



# AUROLA

*Bicycle and Pedestrian Master Plan*

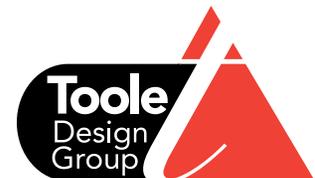


# AURORA

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## *Bicycle and Pedestrian Master Plan*

February 17, 2012  
Prepared by Toole Design Group



# ACKNOWLEDGEMENTS

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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.
- Provide guidance on best practices for pedestrian way finding (included in Appendix D).

- 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.



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.

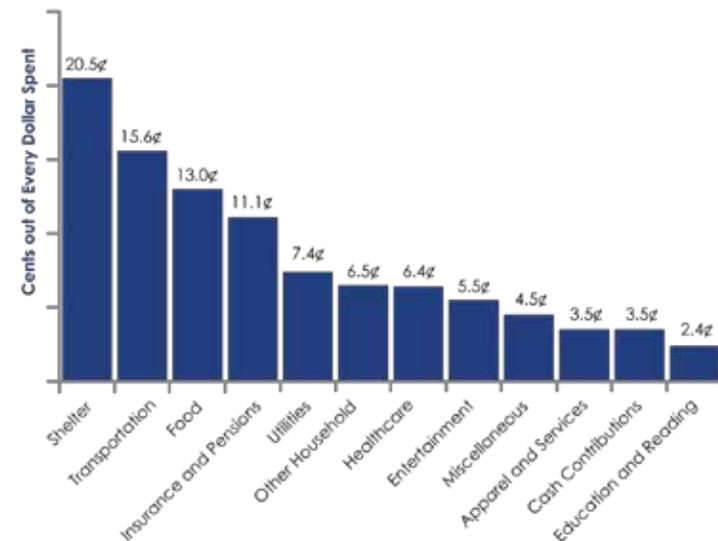
### Economic Development

- 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 8<sup>th</sup> among the top ten cities for young people.<sup>1</sup> 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.

<sup>1</sup> Sperling's Best Places featured on CNBC.com

- Aurora has also made the U.S. News “best places” list for retirement.<sup>1</sup> 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.<sup>2</sup> 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)

<sup>1</sup> <http://money.usnews.com/money/retirement/best-places-to-retire/colorado/aurora>

<sup>2</sup> Surface Transportation Policy Project. “Housing and Transportation,” Online, [www.transact.org/library/factsheets/housing.asp#\\_ednref1](http://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.

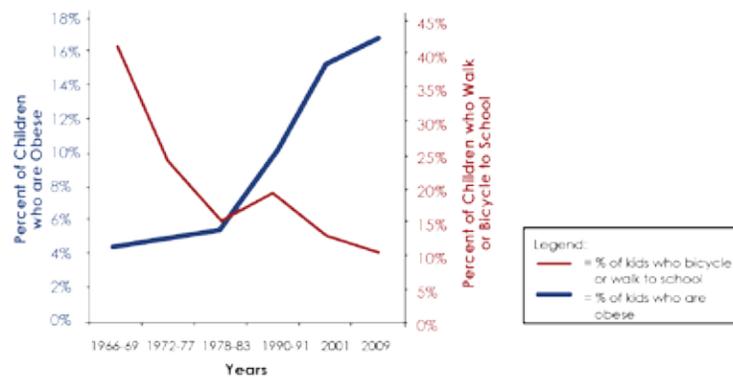
## Health

- 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.<sup>3</sup> 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

<sup>3</sup> 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.<sup>1</sup>
- 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.

**Trend in Obese Children vs. Rate of Bicycling and Walking to School**



CDC, NHANES, McDonald 2007, Odgen 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.

<sup>5</sup> Odgen 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 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.

#### 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.



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 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 160 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
<b>TOTAL</b>	<b>163.88</b>

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 Facilities<sup>1</sup> discusses the different ways in which to classify different types of bicycle riders, including comfort level, physical ability, and trip purpose.

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

When planning 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 2.2 below, 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 6<sup>th</sup> 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 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



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.

