjusted to consider the needs of bicyclists." Accommodating bicyclists at actuated intersections is one relatively cost-effective way in which a city can make significant strides to improve the safety and level of service provided to bicyclists.

Recommendations: It is recommended the city revise its signal timing policy to accommodate bicyclists at all intersections located on the bicycle network as it is implemented, and develop a protocol for assessing concerns from bicyclists regarding detection or additional time to cross at other locations. It is anticipated that this will be an iterative process that will result in signalized intersections being slowly upgraded over time, and on a case-by-case basis as routine maintenance projects are implemented.

Detection

- Detection should be provided at signalized intersections to accommodate the range of cyclists and user types expected. Specifically, an adult commuter cyclist may prefer in-lane detection, while a child biking to school may prefer to ride on the sidewalk and use the pedestrian push-button. It should not be expected that on-road users will be required to leave the roadway to actuate a signal.
- The use of pedestrian push-buttons for bicycles as the only detection method is not desirable for several reasons:
 - The required clearance time for pedestrians is significantly longer than for bicyclists, which would increase the delay for motorists on conflicting approaches at times when only bicyclists are present.
 - Pedestrian signal timing is excessive for cyclists because the flashing don't walk interval is timed for slow pedestrian speeds not bicyclist speeds.
 - Push-button placement is designed for pedestrians, including disabled pedestrians on the sidewalk. Bicyclists would have to access the sidewalk, which may be particularly difficult for bicyclists making a left or through movement on multi-lane approaches and at locations where there is no path to the sidewalk from the roadway.
 - It is unreasonable to expect a bicyclist to have to dismount and carry their bike to the sidewalk at all intersections to become a pedestrian. They are unlikely to do so and this may result in bicyclists crossing against the light where they are not detected or they may be caught on the change interval where the timing is inadequate for them to cross the roadway leaving them in danger of being struck by crossing vehicles. This design is also a discouragement to bicycling and will detract from the objectives of this plan to promote and increase bicycling in Aurora.
- Video detection is the city's preferred method for bicycle detection. Video cameras used for detection have programmable detection zones, distinct detection zones can be programmed for bicyclists in a bike lane or shared lane. This zone should be supplemented with bicycle detection pavement markings and signs per the MUTCD.

- Where video detection is not provided, loop detectors should be set to the highest sensitivity level possible without detecting vehicles in the adjacent lanes. This higher sensitivity will increase the likelihood of a bicycle being detected. Consideration should be given to adding a delay on a detector where there are concerns of false calls. . For locations with shared lanes, a supplemental loop may be provided at the stop bar as an alternative to increasing the sensitivity of an existing loop. For locations with a separate bike facility, a loop detector should be provided in the bike lane. A Type D or Type Q is preferred to detect bicycles because they can be set at a higher sensitivity level while still rejecting vehicles in an adjacent lane. *Note: Some high performance bicycles may not be detected with a loop detector; however, it is possible the detector could detect other items on the bicycle or bicyclist such as the chain ring, chain, shoe cleats, etc¹⁵. However, loop detectors should still be provided for the large portion of the population that do not have high performance bicycles. Over time, if a larger portion of the population has high performance bikes, alternate detection methods (e.g. video detection, push-buttons placed specifically for bicycles) could be used.*



The bicycle detection symbol should be used in bike lanes or shared lanes to depict the "sweet spot" for optimum detection regardless of detection technology.

- Install bicycle detector pavement markings and signs as recommended in the MUTCD to notify bicyclists of the optimum location to be detected. Field checks of the loop detector with a bicycle rim should confirm the location with the highest probability of bicycle detection and a bicycle detector symbol should be applied at that location.

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Signal Timings

- Timings at signalized intersections should be modified on a case-by-case basis to consider the specific needs of bicycles, which have slower acceleration and operating speeds than motor vehicles. A stationary, or “standing”, cyclist entering the intersection at the beginning of the green indication and a moving, or “rolling”, bicyclist approaching the intersection towards the end of the phase should be considered. The needs of standing cyclists can typically be accommodated by increasing the minimum green time on an approach, which is the current state of the practice. The needs of rolling cyclists require increases to the yellow and red times (change and clearance intervals), which may result in a slight loss of capacity at the intersection.

¹⁵ The only bikes this should present a challenge for are 100% carbon fiber bicycles which are expensive and relatively limited in number compared to the general population. These bikes still have limited amounts of steel and aluminum located in the chain ring, wheel hubs, chain, derailleurs, and brakes which may be detected under certain settings.

- The minimum green time should be adjusted such that the total phase duration (minimum green time plus yellow and all red times) are long enough for a bicyclist leaving the stop bar at the beginning of the green indication to clear the far side of the intersection. This time is referred to as the Bicycle Standing Time and is sufficient for a bicyclist to react, accelerate and cross the roadway before the conflicting crossing traffic receives a green indication.
- At intersections with arterial roads and a side street of lower classification, there may be concern about the impact to delay on the arterial when the side street minimum green time is increased (i.e. by 4 seconds as the worst case scenario) to accommodate the bicycle standing time. However, the changes to the minimum green time should have a small, if any, impact to the delay for motor vehicles on the arterial. During peak periods, the green time allocated for a minor approach typically increases over the minimum green time due to high demand on the minor street. During off peak periods, the loss of green time allocated to an arterial road will have little impact due to the lower traffic volumes on the arterial.
- At intersections where the minimum green time is increased, there may also be a concern with the potential increase to emergency vehicle response time. The city should balance the needs of bicyclists and emergency vehicles at signalized intersection and balance the volume of bicyclists, the required increase in minimum green time for bicyclists (between 1 and 4 seconds) and the frequency of emergency vehicles. Furthermore, at locations where there are high bicyclist volumes and high frequency of emergency vehicles, separate stop line detection for bicyclists could be implemented so the longer minimum green is only provided when a bicyclist is present.

<i>Equation for Bicycle Minimum Green and Crossing Time for a Standing Bicyclist¹⁶</i>	<i>Bicycle Standing Time for various intersections widths</i>	
	Intersection Width*	Bicycle Standing Time**
	30	8.3
	40	9
	50	9.7
	60	10.4
	70	11.1
	80	11.8
	90	12.4
	100	13.1
	110	13.8
	120	14.5

¹⁶ DRAFT AASHTO Guide for the Development of Bicycle Facilities (February 2010)
<http://design.transportation.org/Documents/DraftBikeGuideFeb2010.pdf>

$BMG = BCT_{standing} - Y - R_{clear}$ $BMG = PRT + \frac{V}{2a} + \frac{(W + L)}{V} - Y - R_{clear}$	<p>* Distance from Stop bar to far side of conflicting travel lane</p> <p>** Assumes a 6 foot bicycle length and 10mph operating speeds. Slower or faster operating speeds should be considered depending upon conditions (e.g. type of user, grade of road) at the intersection.</p>
<p>where:</p> <p>BMG = bicycle minimum green time (s)</p> <p>BCT_{standing} = bicycle crossing time (s)</p> <p>Y = yellow change interval (s)</p> <p>R_{clear} = all-red (s)</p> <p>W = intersection width (ft)</p> <p>L = typical bicycle length = 6 ft (see chapter 3 for other design users)</p> <p>V = bicycle speed crossing an intersection (ft/s)</p> <p>PRT = perception reaction time = 1 s</p> <p>a = bicycle acceleration (1.5 ft/s²)</p>	

- Change and clearance intervals (i.e. yellow and red times) provided for motor vehicles may sometimes be sufficient for bicyclists. Generally, the yellow times used for motorists, typically between 3 and 6 seconds, are suitable for cyclists. However, it may be necessary to consider lengthening the red time depending upon posted speed limit, intersection width, bicyclist speed, roadway grade and red time used for motorists. The difference in clearance time between faster motorists and slower bicyclists is exaggerated by increased crossing distances and increased motorists speeds; therefore, it is more challenging to accommodate bicycles in the signal timing at wide, high-speed intersections. Additionally bicyclists traveling uphill may have even slower speeds than typical, further increasing their crossing times and requiring longer change and clearance intervals. As indicated above, increasing red times may be challenging due to potential decreases in motor vehicle capacity, increases in red-light running and increases in motor vehicle crashes. Additionally, bicyclists may stop on a yellow indication when approaching intersections with a long crossing distance, which will reduce the number of bicyclists entering the intersection during the change and clearance intervals.

Crossing Islands

Crossing islands facilitate crossings of multiple lane and/or high-volume arterials by providing space in the center of the roadway, allowing the pedestrian or bicyclist to focus on one direction of traffic at a time (two-stage crossing). Median islands (or crossing islands) are constructed at the center of a road to physically separate the directional flow of traffic, and to provide pedestrians and bicyclists with a place of refuge while reducing the crossing distance between safety points.¹⁷

Arterial roadway intersections that have low demand for left-turn movements can be potential candidates for adding median islands. Median islands can be constructed on these roadways by using the available center turn lane area, or by removing parking from one side of the street and shifting the travel lanes. Median islands are likely to be a medium- or long-term improvement on roadways where significant channelization changes are needed to provide enough space for the median island.

¹⁷ AASHTO Guide for the Development of Bicycle Facilities 1999.

The newest AASHTO Bicycle Guidelines outline design considerations for median crossing islands:

- Median islands are beneficial to install on roadways that have high traffic volumes, roadways that are too wide for full roadway crossing, and roadways with more than three travel lanes.
- Minimum width for storage on the median is 6 feet. 10 feet accommodates a bike with trailer
- Island should be large enough for multiple people to be on the island at once e.g. strollers, bicyclists, pedestrians etc.
- Angling the refuge area at approximately 45 degrees is recommended to direct those crossing to face towards on-coming traffic.

Crossing Markings

The crossing markings used for bicyclists may differ depending on if the crossing is at a signalized or unsignalized location. For signalized locations bicycle pavement markings through intersections indicate the intended path of bicyclists through an intersection or across a driveway or ramp. They guide bicyclists on a safe and direct path through the intersection, and provide a clear boundary between the paths of through bicyclists and either through or crossing motor vehicles in the adjacent lane. MUTCD Section 3B.08 requires dotted lines the same width and color to bind the bicycle crossing space. Other treatments include multiple shared lane markings, chevrons, or colored pavement (green). These treatments may not be applicable for crossings in which bicycles are expected to yield priority, such as when the street with the bicycle route has Stop or Yield control at an intersection. At these types of locations high visibility crosswalks may be used to create a visibly prominent crossing location for pedestrians, which also benefits bicyclists. High visibility crosswalks should be used in combination with advanced pedestrian/bike crossing warning signs. Other treatments that may be used in combination with high visibility crosswalks include curb extensions (to shorten crossing distances, crossing islands, and advanced yield markings. And at mid-block locations they may be used in combination with raised speed tables, however these are not recommended on higher speed and volume arterial streets.

Advanced Yield Markings

Advanced yield markings in conjunction with “Yield Here To Pedestrian” signs have proven to be effective at reducing multiple threat crashes at uncontrolled, marked crosswalk locations. A multiple threat crash results when a car in one lane stops to let the pedestrian cross, blocking the sight lines of the vehicle in the other lane of a multi-lane approach which advances through the crosswalk and hits the crossing pedestrian(s). The MUTCD (2009) requires the use of “Yield Here To Pedestrians” (R1-5, R1-5a) sign if yield lines (shark’s teeth) are used in advance of a marked crosswalk that crosses an uncontrolled multi-lane approach. “Yield Here To Pedestrians” sign may also be used without the installation of advanced yield lines. If yield lines and “Yield Here To Pedestrians” signs are used in advance of a crosswalk, they should be placed together and 20 to 50 feet before the nearest crosswalk line; parking should be prohibited in the area between the yield line and the crosswalk. “Yield Here To Pedestrian” signs may be used in conjunction with the “Pedestrian Crossing” (W11-2) warning sign but must be on a preceding post and not block the road user’s view of the W11-2 sign. This application should be considered at trail crossings, pedestrian hybrid beacon crossings, and bicycle boulevard crossings of arterials. It is recommended the bicycle symbol be incorporated onto the signs. If a

pedestrian hybrid beacon is used at a crossing location, then a “Crosswalk Stop On Red” (R10-23) should be used per Section 2B.53 of the MUTCD.

Curb bulbs/Extensions

Curb bulbs are a section of sidewalk extending into the roadway at an intersection or midblock crossing that reduces the crossing width for pedestrians and increases their visibility, and may help reduce traffic speeds.¹⁸ Curb extensions shorten bicyclist and pedestrian exposure time in traffic and increase the visibility of non-motorized users at roadway crossings. By narrowing the curb-to-curb width of a roadway, curb extensions may also help reduce motor vehicle speeds and improve bicyclist and pedestrian safety. Curb extensions are appropriate only for locations that have full time, on-street parking.

Design considerations:

- No wider than parking lane e.g. 7 feet
- Curb radius can be tightened to slow right turning vehicles
- Curb bulbs can provide additional space for curb ramp construction if there is limited right-of-way

Crossings at Off-Set Intersections

Several designs have been developed to facilitate crossing of intersections with “legs” that do not line up directly across from one another. These include bicycle left-turn lanes that create a designated space for two-way left turns using pavement markings, left-turn with raised median that creates a single protected left turn using a raised curb median, and a sidepath. Left turn lanes should be a minimum six feet wide and 8 feet in length so that bicyclists can be completely separated from the travel lanes.



¹⁸ AASHTO Guide for the Development of Bicycle Facilities 1999.

Greater detail on all of these design treatments can be found in the documents mentioned above, as well as other sources such as PedSafe and the National Association of City Transportation Officials (NACTO) website.

High-visibility Pedestrian/Bicycle Crossing Warning Signs

High-visibility bicycle and pedestrian warning signs are recommended at trail crossings. These signs can increase driver awareness of bicyclists and pedestrians, especially at mid-block locations where bicyclists and pedestrians may not be expected. These signs will be most effective when combined with other treatments, such as marked crosswalks, curb extensions, median islands, etc. Signs should be used judiciously—too many signs can cause visual clutter and lead to non-compliance. This sign is incorporated into the new MUTCD.

Sight Distance Improvements

Sight-distance obstructions can increase the risk of bicyclists being struck by vehicles at roadway crossings. Locations may have on-street parking, landscaping, light poles, bus stop shelters, and other features obstructing the line of sight between drivers and bicyclists. While these features can make a street more attractive and serve other valuable functions, they should be placed in locations that do not obscure drivers' views of bicyclists.

Restricting parking within a certain distance of an intersection—typically 30 feet—helps to maintain sight distance. Such a restriction should be put in place in all jurisdictions within the Plan area, if it is not already. Enforcement of this law should be targeted on arterial roadways with bicycle lanes and at intersections where signed bicycle routes cross arterial roadways. At certain locations, it may be appropriate to restrict parking further to achieve the desired improvement in sight distance.

B.9 Bicycle Boulevard Guidance

Introduction

Bicycle boulevards are low-volume and low-speed streets that have been optimized for bicycle travel through treatments such as traffic calming and traffic reduction, signage and pavement markings, and intersection crossing treatments. Bicycle boulevards have been implemented in cities across the country, including Columbia(MD), Minneapolis, Berkeley, and Portland. Bicycle boulevards are garnering more attention as cities look to strategies for attracting more people that are “curious, but cautious” about riding their bicycles in an urban context. Bicycle boulevards allow bicyclists to avoid higher volume, higher speed roadways, offering a more comfortable and leisurely riding experience. For this reason, bicycle boulevards are more likely to attract families, and other more cautious or less confident bicyclists that are less likely to use bicycle facilities on roadways where interaction with higher vehicle volumes and speeds are likely. The primary characteristics of a bicycle boulevard are:

- low motor vehicle volumes
- low motor vehicle speeds
- logical, direct, and continuous routes that are well marked and signed
- convenient access routes to desired destinations (typically parallel routes to higher speed, higher volume arterial or collector streets)

- minimal bicyclist delay
- comfortable and safe crossings for cyclists at intersections

There are several resources available that provide a thorough introduction to the fundamentals of bicycle boulevards, addressing the planning, design, and maintenance of these facilities. These resources include:

Fundamentals of Bicycle Boulevard Planning and Design, Portland State University and Alta Planning+Design, 2009.

Bicycle Boulevard Design Tools and Guidelines, City of Berkeley, 2000.

Traffic Calming State of the Practice, ITE, 1999, <http://www.ite.org/traffic/tcdevices.asp>

Traffic Calming: Roadway Design to Reduce Traffic Speeds and Volumes, Victoria Transport Policy Institute, updated 12/26/11, <http://www.vtpi.org/tm/tm4.htm>

Because these resources provide a good background on bicycle boulevards, this section will not focus on the fundamentals of bicycle boulevards, but rather, on key steps in the planning process, how bicycle boulevards might work in the Aurora context, and the specific design considerations that are most applicable to Aurora.

Bicycle Boulevards in Aurora

Bicycle boulevards have the potential to play an important role in Aurora’s bicycle network. Aurora has an extensive trail network that many people use forming the backbone of Aurora’s bicycle network. A primary objective of this Master Plan is to extend that network by supplementing trails via an on-street bicycling network. The types of riders that are attracted to trails will feel comfortable using bicycle boulevards that are properly designed.

There are several areas in the city where it is possible to connect trails by way of a bicycle boulevard, which could significantly expand the reach of the trail system. Additionally, there are numerous high volume, high speed arterial roadways in Aurora where on-street bicycle facilities are not feasible due to right-of-way or funding constraints. Developing bicycle boulevard facilities parallel to these streets may be an ideal solution for expanding the bicycle network into these areas of the city.

Bicycle boulevards have the potential to provide a high return on investment because they tend to attract a wide range of bicyclists and can address additional neighborhood goals such as traffic calming, green streets, stormwater management, etc that other bicycle facility improvements do not provide. The cost of construction will vary depending on the specific traffic calming and intersection treatments implemented.

Bicycle Boulevard Design Considerations

There are a number of design considerations that should be made before implementing a bicycle boulevard, including how best to manage the speed and volume of motor vehicles and establish bicycle priority, how to minimize impacts to nearby residential streets, how to maintain reasonable access for

emergency and service vehicles, how to guide bicyclists along the route and get them safely across arterial streets. Streets with existing low volumes (less than 1000 ADT) are good bicycle boulevard candidates as they typically require minimal or no traffic diversion treatments. These streets may only require traffic calming measures to get speeds down to 20-25 MPH and increase the comfort and safety of bicyclists. Where traffic volumes exceed 1000 ADT, traffic reduction measures should be considered where reasonable alternative routes exist for motorists in addition to traffic calming measures. Lastly, creating arterial street crossings that are accessible, safe, comfortable, and provide quality level of service are essential to a successful bicycle boulevard route.



Prominent Markings Can Brand the Boulevard and Provide Wayfinding

Recommended Bicycle Boulevards

The Master Plan recommends approximately 20 miles of bicycle boulevards. Recommended bicycle boulevard corridors include the following major routes:

13th Ave – this corridor provides a continuous east-west route that connects Denver and residential areas in northwest Aurora to the planned 13th Ave light rail station, provides a connection under I-225, and connects to the High Line Canal Trail, ultimately providing access to the Sports Park. This route fills a missing trail link providing an alternative to Colfax Avenue while also providing direct access to eight schools.

Uvalda/Wheeling/Vaughn/Zion/ Xanadu (Potomac Bypass) – this bicycle boulevard provides a north-south route parallel to I-225 and an alternative to S Potomac St. It connects medical offices on S Wheeling Way to the Fitzsimons campus and offers several jumping off points to access future light rail stations, including a new pedestrian/bicycle crossing of I-225 at E Florida Ave.

Fulton/Geneva/Dayton (Havana Bypass) - this corridor provides a north-south route through the middle of old Aurora, connecting schools, and neighborhoods between 1st Avenue and the Denver Stapleton development.

Dawson/Pheasant Run/Wagon Trail/Chenango (Smoky Hill Bypass) – this bicycle boulevard provides an east-west route on the north side and parallel to Smoky Hill Rd and connects the Cherry Creek Spillway Trail to the East Tollgate Trail that crosses E Chenango Dr in Arapahoe County. It would also facilitate bicycle travel through the southern portion of the city and tie into numerous other recommended bicycle facilities.

Pitkin/Richfield/Telluride/Rifle (Buckley Bypass) – this bicycle boulevard provides a north-south route on the east side and parallel to Buckley Ave and would improve bicycle travel from the southern portion of

city to the north. It also provides an alternative to the Toll Gate Creek Trail on the west side of the creek while providing connections to the Toll Gate Creek Trail at numerous locations.

Bicycle Priority/Advantage

Design elements that prioritize travel on the bicycle boulevard are intended to raise awareness of the route as a bicycle priority thoroughfare and create conditions that reduce unnecessary delay for cyclists. Design treatments include pavement markings and wayfinding signage, adjustments to stop/yield control, and arterial crossing enhancements.

Employing distinctive symbols and/or colors to distinguish the bicycle boulevard from other roadway signs provides visual cues to motorists and cyclists that this is a different type of roadway. Supplementing wayfinding signage with pavement markings helps to further establish bicycle priority, and also encourages proper positioning by bicyclists while sharing the lane with motor vehicles. Unique bicycle boulevard pavement markings such as “bike dots” or extra large “bike blvd” lettering with bike symbol may be developed. Shared lane markings are being used more commonly in places like Portland and Seattle.









