APPLICABLE STANDARDS AND GUIDELINES

This section reviews a variety of standards and guidelines from different sources that apply to the study corridor, including local, regional, and national level guidance. This section includes reviews of the following:

- Washington County Bicycle Facility Design Toolkit
- Washington County Roadway Design and Construction Standards
- American Association of State Highway and Transportation Officials (AASHTO), A Policy on Geometric Design of Highways and Street (Green Book)
- National Association of City Transportation Officials (NACTO) Guidelines
- Metro Regional Active Transportation Plan
- Americans with Disabilities Act (ADA)
- Federal Highway Administration (FHWA) Cycle Track Report
- Roundabouts: An Informational Guide (NCHRP Report 672)

Guidance from the Washington County Bicycle Facility Design Toolkit

Washington County Bicycle Facility Design Toolkit

The *Washington County Bicycle Facility Design Toolkit* supplements the *Washington County Road Design Standards* by offering design guidance on innovative bikeway facilities that are not currently addressed in the road standards and is consistent with national standards and references developed by AASHTO, FHWA, the United States Access Board, and NACTO. It identifies appropriate bicycle facilities according to the user type that is desired to be accommodated or attracted to

the facility as well as the characteristics of the roadway.

Table 3 identifies some of the roadway characteristics relevant to selecting a bicycle facility type. Based on the characteristics of the study area roadway segments and the desire to incorporate a wide range of users, including those defined as **Interested, but Concerned** or **Type C (Concerned)**[1], the study area segments are recommended to be designed to Protection Level 2 or 3 per the Washington County Bicycle Facility Design Toolkit. Within the urban context, Level 2 protection includes bike lanes or buffered bike lanes and Level 3 protection includes bike lanes, buffered bike lanes, or cycle tracks.

These Level 2 and Level 3 designations are consistent with each of the study area segments designations in the County's Transportation System Plan as *Major Street Enhanced Bikeways. Major Street Enhanced Bikeways* are urban Arterial or Collector roadways that have, or are planned to have, buffered bike lanes or cycle tracks on one or both sides of the road.

Table 3: Bicycle Toolkit Recommendations for Study Corridor Segments

	Segment 1 170th Avenue (Baseline Road to Merlo Road)	**Segment 2** 170th Avenue (Merlo Road to Tualatin Valley Highway)	**Segment 3** Merlo Road (170th Avenue to Jenkins Road)
Roadway Characteristics			
Roadway Functional Classification	Arterial	Arterial	Arterial
Average Daily Traffic (2013)	11,700	16,200	8,600
85th Percentile Speed	39 mph	45 mph	39 mph
Desired User Groups	Advanced, Basic, & Concerned	Advanced, Basic, & Concerned	Advanced, Basic, & Concerned
Connect to School?	Yes	Yes	Yes
Recommended Protection Level	**2**	**3**	**2**
Design Considerations/Constraints			
Freight, Transit, or Emergency Route?		Transit/Freight	Transit/Freight
Frequent Driveways?	No	No	No
On-street Parking?	No	No	No
Challenging Geometry?		Yes	
ROW Constraints?	Yes	Yes	Yes
Structures?	No	Yes	No

[1] These types include people of all ages, such as school children, who enjoy bicycling but may only ride on shared use paths, protected on-street facilities, or low traffic local streets

Table 3 also identifies some of the design considerations and constraints that should be considered when selecting a bicycle facility type. The range of facility types that would be appropriate on an urban arterial include:

- Conventional Bike Lane
- Buffered Bike Lane
- Protected Cycle Track
- Raised Cycle Track
- Two-Way Cycle Track
- Multi-use Off-Street Path

The desire for Level 2 or Level 3 protection needs to be considered in the context of the design considerations and constraints identified above and with the design guidance provided in the *Washington County Bicycle Facility Design Toolkit* for each of the facility types above. This guidance is included in Appendix B.

The *Washington County Bicycle Facility Design Toolkit* also includes design guidance on treatments for bicyclists at intersections and driveways. The range of treatment types that would be appropriate in the study area include:

- Colored Pavement in Conflict Zone
- Bicycle Signal
- Intersection Crossing Markings
- Bike Box
- Two-Stage Left-Turn Queue Boxes
- Wayfinding
- Lighting

Applicability and design guidance on these treatments as well as intersection striping for bike lanes, buffered bike lanes, and cycle tracks is provided in the *Washington County Bicycle Facility Design Toolkit* for each of the treatment types above. This guidance is also included in Appendix B.

