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Metro

Designing Livable Streets & Trails

Rough Draft

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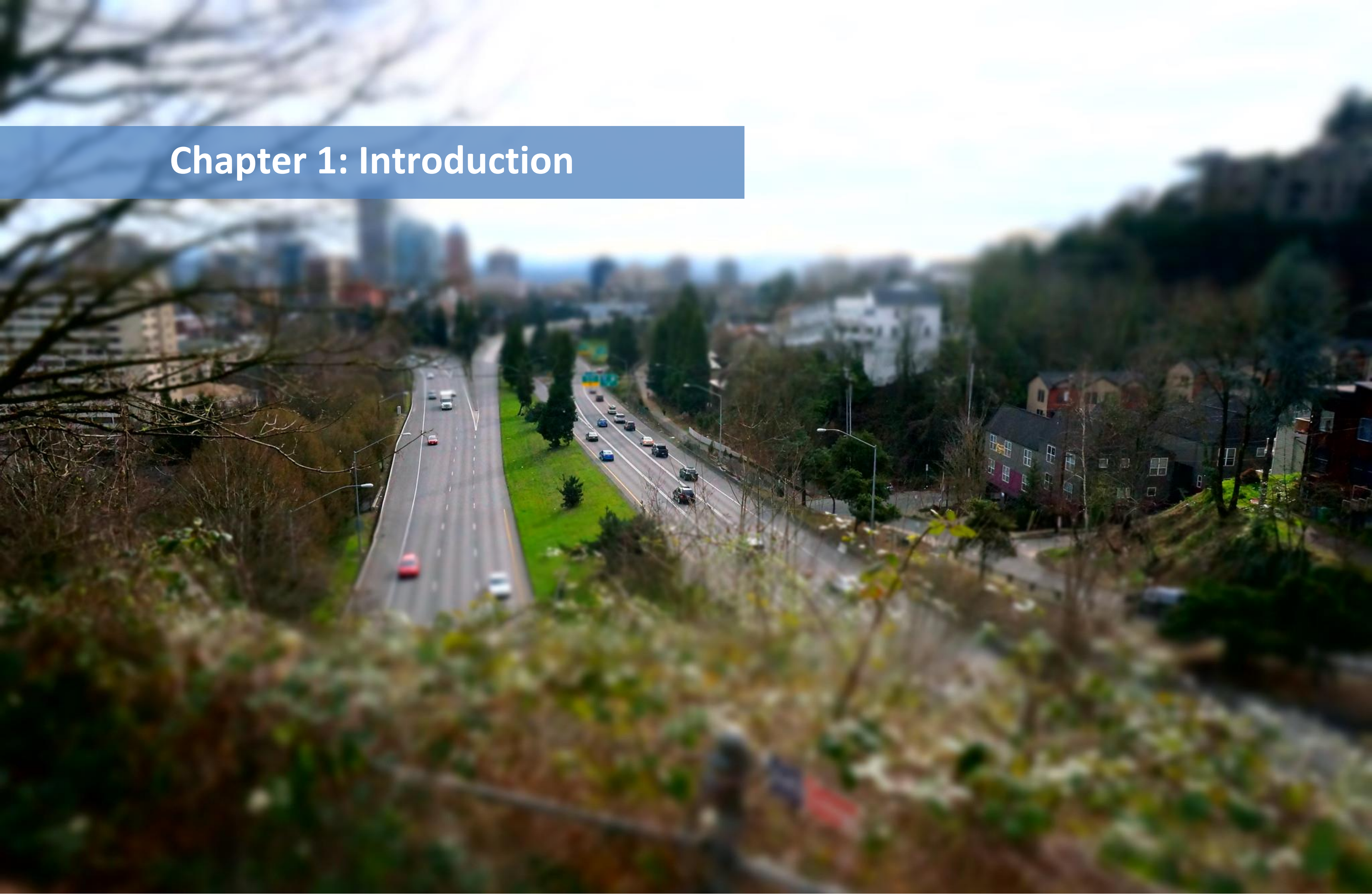
GLOSSARY

Chapter 1: Introduction



INTRODUCTION

Photo

Pedestrian/bike crossing, median with trees, bike box emphasis on people crossing the street with other elements in the background, transit, freight truck – possibly West Burnside St

[Caption: Livable street and trail design includes many elements. The median, enhanced crossings, trees, different travel options, and most of all, the people make this street in X a livable and vibrant place.]

Over the next several decades, the challenges borne by communities in the greater Portland region and the burdens placed upon our transportation network will multiply in quantity and complexity. Our communities will demand that streets and trails serve not only as corridors for the conveyance of people, goods and services, but as community gathering spots and public spaces. Streets and trails in our region serve multiple functions, from mobility and access for all modes of travel, to place-making to managing stormwater to enhancing livability. They must be safe, sustainable, resilient, multimodal and economically beneficial. This guide provides a resource to local jurisdictions and communities to continue to develop livable streets and trails.

Livable Streets and Trails

The design of streets and trails significantly contributes to community and regional livability. Livable streets and trails support independence and access to a variety of travel options; provide orientation, safety and comfort; support social and racial equity and welcoming, safe spaces; encourage a sense of community yet provide sufficient privacy; foster a sense of neighborly ownership and responsibility; avoid and mitigate for light, noise, water and air pollution; and support regional and community outcomes.

1.1 Purpose of the Guide

The purpose of this guide is to support implementation of the greater Portland region's land use vision, the 2040 Growth Concept, and the Regional Transportation Plan, by providing a resource to design regional streets and trails to serve the multiple functions demanded of them while achieving community and regional outcomes.

Regional Streets and Trails

Regional streets accommodate both regional through trips and local trips. Regional streets connect centers and connect to places outside of the region. Under the traditional street functional classification system, regional streets are arterials and throughways. Each regional street is assigned a design classification. See Chapter 3. Providing for both regional through trips and local trips distinguishes regional streets from collectors or local residential streets which serve local access trips.

Regional trails are off-street multi-use paths that connect multiple regional destinations such as regional centers, town centers, regional parks or natural areas, high-frequency transit or other regional trails. They serve as important transportation connections for people walking and bicycling, and support longer bicycle trips, often traversing two or more jurisdictions.

The intended audience for this guide is broad, including members of the public, elected officials, public agency staff of local, regional and state jurisdictions, private developers, architects, landscape architects, planners and engineers. The *Designing Livable Streets and Trails Guide* provides best practices and a performance-based design decision-making framework that will be of interest to these different users and to communities across the US. At the same time, the guide identifies specific design approaches appropriate for Metro's regional street design classifications and regional trails. Within the greater Portland region, local jurisdictions must allow implementation of the design guidelines, and must be consistent with the guidelines when projects use funding allocated by Metro.

This guide focuses on the "preferred design approach" for various design elements rather than on specific engineering measurements and drawings. It is intended to complement existing national, state and local guidelines. The *Designing Livable Streets and Trails Guide* has been developed on the basis of current design guidance, case studies, best practices for urban environments, research and evaluation of existing designs, and professional review and input. It integrates design guidance for regional streets, regional trails, stormwater management and green street treatments into one guide to promote a holistic and comprehensive approach to designing complete streets and a complete transportation system.

The design elements recommended in the guide are allowable under national guidance including guidelines developed by the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA) and the National Association of City Transportation Officials (NACTO).

1.2 Structure of the Guide

This guide is organized such that themes in each chapter build on the previous sections. References and links to other relevant chapters or sections are provided throughout making it easy for the reader to access the material in a non-linear fashion.

Chapter 2 starts with a brief history and a description of the *2040 Growth Concept*, linking land use and transportation planning and design. The land use types determine the way in which transportation facilities should be designed to serve the surrounding and planned land use. This section identifies lessons learned since the first street design guidelines were developed and looks ahead to the changes in technology, demographics and other challenges that transportation design must respond to. Chapter 2 then describes the *Performance-Based Design Framework* used in the guide to achieve community outcomes. Next, the chapter describes the *Desired Outcomes* that make our region a great place. These outcomes are consistent with the goals of the 2040 Growth Concept and the Regional Transportation Plan. We design our transportation system to support these outcomes. Finally, the chapter describes the federal, state and regional *Policies and Regulations* that guides how we design our streets and trails.

Chapter 3 describes the different *Functions* that streets and trails serve, starting with access and mobility for all modes of travel. It then explains the key attributes of each of the *Regional Street Design Classifications* – Boulevards, Streets, Industrial Streets, Freeways and Highways – and provides high level design guidance for each design classification. Key attributes of the Parkway design overlay and Regional Trails are included. Finally, the different functions are linked to each of the regional street design classifications and regional trails.

Chapter 4 describes a set of *Design Principles* that should guide decision-making throughout the design process. Next, the chapter describes the different realms that the street is divided into – the land use realm, pedestrian realm, flex zone, and the center travelway. The various *Design Elements* that serve different functions are then described. These are organized by realm. Design elements for regional trails and on-street trail connections and design elements applicable to all of the realms are presented at the end of the section. Each design element includes a description and the preferred design approach for that element. For some elements, there is direction on how the design approach differs across the various regional design classifications. A list of design resources that provide additional detail concludes the chapter.

Chapter 5 includes a series of renderings of the different street design classifications and regional trails that *Visualize Livable Streets and Trails.* The renderings illustrate how the design elements described in Chapter 4 can be combined in different ways to serve different functions to create livable streets and trails that are responsive to land use context.

Chapter 6 identifies a series of steps in the *Performance-Based Design Decision-Making Framework* to support development of projects that are practical, context sensitive and outcome driven. Each step includes a series of questions or check-lists to provide a process to ensure that the final design of a street or trail, whether it is new or reconstructed, stays true to transportation and land use system plans, adopted policies, stakeholder engagement and decisions made during the funding process. The decision-making framework also helps navigate trade-offs using performance-based practical design so that projects with limited budgets and/or right of way can still achieve the desired outcomes.

A *Glossary* and list of *Additional Resources* are provided at the end of the document.

Design elements support **functions** to achieve **outcomes.**

- Frontage zone
- Pedestrian through zone
- Street furniture zone
- Street corners
- Planters, swales, & basins for stormwater
- Flex zone: On-street parking & other uses
- Surface stormwater conveyance & detention
- Other buffer elements
- Motor-vehicle travel lanes
- Medians
- Traffic calming
- Access management/driveways
- Shared streets & spaces
- Dedicated bicycle facilities
- Transit stops
- Transit priority treatments
- Transit in travelways
- Midblock crossings
- Un-signalized intersections
- Signalized intersections
- Roundabouts & mini-roundabouts
- Unique & gateway & transition contexts
- Multi-use paths on independent alignment
- Multi-use paths in roadway right-of-way
- Trail connections to other facilities
- Trail bridges, boardwalks & structures
- Trail crossings
- Street & trail surfaces
- Lighting
- Wayfinding
- Place-making amenities

- Pedestrian Access & Mobility
- Bicycle Access & Mobility
- Transit Access & Mobility
- Truck Freight Access & Mobility
- Auto Access & Mobility
- Place-Making & Public Space
- Corridors for Nature & Stormwater
- Utility Corridors
- Physical Activity
- Emergency Response

- Safety
- Healthy People
- Healthy Environment
- Social Equity
- Reduced Green House Gas Emissions
- Vibrant Communities
- Transportation Choices
- Sustainable Economic Prosperity
- Efficient & Reliable Travel
- Resiliency
- Security
- Fiscal Stewardship

[Caption: Using a performance-based design approach, design elements are combined to support the various functions of streets and trails. Different functions are prioritized depending on the planned land use context and other policies to achieve desired outcomes.]

Chapter 2: Policy Framework

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POLICY FRAMEWORK

Photo:
Gresham - 2708 Powell Blvd –
Regional Street

[Caption: This segment of Powell Boulevard is a three-lane regional street connecting downtown Gresham to Portland. A planted median provides a pedestrian refuge at street crossings, and increase safety by limiting turns and separating on-coming traffic. The sidewalks are fairly narrow but are often separated from traffic by a buffer planted with street trees.]

This chapter describes the current policy framework for this guide. It describes the 2040 Growth Concept and provides a brief history on street design policy in the greater Portland region. It then defines performance-based design and describes the outcomes identified in regional and community plans that street and trail design should serve. Finally, it lists the key policies, rules and statutes that guide how streets and trails in the region are designed and function. This chapter serves as a reference for several of the design decision-making steps in Chapter 6.

2.1 Region 2040 Growth Concept and Transportation Design

Policies that support livable street design have been a part of transportation and land use planning in the greater Portland region for more than twenty years. Regional street design classifications were first developed and adopted in the 1996 Regional Transportation Plan. (Regional street design classifications are described in Chapter 3.) They were specifically developed to implement the transportation elements of the 2040 Growth Concept, which was adopted in 1994. At the time, the Metro Policy Advisory Committee determined that regional transportation design guidelines were needed to help achieve the 2040 Growth Concept, recognizing that a one-size-fits-all approach to designing streets was not fully supportive of the region's land use vision.

In 1997 the *Creating Livable Streets* handbook was published and presented a radical new approach to transportation design, crossing traditional boundaries between land use and transportation planning and linking street design to community livability. The guide was updated in 2002 and several supplemental guides were developed: *Green Streets, Trees for Green Streets, Wildlife Crossings,* and *Green Trails.*

Today, the integration of land use and transportation planning is widely recognized as a best practice. Transportation agencies are moving away from traditional functional classifications of roadways, and moving towards broader design classifications that respond to land use. This guide carries forward the ethic of the deign guidance developed in the 1990s while updating and introducing new design elements and topics based on new policies and evolving best practices.

The 2040 Growth Concept established a broad regional vision to guide all future comprehensive planning at the local and regional levels, including development of the Regional Transportation Plan, the region's thirty year transportation roadmap. As shown in **Fig X**, the growth concept is based on a series of land use components, called "2040 design types," that are the building blocks of the regional strategy for managing growth in the region. Regional street design classifications correspond to the different land use design types and helps implement the 2040 Growth Concept. **Fig X** in Chapter 3 provides an illustration of how the land use design types and regional design classifications are linked. The 2040 design types are:

- **Centers** include the Central City, Regional Centers and Town Centers. Centers are planned as the densest areas in the region, are well served by transit and are very accessible for people walking and bicycling. Freight truck access to centers supports businesses and residents. Centers include housing, employment, businesses and services. The **Central City** is the hub of business and cultural activities in the region with intensive employment and housing in high-rises. **Regional Centers** provide destination retail and compact employment and housing development, between two and six stories or more. **Town Centers** have two-to five story or more mixed-use buildings with professional services and commercial retail outlets complementing housing.
- **Station Communities** are areas around light-rail or high capacity transit stations outside of centers. They have significant employment development and numerous housing types. Bicycle and vehicle parking at the transit stations support trips by transit into denser areas of the region. Boundaries typically extend a few blocks around the transit station. As well as being extremely well served by transit, station communities are walkable and bikeable.
- **Corridors** are multi-modal frequent transit corridors and typically extend a block or two beyond the street. They are often also regional freight routes. One to three story or more buildings line corridors and contain commercial retail, small scale employment or housing along major transportation routes that link centers together.
- **Main Streets** are similar to town centers, but only extend a block or two beyond the street. Main streets have neighborhood scale commercial retail and housing in one to three or more story buildings. Main streets are multimodal with good transit service.
- **Neighborhoods** comprise most of the land area of the region and provide single-family and multi-family residences incorporating a mix of housing types including row

houses, duplexes and accessory dwelling units. Newer neighborhoods are typically more compact while some older neighborhoods have larger lots and fewer street connections. Providing for pedestrian and bicycle connectivity in older neighborhoods with paths is essential.

- **Employment and Industrial Lands** include a mix of large-scale employment and industrial uses that include office parks, manufacturing, distribution centers, marine and airport facilities and railroad switching yards. Freight access to these areas is essential, as is job access via transit. Pedestrian and bicycle travel should be well separated from heavy freight movements.
- **Parks and Natural Areas** are developed parks and undeveloped areas including natural areas, open spaces and scenic area, rivers and streams, wetlands and floodplains, within and outside of the urban growth boundary. Transportation routes are designed to protect and enhance natural features.

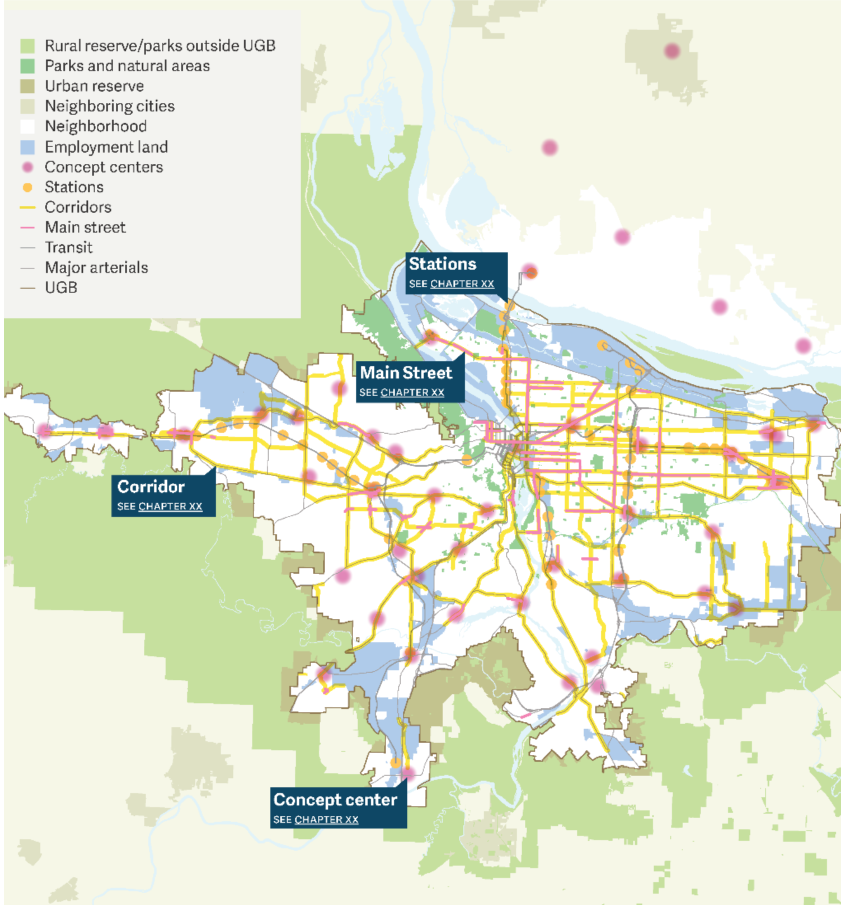

Fig. X The 2040 Growth Concept, adopted in 1994, identifies land use design types to guide future growth and density within the greater Portland region.

The 2040 Growth Concept directs most new development to mixed-use centers and along corridors and main streets. Building neighborhoods and communities to focus new jobs, housing and services in centers and corridors provides many benefits and has important design implications for the region's transportation system. It relies on a balanced transportation system that adequately serves walking, bicycling, driving, transit and freight movement.

Lessons Learned

Over the last twenty plus years since the 2040 Growth Concept and regional street design classifications were adopted, our region has grown and changed. We have had time to assess how our approach to land use and transportation are working. What we have found is:

- A flexible, outcomes-based approach to transportation design is necessary to build a transportation system that supports our regional land use vision.
- Street designs that slows speeds and protects vulnerable users can reduce serious and fatal crashes.
- Protecting and enhancing the environment must be part of the design process.
- Street design, and access to transportation options, has racial and social equity implications.
- Street design, and access to transportation options, impacts public health.
- Including green infrastructure in streets and trails improves environmental and public health outcomes.
- Protecting water quality and stormwater management are responsibilities of transportation planners and engineers.
- Connecting land use and transportation support transit and the twenty-minute neighborhood.
- Complete streets lead to more walking, riding bicycles and taking transit.
- Regional trails are an important part of transportation system.
- Livable streets and trails contribute to a healthy and sustainable economy.
- The design of our transportation system has contributed to our region being one of the most livable in the country.

Emerging Technology and a Changing Region

Over the next several decades our region will face many challenges, including housing affordability, climate change, racial disparities, traffic deaths and life changing injuries, and aging population, and traffic congestion. How our transportation system is designed and how well it implements the 2040 Growth Concept will play a role in how well we can address these challenges. Technology, which is already transforming our region’s transportation system, will also play a role. There are many unknowns, promises and potential perils when it comes to emerging technology in transportation. Street and trail design will necessarily change to adapt to changing technology. These changes must always be based on the principles of people, showing how to adapt new mobility technologies to our regions, and not the other way around.

2.2 Performance-Based Design Framework

This guide uses a performance-based design framework. As the demands on our transportation system increase, so does the need for flexibility in how we design our roadways. Performance-based design can be described as an evolution away from a traditional standards-based design approach to an approach that expands design parameters to be more flexible and context sensitive. The traditional standards based approach to transportation design does not allow engineers and other practitioners to easily apply the wide range of design solutions available today. Additionally, traditional transportation design standards are typically organized around one primary outcome – building roadways on which motor vehicles can drive as fast as possible. Performance-based design provides a rigorous approach that allows for flexibility and responds to context.

National design guidance, including AASHTO's *A Policy on Geometric Design of Highways and Streets*, is moving toward integrating performance-based design to determine appropriate design with flexibility that better aligns roadway function and user needs based on the existing and planned land use context.

In the 2010 Regional Transportation Plan, the Metro Council adopted an outcomes-based planning framework to guide planning and decision making, recognizing that multiple performance-measures were necessary. This framework requires that the Regional Transportation Plan respond to adopted desired outcomes for the region to be a responsible steward of public investment and the social, built and natural environments that shape our communities.[1]

Performance-based design provides a framework for practitioners to track decisions in the design process as a way to support flexibility to choose the best design for the context. Documenting the decision-making process when selecting the design for new or reconstructed roadways is an effective way to manage risk. This includes documenting the design considerations and alternatives evaluated, based on clearly outlined project goals. Chapter 6 of this guide provides a decision-making framework

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[1] In 2008, the Metro Council and regional partners adopted six desired outcomes to guide planning: Vibrant Communities, Economic Prosperity, Safe and Reliable Transportation, Leadership on Climate Change, Clean Air and Water, and Equity.

that guides practitioners through stakeholder engagement and documentation of decisions.

Performance-based design starts with a well-defined project need, goals and related objectives, and then works to align design decisions with achieving the project objectives and furthering system wide outcomes. This approach relies on the development and comparison of design alternatives, employing performance measures and analysis to assess progress towards objectives, and using engineering judgment informed by a multi-disciplinary team to reach a preferred design.

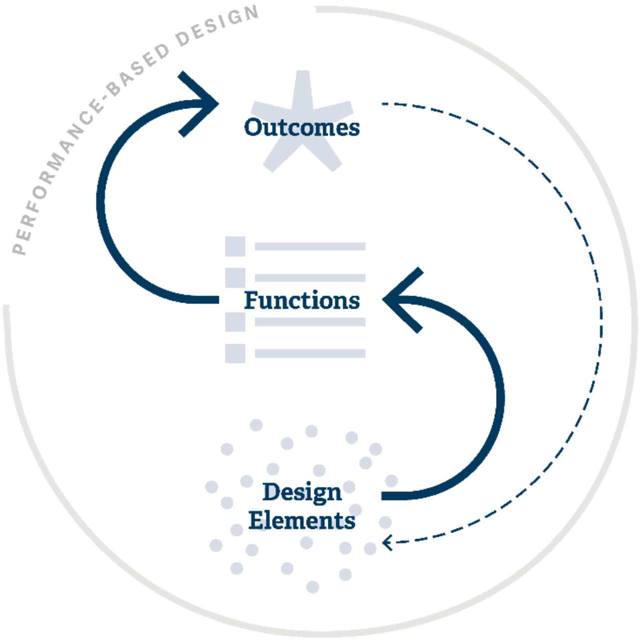

Fig. X illustrates the performance-based design framework – design elements are chosen to support the different functions the transportation system serves, such as safe access to destinations, to help achieve desired outcomes, such as safety.

2.3 Design for Desired Outcomes

The design of streets and trails directly affects the quality of life in our region. Using a performance-based framework streets and trails are be designed to help achieve the following regional and community outcomes.

SAFETY

Streets are designed so that people walking, parking, shopping, bicycling, working and driving can cross paths safely. Streets are designed to slow traffic in urban areas, provide safe crossings, increase separation of users and provide protection for vulnerable users to support Vision Zero - the elimination deaths and life-changing injuries from traffic crashes.

SECURITY

Streets and trails are welcoming, safe places for all people to use. Design elements, including lighting and culturally relevant public art and place making, are used to deter crime and harassment. Activating streets and trails provides more 'eyes on the street' and increases personal security.

TRANSPORTATION CHOICES

Streets and trails are designed to provide a variety of transportation choices that are safe, comfortable and easily accessible. Walking, bicycling, scooters, transit, and rideshare services are equally accessible to people of all ages and abilities.

Efficient and Reliable Travel

Streets and trails are well connected and are designed so that people can get to where they need to go efficiently and reliably by any mode.

HEALTHY PEOPLE

Streets and trails are designed to increase access to active travel. They are comfortable and safe to use for walking, running, jogging and cycling. Air, noise and light pollution are reduced through design and support human health and wellbeing. Streets and trails provide access to parks and nature.