Example of Flipped Stop Sign With Custom Sign Branding the Boulevard

Because stop signs increase cycling time and energy expenditure due to frequent starting and stopping, they tend to result in non-compliance by cyclists. Bicyclists should be able to travel continuously for the entire length of the bicycle boulevard with a minimum of stops. Assigning stop or yield signs to control cross traffic is one way to minimize stops for bicyclists. Mini traffic circles may be an alternative to stop and yield controlled intersections. Parking may need to be removed near the intersection to improve sight distance of bicyclists and motorists approaching the intersection. After stop or yield signs are reoriented to cross streets to provide bicycle priority, an increase in motor vehicle volume or speed along the route may occur – this should be mitigated using traffic calming treatments.

Traffic Calming Strategies on Local Streets and Collectors




There are numerous traffic calming treatments that may be integrated into a bicycle boulevard. Brief definitions are provided below for treatments which are likely to create the highest quality Bicycle Boulevards in Aurora – for more detailed information on each treatment, or to review additional treatments please refer to the resources cited below. NOTE: By means of an interdepartmental team involving members from Planning, Traffic Engineering, Traffic Operations, Fire/Life Safety, and PROS, the city should revisit the existing traffic calming policy to better address Bicycle Boulevard implementation.

<ul style="list-style-type: none">• Mini traffic circles at 4-way intersections— raised circular islands located in the center of intersections of local streets, intended to reduce speed of vehicles approaching the intersection while minimizing delay. Stop and yield signs may be eliminated when mini traffic circles are used. Signage indicating counter-clockwise circulation should be installed in advance and/or on the traffic circle.	
<ul style="list-style-type: none">• Mini traffic circles with Neckdowns at T-Intersection. T-intersections require the use of smaller circles, limited parking restrictions within the circle, and approach neckdowns to deflect the movement across the top of the tee which otherwise could not be deflected by the circle.	
<ul style="list-style-type: none">• Chicanes – raised curb features in the middle of the road (pedestrian refuge) or along the edge (chokers or curb extensions) that create horizontal shifting of travel lanes, which reduces vehicles speeds. Chicanes are typically used on long stretches of straight roadway and are ideal for approaches to signalized intersections where motorists may be inclined to accelerate towards the signal. A “chicaning” effect may also be achieved by alternating the location of on-street parking (on one side of the street) from one block to the next.	

<ul style="list-style-type: none"> • Speed tables or raised crosswalk - long and broad, flat-topped sections of raised roadway (3-4 inches high and 22 feet wide) that slow traffic by requiring motorists to reduce their speed. Speed tables are more comfortable than speed humps for bicyclists to ride over without reducing their speed. A 22 foot table has a motor vehicle design speed of 25 miles per hour. 	
<ul style="list-style-type: none"> • Speed cushions – Similar in design to speed humps, speed cushions are rounded raised areas placed in the center of travel lanes to reduce vehicle speeds. They are generally 10 to 14 feet long (in the direction of travel) with. These are designed to allow free passage of larger chassis vehicles such as fire trucks through the flattened area. 	
<ul style="list-style-type: none"> • Speed humps – Speed humps are rounded raised areas placed across the roadway to reduce vehicle speeds. They are generally 10 to 14 feet long (in the direction of travel). • Speed humps with raised islands are an effective combination on streets with low parking demand. 	

Traffic Reduction Strategies

Traffic reduction design elements are intended to maintain existing low volumes or reduce the overall volume of motor vehicle through trips on the bicycle boulevard, while allowing continuous through travel by bicyclists and other non-motorized users. Impacts on nearby local streets and emergency response should be analyzed before implementing traffic reduction elements.

<ul style="list-style-type: none"> • Partial Diverters - restrict motor vehicle access while allowing bicycle and pedestrian access, typically restricting through movements or left turns. This type of treatment is typically placed on minor streets at an intersection with an arterial street to manage motor vehicle volumes on the minor street. 	
<ul style="list-style-type: none"> • Diagonal Diverters – restrict through motor vehicle access completely at standard 4-way intersections while allowing bicycle and pedestrian access. This type of treatment is typically placed on minor streets at an intersection with an arterial street to manage motor vehicle volumes on the minor street. 	
<ul style="list-style-type: none"> • Median Closures – restrict through motor vehicle access completely at standard 4-way intersections while allowing bicycle and pedestrian access requiring right in and right out motor vehicle movements. This type of treatment is typically placed on minor streets at an intersection with an arterial street to manage motor vehicle volumes on the minor street. This treatment can be used to facilitate bikes crossing the arterial or transitioning from the arterial to the bike boulevard. 	

The above traffic calming and traffic reduction design elements have been in use in several communities for many years. However, concerns regarding traffic calming and reduction that occur on the bicycle boulevard are likely to be similar to concerns that are raised when these improvements are implemented anywhere else in the community. Most commonly, residents and officials will raise concerns about four potential issues related to traffic reduction and calming:

- Access to property;
- Impact on traffic patterns;
- Enforcement issues with motorcycles and mopeds; and

- Emergency response.

These are all legitimate concerns that need to be addressed, and can be addressed through a combination of good design and enforcement, if needed. It is important to keep in mind that eliminating or modifying traffic diversion and calming design elements that are part of a larger system may reduce their effectiveness. Poorly designed traffic diversion and calming elements on so-called bicycle boulevards may backfire creating new traffic problems, such as attracting through motor-vehicle traffic to a bicycle boulevard with fewer stops. This reduces the comfort and safety of cyclists, may negatively impact the neighborhood, and negatively influences opinions regarding the utility of bicycle boulevards in general.

To address each of these concerns it is important to involve stakeholders early. For residents living along a planned bicycle boulevard street, and concerned about accessing their property, presenting the design so that they can see how their access is affected is an important first step. Trial installations of design elements can alleviate resident concerns regarding access by allowing them to “try out” design features and allow any necessary modifications to be made before the city commits to a permanent installation. It is also very important during the initiation and conceptual planning phases to highlight the positive attributes of bicycle boulevards and the benefits residents can expect, including fewer cars on their street, fewer speeders, less noise, and generally, a more livable street.

When motor vehicle traffic is restricted or calmed on the bicycle boulevard it may induce an increase in motor vehicle traffic on adjacent streets. It is important to examine the impacts of traffic calming diversion elements both on the proposed bicycle boulevard and nearby streets, and include mitigation (e.g., additional traffic calming on adjacent streets) for any impact in their designs. Again, trial installations can allow residents to “try out” the design features and allow the city to evaluate and address impacts on traffic patterns.

Where traffic diversion is used, enforcing restrictions to motorcycles and mopeds may be needed. However, experiences in other communities have shown such violations to be seldom-it is likely that motorcyclists, like motorists, prefer to use the higher speed parallel streets when they are available nearby.

Traffic-calming elements can be a concern to fire and police personnel if the design substantially increases response times to properties along the bicycle boulevard. Having the support of the fire and police department is critical-without it development of a bicycle boulevard may be delayed or permanently deferred. Emergency services need to be engaged early in the planning process in order to identify acceptable design elements. Traffic reduction and calming design elements may be designed in such a way that allows a wide-chassis vehicle, such as a fire truck, to pass over, while preventing a similar movement of most passenger vehicles. Again, trial installations of street closures, medians, chicanes, or other design elements that may present an access concern to emergency services may be used to evaluate impacts on emergency responses.

B.10 Bike Parking

The *Association of Pedestrian and Bicycle Professionals (APBP) Bicycle Parking Guidelines, 2nd Edition* covers virtually everything related to bicycle parking, including recommended racks, site layout, security, aesthetics, weather protection, lighting maintenance etc. Model legislation for determining required parking for new developments is also provided.

The APBP guidelines are applicable in both urban and suburban contexts. The only significant difference will be scale. The number of bicycle parking racks needed at a particular location may be less in suburban and semi-rural areas. This difference in demand will immediately be captured if parking requirements are based on density and distance (addressed in APBP Guidelines). Lower densities and longer distances from population centers will generally result in lower demand for bicycle parking.

B.11 Bicycle and Transit Integration

The Regional Transportation District (RTD), like many transit agencies across the country, provides bicycle parking at transit stations. Bicycle parking is attractive for several reasons, including the following:

- Promotes transit ridership
- Is relatively cheap to install
- Can be installed on an as-needed basis when demand increases (assuming there is space)
- Can accommodate several bicycles (passengers) in a relatively small footprint
- Saves the cost of constructing expensive parking garages

Simply providing a few racks and lockers at transit stops, however, is not enough to realize the full potential for accessing transit by bicycle. It requires a thoughtful and purposeful approach that addresses user concerns about security and will attract the maximum number of bicyclists.

The Association of Pedestrian and Bicycle Professionals (APBP) has a comprehensive publication on bicycle parking titled *APBP Bicycle Parking Guidelines, 2nd Edition* that should be adopted by RTD for use at all high ridership transit stations. The manual covers virtually everything related to bicycle parking including recommended rack types, site location and layout, security, aesthetics, weather protection, lighting, maintenance etc.

The City of Aurora and other cities should coordinate with RTD to incorporate into station area planning the parking recommendations for transit stations from the *APBP Bicycle Parking Guidelines*. They call for the following:

- Long-term Bicycle Parking Requirement: Spaces for 5 percent of projected morning peak period daily ridership. Long-term parking racks provides a high level of security and are typically in cages and bicycle rooms as well as lockers located in-doors and out-doors.
- Short-term Bicycle Parking Requirement: Spaces for 1.5 percent of morning peak period daily ridership. Short-term parking usually consists of simple bicycle racks that are convenient and utilitarian but do not provide a high level of security.

When installing bicycle parking at stations, it is desirable to include some excess capacity to accommodate future bicyclists. Some people may decide against riding simply because they feel that there is insufficient available bicycle parking.

Bicycle parking needs should also be considered at heavily used bus stations using the same formula. Separate studies may be required to determine parking needs on a station specific basis.

Not all stations will require this amount (see above) in the short run. If fewer spaces are provided, they should be regularly monitored with more spaces provided as demand increases. In all cases, ground space should be set aside to meet these parking requirements in the future.

The *APBP Bicycle Parking Guidelines* provides very good guidance for installing and managing bicycle lockers. They also point out some of their shortfalls—they can be used for nefarious activities (storage), they may be rented but seldom used, there often is a waiting list for those wanting to rent a locker, renters are generally restricted to one location (unless they rent lockers at multiple stations), and they can be a challenge to administer.

Another approach that is gaining widespread acceptance is to install high capacity bike parking facilities. While there are different designs, they are essentially free-standing, unattended, see-through buildings that require a key card or similar device to enter. Once inside, personal locks secure bikes to traditional racks. This approach has several advantages:

- Transit passes (monthly or yearly) can be used to access the buildings thus avoiding the need to issue individual keys.
- The transparency of the buildings allows for easy surveillance.
- Anyone with a transit pass can use any facility—they are not limited to renting a single locker at just one facility.
- There are generally fewer moving parts, which makes them easier to maintain.

RTD could either manage the high capacity bike parking facilities or contract with a vendor. An additional fee could be added to the cost of the monthly/yearly/daily passes to cover some of the operating costs. However, the amount of this fee should be balanced against the potential to deter cyclists from riding to transit stations. For example, the City of Portland has been experiencing relatively low bike parking utilization rates and the fee amount was determined to be a contributing factor.

Recommended Criteria for Implementing Bicycle Facility Improvements at and to Transit Stations:

RTD should consider installing appropriate bicycle parking at new stations and in conjunction with major retrofitting of existing stations. Space for future bicycle parking should be included in station designs from the onset of a project, regardless of how many bicycle parking spots are installed.

RTD should also prioritize existing stations to determine which stations should be targeted for enhanced bicycle parking. This should be done in conjunction with local jurisdictions so that Bicycle Network improvements providing bicycle access to the stations can be completed at the same time. To accomplish this, RTD and the local jurisdiction will need to agree on mutually acceptable criteria for

setting priorities. A good way to start is by counting the number of bicycles currently parking at each station (count bicycles at racks and elsewhere at the stations). However, this information should be used with care since it may be misleading in situations where there are no facilities leading to the stations from adjacent neighborhoods (i.e. lack of bicycles does not always mean lack of demand). Another good approach is to develop a prioritization map for the city or region that uses a variety of factors to determine where there will likely be demand for bicycle facilities. This still leaves the need to prioritize stations that should be targeted for access and parking improvements. RTD and local jurisdictions are encouraged to adopt the following criteria:

- **Density:** Higher density neighborhoods generally have higher numbers of people that live within bicycling distance of a transit station.
- **Ridership:** Stations with the highest morning peak period daily ridership have more people who will potentially bicycle.
- **Distance from centers:** Stations closest to a downtown or neighborhood commercial area are likely to attract more bicycling while stations further out will tend to serve a different, more automobile-oriented clientele.
- **Proximity to Bicycle Facilities:** Stations close to multi-use trails and future on-road bicycle facilities will likely experience higher levels of passengers accessing the station by bicycle.
- **Other Transit Connections:** The level of connectivity to other transit services (other trains, buses) at the station indicates the station's ability to serve a wide-ranging area.
- **Origin vs. Destination:** Some stations are at the origin of a journey while others are at the destination or end of a journey. Stations that serve both functions are often good candidates for capturing bicycle trips.

B.12 Maintenance

Maintaining bicycle facilities is important to bicycle safety. As vulnerable users, bicyclists are subject to additional discomfort when maintenance is not performed on dedicated bicycle facilities. Providing well maintained facilities can generate more interest and comfort in bicycling. Public Works and Parks and Open Space Departments, as well as CDOT perform much of the roadway and trail maintenance in Aurora. The maintenance quality of roadways and trails in Aurora is high. As the bicycle network is expanded, protocols for bicycle facility maintenance should be developed. In many cases these protocols can be incorporated into existing maintenance protocols. Written maintenance protocols that are budgeted and funded are required in order to maintain a safe bicycle network. Bicycle facilities that were installed prior to development of this Plan should be assessed to determine if they require maintenance or upgrading based on their condition and according to updated standards and guidelines from AASHTO and MUTCD. Responsible entities should refer to this Plan to determine if existing facilities have any design deficiencies that should be addressed to improve safety and to ensure consistency with facilities that will be installed as part of the recommended bicycle network. For ongoing maintenance needs, establish a system for routine evaluation of bicycle facility maintenance needs, as well as a system for citizen reporting.

- Where inductive loops have been installed for bicycle detection, they should be periodically tested to ensure that bicycles can be detected.
- Bicycle lanes and key roadways in the bicycle network that experience a large amount of debris should be given consideration for higher frequency sweeping. If adjacent travel lanes are swept mechanically, sweepers should reach as close to the curb as possible and make sure material is not deposited in the bicycle lanes. Perform spot sweeping if sand is left in bike lanes after a snow or ice event.
- Repave bicycle facilities as part of street repaving projects. Consider repaving streets with bicycle facilities more often and include bicycle facilities as a factor in determining the city repaving schedule.
- Aurora has a detailed snow removal plan which includes removal of snow from important regional trails. The plan should be updated to identify priority, on-street bicycle routes that serve as both connections between important regional trails and important on-street connections to employment centers such as Fitzsimons. When streets with bike lanes are plowed, snow should be removed from the bike lane as well as motor vehicle travel lanes.
- Replace missing or damaged warning, regulatory or wayfinding signs. Replace signs based on manufacturer recommendations related to reflectivity and readability (15-20 years).
- Replace faded or damaged pavement markings. Conduct annual replacement program to replace bicycle pavement markings based on a regular basis as needed. Replace bicycle pavement markings when roadways are repaved.

Appendix C: E Montview Blvd Corridor Safety Improvements Memo

Purpose and Need

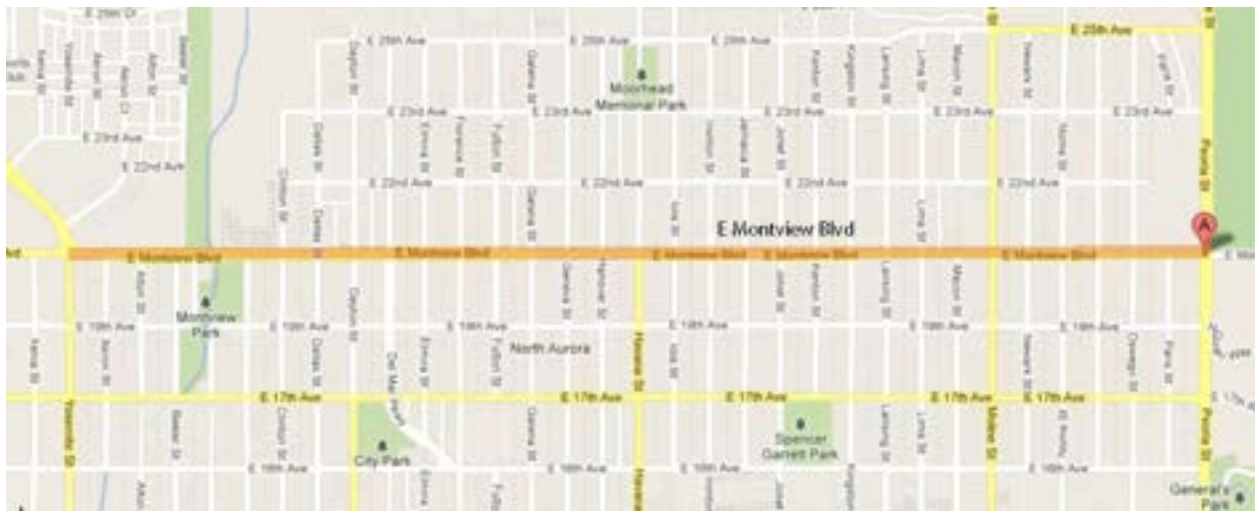
The intent of this memo is to analyze E Montview Blvd between Yosemite St and Peoria St to determine the feasibility of implementing a three-lane cross section or other rechannelization options in an effort to improve the safety and accessibility of the corridor for all roadway users including pedestrians, motor vehicles, freight, transit and bicycles. This memo contains analysis on existing conditions along the corridor including traffic volumes, transit use, parking utilization, roadway channelization and intersection elements. Recommendations on potential improvements to the roadway follow the existing conditions analysis below.

Existing Conditions

Roadway Context

Montview is an important arterial connector between Denver, the Stapleton area, and the Fitzsimons Campus. It serves as a gateway into the city of Aurora and a main activity corridor for adjacent residential neighborhoods. It also provides access to the Westerly Creek Trail and proposed Montview stop on the Regional Transit District (RTD), I-225 Rail Line. The 31-block segment of E Montview Blvd between Yosemite St and Peoria St is largely residential on both sides of the street with a mix of multi- and single-family homes and small business districts. There are two small(1-2 block) business districts at Nome St and at Galena St, and a larger (6-block) business district between Clinton St and Del Mar Parkway. Many of the homes directly adjacent to E Montview Blvd front on side streets. Block lengths are fairly uniform throughout the corridor, and are in the range of 330 to 340 feet. Every block contains alleyways that provide access to parking areas and driveways for residences along E Montview Blvd. The majority of alleyways run perpendicular to E Montview Blvd. On blocks where houses front E Montview Blvd there are alleyways behind these houses, running parallel to E Montview Blvd. There are three schools and one church along the corridor.

E Montview Blvd is currently the most northern east/west arterial serving as a through route between



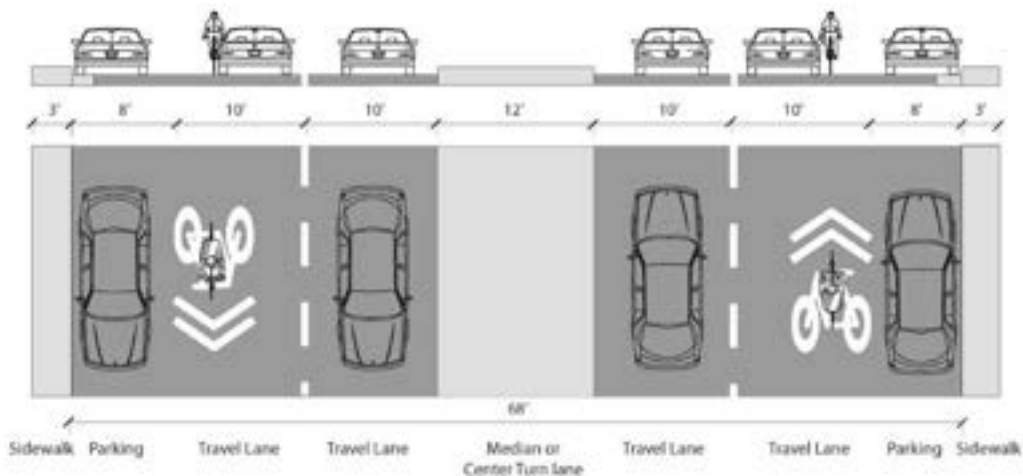
Aurora and Denver. There are a number of significant roadway capacity projects under construction or in the planning stage that will impact the traffic levels on Montview Boulevard. These include

- the construction of the MLK extension between N Havana St and N Peoria Street,
- the completion of Central Park Boulevard/I-70 interchange,
- 17th Avenue interchange,
- Aurora street connections into Stapleton,
- commuter rail service to the soon-to-be constructed Smith-Peoria station,
- Colfax Ave/I-225 interchange improvements, and
- future light rail service to the Anschutz Medical Campus & Colorado Science & Technology Park

While all of these improvements will likely lessen traffic pressures on E Montview Blvd, the construction phase of some of the projects will also temporarily increase demand on Montview until their improvements have been completed. For this reason, no immediate action is recommended for Montview Boulevard. However, the recommendations contained in this appendix will serve as a guide to developing future design recommendations for implementing bicycle and pedestrian improvements to Montview Boulevard.