Providing Level 2 and Level 3 treatment types on Arterials will require one of three modifications to existing plans and/or standards:

- Additional right-of-way and pavement width beyond what is identified in the *Washington County Road Design Standards* for Arterials;
- A reduction in the number of planned lanes;
- A reduction from the standard width for travel lanes on arterials.

Table 4 identifies the amount of additional right-of-way and pavement width beyond a typical arterial that is necessary to accommodate an Enhanced Bikeway if no modifications are made to the typical street section. Kittelson & Associates, Inc. prepared a white paper to accompany the Washington

County Bicycle Facility Design Toolkit summarizing the research on lane width design modifications, included in Appendix C. Additional guidance on reduced lane widths is provided in NACTO's Urban Streets Design Guide, including considerations for transit and freight. Future transit planned along Segment 2 and 3 will need to be considered in the evaluation.

Table 4: Right-of-way and pavement needs for Enhanced Bikeways

	TSP Planned Facility (ft)	Required ROW (ft)	Required pavement width (ft)
Segment 1 (170th Ave. North)	Three-lane arterial w/ Enhanced Bikeway	90' (sufficient for enhanced bikeway)	50' + (3' to 9' for Enhanced Bikeway)
Segment 2 (170th Ave. South)	Five-lane arterial w/ Enhanced Bikeway	98' + (3' to 9' for Enhanced Bikeway)	74' + (3' to 9' for Enhanced Bikeway)
Segment 3 (Merlo Rd)	Five-lane arterial w/ Enhanced Bikeway	98' + (3' to 9' for Enhanced Bikeway)	74' + (3' to 9' for Enhanced Bikeway)

Washington County Roadway Design and Construction Standards

The provisions of the *Washington County Roadway Design and Construction Standards* are "intended to provide a safe and reliable transportation system and to preserve, protect, and improve the public transportation infrastructure." The standards are in place to "ensure long-term viability of the transportation system and avoid unnecessary and excessive maintenance and replacement costs," however, they are flexible, providing a process for exceptions to the standards in situations where any of the following occurs:

1. The specification or standard does not apply in the particular application;
2. Topography, right-of-way or other geographic conditions impose an economic hardship on the applicant and an equivalent alternative is available which can accomplish the same design objective;
3. A minor change to a specification or standard is required to address a specific design or construction problem which if not allowed will result in an undue economic hardship.

Design exceptions must be approved by the County Engineer.

The Standards were reviewed to identify applicable standards for the 170th Avenue / Merlo Road corridor. The remainder of this section summarizes the most applicable standards. In addition to the sections highlighted in detail, the Standards also provide guidance on landscaping, retaining walls, driveways, traffic management devices, roadway illumination, and other roadway design topics along with standard drawings, which would be consulted in the design phase of the project.

Cross Sections

- For rural and interim urban roads, 6-foot wide shoulders are required.
- Arterials have 45-mph design speed and collectors have 35-mph design speed.
- For A-2 (Five-lane arterial), standards require 98-foot ROW, 74 foot paved width, four 12-foot travel lanes, a 14-foot center turn lane, 6-foot bike lanes, a 4.5-foot buffer between roadway and sidewalk, and a 5-foot sidewalk (Exhibit #1 in document, included in Appendix D).
- For A-4 (three-lane arterial), standards require 90-foot ROW, 50 foot paved width, two 12-foot travel lanes, a 14-foot center turn lane, 6-foot bike lanes, a 4.5-foot buffer between roadway and sidewalk, and a 5-foot sidewalk (Exhibit #1 in document, included in Appendix D).
- For C-1 (three lane collector), standards require 74-foot ROW, 50 foot paved width, two 12-foot travel lanes, a 14-foot center turn lane, 6-foot bike lanes, a 4.5-foot buffer between roadway and sidewalk, and a 5-foot sidewalk (Exhibit #2 in document, included in Appendix D).