HEALTHY ENVIRONMENT

Streets and trails are designed to protect the natural environment by managing stormwater, reducing greenhouse gas emissions, minimizing light pollution, and providing wildlife crossings, fish passage, and habitat corridors.

Reduced Green House Gas Emissions

Streets and trails are designed to increase trips made by transit, walking and cycling and to reduce vehicle miles traveled and greenhouse gas emissions from motor vehicles. Street trees and other green infrastructure absorb greenhouse gas emissions and clean the air.

SUSTAINABLE ECONOMIC PROSPERITY

Livable streets and trails benefit businesses by creating walkable and bicycle friendly areas and providing transportation choices to access to jobs. Street designs support freight access to industrial areas supporting export and import activity. Street and trail designs support tourism by creating memorable, unique places and safe and comfortable access to destinations.

RACIAL AND SOCIAL EQUITY

Increasing racial and social equity is considered in the design of streets and trails to create places that are safe and welcoming to all, that are intuitive and easy to use regardless of age, ability, cultural background or language. Streets and trails contribute to revitalization without displacement, and provide transportation choices to jobs, schools, health care, food, nature, cultural resources and other places.

VIBRANT COMMUNITIES

Streets and trails are designed and connected to support efficient urban form. Air, noise and light pollution are minimized. Public art, street trees, and a variety of materials and surfaces create unique places that reflect the identity of the community. Streets and trails are places for travel, but also for community gatherings, meeting places, cultural events and community identity.

RESILIENCY

Streets and trails are designed to be resilient in the face of natural disasters and extreme weather events and to be available as emergency response routes during these and other major events.

FISCAL STEWARDSHIP

Streets and trails are designed with fiscal stewardship in mind, using innovative practical design approaches to reduce costs and conserve resources for construction and maintenance. External costs, such as climate change impacts, are considered in the design process to understand the full costs of including or not including specific design treatments. Achieving desired outcomes is also included in the full cost calculation.

2.4 Land Use and Transportation Policies

Intro Photo (bird's eye view of many streets and highway)

[Caption: The regional transportation system is designed to promote community livability. A connected network of streets and trails provide transportation options that reduce dependence on driving.]

This section identifies the key national, state and regional policies that inform how streets and trails in the greater Portland area are designed and function. Some policies may support innovation or flexibility in design, while others may limit what can or cannot be done. At the local level, local governments apply land use, transportation and development codes to implement these policies on the ground.

As the federally designated metropolitan planning organization for the Portland area region, Metro helps distribute some federal transportation funds to transportation agencies in the region. Therefore, Metro needs to ensure that distribution of these funds addresses and complies with federal and state policies, such as the Endangered Species Act.

Policy	Impact on Design
National Policies	
National Environmental Policy Act (1970)	Any transportation projects that receive federal funding are required to consider the environmental effects of their proposals and actions. Projects must be designed to avoid or minimize environmental impacts.
Clean Water Act Amendment (1972)	Regulates point sources for water pollution, including those from roadways and motor vehicles, through the National Pollutant Discharge Elimination System. Transportation agencies in the Portland region are responsible for managing the stormwater runoff that discharges into our region's waters via regulated municipal separate storm sewer systems (MS4s) along streets, roads, and highways. This guide discusses strategies to meet local or regional NPDES requirements to reduce combined sewer overflows and sanitary flows.
Endangered Species Act (1973) established to protect and recover imperiled species and the ecosystems upon which they depend.	Requires that projects be designed to provide the greatest value to the greatest number of people, while avoiding or minimizing impacts to plant and animal species and their habitat, as well as the ecological processes that naturally sustain these areas. Any projects receiving federal funding must comply with the Endangered Species Act.
Title VI of the Civil Rights Act of 1964	Protects people from discrimination based on race, color, and national origin in programs and activities receiving federal financial assistance, including transportation projects. Depends upon understanding and properly addressing the unique needs of different socioeconomic groups and involving the public for effective transportation decision making.
Americans with Disability Act (ADA) (1990)	Prohibits discrimination against individuals with disabilities in all areas of public life, including transportation. Requires that transportation projects be designed to be accessible to people with disabilities.
Executive Order 12898 Environmental Justice (1994)	Requires that every federal agency identify and address the effects of all programs, policies, and activities, such as transportation design, on minority populations and low-income populations.

	Involving the potentially affected public in developing transportation projects that fit harmoniously within their communities without sacrificing safety or mobility.
Bicycle and Pedestrian Facility Design Flexibility, August 20, 2013 memorandum	Expresses the Federal Highway Administration's (FHWA) support for taking a flexible approach to bicycle and pedestrian facility design.
Revisions to the Controlling Criteria for Design and Documentation for Design Exceptions, May 5, 2016 memorandum	Encourages flexibility and a context-sensitive approach for projects on the national highway system (NHS). Reduced the number of controlling criteria to 10. Of the 10 controlling criteria, only design loading structural capacity and design speed apply to all NHS facility types. The remaining eight criteria are applicable only to "high-speed" NHS roadways, defined as Interstate highways, other freeways, and roadways with a design speed greater than or equal to 50 mph.
Architectural Barriers Act, accessibility guidelines for outdoor developed areas (2013)	Requires that trails in parks and other recreational areas are readily accessible to and usable by individuals with disabilities for federally funded projects.
State Policies	
"Bicycle and Pedestrian Bill" (ORS 366.514) Use of highway funds for footpaths and bicycle trails (1972)	Requires bicycle and pedestrian facilities are provided wherever a highway, road or street is being constructed, reconstructed or relocated. Serves as the state's complete streets policy.
Oregon Statewide Land Use Planning Goals (1974) - Goal 19 Transportation	Requires cities, counties and the state to create a multimodal transportation system plan so residents are not limited in the ways they can access the jobs, goods, or services available in different parts of their community.
Transportation Planning Rule (1991)	Supports the integration of land use and transportation planning. Among its many provisions, includes requirements to reduce vehicle miles traveled. Section 8 and Section 10 are related to Multimodal Mixed-Use Areas (MMA). In areas designated as an MMA, a local jurisdiction does not need to apply local or state mobility standards when evaluating proposed plans, therefore allowing more flexibility in design.
Oregon Transportation Plan (1999) and associated mode and topic plans	Establishes a vision and policy foundation for a multimodal and safe transportation system. Mode and topic plans provide more specificity on how to implement the Oregon Transportation Plan, such as achieving zero deaths and serious injuries.
Oregon Highway Plan (1999)	Includes many elements that impact design, including Policy 1F which establishes mobility targets (as defined by motor vehicle volume-to-capacity ratios). Streets are designed to meet the targets. Land Use and Transportation Policy 1B addresses the relationships between land use and transportation and identifies desired outcomes. Policy 1A describes state highway classifications, including primary functions.

Freight Reduction in Carrying Capacity Review (ORS 366.215) (2017)	Applies to a subset of state highways, known as Reduction Review Routes, and prohibits designs that could limit passage of over-dimensional freight loads, unless safety or access considerations require reduction. Design exceptions to the rule must be approved by ODOT. Some segments of these state facilities traverse centers and are classified as regional boulevards.
ODOT Blueprint for Urban Design (2019)	Serves as interim guidance and highlights opportunities for flexibility in the design of state facilities based on land use context in urban areas.
Regional Policies	
Region 2040 Growth Concept (1994)	Establishes a broad regional vision to guide all future comprehensive planning at the local and regional levels, including development of the Regional Transportation Plan. Regional street design classifications were developed to implement the 2040 Growth Concept. The design classification correspond to the different 2040 land use types, including centers, corridors, main streets and employment and industrial areas.
Regional Framework Plan (1997)	Integrates land use, transportation and other regional planning mandates. For example, Section 1.10 addresses guiding settlement patterns in the region that "makes biking and walking the most convenient, safe and enjoyable transportation choices for short trips, encourages transit use and reduces auto dependence and related greenhouse gas emissions."
Urban Growth Management Functional Plan	Provides tools to implement the 2040 Growth Concept. Requires and recommends changes to city and county comprehensive plans and implementing ordinances. The following impact transportation design: Title 3 addresses protecting water quality, flood management and fish and wildlife conservations; Title 4 addresses protecting freight movement; Title 6 addresses developing centers and corridors, and Title 13 addresses nature in neighborhoods.
Regional Transportation Plan (2018) and associated mode and topic plans: *regional freight, transit, safety and emerging technology strategies and the Climate Smart Strategy.*	Provides policies supporting multimodal complete streets designs to achieve desired outcomes and implement the 2040 Growth Concept. Includes mobility targets consistent for the regional transportation system. Regional strategies include specific actions related to transportation design.
Regional Transportation Functional Plan	Implements the Regional Transportation Plan and the 2040 Growth Concept. Outlines the requirements for local transportation system plans. States that jurisdictions must allow use of regional design guidance. Includes connectivity requirements. Requires that cities and counties

	consider a set of strategies to meet mobility targets, with increased motor vehicle capacity being the last option considered.
Strategic Plan to Advance Racial Equity, Diversity and Inclusion (2016)	Includes specific goals and objectives for Metro to long-term institutional and structural changes to advance racial equity, diversity and inclusion, including ensuring access to safe and reliable transportation.

Chapter 3: Design Functions and Classifications

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DESIGN FUNCTIONS AND CLASSIFICATIONS

Photo
Hillsboro - NE Century Blvd. (NW 231st Ave) in Orenco
Station –community boulevard, minor arterial, raised
bikeway, periodic medians

[Caption: Streets in the region are designed to serve many different functions.]

This chapter introduces the concepts of design **functions** and regional **design classifications**. In this guide, a “design function” or simply “function” is a use or purpose that individual streets and trails can serve, thereby contributing to the desired system wide outcomes described in Chapter 2. The functions are achieved through the design of our streets and trails, further described in Chapter 4. **Figure X** shows the relationships between outcomes, functions, and design elements. The primary functions that should be served by a street or trail are determined by multiple factors including adjacent land use, modal plan priorities and street connectivity. Different functions may be prioritized on different streets and trails contributing to the overall performance of the transportation system. Chapter 6 provides a decision-making framework to help determine which functions should be prioritized during project design and how to work though trade-offs in design. In this way, we can create a regional system of streets and trails that serves all functions and leads to the system wide outcomes. The functions are illustrated in Figure X on the following pages and described further in Section 3.1.

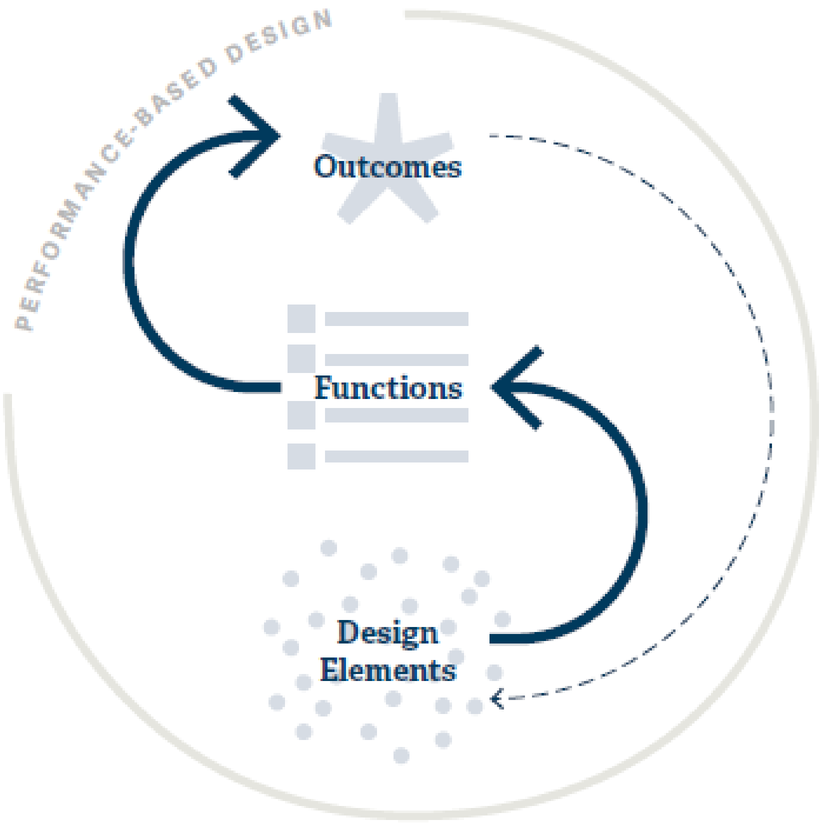
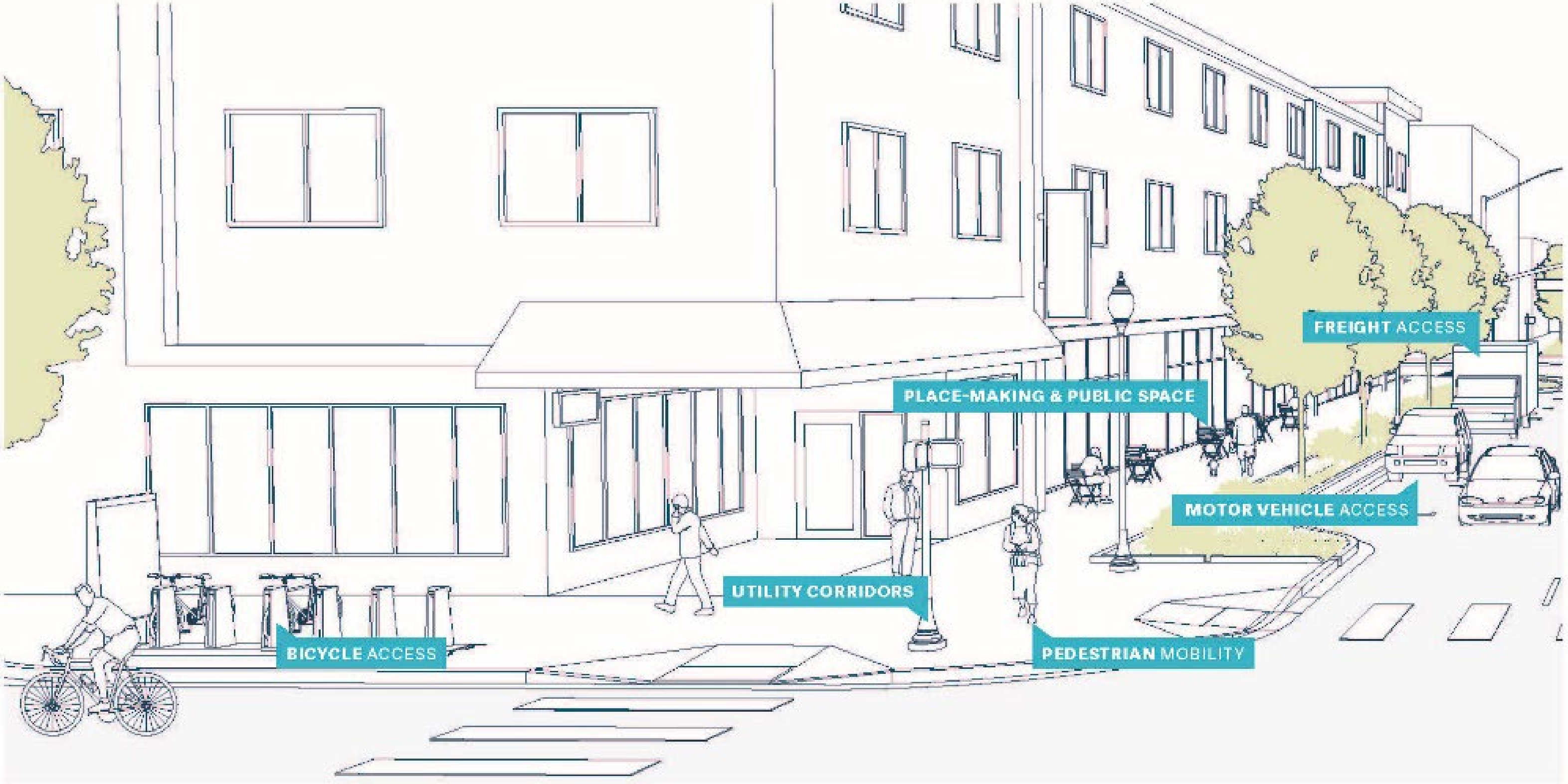


Fig. X illustrates the relationship between outcomes, functions and design elements in a performance-based planning framework.

In 2000, the region adopted regional street design classifications, described in Section 3.2. The design classifications are directly related to the 2040 Growth Concept land use types described in Chapter 2. As such, the design classifications are also related to the functions that are served by each street.

Livable Streets and Trails Functions



Pedestrian
ACCESS & MOBILITY

Every street and trail has safe, comfortable space for people walking, rolling and enjoying the place they're in.

Bicycle
ACCESS & MOBILITY

Connected bicycle networks, separated from heavy vehicle traffic, ensure that bicycling is a great way to get around our communities.

Transit
ACCESS & MOBILITY

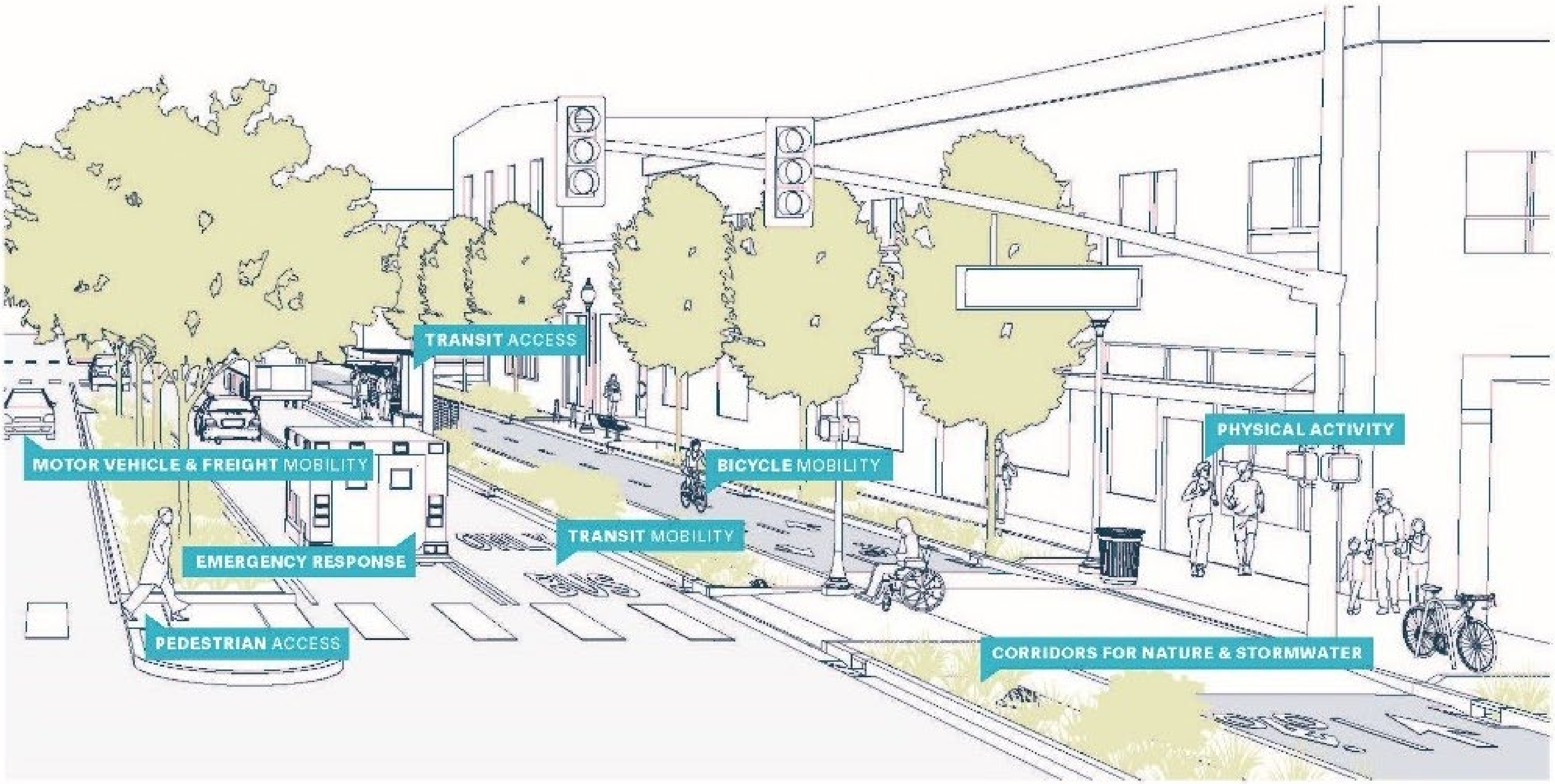
Our streets enable transit to serve the region with an efficient, reliable way to travel between and within our communities.

Freight
ACCESS & MOBILITY

Key freight corridors provide reliable freight movement, and streets allow delivery access to serve both businesses and residents.

Motor vehicle
ACCESS & MOBILITY

Our streets and throughways provide for safe, reliable travel in motor vehicles, providing space to facilitate pooled or shared trips.



Place-making & Public Space

Our streets and trails are a canvas for our community life and daily commerce, helping to form our regional identity.

Corridors for Nature & Stormwater

Weaving nature and sustainable stormwater management into our streets and trails enhances livability and protect our water, air and natural assets.

Utility Corridors

Our transportation corridors move more than just people and goods; they also move water, power, gas, communications and information.

Physical Activity

Our streets and trails are places where people enjoy exercising and spending time outdoors whether for recreation or to get to where they need to go.

Emergency Response

In case of a local or widespread emergency, our streets and throughways must provide access and evacuation routes to keep people safe.

3.1 Design Functions

Within the greater Portland area, every regional street serves more than one function. This section describes the typical functions that streets and trails can serve. Regional streets accommodate regional through trips, local trips and local access. Regional through trips cover longer distances and can require higher travel speeds and less land-use access than local trips. Through trips include transit, motor vehicle and freight trips and longer bicycle trips. Local trips require access and connectivity. Providing for regional through trips, local trips and access distinguishes regional streets from local streets. In the Regional Transportation Plan, regional streets are major and minor arterials and throughways.

The first group of functions are divided into two parts – access and mobility. These two terms are frequently used to describe our transportation system, with varying meaning. In the following descriptions:

- "Access" generally refers to the function of allowing a person or good to reach an intended destination.
- "Mobility" generally refers to the movement and travel between two locations on the transportation system.

PEDESTRIAN ACCESS AND MOBILITY: PEOPLE WALKING OR USING A MOBILITY AID

Every street and trail has safe, comfortable space for people walking, rolling, and enjoying the place they're in.

Serving pedestrians involves both mobility and access functions. For pedestrians, these functions are complementary – a street can provide a high level of pedestrian access and mobility simultaneously, and the two complement each other.

Safe Access: Walking, or using a wheelchair or other health-related personal mobility aid, is a part of every trip. People using transit, driving cars, riding bikes or using other methods of travel still need to walk to the entrance of their destination. This is access. Pedestrian access to places, streets and transit stops must be safe and comfortable. Street crossings, should be frequently located, designed for pedestrian safety and accessible to people with varying abilities. Designs to further enhance pedestrian access include short signal cycles and other pedestrian-related intersection strategies, accessible, frequent crossings, and pedestrian scale street lighting. Our streets and trails should also provide people with enjoyable pedestrian access to our public space and public places, in all types of Pacific Northwest weather conditions. Building overhangs, shelters and street trees provide protection from rain, snow or extreme heat. Benches, plazas and viewing points provide spaces to pause and rest.

Safe Mobility: Pedestrian mobility means being able to walk or roll, reasonably directly and efficiently, from one place to another. Continuous sidewalks, wide enough to serve all the people using them and buffered from vehicle traffic, provide the primary infrastructure for pedestrians. When appropriate, trails should separate people walking and riding bicycles. Direct routes best serve pedestrian mobility, since walking is a relatively slow method of travel. At intersections, pedestrian crossings should be provided on all sides of the intersection, with few exceptions, to avoid undue out-of-direction travel. Signs and other wayfinding elements along streets and trails support navigation. Bicycle Access and Mobility: People riding bicycles or other personal mobility devices.

Connected bicycle networks, separated from heavy and high-speed vehicle traffic, ensure that bicycling is a great way to get around in our communities. The bicycle is the most efficient vehicle invented and has the potential to provide the most cost-effective, healthy mobility option for shorter trips in urban areas. Serving bicyclists and people using other personal mobility devices (such as e-scooters and skateboards, also known as micromobility) requires both mobility and access functions – and for bicyclists, serving each of these functions must be considered distinctly. Design elements that provide bicycle access can be different from designs that facilitate bicycle movement, as described below.