Roadway Condition

E Montview Blvd is an arterial roadway with a posted speed limit of 35 miles per hour. The roadway is 67 - 68 feet wide for the majority of the corridor between Yosemite St and Peoria St. There are two travel lanes in each direction with a two-way center turn lane. The outside eastbound and westbound lanes have shared lane markings installed 11 feet from the curb. Between Yosemite St and Galena St there is a median with left-turn pockets for each cross street. The median serves to physically separate opposing lanes of vehicle traffic. In some places there are what appear to be midblock cut-through walkways in the median for pedestrians, but only one of these locations (between Fulton St and Florence St) is a marked crosswalk location. At intersections the median narrows to two feet to provide a left-turn pocket – this width is not adequate to provide a crossing refuge for pedestrians.



E Montview Blvd Existing Cross Section

Parking is permitted on most of the corridor in the wide curbside lane. The parking lane is not striped. Parking restrictions are in effect at bus stops, intersection approaches and at fire hydrants. On the north side of the street there are parking restrictions at Montview Elementary School for school bus parking 7AM to 4PM on school days, and for emergency snow removal in front of North Middle School and at Montview Plaza. There is a one-hour parking zone in front of 11741 E Montview Blvd, which is a multi-family apartment complex.

A parking study of the corridor was conducted on the 31 blocks between Yosemite St and Peoria St in late September and early October of 2011. The study investigated the on-street and off-street parking available to each residence and business on the corridor. The study looked at parking immediately on E Montview Blvd as well as side streets, alleyways and off-street parking availability in driveways, garages and surface parking lots. Parking on E Montview Blvd was assessed at three different times: on a weekday evening, mid-day on a weekday and on a weekend evening. The study found that all residences and businesses have parking available on and off site (other than E Montview Blvd) and as a result, 94% of the parking spaces on E Montview Blvd are not used. The following table shows the result of the parking study conducted on E Montview Blvd:

Table C.1: Parking Study Summary

Study Times	North Side of Street		South Side of Street	
	# of cars parked	# of vacant spaces	# of cars parked	# of vacant spaces
Tuesday Sept 27,2011: 7-8pm	5	207	3	233
Wednesday Sept 28, 2011: 11am-12pm	5	207	3	233
Saturday Oct 1, 2011: 8-9pm	3	209	5	231
Parking Spots available/not used	6%	94%	5%	95%

Motorized Traffic Conditions

Traffic volumes on E Montview Blvd between Yosemite St and Peoria St vary. According to a September, 2009 count, the intersection of E Montview Blvd and Havana Street (about half way between Yosemite St and Peoria St) has an ADT of 18,701 motor vehicles. Traffic volumes will continue to vary as regional improvements are completed.

Table C.2: Average Daily Traffic

	Date	Direction	AM Peak	PM Peak	Average Daily Traffic (ADT)
E Montview Blvd east side of intersection at Havana St	Sept 2011	Westbound	535	973	8,114
E Montview Blvd east	Sept	Westbound	904	1093	10,587

side of intersection at Yosemite St	2011				
TOTAL			1,439	2,066	18,701

There are seven fully signalized intersections on the corridor at: Yosemite St, Clinton St, Dayton St, Havana St, Moline St, Oswego St and Peoria St. There is one mid-block pedestrian crosswalk signal between the intersections of Florence St and Fulton St. The spacing between signals is not uniform; the following chart shows the distance between signals:

Table C.3: Signal Spacing

Signalized intersections	Gap between signals
Yosemite St & Clinton St	5 blocks (approx. 1,675 ft)
Clinton St & Dayton St	2 blocks (approx. 670 ft)
Dayton St & Havana St	8 blocks (approx. 2,680 ft)
Havana St & Moline St	10 blocks (approx. 3350 ft)
Moline St & Oswego St	4 blocks (approx. 1,340 ft)
Oswego St & Peoria St	2 blocks (approx. 670 ft)

All non-signalized cross streets are stop controlled.

Two transit routes - 20 and 105— service 24 bus stops on the corridor. Bus stops are spaced approximately every two blocks. The route 20 bus is an east/west cross Denver route that provides service between Denver West and the Fitzsimons Campus (through downtown Denver). On E Montview Blvd, it services the street between Yosemite St and Peoria St. At peak hours there are 4 buses per hour at 15 minute intervals. The route 105 bus travels north/south between the Stapleton Park-n-Ride in Denver to the north and the Denver Tech Center in Centennial to the south. It travels on E Montview Blvd between Central Park Blvd and Havana St. At peak hour there are 4 buses per hour at 15 minute intervals, thus between Central Park Blvd and Havana St there are 8 buses per hour servicing transit stops in both directions. The following chart summarizes bus ridership per day at each pair of bus stops between Peoria St and Yosemite St:

Bus Route	Bus Stop	Total Average Daily Passenger Load/Unload	Existing Crossing Treatment of Intersection Closest to Bus Stop
20	Montview & Peoria	118	Signalized intersection
20	Montview & Oakland	75	Unsignalized, no crossing treatment
20	Montview & Moline	45	Signalized intersection
20	Montview & Kingston	30	Unsignalized, no crossing treatment

20	Montview & Jamaica	31	Unsignalized, no crossing treatment
105 & 20	Montview & Havana	156	Signalized intersection
105 & 20	Montview & Galena	127	Unsignalized, no crossing treatment
105 & 20	Montview & Florence	123	Pedestrian signal intersection
105 & 20	Montview & Dayton	231	Signalized intersection
105 & 20	Montview & Clinton	201	Signalized intersection
105 & 20	Montview & Beeler	138	Unsignalized, no crossing treatment
105 & 20	Montview & Yosemite/Central Park Blvd	133	Signalized intersection
TOTAL AVERAGE DAILY RIDERSHIP		1408	

Pedestrian, Bicycle and Bus Stop Conditions

Conditions for Pedestrians

The provision and conditions of sidewalks along the corridor is sporadic. Some blocks do not have sidewalks; other blocks have substandard sidewalks that are three feet wide with a rolled curb. In other locations, sidewalks and planting strip buffers are present. In other locations, the sidewalk jogs around pull-in parking in front of commercial uses.

Wheel chair ramps are present at most intersections though most do not meet current design guidelines for ADA compliant ramps. Many do not have truncated domes and others have lips (bumps) that exceed ¼ inch. Most corners only have a single ramp installed at the center of the curb radius or parallel to E Montview Blvd. Current ADA guidelines recommend two directional ramps wherever possible. At some intersections, the concrete of the sidewalk extends through the intersection.

All signalized intersections have high visibility crosswalks and pedestrian signal heads. Most pedestrian signal indicators are push button activated. Most approaches of signalized intersections and stop controlled side streets do not have advanced stop bars installed.

There are several schools located along the corridor. School crossing signs have been installed in advance of and at the signalized pedestrian crossings at Moline St, Oswego St and Peoria St. The mid-block pedestrian crosswalk signal between Florence St and Fulton St is also marked with school crossing signs and advanced stop bars are installed in advance of this mid-block crossing.

Conditions for Bicycles

Shared lane markings were recently installed along the corridor between Yosemite St and Peoria St. E Montview Blvd to the west of Yosemite St (in Denver) narrows from five lanes plus parking to three-lanes with bike lanes (no parking), one travel lane in each direction and a two-way left turn lane.

Conditions at Bus Stops

Signs demarcate bus stops and most of the stops have benches. Some of the benches are less than three feet from the face of the curb and do not have adequate sidewalk leading up to them. These conditions, along with curb ramps located on curb radii, likely make access to bus stops by the mobility impaired challenging and unsafe.



Sidewalks accessing bus stops are narrow, providing little room for waiting passengers and passing pedestrians

Field Observations

Yosemite St to Chester Street:

On the four-block section of roadway between Yosemite St and Chester St there is a mix of single and multi-family housing along the south side of the street. The William Roberts School, an elementary school, is on the north side of the street. Adjacent to the school there is a planting strip and sidewalk with no intersecting driveways or roadways. There is one vacant commercial building on the north side of the street on the east side of the William Roberts School. On the south side of the street bus stop benches have been placed within three feet of the curb with no additional buffer from the edge of the roadway. All cross streets have left turn pocket access. The only marked crosswalk location is at Clinton St.

Observations

- There is no on-street parking utilized on this section of the corridor. Parking is available on cross streets.
- Left turn pockets at unsignalized intersections create challenging and unsafe crossing conditions for pedestrians. Pedestrians were observed crossing at unmarked locations, having to navigate through left turn lanes in addition to four lanes of traffic.
- Removing parking in this segment may be feasible given low on-street parking utilization on Montview and amount of off-street parking that is significantly underutilized.

Chester St to Dayton St:

The three-block section between Chester St and Dayton St is a business district. The adjacent property use is mostly retail and commercial with the Montview Plaza and other retail on the north side of the street and vacant and occupied retail on the south side of the street. All of the businesses on both sides of the street have surface parking lots. There are signalized intersections at Dallas St and Dayton St. Both



Many pedestrians were observed crossing the street at both signalized and unmarked mid-block locations

intersections have high visibility crosswalks. There are bus stops at both Clinton and Dayton streets, which have the highest transit ridership on the corridor. In spring 2011, an average of 430 people accessed transit at these stops each day. Due to the available parking at vacant retailer parking lots, there may be “hide and ride” transit users using these stops. This could account for the high number of transit users at this location.

Observations

- Left turn pockets at unsignalized intersections create challenging and unsafe crossing conditions for pedestrians. Pedestrians were observed crossing at unmarked locations, having to navigate through left turn lanes in addition to four lanes of traffic.
- Removing parking in this segment may be feasible given low on-street parking utilization on Montview and amount of off-street parking that is significantly underutilized.



Mid-block crosswalk and pedestrian signal with pedestrian crossing warning signs

Dayton St to Fulton St:

This four-block stretch of Montview primarily consists of multi-family housing, some single-family housing and intermittent retail. The roadway characteristics are the same as other stretches of the corridor with two travel lanes in each direction a central median with left turn pockets and narrow, substandard sidewalks. N Florence St and N Fulton St there is a mid-block crosswalk with a pedestrian activated signal. Pedestrians accessing bus stops at Florence St can use the signal. The majority of multi-family units have adequate off-street parking primarily accessed by adjacent alleys. In addition, on-street parking is available for residents on Florence St.

Observations

- Left turn pockets at unsignalized intersections create challenging and unsafe crossing conditions for pedestrians. Pedestrians were observed crossing at unmarked locations, having to navigate through left turn lanes in addition to four lanes of traffic.
- Removing parking in this segment may be feasible given low on-street parking utilization on Montview and availability of off-street parking, as well as on-street parking on side streets.

Fulton St to Havana St:

This four block section of Montview transitions from multi-family with retail to the west to single-family homes at Galena St. The median also ends at Galena St and transitions into a two-way left turn lane. The only signal on these blocks is at Havana, which has high visibility crosswalks and crosswalk signals. There is a bus stop at Havana St. All homes and businesses along this section have access to off-street or side street parking.

Observations

- The nearest marked crosswalk to bus stop located near Galena St (on south side) is 550 feet to the west.
- Removing parking in this segment may be feasible given low on-street parking utilization on Montview and availability of off-street parking, as well as on-street parking on side streets.

Havana St to Moline St:

This 10-block segment of E Montview Blvd is uniform in character. There are two travel lanes in each direction, a two way left turn lane and substandard sidewalks. This section of the corridor is largely single family homes except on the north side of the block between Lima St and Moline St where the Options School and Montview Elementary School are located.

Macon St on the north side of Montview has been vacated for the school property, creating a long block between Lima St and Moline St. There is school bus parking on E Montview Blvd from 7AM to 4PM school days along the frontage of Montview Elementary. Both schools have off-street and side street parking.

There are signals at the intersections of Havana St and Moline St. Both intersections have high visibility crosswalks and pedestrian crosswalk signals. Moline is designated as a school crossing which is signed on the approaches to the intersection.

There are bus stops at Jamaica St and Kingston St both of which are un-signalized intersections. These stops are within a 10-block segment with no signalized crossing locations.

All residences on this stretch of E Montview Blvd have access to alleyways, side streets or driveways and garages for off-site and off-street parking. On the north side of Montview between N Jamaica St and N Kenton St there are eight houses with frontages on E Montview Blvd. These houses all have a paved back alley that runs parallel to E Montview Blvd. Each house has off-street parking. On-street parking on adjacent side streets is also available. Additionally, houses on the north side of Montview in the two-block section between N Kingston St and N Lima St also have back alley access with off-street and side street parking access. All homes on this two-block section have driveways.

Observations

- This 10 block stretch of E Montview Blvd has four bus stops and no signalized crossing locations.
- Intersections near bus stops should be assessed for pedestrian crossing improvements.
- Removing parking in this segment may be feasible given low on-street parking utilization on Montview and availability of off-street parking, as well as on-street parking on side streets.

Moline St to Oswego St:

Residential and commercial lots front this four-block section of East E Montview Blvd, between Moline St and Oswego St. The street cross-section continues as two travel lanes in each direction with a painted two-way left turn lane and substandard sidewalks.

There is a one and a half block stretch of commercial properties between Newark St and Oakland St. The businesses include the Original Aurora Liquor Store, My Life Tattoos, Montview Bar & Grill, and several

other services and restaurants. The businesses all have off-street parking. Based on three parking studies performed on both weekdays and a weekend, the two blocks between Moline and Nome St (both north and south sides) contain the most consistent use of on-street parking spaces by approximately eight motor vehicles. On the south side of the street at Montview Bar & Grill, there is pull-in parking that requires pedestrians to walk around the parking that encroaches on the narrow sidewalk.

Between Moline St and Oswego St, most residences front on side streets with the exception of the north block of Montview between Oakland St and Oswego St. Parking for all residential lots is available on



A pedestrian on crutches approaches uneven sidewalk surface and the pull-in parking near Moline St

both side streets, and driveways or off-street parking areas accessed via an alley. All four blocks have alleys that are either parallel or perpendicular to E Montview Blvd.

There are bus stops on Montview to the west of Oakland St. Both cross streets adjacent to the bus stops: Oakland St and Nome St do not have additional crossing improvements for pedestrians.

There are signals at Moline St and Oswego St. each has high visibility crosswalks and pedestrian crosswalk signals. The signal at Oswego St is a

school crosswalk.

Observations

- Removing parking in this segment may be feasible given low on-street parking utilization on Montview and availability of off-street parking, as well as on-street parking on side streets.
- Intersections near bus stops should be assessed for pedestrian crossing improvements.

Oswego St to Peoria St:

This is a two-block stretch of E Montview Blvd with North Middle School on the entire north frontage and residential lots on the south side of the street. Paris St is a T intersection on the south side of E Montview Blvd and does not continue to the north due to the school grounds.

The intersection of Peoria St has high visibility crosswalks, pedestrian crosswalk signals and is a school crossing that is marked with signs at the east and west crossings. On the western leg of the intersection, E Montview Blvd has a designated right turn lane, a through/ left turn lane and a designated left turn lane. There are two receiving lanes for westbound traffic.

The Route 20 bus stops at far side bus stops east and west of Peoria St. The Route 121 bus stops to the north and east of the intersection.

Observations

- Removing parking in this segment may be feasible given low on-street parking utilization on Montview and availability of off-street parking, as well as on-street parking on side streets.
- Additional striped space demarcating EB right turn lane could be better utilized.

Alternatives Analysis

Given existing and projected vehicle volumes and existing roadway capacity, as well as the low utilization of on-street parking throughout the corridor, there are several options for retrofitting E Montview Blvd. These options are discussed below. Options 2 and 3 entail a road diet, i.e. reducing the number of travel lanes from two in each direction to one. E Montview Blvd is a good candidate for a road diet based on existing roadway capacity, current and projected traffic volumes, relatively high transit ridership, the necessity to get transit riders and other pedestrians across the street safely, and the key role it can play in the bicycle network, connecting Denver/Stapleton to the Anschutz Medical Campus & Colorado Science & Technology Park. Implementation of road diets provides opportunities to install treatments such as sidewalk and sidewalk buffers, curb extensions, crossing islands, etc. that have been shown to be effective at reducing pedestrian crashes.

Vehicle Capacity

Traffic volumes along E Montview Blvd are low enough for motor vehicles to be accommodated in one travel lane in each direction. Typically, one lane in each direction with a center turn lane can accommodate up to 25,000 vehicles per day. Montview currently has approximately 17,400 vehicles per day¹, substantially lower volumes than the threshold. Future projections of the corridor traffic volumes predict that the average daily traffic will decrease from current vehicle volumes to 16,000 for the year 2035². This projected decrease in vehicle volumes further supports reducing the number of travel lanes in this corridor to better serve other transportation modes. The Fitzsimons Area Multi-modal Transportation Study provides details on the modeling assumptions used to determine future vehicle volumes. Among the factors considered are the MLK extension connecting N Havana St to Fitzsimons Pkwy, Colfax Ave interchange improvements, transit systems coming on line, including the commuter rail line connecting Denver to DIA (with a stop at Smith-Peoria directly north of the Fitzsimons Campus, and I-225 corridor light rail extension (with a planned stop within the Fitzsimons Campus).

Safety Benefits

With a reduction in vehicle travel lanes come safety benefits to both motor vehicle drivers and other roadway users. According to a Federal Highways Administration study, road diets reduced all roadway crashes by 29 percent. There is also high transit use along the corridor and people accessing transit are typically going to cross the roadway once a day to access either the bus stop or their residence. Transit riders and other pedestrians currently walk on narrow sidewalks with no buffer between the sidewalk and moving traffic. In addition, there are several long stretches of roadway of 8 and 10 blocks where there are no signalized locations for pedestrians to safely cross the street. People must cross five lanes of traffic to get to and from bus stops. Reducing the number of travel lanes makes uncontrolled

¹ Based on City of Aurora 2008 Traffic Count Volume Map

² Fitzsimons Area Multi-Modal Transportation Study.

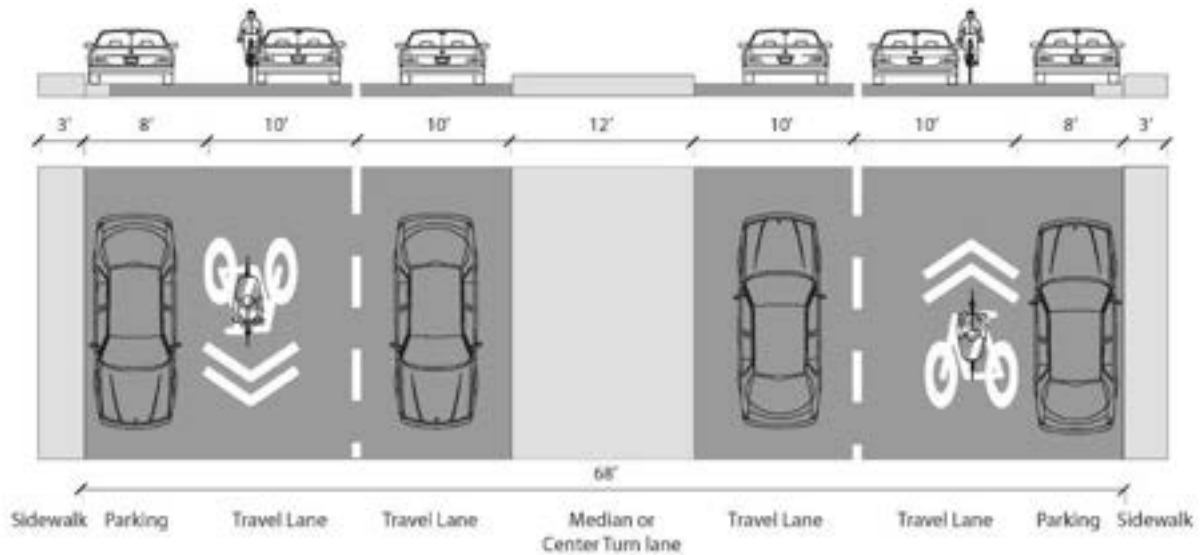
intersections easier to cross for pedestrians not only because it reduces the overall distance pedestrians must cross, but it also eliminates the double threat scenario where one lane of traffic will stop for a pedestrian and the other lane of traffic will not. Crosswalks can often be installed at unsignalized locations when there is one travel lane in each direction. The safety of unsignalized marked crosswalk locations can be greatly enhanced when other treatments such as crossing islands and warning signals are used.

The above mentioned benefits associated with road diets would greatly improve safety of all roadway users, and thus improve the livability of the neighborhood, which could result in economic development benefits. Road diets can provide opportunities to enhance aesthetics by providing additional space for streetscape improvements such as pedestrian-scale lighting, street trees, and other pedestrian amenities. All of these elements, which would likely be implemented in the long-term, would improve the attractiveness of the area for both businesses and residents.