- 13<sup>th</sup> 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 6<sup>th</sup> 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 Westerly Creek Trail and proposed Montview stop on the Regional Transit 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 how 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.

The detailed analysis of Montview Boulevard identifies several alternative cross section designs for the roadway. All of these designs will require further analysis and input from the neighborhood residents and businesses before a final design can be chosen that best supports the economic development and neighborhood revitalization goals and objectives planned for this area of the city. 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.

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.

*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*

## 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 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.



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

### **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,

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 project 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, promotion of walking and biking and 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 wheresome 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 staff to oversee project coordination and integration, project design, administer education and encouragement programs, conduct public outreach, and monitor and report 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 to assist with 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.

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.

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. 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.<sup>1</sup> More cities are also dedicating annual city budget funds to walking and biking improvements and maintenance, which range from \$200,000 to \$15 million with a median of \$1.6 million.<sup>2</sup>



- <sup>1</sup> 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.
- <sup>2</sup> Alliance for Biking and Walking 2012 Benchmarking Report.

**Action 4.1:** Provide annual 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. A 2012 Capital Transportation and Infrastructure Tax Extension Project proposal offers an opportunity to finance the high-priority early action projects for the 1-3 year time frame discussed in section 3.3 below and shown on Figure 3-1.

**Action 4.2:** 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 4.3:** 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 4.4:** 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 grant opportunities other than DRCOG TIP projects.

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 4.5:** 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 service<sup>3</sup> 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

<sup>3</sup> 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 exists<sup>4</sup> for trails where bicyclists of varying degrees of experience are frequently operating in mixed use with pedestrians, joggers, roller bladers, 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

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.



## 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 1-1 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 <a href="http://www.bikeleague.org/programs/bicyclefriendlyamerica/communities/">www.bikeleague.org/programs/bicyclefriendlyamerica/communities/</a> 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. 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 and Nine Mile rail stations. 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.

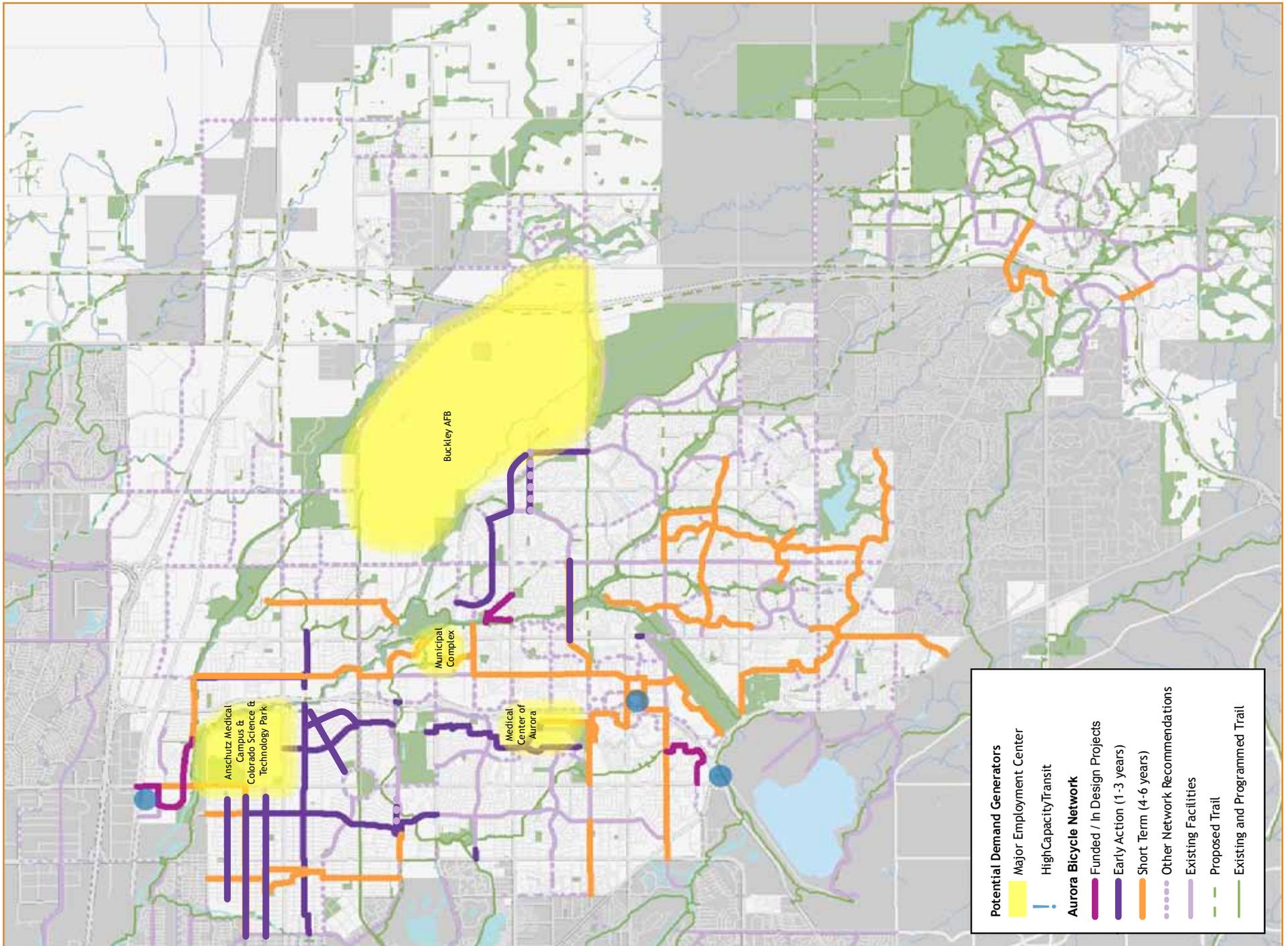
The following examples illustrate a phased strategy:

- 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 cost 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.

### 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 20.65 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.



**Project Name: Montview Boulevard (Yosemite St to Peoria St)**

**Project Description:** Construct enhanced sidewalks, bike lanes, street medians, and pedestrian crossings throughout the two-mile corridor entryway.

Routing Criteria		Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none"> <li>Anschutz Medical Campus &amp; Colorado Science &amp; Technology Park</li> </ul>	<ul style="list-style-type: none"> <li>Provides significant pedestrian safety benefits</li> <li>Provides an opportunity to develop high quality, high profile project with high potential bike ridership</li> <li>See Appendix C for full analysis of design options</li> </ul>
Links High Capacity Transit	<ul style="list-style-type: none"> <li>Montview light rail station</li> </ul>	
Links Multiple Community Facilities	<ul style="list-style-type: none"> <li>5 schools within 2 blocks</li> <li>Moorhead Recreation Center</li> </ul>	
Links to Trail Access points	<ul style="list-style-type: none"> <li>Westerly Creek Trail</li> <li>Sand Creek Trail</li> </ul>	
Addresses Significant Barriers	<ul style="list-style-type: none"> <li>None</li> </ul>	
Provides Parallel Route to High Traffic Street	<ul style="list-style-type: none"> <li>Colfax Ave</li> </ul>	

Project Name: Fitzsimons Campus – Local Bicycle Access (17 <sup>th</sup> Ave, 23 <sup>rd</sup> Ave, Xanadu St, and Hofman Blvd)		
Project Description: Install bicycle route signs and sharrow stencils and provide arterial street crossing safety improvements.		
Routing Criteria		Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none"> <li>▪ Anschutz Medical Campus &amp; Colorado Science &amp; Technology Park</li> <li>▪ Links Aurora and Denver</li> </ul>	<ul style="list-style-type: none"> <li>▪ Relative Cost: Low</li> <li>▪ Bicycle &amp; pedestrian improvements at arterial crossings should be coordinated</li> </ul>
Links High Capacity Transit	<ul style="list-style-type: none"> <li>▪ Montview Blvd and Colfax Ave light rail stations</li> </ul>	
Links Multiple Community Facilities	<ul style="list-style-type: none"> <li>▪ 3 schools within 1 block</li> <li>▪ Moorhead Recreation Center</li> </ul>	
Links to Trail Access points	<ul style="list-style-type: none"> <li>▪ Westerly Creek Trail</li> <li>▪ Tollgate Creek Regional Trail (proposed)</li> </ul>	
Addresses Significant Barriers	<ul style="list-style-type: none"> <li>▪ None, but would provide arterial street crossing improvements</li> </ul>	
Provides Parallel Route to High Traffic Street	<ul style="list-style-type: none"> <li>▪ Colfax Ave, Peoria St, Potomac St</li> </ul>	