Safe Access: People using bicycles need to be able to safely access commercial and community destinations along our streets and trails. Providing access means providing high-quality, comfortable bikeways

and safe crossings and intersections. In some cases on streets with high motor vehicle speeds and volumes, a nearby parallel route such as a low stress bikeway or trail can provide access to destinations, in conjunction with wayfinding and a

Evolving functions and emerging technologies

Over the span of human civilization, our streets have served a variety of functions. Principle among these are **mobility** – moving across the land and **access** – being able to reach destinations. How these functions are served has varied substantially over time. Over a century ago, horseback riding, horse-drawn carriages and horse-drawn streetcars served most mobility needs. Hitching posts were a key element of the street design and dealing with horse manure was one of the challenges. Since then, human innovation has produced bicycles, trains and automobiles, transforming street design. As automobiles became a mainstay for the majority of American households in the first half of the twentieth century, streets were designed primarily to serve people using motor vehicles. However, in the past several decades, street designs have evolved to reflect the needs of people traveling via other methods, in addition to motor vehicles. Today, we are in an era of rapid innovation, evolving technologies and changing demands on our public right of way. As such, the functions outlined in this chapter are meant to be encompassing of these emerging travel methods and uses of the street.

For the purposes of this guide, “bicycles” or “bicyclist” is meant to represent bicycles as well as other travel devices that operate with a relatively similar capacity and speed, including e-bicycles, e-scooters, skateboards and other modes, sometimes referred to as “micromobility.” Motor vehicle typically refers to a personal motor vehicle (i.e. not public transit), and includes all types of motive power (internal combustion, electric, hydrogen fuel cell) and vehicle operator (individual, hired driver, computer).

As our society and technology evolve together, other new functions may be served on our streets. While these new functions may not be included in this edition of Designing Livable Streets, the framework and approach outlined in this guide to serving and designing for key functions can still be applied.

relatively fine-grained street grid. Convenient, secure and covered bicycle parking is also crucial for providing bicycle access. Bicycle parking should be easy to find and located close to building entrances, especially at major nodes, such as grocery stores, restaurants, schools and employment centers. Bicycle sharing and other shared mobility systems also can provide a convenient option, including for people who do not own or regularly use a bicycle. Street designs should provide adequate space within the right of way for parking of shared bicycles and other shared systems where access is prioritized.

Safe Mobility: A safe, interconnected bicycle network of streets and trails provides mobility throughout the region. The bicycle network should be physically separated from higher speeds and heavy motor vehicle traffic to enable people to move safely and comfortably by bike. When bicycle routes are direct, intuitive and connected, bicycling becomes comparable with motor vehicle travel for relatively short trips, in terms of time. Strategies to enhance bicycle mobility, such as "green wave" signal timing (green signals timed for 12-16 mph speed), can further increase the attractiveness of bicycling as a travel method. Bicycle facility design should also be forward-looking. Over the past decades, bicycling in our region has increased substantially, in some places, bicycle lanes or trails are at capacity. E-scooters and e-bikes are further increasing the demand on bicycle facilities. Consider designs that provide significant width for growth in users or that provide flexibility to expand in the future.

TRANSIT ACCESS AND MOBILITY: PEOPLE ACCESSING AND USING TRANSIT

Our streets enable transit to serve the region with an efficient, reliable way to travel between and within our communities.

Serving transit and the people who ride includes both mobility and access functions. For transit, there are often trade-offs between these two functions. Closely spaced stops provide a high level of access, but reduce the mobility function of the transit route. Some designs can help to maximize both access and mobility. A frequent, reliable and accessible transit system is one of the most effective uses of the public right of way. Transit can efficiently move more people than any other mode.

Safe Access: Transit access means having a safe and comfortable transit stop near both the beginning and end of a trip – and a safe way to get to and from the stops. Streets should have comfortable, attractive and universally accessible stops connected to quality sidewalks, bikeways and safe street crossings. Transit stops with higher levels of use should have shelter, seating, bicycle parking and potentially real-time information for travelers. At larger stations, include wayfinding for pedestrians and bicyclists, as well as adequate bicycle storage. Transit access can be provided with a range of transit types and services to effectively serve the varied communities in the Portland area.

Safe Mobility: Transit mobility is vital for the efficient movement of people throughout our region. Where possible, exclusive transit right-of-way can provide improved mobility and reliability during times when streets are congested. When transit is traveling in lanes shared with other vehicles, "enhanced transit" strategies can be used to improve mobility by addressing specific locations of recurring delay. These strategies include transit signal priority, business access & transit lanes, stops located on the far side of intersections, and queue jump lanes to bypass traffic at intersections. Even as transit vehicle types and service models evolve (such as driverless vehicles or on-demand routing), high capacity transit on trunk routes will remain critical to providing cost-efficient, space-efficient mobility for people.

FREIGHT ACCESS AND MOBILITY: MOVING GOODS AND MAKING DELIVERIES

Key freight corridors provide reliable freight movement, and streets allow delivery access to serve both businesses and residents.

Freight requires both mobility and access functions, but these functions are typically emphasized on different streets and are often served by different types of freight vehicles.

Safe Access: For freight, access means being able to deliver a good to the intended destination. The "last mile" and the "last 50 feet" are the most difficult and costly segments of a freight delivery. Delivery vehicles and workers need safe and reliable space to transfer goods to their point of final delivery, without needing to worry about conflicts from motor vehicles. Designated curb space for freight loading and unloading is necessary in high-traffic commercial zones, and one loading zone can serve multiple businesses. Loading zones can be located on side streets or alleys to reduce conflict with other functions. Often these final deliveries are made in smaller trucks or delivery vans that can navigate narrow streets with relatively tight corners. In locations where larger trucks must make frequent deliveries, ensure street designs that can accommodate them, potentially include truck aprons or mountable curbs. Deliveries can also be made by bicycle, and other wheeled delivery methods (such as self-driving pods) are in development. These methods can put higher demands on sidewalks and bicycle facilities and may necessitate greater widths. Also key for providing freight access are the locations where goods are transferred from long-haul routes to the "last mile" portion of the trip. Port terminals and other intermodal facilities must be designed to allow for freight access.

Safe Mobility: Reliable freight movement in the Portland metro area supports businesses and the economy of our region and state. Goods from adjacent farmland and neighboring counties need to reach ports to be exported and sold. High value manufactured goods made within the region often need to be shipped and delivered within a tight time frame. And every day, goods need to be moved through and around the region to be ultimately delivered and distributed to customers. This mobility function is primarily served on key regional freight routes and on industrial routes connecting to manufacturing and industry. Freight is best served with reliable travel times on a system where day-to-day variations are minimized.

MOTOR-VEHICLE ACCESS AND MOBILITY: PEOPLE DRIVING OR RIDING IN A MOTOR VEHICLE

Our transportation system provides for safe, reliable travel in motor vehicles, providing space to facilitate pooled or shared trips.

Motor vehicle travel relies on both access and mobility, but these functions are typically emphasized on different streets. Emphasizing one, either vehicle access or mobility, necessarily means limiting the other. Motor vehicle travel is the most predominant mode of travel in the Portland area and continues to be one of the most convenient ways to travel. As more drivers vie for limited roadway space other modes provide options other than driving.

Safe Access: Access for people traveling in motor vehicles is provided with a well-connected network of local and neighborhood streets, driveways to specific destinations, motor vehicle parking and places to drop-off and pick-up passengers. Serving this function on the curbside is typical in centers, where destinations and businesses are clustered. On-street parking also typically provides motor vehicle access, especially in residential areas. The curb will become an increasingly important space for motor vehicles with emerging new technologies. Both ride-sharing and autonomous vehicles will need frequent curbside access to facilitate passenger drop-off and pick-up. These spaces and movements of vehicles should not impede or imperil or people walking, biking or accessing transit. Reimagining street space to reflect future motor vehicle needs must always make safety the top priority.

Safe Mobility: Motor vehicle mobility typically offers time-efficient movement throughout the region. Streets that provide maximum mobility for motor vehicles typically limit access, such as freeways or highways. Other major streets need to balance motor vehicle mobility with other functions. On urban surface streets, intersections are typically one major constraint in terms of providing motor vehicle mobility. Advanced signal timing strategies can help move vehicles through intersections while promoting relatively low vehicle speeds. Roundabouts also provide for efficient, yet low-speed, motor vehicle movement. Managing access by restricting motor vehicle turning movements from side streets and driveways also promotes safe mobility. As motor vehicle mobility evolves (being increasingly provided by transportation network companies) and vehicles become more automated, people will be able to take advantage of motor vehicle mobility without driving themselves. Providing a reliable level of mobility, with low day-to-day variability in travel times, benefits people using motor vehicles, even if travel times are higher during peak periods.

PLACE-MAKING AND PUBLIC SPACE

Our streets and trails are a canvas for our community life and daily commerce, helping to form our regional identity.

Our neighborhoods and cities are built for people and streets represent a large portion of the public space in our communities. They are a canvas for community life, day-to-day social activity, public art, civic debate and joyful celebrations. Our regional streets and trails help form our region’s identity and contribute to the unique character of special places within our region. Streets and trails should provide a place for everyone to participate in their community. This is placemaking. Placemaking can achieve several different goals – foster community identity, promote art and local artists, create new public spaces or rebuild a community at a human scale. From outdoor seating and unique wayfinding signage to a redesigned park or art-filled commercial corridor, the ultimate goal is to create more livable communities and celebrate the elements that make this region a great place to live. Deliberate placemaking results in a stronger sense of place and strengthened community bonds ultimately leading towards the regional outcomes we are seeking.

To enhance a placemaking function, street and trail designs can include distinctive features, such as gateway intersections, aesthetic bridge designs or public art installations highlighting the local community. Designs should also anticipate occasional street use, such as festivals, parades or farmers markets – where the street is closed to through travel during community events. Visually interesting commercial corridors that are pedestrian scale, small parcel, street-fronting land uses with ground level windows make fun, engaging places to walk and stroll.

CORRIDORS FOR NATURE AND STORMWATER MANAGEMENT

Weaving nature and sustainable stormwater management into our streets and trails protects and enhances our region's natural assets.

Our natural setting helps make our region great, and weaving nature into our streets and trails enhances an already incredible asset. While today's streets are not inherent in nature, they must protect our water and air and the functions of the natural environment, including providing wildlife habitat and places to cross. Street trees provide a wide array of benefits, contributing to wildlife habitat, improved air quality, pollution reduction, shade, aesthetic beauty, human well-being, traffic calming and stormwater reduction. On streets with high levels of walking and bicycling, trees can provide buffers from traffic and air pollution. Weaving nature into our streets and trails should also take into account the impact of lighting on wildlife and the natural environment and use designs to mitigate lighting impacts.

Cities are prominent locations for urban heat islands, where pavement and buildings absorb solar radiation and drive up temperatures. As our climate changes, it is vital to protect and restore nature in our cities to create pleasant outdoor urban spaces and to limit temperature spikes. A dense tree canopy coverage can reduce the urban heat island effect during the summer months.

Streets create stormwater runoff and must be designed to manage this stormwater to reduce impacts to natural systems. Green streets design elements with strategies to manage stormwater with vegetation and natural soils, have distinct advantages and co-benefits over purely piped drainage systems. Vegetated medians, planters, curb extensions and other locations can both treat runoff to improve water quality (reduce pollution) and infiltrate water to reduce quantity of stormwater that eventually makes its way into our delicate system of natural waterways.

Designing streets and trails for stormwater management can also incorporate and enhance other functions, such as placemaking. Green street elements can be used to create a stronger sense of place and make walking and biking more enjoyable.

UTILITY CORRIDORS

Our transportation corridors move more than just people and goods; they also move water, power, gas, communications, and information.

Street rights of way are often the places that vital utilities are located with pipes for water and sewer, power and gas lines, and communications infrastructure. These utilities serve our buildings and land uses, but also serve our streets by powering signal systems, providing street lighting and draining water from the street surface. These utilities have different needs: the water-based utilities use gravity to move and are generally located closer to the curb or the outside travel lane, while the dry utilities, if underground, are usually located in a conduit in the right of way at the side of the street. Working with utility operators to locate underground pipes before an excavation project is vital to avoid line breaks and other issues and is codified into state law. Above ground, they are supported by poles at the side of the street. Street design must provide access to these underground and overhead utilities when repairs are needed. As technology evolves, utility-related demands in street right-of-way will change. Needs for information transmission and sensors will increase, and much of this equipment will be located on utility poles, buildings and within the surfaces of the streetscape. As future smart sensor technology becomes increasingly prevalent, streets should be designed for deployment of sensors that can communicate with a central network. Designs should allow for easy access to sensors to address issues, particularly as yet-to-be-proven technologies are deployed.

PHYSICAL ACTIVITY

Our streets and trails are places where people enjoy spending time outdoors as part of an active lifestyle.

When safe and comfortable, our streets and trails provide people with a place to recreate and get exercise as part of their daily activities. They should provide truly enjoyable spaces, considering safety, shade, sun, seasons and an engaging sensory experience. Spaces that mitigate impacts from noise, heavy motor vehicle traffic and pollution can encourage people to stroll, jog, bicycle, roll or skate, simply for the joy and benefit of being active outdoors. Many people in our region use our streets to move, exercise and enjoy being outdoors, whether strolling, jogging, bicycling, rolling or skating. Street trees provide protection from sun and rain. Street lighting makes evening or early-morning activity possible. And continuous, comfortable walking and bicycling infrastructure is vital for this function.

Physical activity is better served by streets and trails where the negative impacts of motor vehicles are mitigated with designs that reduce noise impacts, provide a buffer between moving vehicles and minimize pollution effects. These spaces will invite people out simply for the joy of being active outdoors and will reap tremendous community health benefits.

EMERGENCY RESPONSE

In case of a local or widespread emergency, our streets must provide access and evacuation routes to keep people safe.

From local emergencies, such as single-alarm fires, to regional crises, such as a Cascadian subduction zone earthquake, our streets are the lifeblood for any response. Our first responders and emergency vehicles need space to operate and deploy resources on our streets to respond to various needs in an emergency.

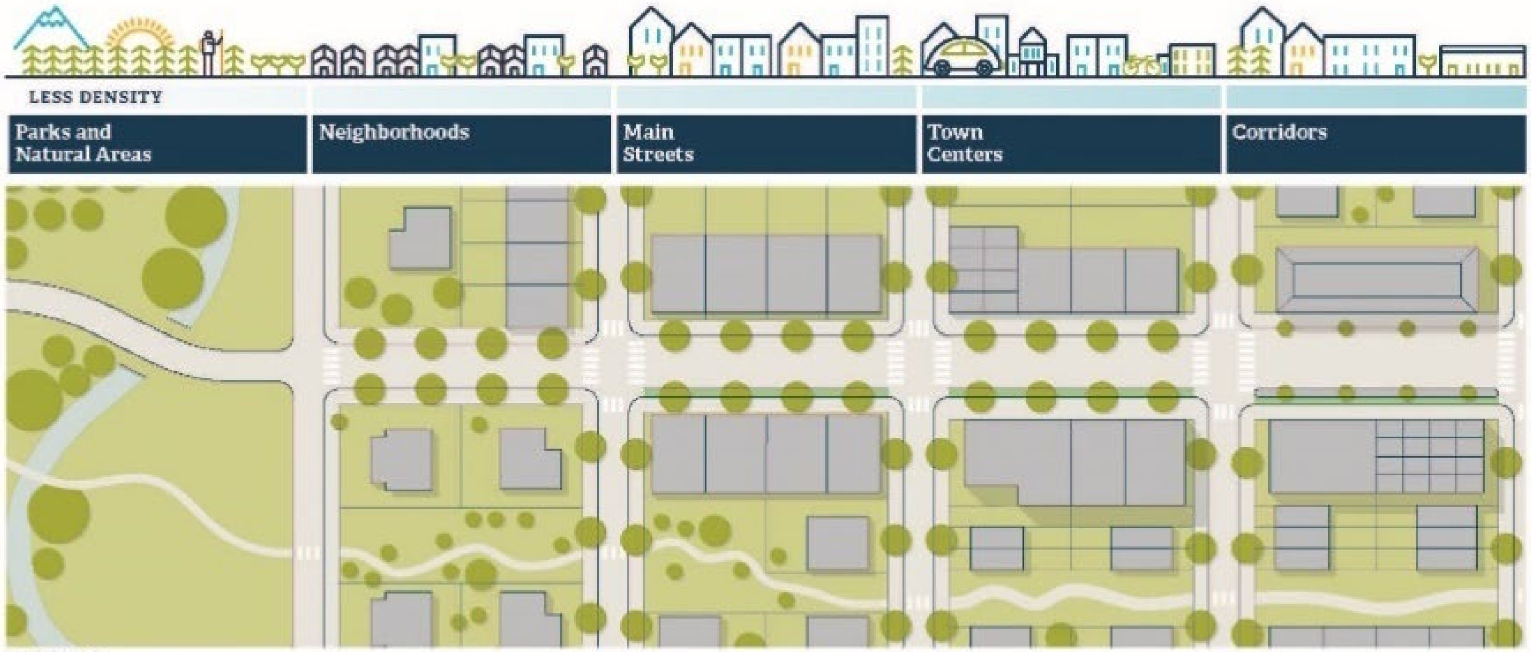
Designs must consider emergency vehicle access needs. Vertical elements like speed bumps should not be used on primary emergency routes, and streets must have sufficient clear width for emergency vehicles to deploy life-saving equipment. In some areas, regional trails and bicycle and pedestrian bridges can serve as additional access routes for emergency vehicles and bicycle emergency services for big events such as an earthquake.

3.2 Regional Street Design Classifications

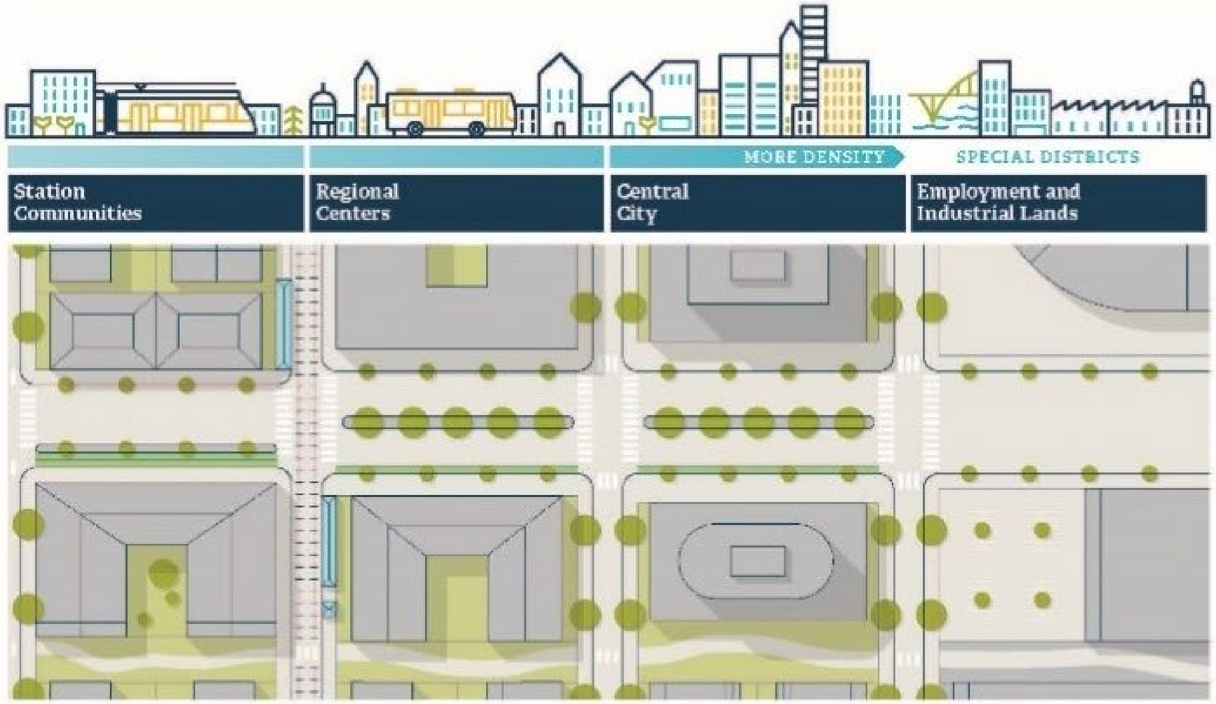
A classification is a formal designation of a street. The classification determines how that street is handled in a range of processes such as roadway design, traffic operations or funding eligibility. The most common classification system for streets is the "functional classification" which is typically determined by motor vehicle travel speed, motor vehicle capacity (number of lanes) and whether the street is in an urban or rural area. This classification system is limited in that it does not take into consideration other functions of the street such as other travel modes, especially bicycling and walking, or the specific role the street serves for surrounding and planned land uses, which can vary greatly in urban areas. A street classification system that considers balancing the needs and safety of all users, including pedestrians, transit riders and bicyclists, and serves the current and planned uses of and contexts of adjacent properties can be referred to as a "design classification." Refer to the 2018 NCHRP Research Report 880 "Design Guide for Low-Speed Multimodal Roadways" for a national perspective on developing best-practice design guidance and a new approach to classifying roadways with 45 mph and lower design speeds.

Metro developed regional street design classifications and adopted them into the Regional Transportation Plan in the early 1990s to specifically link land use context and transportation design, to support the range of transportation needs of the different land use types identified the 2040 Growth Concept and to support implementation of the 2040 Growth Concept. **Figure X** illustrates the relationship between the 2040 land use types and the regional street design classifications. As indicated in the illustration, freeways, highways and trails can traverse all land use types.

Land Use and Transportation Transect



	Parks and Natural Areas	Neighborhoods	Main Streets	Town Centers	Corridors
LAND USE	Undeveloped natural areas including parks, natural areas, open spaces and scenic areas, rivers and streams, wetlands and floodplains.	Single-family and multi-family residences incorporating a mix of housing types including row houses, duplexes and accessory dwelling units. Newer neighborhoods are slightly more compact while some older neighborhoods have larger lots and fewer street connections.	Neighborhood scale commercial retail and housing in one to three-story buildings along multimodal streets with good transit service.	Two to five-story mixed use buildings with professional services and commercial retail outlets complimenting housing that is well served by transit.	One to three-story buildings containing commercial retail, small scale employment or housing along major transportation routes that link centers together and are well served by transit.
TRANSPORTATION DESIGN	Transportation routes designed to protect and enhance natural features. In some cases a Parkway design overlay may be appropriate.	Regional and Community Streets	Regional and Community Boulevards	Regional and Community Boulevards	Regional and Community Streets



Station Communities	Regional Centers	Central City	Employment and Industrial Lands
Areas around light-rail or high capacity transit stations outside of centers with significant employment development and numerous housing types.	Two to six-story compact employment and housing development with destination retail served by high capacity transit.	Center of business and cultural activities for the region with intensive employment and housing in high-rises served by numerous transit options.	A mix of large scale employment and industrial uses that include office parks, manufacturing, distribution centers, marine and airport facilities and railroad switching yards.
Regional and Community Boulevards	**Regional and Community Boulevards**	**Regional and Community Boulevards**	**Industrial Streets, Regional and Community Streets**

Regional street design classifications support multimodal travel and the specific transportation needs of the 2040 Growth Concept land use types. Local streets serve all land use types and do not have a design classification. Freeways, highways and trails can traverse any type of land use. Roadways in parks and natural areas may have a Parkway design overlay to protect and enhance natural features.

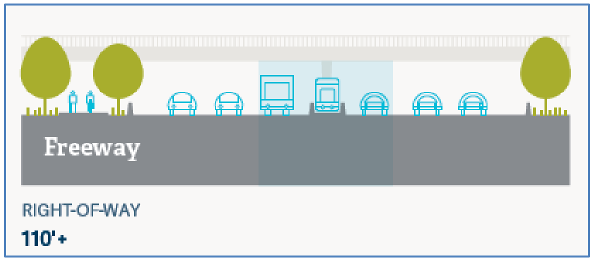
In addition to design classifications, the Regional Transportation Plan includes functional classifications for the different modal networks in the plan: pedestrian, bicycle, transit, freight and motor vehicle. The different modal networks are primarily assigned to the same network of regional streets comprised of major and minor arterials and throughways. The transit network includes some local collector streets and the pedestrian and bicycle networks include regional trails and some local streets. The modal classifications provide policies for the design and function of streets to serve the different modes of travel.

Regional street design classifications are informed by the modal network classifications and describe the typical attributes to balance the different functions inherent in each. Regional design and functional classifications apply to local transportation system plans in the greater Portland region. Cities or counties typically adopt the classifications as-is into their plans or provide a crosswalk if they use different terms for the classifications.

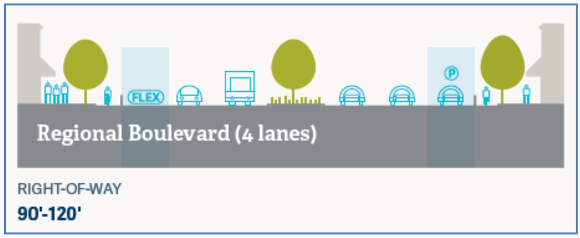
Regional street design classifications are assigned to all throughways and major and minor arterials on the regional transportation system. While the design classifications described below are only applied to arterials and throughways, the design elements and guidance in this guide can easily be applied to any street or trail. The following describes the purpose, function and land use relationships for each regional street design classification.