Roadway Design Elements

- Design controls for crest vertical curves for 45-mph design speed require a minimum K-value of 61 feet (the minimum length of curve per one percent difference in grade). For sag vertical curves, the minimum K value is 79 feet for a 45-mph design speed. Exhibits #7 and #8 (included in Appendix D) in the Standards provide values for other design speeds.
- Sag vertical curves may use shorter curves with the installation of additional road lighting.
- The minimum radius for a horizontal curve on a zero slope roadway is 930 feet for 45-mph arterial design speed. Exhibit #9 (included below) provides additional details for other design speeds and roadway slopes.

Exhibit 9

DESIGN SPEED/CENTERLINE RADIUS-MINIMUMS

ARTERIALS, ALL COLLECTORS AND ALL RURAL ROADS

Design Speed(MPH)	Slope/R min. (e)-4%	(e)-2.5%	(e) 0%	(e)2.5%	(e) 4%	(e) 6%
25	335'	300'	255'	220'	205'	185'
30	500'	445'	375'	325'	300'	275'
35	710'	630'	530'	455'	420'	380'
40	970'	855'	710'	610'	560'	510'
45	1285'	1125'	930'	795'	730'	660'
50	1665'	1450'	1190'	1010'	925'	835'
55	2240'	1920'	1550'	1300'	1190'	1060'
60	3000'	2525'	2000'	1655'	1500'	1335'

- Also provides guidance on transitions into dedicated turn lanes.
- Clear zones must meet AASHTO guidelines; and for curbed roadways, "in no case shall the horizontal clearance from face-of-curb to the face of non-breakaway obstacles be less than 2 feet."
- Intersection design:
    - Sidewalks and crosswalks must meet ADA guidelines.
    - Curb ramps must be provided at all corners of all intersections.
    - Minimum curb radius for an Arterial to Arterial is 55 feet; Arterial to Collector is 40 feet. In areas where bike lanes or on-street parking exist, the radii may be reduced by five feet.

Ancillary Facilities

- Bikeways shall be required in accordance with Community Development Code and Transportation System Plan.
- Urban arterial and collector roads shall include curbs on both sides *except* in situations of interim width improvements. Interim width urban roads shall have six foot wide shoulders with a minimum two-foot paved width adjacent to the road at the road cross-slope.

Drainage Design

The roadway improvements to the study corridor will add a significant impervious area which will result in the increase in stormwater runoff. This will trigger water quality treatment, conveyance design, and may require stormwater detention. Applicable design standards include Washington County Roadway Design and Construction Standards, Cleanwater Services Design and Constructions Standards, Cleanwater Services Low Impact Development Approaches (LIDA) handbook, and City of Beaverton Engineering Design Manual. Other standards may apply to the project through the SLOPES V requirements (SLOPES for Stormwater, Transportation or Utilities) by National Marine Fisheries Service (NMFS) and Army Corps of Engineers due to wetland and potential impact within the corridor.

- Water Quality:
    - Runoff treatment from 0.36 inches of precipitation falling in 4 hours with 96 hours storm event (CWS Standards)
    - Runoff treatment from 50% 2-year, 24-hour storm event (SLOPES V Standards if applicable)

- Conveyance:
    - 25-year, 24-hour storm event

- Detention:
    - 42% of 2-year, 24-hour storm event (SLOPES V Standards if applicable)
    - 2-year, 24-hour storm event (CWS Standards)
    - 10-year, 24-hour storm event (CWS and SLOPES V Standards)

- 25-year, 24-hour storm event (CWS Standards)

Utilities

The corridor improvements will affect both overhead and underground facilities and may require relocations, utility system expansion, or relocation due to conflicts with the new drainage system. The extent of utility impacts or relocations is not known and cannot be discussed extensively until a conceptual roadway layout has been developed. Early coordination and meetings with affected utility companies are necessary since these works can affect project schedule and/or right of way acquisition process.

American Association of State Highway and Transportation Officials guidelines

The *Washington County Roadway Design and Construction Standards* provide the primary source of guidance for roadway design and construction in the County, and draw on the same principles and guidance found in the AASHTO Green Book, the AASHTO Roadside Design Guide, and the AASHTO Guide for the Development of Bicycle Facilities. Therefore, this document does not provide a thorough review of these documents, except in the case of the clear zone, specifically referenced by the Washington County Roadway Design and Construction Standards. The Standards state that the engineer is responsible for meeting AASHTO guidelines. In the case of uncurbed roadways, the Standards directly apply guidance from the AASHTO Roadside Design Guide. However, AASHTO guidance notes that clear roadsides are not practical on urban arterials with curbs. "In such areas, a clearance between the curb face and object of 1.5 feet should be provided. A 3-foot clearance to roadside objects should be provided particularly near turning radii at intersections and driveways." The County's Standard of two feet between the curb face and any non-breakaway obstacles meets the minimum of 1.5 feet in the AASHTO guidance. The 4.5 foot buffer between the sidewalk and roadway in the County's design standards allows enough space for street trees and utility poles to be located in this space while still meeting the two-foot clearance standard.