**Project Name: Moline Street (Montview to Alameda, includes short segment of 4<sup>th</sup> Way, Lima St, and 1<sup>st</sup> Ave)**

**Project Description:** Add shared lane markings and signage, 1<sup>st</sup> Ave and Moline St between 1<sup>st</sup> Ave and Alameda Ave to have bike lanes. Install shared lane markings where there are existing roundabouts and medians.

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

**Project Name: Potomac St 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 Wheeling Way and Ursula Street. Bicycle boulevard to include signing, pavement markings, bicycle advantage stop control, and arterial street crossing improvements. Final design and implementation timeframe 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"> <li>▪ Anschutz Medical Campus &amp; Colorado Science &amp; Technology Park</li> <li>▪ Aurora Medical Center</li> </ul>	<ul style="list-style-type: none"> <li>▪ Relative Cost: Planning – Low, Design/Construction - Medium</li> <li>▪ Widen existing trail (Ursula St) on east side of Aurora Hills Golf Course</li> <li>▪ Crossing at Xapary St/Alameda Ave needs to be improved with signal and/or crossing island</li> <li>▪ Utilize 8' sidewalk on north side of alameda Ave (between Xapary St and Ursula St) or investigate using private driveway associated with churches on north side of alameda Ave (connects to Cedar Ave trail stub)</li> </ul>
Links High Capacity Transit	<ul style="list-style-type: none"> <li>▪ Not directly</li> </ul>	
Links Multiple Community Facilities	<ul style="list-style-type: none"> <li>▪ 4 schools within 2 blocks</li> <li>▪ Bicentennial Arts Center</li> <li>▪ 3 parks</li> </ul>	
Links to Trail Access points	<ul style="list-style-type: none"> <li>▪ 6<sup>th</sup> Avenue Trail</li> <li>▪ High Line Canal Trail</li> </ul>	
Addresses Significant Barriers	<ul style="list-style-type: none"> <li>▪ None</li> </ul>	
Provides Parallel Route to High Traffic Street	<ul style="list-style-type: none"> <li>▪ Potomac St (0.25 miles)</li> </ul>	

Project Name: Mexico Avenue (Chambers Road to Buckley Road)	
Project Description: Re-channelize roadway, i.e. road diet from 4 lanes to 3 lanes (including center turn lane) and extend existing bike lanes that stop east of Buckley Road to Tollgate Creek Trail.	
Routing Criteria	Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none"> <li>▪ Relative Cost: Low,</li> <li>▪ Provides opportunity to install high quality bicycle facility</li> <li>▪ Likely to have traffic calming benefits</li> <li>▪ Likely to reduce the potential for motor vehicle crashes, particularly rear-end crashes</li> </ul>
Links High Capacity Transit	
Links Multiple Community Facilities	
Links to Trail Access Points	
Addresses Significant Barriers	
Provides Parallel Route to High Traffic Street	
<ul style="list-style-type: none"> <li>▪ Enhances connection to Buckley Air Force Base</li> <li>▪ Not directly</li> <li>▪ 1 school within 2 blocks</li> <li>▪ Connects neighborhoods to large open space</li> <li>▪ Tollgate Creek Regional Trail</li> <li>▪ None</li> <li>▪ None</li> </ul>	

**Project Name: Kalispell Way/Kentucky Avenue/Uravan Street**

Project Description: Re-channelize roadway, i.e. road diet from 4 lanes to 3 lanes (including center turn lane) and extend existing bike lanes that stop east of Buckley Road to Tollgate Creek Trail.