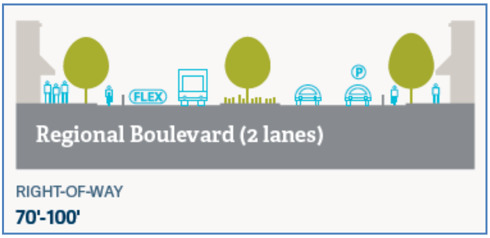
Freeways and highways prioritize long-distance freight, motor vehicle and transit mobility and connect major activity centers. **Figures X and X** illustrate typical cross-sections of a freeway and highway designs. The blue highlighted areas indicate optional design elements depending on right of way availability and prioritized functions.

Fig. X illustrates the relationship between the 2040 land use types and the regional street design classifications. As indicated in the illustration, freeways, highways and trails can traverse all land use types.



Regional and community boulevard classifications are applied to roadways within urban centers, station communities and to main streets. Boulevards serve major centers of urban activity and emphasize access and mobility for public transportation and people walking and bicycling. **Figures X, X and X** illustrate typical cross-sections of regional and community boulevards. The blue highlighted areas indicate optional design elements depending on right of way availability and prioritized functions.





Regional and community street classifications are applied to corridors, main streets, industrial and employment areas and neighborhoods with designs that integrate all modes of travel and provide accessible and convenient pedestrian, bicycle and transit travel. **Figures X, X and X** illustrate typical cross-sections of the regional and community street design classifications. The blue highlighted areas indicate optional design elements depending on right of way availability and prioritized functions.

Industrial streets classifications are applied to roadways that serve intermodal facilities such as airports, and to roadways in industrial and employment areas. Designs primarily serve freight mobility and access while integrating multi-modal travel and access to transit. **Figure x** illustrates a typical cross-section of an industrial street design. The blue highlighted areas indicate optional design elements depending on right of way availability and prioritized functions.

Table X summarizes the general street design classification components for each of the street design classifications described above.

Table X: Regional Street Design Classifications and Their Components

Design Classification	Land use Context	Street Connections	Prioritized Modes of Travel	Functional Classification	Target & Design Speed	Number of Motor Vehicle Lanes	Medians & Turn Lanes	Flex-Zone Uses	Pedestrian Design	Target Pedestrian Crossing Spacing	Bikeway Design	Transit Design	Freight Design
Freeways	Any	Limited, grade separated	Motor-vehicle, freight, transit	Throughway	45 to 60 mph	Six with auxiliary lanes in some places	Barrier with shoulders No turn lanes	Shoulder for safety, emergency use, bus on shoulder or HOV	Parallel facility Crossings on over or underpasses	250 - 2,600 ft	Parallel facility Crossings on over or underpasses	Bus-on-shoulder, express bus, light-rail	Enhanced mobility
Highways	Any	Limited, some at grade, signalized	Motor-vehicle, freight, transit	Throughway	45 to 60 mph	Up to six with auxiliary lanes in some places	Median Limited turn lanes in some locations.	Shoulder for safety, emergency use, bus on shoulder or HOV	Parallel facility Crossings on over or underpasses	250 - 2,600 ft	Parallel facility Crossings on over or underpasses	Bus-on-shoulder, express bus, light-rail	Enhanced mobility
Regional Boulevard	Centers, station communities and some main streets	Many; access management emphasized	Pedestrian, transit, bicycle Access for the above and auto	Major Arterial	20 to 25 mph	Up to four lanes	Median Some turn lanes	Parking, green streets, protected bikeway, enhanced bus, etc.	Wide sidewalks with buffer Enhanced crossings and access to transit	200-530 ft	Protected bikeway unless on parallel facility Enhanced crossings	Enhanced stations, priority bus treatments on ETC routes	Loading and unloading; Truck aprons
Community Boulevard	Centers, station communities and some main streets	Many; access management emphasized	Pedestrian, transit, bicycle Access for the above and auto	Minor Arterial	20 to 25 mph	Two to four lanes	Median Some turn lanes	Parking, green streets, protected bikeway, enhanced bus, etc.	Wide sidewalks with buffer Enhanced crossings and access to transit	200-530 ft	Protected bikeway unless on parallel facility Enhanced crossings	Enhanced stations, priority bus treatments on ETC routes	Loading and unloading; Truck aprons
Regional Street	Corridors, neighborhoods, some main streets and employment and industrial areas	Some to many; access management emphasized	Pedestrian, transit, bicycle Access for all modes	Major Arterial	20 to 30 mph	Up to four lanes	Median Some turn lanes	None, or parking, green streets, protected bikeway, enhanced bus, etc.	Wide sidewalks with buffer Enhanced crossings and access to transit	250-530 ft	Protected bikeway unless on parallel facility Enhanced crossings	Enhanced stations, priority bus treatments on ETC routes	Loading and unloading

Community Street	Corridors, neighborhoods, some main streets and employment and industrial areas	Some to many	Pedestrian, transit, bicycle Access for all modes	Minor Arterial	20 to 30 mph	Two to four lanes	Median Some turn lanes	None, or parking, green streets, protected bikeway, enhanced bus, etc.	Wide sidewalks with buffer Enhanced crossings and access to transit	250-530 ft	Protected bikeway unless on parallel facility Enhanced crossings	Enhanced stations, priority bus treatments on ETC routes	Loading and unloading
Industrial Street	Employment and industrial areas; Intermodal Connectors on freight network	Some; access management emphasized	Motor-vehicle, freight, transit	Major or Minor Arterial	20 to 40 mph	Two to four lanes	Median Some turn lanes	None, or parking, green streets, protected bikeway, enhanced bus, etc.	Sidewalk with buffer or multi-use path Enhanced crossings and access to transit	300-1,000 ft	Protected bikeway unless on parallel facility, or multi-use path Enhanced crossings	Accessible stations, priority bus treatments on ETC routes	Priority freight treatments, wider lanes and intersections

Note: Green Infrastructure, including stormwater management and other green streets treatments, and Utilities, are functions of all design classifications. Regional trails may be parallel to the street and serve pedestrian and bicycle access and mobility.

FREEWAYS AND HIGHWAYS

Lane Use: Freeways and highways connect major activity centers within the region, including the central city, regional centers, industrial and employment areas and intermodal facilities such as the Port of Portland. Freeways cross all types of land uses and buildings are not oriented to these facilities. In highway design, land-use access is typically restricted, with few buildings facing the highway. If buildings are present they are typically on a deep set-back.

Street Connections: Interchanges for freeway design should be spaced no more frequently than every two miles. Highways may have more street connections than freeways, but connections should be minimized. Street connections occur both at-grade or grade-separated. While the limited access design of freeways and highways supports mobility for freight, transit and long distance motor vehicle trips, the design also disrupts connectivity of the street network, trails and wildlife corridors. Providing for connectivity across these facilities for people and wildlife is essential.

Prioritized Modes of Travel: Freeway and highway design prioritizes long-distance freight, motor vehicle and transit mobility and provide inter-city, inter-regional and inter-state connections. Some lanes may be dedicated to high-occupancy-vehicle, freight-only or transit-only travel to support more efficient use of the facilities. Freeways and highways are designed to serve an important emergency response function and are typically identified as primary emergency response routes.

Functional Classification: The freeway and highway design classifications are assigned to facilities with the throughways functional classification in the Regional Transportation

Plan. All throughways are identified as primary regional freight routes and some are identified as frequent transit routes. The multi-use paths that parallel freeways and highways are identified as regional pedestrian and bicycle facilities. The right of way typically ranges from 110 feet or greater. Highways consist of four to six vehicle travel lanes, with additional lanes in some cases. The right of way typically ranges from 100 to 135 feet or greater.

Speed: The limited access, divided freeway and highway design supports higher travel speeds, ranging from 35 to 60 mph. Freeway interchanges are transition zones and are designed for lower speeds and safety for all modes, including bicyclists and pedestrians. On highways, intersections are designed for lower speeds and safety for all modes.

Number of Motor Vehicle Lanes: Freeways typically consist of six vehicle travel lanes, with additional auxiliary lanes in some cases.

Median and Turn Lanes: Freeways are completely divided, prohibiting access and turning movements except at grade-separated interchanges. Highways are usually divided with a median, but may have left-turn lanes where at-grade intersections exist. In both the freeway and highways design, medians can serve as a corridor for light-rail or can be planted with trees or plants (that do not attract wildlife) for stormwater benefits. Bicycle and pedestrian travel should not be located in the median area, including on bridges.

Pedestrian and Bikeway Design: . There is no pedestrian and bicycle access to freeways. Multimodal or pedestrian and bicycle crossings are provided on overpasses or underpasses, and should be spaced no less than one mile apart, with more frequent crossings in denser areas. Pedestrian and bicycle mobility is provided on separate facilities, often a multi-use path or streets parallel to the freeway, separated by a sound wall and trees.

Highway designs can include separated bikeways and sidewalks with a wide landscape buffering, a parallel multi-use path or facilities on parallel facilities, if appropriate. Pedestrian and bicycle crossings are provided should be either grade separated or signalized intersections with protected crossing treatments for the highway design.

Transit Design: In the freeway and highway design classification transit travel can be prioritized in various ways, including high-occupancy vehicle lanes, bus-on-shoulder or light rail within the right of way. Access to transit is prohibited on freeways

Freight Design: Freeway and highway design enhance freight mobility. Freight design also serves other large vehicles such as emergency response.

Flex Zone Uses: Freeway and highway design include a shoulder that is primarily used for emergency stops and crash recovery, but can be flexed for other purposes. Emergency vehicles may use the shoulder to bypass traffic. Shoulders can also be converted to support bus-on-shoulder use or high-occupancy vehicle lanes. Parking is prohibited on freeways and highways. It is not preferred to accommodate bicycle or pedestrian travel on shoulders; pedestrian and bicycle travel should be accommodated on a parallel multi-use path or parallel streets.

Place-making: Design elements can enhance freeways and highways, such as incorporating view sheds of natural features, murals or greening of sound walls, gateway treatments on bridges and light rail stations and lighting features. If the parkway design overlay applies, the scenic beauty of the corridor is enhanced with parkway design elements (see Parkway Overlay below). If light-rail is part of the corridor, station treatments can create public space.

Green Infrastructure: Stormwater management treatments and other green infrastructure are critical design elements for freeways and highways to mitigate the negative impacts of motor vehicles and enhance the travel experience. Bioswales and continuous landscaping along the freeway or highway and in medians, while maintaining clear sightlines, supports filtration and retention of stormwater runoff, and provide noise and pollution mitigation. Light pollution should be minimized to increase safety and protect wildlife. Fish passage must be addressed when throughways cross fish bearing streams. Sound walls and landscaping reduce noise and pollution impacts to adjacent communities.

Utilities: Many utilities use the throughway corridor. Wherever feasible utilities should be placed underground in freeway and highway design.

BOULEVARDS

Land Use: Boulevards serve the multimodal travel needs of the region's most intensely developed and developing activity centers, including the central city, regional centers, station communities, town centers and some main streets. Adjacent land uses and buildings should orient directly to the boulevard with ground-floor commercial activity, contributing to pedestrian friendly environment. Buildings typically have designs that provide transition spaces from the street and support pedestrian access, such as a storefront or arcade.

Street Connections: Boulevards have many street connections, but should typically be access managed with few driveways (combining driveways if necessary). Pedestrian and bicycle crossings should be signalized and enhanced at intersections. Safe, direct and logical pedestrian crossings are provided at all transit stops. For streets with fewer intersections, mid-block crossings may be necessary to provide safe pedestrian and bicycle access to transit and other destinations. Wildlife crossings should also be considered depending on the location.

Prioritized Modes of Travel: Boulevards are designed with elements that promote safe and comfortable travel for all modes. Pedestrian mobility and access are prioritized, as is access to transit. Some boulevards are also identified as bicycle parkways, frequent bus routes or enhanced transit corridors; in these instances mobility for these functions should be enhanced through design. Boulevards can be important roadways for motor vehicle and freight access. Mobility for motor-vehicle and freight travel is slower due to lower speeds and increased levels of street-side activity. Some boulevards are identified as primary emergency response routes and will include designs to allow emergency vehicle access and travel. Freight access may be provided in the center travel way, curb side or on side streets.

Functional Classification: The regional boulevard classification is applied to major arterials and the community boulevard classification is applied to minor arterials. Major arterials are spaced one mile apart; minor arterials have a half mile spacing. In the greater Portland metropolitan area, several regional boulevards are also state highways. Many of these streets will also have regional freight, transit, bicycle and pedestrian classifications.

Speed: Boulevard design supports low travel speeds for vehicles, typically 20 to 25 mph, to increase safety for all modes and accommodate the higher levels of pedestrian activity. Signal timing can be used to support slower speeds that keeps traffic moving.

Number of Motor Vehicle Lanes: Regional boulevards consist of up to four vehicle travel lanes, balanced multimodal function and a broad right of way. Regional boulevards include medians that serve as a pedestrian refuge at street crossings. Pocket turn lanes are typically included in the design. Road reconfigurations from four to three lanes may add a turn lane and parking and/or bicycle facilities if those do not exist. Boulevards consisting of paired one-way streets or couplets, are spaced no greater than one block apart. This design is used to increase capacity of intensely developed commercial areas. Each street might have two to three travel lanes and include all of the design elements of a boulevard except the median. The right of way typically ranges from 70 to 120 feet or greater.

Community boulevards typically have a narrower right of way than regional boulevards and generally consist of two vehicle travel lanes, though can sometimes go up to four travel lanes. Community boulevards may or may not have turn lanes. Road reconfigurations from four to three lanes may add a turn lane and parking and/or bicycle facilities. The right of way ranges from 60 to 80 feet or greater.

Median and Turn Lanes: Landscaped medians planted with large, broad canopied trees are an essential element of the boulevard design. Medians and access management increase safety for pedestrians and all modes. The double median (or “Parisian boulevard”) is another type of regional boulevard that has a central roadway for through traffic separated on either side from local traffic and pedestrian and bicycle travel by tree-lined medians. This type of boulevard has a minimum right of way width of 100 feet, a functional minimum width of 110 feet, and an ideal width of 132 feet or greater. In some cases where right of way is limited, a narrow landscaped median may be used. In conjunction with wide sidewalks that also include street trees, the median functions as a pedestrian refuge, limit head on motor vehicle crashes and to provide a sense of enclosure to calm traffic speeds. Access control is a secondary benefit.

Pedestrian and Bikeway Design: Pedestrian access is supported by ADA accessible sidewalks and curbs, wayfinding and places to stop and sit. Pedestrian access to transit is supported by transit stops with features including shelter, seating and travel information. Bicycle access is supported by bicycle parking, wayfinding and connections to other bicycle routes.

Pedestrian mobility is served with wide, buffered sidewalks. Bicyclist mobility is served with separated bikeways. If a separated bikeway is not possible or desirable then a low stress facility is provided on a parallel facility no less than one block over. Wayfinding, visual cues and bicycle parking connect bicyclists from the low stress bikeways to the commercial and community destinations along the boulevard.

Transit Design: Boulevard designs prioritize transit mobility and access to transit. Design features include covered stations, enhanced pedestrian crossings at transit stops and transit priority treatments such as signal timing.

Freight Design: Boulevard designs include access for freight trucks making deliveries. Sometimes access may be served on side streets or in alleys. Center turn lanes with medians can also support loading and unloading. Some boulevards are also designated as regional freight routes. In these cases designs should accommodate freight while still prioritizing the movement of people. Truck aprons or roundabouts can be used in some contexts to slow vehicle speeds and increase safety. Accommodation of freight on boulevards also serves other large vehicles such as emergency response.

Flex Zone Uses: On boulevards, the flex zone (sometimes referred to as the parking lane) is in high demand because of the level of activity and intensity of uses in centers, station communities and along main streets. In some cases, due to space constraints, the flex zone may be dedicated to a travel lane or bus only lane. Other uses may include drop-off and loading zones, bikeways, bulb-outs for in lane transit loading, green streets treatments or motor vehicle, e-scooter and/or bicycle parking, which can provide a buffer for pedestrians and access to businesses. Parking for motor vehicle and bicycles is typically desirable in boulevards due the high level of commercial activity.

Place-making: Boulevard design incorporates place-making and public space in many ways. Boulevards are centers of activity and often the heart of the community. Public art and designs that reflect the history and culture of the community are desirable. Building design, treatments to street lighting, wayfinding, pavement and landscaping create a sense of place. Many jurisdictions have special design codes for streets within centers and station communities.

Green Infrastructure: Street trees and stormwater management are critical design features of boulevards. Due to the wider width of regional boulevards, a higher capacity swale should be used to accommodate runoff from the larger collection area, or street tree wells and infiltration trenches. Swales can be located in the central median or a side median adjacent to a local access street. Medians, planted pedestrian buffers, pervious pavement treatments and other efforts reduce the amount of impervious surfaces. Light pollution should be minimized to increase safety and protect wildlife. Fish passage must be addressed when the roadway crosses fish bearing streams.

Utilities: Many utilities use the street corridor. Wherever feasible, utilities should be placed underground, especially on regional and boulevards and streets. Underground utilities can reduce the severity of motor vehicle crashes, free up pedestrian space, enhance the visual aesthetics of the street, eliminate need for most tree trimming and are not as vulnerable to extreme weather events. As new technologies emerge, the demand for space on streets, especially within the pedestrian realm will increase. Design solutions to maximize space and minimize visual clutter should be considered in every design process.

REGIONAL AND COMMUNITY STREETS DESIGN CLASSIFICATION

Land Use: Regional and community streets balance the multimodal travel and access needs of corridors, neighborhoods and some main streets and employment and industrial areas. Regional and community streets are located within residential neighborhoods to more densely developed corridors and employment centers where development is set back from the street. Regional and community streets can be within main streets where buildings are oriented toward the street at major intersections and transit stops.

Street Connections: The street design classification may have less street connections than the boulevard design. Streets should typically be access managed with few driveways (combining driveways if necessary). The community street design provides a higher level of local access and street connectivity than regional streets, and have the greatest flexibility in cross sectional elements. Some lanes may be dedicated to transit only lanes or to protected bicycle facilities to support multimodal travel. Road reconfigurations from four to three lanes may add a turn lane and parking and/or bicycle facilities. For streets with fewer intersections, mid-block crossings may be necessary to provide safe pedestrian and bicycle access to transit and other destinations. Wildlife crossings should also be considered depending on the location.

Prioritized Modes of Travel: Streets are typically more vehicle-oriented than boulevards, while integrating all modes of travel and designed as complete streets. Transit and bicycle mobility are also prioritized on regional and community streets, especially when those streets are frequent bus routes, enhanced transit corridors and/or bicycle parkways. Some streets are identified as primary emergency response routes and should include designs to allow emergency vehicle access and travel. Where regional streets are also roadway connectors on the regional freight network, freight mobility and access is also prioritized.

Functional Classification: The regional and community street design classifications are applied to major and minor arterial streets in the Regional Transportation Plan. The regional street classification is applied to major arterials and the community street classification is applied to minor arterials. Major arterials are spaced one mile apart; minor arterials have a half mile spacing. In the greater Portland metropolitan area, several regional boulevards are also state highways. Many of these streets will also have regional freight, transit, bicycle and pedestrian classifications.

Speed: The regional and community street design supports low to medium travel speeds for freight, transit and motor vehicles, typically 20 to 30 mph. Greater separation for people bicycling and walking is needed when speeds are higher. Signal timing can be used to support slower speeds that keeps traffic moving.

Number of Motor Vehicle Travel Lanes: Regional streets typically consist of up to four travel lanes, with a median and turn lanes and have a broad right of way. Some lanes may be dedicated to transit only lanes or to protected bicycle facilities to support multimodal travel. Road reconfigurations from four to three lanes may add a turn lane and parking and/or bicycle facilities. The right of way ranges from 80 to 100 feet or greater.

Community streets typically have a narrower right of way and fewer travel lanes than regional streets. They generally consist of two vehicle travel lanes, though can sometimes go up to four travel lanes. Community streets may or may not have turn lanes. Road reconfigurations from four to three lanes may add a turn lane and parking and/or bicycle facilities. The right of way ranges from 60 to 80 feet or greater.

Regional or community streets consisting of paired one-way streets or couplets, are spaced no greater than one block apart. This design is used to increase capacity of intensely developed commercial areas. Each street might have two to three travel lanes and include all of the design elements of a boulevard except the median.

Median and Turn Lanes: One of the predominant safety and livability features of regional and community street design is the use of a raised median. Regional and community streets can have three different median conditions, depending on the intensity of adjacent land use and site access needs:

- Raised landscaped median should be used along corridors, main streets and station communities where driveways are frequent and where average daily traffic exceeds 28,000 vehicles.
- Narrow landscaped median can be used to restrict turning movements and reduce conflicts along corridors, main streets and station communities. Used where site access is provided from side streets or U-turns are permitted at frequent intervals, and the curb-to-curb width is greater than 50 feet.
- No median within neighborhoods, corridors and main streets where site access is less frequent and can be provided without a median or left-turn lanes and without significantly impacting capacity.

Pedestrian and Bikeway Design: Pedestrian access is supported by ADA accessible sidewalks and curbs, way finding and places to stop and sit. Pedestrian access to transit is supported by transit stops with features including shelter, seating and travel information. Bicycle access is supported by bicycle parking, way finding and connections to other bicycle routes.

Pedestrian mobility is served with wide, buffered sidewalks. Bicyclist mobility is served with separated bikeways. If a separated bikeway is not possible or desirable then a low stress facility is provided on a parallel facility no less than one block over. Wayfinding, visual cues and bicycle parking connect bicyclists from the low stress bikeways to the commercial and community destinations along the boulevard.

Transit Design: Regional and community designs prioritize transit mobility and access to transit. Design features include covered stations, enhanced pedestrian crossings at transit stops and transit priority treatments such as signal timing.

Freight Design: Regional and community street designs include access for freight trucks making deliveries. Sometimes access may be served on side streets or in alleys.

Center turn lanes with medians on regional streets can also support loading and unloading. Some regional streets are also designated as regional freight routes. Truck aprons or roundabouts can be used in some contexts to slow vehicle speeds and increase safety. Accommodation of freight on boulevards also serves other large vehicles such as emergency response.

Flex Zone Uses: On regional and community streets, parking is less desirable than on boulevards. In some cases, due to space constraints and mobility demands, parking may be prohibited and the flex zone may be dedicated to a travel, bus-only lane (with bulb-outs for in-lane boarding) and/or protected bikeway. Other uses include green streets treatments or motor vehicle, e-scooter and/or bicycle parking, which can provide a buffer for pedestrians and access to businesses.

Place-making: Regional and community street design incorporates place-making and public space in many ways. Transit stops and major intersections can serve as anchors along street corridors. Public art and designs that reflect the history and culture of the community are desirable. Building design, treatments to street lighting, wayfinding, pavement and landscaping create a sense of place. Many jurisdictions have special design codes for streets within centers and station communities.

Green Infrastructure: Due to the wider width of regional streets, a higher capacity swale should be used to accommodate runoff from the larger collection area, or street tree wells and infiltration trenches. Swales can be located in the central median or a side median adjacent to a local access street. Medians, planted pedestrian buffers, pervious pavement treatments and other efforts reduce the amount of impervious surfaces. Light pollution should be minimized to increase safety and protect wildlife. Fish passage must be addressed when the roadway crosses fish bearing streams.

Utilities: Many utilities use the street corridor. Wherever feasible utilities should be placed underground, especially on regional and boulevards and streets. Underground utilities can reduce the severity of motor vehicle crashes, free up pedestrian space, enhance the visual aesthetics of the street, eliminate need for most tree trimming and are not as vulnerable to extreme weather events. As new technologies emerge, the demand for space on streets, especially within the pedestrian realm will increase. Design solutions to maximize space and minimize visual clutter should be considered in every design process.

INDUSTRIAL STREETS DESIGN CLASSIFICATION

Land Use: Industrial streets serve low-density industrial and employment areas and intermodal facilities where buildings are seldom oriented to the street.

Street Connections: Industrial street design has some street connections with access to employment and industrial areas. Access management is emphasized. For streets with few intersections, mid-block crossings may be necessary to provide safe pedestrian and bicycle access to transit and other destinations. Wildlife crossings should also be considered depending on the location.

Prioritized Modes of Travel: Industrial streets prioritize heavy truck mobility and access while providing for safe transit, bicycle and pedestrian access and travel. While pedestrian and bicycle demand will typically be lower in these areas the need for safe access to transit and bikeways increase access to jobs or other destinations, such as parks and natural areas. Some industrial streets may also be identified as bicycle parkways, frequent bus routes or enhanced transit corridors; in these instances mobility for these functions should be enhanced through design.

Functional Classification: The industrial street design classification is typically applied to major or minor arterial roadways in the Regional Transportation Plan that connect to intermodal facilities (airports, rail stations, marine terminals and rail yards) or are in 2040 industrial and employment areas – these are identified as intermodal connectors on the regional freight network. The right of way typically ranges from 60 to 90 feet. In the greater Portland metropolitan area, several regional boulevards are also state highways. Some of these streets will also have regional transit, bicycle and/or pedestrian classifications.

Speed: Industrial street design can support low to higher travel speeds for freight, transit and motor vehicles, ranging from 20 to 40 mph, depending on the specific local context. Greater separation for people bicycling and walking is needed when speeds are higher.