National Association of City Transportation Officials Guidelines

The FHWA has officially endorsed use of the guidance from NACTO, both in its *Urban Bikeway Design Guide (2012)* and its *Urban Street Design Guide (2013).* Washington County's own bicycle facility toolkit drew on the guidance from the Urban Bikeway Design Guide, with specific guidelines customized for Washington County. Because of this, the Urban Bikeway Design Guide was not reviewed further. However, the Urban Street Design Guide was reviewed for certain aspects that may be applicable to the 170th Avenue/Merlo Road corridor.

Urban Street Design Guide

NACTO's Urban Street Design Guide (USDG) was developed in response to a growing need from cities for design guidance that better meets their complex needs and moves away from a bias towards

highway designs. The Urban Street Design Guide focuses guidance on "making streets safe and inviting for people walking, shopping, parking, and driving in an urban context. These principles are about creating real spaces for people on city streets. Economic development is integrally tied into this transformation, since great streets support city businesses." The 170th Avenue/Merlo Road study area is in transition from a more rural/suburban character to being a more urban area. 170th Avenue forms the eastern edge of the adopted Aloha Town Center and corresponding Pedestrian/Bicycle District. However, it is not a fully urban area and some principles that would apply in a dense city core may not apply. The following provides a summary of the Urban Street Design Guide recommendations potentially applicable to the study area.

