Appendix D

Existing Conditions and Needs Memorandum

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MONROE NEIGHBORHOOD STREET DESIGN PLAN

TECHNICAL MEMORANDUM #2: NEEDS, CONSTRAINTS, AND POTENTIAL SOLUTIONS

September 11, 2015

Contents

Introduction and Context

Located in northern Clackamas County, Monroe Street has been envisioned by local and regional governments as a primary active transportation route stretching east from the Trolley Trail in Milwaukie to the Interstate 205 Multi-Use Path located in the unincorporated portion of the County. This connection

would improve local access to two lines on the MAX regional light rail system -- the Green Line along I-205 and the newly completed Orange Line in Milwaukie -- and would provide safer bicycling and walking to and within the Clackamas Regional Center. Ultimately, the project would link downtown Milwaukie and the Clackamas Town Center, connecting local neighborhoods to schools, jobs, shopping and parks along the way.

The City of Milwaukie developed a concept design plan for the portion of Monroe Street within city limits, the Monroe Street Neighborhood Greenway Concept Plan, in early 2015. Clackamas County is now planning for the portion of the corridor from SE Linwood Avenue to I-205, a distance of 1.5 to 2 miles, depending on which of several route alternatives is chosen.

This technical memorandum describes the needs, constraints and potential solutions in the corridor, as well as potential design tools to address those needs. The purpose of this memorandum is not to select an alternative, but to describe the conditions and context in which that selection will be made.

Policy Context

The Clackamas County Transportation System Plan (TSP) identifies SE Monroe Street as a key east-west bicycle route connection. The Clackamas County Active Transportation Plan (ATP) designates Monroe as a Principal Active Transportation Route, and Metro's Regional Transportation Plan and Active Transportation Plan identifies Monroe as a Bicycle Parkway, that plan's highest-level bicycle classification. The City of Milwaukie has also designated the stretch of Monroe within city limits as a Neighborhood Greenway in the Milwaukie TSP.

A more detailed analysis of the policy context for the project is contained in the *Monroe Neighborhood Street Design Plan Policy Framework and Alternative Analysis Selection Criteria Memorandum* (August 2015). A list of relevant Clackamas County TSP projects is included as **Appendix C**.

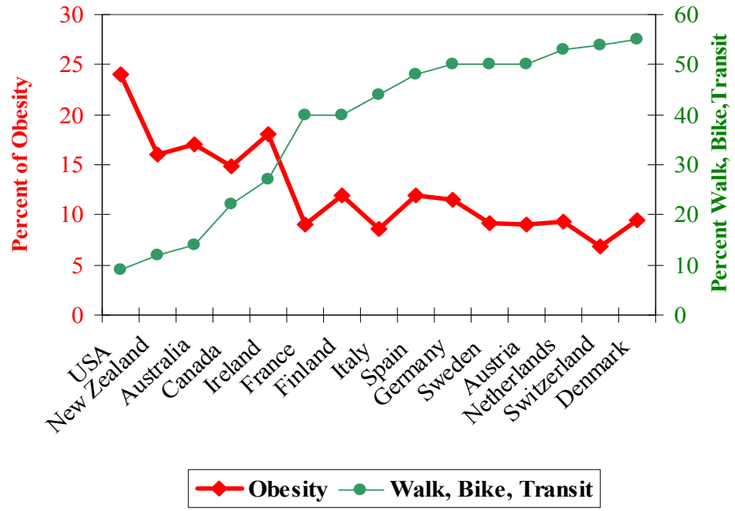
Project Objectives

The Monroe Neighborhood Street Design Plan project (Monroe Plan) is intended to support a healthy and active community by improving bicycle and pedestrian access in an area where dedicated facilities are infrequent and discontinuous. The plan will develop a neighborhood street design that improves safety for all modes of travel, but has a particular focus on creating safer and more comfortable conditions for pedestrians and cyclists. Plan elements will include stormwater management features (such as green street treatments) to address pavement runoff as well as crossing treatments at major intersections.

The Monroe Plan will also include a Safe Routes to School (SRTS) Plan for Whitcomb Elementary School, located on Thompson Street at 74th Avenue. The SRTS plan will identify sidewalk and bicycle gaps and deficiencies within the Whitcomb attendance area, and document road characteristics and intersection improvements conducive to increasing pedestrian and bicycle safety and comfort for school-age children.

Increasing Active Transportation to Improve Public Health

Throughout the U.S. and in Oregon, the rising rate of obesity (along with attendant conditions such as stroke, heart diseases and diabetes) has been identified as a critical public health issue. Numerous studies have documented lower obesity rates in places with higher active transportation levels, as shown in the chart below.



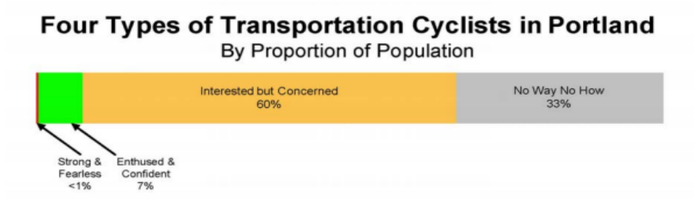
Obesity/Active Transportation Relationship Source (Source: Pucher and Dijkstra, 2003)

Both the Clackamas County Active Transportation Plan and the Metro Regional Active Transportation Plan articulate goals to increase walking and bicycling throughout the Portland Metro region to help improve public health in the region.

Safety and Comfort on Different Types of Streets

Throughout the U.S., surveys have found that the number one reason people do not ride bicycles is fear of being injured by motor vehicles. Different types of riders have a different level of tolerance for traffic; a few stronger, more experienced cyclists may be comfortable in conditions that the majority of riders would find intimidating.

A well-accepted "continuum of cyclists," developed in 2005 by the City of Portland, is shown in the following graphic:



Representing a tiny percentage of the population, the "Strong and the Fearless" are riders who are generally undeterred by roadway conditions.

"Enthused and Confident" cyclists are comfortable sharing the roadway with automotive traffic, but they prefer the safety and comfort of bicycle lanes and bicycle boulevards. This demographic rises as more bicycle facilities are put in place, but it is still a relatively small section of the population.

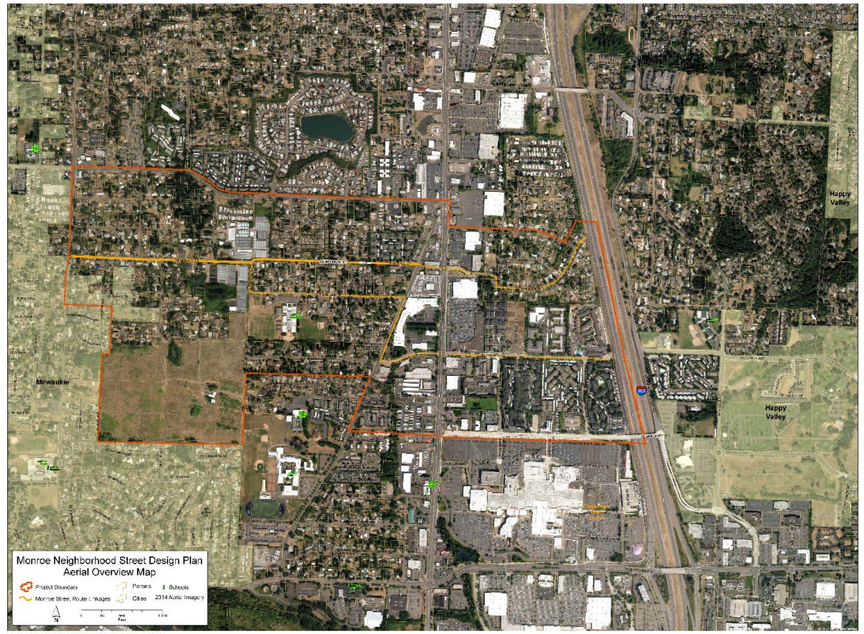
A much larger demographic is the "Interested but Concerned" group. These people are curious about bicycling, and often enjoy recreational riding on separated paths, but they are afraid to ride on streets with cars and trucks. They would ride if they felt safer on the roadways—if there were more quiet streets with few motorized vehicles and paths without any cars at all. Finally, about one-third of the population falls into the "No Way, No How" group that is currently not interested in bicycling at all.

As shown in the graphic above, increasing cycling among the "Interested but Concerned" group represents a huge opportunity to get more people more physically active. The challenge is to create facilities where ordinary people – including children, parents, and older adults – feel protected from the dangers of traffic.

The Monroe Plan project offers an opportunity to create a facility that, in addition to improving pedestrian connections and safety, attracts "Interested but Concerned" bicyclists. Different sections of the project area will require different treatments to achieve this objective. Lower-traffic sections lend themselves to "neighborhood greenway"-type treatments designed to create shared space for all users. These treatments help slow vehicle speeds and discourage cut-through traffic, creating a quiet neighborhood street environment that allows even vulnerable users (such as children and the elderly) to walk and bicycle safely and comfortably. Higher-traffic sections will likely require roadway treatments – such as paths, sidewalks and/or separated bike lanes – that separate pedestrians and bicyclists from cars.

Project Study Area

The Monroe Plan will consider a range of alternatives to provide a safe pedestrian and bicycle connection from the intersection of Monroe Street and Linwood Avenue and the I-205 Multi-Use Path. The map below illustrates the extent of the project study area; potential route options for the Monroe Neighborhood Street Design Plan are shown in yellow.



Note: Map shown above is a placeholder for final map showing all potential route alternatives.

Route Alternatives

This memorandum proposes six route alternatives for further analysis using previously-defined selection criteria.[1] The six proposed alternatives include the following:

Alternative 1: Monroe Street – Boyer Drive (Extended) – 85th Ave – Spencer Drive

Alternative 2: Monroe Street – Fuller Road – Causey Avenue

Alternative 3: Monroe Street – Maplehurst Road/Harmony Drive – Causey Avenue

Alternative 4: Monroe Street – Maplehurst Road/Harmony Drive – Fuller Road – Boyer Drive (Extended) – 85th Ave – Spencer Drive

Alternative 5: Monroe Street – Thompson Road – Fuller Road – Boyer Drive (Extended) – 85th Ave – Spencer Drive

Alternative 6: Monroe Street – Thompson Road – Fuller Road – Causey Avenue

These six alternatives were identified as potential pedestrian and bicycle routes that meet the Monroe Neighborhood Street Plan project goal of improving safety for all modes of travel, with a particular focus on pedestrians and cyclists. Monroe Street itself was given special consideration in light of its designation as a key bicycle and pedestrian link in the Clackamas County TSP, the Clackamas County Active Transportation Plan, and Metro's Active Transportation Plan.

Segments that Comprise Route Alternatives

While each of the six Monroe Neighborhood Street alternatives is distinct, all include one or more of nine separate segments between Linwood Avenue and the I-205 Multi-Use Path. For analysis purposes, these segments have been organized into two sections, with 82nd Avenue serving as the boundary between Section A (west of 82nd Avenue) and Section B (east of 82nd Avenue). Section A contains seven route segments (A1 – A7) between Linwood Avenue and 82nd Avenue (OR 213). Section B contains two segments (B1 and B2) between 82nd Avenue and the I-205 Multi-Use Path. A summarized list of the route segments, organized by section is provided below.

Section A Segments (Linwood Avenue to 82nd Avenue)

- Segment A1: Monroe Street between Linwood Avenue and 72nd Avenue
- Segment A2: Monroe Street between 72nd Avenue and Fuller Road
- Segment A3: Thompson Road between 72nd Avenue and Fuller Road
- Segment A4: Fuller Road between Monroe Street and Causey Avenue
- Segment A5: Maplehurst Road-Harmony Drive between Monroe Street and Fuller Road
- Segment A6: Boyer Drive (Extended) between Fuller Road and 82nd Avenue
- Segment A7: Causey Avenue between Fuller Road and 82nd Avenue

Section B Segments (82nd Avenue to I-205)

- Segment B1: Boyer Drive-85th Avenue-Spencer Drive between 82nd Avenue and the I-205 Multi-Use Path
- Segment B2: Causey Avenue between 82nd Avenue and the I-205 Multi-Use Path

[1] Refers to the selection criteria identified in the *Monroe Neighborhood Street Design Plan Policy Framework and Alternative Analysis Selection Criteria Memorandum* (August 2015).

Overview of Conditions in the Corridor

The cross-section and overall character of the Monroe Neighborhood Street corridor vary considerably throughout the study area, including both low-traffic residential streets and busier collector roadways.

Monroe Street itself has two separate functional classifications in the Clackamas County TSP. Between Linwood Avenue and 72nd Avenue, it is classified as a Collector street.[2] East of 72nd Avenue to Fuller Road, it is classified as a Connector.[3] This includes the discontinuous section of Monroe Street east of SE 78th Avenue known as the "Monroe Gap." which is accessible only to pedestrians.

West of 78th Avenue on Monroe, the public right of way is nearly 60' wide. The effective pavement width is approximately 30'. A mix of soft shoulder and hard curb and gutter runs along the length of Monroe, but sidewalks are mostly absent west of 78th Avenue (with the exception of a 200' orphan section just east of 74th Avenue). East of the gap at 78th Avenue, the street character is more urban with a consistent 5' sidewalk on the north side of the street to Fuller Road. The predominant land use is low-density single-family residential west of 78th Avenue; several multi-family housing complexes are located between the gap and Fuller Road.

Between 72nd and 78th Avenues, Monroe Street is a relatively quiet two-lane local residential street with low volumes and speeds. This is primarily due to the gap in the roadway just east of 78th Avenue, which acts as a natural traffic diverter. This discontinuous section diverts motorists to Thompson Road one block south to reach Fuller Road and points east. Currently, there is a narrow dirt path that does not meet Americans with Disabilities Act (ADA) standards and is accessible only to pedestrians and bicyclists who walk their bikes. The Clackamas County Development Agency has contemplated completing the road sometime in the future, making Monroe a continuous auto route through the neighborhood. However, some Public Advisory Committee and community members have stated a preference to improve the gap for pedestrians and bicyclists only, and leave it closed to automobiles.

[2] A Collector is defined in the TSP as "principal carrier within neighborhoods or single land use areas. Links neighborhoods with major activity centers, other neighborhoods, and arterials. Generally not for through traffic. Low to moderate volume; low to moderate speed."

[3] A Connector "collects traffic from and distributes traffic to local streets within neighborhoods or industrial districts. Usually longer than local streets. Low traffic volumes and speeds. Primarily serves access and local circulation functions. Not for through traffic in urban areas."

Traffic Speeds and Volumes

Although much of Monroe Street has higher traffic volumes and speeds today than are desirable for a neighborhood greenway, the community has expressed support in a community survey for lowering speeds and reducing the amount of traffic on the street. Moreover, the street parallels arterial routes (King Road and Harmony Road) onto which through-vehicle traffic can be potentially redirected. The table below shows traffic speeds and volumes in the project corridor by section.

Observed Weekday Speeds and Volumes by Route Segment

Applies to:	Observation Location	Total Volumes (vehicles per day)	85th Percentile Speed (miles per hour)
Segment A1: Monroe Street between Linwood Avenue and 72nd Avenue	Monroe Street *@ 64th Ave*	2,039	32 mph
	Monroe Street *@72nd Ave*	1,710	34 mph
Segment A2: Monroe Street between 72nd Avenue and Fuller Road	TBD	TBD	TBD
Segment A3: Thompson Road between 72nd Avenue and Fuller Road	Thompson Rd *@79th Ct*	2,390	30 mph
Segment A4: Fuller Road between Monroe Street and Causey Avenue	Fuller Road *@ Monroe St*	3,539	35 mph
Segment A5: Maplehurst Road-Harmony Drive between Monroe Street and Fuller Road	Harmony Drive *@ west of Fuller Rd*	1,031	32 mph
Segment A6: Boyer Drive Extended between Fuller Road and 82nd Avenue	Will be constructed in 2017		
Segment A7: Causey Avenue between Fuller Road and 82nd Avenue	Causey Avenue *@ 400' east of Fuller Rd*	5,048	29 mph
Segment B1: Boyer Drive-85th Avenue-Spencer Drive between 82nd Avenue and I-205 Multi-Use Path	TBD	TBD	TBD
Segment B2: Causey Avenue between 82nd Avenue and I-205 Multi-Use Path	Causey Avenue *@ 400' east of 82nd Avenue*	6,358	30 mph

Lack of Safe Pedestrian Facilities

Built in the early 1960s, subdivisions throughout the study area were constructed largely without sidewalks. Monroe Street and Thompson Road, which have public rights-of-way between 40' and 60' in this neighborhood, lack sidewalks with the exception of a short section on the south side of Thompson Road to improve pedestrian access to Whitcomb Elementary School from the east.

In many locations, features from adjoining front yards (such as hedges or fences), in addition to trees and utility poles, constrain the usable width of the street. As a result, people must walk along a narrow shoulder next to vehicles traveling 25-35 miles mph or faster, creating an uncomfortable environment that is especially inhospitable to people who use mobility devices such as wheelchairs. Except for disconnected sections built piecemeal as part of newer residential development, Maplehurst Road and Harmony Drive lack sidewalks.

East of 82nd, Spencer Drive also lacks sidewalks, but as a dead-end residential street it has considerably lower volumes. While 82nd Avenue, Fuller Road and Causey Avenue do have sidewalks, they are frequently narrow and adjacent to the roadway, creating an unwelcoming pedestrian environment. Most of the corridor is also missing ADA-compliant curb ramp treatments.

Lack of Continuous Bicycle Infrastructure

There are no continuous bicycle lanes traveling east-west through the study area. The closest facility is located three blocks north of Monroe on King Road, which terminates at 82nd Avenue (several blocks west of I-205). Bicycle lanes on King Road are the minimum standard width of 5'. With average (85th percentile) speeds on King exceeding 35 mph east of Linwood Avenue, these bike lanes may not be comfortable for less experienced cyclists.

Thompson Road has standard 5' bicycle lanes between Whitcomb Elementary School and Fuller Road. However, they do not continue further west along Monroe Street, and vehicles have been observed parked in the bicycle lane. Monroe itself lacks proper shoulders and has traffic volumes and speeds too high for low-stress shared conditions, with average daily traffic (ADT) volumes around 2,300 vehicles and average speeds exceeding 32 mph east of Linwood Avenue. There are no bicycle lanes on Monroe. However, the extension of Boyer Drive west to Fuller Road will include dedicated pedestrian and bicycle facilities, connecting Monroe Street to 82nd Avenue and points east.

Further south, Causey Avenue has traffic volumes exceeding 5,000 ADT east of 82nd Avenue, with only a few feet of westbound bicycle lane.

The north-south running I-205 Multi-Use Path is mostly complete between the Columbia River and Gladstone, with a short gap between 82nd Avenue and OR 212/224 south of Clackamas Town Center. In addition, there are north-south bicycle lanes along Fuller Road and 82nd Avenue, though these are discontinuous and only exist as far north as King Road and as far south as Clackamas Town Center. The dropping and adding of bicycle lanes, particularly at intersections and turn lanes, introduces potential conflicts between motor vehicles and bicyclists.