The existing roadway width permits several different roadway configurations that would safely accommodate more modes of travel along the corridor. Three options are discussed below:

Option 1: No Action

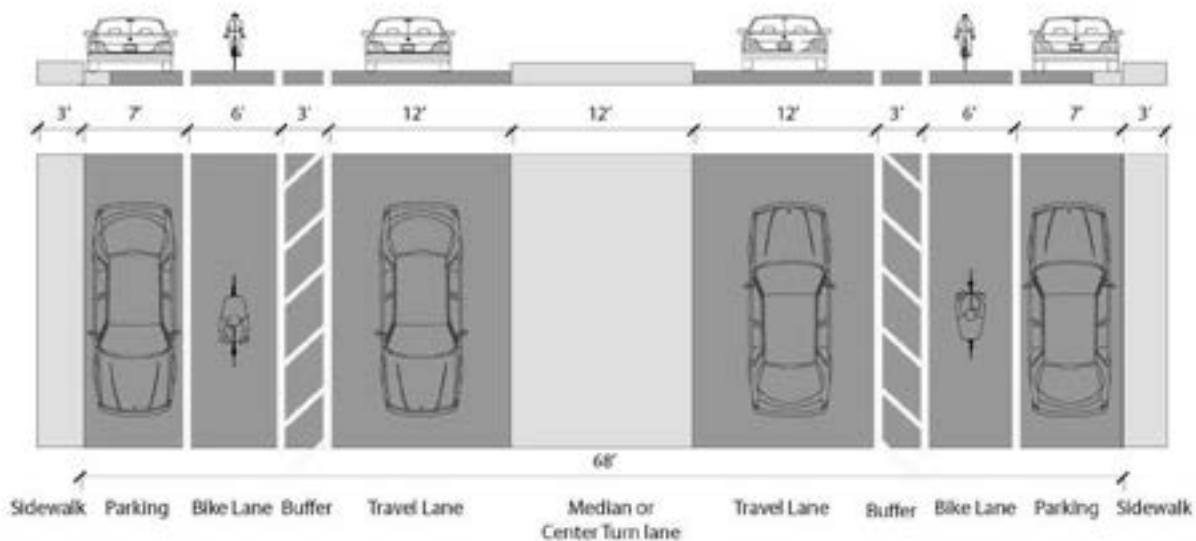
The No Action alternative would maintain the roadway as is with two vehicle travel lanes in each direction and an unstriped parking lane on both sides of the roadway. The center median and left-turn pockets would remain. Pedestrian crossing enhancements would be limited to signalized intersections. The shared lane markings recently installed by the city would remain. A low-cost variation that may improve the function of the shared lane markings and the on-street parking would be to stripe the parking lane. This would better define the parking lane, which could result in higher on-street parking utilization. It would also provide better definition to where the bicyclist is expected in the roadway.



Option 1 Cross Section

Option 2: 5- to 3-lane Road Diet, Maintain On-Street Parking, Add Buffered Bike Lane

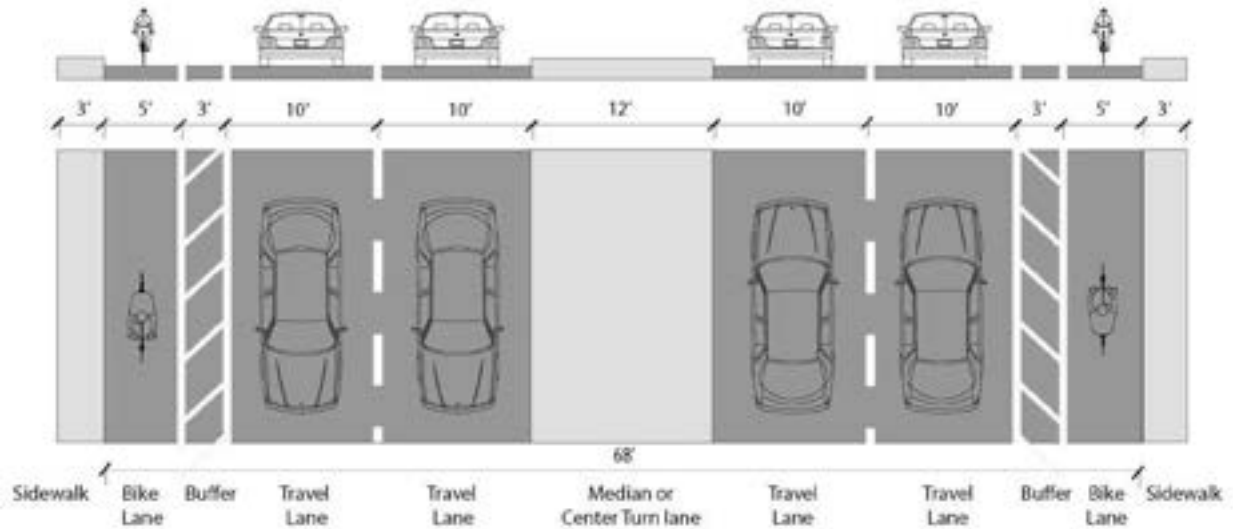
The recommended cross section provides seven feet of parking with a parking line stripe, a six-foot bike lane, a three-foot buffer between the bicycle lane and the travel lane and a 12-foot travel lane. The two-way left turn lane and median would remain 12 feet wide. Although the existing parking lane on E Montview Blvd is not heavily used, providing parking with a parking stripe may formalize parking and encourage more on-street parking that will provide a buffer for pedestrians using the narrow sidewalk. A six-foot bike lane and three foot buffer provides bicyclists with a comfortable travel-way outside of the door zone of parked cars. In addition, a buffer provides additional space between the bicyclist and moving traffic. A 12-foot travel lane provides ample width for all vehicles including freight and transit.



Option 2 Cross Section

Option 3: Maintain Travel Lanes, Remove Parking, Add Buffered Bike Lane

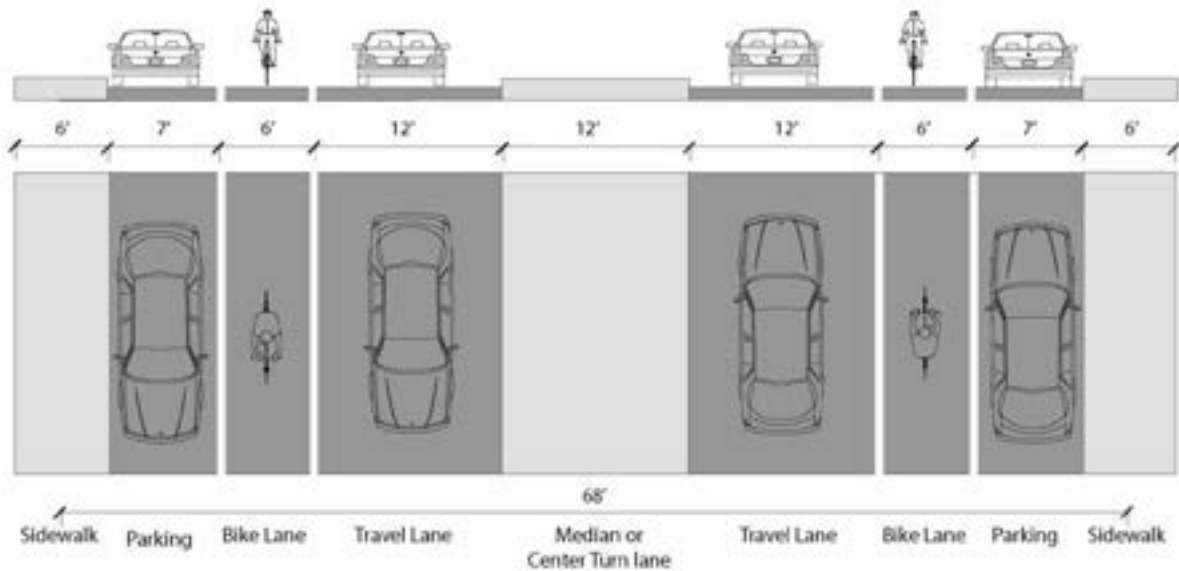
Option 3 would maintain two travel lanes in each direction, but remove parking along the entire length of E Montview Blvd except the few short segments where parking is actually being utilized, e.g. the two block segment between Moline and Nome St where there are some commercial businesses, and between Lima St and Moline St (north side) where there is school bus parking between 7 am and 4 pm. Shared lane markings could be maintained through these segments while a 5 to 6 ft bike lane with a 2 to 3 ft painted buffer could be installed along the rest of the corridor. This level of parking removal seems achievable based on the parking study that was conducted for this analysis. While this option would greatly enhance safety and comfort for bicyclists traveling the corridor, it would not do much to address pedestrian safety and comfort other than providing a buffered bike lane, which would also act as a sidewalk buffer. This option would preclude the installation of pedestrian safety treatments such as curb extensions and marked crosswalks at unsignalized locations.



Option 3 Cross Section

Option 4: 5-to 3-lane Road Diet, Maintain Parking, Widen Sidewalk, Add Bike Lane

Option 4 is a long-term solution to address pedestrian needs on E Montview Blvd. The sidewalks on E Montview Blvd are substandard. To better accommodate pedestrian travel along the roadway between cross streets, transit stops, businesses and schools, the sidewalks on E Montview Blvd should be widened. In this option, the sidewalk is widened from three feet to six feet and the three-foot wide buffer between the bike lane and travel lane is removed. In some locations such as bus stops and business districts there are already wide sidewalks and some locations have planted buffers from the roadway, which greatly improve the pedestrian environment. In addition, parking and bicycle lanes increase the distance between pedestrian and moving motor vehicle traffic.



Option 4 Cross Section

Additional recommendations

Strategies for Roadway Safety Improvements

Traffic Calming/Pedestrian Crossing Improvements

Building curb extensions or bulbs allows for better visibility of pedestrians at intersections and reduces the distance they have to travel to cross the street, lessening their exposure time to traffic. Bulbs can also visually narrow the roadway for motor vehicles, providing a traffic calming effect. Curb bulbs also provide space for curb ramp construction in confined rights of way. Curb bulbs should be considered at intersections where there are long gaps between signalized crossing locations such as along the sections of E Montview Blvd between Dayton St & Havana St and Havana St & Moline St. Spacing curb bulbs at two to three block intervals would provide narrower pedestrian crossings with frequency along the long gaps between signalized intersections. For example, between the gap in signalized crossing locations between Havana St and Moline St, curb bulbs could be installed at Jamaica St, Kingston St (at the existing bus stops) and at Lima St. For the portion of roadway between Dayton St and Havana St curb bulbs could be installed at Galena St in the business district. Curb bulbs also help to define the bicycle lane at intersections by the presence of a curb line.



Example of how a road diet provides opportunities to install curb bulbs at crossing locations.

Modify Left Turn Pockets onto Residential Streets

The current configuration of the median provides designated vehicle turn pockets onto every residential cross street. To improve pedestrian crossings at residential streets, and reduce the number of conflicts associated with left turning vehicles along the corridor, consider modifying the median at some locations to restrict left turns and provide pedestrian refuges. The current raised median width at intersections is two feet. The median could be widened to the full width of the median/turn lane to create pedestrian median refuges, and left turns could be restricted at these locations.

Install Stop Bars

Install advanced stop bars at all signalized intersections on the corridor and at all stop signs on cross streets. While advanced stop bars are not part of the city's standard practice, they should be considered as part of an overall strategy to heighten motorist awareness along this multi-modal corridor where there are a high number of pedestrians present. Advanced stop bars have been shown to be effective at providing guidance for motorists on where to stop so as not to encroach on pedestrian crossings. Many of pedestrian crossings of local side streets are unmarked. Advanced stop bars would help to better define the legal crossing area allow pedestrians an unobstructed crossing.

Conclusion

E Montview Blvd is a key corridor connecting Denver/Stapleton to the Anschutz Medical Campus & Colorado Science & Technology Park, and serves as a gateway into the city of Aurora. It currently accommodates fairly high pedestrian volumes associated with high levels of transit use, schools and businesses, a significant number of cyclists, and approximately 17,400 motor vehicles per weekday. Given the vehicle capacity that the existing five lane section (2 EB and 2 WB travel lanes, center turn lane/median) provides, and the poor pedestrian conditions along the corridor, E Montview Blvd is a good candidate for road diet, i.e. lane reduction.

Option 2, as described above, is the recommended near-term solution for the corridor. It would provide the following benefits:

- 1) Greatly enhance pedestrian safety along the corridor, including reducing crossing distances, providing opportunities to install treatments such as curb bulbs at intersections, and crossing islands,
- 2) Allow for the installation of a high quality bicycle facility (a buffered bike lane) that would provide continuity to the bike lane facility installed by the City of Denver west of Yosemite St. A buffered bike lane would likely attract high ridership and raise the profile of Montview Blvd as a destination and the city as a bike-friendly place,
- 3) Accommodate both existing and projected vehicle volumes.
- 4) Improve vehicle safety by having a traffic calming effect and reducing rear-end crashes and side swipes associated with lane changes.
- 5) Provide an opportunity to greatly enhance the aesthetic quality of the roadway through integration of additional landscaping in curb bulbs and medians, which could serve as a catalyst for other improvements along the corridor, and provide economic development and neighborhood livability benefits.
- 6) While providing all these benefits Option 2 could serve as a relatively low-cost interim step to partial or whole reconstruction of the roadway (Option 4), which should include widening of existing substandard sidewalks to a minimum six foot width, or wider where there are transit stops or other uses generating higher pedestrian volumes.

Appendix D: Wayfinding Protocol and Best Practices

This appendix provides guidance for establishing a comprehensive bicycle wayfinding system, as well as best practices for pedestrian wayfinding.

Introduction

Wayfinding signs provide information about destinations, direction and distance to help bicyclists determine the best routes to take to major destinations. Signs provide on-the-ground information that helps bicyclists understand and use the bicycle street and trail network without the use of a map. Directional signs also provide additional messaging to motorists to expect bicycles on the roadway. The presence of signs encourages bicycling on designated corridors because users feel the signs will direct them to the best route for getting to their destination.

The city of Aurora Bicycle Facility Design Guidelines (guidelines) provide guidance on directional sign type and placement, however they require updating. This document recommends changes to the guidelines for sign design and placement based on best practices and updated national guidelines in the current Manual on Uniform Traffic Control Devices (MUTCD).

History and Current Practice

The Bicycle Facility Design Guidelines provide information for City of Aurora Public Works Department, Parks, Recreation & Open Space Department and Planning & Development Services Department staff in the implementation of signed bicycle routes. The guidelines include:

- Criteria for selecting streets for signs
- Sign types and uses
- Placement criteria

Route Selection Criteria

The city's current guidelines provide criteria for route selection. Route selection is currently based on:

- Route connectivity to other bicycle routes and important destinations
- Streets with a low number of signalized or stop controlled intersections
- Streets with controlled arterial street crossings



Existing bike route sign in Aurora

Sign Types and Uses

The directional sign types recommended in the Aurora Bicycle Facility Design Guidelines are 2003 MUTCD signs. The following list outlines the existing sign types and uses:

Bike Route Signs D11-1:

- Place D11-1 signs along designated but un-named bike routes
- Use with D1, M4 and M6 series signs for direction information, intersecting bike routes, guidance to destinations.

Bike Route Signs M1-8:

- Place the M1-8 on routes with names
- Use with D1, M4 and M6 series signs for direction information, intersecting bike routes, guidance to destinations.

Directional and Supplemental Signs D1, M4 and M6:

- Use in conjunction with D11-1 and M1-8 signs when needed for changes in route direction or guidance to destinations.

These guidelines provide general guidance on the use of the recommended sign family. Implementation per the guidelines has not been uniform or complete. Implementation is limited to the installation of D11-1 sign with the text "BIKE ROUTE" and the occasional use of directional arrows in the M6 series. More detailed guidelines for sign type use and sign assembly composition will help to create a more cohesive sign network. For example, the use of the D1 series sign requires additional guidance because the signs include distance information that changes from location to location. The 2009 MUTCD, provides additional updates to sign type and use which allow for a reduction in sign assembly size and increase in sign assembly legibility.

Existing Sign Placement Criteria

The current guidelines provide general information on sign placement along high and low volume streets. They also outline general guidance for sign placement at bike route intersections, decision point and intervals between decision points. Lateral and vertical placement guidelines are not discussed. The following outlines the sign placement criteria:

D11 and M1 signs (both could be accompanied by D1, M4, and M6 auxiliary signs)

1. High volume or arterial streets
 - Place signs every $\frac{1}{4}$ mile after arterial and collector street intersections, intersections with community facilities or signalized intersections
2. Low volume streets
 - Place signs every $\frac{1}{2}$ mile after collector and arterial street intersections
3. All Streets (in addition to the guidance above)
 - Place at the intersection of bicycle routes with D1, M4 and M6 signs
 - Place at decision points where the bicycle route changes direction
 - Use as route confirmation following D1, M4, M6 guidance
 - With D1, M4 and M6 signs at intervals to provide information on major destinations and distances.

Policy and Regulatory Framework

City of Aurora 2009 Comprehensive Plan

The City of Aurora Comprehensive plan identifies the need to improve existing wayfinding signage. “Existing signage on a variety of pedestrian and bike facilities needs to be enhanced. Maps and related information on bicycle and pedestrian trails need to be readily available to users” (Page 10).

City of Aurora Bicycle Facility Design Guidelines

The existing bicycle sign guidelines outline a set of general guidelines that require an update due to changes in the national guidelines.

Colorado Department of Transportation (CDOT)

The CDOT sign design standards provide guidance on sign components and design such as reflectivity and font. However, the document does not include relevant text and sign sizes for bicycle signs. Additional guidance for bicycle specific sign size is included in the MUTCD.

Manual on Uniform Traffic Control Devices (MUTCD) Guidelines

The Manual on Uniform Traffic Control Devices (MUTCD 2009 edition) includes standards for:

- Sign design for directional bicycle signs.
- Sign installation such as minimum height of signs above ground and horizontal placement from edge of the roadway or trail.
- Symbols and appropriate abbreviations for destination names.

The most recent update to the MUTCD in 2009 introduces new sign types and provides additional right-of-way placement guidelines for directional signs.

American Association of State Highway and Transportation Officials (AASHTO) Guide for the Planning, Design and Operation of Bicycle Facilities

The AASHTO Guide provides supplemental information to the MUTCD. The guide explains the use and benefits of different sign types for bicycle wayfinding.

Best Practices

Chicago

The city of Chicago has implemented an extensive directional sign system for bicycles using destination-based signage for the on-street bicycle network. The D11-1c and D1-1c series signs were developed by the city of Chicago in an effort to consolidate the amount of signage required by the 2003 MUTCD for bicycle wayfinding using the D11-1, D1-1 and supplemental signs. The D11-1c provides specific destination information, such as “To Evanston” in lieu of the general “BIKE ROUTE” text of the D11-1 sign. This is helpful in distinguishing different routes in a dense bicycle route network. The D11-1c is used by the City of Chicago as a confirmation sign to confirm a route selection to be placed on the far side of an intersection after a route choice had been made. The D1-1c consolidates direction, destination and distance information onto one small sign. Several D1-1c signs can be installed together at the approach to a decision point to provide information on multiple routes. The D11-1c and the D1-1c were developed by the City of Chicago and later incorporated into the 2009 edition of the MUTCD.



2003 MUTCD guidelines for directional bicycle signs. Right: Chicago developed the D1-1c sign to consolidate direction, destination and distance information onto one sign.

Seattle

The city of Seattle also has a directional sign system for bicycles. Modeled after the Chicago system, the Seattle system also uses the D11-1c and D1-1c series of signs. Because Seattle has an extensive off street trail system, additional signs were required to distinguish named routes. The M1-8 series of signs are used in Seattle to mark named routes. These signs are installed along named routes with supplementary signs from the M2, M3, M4, M5 and M6 series. M1 signs are also installed at decision points on trails with D1-1c or D11-1c signs (see figure).



Decision signs preceding an intersecting signed bike route in Chicago.

Many of Seattle’s trails are named. In order to include the colloquial route name on the M1-8a sign, adjustments were made to the sign. The route number was replaced with route name within the main body of the sign. The space at the top of the sign was used



Decision and named route signs from Seattle. On trails, both signs types are used to mark the route and provide direction to destinations on and off the trail.

for a logo. This complete sign system helps bicyclists get to destinations throughout the city and provides guidance to and along named bicycle routes.

Sign Types

Bicycle route signs are signs that guide bicyclists along preferred, designated routes to destinations throughout the city and region. Bicycle routes may consist of on-street facilities and off-street trails.

The bicycle route sign system is designed for bicyclists who are familiar with the city's landmarks and districts, but unfamiliar with the preferred route to their intended destination(s). The sign system will provide bicyclists with direction, destination and distance information, along established bicycle routes. To assist the bicyclist, the system will provide three general kinds of guidance:

1. **Decision and Spot Decision Signs (D1):** at decision points where two or more routes intersect or where guidance is required
2. **Named Route Signs (M1):** along designated named routes
3. **Route Designation or Confirmation Signs (D11):** to confirm a route choice and provide guidance at a turn in a route

The Aurora Bicycle Network may consist of two general categories of signed routes:

- Named Routes:
 - Cross town routes (An example might be Moline St, or the 13th Ave Bicycle Boulevard)
 - Trails
 - Recreational Loops (example might include loops that combine trail segments with on-street segments)
- Un-named Network Routes:
 - Routes between destinations such as transit, schools, business districts, major employment centers, or major trail access points

The two route types will work in unison to provide bicyclists with a navigable system along designated bicycle routes.

Decision Signs (D1-1c series)

Decision signs mark decision points where two or more bicycle routes intersect. Decision signs are installed on the approach to an intersection. Signs include direction, destination and distance (in miles) information.



D1-1c

2009 MUTCD Figure 9B-4

Sign Placement in the Right-of-Way: Place 30+ feet on the approach to a decision point or intersection of another signed bicycle route. To allow for comfortable left turns place the decision sign at the appropriate distance from the intersection based on the number of lanes that a bicyclists must merge across:

- No merge: 30 feet
- One lane merge: 100 feet
- Two lane merge: 200 feet

Provide enough distance between the sign and the intersection to allow for comfortable merging across travel lanes.