Routing Criteria	Other Considerations
Links Major Employment Areas <ul style="list-style-type: none"> <li>▪ Buckley Air Force Base</li> </ul>	<ul style="list-style-type: none"> <li>▪ Relative Cost: Low</li> <li>▪ Stripe 7-foot parking lane to provide a 6-foot bike lane (west of Buckley Rd)</li> <li>▪ Buffered bike lane (east of Buckley Rd)</li> </ul>
Links High Capacity Transit <ul style="list-style-type: none"> <li>▪ Not directly</li> </ul>	
Links Multiple Community Facilities <ul style="list-style-type: none"> <li>▪ 1 school</li> <li>▪ Multiple parks</li> </ul>	
Links to Trail Access Points <ul style="list-style-type: none"> <li>▪ Tollgate Creek Regional Trail</li> </ul>	
Addresses Significant Barriers <ul style="list-style-type: none"> <li>▪ None</li> </ul>	
Provides Parallel Route to High Traffic Street <ul style="list-style-type: none"> <li>▪ Alameda Parkway (0.50 miles)</li> </ul>	

**Project Name: South Buckley Air Force Base Gate Connections (from the intersection of Mississippi Avenue and Uravan Street east and south to the intersection of Dunkirk Street and Louisiana Avenue)**

Project Description: Install bicycle facility signs to alert motor vehicle drivers and direct bicyclists in the vicinity of the South Buckley Air Force Base gate

Routing Criteria	Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none"> <li>▪ Relative Cost: Low</li> <li>▪ Provides a critical missing link to a major employer</li> </ul>
Links High Capacity Transit	
Links Multiple Community Facilities	
Links to Trail Access Points	
Addresses Significant Barriers	
Provides Parallel Route to High Traffic Street	



**Project Name: Exposition Avenue Extension**

Project Description: Extend existing bicycle lanes on Exposition Avenue west to Havana Street.

Considerations

- Relative Cost: Low
- Consider one of several options:
  - Shared right-turn lane
  - Reduce width of eastbound vehicle lane and shift westbound vehicle lanes to accommodate westbound bicycle lane up to the Havana intersection
  - Widen sidewalk on north side of Exposition Avenue and use signs and pavement markings to transition users

**Project Name: 12<sup>th</sup>/13<sup>th</sup> Avenue Bike Boulevard (Yosemite St East to the High Line Canal Trail East of Hinkley High School)**

**Project Description:** conduct preliminary planning and neighborhood outreach for developing a bicycle boulevard, including signing, pavement markings, bicycle advantage stop control, and arterial crossing improvements. Final design and implementation timeframe will depend upon neighborhood acceptance, traffic analysis, and modification of the city's current traffic calming approach.

Routing Criteria		Other Considerations
Links Major Employment Areas	<ul style="list-style-type: none"> <li>▪ Anschutz Medical Campus &amp; Colorado Science &amp; Technology Park</li> <li>▪ Links Aurora and Denver</li> </ul>	<ul style="list-style-type: none"> <li>▪ Relative Cost: Planning – Low, Design/Construction - Medium</li> <li>▪ Arterial crossings of Peoria and Potomac need improvements</li> <li>▪ Project phasing may include signing, pavement markings, establishing bicycle advantage stop control, traffic calming measures</li> <li>▪ Provides opportunity to develop a high quality, high profile project with very high potential ridership</li> </ul>
Links High Capacity Transit	<ul style="list-style-type: none"> <li>▪ 13<sup>th</sup> Ave light rail station</li> </ul>	
Links Multiple Community Facilities	<ul style="list-style-type: none"> <li>▪ 8 schools within 2 blocks</li> <li>▪ 2 libraries within 2 blocks</li> </ul>	
Links to Trail Access points	<ul style="list-style-type: none"> <li>▪ High Line Canal Trail</li> <li>▪ Westerly Creek Trail</li> <li>▪ Tollgate Creek Regional Trail (proposed)</li> </ul>	
Addresses Significant Barriers	<ul style="list-style-type: none"> <li>▪ Upgrade to the existing foot bridge over Tollgate Creek, Peoria St</li> </ul>	
Provides Parallel Route to High Traffic Street	<ul style="list-style-type: none"> <li>▪ Colfax Ave (0.25 miles)</li> </ul>	

### 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
<b>TOTAL</b>	<b>159.84</b>	<b>\$12,676,347</b>

\*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.



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