Difficult Crossings for All Modes

East-west travel for all modes can be challenging within the project area due to several crossings that present mobility and access barriers. The Linwood Avenue/Monroe Street intersection is two-way stop-controlled for Monroe Street traffic and can be difficult to cross due to heavy traffic on Linwood Avenue, lack of crosswalks and limited sightlines. Several collisions have been reported at that intersection, and the County's TSP has identified it as a safety focus intersection.

Further east, Fuller Road and 82nd Avenue are very wide streets that are difficult for pedestrians to cross and that lack midblock crosswalks or median refuge areas. 82nd Avenue's heavy traffic volumes (almost 30,000 ADT in 2013), numerous driveway access points and five-lane cross-section make for difficult crossing conditions. Marked crosswalks are located only at signalized intersections, which can be as much as a quarter mile apart.

Due to the high number of crashes along the entire 82nd Avenue corridor, Clackamas County (as well as Portland to the north) has identified 82nd Avenue candidate safety corridor. Crashes involving pedestrians and bicyclists on 82nd Avenue often result in serious injuries or fatalities.

I-205 also poses a major barrier to connectivity, with no crossings between Otty Road and Monterey Avenue, a distance of nearly one mile. This project is intended to improve access to the I-205 Multi-Use Path from points west, in order to make it easier for travelers to use the freeway overpasses.

Transportation Disadvantaged Populations

The highest population densities in unincorporated Clackamas County are located north of King Road between Linwood Avenue and 82nd Avenue, and east of 82nd Avenue between Causey Avenue and Otty Road.[4] These areas have been identified as having a high proportion of transportation disadvantaged populations, which have historically had significant unmet transportation needs or experienced disproportionate negative impacts from the transportation system.

Transportation disadvantaged populations are mapped by census block and calculated by considering the location of elderly populations, youth populations , low-income populations earning less than 200 percent of the poverty line, non-white and non-Hispanic populations, households with 0-1 vehicles, households where no adult speaks English well, and residential areas within 500' of a freeway or highway. The western part of the Greater Clackamas Regional Center/Industrial Area, particularly in the vicinity of SE King Road, has a high proportion of transportation disadvantaged areas. Clackamas County used this information to help identify new transportation projects in the most recent TSP update.

Access to transit is particularly important in transportation disadvantaged areas, where residents may have physical limitations, age-related limitations or economic circumstances that preclude driving to meet daily transportation needs.

The project study area is served by both light rail and bus service. The MAX Green Line along I-205 offers mid-day frequent service (defined as 15 minutes or better) between downtown Portland and Clackamas Town Center, but light rail service drops to 30-minute headways between Gateway and Clackamas in the evenings. A level of service analysis performed by Clackamas County found that bus service performs poorly with regards to service frequency. As part of the MAX Orange Line opening in Milwaukie and northern

[4] American Communities Survey 5-Year Estimates (2009 – 2013) indicates that Census Tract 216.01 has the highest population density within unincorporated Clackamas County (9,554.3 people per square mile).

Clackamas County in September 2015, TriMet is restructuring bus service in this area which will improve east-west transit service.

Providing safe, comfortable access to transit will be critical as service improves – and creating a network for residents to bicycle safely among key destinations will provide an important alternative means of mobility for those whose travel needs are outside the frequency and/or duration of transit service in the area.

Neighborhood Livability Concerns

Monroe Street is primarily a collector through the city of Milwaukie and Clackamas County and generally sees relatively high levels of through traffic, particularly during the afternoon peak period. Collector streets are intended as moderate-volume, moderate-speed streets that provide access and circulation within and between residential neighborhoods, commercial areas, and industrial areas.

Today, many motorists use Monroe in an effort to avoid congestion along Harrison Street and King Road, which can be especially heavy at 42nd Avenue and Linwood Avenue. Neighborhoods along Monroe have voiced concerns regarding the number of vehicles that travel through their communities, as well as the regularity of speeding traffic. Monroe east of Linwood Avenue has a speed limit of 25 mph, but average speeds are closer to 32 mph. The lack of bicycle and pedestrian facilities means residents must walk or bike along the edge of the roadway next to fast moving traffic, or avoid walking and bicycling entirely.

Lack of Street Connectivity

The study area is characterized by a disconnected street grid, which encourages through traffic to use King Road and Monroe Street/Thompson Road to access Fuller Road and 82nd Avenue from the west. While none of the street segments included as route alternatives have congestion above County performance standards, relatively high volumes on Linwood Avenue and King Road result in congestion and safety issues at the King/Linwood intersection.

Today, Monroe Street stops just east of SE 78th Avenue, where only pedestrians can travel along a narrow dirt path. Therefore, the predominant travel pattern is for motorists to use 72nd Avenue to travel one block between Monroe Street and Thompson Road. Occasionally, collisions occur along this S-curve. The roadway geometry also makes entering or exiting Monroe east of 72nd Avenue difficult due to poor visibility and the skew of the intersection.

Safe Routes to School: Whitcomb Elementary School

As part of the Monroe Plan, Clackamas County is partnering with Whitcomb Elementary School to develop a Safe Routes to School (SRTS) Action Plan. County and school staff are assessing area walking and bicycling conditions, identifying the safest routes to the school and solutions to help make those routes a reality. The Action Plan will use information gathered from travel assessments and student/parent surveys to develop recommended priority projects and activities for Whitcomb Elementary to promote safe walking and bicycling to school. The Action Plan, the first step in the process to apply for funding from the Oregon Safe Routes to School program for non-infrastructure projects and activities for K-8 grade schools, is scheduled to be completed in spring 2016.

Currently, students who live north of King Road or east of 82nd Avenue are bused to school due to hazardous crossings. An initial assessment by County staff of walking and bicycling conditions for students within these boundaries identified a number of needed improvements to make conditions safer, including the following:

- Marked crosswalks and signage in several locations, including the intersections of Fuller Road/Thompson Road, Fuller Road/Causey Avenue/Harmony Drive and Thompson Road/77th Avenue
- More continuous sidewalk coverage on Thompson Road, including the north side between Fuller Road and 72nd Avenue where none exists now, and on the south side west of the school
- Sidewalks along 72nd Avenue between Monroe Street and Thompson Road, where the S-curve creates hazardous walking conditions in the absence of sidewalks
- Sidewalks along 74th Avenue between Monroe Street and Thompson Road, where students often walk in the street because vehicles are parked on both sides of the roadway

There is a well-used, marked crosswalk at Thompson Road and 74th Avenue in front of the school. However, there are sight distance issues with motorists heading westbound in the uphill direction on Thompson Road approaching the school. Where the hill crests just east of 74th Avenue, It can be difficult for a motorist to see pedestrians crossing. Therefore, advance warning signage and a rapid flashing beacon may be considered to improve visibility and reduce travel speeds.

County staff have observed vehicles stopped in the shoulder in front of the elementary school, which obscures visibility to the west for motorists attempting to exit the school parking lot. While the curb is painted yellow within 15' to the west of the driveway to indicate on-street parking restrictions, its application is inconsistent, and it is not clear whether on-street parking is allowed anywhere along Thompson Road.

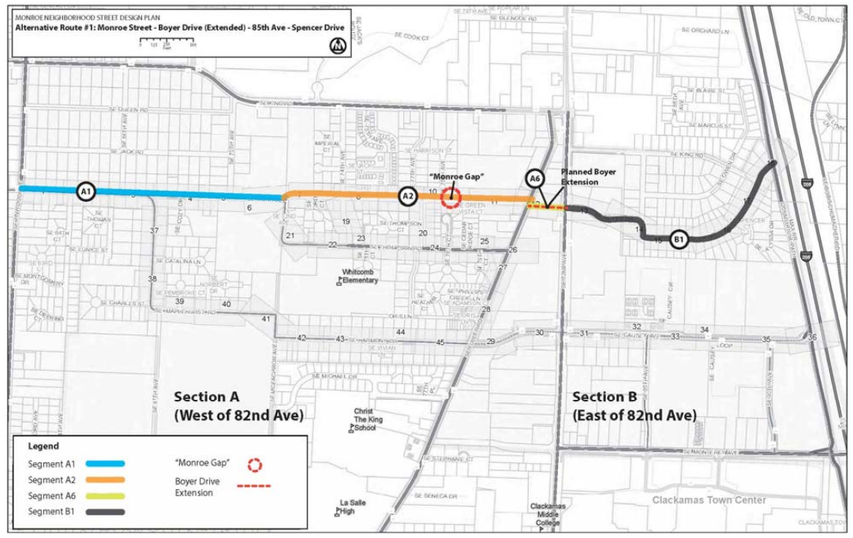
Some bicycle lane markings are present on Thompson Road between 74th Avenue and Fuller Road, although vehicles have been observed parked in the bicycle lane. The initial assessment also found that overgrown vegetation obscuring signage and visibility is an issue along Thompson Road.

To the south of the school, there is an informal walking path that leads to the corner of Maplehurst Road and McEachron Avenue. This path substantially reduces the access time from the south to the school for pedestrians, compared to following the street network. The County could potentially pave the path and make other improvements, although some neighbors have expressed concerns about that action. The entrance to the path on Maplehurst Road is located outside of the public right-of-way.

Summary of Proposed Route Alternatives

The following section provides short summaries for each of the six route alternatives being proposed for further analysis under the evaluation criteria and performance measures described in the Monroe Neighborhood Street Plan Policy Framework memo.[5]

Alternative 1: Monroe Street – Boyer Drive (Extended) – 85th Ave – Spencer Drive

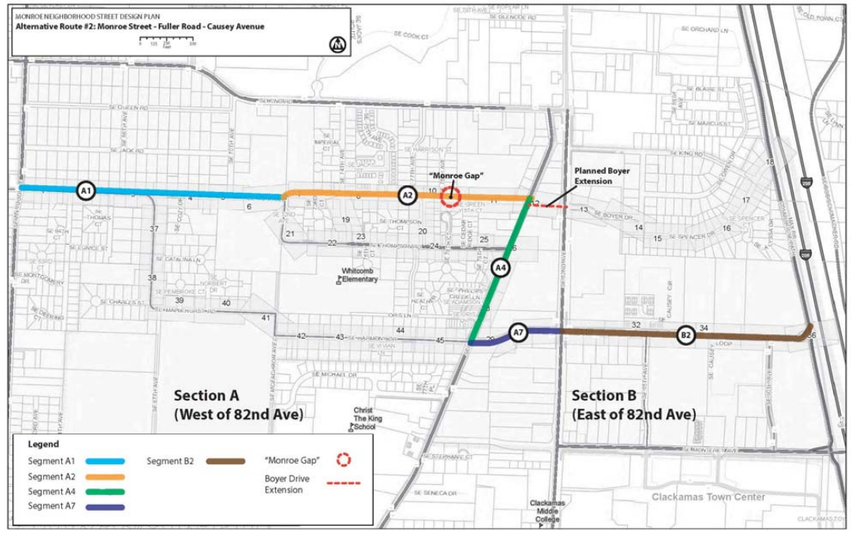


Alternative 1 contains segments A1, A2, A6, and B1.

Alternative 1 runs along Monroe from SE Linwood Avenue to 82nd Avenue, then follows Boyer Drive, 85th Avenue and Spencer Drive to the I-205 Multi-Use Path. This is the shortest and most direct connection of all the alternatives being considered. It assumes construction of the planned Boyer Drive extension between Fuller Road and 82nd Avenue. This alternative includes two design options for closing the "Monroe Gap", discussed further below.

[5] Refers to the selection criteria identified in the *Monroe Neighborhood Street Design Plan Policy Framework and Alternative Analysis Selection Criteria Memorandum* (August 2015).

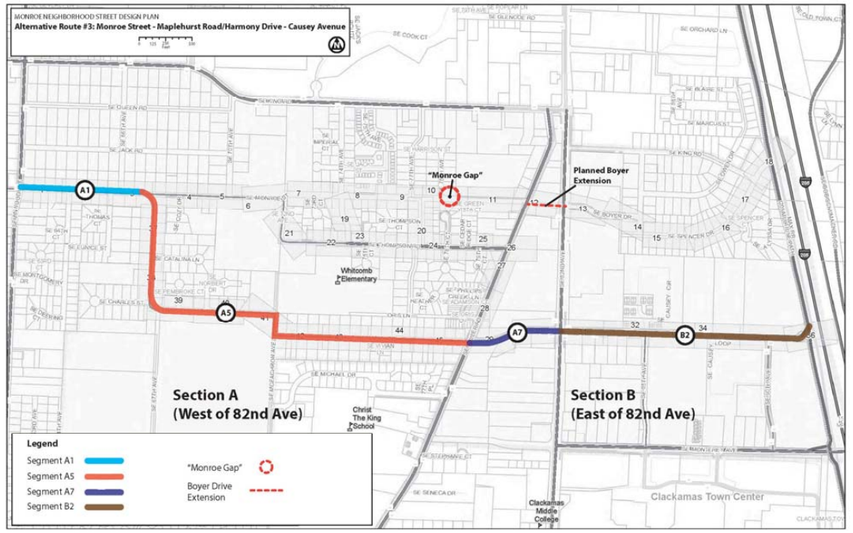
Alternative 2: Monroe Street – Fuller Road – Causey Avenue



Alternative 2 contains segments A1, A2, A4, A7, and B2.

Alternative 2 travels along Monroe between Linwood Avenue and Fuller Road, then follows Fuller Road south to Causey Avenue, and Causey Avenue between Fuller Road and the I-205 Multi-Use Path. This route alternative exhibits a z-shaped network path. This alternative also has two design options for closing the "Monroe Gap".

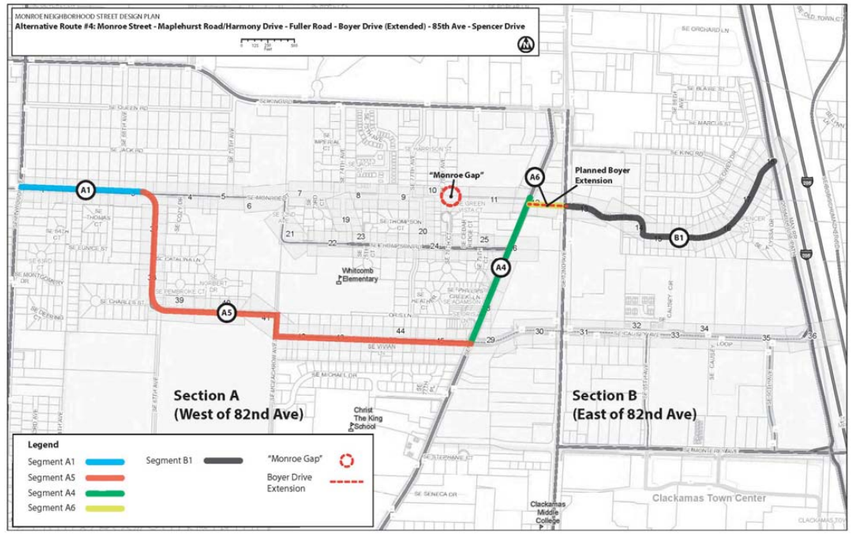
Alternative 3: Monroe Street – Maplehurst Road/Harmony Drive – Causey Avenue



Alternative 3 contains segments A1, A5, A7, and B2.

This alternative would travel from Monroe at Linwood Avenue to Maplehurst Road, and then continue south along Maplehurst/Harmony Drive to Fuller Road. At Fuller Road, Harmony Drive becomes Causey Avenue, which crosses 82nd Avenue before terminating at the I-205 Multi-Use Path.

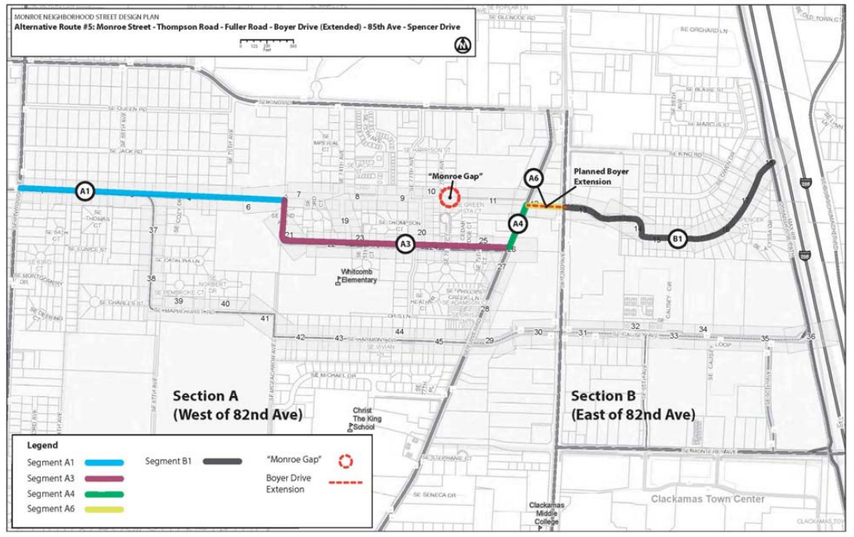
Alternative 4: Monroe Street – Maplehurst Road/Harmony Drive – Fuller Road – Boyer Drive (Extended) – 85th Ave – Spencer Drive



Alternative 4 contains segments A1, A5, A4, A6, and B1.

This route alternative runs on Monroe between Linwood Avenue and Maplehurst Road, then on Maplehurst Road/Harmony Drive from 72nd to Fuller Road, Fuller Road to Boyer Drive, and Boyer Drive to 85th Avenue and then Spencer Drive to connect with the I-205 Multi-Use Path. This U-shaped route is the longest the six alternatives. It also requires the most extensive travel along Fuller Road. This alternative assumes the extension of Boyer Drive.

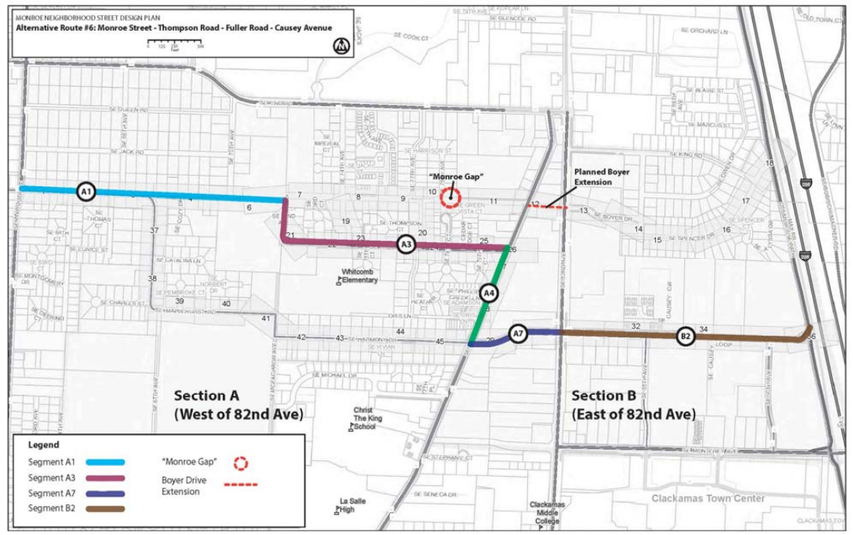
Alternative 5: Monroe Street – Thompson Road – Fuller Road – Boyer Drive (Extended) – 85th Ave – Spencer Drive



Alternative 5 contains segments A1, A3, A4, A6, and B1.