Sign Specs: 36"X6", white on green and retro-reflective.

Sign placement on post: Directional sign organization at a given decision point will be based on the following guidelines:

1. Install D1-1c signs on the approach to intersections where signed routes intersect and where routes lead directly to the intended destination. The bicycle route system can connect business districts, schools, parks, neighborhoods and other important locations that are directly on designated routes.
2. The number of destinations provided on a given post is not to exceed three. This allows for proper vertical clearance to be maintained. Three signs per post is also about the maximum amount of information that can be read by a passing bicyclist.
3. The number of signs on a given post pointing in the same direction is not to exceed two. Limiting destinations to two in one direction is necessary to provide space for destinations in other directions, because this sign type will be installed at intersecting routes.
4. The sign with the nearest destination should go at the top of the assembly with the most distant destination at the bottom. If destinations are equal in distance, the sign with an up arrow should be placed on top. This arrangement allows for the nearest destination to "fall off" the top of the sign and subsequent destinations to move-up as the bicyclists approaches.
5. When directional blades are placed on named routes or they direct users directly to named routes, named route signs (M1-8a and supplementary signs) may be placed on the same sign post below the D1-1c sign(s). Placing multiple sign types on one post will reduce the number of posts used as well as provide all necessary information for bicyclists in one location.



Sign Content: Destination and directional information will be unique on most signs. Determining destinations is important to the function of the network. Distance information will be determined by the spacing of decision points and destination locations.

1. Identify and Rank Destinations:
 - Develop a list of all destinations and rank them in a hierarchy. For example:
 - Primary: trails, business districts, neighborhoods, regional parks
 - Secondary: Institutions, transit stations, other municipalities
 - Tertiary Destinations: other public institutions/facilities, airport, designated bicycle streets
 - The ranking will help determine the sign content at a given decision point within the network.
2. Provide distance measurements in tenth of a mile increments such as 4.3, 1.2. This allows for detailed destination information in denser urban areas. If mileage on a sign is a whole number, do not include the tenth mile placeholder. For example use “4” rather than “4.0”
3. If a bike route terminates at a location where there is no destination use the name of the street or bike route as the destination.

Directional Spot Signs (D1-1b series)

Spot signs are similar to directional signs but provide direction and destination information only. Use D1-1b signs when a destination is off the signed route or when getting to the route requires additional wayfinding. Spot signs may include the words “To” and “Via” where necessary and may vary in width to accommodate limited space in the right of way. Spot signs do not need to be followed by a confirmation sign.

Spot signs may be used where:

1. Guidance to signed bicycle routes from adjacent roadways, side paths etc. or access to important facilities such as a trail is needed.
2. Guidance from signed bicycle routes when important destinations are a short distance off the signed route. In such cases, a directional sign may indicate the best access point from the signed route to the destination. Use additional spot signs to guide bicyclists to that destination.



2009 MUTCD Figure 9B-4



Spot sign along bicycle route in Seattle.

Named Route Signs (M1-8 series)



2009 MUTCD Figure 9B-4

Install M1-8 or M1-8a signs along named regional on-road routes and trails to assist users in wayfinding along named routes or to confirm that the user is on the desired route. Use M1-8 or M1-8a with supplementary signs such as directional arrows (M5 and M6 series) and the words “North”, “South”, “East”, “West”, “To”, “End”, “Begin”, etc. (M3, M4 series). The M1-8 series of signs are small in size and are a cost effective way to mark bicycle routes. There are pros and cons to the use of route numbers or route names. If a route already has a colloquial name, use the colloquial name and not an arbitrary number to avoid confusion. Route names are encouraged because they can often provide additional contextual information such as destination information i.e. Smith Street Bike Route will likely follow Smith Street and Smith Street passes by X, Y and Z locations. Route numbers do not provide this context and require a bicyclist to look at a map to understand where the route goes. In areas where signed bike routes are dense, the use of numbers can be confusing because a bicyclist may have to ride on several numbered routes to get to a destination. Numbered routes can work well for cross jurisdiction travel, on routes that do not already have a colloquial name or on routes with many turns where a colloquial name is not clear. On an M1 sign, route numbers can be more visible than text from a distance.

Sign Specs: Size: 12”X18”, white on green and retro-reflective. The letters on signs should be 2 to 1.5 high for best visibility.

Sign Placement in the Right-of-Way:

On-trail M1-8 or M1-8a signs may be used:

1. At trail entrances and exits
2. 30’-50’ after every controlled intersection or street crossing; or
3. Every ¼ mile to mile where there is a gap in signage. Spacing will depend on the density of the street network
4. At transitional locations (such as trail-to-road transitions) or in cases where bicyclists will be transitioning to sidewalks

On-street M1-8 or M1-8a signs may be placed:

5. 30+ feet before a turn with an M5 or M6 arrow (follow decision sign guidelines for placement at the approach to an



A modified M1-8a sign at the entrance to a multi-use trail. Seattle, Washington.

intersection)

6. 30-60 feet after the turn to confirm the path
7. At decision points where needed
8. Within proximity to a named route (within a few blocks), similar to a spot sign. Named route signs can be used in conjunction with a supplementary sign such as an arrow and "To". When farther than a few blocks off the designated route, decision signs can be used to direct users to named route

Sign placement on post: M1-8 or M1-8a signs can be mounted on the same post, below regulatory, warning or destination signs.

1. M1-8 or M1-8a signs may be placed back-to-back or back-to-back with regulatory or warning signs.
2. When multiple M1-8 or M1-8a signs are placed on the same post, they can be stacked depending on height and visibility. The current route should be the top sign.

Route Designation, Turn and Confirmation Signs (D11-1c series)



D11-1c

2009 MUTCD Figure 9B-4

These signs confirm that a bicyclist is on the correct route. The sign is used in two ways:

1. Route Confirmation Sign: Signs are placed on the far side of an intersection following the directions indicated by decision signs and at intervals along the route to confirm that the bicyclist is still on the correct route.

2. Turn Sign: at turns in a route with an arrow (M5 or M6 series sign).

In this case D11-1c and an arrow sign are placed on the approach to an intersection.

Confirmation signs will include destination information generally with the text "To" the location indicated on the directional sign. When a confirmation sign is used on a named route, an M1-8 or M1-8a sign may be placed below the confirmation sign.

Sign Specs: 24"X18", white on green and retro-reflective.

Sign Placement in Right-of-Way:

Turn Signs:

1. Follow placement guidelines for decision signs.

Confirmation Signs:

2. 30-60 feet on the far side of the intersection after decision points, preferably within sight of the decision sign.
3. 30-60 feet after stop controlled or signalized intersections.
4. Or after every 1/4 mile to mile of unsigned segment along designated on-street routes depending on the density of the street grid.

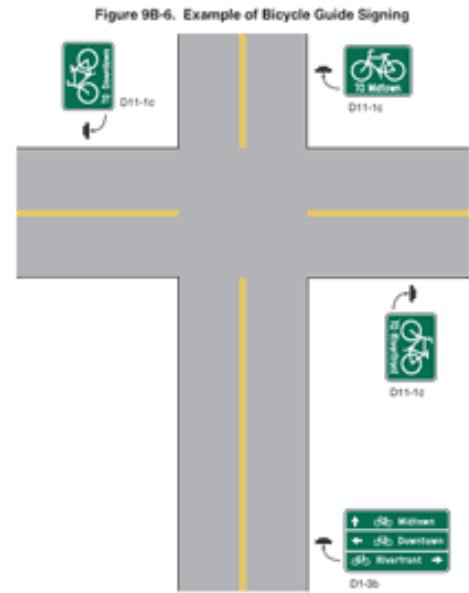


Figure 9B-6 from the 2009 MUTCD provides general lateral placement of D1-1 and D11-1 signs at an intersection.

Sign content:

1. If there are two destinations in one direction, a confirmation sign may include two lines of text. This may require reduction of the bicycle symbol.

Supplemental Signs

Supplemental signs provide additional information to D11-1 or M1 series signs. Cardinal direction signs (M3 series) and alternate route signs (M4 series) are placed above the M1 series. Arrow signs in the M5 and M6 series are placed below D11-1 and M1 signs to provide directional information.



2009 MUTCD Figure 9B-4

Unique Signs

Unique directional signs have been developed for individual trails in the region. The Cherry Creek Basin Signage Guidelines detail signage recommendations for the trail network. The guidelines include directional signs, interpretive signs, mile markers and street signs. Special signposts accompany these signs to create a unified look. The system is designed for both pedestrians and bicyclists.



Examples of directional signs proposed in the Cherry Creek Trail Signage Guidelines



Directional sign examples that would integrate MUTCD signs, the on street network and the color scheme proposed in the Cherry Creek Trail Guidelines

Integration of this regional route sign system with the proposed wayfinding plan is feasible. The use of unique poles with colorful bases and bollards can be installed throughout the trail system to provide trail identification messaging. The signage could be modified to adhere to MUTCD guidelines such as the D1-1 or M1-8 series to provide direction, destination and distance information that is consistent with the on-street network.

General Sign Components

The following guidelines outline general rules for the sign contents:

1. For all signs use upper and lower case letters
2. Use Clearview Series C font. This differs from Colorado Department of Transportation standards and is approved for use by the Federal Highway Administration. It strikes a balance between visibility and maximum characters per sign.
3. Use two-inch high capital letters. This size is visible from approximately 80 feet
4. For destination names that are too long to fit on one line, use intuitive abbreviations
5. Do not use periods in the abbreviations of destination names
6. Avoid the use of diagonal arrows when possible
7. Use graffiti film on bicycle route signs that are lower to the ground, particularly on trails. This will increase the longevity of the signs.

Roadway and Shared-use Trail Placement Guidelines

Guidance on signage placement is important to providing a legible sign system. Predictable and uniform placement of directional signs at traffic controlled intersections and at intervals helps to provide proper guidance particularly if a turn in a route is to occur.

Shared Use Paths

Horizontal, lateral and vertical installation of bicycle signs differs for shared-use trails and roadways. For trails follow lateral and vertical sign placement guidelines in the MUTCD guidelines for signs placed along shared-use trails ([Figure 9B-1](#)):

1. 8 foot minimum vertical clearance
2. 2 foot clearance from edge of trail to edge of sign
3. 4 foot minimum distance between ground and bottom edge of sign

Roadways

For bicyclists, a good baseline distance required to read a sign and determine an action is 30 feet from the intersection. Additional engineering judgment is required when placing directional signs to allow for visibility of the sign with parking and vegetation and other possible obstructions.

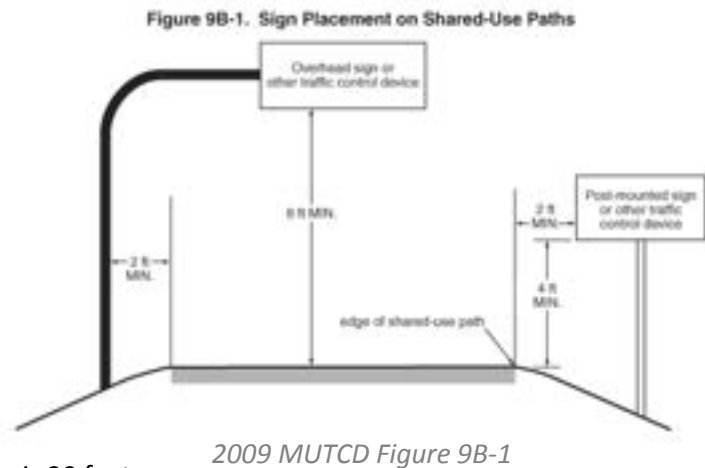
Sign mounting height is also outlined in the MUTCD ([section 2A.18](#)), however, due to speed and sight line differences between bicyclists and motor vehicles, minimum post heights are recommended for bicycle signs.

Mounting height guidance:

1. Sidewalk Clearance: 7 feet of clearance from the bottom of the sign to the ground should be allowed. If there are multiple signs per post, and the lowest sign is lower than 7 feet, the lowest sign cannot stick-out more than 4 inches into the sidewalk. If bicycles use the sidewalk the clearance height should be 8 feet.
2. If there is no sidewalk and few obstructions such as parked cars, optimum vertical height for bicycle signs is 7 feet from the bottom of the sign.

Signing of the Bicycle Network

The Aurora Bicycle and Pedestrian Master Plan recommends a bicycle network that consists of improvements on over 160 miles of roadway. The type and phasing of improvements may vary depending on a number of criteria, including expected user volumes, roadway constraints, vehicle volumes and speeds, feasibility, destinations served, and relative importance in the overall network. Wayfinding is an important component of establishing the network. Wayfinding signs may be used alone, i.e. signed route, or in combination with other treatments such as pavement markings (e.g. bike lanes and shared lane markings). The phasing of signing and other bicycle network improvements do not need to occur at the same time. For example, for some lower speed/lower volume roadways installation of wayfinding signage may proceed the striping of bike lanes, and in this sense could be used as an



interim step toward implementing additional recommended treatments. The network consists of several signed routes that have no pavement markings, and over time, the city may find it makes sense to add additional signed routes to the network. The decision to develop a signed route versus installing a bike lane or shared lane marking may be based on the following criteria:

- Alternate routes parallel, and within close proximity (less than a half mile) to a route with bicycle facilities
- Lower volume streets
- Spur routes, or routes that may span a relatively short distance and terminate at a specific destination or loop back into the main route

Pedestrian Wayfinding: Best Practices

Introduction

Pedestrian wayfinding signage is a low cost solution to overcoming some of the barriers to walking. Pedestrian signage encourages walking with consistent and predictable environmental information that builds confidence in a pedestrian's understanding of their location and route options to important destinations. Good pedestrian signage will help a pedestrian gain a better understanding of the area which in turn strengthens their knowledge of a city, its districts and landmarks. In an effort to increase and promote walking in certain areas; to access transit, for recreation and for orientation in districts, these guidelines will review best practices in pedestrian wayfinding and provide recommendations for the development of a pedestrian wayfinding system in Aurora.

The city has already developed some pedestrian sign elements. Notice signs and trail map kiosk have been developed for some of the trails. These elements are a good starting point to expand a pedestrian wayfinding system.

Objectives:

- Develop pedestrian wayfinding system that encourages walking for access to transit, in business districts and along recreational walking routes.
- Create a unified and consistent system of wayfinding signs that can be installed throughout the City of Aurora. The look, placement and guidance provided by the system should be consistent and legible to most users by utilizing accessible guidelines.
- A sign system with components that are low cost, can be manufactured by the City of Aurora sign shop and can be easily maintained.

Policy and Regulatory Framework

City of Aurora 2009 Comprehensive Plan

The City of Aurora Comprehensive plan identifies the need to improve existing wayfinding signage. "Existing signage on a variety of pedestrian and bike facilities needs to be enhanced. Maps and related information on bicycle and pedestrian trails need to be readily available to users" (Page 10).

Manual on Uniform Traffic Control Devices (MUTCD) Guidelines

The MUTCD does not provide standards for pedestrian wayfinding signs aside from designating pedestrian side paths on shared-use pathways. As a result many municipalities have created unique guidelines for pedestrian wayfinding that suit local standards. The Manual on Uniform Traffic Control Devices (MUTCD 2009 edition) does offer standards for:

- Sign installation such as minimum height of signs above ground and horizontal placement from edge of the roadway or trail.
- Standard icons to use in conjunction with text are provided in the MUTCD

Americans with Disabilities Act (ADA) Guidelines

All pedestrian wayfinding systems must provide guidance for as many system users as feasible. ADA guidelines outline requirements on how to provide accessible graphics in accessible locations. These

requirements include font size and sign placement and necessary contrast between lettering and background and recommendations on tactile surfaces for the visually impaired. Wheelchair accessible routes are required to be demarcated.

Sign system components

Signs and maps:

Finger signs: Finger signs provide information for pedestrians at decision points. Generally, finger signs include direction, destination and distance information. Finger signs are oriented around a central post and point in the direction of travel. Finger signs can help pedestrians determine which way to travel as they proceed to a location through various turns. Finger signs work well in districts with many destinations such as a downtown or business district or at intersections of trails and pathways. Finger signs help pedestrians navigate a network of intersecting pedestrian routes.

Pathway markers: Markers help pedestrians follow a specific pathway. These work well on trails and other popular recreational walking routes where there are few intersecting routes but many turns or jogs in the pathway that require wayfinding guidance. Pathway markers can be fairly small and unobtrusive in the right-of-way because they should be designed for the pedestrian scale.


Map kiosks: Of the various wayfinding devices, maps provide the most information to the user. They can show all possible routes and destinations in a prescribed area and provide a snapshot understanding of the area. Maps can also be spaced fairly far apart and thus do not create as much street clutter as finger blades. Maps generally cover $\frac{1}{4}$ to $\frac{1}{2}$ a mile area and provide a variety of elements relevant to pedestrian travel in the area. Determining the level of detail on maps is crucial to the function of the map for users. Kiosks made of durable materials and designed so that information can be swapped out for updated maps or content will reduce costs by not having to remanufacture the whole sign.

Best Practices

Recreational walking routes:

Designating recreational walking routes is a popular way to promote and encourage walking in a community. Generally, pedestrians enjoy recreational routes that are quiet, have natural scenery and are convenient and safe. These can be on trails, loop routes and along quieter streets. They are generally named routes that can form loops or be linear in nature. Providing guidance along these routes to ensure pedestrians that they are on the correct pathway is important to the comfort and enjoyment of the walking route. The following examples illustrate different methods for guiding pedestrians along recreational walking routes.


Agency	Description	Wayfinding tools
<p>Kirkland Washington</p> <p>Walk Kirkland website: http://www.explorekirkland.com/Do/Recreation/Walking_Kirkland.htm</p>	<p>The city of Kirkland Washington has implemented recreational walking routes throughout the city. Some of the routes have been marked with small 3.5-inch diameter signs with the name of the route and an arrow indicating turns in the route. In addition, the city has developed printable neighborhood walking maps that are available on the city website.</p>	
<p>East Coast Greenway</p> <p>Website: http://www.greenway.org/index.shtml</p>	<p>The East Coast greenway is a walking route network stretching from Maine to Florida that links major metropolitan areas with a combination of simple and effective wayfinding signs and maps. Most segments of the route are available on Google Maps for wayfinding by use of smart phone. The route follows both roadways and trails.</p>	
<p>Seattle Washington</p>	<p>Bollards can also be used to mark pathways. This bollard is installed along a park pathway. Each side of the bollard provides guidance to local destinations and trails. Direction, distance and destination information is included in a low-profile pathway marker.</p>	

<p>Seattle Washington</p> <p>Cheshiahud Lake Union Loop website: http://www.seattle.gov/parks/lakeunionloop/</p>	<p>The Cheshiahud Lake Union Loop is a walking route that follows trails, sidewalks parks and other walking routes around Lake Union in Seattle. The route is defined by finger signs that point out the loop route as well as walkways to adjacent neighborhoods and parks. The signs also tie into the downtown wayfinding system through sign design and color.</p>	
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Districts:

Districts and neighborhoods such as the Aurora City Center that have a network of on-street and separated pathway pedestrian routes, and that cross at intersections require wayfinding that orients pedestrians at decision points. These can include arrival points such as transit stops and parking lots, public spaces and buildings, and other places of interest. The following best practice examples highlight different strategies for pedestrian wayfinding in districts.

The Fitzsimons Area Wide Multi-modal Transportation Study provides background on pedestrian travel patterns in the district. This can be a point of departure for determining routes that pedestrians are currently using as well as identifying important pedestrian generators and destinations.

Agency	Description	Wayfinding tools
<p>Transport of London, England</p> <p>Legible London website: http://www.tfl.gov.uk/microsites/legible-london/default.aspx</p>	<p>The city of London has developed a unified pedestrian wayfinding system that provides guidance within and between neighborhood districts with the use of detailed maps and supplemental destination signs to promote longer pedestrian trips and lessen transit dependency. The system outlines a research-based approach to providing guidance for pedestrians across city districts to not only help them with one trip but to develop a pedestrian’s overall understanding of the city.</p>	

<p>Seattle Washington</p>	<p>These finger signs in Seattle are located at key decision points, (e.g. intersections, plazas) and provide direction and destination information. The signs direct pedestrians to major destinations such as transit stations, shopping districts, museums and public institutions. These signs can work in unison with maps to provide guidance, as pedestrians get closer to major destinations. The sign blades can be manufactured by the city's sign shop and the sign post is city standard issue that has been painted red. The sign assembly is installed by city crews, lowering the cost of the wayfinding system significantly.</p>	
<p>New York, NY</p>	<p>Hudson River Park signage includes maps that show trail users where they are, and some kiosks contain billboards for posting events and other pertinent information.</p>	

Transit Areas:

Providing pedestrian wayfinding within transit stop or station areas helps to facilitate the mode shift from walking to transit and vice versa. The Denver RTD Transit Access Guidelines recommend pedestrian signage only when the facility design itself does not make pedestrian walking routes clear. Thus, wayfinding should supplement transit area planning, and an intact, legible street network to confirm routes on the approach to a station. In addition, providing wayfinding for pedestrians exiting a station is important for orientation to a neighborhood. Pedestrian wayfinding near transit can be integrated with station wayfinding or neighborhood wayfinding if additional guidance is needed. These signage systems are required to follow ADA guidelines for sign placement and legibility. Components of a transit area wayfinding system are:

1. Station identification signs that mark the entrances to stations and that are visible from a distance during the daytime and at night.
2. Route markers that lead pedestrians to and from stations along direct walking routes. Implement route markers when the routes to and from transit are not clear or intuitive. For example, provide route markers to a bridge that must be crossed to access the station.
3. Maps of the neighborhood to help those arriving on transit to get oriented at the exit of the station and walk to nearby destinations within $\frac{1}{4}$ to $\frac{1}{2}$ mile of the station or stop.