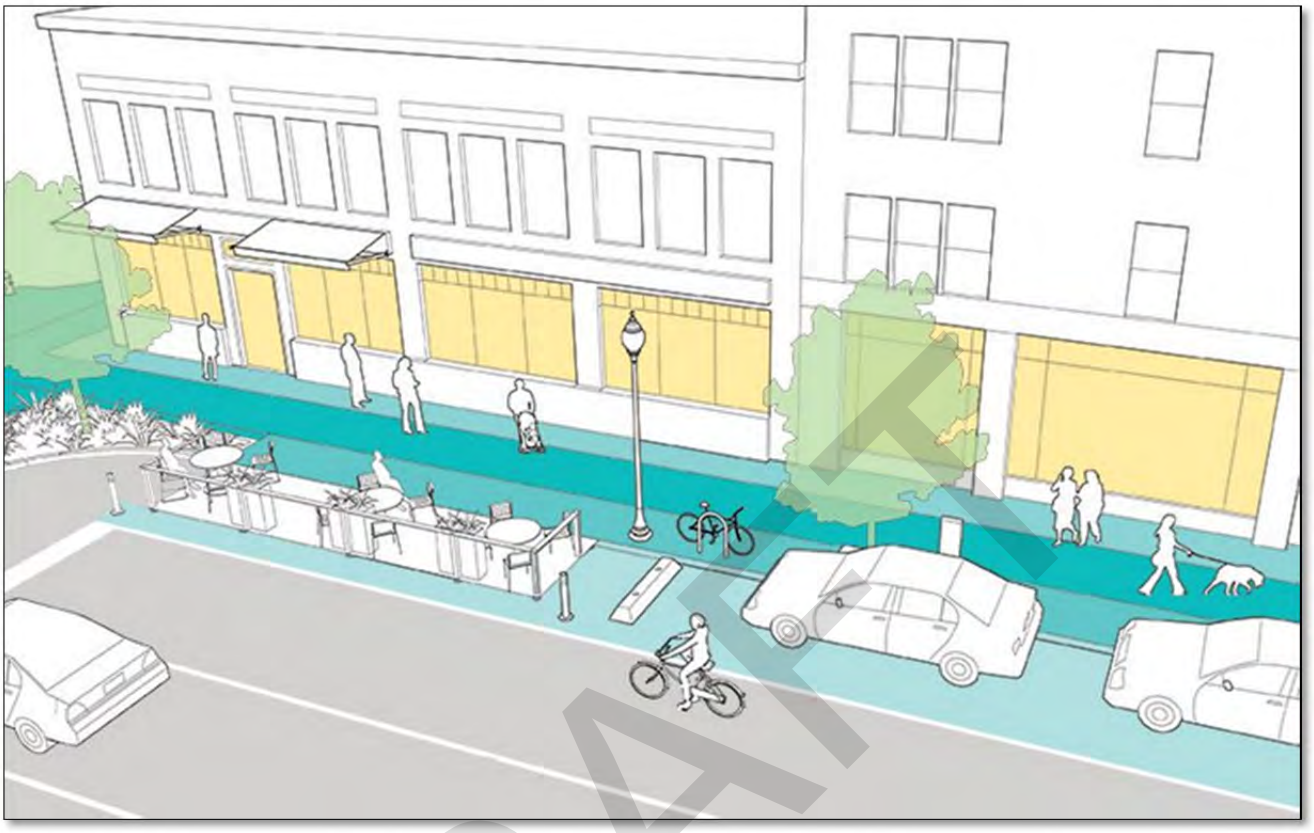
Lane Widths

- NACTO recommends lane widths of 10 feet, with 11 feet on truck or transit routes, in order to discourage speeding and positively impact safety by reducing crash severity. Studies have shown that reductions of lane widths do not impact operations (the measured saturation flow rates are similar for lane widths between 10 feet and 12 feet).
- NACTO USDG states, "Lane widths greater than 11 feet should not be used as they may cause unintended speeding and assume valuable right-of-way at the expense of other modes…Restrictive policies that favor the use of wider travel lanes have no place in constrained urban settings, where every foot counts."

Sidewalk Zones

- NACTO recommends including extra sidewalk width for a *frontage zone* between walking space and adjacent land use (to accommodate street furniture, trash receptacles, bus stops, or signage).
- The *pedestrian through zone* should be 5-7 feet in residential areas, and 8-12 feet in commercial areas.
- The *street furniture/curb zone* may include utility poles, lighting, benches, bicycle parking, etc.
- The *enhancement/buffer zone* is between the sidewalk and the street, and may include stormwater management, parking, cycle tracks, etc.

Diagram from the *Urban Streets Design Guide* showing four sidewalk zones



Sidewalk Design

- An absolute minimum is 5 feet, but in an urban context, sidewalks should go beyond the minimum width.[2]
- At intersections with driveways, sidewalks should be maintained at-grade through the conflict zone.
- Location of fixed objects (utility poles, light fixtures) should not impinge on or restrict the walkway.
- On urban arterials, sidewalks of minimum dimensions directly adjacent to the traveled way should be avoided.

Bus Stops

- NACTO USDG states, "Bus stops must have safe access via sidewalks and appropriate street crossing locations. Where possible, pedestrian crossings should be accommodated behind the departing transit vehicle."
- Include adequate lighting around bus stops to ensure security.

[2] The Oregon Department of Transportation standards designate a 6-foot minimum sidewalk width.

Intersections

- Minimize unused space.
- Use leading pedestrian intervals on signalized intersections.
- Accommodate bicyclists through full signalization or mixing zones.
- Delineate guide markings through intersections to guide vehicles and reduce conflicts.
- Reduce vehicle speeds to match sight distance, rather than enlarging the intersection or removing obstructions.
- Use raised crossings and curb extensions to limit turning speeds where possible.
- Minimize curb radii – 10-15 feet in urban areas, with radii exceeding 15 feet the exception.
- Shorten signal cycles and keep number of phases to a minimum.

Design Speed

- Speeds play a critical role in the cause and severity of crashes.
- Conventional highway design selects a design speed based on how fast vehicles are going (85th percentile speeds). NACTO recommends a proactive urban street design approach, designing streets using a target speed, the speed you would like drivers to go. Maximum target speed for urban arterial streets is 35 mph.