This route follows Monroe between Linwood Avenue and 72nd Avenue, then Thompson Road from 72nd Avenue to Fuller Road, Fuller Road to Boyer Drive, and Boyer Drive to 85th Avenue and Spencer Drive to connect to the I-205 Multi-Use Path. This alternative assumes the extension of Boyer Drive.

Alternative 6: Monroe Street – Thompson Road – Fuller Road – Causey Avenue



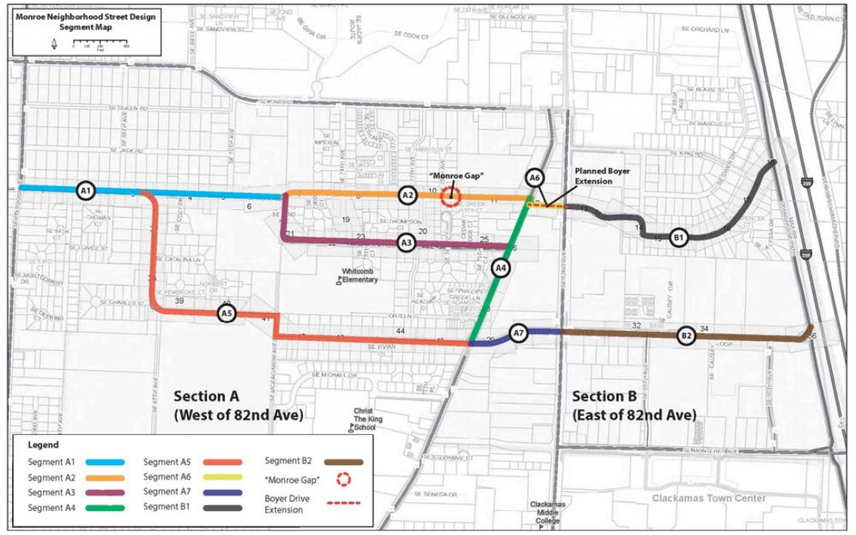
Alternative 6 contains segments A1, A3, A4, A7, and B2.

Alternative 6 runs along Monroe between Linwood Avenue and 72nd Avenue, then Thompson Road between 72nd Avenue and Fuller Road, Fuller Road between Thompson and Causey Avenue, and Causey Avenue between Fuller Road and the I-205 Multi-Use Path.

Segment-by-Segment Analysis: Needs, Constraints, and Potential Solutions

This section of the Needs Memorandum describes the individual segments that comprise the six route alternatives, summarizing the needs, opportunities and constraints therein. Potential design tools to address identified needs and opportunities are discussed for each segment. Existing conditions vary throughout the project corridor—and the applicable design tools for each section vary as a result.

The analysis is organized as follows:



Section A Segments (Linwood Avenue to 82nd Avenue)

- Segment A1: Monroe Street between Linwood Avenue and 72nd Avenue
  - *Design Option A1a: Completion of the Monroe Gap as Exclusive Bicycle/Pedestrian Facility*
  - *Design Option A1b: Completion of the Monroe Gap as Local Street Extension*
- Segment A2: Monroe Street between 72nd Avenue and Fuller Road
  - *Design Option A2a: Completion of the Monroe Gap as Exclusive Bicycle/Pedestrian Facility*
  - *Design Option A2b: Completion of the Monroe Gap as Local Street Extension*
- Segment A3: Thompson Road between 72nd Avenue and Fuller Road
- Segment A4: Fuller Road between Monroe Street and Causey Avenue
- Segment A5: Maplehurst Road-Harmony Drive between Monroe Street and Fuller Road
- Segment A6: Boyer Drive (Extended) between Fuller Road and 82nd Avenue
- Segment A7: Causey Avenue between Fuller Road and 82nd Avenue

Section B Segments (82nd Avenue to I-205)

- Segment B1: Boyer Drive-85th Avenue-Spencer Drive between 82nd Avenue and the I-205 Multi-Use Path
- Segment B2: Causey Avenue between 82nd Avenue and the I-205 Multi-Use Path

Needs and constraints are described for each segment, along with potential solutions. Detailed descriptions of particular tools can be found in **Appendix B**, which serves as a compendium of traffic calming, wayfinding and crossing treatments for bicycle and pedestrian infrastructure.

For in-depth descriptions of treatments for use on higher-volume streets, such as enhanced bicycle lanes and left turn bicycle boxes, the National Association of City Transportation Officials (NACTO) offers free, robust, online design guidance complete with diagrams, treatment benefits, typical applications, and suggested dimensions.[6] This is an important resource for jurisdictions working to improve bicyclist and pedestrian safety.

[6] Available at http://nacto.org/publication/urban-bikeway-design-guide.

Corridor-wide Tools

Certain tools are applicable to all segments throughout the project area, including the following:

Wayfinding Markings and Signage

Sharrows are pavement markings that help identify for all users the fact that bicyclists are expected to share the roadway and act as a reassurance symbol, informing riders that they are on the correct path. Wayfinding signs identify the street as a bicycle route, and often show approximate time and distance to nearby destinations (such as Clackamas Town Center, the Springwater Corridor trail, and local schools). Wayfinding signs can also direct bicyclists and pedestrians from arterial roadways to the Neighborhood Street and vice-a-versa. Sharrows and wayfinding signs are present along the length of Monroe Street in Milwaukie, although intermittently. Both sharrows and wayfinding signage are important active transportation elements, and the opportunity exists to apply them with greater frequency and consistency throughout the corridor.

Curb Extensions, Bioswales and Infiltration Basins

Installing permeable pavement shoulders, curbed bioswales or vegetated basins can result in a narrower-feeling street, slowing traffic while providing for stormwater infiltration. Curb extensions can also help delineate the pedestrian crossings at intersections. It is feasible to incorporate curb extensions into a street without providing curb and gutter along the entire street. ADA-compliant curb ramps could be added at intersections, with street parking accommodated between the bioswale.

Summary of Needs, Constraints, and Potential Solutions

The table on pages 23 and 24 summarizes the needs, constraints, and potential solutions corresponding to each of the nine route segments analyzed in the following sections.

Summary of Needs, Constraints, Opportunities, and Tools by Segment

Needs	Constraints	Opportunities	Potential Solutions
Segment A1: Monroe Street between Linwood Avenue and 72nd Avenue			
• Lower Motor Vehicle Speeds • Pedestrian Access and Visibility • Safe Route to School • Safe and Continuous Bike Route	• Limited available width • Crossing at Linwood Ave • Maplehurst Intersection Geometry • Koida Nursery Traffic	• Remove Double-Yellow Centerline • Narrow Width to Reduce Speeds • Integrate Stormwater Design • 70th Ave Improvement Project • Establish 70th Ave as Nursery Entrance • Wayfinding and Signage • Extent Whitcomb Elementary School Path • Boyer Drive Extension Project	• Neighborhood "Queue" Streets • Sidewalks and Pedestrian Paths • Crossing Signal Enhancements • Wayfinding Markings and Signage • Curb Extensions, Bioswales, and Infiltration Basins • Diversion to Reduce Traffic • Advisory Bicycle Lanes
Segment A2: Monroe Street between 72nd Avenue and Fuller Road			
• Pedestrian Facilities • Difficult Transition at 72nd Ave	• Poor Pavement Condition • Full Gap Closure Could Impact Livability	• Fuller Road Intersection Rebuilding • Reconfigure T-intersection at 72nd Ave • Improve Monroe Gap • Boyer Drive Extension Project	• Wayfinding and Signage • Narrow Roadway Width • Incorporate Stormwater Treatment
Segment A3: Thompson Road between 72nd Avenue and Fuller Road			
• Safety Concerns at 72nd Ave • Parking in Bicycle Lanes • High Volumes and Speeds • Discontinuous Bicycle Infrastructure	• Jog required at Fuller Road • Traffic Volumes and Bicycle Lanes Limit Traffic Calming Opportunities • Fuller Road Intersection Deficiencies	• Retrofit Curb Ramps for ADA Compliance • Rapid Flash Beacon at 74th Ave • Marked Crosswalk at 77th Ave • Intersection Enhancements at Fuller Road • Narrow Lane Widths to Install/Widen Bike Lane or Establish Bike Boulevard • Pedestrian and Bicycle Facilities West of 74th	• Wayfinding and Signage • Buffered Bicycle Lanes • Speed Cushions • Rectangular Rapid Flash Beacons
Segment A4: Fuller Road between Monroe Street and Causey Avenue			
• Lack of Marked Crosswalks • Door Zone Bicycle Lanes • Narrow Sidewalks	• High Travel Speeds • Out-of-Direction Travel	• On-Street Parking Capacity • Underutilized Right-of-Way • Narrow Lane Widths to Reduce Speeds • Signalization of Causey Ave	• Wayfinding and Signage • Wider Sidewalks • Pedestrian Enhancements • Protected or Buffered Bicycle Lanes • Left Turn Bicycle Boxes • Bicycle Signals and Leading Pedestrian/Bicycle Intervals
Segment A5: Maplehurst Road-Harmony Drive between Monroe Street and Fuller Road			
• Pedestrian Access and Visibility • Safe and Continuous Bike Route • Lack of Crosswalks or ADA Compliant Facilities	• Limited Available ROW • Circuitous Route	• Whitcomb Elementary School Access • Popular Bicycle Route	• Wayfinding and Signage • Traffic Calming • Pedestrian Facilities • Curb Extensions, Bioswales, and Infiltration Basins
Segment A6: Boyer Drive Extended between Fuller Road and 82nd Avenue			
• Safe Crossing at 82nd Ave • Cycle Track Transition at Intersections	• Potential Driveway Conflicts • Boyer Drive Construction Timeline • ODOT Jurisdiction over 82nd Ave • Long Wait Times at 82nd Ave	• Multimodal Improvements • Extend Bicycle Box to Accommodate Left-Turning Bicycles • Clackamas Regional Center MMA Project • Programmed Intersection Improvements	• Wayfinding and Signage • Bicycle Signals and Leading Pedestrian/Bicycle Intervals • Green Pavement Markings • Bicycle Detection • Median Refuge Islands • Tighter Corners
Segment A7: Causey Avenue between Fuller Road and 82nd Avenue			
• Discontinuous and Narrow Sidewalks • Lack of Bicycle Infrastructure • Safety Concerns at Intersections	• Philips Creek Bridge • ODOT Jurisdiction over 82nd Ave	• Complete/Rehabilitate Sidewalks • Improve ADA Accessibility • Reconfigure Lanes to Add Bike Facilities • Philips Creek Multi-Use Path Connections • Clackamas Regional Center MMA Project	• Wayfinding and Signage • Bicycle Signals and Leading Pedestrian/Bicycle Intervals • Bicycle Boxes • Green Pavement Markings • Bicycle Detection • Median Refuge Islands • Tighter Corners
Segment B1: Boyer Drive-85th Avenue-Spencer Drive between 82nd Avenue and I-205 Multi-Use Path			
• Bicycle Facilities on Boyer Drive • Lack of Sidewalks on 85th Ave • Collision Risk at 85th and Spencer	• Spencer Drive Grade • Allocation of Space on Boyer Drove • Multiple Turns Complicate Route	• Sufficient ROW to Add Infill Path • Less Busy Compared to Causey Ave • Requires Less Out-of-Direction Travel if headed North	• Wayfinding and Signage • Bicycle Lanes/Tracks • Treatments to Slow Downhill Bikes • All Way Stop Controls • Midblock Crosswalk and Median Refuge Islands
Segment B2: Causey Avenue between 82nd Avenue and I-205 Multi-Use Path			
• Bicycle Facilities on Causey Ave • Repaving and Sidewalk Repair • Missing Pedestrian Elements	• Very High Traffic Volumes • Narrow Cross-Section • Highly Utilized On-Street Parking	• Gentler Grade Compared to Spencer Drive • Nearby High Density Residential Development	• Wayfinding and Signage • Dedicated Bicycle Facilities • Traffic Calming • Curb Extensions • Midblock Crosswalks

Segment A1: Monroe Street between Linwood Avenue and 72nd Avenue

Segment A1 – Needs

Lower Motor Vehicle Speeds

This segment of Monroe acts as a through street for commuters, and is characterized by rolling hills and short sightlines. Despite qualities that would otherwise make Monroe a desirable street for expanded bicycle and pedestrian accommodations, the roadway has relatively fast motor vehicle traffic for a residential area. People who bike along Monroe generally cannot keep up with the speed of prevailing traffic, and lack of a shoulder makes for unsafe and uncomfortable bicycling conditions. Similarly, the lack of shoulder or sidewalks along most of the route makes walking along the street an unnerving pedestrian experience. Speed control is needed to create a safer and more inviting walking and bicycling environment.

Pedestrian Access and Visibility

Sidewalks are needed along this segment of Monroe. There are no sidewalks in this segment of Monroe except for the orphan section of sidewalk east of Maplehurst Road, which fosters a very unwelcoming pedestrian environment. There are no established pedestrian crossings within this section. Pedestrian visibility is a concern at several intersections, especially at the curve where Monroe transitions to 72nd Avenue.

Safe Route to School

A safe access route is also needed for students walking or biking to Whitcomb Elementary School just east of 72nd Avenue on Thompson.

Safe and Continuous Route for Bicyclists

This section has no bicycle-specific infrastructure or shoulder. High speeds make it difficult for people to use Monroe for low-stress bicycling. The centerline stripe along this entire segment makes it potentially even more challenging for drivers and bicyclists to share the road. A low-stress bicycle route is needed through this section of the project area.

Segment A1 – Constraints

Encroachment on Right-of-Way

One of the main constraints along this segment is the existence of encroaching features, both natural and human-made, that reduce the effective width of the roadway dedicated to bicycle and pedestrian infrastructure. Property owners have planted shrubs and hedges, and built fences and other structures within the County right-of-way (ROW), according to parcel maps. In addition, other features such as utility poles and mature trees are located in the ROW. The effective width of the pavement in this section is approximately 22'. Expanding the footprint of the roadway may impact ROW encroachments.

Crossing at Linwood Avenue

Monroe intersects with Linwood Avenue at the west end of the project area. Linwood Avenue is a relatively high-speed, high-volume roadway and its intersection with Monroe lacks sidewalks, corners, or crossing treatments. With poor sightlines from every angle, the intersection is considered difficult and dangerous by drivers, pedestrians and cyclists alike. Currently, this intersection is projected to fall below minimum traffic standards in the year 2035 for Monroe Street traffic only, assuming the existing two-way stop controlled intersection is preserved. The County has identified the area as a safety focus intersection, and with a need for crossing improvements for all users.

Maplehurst Road Intersection Geometry

The Monroe Street/Maplehurst Road intersection is a three-way intersection where Monroe traffic has the right-of-way and Maplehurst Road is stop-controlled. However, this intersection is not at a right angle, as Maplehurst Road curves to the northwest just south of Monroe, following the adjacent property lines. The skew of the intersection and extremely wide southwest curb radius means that motorists can take the turn at a very high rate of speed, potentially endangering the safety of pedestrians. For drivers waiting to turn onto Monroe, a large old-growth tree just east of intersection can obscure views of westbound traffic. Pedestrians on the south side of Monroe must navigate approximately 90'of pavement to cross the intersection of Maplehurst. Safety improvements are needed to protect pedestrians and bicyclists.

Koida Nursery Traffic

The Koida Nursery, located just east of 70th Avenue, attracts trips on Monroe. The nursery is located on both north and south sides of Monroe, causing increased vehicle trips across the street. Customers and freight trucks often use Monroe to access the nursery from the west throughout the day. In addition, nursery employees can cause increased traffic during peak commute periods. Although some off-street parking is available, employees and visitors often park along the shoulder of Monroe and surrounding streets, thereby limiting the ROW available for use by bicyclists and pedestrians.

Segment A1 – Potential Solutions

Remove Double-Yellow Centerline

Monroe Street has a double yellow centerline between Linwood Ave and Fuller Road. In general, federal and ODOT guidelines recommend a centerline where volumes exceed 3,000 vehicles per day (ODOT, 2011), which is greater than current volumes on Monroe. This presents an opportunity to consider removing the centerline, which poses several potential benefits. First, it encourages cyclists to follow a track closer to the center of the street away from the curb or parked cars. (Riding near the center deters unsafe passing maneuvers and avoids hazards such as opening car doors, right turn conflicts and road debris). Second, it encourages motorists to give more space when overtaking bicycles by eliminating the need to stay to the right of a double yellow line. Finally, removing the centerline signals to users that the street is a lower-speed, shared environment where all modes are equally prioritized.

Utilize Full Right-of-Way/Neighborhood "Queue" Streets

The existing right-of-way appears to be 40' wide which does not provide adequate width for the County standard for a collector. The County could apply the state's Neighborhood Street Design Guidelines to Monroe Street, which allow 14' to 16' of effective clear width on streets if there is on-street parking (State of Oregon, 2000). This is reduced from the effective 20' clear width mandated in the International Fire Code standards. However, the guidelines have been endorsed by the Office of the State Fire Marshal, Oregon Fire Chiefs Association and Oregon Fire Marshals Association. Expanding the footprint of the street to add bicycle and pedestrian infrastructure could potentially cause conflict with long-time residents who have planted or constructed features in the public ROW as an extension of their front yards.

This would create a "queuing street," lowering average speeds as motorists traveling in opposite directions take turns at pinch points. The effect would likely reduce traffic volumes by making Monroe less desirable as a through route. Such a design would require an exception from previously adopted County road standards. Currently, there is no formal on-street parking along Monroe, but new on-street parking or other features such as chicanes could be introduced to serve as traffic calming in strategic locations, while otherwise maintaining 20' clear width for fire truck access.

Provide Separated Pedestrian Accommodations

Milwaukie's Monroe Street Neighborhood Greenway Concept Design Plan recommended a north side permeable paved path between 42nd Avenue and Linwood Avenue to improve pedestrian access and safety. This path could be continued within the County section of Monroe or could switch to the south side as right-of-way allows.

Pedestrian facilities could include separated paths constructed with asphalt or permeable pavement and curb extensions at intersections. Curb extensions physically narrow the driving lane and create a shorter distance for pedestrian crossings while also creating an opportunity for stormwater treatment. Permeable pavement options are ADA-compatible and allow stormwater to infiltrate through the pavement instead of running off into the storm system.