The following are best practice examples of transit area wayfinding for pedestrians.

Agency	Description	Wayfinding tools
<p>Denver Regional Transportation District</p>	<p>Integrate design elements from regional transit systems into pedestrian wayfinding. For example, use RTD station identification signs at light rail stations and integrate existing colors into additional pedestrian oriented transit signage.</p>	 
<p>Portland Oregon, TriMet Regional Transit</p> <p>TriMet website: http://trimet.org/index.htm</p>	<p>In Portland transit route signs and maps are incorporated with a station identification sign at a bus and light rail station. This integration of wayfinding elements is more costly but provides several different types of information for different purposes at one location.</p>	

<p>City of Pittsburgh, Pennsylvania Streetscape Components Catalog website: http://www.city.pittsburgh.pa.us/dt/StScpCat.pdf</p>	<p>Pittsburg has developed a wayfinding system that uses the same shape and color pylon for wayfinding, transit or interpretive information. The pylon is 8 feet tall and works as both a transit stop marker and a wayfinding device.</p>	
<p>Washington D.C.</p>	<p>The Metro Rail uses signs to point pedestrians toward rail stations.</p>	

Appendix E: Assessment of Key Off-street Connectors

E 1st Ave to Highline Canal/ S Moline St

A bridge over the Highline Canal would be beneficial for continuity of the 1st Avenue on-street bike facility and improving neighborhood connectivity. Establishing this connection would entail securing public access through non-city-owned parcels and relatively low-cost engineering solutions.

Opportunities and Constraints

The Highline Canal is owned and operated by Denver Water. There are plans for this facility to be turned over to the City of Aurora.

Potential Impacted Owners and Stakeholders

Denver Water

Century Link (Property Owner: Parcel 1973-11-4-02-001)

Lyn Meadows Association (Property Owner: Parcel: 1973-11-1-17-045)

Conceptual solutions

Option 1: \$\$ +/- \$56,000 Utilize the existing access at E. 2nd Avenue and Oswego Street. A well worn path exists at the midpoint of the open space along E. 1st Avenue and leads directly across the Highline Canal to the existing marked access on E. 2nd Avenue. Pedestrians currently cross the Highline Canal when it is dry. The paved path and gravel ditch rider trail are located at the same elevation on the northwest side of the canal reducing the need for and significant grade adjustments. A small bridge could be installed with minimal impact to the Canal. The bicycle route would continue on E. 2nd Ave/E. 4th Way the south on Kenton St. to E. 1st Avenue avoiding the pinch point on E. 1st due to the medians.

This solution would require the installation of a +/-40' pre-engineered pedestrian bridge crossing the Highline Canal and minimal modification to the ditch rider trail and surrounding areas. A total of approximately 200' paved trail would be required. Easements and/or access agreements may be required from both Denver Water and Century Link.

Bridge: \$28,000

Excavation, construction, equipment, and testing: \$20,000

10' concrete trail: \$8,000

Option 2: \$\$\$ +/- \$117,400 Cross the Highline Canal at near the western dead end of E. 1st Avenue with a bridge structure. The ditch rider trail and paved trail run in parallel with a grass slope approximately 3' in height between them. A paved access ramp from the existing path up to the ditch rider trail and to the bridge structure would need to be designed to accommodate the grade change. The route would continue on the Highline Canal Trail to The S. Moline St. Crossing. From there it would head north on S. Moline St. then head west on E. 1st. Avenue toward Havana St.

This solution would require the installation of +/-80' pre engineered pedestrian bridge crossing. The final length would be determined by the angle of approach. Grade modifications would need to be made from the existing paved trail to the current ditch rider trail. A total of approximately 260' paved trail would be required. Easements and/or access agreements may be required from Denver Water.

Bridge: \$65,000

Excavation, construction, equipment, and testing: \$40,000

Grade modifications: \$2,000

10' concrete trail: \$10,400



E.1st Avenue to Highline Canal



Option 1 Crossing



1. S. Moline/Highline



3. E. 1st /Highline Canal



2. Grade Change



4. E. 1st and Highline Canal



Option 2 Crossing

E Yale Ave/ Ventura / W. Toll Gate Creek

An existing 8' wide bridge structure exists over the W. Toll Gate Creek/Detention Pond and is connected to E Yale Avenue and S. Salida Way with 4' paved paths. The change in width is further complicated by chain link fence/railing creating 90 degree angles and constrictive maneuverability issues for bicyclists. The railing/fence is mounted on top of the concrete slab creating an effective width of +/-7'.

Opportunities and Constraints

The existing trail is an Aurora Water facility. Improvements and maintenance agreements would be required between the

City of Aurora and Aurora Water for an improved

trail. **Potential Impacted Owners and**

Stakeholders Aurora Water

Conceptual solutions

Option 1: \$ +/--\$29,200 Utilize the existing 8' wide crossing. This solution would require 4' of widening of the existing 4' concrete trails on both sides of the existing crossing (200' total), an extension of the existing trail to East Yale avenue and two new access ramps to recommended on street facilities on E. Yale Ave./S. Ventura St. and S. Salida Way, and modifications to the placement and attachment of the existing chain link railing/fence. The railing/fence is currently mounted on top of the concrete slab resulting in a less than desirable +/-7' wide path. A railing modification can be designed to accommodate full use of the 8' path for bike and pedestrian traffic without introducing substantial additional load to the structure.

Railing modifications: \$20,000

4' concrete trail widening: \$3,200

10' concrete trail: \$1,000

Access ramps (2) \$5,000

Option 2: \$\$\$ +/--\$122,000: Create a new crossing with a pre-engineered pedestrian bridge. This solution would require the installation of a 60-80' bridge and the paving of 225-275' of new trail and two new access ramps to on street facilities on E. Yale Ave./S. Ventura St. and S. Salida Way. Access to the existing facility could then be restricted to pedestrians only or authorized maintenance personnel with the placement of signage and bollards.

This solution would create a new trail adjacent to the existing structure. This would require the installation of +/- 80' pre engineered pedestrian bridge crossing and construction of 250' of new 10'trail. Access across the existing facility could be restricted for maintenance only.

Bridge: \$65,000

Excavation, construction, equipment, and testing: \$40,000

Grade modifications: \$2,000

10' concrete trail: \$10,000

Access ramps (2) \$5,000



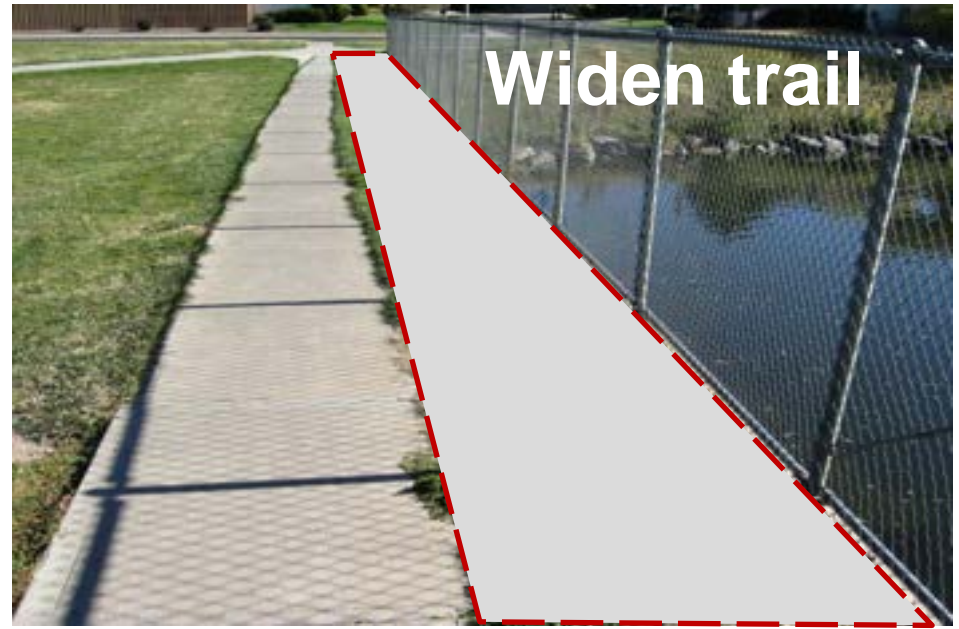
E. Yale Ave/ S. Salida St.



4' trail looking north: Widen to 8'



Transition to bridge crossing: Trail widening and railing modifications needed



4' trail look south: Widen to 8' Some fill required



A railing modification is needed to provide 8' clear on the existing trail crossing

Option 1: Modify Existing Crossing



New bridge crossing and trail can be placed north of the existing structure and connect E. Yale Ave to S. Salida St.



New Crossing would be 10' wide and 60'-80' long

Option 2: New Crossing

Appendix F: Planning Level Cost Estimates and Assumptions

Cost Summary

	Miles	Total Cost
New On-Street Facilities (full build out)		
Bike lanes*	70.26	\$1,833,786.00
Buffered Bike Lanes*	4.15	\$159,318.50
Shared lane markings*	16.55	\$339,275.00
Separated bikeway	3.03	\$2,035,463.10
Widened sidewalk connector	26.12	\$4,725,108.00
Shared use pathway	0.85	\$394,655.00
Bicycle boulevard	19.72	\$1,815,817.60
Paved shoulder	5.11	\$1,349,040.00
Signed bike route	14.05	\$23,885.00
Study**	3.37	TBD
TOTAL	163.21	\$12,676,348.20
Other New Facility Costs		
		Typical Unit Cost
Install Full Traffic Signal		\$200,000.00
Install Pedestrian Crossing Signal		\$90,000.00
Install Pedestrian Crossing Island		\$40,000.00
Upgrade Existing Pedestrian Crossing Signal to Accommodate Bicycles		\$12,000.00
Signs		\$440.00
Bike Racks		\$300.00
Calibrate bicycle detection at traffic signals (on-street facilities)		\$400.00
Maintenance Costs		
	Maintenance Assumptions	Typical Unit Cost Per Mile (10 year period)
Replace Damaged/Missing Signs (on-street facilities)	<i>A general assumption is that approximately 100 signs will need to be replaced each year and that all signs will be replaced 15 to 20 years out.</i>	\$170,000.00
Sweep bicycle lanes and other on-road facilities	<i>Assumes sweeping twice per year and occasional spot sweeping after major rain events. Periodic system-wide sweeping would likely reduce cost per mile.</i>	\$20,000.00
Replace pavement markings (on-road facilities)	<i>Unit costs per mile assume only those markings that would not otherwise be present on the roadway, e.g. bike lane and sharrow symbols, and an additional stripe in each direction in the case of a bicycle lane. Paint markings can typically be expected to last 2 to 3 years with variation depending on whether markings are within the path of vehicle travel or adjacent to parking lane.</i>	
Shared Lane Markings		\$29,700.00
Bicycle Lanes		\$46,530.00
Separated Bikeway (i.e.Cycle Track)		\$8,910.00
* Striping of parking lane is assumed for cost calculation. Cumulative costs for these facilities will likely be lower given that many streets do not have parking lanes.		
** Streets where design solution not immediately apparent. Shared lane markings are assumed for these facilities for the purpose of cost estimating.		
Disclaimer		
<p>These costs are intended to be general and used for long-range planning purposes. The construction estimates do not include costs for planning, surveying, engineering design, right-of-way acquisition, mobilization, maintenance of traffic during construction, landscaping/aesthetics, utility adjustments, lighting, drainage, storm water management, erosion and sediment control, significant grading, bridges, retaining walls, significant changes in vehicular traffic patterns, or contingency costs. Maintenance costs are based on estimates from a variety of sources. Construction costs will vary based on the ultimate project scope (i.e. combination with other projects) and economic conditions at the time of construction.</p>		

Cost Assumptions

	Facility Unit Cost (per mile)	Calculation	Assumptions
On-Street Facilities			
Two lane collector (with parking)			
Add bike lanes	26,100.00	Facility Unit Cost = \$1 per linear foot * 5280 feet * 2 lines * 2 sides + \$165 per bike symbol * 15 bike and arrow per mile * 2 sides	Assumes pavement costs are not specific to the bicycle improvement. Assumes 2 bicycle lane lines and 15 bike and arrow symbols per mile are added on each side of the roadway to create the bicycle lane. \$165 per bike and arrow symbol includes the material (thermoplastic) and installation costs.
Add buffered bike lane	\$38,390.00	Facility Unit Cost = (3 lines*5280*\$1* 2 sides)+(880 LF diagonal lines*2*\$1)+(15 bike and arrow per mile*\$165)	Assumes a 30" diagonal stripe every 15 feet between two continuous parallel lines both sides of street, 15 bike and arrow symbols per mile both sides. \$165 per bike and arrow symbol includes the material (thermoplastic) and installation costs.
Four or Five Lane Arterial (no parking)			
Add bike lanes	20,500.00	Facility Unit Cost = \$1 per linear foot * 5280 feet * 1 line * 2 sides + \$165 per bike and arrow * 15 bike and arrow per mile * 2 sides	Assumes pavement costs are not specific to the bicycle improvement. Assumes 2 bicycle lane lines and 15 bike and arrow symbols per mile are added on each side of the roadway to create the bicycle lane. \$165 per bike and arrow symbol includes the material (thermoplastic) and installation costs.
Add buffered bike lane	\$27,830.00	Facility Unit Cost = (2 lines*5280*\$1* 2 sides)+(880 LF diagonal lines*2*\$1)+(15 bike and arrow per mile*\$165)	Assumes a 30" diagonal stripe every 15 feet between two continuous parallel lines both sides of street, 15 bike and arrow symbols per mile both sides. \$165 per bike and arrow symbol includes the material (thermoplastic) and installation costs.
Shared lane markings			
Add shared lane markings only	9,900.00	Facility Unit Cost = \$165 per shared lane marking * 30 shared lane markings per mile * 2 sides	Assumes 30 shared lane marking symbols per mile are added on each side of the roadway to create the shared lane pavement marking facility. \$165 per bike and arrow symbol includes the material (thermoplastic) and installation costs.
Add shared lane markings and pavement stripe	20,500.00	Facility Unit Cost = \$1 per linear foot*5280 feet*2 lines + \$165 per shared lane marking * 30 shared lane markings per mile * 2 sides	Assumes parking lane lines added to both sides of street and 30 shared lane marking symbols per mile are added on each side of the roadway to create the shared lane pavement marking facility. \$165 per bike and arrow symbol includes the material (thermoplastic) and installation costs.
Separated bikeway			
Separated bikeway (within existing roadway)	\$671,770.00	Facility Unit Cost = 9 bike and arrow symbols per mile*\$165 + Extruded curb: \$190 per 3-foot section*1760	Assumes a one-way separated bikeway both sides of street with 9 bike and arrow symbols per mile and continuous concrete extruded curb. If new signal heads and timing required add 20%. This cost does not take into account breaks in the facility such as at intersections and driveways, and therefore should be considered an overestimate of actual cost per mile.
Separated bikeway (wide roadway)	\$992,585.00	Facility Unit Cost = Earthwork: 4700 CY*\$15+Aggregate base: 2400 CY* \$50 + Asphalt surface course: 600 Tons * \$85 + Asphalt base course: 2400 Tons * \$85 + Curb/gutter: 10560 LF * \$20 + Extruded curb: \$190 per 3-foot section*1760	Assumes earthwork 6 ft wide, 2 ft deep; aggregate base 6 ft wide 1 ft deep; asphalt surface course 6 ft wide, 0.125 depth; asphalt base course 6 ft wide, 0.5 ft deep; curb and gutter moved both sides, 9 bike and arrow symbols per mile, and continuous concrete extruded curb.Total project costs may include the following additional costs as percentage of construction cost: 5% landscaping; 5% Maintenance of traffic; 30% Utility Adjustments. Does not take into account breaks in the facility, e.g. driveways and intersections, and therefore, costs are overestimated.
Widened sidewalk connector			
Widened sidewalk connector	\$180,900.00	Facility Unit Cost = Aggregate base course: 12 ft*5280* 1 ft deep/27*\$50 per unit+ concrete surface: 5 ft * 5280 ft * \$5/SF	Assume widen existing 5 foot sidewalk to 10 feet, one side of street. Total project costs may include the following additional costs as percentage of construction cost: 5% landscaping; 20% Drainage and E&S; 5% Maintenance of traffic; 30% Utility Adjustments. Does not take into account breaks in the facility, e.g. driveways and intersections, and therefore, costs are overestimated.
Shared use pathway			
	\$464,300.00	Facility Unit Cost = earthwork, excavation, grading: 16 ft *5280*2 ft deep/27ft*\$15 per unit + aggregate base course for pavement: 12 ft*5280* 1 ft deep/27*\$50 per unit + asphalt surface course: 12 ft*5280*0.125feet deep /13.3 cubic feet in a ton*\$85 per unit + Asphalt base course: 5 ft*5280*0.5 feet deep/13.3 13 cubic feet in a ton	Assume a shared use pathway in existing right-of-way. 12 ft of new asphalt surface \$201,200 per mile including unit material costs. Total project costs may include the following additional costs as percentage of construction cost: 5% landscaping; 20% Drainage and E&S; 5% Maintenance of traffic; 30% Utility Adjustments
Bicycle Boulevard (assumes 8 blocks per mile)			
	\$92,080.00	Facility Unit Cost: 6 curb bulbs*\$5,000 each+8 speed humps*\$4,500 each+ centerline thermoplastic 800feet*\$3 per foot+32 thermoplastic shared lane markings at \$300 each+32 sign assemblies at \$440 each.	Assumes the installation of curb extensions and speed humps without drainage impacts, centerline strip for the first 50 feet of each residential street intersection, assumes the use of sharrow pavement markings with 4 markings per block and 4 sign assemblies per block. Add 5% for landscaping, 10% for drainage, 5% for traffic control and 10% for utility adjustments.
Paved shoulder			
	\$264,000.00	Facility Unit Cost = \$20.00 per linear foot*2*5280, includes a 25% contingency	Assumes earthwork (4 feet width, 2 feet depth), aggregate base (4 feet width, 1 foot depth), asphalt surface course (4 feet width, 0.125 depth), asphalt base courses (4 feet width, 0.5 depth), pavement markings (2 lines entire length) plus 5% for landscaping, 10% for drainage and E&S, 5% for traffic maintenance, 10% for utility adjustment
Bike Route Signing			

	\$1,700.00	\$170 per sign assembly*10	Spacing of bike signs is flexible based on Engineering judgement & current practices. This calculation assumes up to 10 signs per mile installed on both sides of bicycle route (includes warning signs along the bicycle route and wayfinding signs). In some cases the number of signs per mile may be more or less than 10. Unit cost includes one sign, post and installation. Some wayfinding sign assemblies may have more than one sign, and therefore would be higher cost.
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Other Facility Costs		Unit Cost	
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Install Full Traffic Signal		\$200,000.00	Assumes that the full cost of the traffic signal is applied as a bicycle facility improvement (no cost shared by pedestrian, transit, motor vehicle, or other budgets)
Install Pedestrian Crossing Signal		\$90,000.00	Assumes that the full cost of the pedestrian crossing signal is applied as a bicycle facility improvement (no cost shared by pedestrian budgets)
Install Pedestrian Crossing Island		\$40,000.00	Assumes that two 11' by 10' islands and signs will be provided at each intersection, and that the full cost of the pedestrian crossing islands will be applied as a bicycle improvement (no cost shared by pedestrian budgets)
Upgrade Existing Pedestrian Crossing Signal to Accommodate Bicycles		\$12,000.00	Assumes 4 special-order bicycle traffic signal heads will be needed at the intersection. Assumes no other hardware or software upgrades, but such upgrades may be necessary.
Signs		\$170.00	Typically up to 10 signs per mile are installed on each side of trunk bicycle routes (includes warning signs along the bicycle route and signs to direct bicyclists to and from nearby destinations). Includes sign, post and installation.
Bike Racks		\$300.00	Assumes standard inverted U rack and includes installation.
Calibrate bicycle detection at traffic signals (on-street facilities)		\$400.00	Assumes four approaches per intersection calibrated at man-hour per approach, \$100 per man hour

Maintenance Costs			
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Replace Signs (on facilities)		\$170.00	Assumes replacement of 10 regulatory, warning, wayfinding signs per mile of network at \$170 per sign over a ten to twelve year period.
Sweep bicycle lanes and other on-road facilities		\$1,000.00	Assumes that spot sweeping after major rain or snow/ice storms and sweeping of bicycle lanes two times per year averages \$1,000 per mile. Total cost depends on the number of on-road Bicycle Facility Network miles that are complete and number of major storm events.
Replace Pavement markings (on-road facilities)	<i>Epoxy markings generally need to be repainted every 2 to 3 years. Thermoplastic may last 5 to 6 years.</i>		
Shared lane markings	\$9,900.00	Facility Unit Cost = \$165 per shared lane marking * 30 shared lane markings per mile * 2 sides	Assumes all markings repainted at \$300 per shared lane marking * 30 shared lane markings per mile * 2 sides
Bicycle lanes	\$15,510.00	Facility Unit Cost = \$1 per linear foot * 5280 feet * 2 lines * 2 sides + \$165 per bike and arrow * 15 bike and arrow per mile * 2 sides	Assumes all markings repainted at \$1 per linear foot * 5280 feet * 1 lines * 2 sides + \$250 per marking * 30 markings per mile * 2 sides
Cycle track	\$2,970.00	Facility Unit Cost = \$165 per bike and arrow symbol * 9 per mile * 2 sides	Assumes bike and arrow symbols repainted per mile*\$165 * 2 sides
Buffered bike lane	\$18,315.00	Facility Unit Cost = 2 lines*5280*\$1* 2 sides)+(880 LF diagonal lines*2*\$1)+(15 bike and arrow per mile*\$165)	Assumes all markings are repainted at \$1 per linear foot*5280*2 lines+880 LF diagonal lines*2 sides*\$1 per linear foot +15 bike and arrow per mile*\$165

Global Assumptions

- 1) Cost calculations assume that bicycle facility improvements are made on both sides of the street. Costs are generally over-estimated for the small portion of recommendations on one-way streets.
- 2) Cost estimates do not include design unless specifically stated in assumptions. Design costs, which includes construction planning, public process, facility design, and other background work required to implement the project, can generally be estimated at 12% to 15% of the facility construction cost. More controversial projects may have higher design cost.
- 3) Cost estimates involving major construction do not include contingency costs, which typically are estimated at 15 to 25% of the construction costs.
- 4) Other costs where applicable include landscaping 5%, Drainage 10% (unless otherwise noted), Traffic control 5% and Utility adjustments 10%.