Number of Motor Vehicle Travel Lanes: Industrial streets typically have two to four travel lanes with turn lanes. Additional lanes are appropriate in some situations. Travel lane widths are generally wider in industrial streets. Medians increase safety

Pedestrian and Bikeway Design: In the industrial street design people walking and bicycling are separated from freight and motor vehicle traffic, ideally on a separated multi-use path, for the safety and comfort of all users. Crossings are protected and may be provided by an overcrossing. Bicycle facilities on parallel streets may be appropriate in some instances if it does not prohibit bicycle access or mobility.

Transit Design: Some industrial streets may serve transit, especially for access to jobs. Access to transit stops should be safe and direct. Transit stops should have shelters. Some streets may have priority transit treatments, if appropriate.

Freight Design: Industrial streets serve as primary freight routes and often include specific design treatments to improve freight mobility. Street corners with larger turning radii improve truck mobility and access. Truck aprons or roundabouts can be used in some contexts to slow vehicle speeds and increase safety. Industrial streets rarely include on-street parking. Industrial streets are designed for through service transit with some transit stops. The flex zone may be dedicated to travel lanes, bus and freight only lanes or protected bikeways. A center median serves to reduce conflicts and restrict turning movements except at intersections. Pedestrian and bicycle crossings are included at intersections. Pedestrian travel is accommodated on a sidewalk with buffer or a parallel multi-use path. Bicycle travel is provided on a protected bikeway, multi-use path or on a parallel street.

Green Infrastructure: A higher capacity swale should be used to accommodate runoff from the larger collection area, or street tree wells and infiltration trenches. Swales can be located in the central median or a side median adjacent to a local access street. Medians, planted pedestrian buffers, pervious pavement treatments and other efforts reduce the amount of impervious surfaces. Light pollution should be minimized to increase safety and protect wildlife. Fish passage must be addressed when the roadway crosses fish bearing streams.

Utilities: Many utilities use the roadway corridor. Wherever feasible utilities should be placed underground, especially on regional and boulevards and streets. Underground utilities can reduce the severity of motor vehicle crashes, free up pedestrian space, enhance the visual aesthetics of the street, eliminate need for most tree trimming and are not as vulnerable to extreme weather events. As new technologies emerge, the demand for space on streets, especially within the pedestrian realm will increase. Design solutions to maximize space and minimize visual clutter should be considered in every design process.

PARKWAY DESIGN OVERLAY

A design overlay can be applied to roadways in undeveloped areas including parks, natural areas, open spaces and scenic areas, rivers and streams, wetlands and floodplains. Parkways serve as linear parks and often have a parallel multi-use path. They are designed to protect, preserve and enhance the natural environment and natural features. They may connect important natural features. Travel speeds are slower, no higher than 45 mph, and access is limited. They are typically not commercial or freight routes. Wide green buffers separate the roadway from buildings and development. Special design of railings, lighting and way finding may be applied to emphasize the Parkway elements.

REGIONAL TRAILS

Regional trails, or multi-use paths, are not included in the regional street design classifications, just as local streets that might serve as a regional bikeway or a collector that might serve as a frequent transit route are not included. However, because off-street regional trails are a key part of the regional transportation network, pertinent key attributes of regional trails are included here.

Land Use: Regional trails can traverse any type of land use. They are often situated in riparian corridors, rail corridors or utility corridors. However they can just as likely be situated within the road right of way, as in a freeway or highway corridor. Or, a regional trail may transition to an “on-street connection” where it might be designed as a protected bikeway and sidewalk buffered by street trees. Whatever the location or design, trails provide for comfortable and safe pedestrian and bicycle travel.

Street Connections: Within the urban area, multiple access points to trails increase security and access to destinations. Street crossings for trails should be enhanced for safety. Depending on the travel volumes of both the trail and the street the enhanced crossing might prioritize trail users with activated signals.

Prioritized Modes of Travel: Regional trails prioritize non-motorized travel, typically by foot, bicycle or a mobility device such as a wheelchair. As the use of new micromobility options such as e-scooters and electric bikes increase in use there will be a greater demand on trails to accommodate these new modes of travel. Trails, especially bridges over rivers or throughways, can serve as emergency vehicle routes.

Functional Classification: Within the Regional Transportation Plan, regional trails that are part of the regional pedestrian and bicycle networks are assigned the functional classification of either Pedestrian/Bicycle Parkway or Regional Pedestrian Corridor/Regional Bikeway. Not all regional trails are included in the regional pedestrian and bicycle networks.

Green Infrastructure: When in natural areas they must be designed to avoid, minimize and mitigate impacts on the environment. In some instances there will be opportunities to restore degraded landscapes and provide improved access to natural areas.

Utilities: Trails can be located within power line corridors. Development of the trail can benefit the utility by serving as a paved and maintained access road for utility vehicles.

LINKING FUNCTIONS AND DESIGN CLASSIFICATIONS

Table X links the design functions of streets and trails described in Section 3.1 with each of the street design classifications and regional trails described above. As shown in the table, different functions are prioritized depending on the design classification. This table will be referred to again in Chapter 6 as a tool for working through trade-offs in project design.

Table X: Regional Design Classifications and Functions

Regional Design Classifications	Pedestrian Access	Pedestrian Mobility	Bicycle Access	Bicycle Mobility	Transit Access	Transit Mobility	Freight Access	Freight Mobility	Auto Access	Auto Mobility	Place-Making, Public Space	Nature Corridors	Stormwater Management	Utility Corridors	Physical Activity	Emergency Response
Freeways	🔴	🔴	🔴	🔴	🔴	🟩 🟢	🔴	🟩 🟢	🔴	🟢	🔴	🟡	🟡	🟢	🔴	🟢
Highways	🟡	🟡	🟡	🟡	🔴	🟩 🟢	🔴	🟩 🟢	🔴	🟢	🔴	🟡	🟡	🟢	🔴	🟢
Regional Boulevard	🟩 🟢	🟩 🟢	🟩 🟢	🟢	🟩 🟢	🟢	🟡	🟡	🟢	🟡	🟢	🟢	🟢	🟡	🟡	🟡
Community Boulevard	🟩 🟢	🟩 🟢	🟩 🟢	🟢	🟩 🟢	🟢	🟡	🟡	🟢	🟡	🟢	🟢	🟢	🟡	🟡	🟡
Regional Street	🟩 🟢	🟢	🟢	🟩 🟢	🟢	🟩 🟢	🟢	🟡	🟢	🟡	🟡	🟢	🟢	🟡	🟡	🟡
Community Street	🟩 🟢	🟢	🟢	🟩 🟢	🟢	🟩 🟢	🟢	🟡	🟢	🟡	🟡	🟢	🟢	🟡	🟡	🟡
Industrial Street	🟡	🟡	🟡	🟡	🟡	🟡	🟩 🟢	🟢	🟢	🟢	🟡	🟡	🟡	🟢	🔴	🟢
Regional Trail	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🟢	🟢	🟡	🟡	🟢	🟡

🟢 Typically prioritized
🟡 Typically accommodated
🔴 Typically served on parallel facility
🟩 Prioritize in trade-offs in constrained spaces

Chapter 4: Design Elements

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Chapter 4 provides more detail on design guidance for streets and trails in the greater Portland area. At the core of this approach is designing to serve the land use context, as described in Chapter 2.

The information in this chapter is organized in two parts:

- Design principles provide an overarching approach to design that supports achieving our systemwide regional outcomes described in Chapter 2.
- Design elements include information on designing for specific functions and for the regional street design classifications, which correspond to land use. Appendix B includes a compilation of design resources, including a variety of sources used to develop the guidance in this chapter. These resources provide more detailed information on many of the topics covered within this chapter.

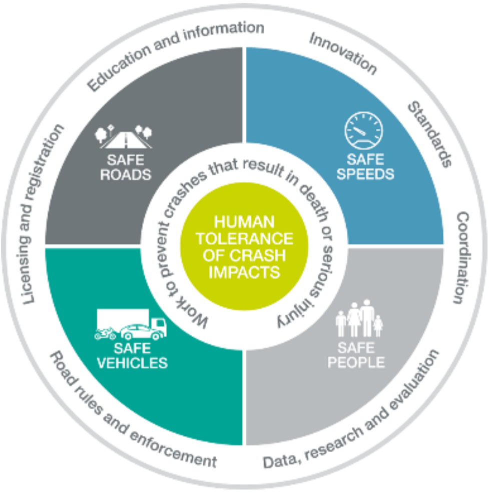
Full-Page Professional Photograph

DESIGN PRINCIPLES

Safe Systems Approach

The safe systems approach involves a holistic view of the transportation system and the interactions among speeds, vehicles and street users. It is an inclusive approach that prioritizes safety for all user groups of the transportation system, including drivers, motorcyclists, passengers, pedestrians, bicyclists, transit riders and commercial and heavy vehicle drivers. Consistent with the region's long-term safety vision, it recognizes that people will always make mistakes and may have road crashes, but roadways should be designed so that those crashes do not result in death or serious injury.

Street design emphasizes separation and survivable speeds and provides transportation options to reduce the need for travel by private vehicle. Separation means creating physical barriers between people moving at different speeds. As speed differentials increase, the level of separation should also increase. Medians, access management treatments, protected bike lanes and other street designs can minimize crashes. Designs that minimize and manage conflict points can reduce crashes and crash severity. Survivable speeds can minimize the impacts of crashes when they do occur. Guidance within this chapter focuses on designs that align with a safe systems approach.



Source: *https://www.roadsafety.gov.au/nrss/safe-system.aspx*

Target Speeds

Designing streets for survivable, safe speeds is a core design principle. Vehicle speeds are related to many aspects of street design, street functions and the systemwide outcomes. A discussion of speed starts with "target speed," which is the maximum desired operating speed for vehicles on the street. On streets where transit access and regular pedestrian and bicycle travel are expected, vehicle speeds should be low. A person walking who is hit by a vehicle going 25 mph has, on average, a 90 percent chance of surviving the crash.[1] At 40 mph, however, that drops to 50 percent. A target speed of 20 to 25 mph is generally appropriate for local streets, as well as regional and community boulevards; 20 to 30 mph is generally appropriate on regional and community streets, though some regional streets may have higher target speeds of up to 40 mph where there is limited access along and across the corridor. Highways and freeways, where people walking and bicycling are not typical, may

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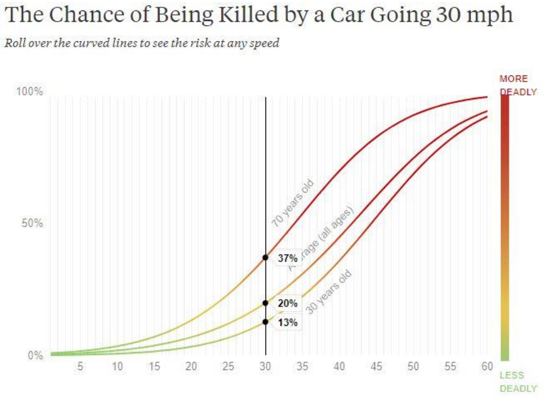
[1] Tefft, B. C. (2013). Impact speed and a pedestrian's risk of severe injury or death. *Accident Analysis & Prevention, Volume 50*(January 2013), pp 871-878.

have higher target speeds to promote motor vehicle and freight mobility – ranging from 35 to 60 mph within greater Portland. Industrial streets vary but may have target speeds between 20 and 40 mph depending on the specific local context.



Source: *https://www.propublica.org/article/unsafe-at-many-speeds*

“Design speed” is a design control often used in roadway design guidance to determine minimum sight distance, curvature and other elements (e.g., deceleration). In the past, guidance has encouraged selection of as high a design speed as is practical. However, to achieve target speeds, the design speed should generally align with the target speed. Ultimately, posted speed should also align. In Oregon, speeds are set by the State through a process that takes into account measured speeds, crash history and other factors.

Achieving a target speed can be influenced by various street design elements. Wider, more “open” roadways promote higher operating speeds. Conversely, a roadside busy with buildings, parked cars, and street trees can provide cues to drivers to reduce speeds. The “traffic calming” element discusses treatments demonstrated to decrease operating speeds.

Photo:

A wider, more “open” roadway

Photo:

A narrower, more constrained roadway

Designing for All Users

Streets should be designed for the people of all ages and abilities and the vehicles that serve daily needs. Prior to developing a street design, practitioners should consider each of the users and how they will navigate the street:

- Pedestrians – Street designs need to support mobility and access for people with a range of needs and physical abilities. The pedestrian realm and street crossings should be designed to serve people using wheelchairs, people with vision or hearing disabilities, slower-moving people and young people. The typical user will influence design elements such as sidewalk width, buffers, crossing treatments and signal timing.

Photo idea:

Someone in a mobility device using an accessible curb ramp or on a sidewalk

- Bicyclists – People riding bicycles vary significantly in their abilities and confidence, as well as the type of bicycle they use. While some bicyclists are confident navigating streets in a mixed traffic environment, most people do not feel comfortable with a lot of vehicle exposure. Streets should be designed to serve bicyclists of all ages and abilities – and in places where this is not possible, parallel routes can serve these bicyclists. Bicycles also come in all shapes and sizes. Bicycles with trailers are often used to haul cargo or carry children, and electric bicycles can often maintain higher speeds. Moreover, new and emerging technologies are supporting development of even more "vehicle" types, such as stand-up e-scooters. Practitioners should anticipate these "vehicle" types using the streets.

Photo idea:
Cargo bike, or
family bike, or
e-scooter

- Transit, Freight and Private Motor Vehicles come in a wide variety of shapes and sizes with varying ability to make wide turns. They serve a variety of essential needs within greater Portland, including deliveries, emergency response, transit, long-haul freight and day-to-day mobility for people. When developing street and intersection designs, practitioners should select a "design vehicle" which is the largest vehicle that is anticipated to use the street, or navigate an intersection, *on a regular basis*. Because selection of a design vehicle influences street dimensions such as turning radii, which can impact safety and operating speeds, practitioners should choose the smallest possible design vehicle. Larger vehicles, can still be accommodated by encroaching on opposing lanes or using multiple point turns. Likewise, special features such as speed cushions or truck aprons can be included to accommodate emergency vehicles and large freight trucks while still maintaining traffic control treatments that reduce speeds for regular traffic.

Personal Security

Ultimately, people must feel safe on and along a street to use it. Designing a street and/or trail that allow for safe through movements, as well as safety along the route, will encourage people of all genders, ages and abilities to move around on the street.

The Safe Systems Approach outlines a framework that works to reduce crashes and allow people traveling by foot, bicycle, transit or personal vehicle to travel safely to their destination. Reducing the risk of crashes is only one safety aspect that needs to be considered. It is also vitally important that pedestrians and bicyclists, the most vulnerable users on our transportation system, feel secure while traveling. This can include design features such as appropriately scaled street lighting, as well as more holistic approaches, including longer sightlines and minimizing pinch points.

Street and Network Connectivity

Diagram:
Diagram illustrating street connectivity

Street networks should be designed with a variety of streets to serve different types of travel and support a variety of land uses. Some streets – throughways – typically serve longer distance trips across the region and may have limited connections. Other streets should be well-connected to provide multiple routes and options between destinations for people traveling in a variety of ways. This allows for better traffic circulation and increased reliability. Walking and biking are easier and more enjoyable in a connected street network with relatively short block lengths (250 to 600 feet), rather than one with disconnected streets. A connected street network also can avert the need for large multi-lane streets and large intersections, which can pose barriers to people walking and biking. Emergency response also benefits from a well-connected street system. Even where less-connected street networks are established, look for opportunities to increase connectivity for pedestrians and bicyclists can be increased with trails, paths, bridges and street crossings.

In some locations environmental factors may impact street connectivity. Stream crossings for local streets will likely have greater spacing (800 to 1,200 feet) based on overall topography along these streams. Where streets do cross streams, the crossings should be designed to mitigate impacts to stream quality. In some places, topography creates challenges to developing a street grid: steep slopes may limit street connectivity. Outside of centers, street networks should be designed around, rather than through, environmentally sensitive lands. Street networks should allow for preservation of continuous natural areas and parks. In some places, a soft surface foot path or paved trail may be appropriate to allow people to walk or bicycle. Metro's *Green Trails* provides more guidance for these situations.

Flexible Approach to Geometric Design

Applying flexibility in geometric street design allows practitioners to optimize the street functions while avoiding excess costs. In past decades, the transportation industry sought to standardize dimensions and designs through publication of national guidelines, standards and requirements. However, in recent decades, industry leaders are encouraging a more flexible approach to design and encouraging practitioners to respond to the unique contexts, needs and constraints of the areas where they work. Recent resources highlight the inherent flexibility in existing design guidance and this guidance is continually evolving. The resource section at the end of Chapter 4 includes publications that provide guidance on design flexibility. In taking a flexible design approach, practitioners should use professional judgment and draw on a variety of resources to develop context-sensitive designs. In the development of designs, practitioners should document the reasoning behind their design decisions to support continued evolution of best practices and align with tort liability practices to defend decisions and designs.

Protecting our Environment

The greater Portland region has an abundance of lush environmental landscapes. Incorporating and protecting the natural environment must be a priority when designing a livable place. Protecting and enhancing the natural environment creates more pleasant places for people to live, work and play, while also providing numerous health benefits. Trees provide protection from sun and rain while reducing the impacts of urban heat islands and stormwater runoff. Natural areas help reduce pollution and sequester carbon dioxide to limit the impacts of climate change. Designs that reduce motor vehicle travel will also reduce light pollution from headlights and tall streetlights. Preserving habitat will limit disruptions for other species that also call our region home. Our natural environment should be celebrated and woven into the fabric of our communities through today's designs.

Designing streets to encourage modes other than motor vehicle travel will help the greater Portland region be a national leader in addressing climate change. Building a transportation system that prioritizes walking, biking and transit use will provide opportunities to preserve and restore natural areas while reducing carbon emissions.

Design for the Future We Want

Photo idea:

Street fair or block party

Transportation is in a period of rapid technological change and innovation. As we design our streets, we must ensure that these designs move us toward the regional systemwide outcomes. Achieving this means designing streets to create more places where people want to be. It means designing to encourage walking, bicycling, transit, other forms of shared mobility, and other emerging travel modes that align with our systemwide outcomes. It means allocating street space to the functions that matter most, not necessarily to the newest technology. It is impossible to predict with certainty the benefits and impacts of a specific technology – so our street designs should also support the flexible piloting of innovations. With this approach, measuring and evaluating effects can ensure that our street designs support our systemwide outcomes and provide access and benefits for all. Ultimately, when we design streets to serve our future, it should be the future we want – not simply a response to external factors and trends.

DESIGN ELEMENTS

Design elements are the building blocks that make up our streets and trails. In this section, design elements for streets are addressed first, and then for trails. Design elements that are applicable to both streets and trails, such as lighting, are addressed at the end. Street design elements are organized by the street realms described below. Each design element includes a description, illustrative photos and/or diagrams and the preferred design approach based on best practices that support achieving systemwide outcomes. Other design resources providing more detail are listed after each design element. Where applicable, some guidance on applying the design element to the regional design classifications is also provided.

The guidelines are intended to assist in the design of new and reconstructed streets and trails. Although they are not necessarily intended to be applied to maintenance projects that preserve and extend the service life of existing streets and structures, they can be used to complement projects when minor retrofits are needed.

Street Realms

3D Half-Block Diagram Rendering:
Figure that shows street view with each of the different realms highlighted and labeled.

The street realm is the overall setting in which people experience the character and use of a street. It is composed of the center travelway, flex zone, pedestrian and adjacent land use realms. Streets typically have several realms, and these realms tend to serve different functions. In our complex and evolving urban areas, however, the lines between these realms are increasingly blurred. In regional streets, these realms together support movement and access for all travel modes, provide public community spaces and support activities in the land uses. On-street connections for trails, or paths that are within the street right of way are included in the street realm, but otherwise trails are within their own corridor.

The **adjacent land use realm** is typically outside the public right of way, but includes elements that directly interact with street uses and form the character of the place. In centers and along some corridors, the land use realm often includes buildings immediately fronting the sidewalk. It may also include plazas, parks, parking, landscaping, industrial uses or natural areas. The land use realm is pivotal in creating a sense of place – and it is closely tied to the pedestrian realm.

The **pedestrian realm** includes the area immediately adjacent to the land use realm and typically includes a sidewalk, though alternate designs may include a pedestrian realm at the same grade as other parts of the street. The pedestrian realm, described further within the elements, provides space for pedestrian movement and access, but also supports a variety of other functions. It often includes street furniture, street trees and places for people to connect.

The **flex zone** is the space between the pedestrian realm and the center travelway. The flex zone has emerged as a versatile space, in high demand by a variety of functions. It is used for parking – of cars, bicycles, e-scooters and more – and a variety of other potential uses. These include loading/unloading, pick-up and drop-off of passengers, transit boarding curb extensions or islands, street seating or parklets, space for separated bicycle facilities and green streets stormwater treatments.

The **center travelway** is the space in the middle of the street where people travel. Typically, the center travelway supports primarily vehicle travel, including freight and transit. Bicycle travel may be served in the center travelway or in the flex zone. The center travelway is often divided by a median and/or turn lanes, which can provide a space for street trees or green streets treatments and increases safety. In general, narrower center travelways (four lanes with a median or less) are best for supporting mobility functions without negatively impacting other functions of the street (such as pedestrian access).

As context-sensitive street design has emerged, and agencies are increasingly using an appropriate design approach to respond to community needs, the lines between the realms have been blurred. Different street functions may be served in one realm on one street, and another on a different street – depending on the street design. For example, on low-traffic low-speed streets, bicyclists may use the center travelway. However, on streets with a high traffic, street design may incorporate a separated bicycle lane between on-street parking and the sidewalk – in the flex zone. Therefore, the organization of the design element guidance reflects flexibility, and is presented as follows:

First, it includes a discussion of best practices specifically related to each realm: the **Pedestrian Realm**, including overall design, street corners, and street trees; the **Flex Zone**, including overall design and approach to buffers, shy distance, shoulders; and the **Center Travelway**, including motor vehicle lanes, medians, access management, and traffic calming.

Next, it covers guidance related to key street functions that frequently span two or more realms: **Green Streets and Stormwater**, **Bikeways** and **Transit**.

The guidance then covers **Intersections and Crossings**, including signalized and unsignalized intersections, roundabouts and midblock crossings; and **Regional Trails**, including both multi-use paths and on-street regional trail connections.

The final section includes **Systemwide Design Elements** that apply broadly across the transportation system and beyond, including street and trail surfaces, lighting, wayfinding and place-making amenities.

In developing designs, consider all street realms and cross-sectional design elements concurrently, since each realm can support a variety of different functions. Design the street as an integrated whole, considering the inter-relationships among various street users and the adjoining land uses. Depending on the current street use and desired functions, it could be beneficial to reallocate space from one realm to another.

Land Use Realm

The land use realm encompasses the property that faces a street, including land use types and building facades. It also includes the frontage zone from the pedestrian realm, which is a location where pedestrians and adjacent land uses interact on the sidewalk.

The site planning and building design of the adjacent land use can contribute to supporting walking and transit as a competitive choice over the motor vehicle. Future land use development should be viewed as an opportunity to redirect private investment to support a multimodal transportation network. The front entrance of a building should be oriented to the street; this is fundamental to increasing access and mobility for walking, biking and transit. In addition, it facilitates pedestrian access and supports pedestrian activity along the street.

Photo snapshot #1

Street fair or block party

Photo snapshot #2

Street fair or block party

Photo snapshot #3

Street fair or block party

Photo snapshot #4

Street fair or block party

Design Element Sketch

Pedestrian Realm

The pedestrian realm has three zones: the frontage zone, the pedestrian through zone and the street furniture zone.

The frontage zone is immediately adjacent to buildings or other fronting land uses. This zone serves as a business' front door to the community. Overhangs, signs, and restaurant seating are common features in this zone.

The pedestrian through zone is a clear space for people moving along the sidewalk. It must be accessible and comfortable for all users, with sufficient space for the anticipated level of walking activity. A wider pedestrian through zone is needed in high-traffic areas such as downtowns.

The street furniture zone is an area of buffer space between the pedestrian through zone and the street. It often has street trees, seating, transit stops, bikeshare stations, utilities and lighting, among other things. These uses all compliment the sidewalk, but they are distinct in their use and purpose.

The three zones serve unique roles and together can create an inviting pedestrian environment. The overall width and design features of the pedestrian realm are determined primarily by the level of pedestrian and commercial activity and land use context. Table 1 provides guidance on the range of widths and predominant design features depending on the design classification. Typically wider pedestrian realms are desired in areas with higher levels of existing or planned pedestrian and commercial activity, ranging from 10 to 20 feet or more.

Photo snapshot
A sidewalk with street trees and plentiful restaurant seating – all being used. Streets like Division or Alberta come to mind. *Do we have something more specific?*

Caption: The pedestrian realm, which typically includes a sidewalk, offers space for walking, lingering and connecting – connecting to nature, to other people, to businesses and to community spaces.

DESIGN APPROACH

FRONTAGE ZONE

- **Including an ample frontage zone** can allow businesses to connect to passersby through sidewalk seating or outdoor displays. Frontage treatments and widths vary from commercial (arcades, storefronts, etc.) to residential (raised terraces, porches) land uses, as well as street width and traffic volumes. In some locations, space for an ample frontage zone may not exist because the sidewalk is not wide enough or is in a residential neighborhood. In these cases, the frontage zone simply consists of at least 18 inches of shy distance from walls or vertical vegetation.
- **Vegetation and street trees adjacent to the sidewalk** enhance the pedestrian realm, and are especially desirable in locations where buildings do not front the sidewalk.