One member of the Monroe Neighborhood Street Design Project Advisory Committee (PAC) suggested extending the path on the south side of Monroe east of Linwood Avenue in order to directly serve Whitcomb Elementary School, which is on the south side of Thompson Road. There may be opportunities further east to transition the path from the north to south side, such as the 72nd Avenue intersection.

Integrate Stormwater Design Treatments

As pedestrian and bicycle accommodation concepts and designs are developed, there will be various opportunities to integrate or separate stormwater treatment elements into these facilities. If conventional sidewalk and curb installation is not determined to be desirable or immediately feasible due to high cost, the County has an opportunity to consider alternative design treatments to accommodate pedestrians, handle stormwater, and calm traffic through multi-purpose green infrastructure. Examples include permeable pedestrian paths and landscaped curb extensions at intersections.

Establish 70th Avenue as Main Nursery Entrance

The 70th Avenue Improvement Project brought the street to a much higher standard of paving than Monroe, and presents an opportunity for the nursery to route all of its trucks to King Road via 70th Avenue, thereby avoiding the problematic Monroe Street/Linwood Avenue intersection.

Include bicycle and pedestrian improvements as part of the Boyer Drive Extension Project

This intersection will be rebuilt as part of the Boyer Drive Extension project, connecting Monroe Street directly to 82nd Avenue. Currently in the planning phase, this project will signalize the intersection, add marked crosswalks and realign Monroe slightly to the south to connect with Boyer Drive, thereby creating a new four-way intersection at Fuller Road. On-street parking on the east side of Fuller Road will be removed to install curb extensions at the northeast and southeast corners of the new intersection. All corners will include ADA-compliant curb ramps. There is also the possibility for a bicycle box to be installed at the east leg of the intersection.

Crossing Signal Enhancements

To aid in pedestrian and bicycle crossing, high-visibility marked crossings and advance signage could be installed to increase safety and comfort for vulnerable road users. A hybrid beacon is a special type of signalized crossing treatment used to warn and control traffic on a major street at an intersection with a minor street. The beacon is activated by a push-button and is used to help pedestrians and bicyclists cross a major street or highway at a marked crosswalk. This type of beacon could be an appropriate crossing treatment along collector roads with higher motor vehicle speeds and volumes.[7] Rectangular rapid flash beacons (RRFBs) are a lower-cost option that could help pedestrians and bicyclists cross at high-speed, high-volume intersections. RRFBs have yellow flashing lights activated via pushbutton or detection.

[7] The pedestrian volume thresholds required for this type of signal are significantly lower than for a traditional traffic signal.

Diversion to Reduce Traffic Volumes

Diversion is typically used where active transportation corridors on local streets intersect with higher-volume streets. Diverters restrict motor vehicle access into the neighborhood, but allow bicycles to continue straight through.[8] Diverters can incorporate curb extensions and green street features such as bioswales or infiltration basins. Median diverters can also create refuge areas for pedestrians and cyclists (provided the median island is wide enough).

Several types of semi-diverters may be considered to reduce traffic volumes and speed on this section of Monroe Street. A partial diverter completely restricts automobile movement in one direction (usually by prohibiting motorists from turning onto a neighborhood street off a major roadway), while permitting travel in the opposite direction. The partial diverter narrows the travel lane with curb extensions to discourage wrong-way driving. These features can be mountable to allow for emergency vehicle access.

A median diverter is a barrier in the median of a major cross-street where it intersects with a neighborhood greenway, blocking all through and left-turn motor vehicle traffic along the greenway in both directions, but providing cut-outs that permit through bicycle movement.

Snake diverters are mountable median diverters that reduce the volume of through traffic without narrowing the major cross-street. More elaborate median diverters are wider and incorporate refuge islands which provide a safe place for pedestrians and bicyclists to wait for a gap in traffic when crossing, while also narrowing the travel lanes along the cross-street to reduce speeds.

A right-in/right-out diverter has similar function to a snake median diverter, using islands to prevent through motor vehicle movements while permitting through bicycle access. These diverters typically are not designed to be mountable. The Monroe Street Greenway concept plan in Milwaukie recommended installing a median diverter at the Linwood Avenue intersection to reduce through traffic volumes and alleviate conflicts between roadway users.

A full diverter would completely prohibit motor vehicle access but allow pedestrians and bicyclists to continue unrestricted. They can be constructed to be permeable to emergency vehicles. A full diverter on Monroe at some point west of 72nd Avenue could be beneficial to reduce cut-through traffic and improve safety where numerous crashes have occurred at the S-curve, but would affect access to points east, including Whitcomb Elementary School. Koida Nursery traffic could use the upgraded 70th Avenue as primary access.

Advisory Bicycle Lanes

Advisory bicycle lanes are an experimental treatment that delineates space for bicyclists on roadways that are too narrow for standard bicycle lanes. Used primarily on lower-volume streets, advisory lanes are marked by a dashed line to the left and solid line to the right, giving bicyclists a space to ride but also allowing motorists to merge into them when necessary to pass oncoming traffic. Motorists must yield to bicycles in the advisory lanes, and must otherwise remain in the center travel lane. Because the street remains two-way, this narrow lane encourages motorists to be more cautious when negotiating passing vehicles. When advisory bicycle lanes are installed, the yellow centerline is removed.

[8] A good median diverter example is located on page 10 of the Washington County Neighborhood Bikeway Toolkit.

Segment A2: Monroe Street between 72nd Avenue and Fuller Road

East of 72nd Avenue, Monroe Street is a quieter two-lane local residential street with low volumes and speeds. This is primarily due to a gap in the roadway just east of 78th Avenue, which acts as a natural traffic diverter. This discontinuous section results in motorists diverting to Thompson Road one block south to reach Fuller Road and points east. Currently, there is a narrow dirt path that is not ADA-compliant and only accessible to pedestrians and bicyclists who walk their bikes. The Clackamas County Development Agency has contemplated completing the road sometime in the future, making Monroe the preferred route for through auto traffic in this neighborhood. However, some Public Advisory Committee and community members have stated a preference to improve the gap for pedestrians and bicyclists only, and leave it closed to automobiles.

Monroe Street is much wider in this section, with public ROW approaching 60' wide in some areas. The effective pavement width is also wider, at 30', compared to the more constrained area further west, which leaves sufficient room for on-street parking. There is a mix of soft shoulder and hard curb and gutter along Monroe, but sidewalks are mostly absent west of 78th Avenue with the exception of a 200' orphan section just east of 74th Avenue. East of the gap, the street character is more urban with a consistent 5' sidewalk on the north side of the street to Fuller Road. The predominant land use is low-density single-family residential west of 78th Avenue; several multi-family housing complexes are located between the gap and Fuller Road.

Segment A2 – Needs

Improved Pedestrian Facilities

Consistent with the section west of 72nd Avenue, Monroe is in need of new or improved pedestrian facilities. West of 78th Avenue, there are almost no pedestrian accommodations. East of the gap, there are narrow sidewalks directly adjacent to the curb and without ADA ramps. This sidewalk is generally in poor to fair condition; sidewalk rehabilitation and replacement could occur gradually as funding becomes available. The wider ROW width here offers an opportunity to repurpose the street to accommodate new pedestrian facilities, or expand the sidewalks toward the street with minimal impact on on-street parking. This would also narrow the street and, in turn, help calm traffic.

Safer Transition at 72nd Avenue

The existing intersection of Monroe Street and 72nd Avenue is difficult to negotiate for traffic entering or exiting the east leg of the intersection. Prevailing traffic uses the west and south legs, which have the right-of-way, while eastbound traffic continuing along Monroe must wait for northbound traffic on 72nd Avenue to clear before veering left. Traffic heading west on Monroe must also wait for an opening in traffic before turning. Visibility is a major problem at this intersection, and vehicles traveling the S-curve frequently exceed 25-30 mph, which can lead to collisions or close calls. There are no pedestrian accommodations (neither sidewalks nor crosswalks), resulting in a need for pedestrian safety improvements.

Segment A2 – Constraints

Poor Pavement Condition

The roadway surface at 77th Avenue is unimproved and would require complete reconstruction to allow through bicycle or automobile traffic.

Full Gap Closure Could Impact Livability

Monroe Street between 72nd and 78th avenues primarily serves local circulation and access. In an area that has no sidewalks or bicycle facilities, opening the gap for through automobile access would likely increase volumes on a street that is accustomed to relative quiet. It would also negatively impact pedestrian

conditions unless dedicated infrastructure was built throughout to close the current gap for motor vehicles. Such an investment would increase project costs significantly.

Segment A2 – Potential Solutions

Improve safety for pedestrians and bicyclists at the Fuller Road Intersection

The intersection of Monroe and Fuller Road is a three-way intersection, where Fuller Road traffic has right-of-way and Monroe traffic is stop-controlled. The curb radius at this intersection is wide, which allows right turning motorists to maintain higher speeds and sets up compromising safety conditions for bicyclists and pedestrians. Despite these current conditions, this intersection is planned to be rebuilt as part of the Boyer Drive Extension Project. This presents an opportunity to leverage existing plans and investments to make Monroe a safe and welcoming neighborhood street for all users.

Reconfigure T-Intersection at 72nd Avenue to improve safety

One option for reconfiguring the intersection is to install an all-way stop and marked crosswalks. However, this could lead to increased congestion on the prevailing route (west and south legs), which carry more traffic than the east leg.

Another option is to install a mini-roundabout at this intersection to keep traffic moving, but slow it to 10-15 mph. This solution would incorporate pedestrian crossings, reduce the severity of potential collisions and make it easier for vehicle or bicycle traffic to access Monroe east of 72nd Avenue. However, it would likely require easements or acquisitions from adjacent properties, including Koida Nursery.

Improve Monroe Gap

The Monroe Gap east of 78th Avenue should be improved at least to provide bicyclists and pedestrians uninterrupted access. A concrete or permeable paved pathway would need to be 12'-15' wide with ADA-compliant ramps and barriers installed on either side of the gap to accommodate two-way travel while preventing motorists from traversing this section (with the exception of emergency vehicles).

Developing the gap to full local street standards would allow automobile access and increase automobile volumes and speeds significantly along this section. This improvement would make Monroe east of 72nd Avenue unsuitable as a low-stress active transportation corridor.

Boyer Drive Extension Project

This intersection will be rebuilt as part of the Boyer Drive Extension project, connecting Monroe Street directly to 82nd Avenue. Currently in the planning phase, this project will signalize the intersection, add marked crosswalks and realign Monroe slightly to the south to connect with Boyer Drive, thereby creating a new four-way intersection at Fuller Road. On-street parking on the east side of Fuller Road will be removed to install **curb extensions** at the northeast and southeast corners of the new intersection. All corners will include ADA-compliant **curb ramps**. There is also the possibility for a **bicycle box** to be installed at the east leg of the intersection.

Narrow Roadway Width and Incorporate Stormwater Treatment

On-street parking is currently permitted on both sides of Monroe Street in this section, which makes the roadway feel spacious when parking lanes are unoccupied – and can lead to higher vehicle speeds. Installing curb extensions at intersections would narrow the roadway and provide a visual cue for motorists to slow down, while also reducing pedestrian crossing distance. Bioswales incorporated into the curb extensions could provide stormwater treatment opportunities and add "green" elements.

Bicycle Boxes

Bicycle boxes are dedicated areas at signalized intersections that allow bicyclists to pull in front of waiting traffic at red lights. Bicycle boxes help to reduce conflicts between right-turning motorists and straight-through bicycle riders (known as "right hook" collisions) and increase cyclist visibility at busy intersections.

They also provide the bicyclist a head start when the light turns green. Motorists cannot turn right on red at intersections when a bicycle box is present. Bicycle boxes could improve bicyclist safety and comfort on all corners of the Boyer Drive project intersection. Bicycle boxes would be particularly useful if Fuller Road is selected as part of the Monroe neighborhood street design, since bicycle riders will need a safe way to turn onto and off of Monroe.

Segment A3: Thompson Road between 72nd Avenue and Fuller Road

Thompson Road is a two-lane roadway and the continuation of Monroe Street east to Fuller Road past the S-curve where the road jogs south at 72nd Avenue. Whitcomb Elementary School is located at 74th Avenue. The public ROW width on Thompson Road varies between 40' to 50' and pavement width is generally 35'. Although the roadway is designed as a collector for through traffic, has almost identical traffic volume figures as Monroe west of 72nd Avenue (2,400 ADT at Fuller Road) and is built to a higher level of standard, the County designates Thompson as a local street instead of a collector street. Unlike Monroe, Thompson Road has conventional curbs and storm drainage, standard 6' bicycle lanes and a 5' sidewalk (curb-tight in some locations) on the south side of the street between Whitcomb Elementary School and Fuller Road. There is also a marked crosswalk at 74th Avenue for students and parents accessing the school from the north, although visibility is diminished for westbound motorists traveling uphill just before the intersection. The posted speed limit on Thompson Road is 25 mph, but there is a school zone speed limit of 20 mph between 7am and 5pm.

Segment A3 – Needs

Address Safety Concerns at 72nd Avenue

The S-curve where Monroe jogs south along 72nd Avenue to Thompson lacks any dedicated pedestrian or bicycle infrastructure and is a notable collision risk due to high speeds and poor visibility. The North Clackamas School District marks the curve as a hazard area and advises Whitcomb Elementary School students arriving from the west to walk on 74th Avenue and Monroe instead where traffic is calmer, although neither of those streets have sidewalks.

Eliminate Parking in Bicycle Lanes

During a recent tour of Thompson Road, the project team observed vehicles parked in the bicycle lane, forcing people on bikes to merge into the general travel lane and compromising user safety.

Reduce Relatively High Volumes and Speeds

While dedicated sidewalk and bikeway facilities are provided for most of this section, observed motor vehicle traffic volumes and speeds were slightly higher than what are considered comfortable for less confident roadway users on foot or bike. The presence of lightly traveled bicycle lanes contributes to the relatively wide-open nature of the roadway, which may encourage drivers to travel at faster speeds.

Address Discontinuous bicycle infrastructure

The bicycle lanes heading westbound end at Whitcomb Elementary School, meaning that bicycle riders must merge into traffic just before the roadway jogs north along 72nd Avenue. This compromises the safety of vulnerable road users and creates a high-stress environment. There is no signage warning motorists that bicycle riders will be merging into the travel lane.

Segment A3 – Constraints

Requires Jog at Fuller Road

Of the three main east-west corridors being considered in Section A, only Thompson Road does not continue east of Fuller Road, which would require bicycle riders heading east to the I-205 path to jog either to the north to reach the Boyer Drive extension or south to reach Causey Avenue. The lack of a direct route across

Fuller Road and 82nd Avenue increases the number of turns and out-of-direction travel; this may be disorienting to bicycle roadway users or may discourage them from using the corridor entirely.

Traffic Volumes and Bicycle Lanes Limit Traffic Calming Opportunities

The existing bicycle lanes are relatively well-suited for the nature of the roadway given the observed volume and travel speeds. However, because of the lack of on-street parking, there is less opportunity for the County to install traffic calming measures such as chicanes[9] or curb extensions to slow down traffic and reduce pedestrian crossing distance. Removing the lanes to install this infrastructure and implementing a shared-space environment like a bicycle boulevard would be incompatible with the current character of Thompson Road. However, speed cushions may be still be used to reduce travel speeds.

Fuller Road Intersection Deficiencies

The intersection of Thompson Road and Fuller Road is a three-way intersection, where Fuller Road traffic has right-of-way and Thompson Road traffic is stop controlled. This location has been the site of several collisions in recent years. Overgrown vegetation at the northwest corner of the intersection can interfere with the sightlines for motorists waiting to turn onto Fuller Road. The curb radius at this intersection is wide, which allows motorists to turn right at high speeds, compromising pedestrian and bicyclist safety. In addition, Fuller Road is approximately 40' to 48' wide between the curbs at Thompson Road, with the ROW slightly wider south of the intersection. However, due to the skew of the intersection, the actual distance to cross is 50' to 58', and there are no marked crosswalks.

Segment A3 – Potential Solutions

Retrofit Curb Ramps for ADA Compliance

Along Thompson Road, there are curb ramps along the south sidewalk but none are ADA-compliant. These ramps should be retrofitted to accommodate mobility devices.

Rectangular Rapid Flash Beacon at 74th Avenue

An initial County audit of facilities on Thompson Road for the SRTS plan identified 74th Avenue as a potential location for a rapid flash beacon or other crossing enhancements such as increased signage. Rectangular rapid flash beacons (RRFBs) are user-actuated amber lights that supplement warning signs at non-signalized intersections or mid-block crosswalks. They can be activated manually by a push button or passively by a pedestrian detection system. RRFBs use an irregular flash pattern that gets driver attention and encourages yielding to crossing pedestrians. This could be installed at 74th Avenue to aid students who are crossing Thompson Road to access Whitcomb Elementary School.
These improvements should be coupled with a new ADA-compliant landing on the north side of the street and potentially a new sidewalk or path on the east side of 74th Avenue to facilitate school access.

Marked Crosswalk at 77th Avenue

The County's SRTS audit identified a need for additional marked crossings along Thompson Road and suggested 77th Avenue as a potential location to improve crossing safety for pedestrians accessing from the north.

Intersection Enhancements at Fuller Road

Curb extensions could be installed at the northwest and southwest corners of the intersection, and the stop bar for Thompson Road traffic should be advanced in order to improve visibility and reduce vehicle turning speeds. This improvement would also significantly reduce the crossing distance for pedestrians. Marked crosswalks could be installed on all three sides of the intersection.

[9] Chicanes are a type a mid-block speed control treatment, consisting of offset curb extensions on residential or low volume downtown streets. This creates a weaving effect that slows traffic speeds considerably.

Narrow Lane Widths to Install/Widen Bike Lane or Establish Neighborhood Greenway

The travel lanes on Thompson Road are currently 11' wide and could be reduced by 1' in each direction to provide more space for bicycles on the street. The County's standards allow for travel lane widths between 10' to 12' on collectors. Research has shown that 10' travel lanes improve safety because they reduce the temptation for motorists to speed.

Alternatively, if actions can be taken to reduce through traffic on Thompson Road, the County could consider removing the centerline and bicycle lanes to establish a bicycle boulevard on this street.

Pedestrian and Bicycle Facilities West of 74th

Pedestrian and bicycle accommodations between Monroe Street and Thompson Road are desirable to reduce out-of-direction travel to Whitcomb Elementary School. An analysis of tax lot maps reveals that right-of-way may be available on 72nd Avenue to add a sidewalk. The nature of bicycle facilities in this section will depend on the scope of additional improvements that are made along the corridor.

Buffered Bicycle Lanes

Buffered bicycles lanes include a painted 2' buffer separating the bicycle lane from adjacent auto traffic. These could be striped along Thompson Road, which would establish greater separation between motor vehicles and vulnerable road users.