5)The cost of roadway markings may vary depending on material used. Epoxy costs are in the range of \$0.5/LF while thermoplastic costs may vary from \$0.5 to \$2.00 LF depending on quantity ordered and market.

Appendix G: Funding Sources

There are multiple potential funding sources at the local, regional, state and federal level available for bicycle and pedestrian projects. Below is a list of these funding sources. NOTE:

Local Funding

CIP/CPF

The city of Aurora funds much of its transportation projects through its Capital Improvement Program, and in particular, the Capital Projects Fund. The Capital Projects Fund (CPF) provides for general government infrastructure and facilities including streets, information systems, and facilities. The broad purpose of the CPF makes it a key resource in achieving many of the City's strategies for growth and maintenance of infrastructure. The CPF accounts for 15.7 percent of the CIP five-year plan. Currently, there are significant burdens on the CPF, so it will be important to identify and actively pursue other funding sources for new and improved bicycle facilities, particularly for higher cost projects that cannot be implemented as routine roadway construction and maintenance.

Open Space Fund

The Open Space Fund (OSF) was created in 2011, combining the Arapahoe County Open Space Fund (ArCo Fund) and the Adams County (AdCo) Open Space Sales Tax Fund previously held in the city's Designated Revenue Fund. It provides for the acquisition, development, and maintenance of parks and open space in the city. The primary source of Open Space Fund revenue is a one quarter of one percent Arapahoe County Open Space sales and use tax. Voters approved an extension of this tax until 2023. The OSF accounts for 3.4 percent of the CIP five-year plan.

The recommended bicycle network consists of numerous "sidewalk connectors", many of which improve direct access to trails. The Open Space Fund may be an important source of funding for the implementation of these facilities.

State Funding Sources

The State of Colorado administers several grant programs through transportation-related funds as well as funding dedicated for recreational facilities and public health initiatives.

- Great Outdoors Colorado (GOCO) allocates lottery dollars to support recreational facilities, parks and open space including non-motorized projects in accordance with the Recreational Trails System Act of 1979. These annual funding sources should be considered for new trail planning and construction, trail maintenance and education particularly for trails connecting between state natural resources and between municipalities.
 - Local Parks and Outdoor Recreation (LPOR) Grant: awards up to \$350,000 with a minimum, 10 percent match for the development of new parks and open space or enhancement of existing facilities.
 - Mini Grants award up to \$45,000 for new facilities or improvements to existing recreational facilities with a minimum 10 percent match.

- LiveWell Colorado, a program administered by the State of Colorado Health Department, provides grant funding for projects and programs that encourage healthy lifestyles including Safe Routes to School.
- FASTER (Funding Advancement for Surface Transportation and Economic Recovery) is administered by Colorado State Department of Transportation for local transit projects. In 2011, \$23.3 million was allocated for transit projects statewide. These funds are applied to transit related projects such as multi-modal access to transit.

Federal Funding Sources

There are several grants and funding opportunities from federal transportation and non-transportation programs. Some of the sources may be applied for directly while others are distributed through the Denver Regional Council of Governments or the Colorado Department of Transportation. **Many of the funding programs listed further below could change, or be eliminated, with authorization of the new transportation bill (American Energy & Infrastructure Jobs Act), which is expected in 2012.** The bill's funding provisions that would support bicycle and pedestrian projects are unknown.

Section 217 of Title 23 of the U.S. Code calls for the integration of bicycling and walking into the transportation mainstream. A series of transportation bills passed by U.S. Congress has recognized the increasingly important role of bicycling and walking in creating a balanced, intermodal transportation system, and has provided funding sources to create more walkable and bike-friendly communities. The most current legislation is the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, or "SAFETEA-LU".

The Act, which was signed into law in August 2005, authorized \$244.1 billion in federal gas-tax revenue and other federal funds for all modes of surface transportation – highways, bus, rail, bicycling, and walking. None of the funds are dedicated solely for bicycle or pedestrian facilities or programs, but these programs are eligible for the funds. According to the FHWA, bicycle projects are broadly eligible for funding from almost all the major Federal-aid highway, transit, safety and other programs. Bicycle projects must be "principally for transportation, rather than recreation, purposes" and must be designed and located pursuant to the transportation plans required of the State of Colorado. Generally, the local government or state must share the cost with the Federal aid, and must match 20% of the cost while the Federal aid covers 80% of the cost. However, some federal programs such as Safe Routes to Schools and Section 402 are 100% federally funded.

Federal-aid Highway Program

- National Highway System funds may be used to construct bicycle transportation facilities and pedestrian walkway on land adjacent to any highway on the National Highway System
- Surface Transportation Program funds may be used for either the construction of bicycle transportation facilities and pedestrian walkways, or non-construction projects such as maps, brochures, and public service announcements related to safe bicycle use and walking.
 - Ten percent of each state's annual Surface Transportation Program funds is set aside for Transportation Enhancement Activities, which include facilities for pedestrians and bicycles, safety and educational activities for pedestrians and bicyclists, and the preservation of abandoned railway corridors.

- Ten percent of each State’s annual Surface Transportation Program funds are set aside for the Hazard Elimination and Railway-Highway Crossing Programs, which addresses bicycle and pedestrian safety at hazardous locations.
- Funds from the Congestion Mitigation and Air Quality (CMAQ) Improvement Program may be used to construct bicycle facilities, pedestrian walkways, or non-construction projects such as maps, brochures, and public service announcements related to safe bicycle use.
- Funds from the Recreational Trails Program may be used for all kinds of trail projects. Of the funds apportioned to States, 30% must be used for motorized trail uses, 30% for nonmotorized trail uses, and 40% for combination trail uses.
- National Scenic Byways Program funds may be used for construction of a bicycle and pedestrian facility along scenic byways.
- Job Access and Reverse Commute (JARC) Grants are available from the Federal Transit Administration to support bicycle-related services and other projects that are designed to transport welfare recipients and eligible low-income individual to and from employment.
- High Priority Projects and Designated Transportation Enhancement Activities include numerous bicycle, pedestrian, trail, and traffic calming projects in communities.

Federal Transit Program

- Urbanized Area Formula Grants, Capital Investment Grants and Loans, and Formula Program for Other than Urbanized Area transit funds may be used for improving bicycle and pedestrian access to transit facilities and vehicles.
- The Transit Enhancement Activity Program sets aside 1 percent of Urbanized Area Formula Grant funds specifically for pedestrian access and walkway and bicycle access, including bicycle storage facilities and installing equipment for transporting bicycles on mass transportation vehicles.

NOTE: FTA’s Final Policy State on the Eligibility of Pedestrian and Bicycle Improvements Under Federal Transit Law (docket number FTA-2009-0052) issued 8/19/11 simplifies the process for determining whether a pedestrian or bicycle improvement qualifies for FTA funding. For the reasons outlined in this Policy Statement, and for purposes of determining whether a pedestrian or bicycle improvement has a physical or functional relationship to public transportation, all pedestrian improvements located within one-half mile and all bicycle improvements located within three miles of a public transportation stop or station shall have a de facto physical and functional relationship to public transportation.

Highway Safety Programs

- State and Community Highway Safety Grant Program (Section 402) supports State highway safety programs designed to reduce traffic crashes and resulting deaths, injuries, and property damage. Funds may be used for a wide variety of highway safety activities and programs

including those that improve pedestrian and bicycle safety. States have funded a wide variety of enforcement and educational activities with Section 402 funds including safety brochures; “Share the Road” materials; bicycle training courses for children, adults, and police departments; training courses for traffic engineers; helmet promotions; and safety-related events.

Other Federal Programs

- Transportation and Community and System Preservation (TCSP) program is a competitive grant program designed to support projects that show how transportation projects and plans, community development, and preservation activities can be integrated to create communities with a higher quality of life. Bicycling, walking, and traffic calming projects are eligible activities and may well feature as an integral part of many proposed projects that address larger land use and transportation issues.
- Safe Routes to School (SRTS) provides funds to States to improve the ability of primary and middle school students to walk and bicycle school safely. The program fund two distinct types of projects: infrastructure projects (engineering improvements) and non-infrastructure related activities (such as education, enforcement, and encouragement programs). Infrastructure funds can be utilized for on and off-street bicycle and pedestrian facilities on any public right-of-way within a two-mile radius of an eligible school.
- Highway Bridge Replacement and Rehabilitation Program (HBP) or (BRR) funds the replacement or rehabilitation of highway bridges. If a highway bridge or deck is being replaced, and bicyclists are permitted at each end, then the bridge must include safe bicycle accommodations (at reasonable cost).

More information on many of the programs listed above can be found at the Federal Highway Administration’s Bicycle and Pedestrian Program website;
<http://www.fhwa.dot.gov/environment/bikeped/>

Appendix H: Programs for Education, Encouragement, and Enforcement

H.1 Introduction

Infrastructure is only part of the solution to making a place more bicycle and pedestrian-friendly. Efforts must also be made to address non-infrastructure elements such as unsafe behaviors of all roadway users, safe bicycling skills, and general awareness of bicyclists on the roadway. This section documents existing programs undertaken by the city, partnering agencies, and volunteer organizations followed by recommendations for revised and additional programs that uphold the vision and goals set forth for the Plan.

It is worth emphasizing the important role that volunteers and advocates will play in improving conditions for bicyclists and pedestrians in Aurora. The city can set the course via policies and infrastructure improvements, but the actual conditions can only be impacted by the actions of all citizens both in daily conduct and organized group actions. Fortunately, there are groups, clubs and individuals dedicated to improving bicycling conditions in Aurora. One such group is Bicycle Aurora, with which the city has worked closely in recent years as it has strived to make incremental improvements for bicyclists. There are a number of other agencies and organizations that could potentially play an active role in encouragement and education efforts, including Tri-County Health Department, Colorado Department of Transportation, RTD, and neighboring jurisdictions. The combined efforts of the city and its partners will help to establish and sustain a bike culture.

H.2 EDUCATION

A safe transportation system begins with an understanding of the rights and responsibilities of all residents that use the city's streets, sidewalks, and trails. Education is required to address issues such as wrong-way riding and riding without a helmet, how bicycles and cars can safely share the road, the importance of looking both ways, and compliance with stopping regulations. This information needs to reach as many residents as possible and it needs to be provided in both English and Spanish. Below is a discussion of programs and other efforts focused on educating the public about bicycling safety, some of which the city of Aurora and its partners are already offering or pursuing.

Safe Routes to School (SRTS)

Safe Routes to School (SRTS) programs are sustained efforts by parents, schools, community leaders and local, state, and federal governments to improve the health and well-being of children by enabling and encouraging them to walk and bicycle to school. The City of Aurora, in partnership with Aurora Public Schools, has supported SRTS applications in the past.

The majority of Aurora's public schools are located on collector streets and accessibility via walking and biking would be greatly improved with implementation of the recommended bicycle network. Bicycle and pedestrian safety are skill sets that will benefit the children through their entire lives. Children are being driven more often than children a generation past, and are given fewer opportunities to practice

safe biking and walking skills with their parents. Ensuring consistent, certified instruction for all children of Aurora will help to improve safety for the city's next generations. To support pedestrian education, the Aurora Public School District and Cherry Creek School District should be encouraged to adopt the NHTSA Pedestrian Safety Curriculum as part of the school physical education annual curriculum. Bicycle Colorado (see description of group further below) may be another potential partner in pursuing SRTS funding and programming.

Tri-County Health Department Injury Prevention Programs

The Tri County Health Department's Injury Prevention Program focuses on prevention of unintentional injuries, including those related to walking and biking. TCHD is an active partner in Safe Kids Denver Metro, which is focused on reducing preventable injuries in children. *Safe Kids Ride This Way* and *Safe Kids Walk This Way* are two educational programs focused on bicycle and wheeled sport safety and pedestrian safety, respectively.

Aurora Police Department Kid's District

The Aurora Police Department, through its *Kid's District* initiative, offers bicycle safety tips on its website.

Educating Law Enforcement Officers About Bicycles

It is important for all law enforcement officers to fully grasp the rights and responsibilities of all roadway users. Educating law enforcement officers about the laws applying to bicycles, as well as the operational characteristics of bicycles can help officers better understand what behaviors they should be targeting from an enforcement point of view.

Police Education Seminars & Rodeos

The Aurora Police Department has approximately 50 officers that have bicycles assigned to them, including about 20 School Resource Officers. These officers could be certified by the League of American Bicyclists to provide bicycle safety education such as seminars and experiential rodeos. The instructor begins each rodeo with an explanation of bicycle skill expectations for students. Various stations are set up to give students the opportunity to practice a variety of specific bike handling skills for operating a bike safely and legally on the street. Bicycle rodeos are provided during the school day, and at events upon request. Health fairs and safety events should be seen as opportunities to promote safe cycling clinics for children, families and adults.

City Website

The city's website is helpful and functions as a clearinghouse for several important transportation-related resources. The following actions are recommended to expand and enhance the existing city of Aurora website for bicycle and pedestrian-related content:

Create a dedicated bike/ped section on the city's website

The city should host and maintain an online reference that provides easy access to bicycle laws, safety tips, maps of the bicycle network, as well as programs that encourage people to bike more often. Ideally, this information should be presented all in one place on the city's website, or if this is not desired, then links to relevant pages, i.e. 'Transportation Planning', or 'Parks and Recreation' should be

compiled and provided in one place. As the city's bike program grows, so does the content on the website.

Register an additional Bike/Ped web address that is more intuitive

Bicycle and pedestrian related information on the city's webpage should be placed in an intuitive location. Most people will not think to look in the transportation planning section of the city's website. This recommendation is not to create an entirely separate website, but to register web addresses that are easier to remember, and to link/forward those web addresses to contents' location on the city website. For example, it is easier to remember www.bikeAurora.gov¹ and can easily be included in flyers, emails, postcards, etc.

Add a calendar showing bicycle events

Posting bicycle events on a monthly calendar would help people become more aware about upcoming events. The city partners with other agencies and interest groups that have bicycling events. These events should be publicized on the website in a format that is accessible and easy to read.

Add a "report a problem" link to the city's Bike/Ped Webpage

Aurora could incorporate a mechanism on its bike/ped webpage for the public to report location-specific problems with city infrastructure. Placing a link on the Bicycle webpage will help people find the link quickly, while their concern is on their mind. Once comments are submitted on the electronic form, a city staff person is notified and has the tools needed to investigate the concern.

Cross-post bicycle-related volunteer opportunities

Cities can always use help from volunteers. Whether the job is to help distribute flyers or to report debris on a trail, there are simple jobs that enthusiastic citizens can perform. The city advertises volunteer opportunities on its webpage. It would be helpful if any volunteer opportunities related to bicycling were to be cross-posted on the city's bicycle web page. The bicycle web page audience is interested in bicycling and may be willing to volunteer time to improve conditions.

Cross-post bicycle-related activities and programs

Several city departments have activities and programs that are in support of bicycling. The city's Parks Recreation and Open Space, Public Works, Police and Planning & Development Services departments all have programs that either address bicycling directly or have complementary objectives. Cross posting the efforts of other city agencies and departments will make for a more convenient experience for the web user, and will promote cooperation and joint development across city departments.

Develop a Comprehensive Safety Education Program

As resources become available, the city, in partnership with other organizations such as Tri County Health Department, DRCOG, and private industry, e.g. healthcare, should develop a comprehensive safety education program/campaign programs. The tone should be cooperative, emphasizing that all modes need to be aware and respectful of each other on roads and trails. Below are additional activities that should be marketed under the umbrella of an energized and comprehensive program.

¹ As of January 5, 2011 this web address is unregistered and available.

Create a brand for the safety education program

The city's bike and pedestrian program needs its own identity. Creating brands that can be applied on all new materials will help spread awareness and maintain a consistent message. The brand should be apparent on all activities and products that are associated with the program.

Create & distribute educational and promotional materials

Educational and promotional materials such as maps, bumper stickers, billboards, website content flyers, etc having a unified theme and message can be very effective and raising awareness about bicycle safety. Many materials should be made available in both English and Spanish.

Promote and support adult bicycle safety classes

Many adults are unaware of how to properly fit and wear a helmet, signal turns to vehicular traffic and other safe road riding skills. The city should promote adult bicycle clinics and engage volunteers that are certified bicycle instructors (by the League of American Bicyclists) to organize and conduct the clinics. Clinics should be posted on the bicycle calendar of events. The city bicycle web page can also provide links to those groups that provide publicly accessible clinics and workshops.

Additionally the city could provide classroom space for bicycle safety workshops. Groups and clubs regularly offer clinics and workshops but have difficulty finding spaces that can provide both classroom space, and areas to practice maneuvers. Several civic buildings have meeting rooms and parking lots that can be used for instruction. These spaces are usually unused during weekend and evening hours. Providing these spaces for free would increase the frequency that clinics and workshops are offered.

H.3 ENCOURAGEMENT

Aurora is fortunate to have an enthusiastic and large cycling community. In Aurora, the increasing popularity of recreational bicycling is unmistakable as more bicyclists are seen on the streets each year. The city has several cycling clubs and groups that promote bicycling in and around the city and organize group rides. While many of the groups are oriented to recreational riding, their members' presence on the roads and trails increases awareness of all cyclists. In addition to recreational riders, there are a growing number of residents that cycle for transportation out of either choice or necessity.

Bike to Work Day

The purpose of Bike to Work Day (BtW) is to encourage people to try substituting their bike for their car for one day with the hope that the day's experience could inspire more regular bike commuting. The city has participated in Bike to Work day for over 15 years by encouraging its employees to bike to work, as well as holding bike commuter "lunch-and-learn" workshops, and having a mobile cyclery unit provide free bike tune-ups. The city has also partnered with Bicycle Aurora, the DRCOG, and local restaurants to provide a breakfast station and prizes for participants. The BtW day event has received local news coverage, and has grown in popularity over the years. The city should continue to seek partners to promote this event, and should explore other strategies for increasing the number of participants.

Create a Bicycle Facilities Map

A bicycle facility map can be an effective tool for encouraging novice bicyclists to ride more often because it helps them understand key connections for getting to their destination. The city will be

developing a city-wide bicycle facilities map, which will be available in both print and digital formats (downloadable PDF). The map will not only provide detailed bicycle facilities information (on-street routes and off-street trails), but could potentially include safety tips, bikes on buses and trains information, and a summary of laws and regulations applying to bicyclists. The map should be designed in a format that is also viewable by people using smartphones as these are growing in popularity as navigational tools.

Employee commuting incentive programs

The City of Aurora has included information on the federal Employee Commuting Incentive Program on its bicycle transportation website. It explains that as a result of The Bicycle Commuter Act (2009) employers may now reimburse their employees up to \$20 per month (\$240 per year) tax-free for “reasonable” expenses related to one’s bike commute.

Bicycles and Transit

Depending on where they live, there are people who can make nearly all of their trips by bike. However, it is more likely that there are everyday trips located just outside the comfort of a bike ride. To incorporate bike travel for those trips longer than a few miles, public transit can be an attractive solution. Most RTD buses are equipped with bicycle racks, and bicyclists can use these racks for no additional cost.

Another way to combine bicycle and transit trips is to provide secure parking facilities at transit and shuttle hubs such as bus depots and parking garages. A prime example of such a connection is promoting access to the existing Nine Mile Light Rail Station via the Toll Gate Creek Trail and Cherry Creek Spillway Trail, or to the soon-to-be-constructed Iliff station via recommended on-street bicycle facilities. People can choose to bike to the hub, and then take transit for the rest of the way. Alternatively, people can choose to leave a bike waiting at the transit hub and bike the rest of the way after the bus ride. This type of “trip chaining” can be very attractive to the many Aurora residents who commute to and from Denver every day. It can also complete the picture for visitors looking to park once and explore the town via bicycle.

Partnering

Entities and interest groups outside the city will contribute to the success of the Master Plan. Below is a list of existing and organizations that city can partner with to encourage bicycling, including facilitating, organizing, or cross publicizing efforts.