Metro Regional Active Transportation Plan

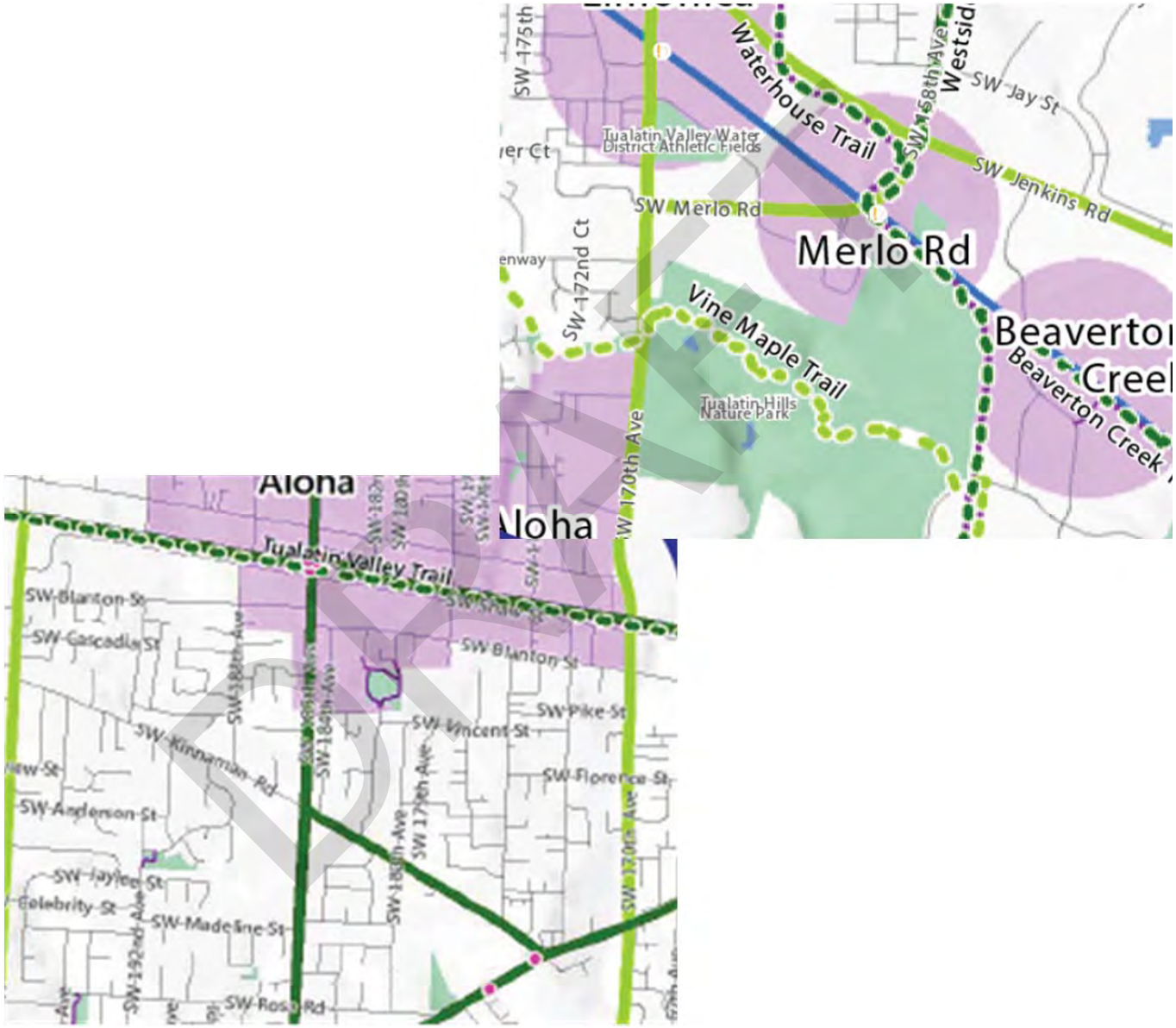
The Metro Regional Active Transportation Plan identifies a vision, policies and actions to complete a seamless green network of on- and off-street pathways and districts connecting the Metro region and integrating walking, biking and public transit. The following provides a summary of the plan within the study area.

- The plan designates all three study area segments as on-street regional pedestrian corridors. This is the second highest functional classification in the plan. Regional pedestrian corridors are any major or minor arterial street or regional trail that is not designated as a pedestrian parkway.
- Much of the corridor, including the Elmonica/170th Ave and Merlo/158th Ave station areas and the area west of the southern part of Segment 2, is included in the Regional Pedestrian District designation, areas that "correspond with 2040 Growth Concept Design Types - the Central City, Regional and Town Centers and Station Communities; bicycle and pedestrian districts are the same. All streets and trails within a district are part of the regional pedestrian network. A pedestrian district is an area with a concentration of transit, commercial, cultural, educational, institutional and/or recreational destinations where pedestrian travel is attractive, comfortable and safe. Pedestrian districts are areas where high levels of walking exist or are planned."
- Includes the Vine Maple Trail, the Westside Trail, and the Beaverton Creek Trail.
- Designates all three segments of the study area as on-street regional bikeways. This is "the second highest functional classification and, like bicycle parkways, can be on any type of facility.