Speed Cushions to Reduce Speeds

Speed humps or cushions are a viable form of traffic calming to reduce travel speeds. Spacing humps between 300' and 500' apart is most effective at lowering the 85th percentile speed to the targeted range. These cushions could be installed with cutouts to accommodate emergency vehicles.

Segment A4: Fuller Road between Monroe Street and Causey Avenue

Fuller Road is a two-lane collector that runs diagonally on a southwest-to-northeast axis between King Road and Harmony Road. To the east are service and auxiliary entrances for the commercial properties that mostly front on 82nd Avenue one block east. On the west side is a mix of single-family residential and medium density multifamily housing. Furthermore, Fuller Road has significantly higher volumes south of Causey Avenue (6,285 ADT) compared to farther north (3,810 ADT at Monroe). The cross-section varies based on location, as the right-of-way varies from 60' at Monroe Street and Thompson Road to 80' just north of Causey Avenue. Pavement width is generally 40' to 48' across. There are two 11' travel lanes, curb-tight 5' sidewalks, standard 5' bicycle lanes and an east side curbside parking lane throughout the corridor. Where ROW is wider, there is also a west side parking lane. There is one, two-way stop intersection at Causey Avenue/Harmony Drive. However, there are no marked crosswalks along the corridor. The posted speed limit is 30 mph.

Due to a high incidence of crashes at the King Road/Fuller Road intersection, the County is currently designing an extension of Boyer Drive that will connect one block west from 82nd Avenue to the Fuller Road/Monroe Street intersection. Upon completion, the County plans to restrict access to right-in/right-out movements at King Road and make Boyer Drive the primary access point to Fuller Road from the north. The project is expected to be completed in 2017.

Segment A4 – Needs

Marked Crosswalks and Wide Curb Radii at Intersections

Fuller Road would be utilized for portions in four of the potential six route alternatives in Section A. Specifically, it would connect bicycle riders from Monroe Street, Thompson Road or Harmony Drive to either

Boyer Drive or Causey Avenue. This creates the need for well-designed intersections that accommodate pedestrian or bicycle traffic turning onto or off of Fuller Road. Currently, the intersections of Fuller Road at Monroe, Thompson and Causey do not have marked crosswalks and have wide curb radii that encourage higher turning speeds and increased crossing distance.

Wider Sidewalks

Fuller Road has curb-tight 5' sidewalks on both sides of the street. The west side of Fuller Road has residential land uses while the east side of the street is commercial. According to County design standards, sidewalks along commercially-zoned properties must be a minimum of 7' if they are adjacent to the curb; therefore the east sidewalk is below standard. Expanding sidewalks where ROW is available can increase pedestrian comfort.

Segment A4 – Constraints

Relatively High Travel Speeds

The current posted speed limit is 30 mph, but the relatively wide cross-section encourages motor vehicle operators to travel at higher speeds, which compromises safety for vulnerable road users. As driver speed increases, the cone of vision narrows and distance necessary to react and brake increases (City of Portland, 2015). Studies show that a pedestrian involved in a collision with a motor vehicle has a 45 percent likelihood of suffering fatal injuries at vehicle speeds between 30-35 mph and an 85 percent likelihood of fatal injuries at vehicle speeds exceeding 40 mph, compared to 5 percent for vehicle speeds at 20-25 mph.

Out-of-Direction Travel

For a pedestrian or bicyclist traveling east or west along the transportation corridor, deviating onto Fuller Road will require out-of-direction travel (because of the northeast-southwest orientation of the roadway), which will likely result in additional travel time and can cause potential confusion about the route. The need to jog onto Fuller Road requires turning across a relatively busy roadway which could be uncomfortable for less confident riders. Strong wayfinding, including signage and pavement markings, will be key to help roadway users orient themselves while traveling in the area.

Door Zone Bicycle Lanes

The current on-street bicycle lanes are 5' wide, which is narrower than the County standard of 6'. In addition, the lanes are adjacent to curbside parking, which is a significant dooring hazard for people on bicycles. Dooring is when a vehicle driver or passenger opens their car door directly in the path of a moving bicyclist, causing a collision, and is more likely to occur when bicycle lanes are directly situated next to a parking lane. This condition occurs the full length along the east side of the street and south of Thompson Road on the west side of the street.

Segment A4 – Potential Solutions

On-Street Parking Capacity

Most of Fuller Road between Monroe and Causey is fronted by commercial properties to the east and multi-family residential to the west. There are very few driveways that open onto Fuller Road and most of the residences have parking facilities available off-street. In addition, site visits have revealed that there could be excess parking supply in comparison with the current demand, which could be definitively determined with a parking utilization study to determine occupancy rates.

Existing parking lanes could be reconfigured to allow more space for bicycle and pedestrian facilities, and reduce conflicts. North of Thompson Street, Fuller has one existing parking lane that could be repurposed for moving traffic. To the south, one of the two parking lanes could similarly be removed to prioritize active transportation on the street.

Underutilized Right-of-Way

It may possible to retain on-street parking while making active transportation improvements. Depending on the location, there is generally 5’ to 10’ of ROW currently used by adjacent property owners, with over 20’ available just north of Causey Avenue. The County could reclaim this ROW if funding was available for a more significant street reconstruction.

Narrow Lane Widths to Reduce Travel Speeds

The travel lanes are 11’ wide and could be reduced by 1’ in each direction to provide more space to accommodate bicycles on the street. The County’s standards allow for widths between 10’ and 12’ on collectors. Research has shown that 10’ travel lanes improve safety because they reduce the temptation for motorists to speed.

Signalization of Causey Avenue/Harmony Drive Intersection

Fuller Road is relatively wide at Causey Avenue/Harmony Drive, especially at the north leg of the intersection where Fuller Road is one lane wide in each direction with a left-turn lane for southbound Fuller Road traffic heading east on Causey. The intersection is stop controlled for Causey Avenue/Harmony Drive and relatively busy, with 6,300 ADT on Fuller Road just south of the intersection and almost 5,000 ADT on Causey Avenue just east. Although it does not yet meet Oregon Department of Transportation (ODOT) warrants for signalization, a traffic signal here would benefit cyclists needing to turn left from southbound Fuller Road to eastbound Causey. Currently, bicycle riders on Fuller need to merge left to use the left turn lane, a maneuver that can be difficult in heavy traffic and very uncomfortable for less experienced cyclists. With signalization, specific enhancements such as left turn boxes, standard bicycle boxes, leading pedestrian/bicycle intervals or bike signals could be installed to aid this movement.

Other Fuller Road/Causey Avenue/Harmony Drive Intersection Enhancements

To facilitate bicycle travel between Fuller Road and Causey Avenue, another option is to install a left turn bicycle box to allow people who bike to make a two-stage left turn by crossing the intersection and then stopping in the box ahead of traffic stopped on Harmony Drive but out of the path of moving traffic on Fuller Road. Here, they would wait for a break in traffic before continuing with their left turn to proceed east on Causey Avenue. The left turn box could potentially be installed even if the intersection remained unsignalized.

Alternatively, the County could stripe a specific left turn lane for bicycles (or pavement sharrows marking the recommended track for bicyclists in the general travel lane and left turn lane near the intersection) to alert motorists toward the presence of bicycle riders. Other enhancements may include curb extensions, especially at the northeast corner to narrow the crossing width (currently greater than 70’ across Fuller Road) and make pedestrians more visible to motorists, marked crosswalks and rebuilt ADA-compliant curb ramps.

Wider Sidewalks

Clackamas County dictates a 7’ sidewalk standard for collector streets in commercial areas, due to higher expected pedestrian activity. Implementing 7’ or wider sidewalks would contribute to a more comfortable pedestrian environment.

Pedestrian Enhancements

The Monroe Street and Thompson Road intersections should be improved to facilitate pedestrian access and safety. Potential enhancements include ADA curb ramp retrofits, curb extensions to reduce vehicle turning speed and pedestrian crossing distance, and marked crosswalks on all legs of the intersection.

Protected or Buffered Bicycle Lanes

Protection for bicyclists provided by the existing substandard bicycle lanes could be enhanced by adding a painted or protected buffer to increase separation between people who bike and parked vehicles – and potentially one between bicycle riders and moving vehicles. Fuller Road is especially suited for protected bicycle lanes because there are relatively few driveway or street access points that create conflict between roadway users. Where parking is currently prohibited, a 2’ to 3’ painted buffer could be installed, potentially with vertical delineators such as candlestick wands and/or removable curbs, to create a 7’ to 8’ wide facility that meets County standards and increases separation to improve safety and comfort for cyclists. Installing a protected buffer would also discourage motorists from mistaking the bicycle lane for a parking lane.

Reconfiguring the cross-section to eliminate one of the two parking lanes south of Thompson Road (for example, the southbound parking lane) could provide space for the remaining parking lane to serve as a buffer for the northbound bicycle lane. A northbound parking-protected bicycle lane could consist of a 6’-7’ bicycle lane plus a 3’ buffer to protect moving cyclists from opening passenger doors and provide a passing space. This cross-section would eliminate dooring risk on one side of the street and greatly reduce risk on the other, while increasing segregation between modes and improving safety and comfort for all users.

At driveway entrances, green skip striping and signage should be used to denote the potential for conflicts and warn motorists of the presence of bicyclists. Parking restrictions should be applied within 20’ to 30’ of all driveway entrances to improve visibility.

Left Turn Bicycle Boxes

Left turn bicycle boxes enable bicycle riders to make two-stage left turns if they prefer not to make a vehicular left turn, whether they are less confident or if traffic volumes are too high to merge into the general travel lane. These bicycle boxes are situated on the far side of the intersection, in the shadow of the parking lane. A person who is bicycling northbound on Fuller and wants to make a left turn onto Monroe or Thompson westbound would use the bicycle box as a staging area to wait for traffic to clear before continuing their left turn. The major benefit of the bicycle box is to allow for riders to avoid merging in uncomfortable high-traffic situations, outside of the main travel path for vehicles and bicycles. These could also be installed at the Causey Avenue intersection, although they are better suited for signalized four-way intersections.

Bicycle Signals and Leading Pedestrian/Bicycle Intervals

Bicycle signals are traffic signals for bicycle riders, with signal heads that are smaller and distinctive from traditional signals. These signals are used when bicycle and automobile movements need to be completely separated for the purposes of safety. Right turns are prohibited when a bicycle signal is green.

Similarly, leading pedestrian or bicycle signal intervals provide pedestrians and bicyclists with a 5-second head start to enter the intersection before motorists receive a green signal. This helps them cross the intersection more easily, while also increasing their visibility to motorists. Right turns on red are prohibited with a leading interval.

A bicycle signal phase could be installed as a “scramble” signal to allow bike riders to make a left turn diagonally across the intersection while avoiding conflict from other traffic movements, which would have a red signal in all directions while bicyclists had a green signal. This would be the safest option, but would cause a slight delay to other travel modes at the intersection.

Segment A5: Maplehurst Road-Harmony Drive between Monroe Street and Fuller Road

Maplehurst Road-Harmony Drive is a residential connector street between Monroe Street and Fuller Road. This corridor includes a short section of McEachron Drive between Maplehurst Road and Harmony Drive. The street is mostly undeveloped with gravel shoulders, although there are intermittent sidewalks, curbs and storm drainage where newer development has occurred. Most of the surrounding land use is low-density residential. One major exception is the 34-acre agricultural parcel located where Maplehurst Road intersects Norbert Drive. The County's long-term plans include new housing development on this farmland, which could dramatically affect the character of the street and surrounding neighborhood.

For now, Maplehurst-Harmony remains mostly pastoral, with relatively low travel volumes and speeds. Total ROW ranges from 40' on Maplehurst Road to 50' on Harmony Drive, and total pavement width is approximately 22' to 24'. Where sidewalks have not been installed, the remainder of the ROW is occupied by informal on-street parking along gravel shoulders. There are three right-angle turns which are a potential crash risk at higher speeds, although the majority of nearby crashes have been reported at the eastern end of Harmony Drive, where there is a two-way stop-controlled intersection with Fuller Road and Causey Avenue. The posted speed limit is 25 mph.

Segment A5 – Needs

Pedestrian Access and Visibility

As on Monroe Street, there is no pedestrian infrastructure along most of Maplehurst-Harmony except for patchwork sidewalks adjacent to newer development. Pedestrian visibility is a concern at three locations where sightlines are reduced at right-angle turns. Maplehurst is also a key route for students walking to Whitcomb Elementary School from the south, and a safe route is needed for students walking or biking to the school.

Safe and Continuous Route for Bicyclists

This section currently has no bicycle-specific infrastructure and there is no shoulder available, although speeds and volumes are lower on Maplehurst-Harmony compared to Monroe. There is no centerline stripe along this entire segment, which is preferable on streets where slower speeds and shared-space operation between motorists and bicycle riders is desirable.

Crosswalks or ADA-Compliant Ramps

The Harmony Drive/Causey Avenue/Fuller Road intersection lacks marked crosswalks or ADA-compliant curb ramps on most corners of the intersection. In addition, pedestrians must cross 70' of pavement to get across Fuller Road due to the wide curb radius on the northeast corner.

Segment A5 – Constraints

Limited Available Right-of-Way

Similar to Monroe, the main constraint in this segment is limited right-of-way and encroachment from adjacent front yards into the public space. This is most apparent along Maplehurst between Monroe and Charles Street where the ROW is 40' wide. The effective width of the pavement in this section is approximately 22' to 24' and front yard ROW encroachments will be impacted if the roadway footprint is expanded.

More Circuitous Route

Maplehurst-Harmony is a less direct route than Monroe Street or Thompson Road, and would be more difficult to pair with the Boyer Drive/Spencer Drive segment in Section B. In addition, using Maplehurst-Harmony would mean significant out-of-direction travel for riders intending to access the I-205 Multi-Use Path north toward Portland.

Segment A5 – Potential Solutions

Whitcomb Elementary School Access

A dirt path leading southwest from Whitcomb Elementary School to the corner of Maplehurst Road and McEachron Avenue is a popular access point for students walking to school and provides a safe option for students who otherwise would need to walk up to an additional three-quarter mile on streets without sidewalks. Improving this path would provide incentive for the County to prioritize pedestrian access improvements on Maplehurst-Harmony. Pedestrian accommodation may require a phased approach if conventional sidewalk and curb installation is not determined to be desirable or immediately feasible due to high cost. Pedestrian facilities could include separated paths constructed with asphalt or permeable pavement and curb extensions at intersections.

Popular Bicycle Route

During the PAC and TAC field trip, several participants mentioned that Maplehurst-Harmony is already a popular cycling route in the area due to the corridor's calm and pastoral setting, even though there is no dedicated bicycle infrastructure. Traffic volumes are lower than on Monroe-Thompson, and there is no double yellow centerline, making it easier for riders to share the road with motorists.

Traffic Calming

Possible traffic calming measures to lower vehicle speeds and volumes in this section include pavement markings, speed cushions, stormwater treatment facilities, curb extensions, diversion and a range of intersection treatments.

The speed limit could be reduced in conjunction with these measures. However, statutory reductions in speed limit have little effect on motorist behavior without making requisite changes to street design and committing to periodic traffic enforcement to compel drivers to slow down.

Pedestrian Facilities

A safe pedestrian facility along this section is critical to a successful project. An initial solution could include providing a pedestrian route along one side of the street – perhaps constructed initially as an asphalt pathway. An asphalt path could be constructed without the added costs of curb and gutter and underground stormwater collection.

Assuming a narrowed-width facility, the County owns enough right-of-way to construct sidewalks on both sides of Maplehurst-Harmony. However, many property owners, especially along Maplehurst Road, have planted shrubs or hedges or constructed walls and fences that either abut or encroach upon County right-of-way. Sidewalk construction would likely affect these encroachments. Further east, Harmony Drive has a 50' ROW, allowing for easier accommodation of pedestrian facilities.

Curb Extensions, Bioswales, and Infiltration Basins

Installing permeable pavement shoulders, curbed bioswales or vegetated basins can result in a narrower-feeling street, slowing traffic while providing for stormwater infiltration. Curb extensions can also help delineate the pedestrian crossings at intersections. It is feasible to incorporate curb extensions into a street without providing curb and gutter along the entire street. ADA-compatible curb ramps could be added at intersections, with street parking accommodated between the bioswale.

Segment A6: Boyer Drive Extended between Fuller Road and 82nd Avenue

Clackamas County is developing a $4 million road construction project to connect Monroe Street and Boyer Drive between Fuller Road and 82nd Avenue. This project will make goods and services on 82nd Avenue and near Clackamas Town Center more accessible for neighborhoods to the west, while improving safety in the vicinity of Fuller Road and King Road. This one-block section consists entirely of commercial land uses on both sides of the roadway. Once the project is complete in summer 2017, the prevailing traffic pattern between 82nd Avenue and Fuller Road will utilize the extended Boyer Drive. As a result, Fuller Road will be restricted to right-in/right-out access at King Road.

The project will consist of a new three-lane roadway with sidewalks, bicycle facilities in the form of a cycle track, landscaping and storm drainage facilities. The expected speed limit in this new section is 25 mph. Other project elements include redesigned intersections at Fuller Road and 82nd Avenue, as well as a slight realignment of Monroe Street to meet with Boyer Drive at Fuller Road.

Potential intersection enhancements at Fuller Road and 82nd Avenue include marked crosswalks, bicycle boxes, ADA-compliant curb ramps and signalization at Fuller Road. The newly built corners at the Fuller Road/Monroe Street/Boyer Drive intersection are expected to have fairly tight corner radii which is essential to reduce vehicle turning speeds, reduce pedestrian crossing distance and increase visibility.

It is important to note that the aforementioned project is resolving the largest outstanding need, which is the lack of a connection at this location. The following needs assessment will assume that the project will be constructed as currently proposed.

Segment A6 – Needs

Safe Crossing of 82nd Avenue and Fuller Road

Pedestrian conditions are expected to improve at the redesigned 82nd Avenue intersection, with new ADA-accessible curb ramps and marked crosswalks. However, curb radii will remain wide, which encourages motorists to take turns at higher speeds, compromising pedestrian safety while also requiring them to cross a longer distance. Currently, pedestrians must traverse 80' when crossing 82nd Avenue. There have been several collisions involving pedestrians along this section of 82nd Avenue. In addition to the planned improvements to this intersection, additional protections for pedestrians and cyclists crossing at 82nd Avenue and Fuller may be needed.

Cycle Track Transition at Intersections

The planned cycle track is intended to ramp down to street grade just before the 82nd Avenue and Fuller intersections. At these intersections, a bicycle box is proposed to allow bicycle riders to queue ahead of motor vehicle traffic waiting in front of the intersection, while moving the stop bar for motor vehicles further back and prohibiting right turns on red. Bicycle boxes are most effective when bicycle riders are approaching the intersection at a red light. In fact, this infrastructure may give riders a false sense of security when approaching at a stale green because right-turning motorists at 82nd Avenue and Fuller Road may not be expecting a person on a bicycle approaching from behind to their right, which can lead to possible "right-hook" collisions. It will be important that the proposed design does not put the ramp down to street level in a location where right-turning motorists may not expect to interact with bicycle riders.