PEDESTRIAN THROUGH ZONE

Photo snapshot

- **An unobstructed, smooth pedestrian through zone** of at least 10 feet is necessary on regional streets with high number of vehicles or pedestrians. On calmer streets (lower volumes), 6 feet is desirable[2].
- An ample pedestrian through zone helps create places where people of all abilities can enjoy traveling and can do so together. Two people walking side by side need 6 feet of space, and 9 feet allows them to pass by someone approaching in the opposite direction. Two people using wheelchairs can comfortably pass side-by-side with 8 feet of space.

STREET FURNITURE ZONE

Photo snapshot

This zone is vital for creating a buffer from motor vehicle traffic or higher speed bicycle facilities to provide real and perceived safety benefits to pedestrians. The street furniture zone can serve a wide variety of uses within the same street, or even the same block, including bicycle parking, green streets treatments, street trees, utilities, lighting and public art. The uses should generally be aligned and organized within the street furniture zone.

- **A buffer of at least 5 feet** is desirable on higher speed or higher vehicle traffic streets, typically streets with speeds over 30 mph.
- **Make sure there are places for passengers** exiting vehicles if there is on-street parking adjacent to the street furniture zone. People generally need about 3 feet of buffer width space to open the car door and step out.

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[2] To meet ADA standards, a minimum of 5 feet wheelchair passing space at intervals of no more than 200 feet is required.

Table 1

Regional Design Classifications	Pedestrian Realm									
	Frontage Zone			Pedestrian Thru Zone (choose 1)			Street Furniture Zone (choose 1)			Pedestrian-scale lighting
	Awnings on buildings / storefront windows (18' minimum)	Sidewalk cafes (2' minimum)	Landscaping (variable width)	5-6' unobstructed	6-8' unobstructed	>8' unobstructed	Minimal buffer (2')	Landscape/ stormwater buffer (4'-8')	Street Furniture / bike parking (4'-8')	
Freeways	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Highways	🔴	🔴	🔴	🟡	🟡	🔴	🔴	🟡	🔴	🔴
Regional Boulevard	🟢	🟡	🔴	🔴	🟡	🟢	🔴	🟢	🟢	🟢
Community Boulevard	🟢	🟢	🔴	🔴	🟡	🟢	🔴	🟢	🟢	🟢
Regional Street	🟡	🟡	🟡	🟡	🟢	🟡	🔴	🟢	🟡	🟡
Community Street	🟡	🟡	🟡	🟡	🟢	🟡	🔴	🟢	🟡	🟡
Industrial Street	🔴	🔴	🟡	🟢	🟡	🟡	🟡	🟢	🔴	🔴

🟢 Preferred design treatment

🟡 Potential design treatment

🔴 Not a typical design treatment

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
    - *Urban Street Design Guide* Sidewalks

    - *Transit Street Design Guide* Accessible Paths & Slopes
- Pedestrian and Bicycle Information Center
    - *Streetscape* Street Furniture
- SFBetterStreets
    - *Design Guidelines* Sidewalk Zones

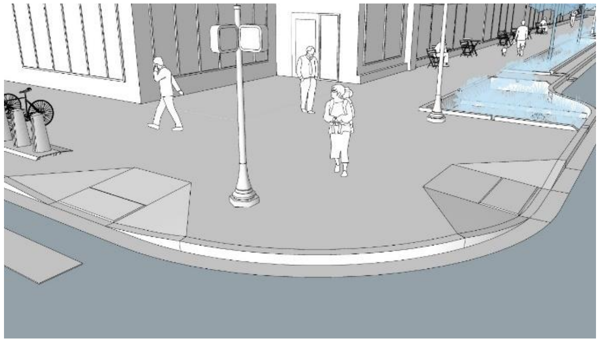
Street Corners

Every intersection in the transportation system creates street corners – the space where sidewalks come together. Pedestrians leave the sidewalk to cross the street at street corners, and vehicles and trucks make turns around them. Transit stops are often located at or near them. Street corners, in conjunction with adjacent land uses, can also serve as a place for entertainment, gathering, speaking or other activities, and serving a place-making function. Table 2 provides guidance on the design of street corners.

Photo snapshot #2

A photo of a street corner with pedestrians, businesses, and at least one design feature (such as a curb extension). Truck apron paired with bollards (bullet #3)

Caption: Curb extensions ensure that people crossing the street are visible to people driving. Curb extensions also provide space for benches, pedestrian scale lighting, newspaper boxes and planters. The perpendicular pedestrian curb ramps or curb cuts make it easier for people using mobility devices to cross. The tight corner is appropriate for this downtown setting and keeps turning movements of motor vehicles slow.



DESIGN APPROACH

- Corner radii and the configuration of medians should be designed to shorten pedestrian crossing width. Minimizing corner radii creates compact intersections with slow turning speeds and increases safety**.** Avoid design of channelized right-turn islands (pork chops) especially uncontrolled right-turns, as these decrease pedestrian safety.
- **Curb extensions** not only enhance safety, they support vibrant communities by providing valuable space for stormwater planters, art elements, benches, street lighting, way-finding and other place-making activities.
- In industrial areas and on industrial streets, wider curb radii support freight movement. On major freight routes that are also regional boulevards and streets, truck aprons paired with bollards can be used to allow for wide truck turns while maintaining livability and safety.
- Street corners must be designed in alignment with Americans with Disabilities Act (ADA) guidance to

ensure that people of all abilities can safely navigate crossings at intersections. Perpendicular curb cuts are the preferred design.

- Transit stops and pullouts at street corners are preferred to be located at the far side of an intersection. This way, it is possible for a pedestrian to cross the street behind the bus and be visible to oncoming traffic.

Table 2

Regional Design Classifications	Street Corners						
	Tight corner radii (5-15')	Wide corner radii (>15')	Perpendicular curb cuts (two)	Bulb-outs	Flow-through planter	Truck apron	Transit stop/ pullout
Freeways	-	-	-	-	-	-	-
Highways	🔴	🟢	🟢	🔴	🟡	🟡	🟡
Regional Boulevard	🟢	🔴	🟢	🟢	🟡	🟢	🟡
Community Boulevard	🟢	🔴	🟢	🟢	🟡	🟢	🟡
Regional Street	🟡	🔴	🟢	🟡	🟡	🟢	🟡
Community Street	🟡	🔴	🟢	🟡	🟡	🟢	🟡
Industrial Street	🔴	🟢	🟢	🔴	🟡	🟡	🟡

🟢	Preferred design treatment
🟡	Potential design treatment
🔴	Not a typical design treatment

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
  - *Urban Street Design Guide* Intersection Design Elements: Corner Radii
  - *Urban Street Stormwater Guide* Stormwater Elements: Stormwater Curb Extension

- Federal Highway Administration (FHWA)
    - *Signalized Intersections: An Informational Guide* Chapter 4: Geometric Design
    - *PEDSAFE Pedestrian Safety Guide and Countermeasure Selection System*: Curb Radius Reduction
    - *BIKESAFE Bicycle Safety Guide and Countermeasure Selection System:* Curb Radius Reduction
- Institute of Transportation Engineers (ITE) Unsignalized Intersection Improvement Guide
- United States Access Board *Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way*

Flex Zone

The flex zone is the area adjacent to the sidewalk curb, often a place for on-street parking, but can serve a wide range of other functions. Table 3 provides guidance on the use of the flex zone.

Photo snapshot #1
Freight loading zone

Photo snapshot #3
Bicycle Parking

Photo snapshot #4
Pick-up/Drop-off
OR
Outdoor seating

Caption: The flex zone can serve a variety of functions simultaneously. Mixing flex zone uses, or simply providing a separate or additional curbside use beyond on-street parking, can further support desired outcomes.

DESIGN APPROACH

- **Support the priority functions of the street**, based on the design classifications and land use context, as shown in Table 3. Flex zone uses should contribute to system wide outcomes such as safety, transportation options and vibrant communities.
- **Use a data-driven, flexible approach to allocating space**. Start with an inventory and data collection on the current use of the flex zone and determine if any uses can be served on adjacent streets or even private property.
- **Manage and price use** of the curb when the flex zone is in high demand locations. Flex zone uses can shift depending on the time of day, and street design can be flexible enough to allow a variety of uses for this limited space. Freight deliveries, for example, will rarely conflict with a restaurant’s peak demand period, so a flex zone can support both uses.

Table 3

	Flex Zone Uses											
Regional Design Classifications	Car Parking	Bike Parking	Other parking (scooter, motorcycle)	Loading/ unloading	Pickup / dropoff	Parklets and sidewalk cafes	Transit or Business Access/ Transit Lanes	Transit stops / amenities	Separated bike facilities	Wider Sidewalk	Green streets treatments	Shoulder
Freeways	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🟡	🟢
Highways	🔴	🔴	🔴	🔴	🔴	🔴	🟡	🔴	🟡	🔴	🟡	🟢
Regional Boulevard	🟡	🟢	🟡	🟡	🟡	🟡	🟢	🟢	🟡	🟢	🟡	🔴
Community Boulevard	🟢	🟢	🟢	🟡	🟡	🟡	🟢	🟢	🟡	🟢	🟢	🔴
Regional Street	🟡	🟡	🟡	🟡	🟡	🔴	🟢	🟢	🟡	🟡	🟢	🟡
Community Street	🟡	🟡	🟡	🟡	🟡	🔴	🟢	🟢	🟡	🟡	🟢	🟡
Industrial Street	🟡	🔴	🔴	🟡	🔴	🔴	🟢	🟢	🟢	🟡	🟡	🟡

🟢 Preferred use
🟡 Potential use
🔴 Not a typical use

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
  - *Blueprint for Autonomous Urbanism* Curbside Management
  - Curb Appeal: Curbside Management Strategies for Improving Transit Reliability
- Seattle Department of Transportation (SDOT)
  - Flex Zone/Curb Use Priorities in Seattle
- SF Park
  - Putting Theory Into Practice
- District Department of Transportation (DDOT)
  - *ParkDC* Innovative Curbside Management

- International Transport Forum
    - The Shared-Use City: Managing the Curb
- Institute of Transportation Engineers (ITE)
    - *Curbside Management Resources* Curbside Management Practitioners Guide

Buffer/Shy Distance

Shy distance should be used to create separation between uses and is very important when speed differentials are present. The shy distance needs to be considered within all street realms and on trails. In some cases, this buffer space is simply a horizontal space, but in other cases, a buffer can include a vertical element to further separate uses physically. If a building or other tall vertical object (such as a fence or vegetation) is immediately adjacent to a space for travel, users cannot use the space immediately adjacent to the vertical object. A buffer between walking and bicycling facilities provides safety and comfort for pedestrians. Buffers between bicyclists and motor vehicles are important for providing comfort to most bicyclists. Finally, shy distance between motor vehicle travel lanes and curbs may be necessary, depending on the lane widths, vehicle types and operating speeds. Shoulders on highways and freeways can enhance motor vehicle safety and provide important space for people addressing a vehicle breakdown, for example. However, shoulders and excessive shy distance on urban streets is unnecessary and can encourage increased vehicle speeds.

In developing the street section, consider holistically how the various street users are organized and what types of buffers can best mitigate conflicts and impacts.

Photo snapshot #1

A commercial street in the region: Main St in Tigard, Cully Boulevard in NE Portland with raised bike lanes, Main St in Oregon City

Photo snapshot #2

Caption: Buffer space between street users and other elements can enhance safety and comfort for all users. Benches and transit stops, street trees, parking lanes and bollards: There are many ways to create shy distance between vehicles and pedestrians or bicyclists.

DESIGN APPROACH

- **Provide a buffer between** the pedestrian through zone (walking area of the sidewalk) should have 4 feet of buffer space (minimum 2-foot buffer) where motor vehicles operate, with a greater buffer preferred, particularly in places with higher motor vehicle speeds and volumes. Pedestrians also require at least 18 inches of shy distance from building or other tall vertical objects.
- **Provide buffers separating pedestrians from bicycle traffic**, but also to separate bicyclists from motor vehicle traffic and parked car doors. A buffer of 2-3 feet between bicycle facilities and parked cars is important to avoiding bicyclists getting hit by someone opening their car door especially in areas with high parking turnover.
- Pedestrians and bicyclists need at least 6 inches of shy distance from a curb. Including 1-foot shy distance from a curb for motor vehicles is appropriate, when paired with the narrowest lanes

appropriate for the context. Zero feet of shy distance is an option in space-constrained environments, but wider sidewalks would be preferred to allow pedestrians to create shy distance by walking further from the travel lane.

- Buffer space between motor vehicles and other users should be designed to encourage lower motor vehicle speeds. On an existing street with 11- or 12-foot travel lanes and standard bicycle lanes, a simple restriping project can introduce a painted buffer between the bicycle lane and the travel lanes by slightly narrowing the lanes. A wide striped buffer adjacent to relatively wide travel lanes may have the opposite effect, increasing vehicle speeds or inviting drivers to use the buffer to pull over or decelerate.
- Buffers with significant vertical elements (such as vegetation or parked cars) can also help mitigate effects of motor vehicle noise and emissions. On highways or freeways with pedestrian or bicycle facilities, including parallel multi-use paths within the right of way, the buffer should include significant vertical separation to protect from noise, emissions and high-speed vehicle traffic.

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
    - *Urban Bikeway Design Guide* Bike Lanes
- Federal Highway Administration
    - *Course on Bicycle and Pedestrian Transportation* Walkways, Sidewalks, and Public Spaces
- Oregon Department of Transportation (ODOT)
    - Bicycle & Pedestrian Design Guide
    - *Highway Design Manual* Chapter 13 Pedestrian and Bicycle
- Safe Routes to School Guide
    - Sidewalks
- Victoria Transportation Policy Institute
- TDM Encyclopedia

Travelway

3D Half-Block Diagram Rendering:
Figure that shows street view with each of the different realms highlighted and labeled.

Motor Vehicle Travel Lanes

Motor vehicle travel lanes must function for a wide array of vehicles, from buses and trucks to personal automobiles and bicycles (in places where no bicycle lane exists). The number of lanes, and their widths, has a broad impact not just on motorists using the street but on everyone in the community, since they often make up a significant portion of the overall street width and public right of way. The design and widths of travel lanes impact capacity for various vehicle types and modes of travel, motor vehicle speeds, safety for all users and exposure of pedestrians and bicyclists to traffic, and the opportunity for uses besides motor vehicle travel within the right-of-way. On most streets, lane widths of 10 feet provide adequate capacity and can improve safety for all users. All else equal, narrower travel lanes reduce crossing distance for bicyclists and pedestrians and create more space for other functions or safety features. In designing the lane configurations and widths, practitioners should consider the full context of the street, the priority functions and the potential opportunity cost of providing additional or wider travel lanes. In some cases, travel lanes can be designated specifically for transit use to enhance transit mobility. Table 4 provides guidance on the design of motor vehicle travel lanes.

Design Element Sketch

Photo snapshot
A multimodal roadway: downtown Beaverton, Division St, Grand/MLK with bus and streetcar

Caption: From the region's busiest streets to local and collector roadways, motor vehicle travel lane design determines how everyone will use and travel through the right-of-way.

DESIGN APPROACH

- **Consider all cross-section design elements concurrently** when determining number and width of motor vehicle travel lanes.
- **Default to the lower motor vehicle lane widths** and increase widths depending on conditions. This best practice is supported by research that shows that narrower lanes on urban streets lead to slower vehicle speeds and improved safety. Elements adjacent to the travel lane can impact an appropriate lane width.

    - For lanes where regular transit and heavy vehicles are not anticipated, 10-foot lanes are appropriate (narrower lanes may be appropriate for low speeds or volumes).
    - Turn lanes on urban streets, including two-way left-turn lanes, can also be narrowed to 9 or 10 feet.
    - On streets with regular transit vehicles or regular freight traffic, ensure a minimum of a 1-foot shy distance between the lane and vertical objects such as parked cars, or use an 11-foot outer lane. Transit buses in the region are typically 10.5 feet wide, including rear-view mirrors. However, buses have been operating throughout greater Portland in 10-foot travel lanes.
    - On industrial streets, use 11-foot lanes to serve primarily industrial uses.
    - On highways, industrial streets or regional streets between centers with higher target speeds (40 mph), 11- or 12-foot lanes may be appropriate.
- **Design vehicle** - choose the largest vehicle anticipated for daily, regular use of the street and design turn lanes to accommodate. An occasional larger vehicle can be accommodated by using opposing lanes or multiple point turns.
- **Design elements for other modes should not be "squeezed" or eliminated to accommodate turn lanes.** Carefully weigh the benefits and impacts of turn lanes within the context and the priority functions. Turn lanes separate through and turning vehicle movements, which increases motor vehicle capacity at intersections. In some contexts, turn lanes provide motor vehicle safety benefits. However, turn lanes increase pedestrian crossing distance and exposure. Introducing right turn lanes can create weaving conflicts between right-turning vehicles and through bicyclists, though this conflict can be addressed through separated bicycle lanes and intersection design.
- **Lane reallocation**, which shifts street space from motor vehicles to other travel modes, should be considered when safety, transit, bicycle, or pedestrian improvements are a high priority. Streets with two or more through lanes per direction may be able to reallocate space to exclusive transit lanes, separated bicycle lanes, or expanded pedestrian space, while still maintaining their motor vehicle mobility function, with improved safety performance.
- **Design streets to ensure and protect priority functions,** such as walking, that are less likely to change as future technology and innovation changes the types of vehicles people use to move around.

Table 4

Regional Design Classifications	Motor Vehicle Travel Lanes							
	<10 foot lanes	10 foot lanes	11 foot lanes	12 foot lanes	>12 foot lanes	Two-way left-turn lanes	Turn lanes at intersections	Transit or Business Access/Transit Lanes
Freeways	🔴	🔴	🔴	🟢	🟡	🔴	🔴	🟢
Highways	🔴	🔴	🟡	🟢	🟡	🟡	🟢	🟢
Regional Boulevard	🔴	🟢	🟢	🟡	🔴	🟡	🔴	🟢
Community Boulevard	🟡	🟢	🟢	🟡	🔴	🟡	🔴	🟡
Regional Street	🔴	🟢	🟢	🟡	🔴	🟡	🟡	🟢
Community Street	🟡	🟢	🟢	🟡	🔴	🟡	🟡	🟡
Industrial Street	🔴	🔴	🟢	🟢	🟡	🟢	🟡	🟡
	🟢	Preferred condition						
	🟡	Typical condition						
	🔴	Not a typical/preferred condition						

DESIGN RESOURCES

- National Association of City Transportation Officials
  - *Urban Street Design Guide* Streets, Street Design Elements
- Transportation Research Board (TRB)
  - *HCM 2010* Highway Capacity Manual
  - *NCHRP Research Report 855* An Expanded Functional Classification System for Highways and Streets

  - *NCHRP Research Report 880* Design Guide for Low-Speed Multimodal Roadways
  - Relationship of Lane Width to Safety for Urban and Suburban Arterials
- Federal Highway Administration (FHWA)
  - Achieving Multimodal Networks: Applying Design Flexibility & Reducing Conflicts
- Institute of Transportation Engineers (ITE)
  - Designing Walkable Urban Thoroughfares: A Context Sensitive Approach
  - *ITE Journal: September 2018* Optimizing Lane Widths: A Data Driven and Performance-Based Approach
- Canadian Institute of Transportation Engineers (CITE)
  - Narrower Lanes, Safer Streets
- American Association of State Highway Transportation Officials (AASHTO)
  - A Policy on Geometric Design of Highways and Streets (The Green Book), 7th edition

Traffic Calming

Traffic calming includes a variety of street design details and other strategies that promote lower vehicle speeds, in alignment with which should generally be between 20 and 30 MPH on urban streets. Selecting and achieving a relatively low motor vehicle target speed particularly in centers, helps ensure a safer and more welcoming environment for a variety of other functions our streets serve. Pedestrians and bicyclists are more comfortable and safer when traveling and street life can thrive. Additionally, slower speeds do not necessarily lead to congestion, nor do they lead to significant travel time increases in urban areas, where intersection delay accounts for a higher portion of total travel time. Traffic calming is appropriate on any type of street, from a local residential street to a major urban arterial. The applicable traffic calming strategies, however, vary based on the street type and context. Table 5 provides guidance on when specific traffic calming features should be applied.

Photo snapshot
Arterial roadway with traffic calming major arterial with raised median, pedestrian crossing

Caption: Traffic calming measures can create streets that are suitable and pleasant for everyone. Slower vehicle traffic and street trees provide a more pleasant pedestrian experience, which helps foster local business and neighborhood connections. Lower speeds can encourage more people to bike or use the street as a public space.

DESIGN APPROACH

On most regional streets, design elements that prompt drivers to slow down are most appropriate.

- **Visually narrowed streets** – through inclusion of on-street parking, street trees, street furniture or buildings immediately fronting the sidewalk – can signal a lower speed environment.
- **Managing speeds** by narrowing travel lanes, travel lane reduction, curb extensions and raised medians.
- **Textured or different colored pavement** may be appropriate in centers, particularly as a gateway treatment.
- **Roundabouts** are another effective traffic calming measure, as they require all vehicles to yield before entering, and effectively slow speeds to 15-20 mph. Roundabouts also reduce conflict points and have demonstrated improved safety performance over other intersection types.
- **Signal timing** can be set to progress traffic at slower speeds.
- **Speed bumps or speed cushions** (with wheel cutouts for emergency vehicles), speed tables, and raised crosswalks or raised intersections are typically applied on local and collector streets with lower speeds
- **Traffic diverters** are typically applied only on local streets.

Table 5

Regional Design Classifications	Traffic Calming													
	Median Island	Curb Extensions	Speed Feedback Signs	Narrow Lanes	Roundabout	Lane Reallocation / Road Diet	On-Street Parking	Street Trees and Street furniture	Signal Timing	Pavement treatment / texture	Raised intersection	Traffic diverters*	Traffic Circles*	Speed Hump or Bump*
Freeways	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Highways	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Regional Boulevard	🟢	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🔴	🔴	🔴
Community Boulevard	🟡	🟢	🟡	🟢	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴
Regional Street	🟢	🟡	🟡	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🟡	🔴	🔴	🔴
Community Street	🟡	🟡	🟡	🟡	🟢	🟡	🟢	🟢	🟡	🟢	🟢	🔴	🔴	🔴
Industrial Street	🔴	🟡	🟡	🔴	🔴	🟡	🔴	🟡	🟡	🟡	🟡	🔴	🔴	🔴

🟢	Preferred design treatment
🟡	Potential design treatment
🔴	Not a typical design treatment

*While these treatments are not appropriate on regionally classified streets, they can be very useful for traffic calming on local, residential streets.

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
  - *Urban Street Design Guide* Street Design Principles, Speed Reduction Mechanisms
  - *Urban Bikeway Design Guide* Speed Management
- Federal Highway Administration (FHWA)
  - *Traffic Calming E-Primer* Module 3: Toolbox of Individual Traffic Calming Measures
  - *Techbrief* Traffic Calming on Main Roads Through Rural Communities
  - *Safety Program* Speed Management Toolkit
  - *Course on Bicycle and Pedestrian Transportation* Traffic Calming
- National Collaborating Centre for Healthy Public Policy
  - *Traffic-calming Measures* Glossary

Access Management and Driveways

Access management refers to policies and designs that impact the level of motor vehicle access to adjacent land uses and can create a safer and more comfortable transportation network for all users.

In Chapter 3, access and mobility are described as two separate functions, and for motor vehicles, they are fundamentally different. When motor vehicle access is high, there are frequent intersections and each land use parcel may have one or more driveways, where all turning movements are allowed. It takes longer for motor vehicles to travel through these areas, since these streets have a lot of vehicles turning on and off the street. Where access is limited, as on a freeway, vehicles can travel at higher speeds and therefore have greater mobility. Access management is the practice of organizing and managing vehicle movements to balance motor vehicle access and mobility as appropriate for the context. Managing vehicle access and turning movements can also improve safety and operations for other street users. Cars turning in and out of driveways impact people walking and biking, since cars must also cross sidewalks and bicycle facilities.

Access management practices include a range of tools – from land use code (which can require shared access between parcels) to physical restrictions on turning movements to signalization strategies. Access management strategies should be developed and applied on all streets, based on the street context and priority functions. Table 6 provides guidance on access management design treatments.

Photo snapshot

A car pulling out of a driveway across a sidewalk and a bike lane, preferably with a good sightline. Maybe a street with a median. SW Harrison with the streetcar line comes to mind.

Photo snapshot #2

A before and after photo?

Caption: Proper access management is about ensuring that all transportation modes can safely navigate through a street.