Bicycle Aurora - <http://www.bicycleaurora.org/> - Bicycle Aurora is focused on "Promoting a safe, planned, logical and connected bicycle trail/route system that will improve the quality of life in Aurora, Colorado". Bicycle Aurora has been meeting on regular basis with city staff to identify needs and solutions to improving bicycling in Aurora.

Bicycle Colorado - <http://bicyclecolo.org/> - Bicycle Colorado is the nonprofit organization dedicated to building a bicycle-friendly Colorado. Its mission is to encourage and promote bicycling, increase safety, improve conditions and provide a voice for cyclists in Colorado. Programs of Bicycle Colorado include:

Safe Routes to School, Share the Road, Complete Streets, Legislation, Trail Pros, and Bicycle Commuter Services.

Bicycle Shops – Aurora has numerous bicycle shops through which education and encouragement information could be disseminated. Shops may also be potential sponsors of events like Bike to Work Day or community races.

Other potential partners include major employers, higher education and other schools

- Anschutz Medical Campus & Colorado Science & Technology Park
- Medical Center of Aurora
- Buckley Air Force Base
- Lowry Community College
- Community College of Aurora
- Concorde Career College
- Pickens Technical College
- Anthem College
- Aurora Public Schools
- Cherry Creek School District

Group Rides

Whether for recreation or commuting purposes, riding in groups gives novice cyclists confidence to ride both on and off-road, and introduces new and convenient routes for everyday rides. The rides can cover vast areas and provide tours of the city, or they can help people identify comfortable and convenient routes to work. The best rides are those that start and end in the same location but explore new routes and destinations, giving people a new awareness of the Bicycle Network. Group rides have the added benefit of creating a strong bicycle presence on the roads.

Bicycle Aurora organizes group recreational rides for its members. Bicycle Aurora has also been active in promoting bicycle safety and could be engaged to conduct safety clinics at area schools and for youth groups.

Students can also benefit from group rides. The Safe Routes to School movement encourages young cyclists to bike to school in groups with adult chaperones. These rides increase the students' confidence in their bicycling skills and establish healthy habits for life. Bicycle trains have been especially effective for high-school aged students, providing a cheaper alternative to driving.

While the actual rides may be led by volunteers from local bicycling organizations, the city's role in this strategy can be to provide resources and materials on planned group rides by including group ride events on the bicycle calendar page. The city can also link to other groups that produce how-to materials for organizing group rides or bicycle trains to school.

Triathlons/races

Since 2009, Aurora has hosted the finish line for a stage of the Race Across America. In its 30th year, this is one of the longest distance bicycle races in North America at 3,000 miles. Over one million dollars is raised each year for charities and non-profits by its racers. Local races have included triathlons at city Dock as well as adventure races and the popular Aurora Bay Country Century.

Children could have the opportunity to compete and improve their bicycling skills in a local swimming, biking and running race event co-sponsored by the Aurora Parks, Recreation & Open Space Department (PROS) and local groups such as the University of Colorado Hospital.

Market the city as an “Active Vacation” destination

Aurora already has a thriving outdoor-activity culture. Promoting Aurora as an active vacation destination will increase the number of bicyclists and promote awareness for all modes. Promoting cycling as a tourist activity also gives greater weight to bicycle infrastructure projects.

Achieve Bronze Level Bicycle Friendly Community Status

Cities across the nation are applying for Bicycle Friendly Community status recognize accomplishments related to bicycling and guide discussions about local challenges and opportunities for bicycling. The award criteria help to prioritize efforts and strategies to improve existing conditions. Community leaders recognize that the tiered structure of the award (bronze, silver, gold, and platinum) helps to establish milestones for future progress. Once awarded, the LAB provides feedback on how to advance to the next level, making it easier for communities to organize next steps for Plan implementation. Finally, the national recognition publicly announces that the Community is committed to enhancing bicycling conditions. As of 2011 there are only 180 formally recognized Bicycle Friendly communities across the country.

H.4 ENFORCEMENT

Police on Bikes

An effective way to engage bicyclists and model safe bicycling maneuvers is to put police officers on bicycles. The Aurora Police Department has approximately 27 Police Area Representative (PAR) officers and 20 School Resource Officers (SRO) with bicycles assigned to them. Officers currently use bikes on an as needed basis. Regular patrols are limited to parks and trails during summer months. As the bicycle network becomes more developed the city should provide more regular patrols by bicycle-mounted officers. These officers have increased mobility and are more accessible to pedestrians and bicyclists. Police on bicycles also tend to have a more thorough understanding of the rights and responsibilities of all users as they receive specialized training on bicycle safety skills and laws. An added benefit to using bicycles instead of cars is that officers on bicycles travel at slower speeds and are more engaged with their surroundings.

Progressive/Educational ticketing

It is likely that drivers are unaware of bicycle safety legislation. Many people do not know that Colorado recently passed a law requiring cars to give bicyclists a three-foot buffer when passing or riding alongside them. While it is everyone's responsibility to be educated on current laws, it is more effective

to educate drivers and bicyclists before issuing citations. With progressive ticketing, officers offer educational materials, and then warnings before issuing citations and fines. Offering this grace period allows drivers time to adjust to new laws. This approach can also be applied to bicycle enforcement.

Support distracted driving campaigns

Drivers that are not fully paying attention to the road and other vehicles create unsafe conditions for all modes. Bicyclists are especially vulnerable as they are often hidden in driver's blind spots. Enforcing Colorado State laws that prohibit hands-on cell phone use (by those who are under 18 years of age) and texting while driving (by all persons) will emphasize the city's commitment to ensure safety for all modes.

Schools can also participate by conducting pledges for parents promising that they will not use their cell phones while driving, especially in school zones. The city could also consider adopting an ordinance that allows Police to issue fines specifically to individuals caught using hands-on cell phone devices while driving in school zones.

Crossing stings

Crossing stings are an effective way to enforce Colorado State law that requires all vehicles to yield to pedestrians in crosswalks. Plain clothes police officers attempt to cross the street when cars are approaching. If cars do not stop in the appropriate time and distance, the drivers are issued educational materials and warnings, which may lead to tickets for repeat offenders. While bicyclists do not usually use crosswalks, it does improve safety for all modes as they are reminded to watch out for non-motorized traffic. It should be noted the crosswalks are used by bicyclists when crossing trail/road intersections. Crossing stings should be used in a limited and targeted way as they can result in a backlash against police. Areas to focus crossing stings may be in school zones, and are likely to be most effective, and create the least amount of backlash, when initiated by the school administration or district.

Appendix I: Bicycle Facilities Map Memo

Steve Spindler Cartography

Aurora, Colorado Bicycle Map Memo: An approach to bike map development

Step 1: What Aurora wants to accomplish, and why. We've discussed developing a map that appeals to a wide audience and highlights facilities and connections between trails, parks, public transportation, schools, and Denver. Bicycling increases viability of public transportation, and trips converted from motorized vehicles reduce air pollution. Bicycling is better facilitated through on-road facilities that accommodate bicycling and walking. A cyclist should be able to look at the map and think of bicycling as a trip option, if not now, then in the future.

Step 2: Distribution. The cost to publish 5000 copies of a 24x32" map will likely be \$3000. Because funds are not currently available, the map should be posted online in PDF format. Data can also be layered over a google map that includes bicycle routing and cue sheet information. An example is online at bikemap.com/de.

Step 3: Data & scale. Much of the data has already been compiled by the City of Aurora and Toole Design Group. Due to greater bicycle use in the northwestern part of the city, this area can be shown at a detail that includes many street names. An overview of the city that is adequate for planning a trip can be shown at a scale of 1:50,000.

Step 4: Layout. Laying out a map and corresponding information is similar to a puzzle. There is finite space. More detailed information of use to cyclists that is not essential to navigation can be posted online.

A rough map is posted online at bikemap.com/aurora/coverside11-21.pdf and bikemap.com/aurora/mapside11-21.pdf. This gives space for the legend, safety information, and other important information. It's meant to provide direction.

Step 5: Photographs. Photos illustrating concepts of the plan or of people having fun can be obtained. There will not be a lot of room for photos, so few will be needed. Typically, photos of cyclists will illustrate safe cycling, transit, and facilities.

Step 6: Covers and styles. It's often best to agree to a cover before the rest of the brochure is stylized. This allows the designer an opportunity to plan the design around the cover. A possible base map design is suggested in the pdfs. White streets cause the important data to be more prominent.

Step 7: Feedback. It's often valuable to print out a few copies and get potential audiences to use them and give feedback. Really, you don't want people to tell you how they used it so much as you want to observe them using it and see what sticks out in their head.

Step 8: Printing and distribution. The suggested layout fits in an envelope, or it can be designed as a self-mailer. It is 24x32", accordion folding to 4"x8", printed on a 70 coated stock, with a matte finish. The matte finish will reduce glare when someone looks at the map in the sun.

Edits: The easiest way to edit the map is directly in Adobe Illustrator with MAPublisher. Individual layers can be exported from ArcGIS as well and placed into the Illustrator file. To provide comments, the most efficient way is to mark up a PDF using Adobe Acrobat Professional. This allows the cartographer to check off when an edit has been done and assures that edits will not be missed.



Final note: We often think of a map as being something that is produced by a stakeholder to be consumed by a specific audience. It may be useful to think of the map as something that can be edited and repurposed by the audience.

Yesterday I saw a bicyclist in a coffee shop with a regional bike map. He had highlighted the map in pink to show where he had ridden.

The Aurora Bike Map can take on new meaning as people put themselves into it. Regardless of who uses the map or how, people will see a symbol of the importance of bikes in the city.

You may want to make the map public domain and see what people can do with the data.

Aurora Bike Map (Web/Print) Cost Plan

Note: Rate of \$90/hr includes overhead (insurance, operating costs). The part of concept development was done largely through the existing contract.

Concept Development		\$5000
Travel		\$1000
Flight	\$280	
Hotel	\$310	
Car & gas	\$90	
Food	\$120	
Misc	\$200	
Time (16 hrs)		\$1400
Field Research	\$720	
Meeting Time	\$720	
Phone meetings/follow up		\$1000
Phone calls	\$360	
Pre/Post Meeting	\$360	
Memos/Emails	\$450	
Map Planning (20 hrs)		\$1800
Data review	\$450	
Map Styles	\$720	
Research	\$180	
Communications	\$270	
Cartography		\$12,420 [or \$7920]
Main map, 1:50,000 Scale		
80 hrs	\$7200	
Large scale insets (optional)		
50 hrs	\$4500	
Communications/Revisions fixed fee		
8 hrs	\$720	
Brochure Design		\$2880
Cover samples (3)	\$1080	
Layout	\$1800	
Photos supplied by client		

Web Functionality**\$2520**

Communications	8 hrs	\$720
Data Prep	2 hrs	\$180
CSS	8 hrs	\$720
JavaScript	10 hrs	\$900

Printing Rough Costs**\$3000 to \$8000**

Copies	Budget
5000	\$3000
10,000	\$5000
20,000	\$7500

Distribution

Distribution through the municipal center, bike shops, advocacy group and libraries done by the City.

Edits

Updates at \$90/hour.

Appendix J: Sable & Iliff Intersection Design Case Study

This case study is intended to demonstrate techniques for carrying bicycle facilities through an intersection to improve bicyclist safety and comfort. All of these design recommendations may not be appropriate for all intersections in the city where bicycle facilities intersect another street. This case study is intended to convey the “thinking” behind the designs chosen and the approximate level of effort required to develop the design. Although the design recommendations supplied in this appendix may not be 100% consistent with current City of Aurora policy, the designs are based on best practice, 2009 MUTCD, and the forthcoming update to the AASHTO Bicycle Guide (summer 2012 expected). Just as the city has adopted special design standards for Urban Streets to accommodate higher concentrations of bicyclists and pedestrians, the further purpose of this case study is to offer designs that may be appropriate in limited cases where added safety measures are worth considering given the potential for higher bicycle traffic volumes. Examples of locations where these enhanced treatments might be appropriate include arterial crossings in proximity of light rail stations and major employment entrances.

Pavement Markings and Signing

Existing Condition

Sable Boulevard runs north to south and intersects Iliff Avenue at a signalized intersection. The southern leg of the intersection (S Dillon St) is currently striped as one 20’ southbound through-lane and two northbound lanes – one 10’ left-turn lane and one 10’ through-lane. The northern leg of the intersection (S Sable Blvd) is currently striped as three southbound lanes – one 12’ right-turn lane, one 10’ through-lane and one 10’ left-turn lane – and one 18’ northbound through-lane. At S Sable Blvd and Baltic Place, there are left-turn lanes in both directions and north of Baltic Place, existing 6’ bike lanes are on the northbound and southbound curbs.

Proposed Condition

Bicycle facilities are proposed for S Sable Blvd to connect the existing facilities north of Baltic Place through the intersection with Iliff Avenue. The accompanying plan sheet illustrates the proposed condition described below.

Pavement Markings - North of Iliff Avenue

At the connection of the existing bike lanes at Baltic, pavement markings have been revised to add a 5’ bike lane on the curb in both directions. South of Baltic Place, pavement markings have been revised to begin the right turn lane approximately 50’ south of the intersection, at the same point where cyclist will transition from their curbside dedicated lane to their dedicated lane to the left of the right-turn lane. This movement allows for less conflict at the intersection at Iliff Avenue between the cyclist making the through movement and the vehicles making the right turn onto Iliff Avenue. In order for the cyclist to make this transition of 5 feet, a taper/transition length was designed based on the 2009 MUTCD equation:

$$L = \frac{WS^2}{60}$$

where,
 L = Taper Length (ft)
 W= width to transverse laterally (ft)
 S = speed (mph)

Per the equation above, the 5' lateral transition only requires 52'; however, a minimum length of 100' is considered best practice for low speed urban streets per the MUTCD and therefore, the proposed striping provides 100 feet. The pavement markings within this 100' transition space are dashed at a 2' stripe – 4' space interval. In addition to this area, the 2' stripe – 4' space interval is also proposed at the breaks in the bike lane at street and driveway intersections. These dashed lines alert the cyclist that a turning vehicle from the crossing streets/driveways could potentially turn into the dedicated bike lane in these areas. The lines also indicate to motorists that they are leaving the through lane, crossing the bike lane whereupon they should yield to bicyclists to enter the right turn only lane. A standard length of 50' of 2'/4' dashed stripe is designed for bike lanes on the approach to an intersection and a standard length of 25' of 2'/4' dashed stripe is designed for bike lanes on the departure of an intersection. This type of design (right turn lane with separate bike lane) is preferred at intersections to reduce the likelihood of a bicyclist being hit by right turning vehicles (right hooked). At locations without bike lanes up to the intersection, bicyclists are likely to stay close to the curb line.

A striped median has been proposed just south of Baltic Place to accommodate the extra width available due to the fact that the right-turn lane starts approximately 50' further south than the existing condition.

Proposed pavement marking symbols have been added to the vehicular lanes and the bike lanes. Turn lane arrows and "ONLY" text has been placed at a standard 32' apart. Bike lane symbols have been added to the bike lanes at the intersection breaks, located before or after the 2'/4' dashed lines (refer to plan). 2' stop lines have been installed 5' back from the existing crosswalk edge. Care has been taken to keep lane use symbols clear of the primary areas for bicycle detection which are marked with supplemental, bike detector symbols as shown in the photo at right.



Pavement Markings - South of Iliff Avenue

The existing centerline on S Dillon Street, south of Iliff Avenue, is to remain. The southbound existing width is proposed to provide a 7' buffered bike lane on the curb, with a 3' wide buffer and 10' southbound travel lane. The northbound lanes have not changed in width and remain 10' wide for the left-turn lane and the through-lane. South of E Caspian Pl, buffered bike lanes (7' bike lane and 3' buffer) are proposed on the curb in each direction. Cyclists traveling northbound on S Dillon St towards Iliff Avenue will enter a shared through-lane just north of E Caspian Place. Shared lane marking symbols are alternated with "through-right" lane arrows and are centered in the 10' wide lane to alert both the cyclist and the motorist to it is a shared lane. The markings are in the center of the lane to encourage cyclists to stay away from the curb where they are at risk of being right hooked and will have difficulty actuating the detection device (loop or video).



Proposed Signs

The following signs are proposed to be installed along the corridor:

- “Bike Lane Ends” – This sign is proposed to be installed 50’ south of the intersection of S Dillon St and E Caspian Place on the northbound side to alert the cyclist that the dedicated lane is ending and a shared lane is starting.
- “Bikes May Use Full Lane” – This sign is proposed to be installed just north of E Caspian Place on the northbound side of S Dillon St. This sign works in conjunction with the shared lane marking pavement symbol and alerts both cyclists and motorists that this through-lane is to be shared and cyclists should be controlling the lane.
- Bicycle Detection Sign (R10-22) – This sign is proposed to be installed at the stop line of northbound S Dillon Street at the intersection with Iliff Avenue and at the stop line of S Sable Blvd at the intersection with Iliff Avenue. This sign works in conjunction with the bicycle detector symbol (Placement of this symbol is discussed below). This sign should be mounted as close as practical to the right of the detector symbol.
- “Begin Right Turn Lane – Yield to Bikes” – This sign is proposed to be installed approximately 50’ south of Baltic Place on southbound Sable Blvd. This sign alerts motorists that they can begin the shift to the right to make a right turn at Iliff Avenue and in doing so, yield to cyclists in their dedicated bike lane.



Signal Timing Changes

The minimum green times at the intersection need to be increased to allow a bicycle entering the intersection at the beginning of the green indication enough time to cross the intersection before the conflicting crossing traffic receives a green indication. This time is called the “Bicycle Standing Time” and it is defined by the equation shown below. The minimum green on each approach should be greater than or equal to the “Bicycle Standing Time” minus the yellow and red times, also shown below.

$BMG = BCT_{standing} - Y - R_{clear}$ $BMG = PRT + \frac{V}{2a} + \frac{(W + L)}{V} - Y - R_{clear}$
<p>where:</p> <p>BMG = bicycle minimum green time (s)</p> <p>BCT_{standing} = bicycle crossing time (s)</p> <p>Y = yellow change interval (s)</p> <p>R_{clear} = all-red (s)</p> <p>W = intersection width (ft)</p> <p>L = typical bicycle length = 6 ft (see chapter 3 for other design users)</p> <p>V = bicycle speed crossing an intersection (ft/s)</p> <p>PRT = perception reaction time = 1 s</p> <p>a = bicycle acceleration (1.5 ft/s²)</p>

Bicycle Minimum Green and Bicycle Standing Time

The following table shows the calculations for determining the Bicycle Standing Time and the Bicycle Minimum Green times for each approach of the intersection. The calculations assume a bicycle speed of 10 miles per hour.

Approach	Existing Y + R	Existing Min. Green	Crossing Width (W)	Bicycle Standing Time	Required Minimum Green for Bicycles	Increase to Minimum Green
NB	5.5 sec	4 sec	110 feet	11.5 sec	6 sec	2 sec
SB	5.5 sec	4 sec	110 feet	11.5 sec	6 sec	2 sec
WB	5 sec	5 sec	73 feet	11.3 sec	6.3 sec	1.3 sec
EB	5 sec	5 sec	71 feet	11.1 sec	6.1 sec	1.1 sec

Bicycle Minimum Green requirements for the intersection of Sable Street and Iliff Avenue

Detection Updates

Bicycle detection can be implemented using both video detection and loop detectors. Bicycle detection pavement markings should supplement each type of detection so bicyclists know where to wait to be detected. For locations with video detection, distinct detections zones can be programmed for bicycles in a bike lane or shared lane. For locations with loop detectors, existing detectors can be calibrated or

new detectors can be added to detect bicyclists. See Appendix B of the Master Plan for more information on bicycle detection at signals.

The intersection of Sable Boulevard & Iliff Avenue has video detection for both Iliff Avenue approaches. The detection zones for the southbound approach should be modified to provide a distinct detection zone for the bike lane. For the purpose of this case study, it is assumed that both Iliff Avenue approaches have loop detectors to demonstrate how an intersection with loop detection can be modified to accommodate bicycles.

Detection should be provided for all movements on both Iliff Avenue approaches, as depicted on the plan sheet. The sensitivity of each loop should be increased to the highest sensitivity level possible without detecting vehicles in the adjacent lanes. Field checks of the loop detector with a bicycle rim should determine the “sweet spot” for bicycle detection, which is likely directly over the outside edge of the loop. A bicycle detector symbol should be applied at that location. Further, it is recommended the side chosen for placement consider positioning the bicyclist in a logical position to begin the movement in full view of motorists behind them. On the southbound approach, a 3 to 5 second delay on the right most detector to reduce unnecessary calls from right-turning vehicles.

At intersections with video detection, the field of view and detection zones may require some adjustments. At intersections with loop detection, it is most likely going to be feasible to leave the existing vehicle loops in place as the large size of the loop will adequately detect vehicles in a lane (even if a portion of the loop is not in the lane). Only locations where the lane shift results in a loop being located in or near an opposing lane should there be a need to re-install loops.

Assessment of Cone of Vision

In this example, the addition of the bike lane results in a lane shift of 5 feet. Due to the far side placement of the traffic signals required by the MUTCD and the long crossings typical for most arterials (5-7 lanes) in Aurora, there will be no need to relocate signal heads to meet MUTCD cone of vision criteria.

Design Level of Effort

This type of design should be able to be completed by a single staff person within 8-12 hours depending upon the need for field verification, measurements, and complicating geometry.