Segment A6 – Constraints

Boyer Drive Construction Timeline

The anticipated planning, funding and construction timeline of the Monroe project is likely to take place over several years and will likely require a phased approach as funding sources are identified and secured. This may limit the opportunity to make additional improvements once construction of the Boyer Drive project is complete. Therefore, any proposed improvements proposed as a result of this project will likely need to be incorporated while the Boyer Drive project is in the engineering design phase (currently it is at 60% level of design).

ODOT Jurisdiction over 82nd Avenue Intersection

Boyer Drive crosses 82nd Avenue at one of only two signalized intersections within the entire study area. No median island is available to provide refuge for pedestrians needing extra time to cross the highway. Due to wide crossing distances and high traffic volumes and turning movements, the crossing is a significant barrier to active transportation. A balance between vehicle mobility and the mobility and access needs of other roadway users will need to be achieved. Because 82nd Avenue is a state highway, ODOT will actively review and provide guidance on potential modifications to the intersection signal or geometric design proposed as part of this project.

Segment A6 – Potential Solutions

Multimodal Improvements

While the Boyer Street project design has not been finalized, the presumed right-of-way is 67' wide. The cross-section includes a 12' path on both sides of the street, delineated by a painted line between a 6' one-way cycle track and a 6' bi-directional pedestrian path. The southbound path will include a 5' landscape buffer between the street and the path. The roadway will be 34' wide, with two 11' travel lanes and one 12' left turn lane. The travel lanes will include painted sharrows, indicating that faster cyclists will be allowed to use the roadway instead of the side-path.

A cycle track is a bicycle facility raised on a curb that can be at the same grade of the sidewalk or in between the sidewalk and roadway grades. This design offers greater separation from traffic than a standard striped bicycle lane, helping to encourage "interested but concerned" bicycle riders.

Extend Bicycle Box to Accommodate Left-Turn Bicycle Users

Because there is no parking lane on Boyer Drive, it would be difficult to accommodate a left turn bicycle box at the Fuller Road and 82nd Avenue intersections without coming into conflict with crosswalk users. However, a simple improvement would be to extend the bicycle box to occupy the space of the dedicated left-turn lane as well. This would allow riders to transition from the cycle track to the left-turn lane in front of waiting motorists (as long as the signal is red while approaching) without needing to make a two-stage left turn or take the lane for the entire block in order to safely make a vehicular left. A bicycle box should also be considered for westbound Boyer Drive at 82nd Avenue.

Clackamas Regional Center Multimodal Mixed-use Area (MMA)

As part of the Clackamas Regional Center MMA project, the County will be looking at alternative or supplementary performance standards, which may allow for context-specific treatments that respond to adjacent land uses. These alternative or supplementary standards present an opportunity to advance bicycle and pedestrian safety and connectivity.

Green Pavement Markings and Signage to Denote Conflict Areas

At major intersections and driveway entrances, green skip-stripe paint could be used for the bicycle facility to denote the potential conflicts between vulnerable road users and turning motorists. Signage should also be incorporated to alert all modes to be cautious and courteous when navigating these conflict points.

Bicycle Detection

Bicycle detection loops or poles placed at locations for cyclists to activate the signal are recommended.

Median Refuge Islands and Tighter Corners

Eliminating the northbound right turn only lane for 82nd Avenue traffic would provide space to install a raised median with refuge islands at the 82nd Avenue intersection for pedestrians and cyclists if they cannot cross the entire intersection in one signal cycle. This would help make crossing 82nd Avenue more inviting and easier, especially for people with disabilities. An example of this type of intersection treatment is shown in the photo to the right, from the NACTO *Urban Bikeway Design Guide* (2013). Narrowing the corner radii at the intersection would also reduce crossing distance for pedestrians and improve safety by reducing turning speeds. Special design considerations can be implemented to make sure that trucks can still negotiate right turns at the intersection.

Segment A7: Causey Avenue between Fuller Road and 82nd Avenue

Causey Avenue in Section A is a one-block long, three-lane collector street between Fuller Road and 82nd Avenue. Total ROW is generally 65' wide, while the overall cross-section consists typically of two 14' general travel lanes, a 16' wide center turn lane and two 5' to 10' landscaped sidewalks. Recorded travel volumes east of Fuller Road are relatively high at 5,000 ADT. The speed limit is not posted in this stretch but is presumed to be 25 mph, although actual observed speeds may be higher. The sidewalk is in poor shape and in need of repair. General land use is predominantly strip commercial on both sides, with the exception of the Clackamas Fire District station at the intersection of Causey Avenue and Fuller Road.

There is one stop-controlled intersection at Fuller Road and a signalized intersection at 82nd Avenue. At both locations there are two approach lanes at the intersection (at Fuller Road there is a through-left lane and a right turn only lane; at 82nd Avenue there is a left-turn-only lane and a through-right lane). In addition, there is also one relatively busy driveway access point for the adjacent shopping center which can lead to conflict between various travel modes.

Segment A7 – Needs

Continuous and Wider Sidewalks

The sidewalks in this section vary from 10' at the widest point to 5' across Phillips Creek, where they are further tightened by encroaching vegetation. West of the creek, crossing the north sidewalk is inaccessible for mobility devices due to a missing concrete panel and a tree and sign blocking the sidewalk. Pedestrians often walk in the street, which can be dangerous since volumes are relatively high at 5,000 ADT. The sidewalks also do not meet County standards for 7' wide facilities along collector streets in commercial zones. The *Clackamas Regional Center Pedestrian and Bicycle Plan* recommended repair and replacement of sidewalks on Causey Avenue west of 82nd Avenue to meet standard requirements.

Bicycle Infrastructure

Similar to the sidewalk issues, the existing cross-section does not provide safe passage for bicycle riders in this section where there are no existing bicycle facilities. Currently riders can choose to either take the lane or situate themselves near the curb in moderately heavy traffic. Both scenarios reflect a high-stress situation intimidating for all but the most confident riders.

Address Safety Concerns at Intersections

Roadway safety is a significant issue on Causey Avenue, with multiple crashes reported along this section and at both nearby intersections. The intersection with 82nd Avenue is likely the most difficult environment for active transportation besides the aforementioned sidewalk gaps. While the intersection has marked crosswalks, the wide curb radii decreases pedestrian visibility and allows vehicles to take turns at higher

speeds. Because 82nd Avenue is six lanes wide in this section, plus bicycle lanes, pedestrians crossing at the Causey Avenue intersection must traverse 85'. There are no ADA-compliant curb ramps at the intersection.

The *Clackamas Regional Center Pedestrian and Bicycle Plan* recommended installing new pedestrian amenities at the 82nd Avenue/Causey Avenue intersection, including sidewalk ADA ramps and covered shelters at nearby transit stops.

Segment A7 – Constraints

Phillips Creek Bridge

Widening sidewalks may require retrofitting or replacing the bridge over Phillips Creek. Due to the high cost, this would be a longer-term project unlikely to be advanced until the bridge is closer to the end of its useful life span.

ODOT Jurisdiction of 82nd Avenue Intersection

Causey Avenue crosses 82nd Avenue at one of only two signalized intersections within the entire study area. No median island is available to provide refuge for pedestrians needing extra time to cross the highway. Due to wide crossing distances and high traffic volumes and turning movements, the crossing is a significant barrier to active transportation. A balance between vehicle mobility and the mobility and access needs of other roadway users will need to be achieved. Because 82nd Avenue is a state highway, ODOT will actively review and provide guidance on potential modifications to the intersection signal or geometric design proposed as part of this project. In this instance, ODOT's stricter standards for maintaining vehicle throughput at intersections and accommodating truck turning movements may make it challenging to make significant improvements to the pedestrian and bicycle environment at Causey Avenue.

Segment A7 – Potential Solutions

Complete/Rehabilitate Sidewalks and Improve ADA Accessibility

The sidewalks should be improved to allow full ADA accessibility through the entire section, including adding ADA-compliant curb ramps. Long-term goals include widening the sidewalks to meet the County's clear width standards of 7' for collectors in commercial areas. Widening the sidewalk to the street side would be most feasible and cost effective; the existing pavement on Causey Avenue is 44' wide with one travel lane in each direction and a generously sized center turning lane, allowing ample space to widen the sidewalk on both sides. This would improve pedestrian safety and narrow the roadway, eliminating unused space that currently encourages higher speeds – but may be at the expense of providing bicycle lanes unless the center turn lane was removed.

Reconfigure Lanes to Add Bicycle Facilities

The *Clackamas Regional Center Pedestrian and Bicycle Plan* recommended adding bicycle lanes to this section of Causey Avenue. Narrowing the travel lanes from 14' to 10' and the center turn lane from 16' to 12' would provide 12' that could be purposed towards 6' bicycle lanes, while also encouraging reduced travel speeds. An extra 2' of space from the center turn lane could allow for 7' bicycle lanes that include a 2' painted or physical buffer to provide extra separation between bicycles and motorists.

Phillips Creek Multi-Use Path Connections

The County's TSP identifies a future multi-use path along Phillips Creek as a long-term project. If completed, this trail would provide another useful connection between the Monroe Street corridor and Clackamas Town Center, as well as other services along 82nd Avenue.

Clackamas Regional Center MMA Project

See correlating discussion under A6.

Bicycle Boxes

Bicycle boxes should be considered at the 82nd Avenue intersection for Causey Avenue traffic. Bicycle boxes are dedicated areas at signalized intersections that allow bicyclists to pull in front of waiting traffic at red lights. Bicycle boxes help to reduce conflicts between right-turning motorists and straight-through bicycle riders (known as "right hook" collisions) and increase cyclist visibility at busy intersections. They also provide the bicyclist a head start when the light turns green. Bicycle boxes are typically 14' wide rectangles located in front of the stop bar for motorists but behind the pedestrian crosswalk and are painted green to catch the attention of motorists. Motorists cannot turn right on red at intersections when a bicycle box is present.

Green Pavement Markings and Signage to Denote Conflict Areas

At major intersections and driveway entrances, green skip-stripe paint should be used for the bicycle facility to denote the potential conflicts between vulnerable road users and turning motorists. Signage should also be incorporated to alert all modes to be cautious and courteous when navigating these conflict points.

Bicycle Detection

Bicycle detection loops or poles placed at locations for cyclists to activate the signal are recommended.

Median Refuge Islands and Tighter Corners

Eliminating the northbound 'right turn only' lane would provide space to install a raised median with refuge islands at the 82nd Avenue intersection for pedestrians and cyclists if that they cannot cross the entire intersection in one signal cycle. This would help make crossing 82nd Avenue more inviting and easier, especially for people with disabilities. Narrowing the corner radii at the intersection will also reduce crossing distance for pedestrians and improve safety by reducing turning speeds. Special design considerations can be implemented to make sure that trucks can still negotiate right turns at the intersection.

Segment B1: Boyer Drive-85th Avenue-Spencer Drive between 82nd Avenue and I-205

Boyer Drive east of 82nd Avenue is a three-lane local street primarily serving adjacent commercial centers and the Boyer Meadows subdivision. Its total ROW width is 65', including two 13' travel lanes and one 14' center turn lane. In addition, the south sidewalk is 8' to 10' (with a 5' clear width in the wider section) while the north sidewalk is 8'. However, the north sidewalks ends just west of the 85th Avenue intersection. Traffic volumes and speeds are generally low but there are no bicycle facilities or marked crosswalks (except at the 82nd Avenue signalized intersection). Boyer Drive terminates at a three-way intersection with 85th Avenue; traffic on Boyer Drive has the right-of-way while 85th Avenue is stop-controlled.

This alignment briefly jogs south onto 85th Avenue for one block before turning east onto Spencer Drive. The 85th Avenue/Spencer Drive intersection has no stop control. Both of these facilities are local residential streets with low volumes and speeds, and each includes 50' of total ROW and 28' of pavement width. In addition, while both streets have on-street parking, curbs and drainage, neither street has sidewalks or bicycle facilities. Spencer Drive has a 0.3-mile moderate uphill climb (5.3 percent grade) until it dead-ends at the I-205 Multi-Use Path. The speed limit is 25 mph throughout this section.

Segment B1 - Needs

Bicycle Facilities on Boyer Drive

Boyer Drive has no bicycle lanes or any other infrastructure for bicycles. While volumes are relatively low, the street generally seems wide and overbuilt which can encourage motorists to increase speeds. Repurposing the existing space will help facilitate bicycle travel and could also help reduce speeds.

Sidewalks on 85th Avenue and Spencer Drive

85th Avenue and Spencer Drive lack pedestrian facilities, which forces local residents or trail users to walk in the street and can potentially be a hazard at corners when visibility is reduced. Both streets were constructed with storm drainage and curbs.

Reduce Collision Risk at 85th and Spencer Intersection

One member of the PAC who lives in the subdivision commented that the intersection of 85th Avenue and Spencer Drive is a safety trouble spot, primarily due to drivers not properly yielding. However, no incidents were reported in the vicinity between the years 2007 and 2010. The intersection has no stop control, although Spencer Drive dead-ends just west of the intersection, meaning that the north and east legs receive the dominant flow of movement.

Segment B1 – Constraints

Challenges Created by Spencer Drive Grade

The steep winding grade on Spencer Drive presents issues in both directions. First, in the uphill direction eastbound, it creates a noticeable differential in speeds between people who bike and drive along the street. For an individual using the Monroe Street corridor to access Clackamas Town Center via the I-205 path, it likely would not make sense to traverse up the hill on Spencer Drive only to pedal back downhill once on the trail. Second, and of more concern, is that the grade facilitates speeding by bicyclists in the downhill direction. This can lead to conflicts with residents backing out of driveways or with motorists at curves where visibility is reduced.

Allocation of Space on Boyer Drive

At 40' wide between curbs, Boyer Drive is slightly too narrow to accommodate bicycle lanes without either removing the center turning lane (to provide enough space for enhanced bicycle lanes) or reducing the width of the lane to 10' (to accommodate standard 5' bicycle lanes). Sharrow pavement markings may be adequate for this section, depending on measured volumes and speeds.

Multiple Turns Complicate Route

This alignment would require two quick right-hand turns in succession, which may make it more difficult for riders to follow the route. Wayfinding will be key in this section to direct bicyclists and pedestrians to the I-205 path.

Segment B1 – Potential Solutions

Sufficient ROW to Add Infill Path

There is up to 20' of available public right-of-way to add a concrete sidewalk or asphalt path on one or both sides of 85th Avenue and Spencer Drive. Because curbs and gutters already exist on both streets, retrofitting pedestrian facilities is not expected to be as costly nor to have a substantial impact on the neighborhood's character. However, much like in other neighborhoods, there has been considerable encroachment of front yards within this ROW which makes reclaiming this space for a pedestrian facility potentially difficult.

Less Busy Compared to Causey Avenue

This route has much lower traffic volumes and speeds than the other alternative in Section B (Causey Avenue) and is generally a more comfortable place to ride a bicycle today. This area will likely not need more substantial investment besides signage and sharrows.

Requires Less Out-of-Direction Travel If Heading North

For riders heading north on the I-205 Multi-Use Path towards Portland, the Spencer Drive route represents significantly less out-of-direction travel than the Causey Avenue alternative. Riders would also be able to connect at the Fuller Road MAX station to continue on their journey.

Bicycle Lanes and Cycle Tracks

Depending on how the existing lanes are resized or reconfigured, there should be enough room available for two standard bicycle lanes on Boyer Drive, with the potential of further enhancements such as a painted buffer and/or vertical delineators to create a low-stress environment for bicycling.

If the County was interested in pursuing a full street rebuild, the cycle track facility planned for the extension of Boyer Drive could be implemented in the existing section to create a uniform, consistent facility from Fuller Road to 85th Avenue. This would be an expensive project though, because the existing curbs would have to be moved inward toward the street and the sidewalks expanded to create the cycle track. The existing street trees would also need to be removed.

Treatments to Slow Downhill Bicycles on Spencer Drive

Several PAC members had concerns about the steep grades on Spencer Drive encouraging westbound riders to speed downhill, potentially endangering themselves and pedestrians. Several treatments could reduce the collision risk, including speed bumps and signage and pavement markings advising riders to slow down and watch for vehicles exiting from driveways. Horizontal or vertical deflection features such as pinch points and/or chicanes could calm traffic and reduce speeds for motorists, although they could present a danger to night-time bicyclists.

All Way Stop Controls

Boyer Drive has no stop control at the 85th Avenue intersection, which can endanger pedestrians crossing at the west leg who do not expect eastbound motorists to proceed through the intersection without stopping. Further, there is no stop control at the 85th Avenue/Spencer Drive intersection. It is recommended that all-way stop conditions at both intersections be considered to improve safety for all road users. Marked crosswalks and ADA-compliant curb ramps should also be considered.

Midblock Crosswalk and Median Refuge Islands

Boyer Drive is a superblock between 82nd Avenue and 85th Avenue, a distance of over 500'. The only intervening access points serve adjacent commercial development, but there is no marked crosswalk connecting them. Installing a midblock crosswalk in close proximity to commercial driveway entrances would help pedestrians access these developments without having to jaywalk or walk several feet out of direction to cross at the nearest intersection. A median refuge island would improve pedestrian visibility and allow people walking to cross Boyer Drive one direction at a time.

Segment B2: Causey Avenue between 82nd Avenue and I-205

Causey Avenue is a relatively busy 2-3 lane urban collector between 82nd Avenue and I-205 that serves a mix of commercial uses along 82nd Avenue and dense multifamily residential further east. The road dead-ends at the freeway, but through access is available to the south at 85th Avenue and 90th Avenue. As a result, volumes are high at 5,900 ADT and no dedicated bicycle facilities are available except for a 375' piecemeal section westbound installed as part of a newer development. Sidewalks are between 5'and 10' wide, although the wider sections are typically made up of a 5' landscaping zone and a 5' clear width zone. Except for the cul-de-sac area, most of the sidewalk is buffered from the street by landscaping. Curb extensions have been installed at the newer developments to reduce crossing distance and narrow the street. However, marked crosswalks are missing in some locations.