DESIGN APPROACH

- On regional streets, limit access to properties while providing good street connectivity with street connections every.
    - ○ **Raised medians should be used to manage safe access on urban streets with four or more through lanes.** Raised medians limit individual parcels to right-in/right-out turning movements and remove conflicts associated with left turns. In some cases, a median opening can allow for left turning movements into driveways. (See

    "Median" element for more information).
  - **Consolidation or relocations of accesses to side streets** can occur over time as properties redevelop. Make sure local code and access management standards are clear.
  - Other treatments, such as a channelized island ("pork chop") can also restrict left turn movements in and out of individual driveways.
- **Consider and design access management strategies in tandem with designs for pedestrian and bicycle movement.**
  - Two-way left-turn lanes provide improved access opportunities for motor vehicles, but do not offer protection from turning vehicles for pedestrians and bicyclists traveling along the street. These turn lanes, if continuous, create wide streets without providing a pedestrian refuge. Where there are two-way left-turns provide raised median refuge islands to increase safety.
  - Dual right turn lanes should be avoided in places where pedestrian and bicycle movement and access are priorities. If they are used, employ signal timing to separate the pedestrian and bicycle crossing phase from the right turning movement. Most people do not feel comfortable crossing two lanes of right turning traffic to continue straight on a bicycle.
  - In designing right turn lanes at intersections and at driveways, seek to minimize the level of stress for bicyclists traveling straight. Limit the length of right turn lanes and ensure vehicles need to slow (and yield to bicycles, if applicable) to enter them.
- **Design driveways to minimize conflicts with pedestrians and bicyclists traveling along the street.**
  - Use the narrowest driveway width possible to serve the land use. Use apron-type driveways with continuous grade sidewalk except at high-volume driveways, where street-type intersections may be used. For wide driveways, a channelizing island can serve as a refuge for pedestrians crossing.
  - Use tight corner radii, especially in centers, with truck aprons if needed to accommodate larger vehicles.
  - If the street includes a separated bicycle facility, include the appropriate green striping across moderate-to-high volume driveways to signal a conflict zone to bicyclists and drivers. Ensure adequate sight lines for both bicyclists and drivers approaching the driveway.
  - Avoid "negative offset" of driveways on opposite sides of a street, in which vehicles turning left into the driveways come into conflict with one another in the two-way left-turn lane or manage this with a raised median.
- **Roundabouts provide fewer conflict points and less delay for all travel modes**, and they also provide easier U-turn opportunities for vehicles traveling on streets with medians or other left-turn restrictions.

Table 6

Regional Design Classifications	Access Management / Driveways							
	Medians	Restricted Left-Turn Movements	Two-Way Left-Turn Lane	Left Turn Lanes	Right Turn Lanes	Reducing Access Points	Roundabout	Frontage Road
Freeways	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🟢
Highways	🟢	🟢	🔴	🟢	🟢	🟢	🔴	🟡
Regional Boulevard	🟢	🟢	🟡	🟢	🟡	🟢	🟡	🔴
Community Boulevard	🟢	🟢	🟡	🟢	🔴	🟢	🟢	🔴
Regional Street	🟡	🟢	🟡	🟢	🟡	🟢	🟡	🔴
Community Street	🟡	🟢	🟡	🟢	🔴	🟢	🟢	🔴
Industrial Street	🟡	🔴	🟢	🟡	🟡	🔴	🔴	🟡

🟢 Preferred design treatment

🟡 Potential design treatment

🔴 Not a typical design treatment

DESIGN RESOURCES

- National Cooperative Highway Research Program (NCHRP)
  - *Project 03-120* Assessing Interactions Between Access Management Treatments and Multimodal Users
- Federal Highway Administration (FHWA)
  - *Access Management* Access Management Program Plan
- Oregon Department of Transportation
  - *Analysis Procedures Manual* Version 2

Medians

Medians serve a variety of functions on a street and can enhance street safety and livability.

Medians may be landscaped, raised concrete or simply painted. Landscaped medians can include green streets treatments while also serving an access management function. Medians can be space for lighting, street trees and traffic control devices while also providing space for vehicle turn lanes at intersections and accesses. Medians provide pedestrian and bicycle refuge islands at intersections and midblock crossings. In short, median design ranges significantly based on the context and desired functions of a particular street. Continuous two-way left-turn lanes may be used in residential areas and commercial areas with frequent driveways and intersections and where motor vehicle speeds are moderate. Two-way left-turn lanes remove left-turning vehicles from through travel lanes, reducing conflict and delay for through vehicles.

Landscaped medians restrict turning movements and reduce conflicts in commercial corridors and in centers. They also provide pedestrian refuge and can be used to install lighting and traffic control devices. Table 7 provides guidance on the design of medians.

Photo snapshot

A tree-lined landscaped median along a moderately busy street. Preferable if such a shot could include a bus driving along. Cornell Road?

Caption: In addition to creating safer streets for all users, medians also provide a more comfortable and pleasant experience.

DESIGN APPROACH

- Regional streets can have different median conditions, depending on the intensity of adjacent land use, motor vehicle speeds and volumes, cross street and site access needs, pedestrian and bicycle activity, presence of transit, stormwater management approach and available right of way.
    - **Use raised medians where site access is provided from side streets** or U-turns are permitted at frequent intervals. Narrow raised medians (<10 feet) can be applied in places with infrequent driveways and intersections while wider raised medians (>12 feet) are preferred to accommodate left turn lanes at intersections. Landscaped medians can also be designed as green streets treatments, in which stormwater runoff is conveyed to the median and infiltrated through median planters.
    - Street trees and/or plantings should be included wherever possible within medians and can be accommodated in a minimum width of 4 feet. Street trees and plantings can contribute to traffic calming, improve air quality reduce stormwater runoff and enhance aesthetics and livability of the street.
    - **Concrete raised medians** are appropriate as access management treatments and in locations where median landscaping cannot be accommodated or maintained.
    - **Concrete barrier or cable barriers** are used in the medians of higher

speed divided highways or freeways and can help reduce motor vehicle crash severity.

- **Consider emergency vehicle access needs** Emergency vehicles typically need 20 feet of clear width to be able to deploy equipment and reach upper stories of buildings. Medians may be mountable to serve emergency vehicle needs. On highways or freeways with continuous raised medians or barriers, include periodic median openings, limited to emergency vehicle use for U-turns.
- **Streets with four or more through lanes should have medians** to improve motorist safety and to create safe ways for pedestrians and bicyclists to cross. Median refuge islands reduce crossing distances for these more vulnerable modes. Refuge islands should be a minimum of 6 feet wide and should offer an at-grade crossing (cut-through). Include pedestrian push buttons and signal heads within the refuge to allow people to make two-stage crossings if needed.
- **x Consider exclusive transit space within the median** on high capacity transit streets. This treatment is discussed further in Transit in Travelways.

Table 7

Regional Design Classifications	Medians								
	Landscaped Median	Green streets / stormwater treatments	Street Trees	Exclusive transit	Raised concrete median	Median refuge islands	Two-Way Left Turn Lane	Vertical concrete or cable barrier	No Median
Freeways	🟡	🟢	🔴	🟢	🔴	🔴	🔴	🟢	🔴
Highways	🟢	🟢	🟢	🟢	🟡	🟡	🟡	🟢	🔴
Regional Boulevard	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🔴	🔴
Community Boulevard	🟢	🟡	🟢	🔴	🟡	🟢	🟡	🔴	🟡
Regional Street	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🔴	🔴
Community Street	🟡	🟡	🟢	🟡	🔴	🟡	🟡	🔴	🟡
Industrial Street	🟡	🟡	🟢	🔴	🟡	🟡	🟢	🟡	🟡

🟢 Preferred design treatment

🟡 Potential design treatment

🔴 Not a typical design treatment

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
  - *Urban Street Design Guide* Pedestrian Safety Islands
  - *Urban Bikeway Design Guide* Median Refuge Island
  - *Transit Street Design Guide* Downtown Median Transit Street, Median Rapid Transit Corridor
- Federal Highway Administration (FHWA)
  - *Traffic Calming ePrimer* Median Island

- *Office of Operations* Benefits of Access Management Brochure

Green Streets and Stormwater Management

A green street is a transportation right of way that maximizes stormwater management on-site; fosters safe pedestrian, bicycle, transit and vehicular access and connectivity; and designs with natural systems in mind. Stormwater management methods within the right of way utilize natural and engineered systems of vegetation and soil to handle runoff, reduce pollutants and store water events that enhance watershed health. Green streets provide many other benefits beyond stormwater management. Trees and vegetation also beautify our streets and soften the urban environment, creating more enjoyable spaces. They contribute to cooling and help mitigate the urban heat island effect. They improve air quality and filter pollutants found in runoff and provide buffers from noise. Vegetation within the street right of way, in conjunction with other designs, contributes to traffic calming. Green streets help maintain and restore natural processes, incorporating streets into the natural ecosystem. Our streets, for the most part, are made up of impervious surfaces. As precipitation falls onto these hard surfaces, it becomes stormwater runoff that needs to be managed and directed off the surface of the street. The traditional method of handling stormwater runoff in the right-of-way has been to quickly funnel water into subsurface pipes that then discharge to water treatment plants or directly into water bodies. This management approach presents major infrastructure cost and environmental impacts to our waterways. Green streets can reduce these negative impacts and are now being implemented widely within the greater Portland.

Overall approaches to managing stormwater have changed substantially over the last few decades, and knowledge, understanding and practices will continue to evolve as new information, regulation and technologies emerge. Treatment methods, soil types and plant species are likely to continue to evolve as the region develops best practices through experience. However, one constant is that run-off generated from the buildup of impervious surfaces in urban areas needs to be managed.

The photos show several different green streets treatments: planters, curb extensions, basins, swales, ponds and constructed wetlands, stormwater medians, hybrid facilities and underground injection control.

Table 8 provides guidance on green streets and stormwater management treatments and suitable locations.

PLANTERS

Caption: Planters are structured facilities of varying shapes and sizes with hard walls, generally flat bottoms, soil, and vegetation. Planters can be designed to infiltrate water or have impermeable liners where infiltration is not feasible. Planters are an ideal facility selection for many street types; with their hard edges and level bottoms, they provide ample stormwater storage volume in consolidated spaces. The use of liners or impermeable faces also allows them to be placed adjacent to conditions that usually prohibits infiltration, such as a building face or underground water pipe. Planters are often used as a series of facilities within a streetscape to meet storm requirements. They are typically installed inside the street furniture zone in a shaped (mostly rectangular), cast-in-place concrete box. A series of planters on 2nd Street in downtown Lake Oswego providing stormwater management within the right-of-way. A "step-out zone" is provided at the curb edge to allow people into and out of their vehicles. All street trees within this project were planted within structural soils. An ornamental rail has been provided for aesthetic purposes but is not required for most planter designs.*

CURB EXTENSIONS

Caption: Curb extensions are like planters – they have hard edges, generally flat bottoms, soil, vegetation, and impermeability if desired. The defining aspect of this facility type is their placement within the flex zone in the roadway as "bulb-outs" adjacent to corners, along a street mid-block, or at pedestrian crossings. Curb extensions can also be combined with adjacent planters within the pedestrian realm to maximize capacity. Curb extensions are a good facility selection on streets with on-street parking and can also contribute to pedestrian safety and access when designed in combination with pedestrian crossings. This curb extension on E Burnside Street in Portland. Check dams are used on steep streets, such as in this example, which holds back water before it can flow through the planter maximizing runoff infiltration and its contact with soil and plant materials for pollution reduction.

BASINS

Caption: Sometimes referred to as "rain gardens," basins are depressed facilities of varying shapes with bermed side slopes, flat bottoms, soil, and vegetation. Basins are utilized where infiltration rates are acceptable. They are typically – but not always -- used as a single facility to handle larger volumes of water within a catchment area. Basins are a good facility selection for placement in unconventional remnants of right of way outside of major pedestrian cross-traffic areas, due to their large footprint. This Stormwater basin on Warner-Milne Road in Oregon City, is set off to the *side of the street with runoff going into inlets that outfalls into the facility. Sculptural art with its serpentine, weathering-steel panels is also provided that highlights the path of runoff through the facility as it is treated.*

SWALES

Caption: Swales are depressed landscape strips that are long and sloped with earthen sides. Within the right of way, swales take up more room than planters because they lack a hard edge and need side slopes to match adjacent grades such as sidewalks. Along streets that have available room, however, swales are a lower cost option due to not having to construct hard edges. Another advantage of swales is they can naturally convey water along their sloped surfaces, which can further reduce subsurface drainage pipe needs. Careful design decisions should be made about their placement along streets with a lot of pedestrian traffic as they may limit crossings. Swales are a good choice where space is available and a continuous buffer from the roadway is desirable. This streetside swale in Southwest Portland flows with the street slope. The right of way and street design allowed for a swale condition, with bermed side slopes.

PONDS AND CONSTRUCTED WETLANDS

Caption: Ponds and constructed wetlands are large, depressed facilities with earthen side slopes. They can take a wide variety of shapes. Somewhat similar in concept to basins, they are often utilized to handle extensive catchment areas with large runoff volumes. Ponds and constructed wetlands are used where infiltration rates are low. They can store water temporarily or longer-term and are designed with a permanent wet-pool that settles pollutants. Outlet control structures, designed to regulate water levels and flows leaving the site, are an integral part of ensuring proper operations to meet storm design requirements. Ponds are a good tool to use where contiguous space is available and where infiltration rates are not ideal for basins. This pond is alongside Brookwood Parkway in Hillsboro. Ponds require large spaces to be installed and require maintenance roads and fencing, which should be a consideration in choosing this facility type. Integrating these facility types into the streetscape character can be challenging.

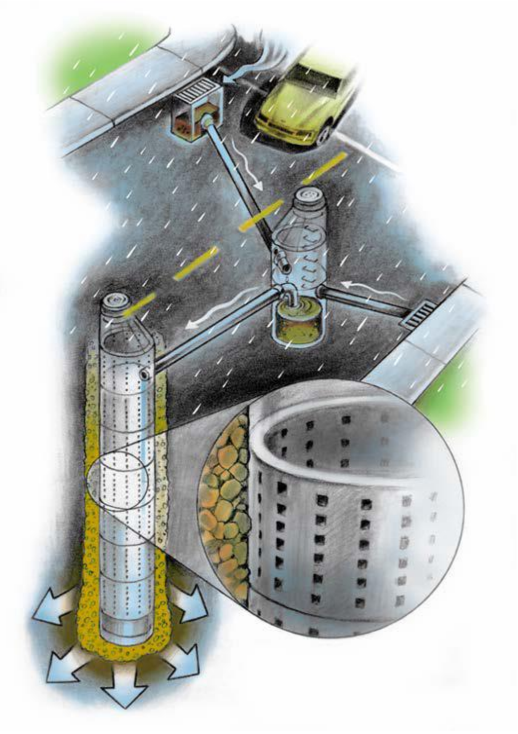
STORMWATER MEDIANS

Caption: *Stormwater medians allow for runoff to be managed in the center of the street rather than the sides. Most streets are designed to be crowned, where water sheds to the outside of the street. With stormwater medians, the roadway cross section orientation is altered to allow for water to shed towards the center. Depending on the space available and slope of the street, swale and planter configurations are a good option in the median. This median on SW 124th in Tualatin has a swale running alongside the street. Design of the roadway cross-slope and ability to get runoff into the median without impacting traffic safety is imperative for these designs. The roadway slopes from one end to the other, and additional storm facilities were provided at the low end of the cross-slope for additional storm capacity. Vegetation within the median should be designed to not obstruct sightlines (stopping sight distance) for drivers navigating the street.*

HYBRID FACILITIES

Caption: Stormwater facility types can be mixed to form unique facility designs, appropriate for the street context. Different elements of facilities can be combined, blurring the definition of the facility type. Hybrid facilities allow for additional flexibility in choosing designs that can best meet a street's dimensional or cost restrictions. For example, a planter with a bermed side slope on one end, rather than continuous vertical walls, may be the best way to serve a specific street context and project goals. This hybrid facility on SE Division Street in Portland includes a curb extension in the flex zone that extends into the furniture zone with a bermed and vegetated side slope at the sidewalk edge, which negates the need for a planter wall to be constructed.

UNDERGROUND INJECTION CONTROL



Source: https://www.portlandoregon.gov/bes/64040

Caption: Underground injection control facilities are any systems of below ground collection and infiltration of stormwater runoff. Underground injection controls are heavily regulated in their placement and maintenance given its design of "injecting" water below the surface, which can be difficult to control if there is a hazardous spill, for instance. An underground injection control method often used within the right *of way includes a "sump." Sumps are hollow and perforated structures, typically made of stacked cylindrical precast concrete rings. At the street level, adjacent storm inlets are directed to a sedimentation manhole that allows sediment in runoff to settle, which provides treatment. The sedimentation manhole is then piped into the "sump" system which allows water to infiltrate into the ground below managing the stormwater volume requirements. In lieu of using a sedimentation manhole, treatment requirements can be provided in vegetated stormwater facilities instead, which can be piped into the sumps. Sump systems, on their own, do not provide a greening benefit on the street surface, and therefore should not be the first choice for stormwater management. However, in places with high infiltration rates, inability to site vegetated facilities and at a distance from groundwater or sensitive water supplies, sump systems may be appropriate.*

PERMEABLE PAVEMENT

Caption: Permeable (or pervious) pavements are load bearing pavement systems such as concrete, asphalt, or unit pavers that allow the passage of water through their pavement profile. Permeable concrete and asphalt pavements are poured in place that are similar in appearance their traditional counterparts except their mixtures are comprised of specially-graded aggregates with limited fines. This allows for water to flow between the pavement and infiltrate. Permeable unit pavers are specially designed manufactured units that are set in place. The design of the pavers facilitates them to be placed close enough to one another but still allow passage of water through gaps in their joints. Adequate subsoil infiltration rates and aggregate base material selection are all considerations for their proper implementation and design. Permeable pavement systems will also need to consider maintenance regimes to keep sediment and organic material from clogging their openings. Permeable unit pavers as shown above highlights the use of pavers installed along the on-street parking aisle along SE 21^st^ Ave. in the Sellwood-Moreland neighborhood.

DESIGN APPROACH

- **Minimize impervious paving** to limit runoff by using minimum standards or utilizing pervious paving where appropriate.
- **Maximize green street and stormwater treatments** to reduce stormwater pollution and volumes.
- **Handle stormwater in proximity to its source** and integrated with the street design, which reduces the need for subsurface stormwater infrastructure.
- **Use vegetated facilities** that infiltrate to the maximum amount possible, which recharges groundwater and helps achieve volume reduction.
    - Installation of trees within stormwater facilities is

    allowable with proper coordination of underground utilities, where facilities have the appropriate dimensions for the trunk to grow, and where maintenance needs and requirements are understood.
  - Facilities lined with impermeable membranes may be necessary in some locations.
- **A combination of approaches and facility types** can be used within a catchment area and project. Design considerations in selecting potential treatment options include:
  - Local soil infiltration rates.
  - Vegetation and tree selection that maximizes stormwater benefits (broadest canopy possible for site context).
  - Offsite storm discharge location.
  - Conveyance method(s) needed: sheet flow, overland flow, inlets, drains and pipes.
  - Seasonal high groundwater levels.
  - Locations of below and above ground utilities.
  - Site context, street classification, adjacent land uses, existing land and tree cover, and slope.
- **Medians with swales should be carefully deployed** in areas where pedestrian crossings are anticipated; they may present challenges to people crossing the street.
- **Design with low curbs or rails** alongside facilities adjacent to pedestrian routes to protect from people falling into facilities.
  - Most facilities will not be deeper than 30 inches and would not require a code-compliant guardrail.
  - Curbs 4 inches in height from paved surface along pedestrian routes typically provide the most economical safety barrier.

TREES

Street trees are indispensable to the attractiveness, comfort and safety of street design. Every part of a tree aids to naturally manage stormwater, from their leaves down to their roots. Trees come in different shapes, colors, foliage types, and sizes that affect how space is defined, how much shade is provided, and how much rainfall will impact the urban environment. Regardless of tree variabilities, as precipitation falls from the sky, it is intercepted into a tree's canopy -- comprised of branches, twigs, and leaves – where water is retained temporarily, where evapotranspiration partially occurs, and then funneled down its trunk or off its leaves for infiltration into its root system. Trees are the simplest and most sustainable tool available in managing stormwater.

Street trees serve several objectives:

- Separate and define the boundary between the pedestrian realm and the travelway, reducing the impacts of volume and speed of traffic on pedestrians and adjacent land use.
- Provide tranquility to the street, slow the pace and intensity of street activity and enhance the wellbeing of pedestrians and motorists by creating a sense of enclosure.
- Provide an important stormwater management function by reducing runoff, providing stormwater

interception, detention and improving water quality.
- Provide shade in the summer and allow sunlight in the winter.
- Help reduce the scale of wide streets to a human scale.
- Provide identity to a street, orientation of the street within the systems of streets within a city, and provide status and prestige to address along the street.
- Reinforce the design and hierarchy of the regional street system.
- Give sense of place to the natural regional identity of the Portland metropolitan area.

Planting new trees should consider site context and adjacent structures, street classification and available rooting space for the tree species planted. Trees can be planted inside or outside of stormwater facilities, and the consideration for urban conflicts like utilities are considerable for both. Some tree species will need more than 1,000 cubic feet of soil volume to grow well and reach mature size. Each site may present individual challenges for a tree's successful growth. Consider planting trees in that easiest to plant spaces first that maximizes the ability for the trees' roots to grow.

Caption: A mature English Oak in the planted buffer. Generally, the largest canopy tree possible for the site context should be planted to increase stormwater benefits, provide adequate shade, provide noise and pollution barriers and increase safety and comfort for people on the sidewalk.

Available soil volume will be the most limiting factor for growing trees that provide shade, define space, and maximize stormwater benefits within the right of way. Streets are comprised of a myriad of impervious paving, compacted subsoil layers and underground or overhead utilities. These elements directly compete against tree's ability succeed. To address this, projects should seek to maximize the available soil volume and consider using the following methods (or combination of) to grow large trees and manage runoff with trees:

- **Structural Soils** are a growing medium consisting of specially graded angular rock or sand mixed with soil, that when blended and compacted, available air and water pockets within the mix allows for roots to grow within it. Structural soil's ability to be compacted allows for many pavement types to be placed directly on top of its profile.
- **Roots Paths** are narrow trenches extending radially from a tree pit about 4 inches wide and 12 inches deep, inserted below new pavement. Root paths allow for roots to grow and extend below the pavement with less

restrictions from compaction. Root paths can be connected to other planting area spaces to maximize the exchange of air and water.

- **Continuous Trenches** is a concept and method of installation where contiguous soil volumes are installed to allow for air and water exchange for tree roots, often between rows or groups of trees to maximize resource exchange. Many times these systems are constructed in the furniture zone as the compaction requirements are less stringent than in the sidewalk. Continuous soil trenches may utilize different methods to achieving a continuous trench such as structural soils, unit pavers or permeable pavers which allows for some water and air movement, and connected or elongated tree grates which can share large volumes of appropriate tree growing planting soil media.
- **Suspended Pavement / Structural Cells** are engineered or manufactured boxes, cells or vaults that "suspend" pavement above the soil volume below. The pavement is installed on top of the structured system, but inside the void is a large amount of soil volume specifically designed and compacted to allow for optimal root expansion. These systems have a high upfront expenditure but may be justified over time as they reduce the need for repaving of broken pavement sections caused by root upheaval and they result in reduced tree mortality and subsequent tree replacement costs. In considering the cultural and environmental value of healthy trees with broad canopies, the expenditure can often be legitimized.
- **Stormwater Trees** are a relatively new design technology in which stormwater management occurs within suspended pavement or structural cell systems filled with a specially designed soil mix and planted with trees. Runoff is directed into the system by diverting adjacent street inlet runoff into the "cells" of these systems where it runs through the soil mix and tree roots. As the water flows through the soil, it is treated, temporarily stored and appropriately discharged away from the cells. This design option would represent one of the most compact design choices for streets with limited space. These systems can also provide adequate soil rooting volumes for larger canopy tree growth. Stormwater tree systems would be an ideal treatment on streets where trees normally are found within the street furniture zone.

Caption: An oversized tree grate in the Pearl District in Portland maximizes soil volume over a typical street tree installation. Stormwater runoff from the adjacent sidewalk panels will flow into the tree opening. This installation could further be enhanced by providing root paths under the pavement or connecting to a similarly installed street tree planting and grate system to create a continuous trench.

DESIGN APPROACH

- **Preserve existing trees and plant new trees** which intercept rainfall before it hits impervious surfaces and provide multiple other benefits.
- **Preservation of existing trees** should occur early in planning and design and extend through the end of construction.
- **Plant the largest canopy tree** possible for the site context to increase stormwater and other benefits.
    - Understand the required amount of viable soil necessary for healthy tree growth that allows the tree to grow for longevity.
    - Follow the principle of the "right tree in the right place."
- **Plant trees in maximum available growing spaces** not in minimum standards wherever possible.
    - Balance the needs of other street uses with trees. Move beyond minimum tree opening standards and towards maximums. Provide and allow for trees to be installed in manners that exceed the minimum standards.
    - A simple guideline for adequate soil volume is to provide 1.5 cubic feet of soil volume for each square foot of projected mature crown.
    - Tree opening "pit" dimensions will depend on available space and tree species and canopy. As a general rule, no tree should be planted with less than 4 feet of width between pavements. The linear dimension of tree openings alongside pedestrian routes can often be elongated beyond 4 feet.
- **Select culturally appropriate tree species** which reduce maintenance burdens, are site sensitive and climate resilient.
    - Desirable characteristics of trees should include:
        - Persistent or dense-canopy foliage.
        - Wide spreading canopy.
        - Long-lived.
        - Tolerant of poor soils, drought, poor drainage, urban pollutants and meets USDA hardiness or
        - Does not present a major nuisance (e.g., messy fruit or attractive to pests).
        - Tough bark.
        - Extensive, but not destructive root structures.