Regional bikeways connect to bicycle parkways and complete the regional network of bicycle routes."

- Tualatin Valley Highway is designated as both a bicycle parkway and a pedestrian parkway (the highest functional classification for each), with the potential for off-street facilities, on-street facilities, or both.

Pedestrian map from Regional Active Transportation Plan



Americans with Disabilities Act

The Public Rights-of-Way Proposed Guidelines specify design details to ensure accessibility by all users, including geometric design of sidewalks, pedestrian signals, crosswalks, and other right-of-way characteristics. These guidelines will be followed in the development of the actual design for the 170th

Avenue/Merlo Road corridor and are not outlined extensively here. However, design of roundabouts is an area that is currently evolving with respect to designing for visually impaired pedestrians.

To date, the United States Access Board, which publishes the ADA Standards, has not put forth requirements for single-lane roundabouts to have additional design features for visually impaired pedestrians. However, guidelines currently suggest that multi-lane roundabouts should have a pedestrian activated signal, pedestrian hybrid beacon, or other feature that provides equivalent facilitation at pedestrian crossings of all legs.

NCHRP 03-78B is an ongoing research effort looking into other types of treatments that may provide equivalent facilitation and the different situations in which they work best; however, the US Access Board has not yet made a determination of a performance measure or threshold that will determine equivalent facilitation. Currently, the responsibility for demonstrating equivalent facilitation in the event of a challenge rests with the covered entity.

FHWA Cycle Track Report

The FHWA recently sponsored research into planning, safety, and design of cycle tracks. The draft document will be released by late 2014 and provides information about various design considerations related to cycle tracks, including one-way and two-way designs; interactions with ADA parking spaces, bus stops, and loading zones; intersection treatments; and connections to other types of bicycle facilities, including bike lanes and off-street paths. Kittelson & Associates, Inc. is part of the consultant team that performed the research and developed the report and will be able to draw on the recommendations of the report in the Solution Alternatives memorandum.

Roundabouts: An Informational Guide (NCHRP Report 672)

Roundabouts: An Informational Guide provides guidance on all aspects of implementing roundabouts. In particular, Chapters 6 through 10 offer guidance on geometric design, traffic control devices, illumination, landscaping, and construction and maintenance. Of primary relevance to the 170th Avenue/Merlo Road concept design is understanding the spatial needs for a potential roundabout at the 170th Avenue/Merlo Road intersection. *Roundabouts: An Informational Guide* provides typical ranges for the inscribed diameters of various roundabout types, shown below in Exhibit 6-9 from the guide. The likely design vehicle for a roundabout would be a WB-67 tractor-trailer combination. Considering the addition of pedestrian facilities, a landscape buffer and potential bicycle facilities, the circle diameter for the full right-of-way needed could be 20-40 feet wider than the ranges in Exhibit 6-9 from *Roundabouts: An Informational Guide*, included below.

Exhibit 6-9
Typical Inscribed Circle Diameter Ranges

Roundabout Configuration	Typical Design Vehicle	Common Inscribed Circle Diameter Range*	
Mini-Roundabout	SU-30 (SU-9)	45 to 90 ft	(14 to 27 m)
Single-Lane Roundabout	B-40 (B-12)	90 to 150 ft	(27 to 46 m)
	WB-50 (WB-15)	105 to 150 ft	(32 to 46 m)
	WB-67 (WB-20)	130 to 180 ft	(40 to 55 m)
Multilane Roundabout (2 lanes)	WB-50 (WB-15)	150 to 220 ft	(46 to 67 m)
	WB-67 (WB-20)	165 to 220 ft	(50 to 67 m)
Multilane Roundabout (3 lanes)	WB-50 (WB-15)	200 to 250 ft	(61 to 76 m)
	WB-67 (WB-20)	220 to 300 ft	(67 to 91 m)

* Assumes 90° angles between entries and no more than four legs. List of possible design vehicles is not all-inclusive.