The total ROW along the street varies between 55' and 72', although pavement width is typically 35'except in locations where a left turn pocket has been provided at 85th Avenue or where three westbound approach lanes (one left-turn-only, one through lane, one right-turn-only lane) at the 82nd Avenue intersection. Two 10' general travel lanes are provided, in addition to two 7.5' parking lanes which are heavily utilized by nearby residents and visitors. Causey Avenue is 50' wide between the curbs at its widest point and 25' wide

at its narrowest. The street has a gradual half-mile long uphill climb (3.2 percent grade) until it dead-ends at the I-205 Multi-Use Path trailhead. The speed limit is posted at 25 mph throughout this section, but vehicle speeds are observed exceeding that limit

Segment B2 – Needs

Bicycle Facilities on Causey Avenue

Causey Avenue currently lacks bicycle lanes or any other bicycle infrastructure, which means that riders must share the narrow lane with drivers on a busy street where motorist speeds frequently exceed 25 mph. This creates a very high-stress environment and is compounded by the significant dooring hazard presented by the continuous on-street parking which is highly utilized throughout the day. To avoid these hazards, riders must take the lane, and can be subject to aggressive or menacing behavior from motorists that reduces usability for all but the strongest riders.

Repaving and Sidewalk Repair

The pavement surface along Causey Avenue is in poor shape, with ruts and potholes causing discomfort for all roadway users and potentially leading to increased repair costs and risk of single-vehicle collisions. Between 82nd Avenue and 90th Avenue, heaving sidewalks impact pedestrian accessibility and have been targeted by the County for recommended improvements.

Complete Missing Pedestrian Elements

This section has numerous driveways for access to adjacent commercial and residential developments. However, there are only a few formal street intersections which creates a superblock with large gaps between marked crosswalks. In addition, there are very few ADA-compliant curb ramps along this corridor.

Segment B2 – Constraints

Very High Traffic Volumes

Causey Avenue's level of activity reduces flexibility for implementing bicycle improvements. The *Clackamas Regional Center Pedestrian and Bicycle Plan* recommended installing bicycle boulevard treatments on between 82nd Avenue east to the I-205 Multi-Use Path with suggested project elements including left turn lane removal, curb extensions, raised crosswalks for traffic calming and bike sharrows. However, existing traffic volumes on Causey Avenue are too high to realistically support low-stress riding using a shared bike boulevard treatment. In addition, the eastbound grade is approximately 4%, coupled with short, steeper sections that slow cyclists considerably as they climb the hill, creating a disparity in speeds between motorists and bicycle riders. For a slower-moving cyclist, being overtaken in a shared space by faster vehicles can be uncomfortable—and in some instances unsafe.

Narrow Cross-Section

At 25' to 35' wide between curbs, Causey is too narrow to add dedicated bicycle facilities without reallocating parking lanes. In addition, lane dimensions are already at their usable minimum width which removes lane narrowing as a potential option.

Highly Utilized On-Street Parking

The parking lanes on Causey are routinely occupied by vehicles, which will likely make it politically difficult to repurpose a lane for dedicated bicycle facilities and creates a hazard for people who bike in the "door zone". The County currently does not institute demand management practices for these spaces, either by limiting the duration of parking, charging an hourly rate, or both. The County also does not run any kind of parking permit system.

Segment B2 – Potential Solutions

Gentler Grade Compared to Spencer Drive

Compared to Spencer Drive, the grade on Causey Avenue is gentler (3 percent vs 5 percent) although the length of the grade is longer (2,300' vs 1,500').

Nearby High Density Residential Development

Although the amount of vehicle traffic generated by surrounding land uses is high, selecting Causey Avenue as the active transportation route would most directly serve the densest part of the project study area and provide the greatest aggregate benefit to nearby community.

Dedicated Bicycle Facilities

Due to observed high volumes and speeds, a bicycle boulevard treatment is not recommended for Causey Avenue without implementing traffic diversion. Instead, dedicated bicycle lanes are more appropriate at this location, particularly in the uphill direction, and would be consistent with the County's proposed treatment west of 82nd Avenue. In the downhill direction, bicycle lanes are preferable but sharrow markings may suffice, as long as other traffic calming measures were implemented to reduce speeds. However, this would almost certainly require removing one or possibly both lanes of on-street parking, although the absence of single-family residences and relative scarcity of owner-occupied households may reduce neighborhood pressure to retain all parking.

Traffic Calming

Travel volumes and speeds are high in this section of Causey Avenue, and traffic calming measures will be necessary to create appropriate roadway conditions for a bicycle boulevard. Speed cushions, curb extensions, chicanes, pinch points and raised crosswalks are all potential treatments, but the roadway's current collector designation may limit the range of options available. The gradually increasing and sustained grade from 82nd Avenue to I-205 presents a real challenge for eastbound cyclists sharing the space with motorists. However, implementing these speed control measures could make low-stress shared operation in the downhill direction more feasible.

Curb Extensions and Midblock Crosswalks

Crossing enhancements such as curb extensions and midblock crosswalks are useful for increasing pedestrian visibility and reduce street crossing distance. ADA-compliant curb ramps are also recommended to improve accessibility.

Next Steps

As described above, different route alternatives for the Monroe Neighborhood Street Design Plan will lend themselves to different treatments along each route segment to improve safety and comfort for all travel modes, and particularly for pedestrians and bicyclists. Building on the segment-by-segment analysis of needs, opportunities, and constraints contained in this memo, the next step will be to apply the project Evaluation Criteria to each of the six route alternatives. Through a careful screening of each alternative and its associated route segments against project objectives, the evaluation criteria, and input from the TAC, PAC, and general public, a preferred alternative will be selected for final recommendation in the Monroe Plan. In addition, the TAC, PAC and general public will help determine which of the potential tools described herein will be included in the final Plan for the project. When completed in spring 2016, the plan will likely set out an approach to funding and implementing the improvements it describes.

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Appendix A:
Bicycle and Pedestrian Facility Tools

Excerpted From:

City of Portland Neighborhood Greenways Assessment Report (2015), Appendix C: Tools and Designs for Neighborhood Greenways……Pages 39 – 55

Milwaukie Transportation System Plan (2013), Chapter 6: Bicycle Element. Bicycle Facility Improvement Toolbox……Pages 6-3, 6-4, 6-5, 6-6, 6-7

Excerpt from City of Portland Neighborhood Greenways Assessment Report (2015), Appendix C: Tools and Designs for Neighborhood Greenways

The following tools are described as part of the Portland Bureau of Transportation's (PBOT) Neighborhood Greenway Assessment Report (2015). Descriptions are included here for reference.

AUTO SPEED REDUCTION ALONG NEIGHBORHOOD GREENWAYS

Speed bumps are the primary tool to manage auto speeds along neighborhood greenway routes where speeding is a problem. The desired 85th percentile operational speed on neighborhood greenways is 20 miles per hour (mph). This goal is supported by international research indicating a cyclist struck at 20 mph has less than 15 percent risk of fatality[1].

Research indicates that the spacing of speed bumps and speed tables should not exceed 350 feet in order to achieve the desired operating speed of 20 mph. The spacing of speed bumps should be reduced to as close as 300 feet apart in response to higher pre-project 85th percentile speeds. Reference Portland's 2013 Draft Traffic Manual, Section 3.1 – Traffic Calming, Speed Bumps for detail design guidance, unless otherwise stated. The following are examples of speed bumps used in Portland.

14-FOOT SPEED BUMP

14-foot speed bumps are used on Local Service streets to achieve residential speeds. They have a parabolic profile and maximum height of 3 inches. Worst-case fire engine delay per 14-foot speed bump is approximately 9.4 seconds.

1. Wramborg, P. (2005) "A New Approach to a Safe and Sustainable Road Structure and Street Design for Urban Areas," paper presented at Road Safety on Four Continents Conference, Warsaw, Poland.

22-FOOT SPEED BUMP (AKA SPEED TABLE)

22-foot speed bumps use two 6-foot parabolic ramps and a 10-foot flat section between the ramps, and 3-inch maximum height. The flat section reduces the slowing effect on motorists at the bump. 22-foot speed bumps are used on Neighborhood Collector streets not designated as Major Emergency Response routes and on Local Service streets with active transit routes. Worst-case fire engine delay per 22-foot speed bump is approximately 9.2 seconds. This photo shows the former marking standard.

RAISED CROSSWALKS

Raised crosswalks use the 22-foot speed bump profile and add the continental-style crosswalk marking. Type 1 raised crosswalks meet the curb, and the curb ramp is constructed to match the 3-inch speed bump height. Type 2 raised crosswalks, as shown here, have a 3-foot-wide tapered edge down to the roadside. See the Draft Traffic Manual Section 3.6 for design details.

SPEED CUSHIONS

Speed cushions are a "freight-friendly" version of the 14-foot speed bump. Channels are incorporated to permit freight trucks to straddle the narrower bump sections and, ideally, minimize delay. Estimated delay per device for a freight truck is under 2 seconds.

OFFSET SPEED BUMPS

Offset speed bumps have the same dimensions as standard 22-foot speed bumps but are split down the centerline of the street with the two halves separated. Offset speed bumps permit emergency response vehicles to bypass the bumps by placing one or both sides of the vehicle into the opposing traffic lane. This action can significantly reduce the delay to emergency response vehicles associated with driving both sides of the vehicle over a speed bump. Estimated delay per device for a freight truck is under 2 seconds. This photo is from Beaverton, Oregon.

Traffic circles have been used in the past to reduce vehicle speeds; however, research has shown that the speed-reduction effect of traffic circles is limited to within about 100 feet of the intersection at which they are placed. When placing speed bumps along a neighborhood greenway with existing traffic circles, it is permissible to place speed bumps within 200 feet of a traffic circle, or remove the circle to achieve a more uniform speed- bump spacing.

TRAFFIC CIRCLE, FORMER CURB

Portland first adopted traffic circles to address speeding concerns, but has found them to be of limited influence on speeds and expensive to construct. Traffic circles also are unwelcome by people biking due to a perception that people driving speed up to pass people biking before the circle. In testing, traffic circles presented the greatest delay to freight engines, at up to 10.7 seconds per circle. Existing traffic control is usually maintained after traffic circle construction. See the Draft Traffic Manual, Section 3.2, for design details.

TRAFFIC CIRCLE, CURRENT CURB

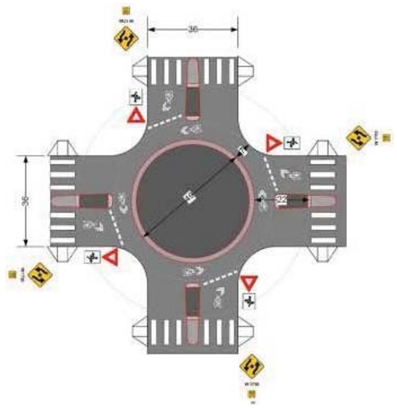
Current design standards have moved to a low curb, more similar to the truck apron of a modern roundabout.

Mini-roundabouts are a tool to reduce speeds at busier Local Service intersections. Mini-roundabouts used at minor intersections should use an automobile as the circular roadway design vehicle, so that speeds are reduced as much as possible. Reference Portland's 2013 Draft Traffic Manual, Section 3.3 - Traffic Calming, Roundabouts for detail design guidelines.

MINI-ROUNDABOUT, PORTLAND TEST SITE

Mini-roundabouts use all the design and operational features of a modern roundabout (deflection, low-speed operation, all-way yield), but do not have a central landscaped circular island. Instead the center island is all at truck-apron height. This permits mini-roundabouts to be used in constrained environments where truck and bus access is to be maintained.

BIKE MINI-ROUNDABOUT



A bike mini-roundabout would be designed so that only passenger vehicles and people biking could move around the central island on the roadway. All other vehicles would need to use some portion of the truck apron regardless of the desired travel path.

AUTO TRAFFIC VOLUME MANAGEMENT ALONG NEIGHBORHOOD GREENWAYS

PBOT has traditionally limited its use of access management due to concerns of diverting traffic to adjacent streets where it would be equally undesirable, as well as the impacts on convenient access. PBOT recommends minimal increase in auto traffic volumes on streets designated as neighborhood greenways where those automobile volumes are already below 1,000 average daily traffic (ADT). For streets currently above 1,000

ADT, the access management tools described below can bring traffic volumes to recommended levels. In certain cases, access management may not be the most desirable tool, and other roadway designs, education campaigns or enforcement actions could be implemented.

Access management devices are typically located at major cross streets and take the form of constructed barriers that limit access onto the neighborhood greenway route from the major cross-street by automobile traffic. Internal access management for automobiles should be considered when community amenities, such as parks or community centers, are located along a neighborhood greenway route near a major cross street or without other convenient access. Automobile access management devices can take several forms. They should permit access by people walking and biking, and accommodate the access needs of emergency response vehicles, if necessary. The following are examples of common access management devices, which can be combined to achieve greater restriction of access.

SOFT DIVERSION – PINCH POINTS

Pinch points introduce friction for automobile traffic. Instead of blocking one direction of access, two directions are constricted to a single lane, requiring opposing motorists to take turns passing through. The nature of this treatment makes it most appropriate for application along a neighborhood greenway, away from main road crossings.

CURB EXTENSION ALONE SEMI-DIVERTER

This is a curb extension that blocks vehicle entry to a street by closing off the parking lane and a portion of the entry lane on the entry street. Space is retained to permit bicycle entry as well as space for a freight truck to enter. The version depicted also incorporates a storm water swale in the curb extension. See the Draft Traffic Manual, Section 3.5, for design details.

CURB EXTENSION WITH ISLAND SEMI-DIVERTER

This curb extension blocks vehicle entry to a street by closing off the parking lane on the entry street. A freight-truck-mountable island is placed near the centerline with a 6-foot minimum space between the island and curb extension to permit bicycle entry. It is recommended that the island include vertical delineators to further discourage auto use. The version depicted also incorporates a storm water swale in the curb extension.

ISLAND SEMI-DIVERTER TYPE A

This island blocks vehicle entry to a street by closing off the parking lane and a portion of the entry lane on the entry street. Space is retained next to the centerline to permit bicycle entry, as well as space for a freight truck to enter. Space is retained next to the curb to permit drainage. The version depicted shows the common signing used to discourage motorist violations.

ISLAND SEMI-DIVERTER TYPE B

This is an island that blocks vehicle entry to a street by closing off the travel lane and a portion of the parking lane on the entry street. Space is retained next to the curb for drainage and to permit bicycle entry. The version depicted shows the common signing used to discourage motorist violations. Emergency responder access is via the opposing lane.

MEDIAN BARRIER, NON-MOUNTABLE

This island blocks vehicle entry to a street, eliminating left turns from the cross street - usually a major cross street - and uses a full-height (6-inch) curb for all sections of the island. The island also eliminates left turns from the side street, making the side street operate as "right in, right out" only. Gaps are retained for pedestrian and bike access. Left-turn emergency responder access is via the opposing lane. See the Draft Traffic Manual, Section 3.4, for design details.

MEDIAN BARRIER, MOUNTABLE

This is an island that blocks vehicle entry to a street, eliminating left turns from the cross street - usually a major cross street. The island also discourages left turns from the side street, making the side street operate as “right in, right out" only. Gaps are retained for pedestrian and bike access. Left-turn emergency responder access is via the opposing lane, or a lowered middle section (3- to 4-inch height curb with angle face). The lowered islands have less deterrence for motorists than a full-height curb.

MEDIAN BARRIER, SKINNY

While most medians will provide a refuge space for pedestrians and cyclists, on occasion there is not sufficient road width available. This location depicts enhancements with vertical delineation to deter violations. Left-turn emergency responder access is via the opposing lane.

DIAGONAL DIVERTER, IMPERMEABLE

A diagonal diverter breaks a standard four-leg intersection into two opposing left- or right-turn corners. The diagonal diverter shown here is accomplished with full curb and sidewalk connections, though small islands are also possible. Bicycle access is via widened ramps at the former corners (see next photo), while pedestrian pathways remain the same. Stop signs are frequently used at all approaches, since people biking may proceed after stopping and come out from behind vegetation. This feature requires an alternate emergency response route.

DIAGONAL DIVERTER BIKE ACCESS

Bike access at a diagonal diverter, combined with corner ramps.

DIAGONAL DIVERTER, PERMEABLE

With this low-cost diversion method, the placement of tall planters is used to prevent all automobile through movement at this right-offset intersection. The crosswalk is inside the planters, and the planters are spaced 4 to 5 feet apart. The planters are not secured to the roadway, and can be pushed aside by emergency vehicles if needed.

DIAGONAL DIVERTER, CUL-DE-SAC / DEAD END

Closure of a street at an intersection can be accomplished in a variety of ways, from temporary planters to small islands, or full curb and sidewalk connections. Frequently such closures include ramps with break-away posts to permit bicycle and freight truck access.

FULL DIVERTER, POCKET PARK

One of the most aesthetically pleasing, and most expensive, full diversion methods, pocket parks retain access for people walking and biking, with the addition of green space for the local community.

SHARED USE PATHS ON UNIMPROVED ROAD

Developing unimproved rights-of-way for non-motorized use is a good way to improve connectivity for cyclists and pedestrians without encouraging auto cut-through traffic.

CONTRA-FLOW BIKE LANE

Contra-flow bike lanes involve the conversion of a street (usually narrow) to one-way operation for auto traffic, with the placement of a bike only lane in the opposing direction. Parking removal is often needed, if not already in place. Reinforcement of the bike-only access may be necessary, using a small diversion island. Alternating contra-flow bike lanes along a corridor can effectively reduce auto traffic volumes at a low cost. On wider streets, changing the remaining parking to angle alignment can offset parking loss from the bike lane. Alternatively, the contra-flow bike lane can have a parking lane adjacent to it on wider streets, eliminating most parking loss.

ACCESS MANAGEMENT SIGNING EXAMPLES

ENHANCING CROSSING SAFETY AT BUSIER CROSS STREETS

While a neighborhood greenway may have the slowest speeds and fewest automobiles in the city, crossing busy arterial roadways presents a challenging, uncomfortable environment for people walking and bicycling. PBOT recommends a minimum crossing level-of-service guideline of 50 people walking and/or biking per hour, and a preferred goal of 100 per hour, when considering how to improve crossings at busier intersections on new neighborhood greenways. These guidelines are based on historical data showing that Portland's most popular bike boulevard routes are already achieving peak-hour demand levels in the 100+ cyclists per hour range.

Portland uses protocols identified in the National Cooperative Highway Research Program Report 562 (NCHRP 562), Improving Pedestrian Safety at Unsignalized Crossings (2006), to evaluate how to improve a crossing to achieve Portland's crossing service guidelines. As Portland has established service level targets, the data collection for current pedestrian and cyclist crossing use is eliminated from the standard protocols identified in NCHRP 562, making the analysis simpler. Standard crossing enhancements at busier intersections, in preferred ascending order, include:

- Signing and marking (minimum);
- Pedestrian refuge islands;
- Curb extensions;
- The addition of rapid flashing beacons to any of items 1-3;
- Combinations of items 2-4 in addition to item 1;
- Pedestrian hybrid beacons; and
- Full signalization with bike buttons or loops.

NEIGHBORHOOD GREENWAY MARKED CROSSING

In every case, marked crossings are added on both legs of the busier cross street. At two-lane crossings, near-right signing is added as a minimum. At multi-lane crossings, islands are common features and additional signing is usually added on the median and at the far right crossing as well. Multi-lane crossings also include advance stop bars and signing; and five-lane crossings include rapid flash beacons with refuge islands.

CROSSING SIGNS

Portland's standard sign for a neighborhood greenway crossing.

PEDESTRIAN REFUGE ISLANDS

Refuge islands are raised concrete islands at crosswalks that break a crossing into two halves. This permits people crossing to concentrate on a single direction of traffic and string together two opposing gaps that do not coincide by pausing at the island. This is especially helpful for the youngest and oldest pedestrians. See the Draft Traffic Manual, Section 3.4, for design details.

CURB EXTENSIONS

Curb extensions shorten the crossing distance, reducing exposure to cross-traffic and permitting the use of shorter gaps in traffic. Curb extensions also bring people walking and biking closer to the street centerline, increasing visibility between motorists and those wishing to cross. People crossing still must find gaps in two directions of traffic that coincide, a more difficult task for the youngest and oldest pedestrians. See the Draft Traffic Manual, Section 3.5, for design details.

BUFFERED BIKE LANE AND BICYCLE TURN BOX

When bike routes that share the roadway with auto traffic have to cross busier roads and a jog is involved, this treatment helps guide people biking and keep bicycle and auto traffic separated. A street-level treatment without vertical delineation is easier to maintain with standard equipment. This application also requires people biking to look back over their shoulder to check for conflicts, an action older cyclists may have difficulty with.

RAISED CYCLE TRACKS

Extended lengths of curb extensions can be used to provide a raised separated space where a neighborhood greenway must jog from one side of a busy street to another. The space created can be shared with pedestrians, or delineated for separate use as shown here. This application shows the contra-flow lane next to opposing traffic to prevent cyclist path crossover.

RAPID FLASHING BEACONS

Rapid flashing beacons are activated by push button and provide positive guidance to motorists that a person walking or biking wishes to cross but, as a flashing yellow beacon, do not require motorists to stop. Such beacons usually include a verbal warning to pedestrians that autos may not stop, and can include illumination that activates when the button is pushed.

PEDESTRIAN HYBRID BEACONS (PHB)

PHBs rest in "off" position. Once a button is actuated, they begin flashing yellow, go to solid yellow, then solid red, and require motorists to stop as with a standard signal. Once the crossing signal phase is complete, the motorist signal heads begin flashing red, permitting people driving to proceed if the path is clear, before going dark.

BIKE SIGNALS

Bike signals are added where there are potential conflicts between people driving and people biking using the same intersection. Common conflicts involve left-turning motorists and through cyclists. Less common is the diagonal cycle path at a signalized intersection.

FULL SIGNALS

Though uncommon, full signals are sometimes recommended at the busiest of crossings, particularly where other safety needs exist. This location includes a school crossing upgrade with a two-way cycle track connection.

PEDESTRIAN COUNTDOWN SIGNAL HEADS

Pedestrian countdown signal heads provide information to road users regarding remaining time before the signal will go to amber. This assists people walking and biking to determine if there is sufficient time to cross a street based on that user's abilities.

CYCLIST PUSH BUTTONS

When electronic warnings or traffic controls are installed at neighborhood greenway crossings, either inductive loops or push buttons at the roadside are provided so people biking can actuate the controls.

NEIGHBORHOOD GREENWAY WAYFINDING

The primary marking for neighborhood greenways is the shared roadway marking, aka sharrow. Portland uses guide sharrows, with a tail added to the standard chevron markings, to inform cyclists of a direction change along a neighborhood greenway. Sharrow legends are placed 25 to 50 feet from major cross streets and spaced at up to 250-foot intervals after that initial marking. Opposite-direction sharrows are typically placed at the mid- point of the first direction such that alternating directional sharrows are encountered every 125 feet along a neighborhood greenway. In advance of a direction change, or decision point, along the neighborhood greenway, the last sharrow will use the directional chevron to inform cyclists of the change of direction, or a pending decision point, where the neighborhood greenway intersects another bikeway.

The bike-person symbol with arrow legend is used on bike lanes, and the bike-person alone at bike median crossings. Guide signing of neighborhood greenways will occur in advance of major cross-streets and intersections with other bikeways. Guide signing will identify major destinations, distance to the tenth of a mile, and approximate time to achieve that distance at 8 mph.

STANDARD SHARROW

The standard shared lane marking, aka sharrow, is a bike symbol with a double chevron on top. The chevron can be rotated to the right or left side to indicate changes of direction, if turn sharrow markings are not used. Multiple chevrons can indicate crossing choices. Shown here is the former "dinner plate" marking that the sharrow replaced, and a previous version of the sharrow.

TURN SHARROW

Shown here is the right turn sharrow marking.

DECISION POINT SHARROW

Multiple chevrons can indicate direction choices.

BIKE LANE SYMBOL (BIKE PERSON + ARROW)

BIKE-PERSON SYMBOL AT MEDIAN

The bike-person symbol is used at standard-width medians to identify the gap for the exclusive use of people biking.

ROUTE GUIDE SIGNING

A standard bikeway guide signing showing destination, distance and time.

LOCATION DESTINATION GUIDE SIGNS

Local destination guide signing is intended to inform people biking on neighborhood greenways of nearby destinations or amenities on adjacent, parallel auto collector streets.

LOCAL DESTINATION GUIDE SIGNS

Artwork and other creative designs can enhance the street and highlight its unique function as a place for people.

Excerpt from Milwaukie Transportation System Plan (2013), Chapter 6: Bicycle Element. Bicycle Facility Toolbox

BICYCLE FACILITY IMPROVEMENT TOOLBOX

Types of Bicyclists

Bicyclists are a varied group of people with different skill levels, abilities, bicycling experience, and trip types. For example, there are everyday commuters, avid recreational riders, children going to school, and families riding around in their neighborhoods. Their needs and comfort level with the bicycle infrastructure in Milwaukie will vary as a result of these differences. The City needs to accommodate these different types of bicyclists by providing adequate facilities for all different types of riders.

Bicycle trips are typically longer than walking trips and shorter than motor vehicle trips, and are attractive at distances up to three miles. Bicycle facilities can generally be categorized as multiuse paths, cycle tracks, bike lanes, shared roadways, and neighborhood greenways. Each of these facilities serves a particular purpose for bicycle travel. Bike lanes, cycle tracks, and multiuse paths can all accommodate trips of up to three miles. However, if the trip is shorter, or if the destination or origin of the trip is not next to a roadway with a bike lane, many bicycle trips can also be made on local streets. Table 6-1 summarizes each of these facilities with a general description of the elements inherent to each facility.

Table 6-1 Bikeway Types

Bikeway	Description
Multiuse path	Off-street route, typically recreational-focused, which can be used by several transportation modes, including bicycles, pedestrians, and other nonmotorized modes (i.e., skateboards, roller blades, etc.).
Cycle track	Exclusive bike facility within the roadway, with elements of both a separated path and a bike lane. Separated from motor vehicle traffic by parked cars, bollards, landscaping, or other barriers.
Bike lane	Area within street right-of-way specifically designated for bicycle use.
Shared roadway	Roadways where bicyclists and autos share the same travel lane. May include a wider outside lane and/or bike boulevard treatment (priority given to through bikes on local streets).
Neighborhood greenway	Lower-order, lower-volume streets with various treatments to promote safe and convenient bicycle travel and enhance pedestrian travel as well. Usually accommodate bicyclists and motorists in the same travel lanes, often with no specific vehicle or bicycle lane delineation. Assign higher priority to through bicyclists, with secondary priority assigned to motorists. Also include treatments to slow vehicle traffic to enhance the bicycling environment.

Bicycle Facility Design Considerations

Multiuse Paths

As their name implies, multiuse paths are designed to accommodate many types of users, and are typically constructed along an independent path such as a stream or greenway. Paths can also be built parallel to a roadway, but are most effective when built independent of a road, separating bicyclists from auto traffic. The American Association of State Highway Transportation Officials (AASHTO)[1] and the Oregon Department of Transportation (ODOT)[2] state that mixed-use paths can be designed along roadways, provided several design considerations are met:

Figure 6-1 Multiuse Path

Photo credit: Vince Schreck, www.pdxfamilyadventures.com

- A minimum 5-foot buffer should be provided between the path and roadway to protect path users from conflicts with motorists.
- Relatively few vehicle/path user conflict points (e.g., cross-streets or driveways).
- The path can be terminated at each end onto streets with good bicycle/pedestrian facilities or onto another safe, well-designed path.
- The path should not take the place of bicycle/pedestrian facilities (e.g., sidewalks and bicycle lanes) on the parallel street.

Cycle Tracks

Figure 6-2 Cycle Track

Cycle tracks can take a number of forms, depending on the nature of the existing street infrastructure. They combine some elements of a fully separated path with those of a bike lane in the roadway. The key element of a cycle track is that it uses parked cars, bollards, landscaping, curbing, or other barriers to provide some separation from motor vehicle traffic. Cycle tracks may be one-way or two-way, and they may be located at road level, sidewalk level, or an intermediate level. They are distinct from the sidewalk and are designed exclusively as bike facilities. A recommended minimum width is 7 feet, with an additional 2-ft "door zone" buffer (where adjacent to parked cars). Pavement markings on the cycle track provide guidance for bicyclists, as well as for motorists and pedestrians that may cross the cycle track at driveways or intersections.

Photo credit: Michael O'Hare, www.citiesforpeople.net

There are currently no cycle tracks in Milwaukie, and no potential cycle track routes have been identified to date. However, this type of facility represents an option for future bike improvements that might be most appropriate in certain settings to provide safer bike routes in high-traffic corridors.

[1] *A Guide for the Development of Bicycle Facilities*, American Association of State Highway and Transportation Officials, 1999.
[2] *Oregon Bicycle and Pedestrian Plan, An Element of the Oregon Transportation Plan*, Oregon Department of Transportation, Adopted June 14, 1995.

Bike Lanes

When possible, bike lanes should be directly adjacent to the curb, rather than adjacent to parked cars or combined with sidewalks. The recommended width of six feet provides sufficient travel space and additional room for bicyclists to steer clear of the curb or parked cars while maintaining a comfortable distance from adjacent moving traffic. Wide bike lanes also enable bicyclists to maneuver around drainage grates, manhole covers, glass and debris. Provision of bike lanes also benefits motor vehicles, which gain greater shy distance/emergency shoulder area, and pedestrians, who gain a buffer between walking areas and moving vehicles. Where right-of-way is limited, the bike lane can be reduced to 5 feet. Alternatively, widening the curb travel lane (for example, from 12 feet to 14 or 15 feet) can provide better bicycle accommodations and a greater measure of safety as well. However, with higher-volume roadways (e.g., streets with more than 3,000 Average Daily Trips), dedicated bike lanes are much more desirable than wide outside lanes.

Figure 6-3 Bike Lane

Photo credit: LA-32 Neighborhood Council, http://la32nc.org/category/transportation/

The signing and marking of bike lanes should follow the *Manual on Uniform Traffic Control Devices* (MUTCD). Design features in the roadway can improve bicycle safety as well. For example, using curb storm drain inlets rather than catch basins significantly improves bicycle facilities.

Shared Roadways

Shared roadways can be designed to safely accommodate both bicycle and auto traffic. Figure 6-5 illustrates an example of an appropriate warning sign with a supplemental "Share the Road" plaque that may be used to draw more attention to the fact that slow-moving forms of transportation may be using the roadway. When used, the supplemental plaque must be installed below the warning sign on the same signpost. Directional pavement markings may also be considered on shared roadways to supplement the bicycle warning signs when desired. The pavement markings illustrated in Figure 6-5 below are typically called "Sharrows" or "Shared Lane Markings" and are utilized on bicycle travel routes that have on-street parking but no designated bike lanes. Sharrows are commonly used on streets where dedicated bike lanes are desirable but are not possible for any number of reasons. The marking helps to align bicyclists, to shift their travel pattern out of the direction of a parked car door opening into their travel path.

Figure 6-4 Shared Roadway

Photo credit: Portland Bureau of Transportation, www.portlandoregon.gov/transportation/

Figure 6-5 Bicycle Signs and Markings

Bicycle Warning Sign | "Share the Road" Plaque | Bike Route Sign | Bicycle Pavement Marking | Bicycle Wayfinding Signage

It should be noted, however, that while posting "Bike Route" signage for bicyclists is an acceptable way for the City to demarcate bike routes, such signs should be coupled with pavement markings and/or way finding signage for bicyclists to get the most value out of the City's investment. Although this is an adopted MUTCD sign, it does not provide much information. Adding wayfinding information such as distances to various destinations, directional arrows, and estimated travel times makes the sign much more useful. These signs are most effective when placed in useful locations, such as where a bike route makes a turn that is not intuitive to riders.

Neighborhood Greenways

The term "neighborhood greenway" has recently evolved from the "bike boulevard" concept of treatments, which improve the network of safe bicycle routes by generally utilizing streets with lower traffic volumes and vehicle speeds, such as minor collectors or local streets that pass through residential neighborhoods. The neighborhood greenway treatments also make these routes safer for pedestrians and motorists (for example, through inclusion of traffic-calming devices), while at the same time incorporating low-impact stormwater treatment measures such as bioswales and raingardens. The general traffic calming provided by neighborhood greenway improvements adds to neighborhood livability.

Figure 6-6 Neighborhood Greenway

Image credit: Bicycle Transportation Alliance/Owen Walz, owenwalzdesign.com

Traffic controls along a neighborhood greenway assign priority to bicyclists while encouraging through-vehicle traffic to use alternate parallel routes. Traffic calming and other treatments along the corridor reduce motor vehicle speeds so that motorists and bicyclists generally travel at the same speed, creating a safer and more comfortable environment for all users. Neighborhood greenways also incorporate treatments to facilitate safe and convenient crossings of major streets. Neighborhood greenways work best in well-connected street grids, where riders can follow reasonably direct and logical routes and where higher-order, parallel streets exist to serve through-vehicle traffic.

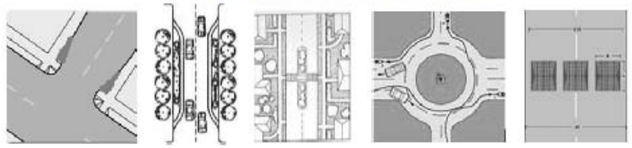
Milwaukie's neighborhood greenway network could be developed through a variety of improvements ranging from minor street enhancements (e.g., directional pavement markings) to larger-scale projects (e.g., intersection signalization). The various treatments fall into five major application levels based on their degree of physical intensity, with Level 1 representing the least physically intensive treatments that can be implemented at relatively low cost:

- **Level 1: Signage** (e.g., wayfinding and warning signs along and approaching the neighborhood greenway).
- **Level 2: Pavement markings** (e.g., directional pavement markings, shared lane markings).
- **Level 3: Intersection treatments** (e.g., signalization, curb extensions, refuge islands).
- **Level 4: Traffic calming** (e.g., speed humps, mini traffic circles).
- **Level 5: Traffic diversion** (e.g., choker entrances, traffic diverters).

Corridors targeted for higher-level applications would also receive relevant lower-level treatments. For instance, a street targeted for Level 3 applications should also include Level 1 and 2 applications as necessary. It should be noted that some applications might not be appropriate on all streets. In other words, it may not be necessary to implement all Level 2 applications on a particular street designated for Level 2 treatment in order to create a functional neighborhood greenway.

Figure 6-7 shows examples of some of the types of intersection treatments and traffic-calming measures that could be appropriate for application on neighborhood greenway routes. Some study and analysis is necessary to determine which measures would be most effective in specific locations. Within Chapter 11 Neighborhood Traffic Management, Table 11-1 provides more examples of traffic-calming measures.

Figure 6-7 Sample Traffic-Calming Measures



Bulbout **Choker** **Center Median** **Traffic Circle** **Speed Cushion**

Experience from other cities that have implemented neighborhood greenways shows that on-street vehicle parking can function as a traffic-calming measure. Drivers generally seem to slow down in response to the physical narrowing of the travel lane and the higher perceived risk of collision. In addition, parked cars create a barrier between moving cars on the street and pedestrians on the sidewalk. This barrier enhances both actual and perceived safety for pedestrians. Allowing or encouraging on-street vehicle parking can be one tool employed to make neighborhood greenways safe and pleasant for nonmotorized travel.

Bicycle Parking

Bicycle parking and storage facilities are an important component of an effective bicycle system. Lack of proper storage facilities discourages potential riders from traveling by bicycle. Bike racks should be located at significant activity generators including schools, parks, and commercial areas, as well as at major transit stops. Racks should be placed in highly visible locations and within convenient proximity to main building entrances. Bike racks should be designed to

Appendix C:
Relevant Clackamas County TSP Projects

Network Type	Priority	Project Type	Project Name	Project Description	From	To
Off-Street	20-Year	Capital	72nd Ave Multi-Use Path Connection	Construct multi-use path	Thompson Rd	Harmony Rd
Street	20-Year	Capital	85th Ave	Add sidewalks and bikeways	Causey Ave	Monterey Ave
Street	20-Year	Capital	Boyer Dr	Construct new 2 lane roadway with turn lanes at 82nd Avenue and Fuller Rd, bikeways and pedestrian facilities; install flashing yellow arrow for left turns on northbound and southbound approaches at 82nd Avenue intersection.	82nd Ave	Fuller Rd
Street	20-Year	Capital	Boyer Dr/85th Ave/ Spencer Dr	Add bikeways	82nd Ave	I-205 bike path
Street	20-Year	Capital	Causey Ave	Add bikeways and shared facility markings in accordance with the Active Transportation Plan.	Fuller Rd	I-205 bike path
Pedestrian	20-Year	Capital	Linwood Ave	Add pedestrian facilities in accordance with the Active Transportation Plan.	Monroe St	Johnson Creek Blvd
Street	20-Year	Capital	Monroe St	Add bikeways, pedestrian facilities and traffic calming in accordance with the Active Transportation Plan.	72nd Ave	Fuller Rd
Street	20-Year	Capital	Monroe St/72nd Ave/ Thompson Rd/Fuller Rd	Add bikeways and traffic calming in accordance with the Active Transportation Plan.	Linwood Ave	Causey Ave
Pedestrian	Preferred	Capital	Linwood Ave/Monroe St intersection	Add curbs/sidewalks, improve horizontal alignments	Location-specific	Location-specific
Pedestrian	Preferred	Capital	Monroe St/72nd Ave/ Thompson Rd	Add pedestrian facilities	Linwood Ave	Fuller Rd
Off-Street	Long-Term	Capital	I-205 Pedestrian/Bike Overpass	Construct a bike / pedestrian crossing over I-205 to connect transit services, businesses and residents in accordance with the Active Transportation Plan	Causey Ave	Sunnyside Rd
Off-Street	Long-Term	Capital	Phillips Creek Multi-Use Path	Construct multi-use path	Causey Ave	North Clackamas Regional Park Trail

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