Table 8

Regional Design Classifications	Green Streets									
	Treatment Type						Location			
	Pond / constructed wetland	Basin / raingarden	Swale	Planter	Trees / structural soils	Underground Injection Control (UIC)	Bulb-outs	Linear facility (streetside)	Median facility	Remnants of ROW
Freeways	🟢	🟡	🟡	🔴	🔴	🟡	🔴	🔴	🔴	🟢
Highways	🟢	🟡	🟡	🟡	🟡	🟡	🔴	🟡	🟡	🟢
Regional Boulevard	🔴	🟡	🔴	🟢	🟢	🟡	🟢	🟢	🔴	🟢
Community Boulevard	🔴	🟡	🔴	🟢	🟢	🟡	🟢	🟢	🔴	🟢
Regional Street	🟡	🟢	🟡	🟢	🟢	🟡	🟢	🟢	🟢	🟢
Community Street	🟡	🟢	🟡	🟢	🟢	🟡	🟢	🟢	🟡	🟢
Industrial Street	🟢	🟢	🟢	🟡	🟢	🟡	🟡	🟢	🟢	🟢
Regional Trail	🟢	🟢	🟡	🟡	🟢	🟡	🔴	🟡	🔴	🟢

🟢	Preferred design treatment
🟡	Potential design treatment
🔴	Not a typical design treatment

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
  - *Urban Street Stormwater Guide* Stormwater Elements: Stormwater Curb Extension

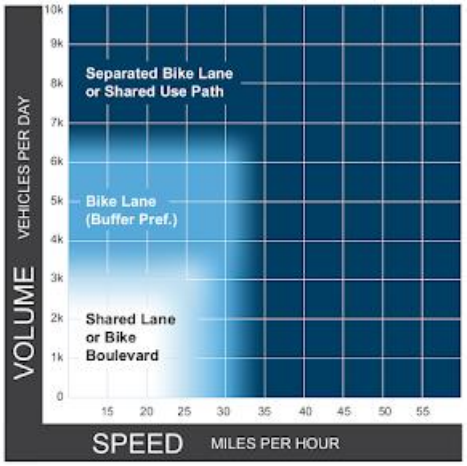
- City of Portland Stormwater Management Manual (SWMM)
    - *2016 Stormwater Management Manual*
- Sustainable Sites Initiative (SITES)
    - SITES v2 Reference Guide
- Portland Parks and Recreation
    - Portland Planting Standards
- James Urban, FASLA
    - *Up by Roots Health: Healthy Soils and Trees in the Built Environment*

Full-Page Professional Photograph for Bikeway Design

Bikeways Design

A connected system of safe and comfortable bikeways, designed to limit exposure to motor vehicles, serves people of all ages and abilities.

Designing for bicyclists of all ages and abilities requires a design approach that selects an appropriate bike facility based on street characteristics and surrounding land uses. As street size, traffic speeds, motor vehicle volumes and bicycle volumes vary, so do design treatments. Greater physical separation is needed on streets with higher speeds and volumes, which includes nearly all regional streets. Table 10 provides guidance on when to implement specific bike facility types.



Low-traffic Shared Lane

Caption: A shared lane on streets with low traffic, less than 1,500 vehicles a day, also known as a bicycle boulevard. Pavement markings and bike wayfinding alert drivers to expect bicyclists on the street and alert bicyclists to "take the lane." This bicycle boulevard in downtown Beaverton provides access to businesses and services.

Bike Lane

Caption: A standard bike lane, typically about 6 feet wide and immediately adjacent to motor vehicle travel lanes. This type of facility should not be used on streets with more than 3,000 motor vehicles a day and/or operating speeds greater than 30 miles per hour. This bike lane connects to Portland's Waterfront Park.

Buffered Bike Lane

Caption: A buffered bike lane includes a striped buffer of 2 feet or more. It increases the lateral distance between bicyclists and motor vehicles. This type of facility should be used on streets with traffic volumes of 3,000 to 6,000 vehicles a day and operating speeds between 25 and 35 miles per hour.

Separated Bike Lane

Caption: A separated bike lane is located within the street right of way, but physically separated from motor vehicles with a vertical element. These types of facilities are more comfortable for bicyclists and can attract a variety of people. This is the preferred design be used for on-street trail connections. This separated bike lane in Orenco Station is level with the sidewalk. A planted buffer separates people walking and bicycling.

DESIGN APPROACH

- **Separated bike lanes are the preferred treatment** on streets where annual average daily traffic exceeds 6,000 vehicles or speeds are 30 mph or higher (see table below).
    - If a separated bike lane is not feasible in the short-term yet remains the long-term vision, a standard bike lane or buffered bike lane should be included if possible, and a parallel bike route should also be designated and implemented.
        - In constrained areas where all options have been considered to provide the preferred separated bike lane even in the long-term, then appropriate signing and striping up- and downstream of the constrained segment will be provided to emphasize and communicate a clear message for all users through this segment.
    - In some cases, a parallel route may be preferred:
        - If the parallel route is equally direct and convenient, and is more comfortable, or
        - In cases where bicycling is not a prioritized function and constrained space is used to serve higher priority functions
    - Parallel routes should be comfortable for all ages and abilities, should be equally as direct and should provide wayfinding to access destinations on parallel street.
- **Design the bike facility in conjunction with other cross-sectional elements and considering the anticipated future bike volumes and other micromobility users,** rather than using standard minimum width. Table 9 below provides recommended widths for one-way and two-way bike facilities. In addition to the operating width, designs should include buffer between both pedestrian space and motor vehicle lanes.
- Bikeway design must also take into account other types of street users and

expanding vehicle types. People using electric scooters, electric bikes, skateboards or other personal “micromobility” vehicles also are likely to use bike facilities. As technology evolves, people using other new types of travel are likely to use bike facilities. In designing bike facilities, think of them as serving various forms of micromobility moving at speeds of 5 to 20 mph. Demand for this type of travel is growing.

- Refer to the intersections design element for the preferred approach for safe bike travel through intersections.

Table 9

Peak Hour One-way User Volume	Preferred Operating Space Width	Minimum Operating Space Width	Preferred Shy Distance Width	Minimum Shy Distance Width
<150	6.5 feet	5 feet	2 feet	1 foot
150-750	8 feet	6.5 feet	2 feet	1 foot
>750	10 feet	8 feet	3 feet	1 foot
Peak Hour Two-way User Volume	**Preferred Operating Space Width**	**Minimum Operating Space Width**	**Preferred Shy Distance Width**	**Minimum Shy Distance Width**
<150	11 feet	8 feet	2 feet	1 foot
150-350	12 feet	10 feet	3 feet	1 foot
>350	16 feet	12 feet	3 feet	1 foot

Table 10

Regional Design Classifications	Bicycle Facility						
	Shared street/ shared lanes*	Standard 6' bike lane*	Buffered bike lane	Separated Bike Lanes (one-way)	Separated Bike Lanes (two-way)	Multi-use path (shared alignment)	Parallel facility (path or street)
Freeways	🔴	🔴	🔴	🔴	🔴	🟢	🟢
Highways	🔴	🔴	🔴	🟡	🟡	🟢	🟢
Regional Boulevard	🔴	🔴	🟡	🟢	🟡	🟡	🟡
Community Boulevard	🔴	🔴	🟡	🟢	🟡	🟡	🟡
Regional Street	🔴	🔴	🟡	🟢	🟡	🟡	🟡
Community Street	🔴	🔴	🟡	🟢	🟡	🟡	🟡
Industrial Street	🔴	🔴	🟡	🟢	🟡	🟢	🟢
	🟢	Preferred condition					
	🟡	Potential condition					
	🔴	Not a preferred condition					

* These facilities do not serve most potential users on streets with regional design classifications, however, this design may be appropriate on other streets with low vehicle speeds and volumes.

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
    - *Urban Bikeway Design Guide* Bike Lanes, Cycle Tracks, Bikeway Signing & Marking, Bicycle Boulevards

  - *Urban Street Design Guide* Streets, Street Design Elements
  - Designing for All Ages & Abilities: Contextual Guidance for High-Comfort Bicycle Facilities
- Federal Highway Administration (FHWA)
  - Separated Bike Lane Planning and Design Guide
  - Achieving Multimodal Networks: Applying Design Flexibility & Reducing Conflicts
- Massachusetts Department of Transportation (MassDOT)
  - Separated Bike Lane Planning & Design Guide
- Transportation Research Board (TRB)
  - *NCHRP Research Report 880* Design Guide for Low-Speed Multimodal Roadways
- American Association of State and Highway Transportation Officials (AASHTO)
  - Guide for the Development of Bicycle Facilities (forthcoming)
- Portland Bureau of Transportation (PBOT)
  - Portland Protected Bicycle Lane Planning and Design Guide

Full-Page Professional Photograph for Transitway Design

Transit Design

TRANSIT IN TRAVELWAYS

Transit within the right of way comes with a wide variety of vehicle types, service types and corridor designs, Commuter rail and light rail require exclusive guideways and can run in the center of the street, on the side or parallel to. Bus rapid transit, streetcar and frequent bus have semi-exclusive transit treatments. Frequent, regular and shuttle buses operate in mixed traffic. Developing street designs to support transit requires an understanding of the type of transit service that will be incorporated on it. This section provides the preferred design approach for transit within the travelway. Table 11 provides guidance on types of transit treatments within the travelway.

Photo snapshot
The MAX perhaps E Burnside,
downtown Beaverton, or
Hillsboro. OR a photo of the
transit mall

Caption: High-capacity rail transit across the greater Portland area has dedicated space within existing rights of way. The Portland Streetcar and most bus lines operate in mixed-traffic, with some transit prioritization at key locations. Each transit mode has its own set of travelway standards and needs; designs should seek to maximize transit effectiveness while also serving other priority functions on the street.

DESIGN APPROACH

- **Transit priority treatments** to improve the transit speed and reliability should be considered in any transportation project. This could include transit only lanes, business access and transit (BAT) lanes, bus on shoulder, transit priority at traffic signals (time and space) and bus stop placement. The transit priority treatments design element will have more details.
- **Provide an exclusive guideway for transit** whenever possible on streets where high capacity transit is a goal. An exclusive space ensures that transit will not be delayed by congestion, increasing its reliability. It also enables service to grow to serve additional passengers. When an exclusive guideway is not possible, maximize transit priority through other treatments (see Transit Priority Treatments).
- When high capacity transit with exclusive space is established on an existing street, determine whether center- or side-running transit is more appropriate – the decision is context-specific.
  - Center transitways are often found on multi-lane roads and can provide reliable transit service and have minimal conflicts with other street functions. However, passengers must be able to cross to the center of the street, where ample boarding islands/medians must be provided.
  - Side-running transitways, if exclusively dedicated to transit operation, also provide high reliability and can allow passengers to board from sidewalks. Consider locations of destinations in designing transitways and access to stops.
  - Curbside bus lanes can be easier to integrate into an existing street –

however, they often face more conflicts with other street functions, such as vehicle access to land uses and bicycle travel.

Table 11

Regional Design Classifications	Transit in Travelway						
	Local Bus	Enhanced Bus Transit	High Capactiy Transit - Bus (Bus Rapid Transit)	High Capacity Transit - Rail	Streetcar	Center-running Transit	Side-running Transit
Freeways	🔴	🟢	🟢	🟢	🔴	🟢	🟢
Highways	🔴	🟢	🟢	🟢	🔴	🟢	🟢
Regional Boulevard	🟢	🟢	🟢	🟢	🟡	🟢	🟢
Community Boulevard	🟢	🟢	🟢	🟢	🟢	🟡	🟢
Regional Street	🟢	🟢	🟢	🟢	🟡	🟢	🟢
Community Street	🟢	🟢	🟡	🟡	🟢	🟡	🟢
Industrial Street	🟡	🟡	🟡	🟡	🟡	🔴	🔴

🟢 Preferred condition

🟡 Potential condition

🔴 Not a preferred condition

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)

- *NACTO Transit Street Design Guide* Transit Street Principles, Transit System Strategies, Stations & Stops

Transit Stops

Transit stops, serving as pick-up and drop-off locations, are where passengers congregate before boarding a transit vehicle. Transit stop features vary widely depending on context, from a sign with the transit line number, to shelters and benches to a transit platform with level boarding and real-time arrival information. Other stop design considerations include stop placement along the street, transit vehicle pull-outs, boarding platforms and interactions with bicyclists. The context and function of the specific stops and streets impact these design decisions; however, designs should seek to maximize both transit mobility and access. Table 12 provides guidance on types of transit stops.

Photo snapshot

Transit stop with a shelter, such as along Division, 82nd, TV Highway or transit mall

Caption: Transit stops are place where a person's trip transitions from walking or bicycling to riding a bus, train or other transit vehicle. Transit stops with shelters provide protection from sun, wind and rain and a place to sit while waiting for transit. Everything about a transit stop should facilitate the transit experience in a way that makes transit safe, reliable, enjoyable and convenient.

Design Element Sketch

DESIGN APPROACH

- **Safe enhanced crossings should be located** at or near transit stops, generally within 100 feet. Additionally, safe crossings should be located at or near stops for people coming from or heading to the other side of the street.
- **Universal design** treatments must be used to ensure safe and comfortable access to and from the transit stop for people of all abilities.
- Complete, accessible walkways leading to and from transit stops are critical for access.
- **Far side stops** located at the far side of a signalized intersection, after the transit vehicle has passed through it, are preferred, especially when coordinated with transit signal priority.
- **Near-side stops** work well at stop-controlled intersections, or intersections where the transit vehicle usually arrives on red, since they avoid the transit vehicle needing to "double stop." Near-side stop placement at intersections should discourage right-turning vehicles from passing the stopped transit vehicle. However, they should also be set back far enough to not impede visibility for crossing pedestrians.
- **In-lane stops**, in which the transit vehicle stops in the lane to pick up and drop off passengers minimize transit delay while also providing optimal access for transit users and are preferred. In-lane stops may require curb extensions on streets with on-

street parking. In-lane stops prioritize transit movement over motor vehicles; however, they may not be appropriate on higher speed streets, or at specific locations critical to system traffic operations.

- **Bikeway design at stops** should seek to manage conflicts between bicyclists, transit vehicles, and boarding and alighting passengers while maintaining mobility for bicyclists. There are a variety of strategies for achieving this:
  - **Bicycle bypass** – A lateral shift of a curbside bicycle lane allows it to run behind the transit stop. Most designs raise the bicycle bypass to the level of the transit stop with a marked crossing across the bike lane. A narrowed lane could be used to induce slower bicycle speeds.

Photo snapshot: Bicycle bypass

  - **Floating bus stops** – A separated bicycle lane runs behind a transit stop with no lateral shift. A separated bicycle lane, if not already at curb height, should be brought up to meet the level of the floating bus stop. Narrowed lanes are also appropriate here too.

Photo snapshot: Floating bus stop

  - **“Up and over”** – In this design, there is a mixing zone that serves as a bicycle lane when there is no transit present, and the passenger waiting area is behind the bicycle lane. When the transit vehicle arrives, bicyclists stop and yield to boarding and alighting passengers. There is limited precedent for this design concept in the United States, but it is used in other countries and may be suitable in space-constrained corridors.

Photo snapshot: Up and over

Table 12

Regional Design Classifications	Transit Stops							
	Far-side bus stop	Near-side bus stop	Mid-block bus stop	In-lane bus stop	Pull-out bus stop	Floating bus stop or bike bypass	"up and over" bus stop	Shared bike and bus mixing zone
Freeways	🔴	🔴	🔴	🔴	🟢	🔴	🔴	🔴
Highways	🟡	🟡	🔴	🔴	🟢	🔴	🔴	🔴
Regional Boulevard	🟢	🟡	🟡	🟢	🟡	🟢	🟡	🔴
Community Boulevard	🟢	🟡	🟡	🟢	🟡	🟢	🟡	🟡
Regional Street	🟢	🟡	🔴	🟢	🟡	🟢	🟡	🔴
Community Street	🟢	🟡	🔴	🟢	🟡	🟢	🟡	🟡
Industrial Street	🟢	🟡	🔴	🟢	🟡	🟢	🟡	🟡
	🟢	Preferred condition						
	🟡	Potential condition						
	🔴	Not a preferred condition						

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
  - *Transit Street Design Guide* Stations & Stops, Station & Stop Elements, Transit Streets, Transit System Strategies
  - *Urban Street Design Guide* Street Design Elements
- Federal Highway Administration (FHWA)
  - Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts
  - Separated Bike Lane Planning and Design Guide

- Seattle Department of Transportation (SDOT)
    - Bike Lanes and Transit Service
    - Expanding Networks to Seattle’s Job Centers
- Massachusetts Department of Transportation (MassDOT)
    - Separated Bike Lane Planning & Design Guide

Transit Priority Treatments

This section describes design treatments that increase the reliability and efficiency of transit. These investments can be grouped in three buckets: regional investments, corridor improvements, and specific hotspot treatments.

The Transit Stop element also includes strategies for maximizing transit mobility. Improving the speed and reliability of the bus network can be implemented at the regional scale, along corridors or at “hot spot” locations.

Regional investments, which include bus on shoulders, transit signal priority and headway management, focus on improving collective transit service without looking at specific routes.

Corridor improvements, which include level boarding, all-door boarding, bus stop consolidation, rolling stock modification and transit signal priority, examine operations on specific transit routes or corridors. These improvements broadly serve to improve transit travel time and reliability

Specific hotspot treatments include dedicated bus lanes, business access and transit (BAT) lanes, queue jump or right turn except buses, peak-period only transit lanes, multi-modal interactions, curb extensions at transit stops, far side bus stop placement and street design modifications. In locations where a transit line is operating acceptably except at a single location, or where reliability is often comprised, a hotspot treatment may be needed to address the issue.

Photo snapshot

Photo of a bus transit lane, preferably with a bus in it

Photo snapshot #2

Showing a different transit priority treatment

Caption: Bus-only lanes are one strategy that prioritizes transit movement on our streets and helps buses avoid congestion. While light-rail transit has dedicated lanes and transit signal priority, there are few places in the region where buses have the same luxury.

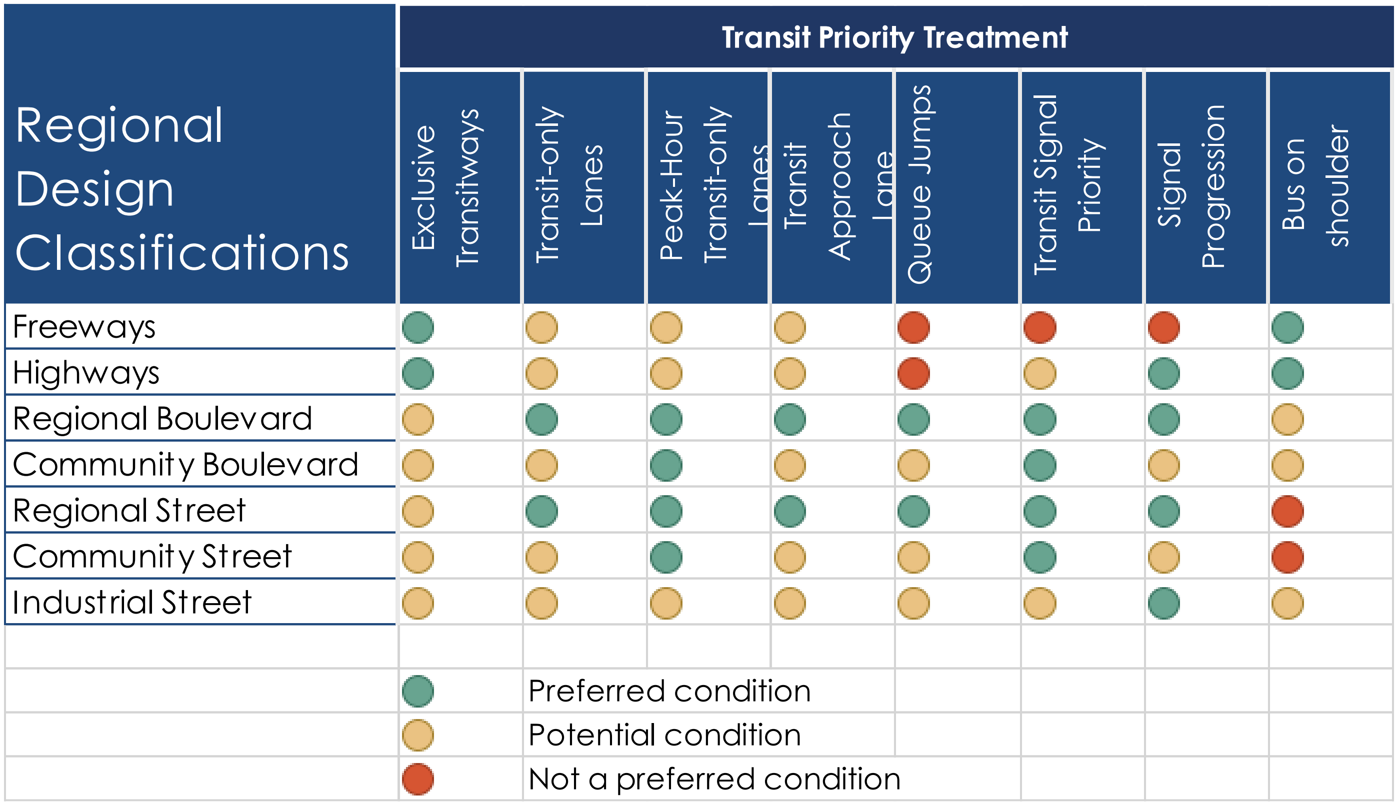
DESIGN APPROACH

- **Transit priority treatments** to improve the transit speed and reliability should be considered in any transportation project. This could include transit only lanes, business access and transit (BAT) lanes, bus on shoulder, transit priority at traffic signals (time and space) and bus stop placement.
    - Provide transit-only lanes on multi-lane streets to address transit delay and increase transit mobility.

Removing parking, reducing lane widths or dedicating an existing lane are all options.

  - Bus on shoulder, on highways or freeways with a wide shoulder and highly congested conditions, consider allowing buses to run on the shoulder.
  - Exclusive space for transit vehicles at specific pinch points, such as an approach to a bridge or significant intersection, can also be highly effective at reducing delay and improving reliability if they are long enough for the transit vehicle to "skip" at least one signal cycle. Designs including red pavement markings help make other drivers aware of the transit lane and can increase compliance.
  - Consider peak-only transit lanes on congested street segments, where on-street parking can be prohibited during peak periods, with the space dedicated to transit operations.
  - Business-access transit lanes are outer lanes designated exclusively for transit and right-turning vehicles. These lanes are easier to implement than a fully exclusive transit lane, since they do not require removing driveway access to businesses.
  - Where both transit lanes and separated bike lanes are included in a street, careful consideration of the treatment at intersections is needed to ensure safety and travel time are improved for transit and bicyclists.
- **Design intersections to optimize transit mobility and access.** Transit signal priority helps avoid delays to transit vehicles at major intersections, while intersection queue jumps and transit signal progression can help keep transit moving along busy corridors.

Table 13



Regional Design Classifications	Transit Priority Treatment							
	Exclusive Transitways	Transit-only Lanes	Peak-Hour Transit-only Lanes	Transit Approach Lane	Queue Jumps	Transit Signal Priority	Signal Progression	Bus on shoulder
Freeways	🟢	🟡	🟡	🟡	🔴	🔴	🔴	🟢
Highways	🟢	🟡	🟡	🟡	🔴	🟡	🟢	🟢
Regional Boulevard	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟡
Community Boulevard	🟡	🟡	🟢	🟡	🟡	🟢	🟡	🟡
Regional Street	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🔴
Community Street	🟡	🟡	🟢	🟡	🟡	🟢	🟡	🔴
Industrial Street	🟡	🟡	🟡	🟡	🟡	🟡	🟢	🟡

🟢 Preferred condition

🟡 Potential condition

🔴 Not a preferred condition

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
    - *Transit Street Design Guide* Transit Lanes & Travelways, Active Transit Signal Priority, Transit Approach Lane/Short Transit Lane
- Portland Bureau of Transportation (PBOT)
    - *Enhanced Transit Corridors Plan* Executive Summary and Plan

Full-Page Professional Photograph for Intersections and Crossings

Intersections and crossings

SIGNALIZED INTERSECTIONS

Signalized intersections provide traffic control for pedestrian, bicycle, transit, freight and motor vehicle movement, balancing mobility and access. Pedestrian, bicycle and transit travel through intersections should be prioritized.

Providing adequate visibility for all users by maintaining sight triangle clear of obstructions and designing for predictable movement by providing consistent signal phasing (e.g., leading pedestrian intervals) setting consistent user expectations will lead to reduced crash rates and crash severity. Creating more compact intersections will lower motor vehicle speeds while limiting pedestrian exposure. And thinking about intersections within the context of the broader street network can help practitioners identify specific locations that would benefit most from a change.

Photo snapshot

An intersection that emphasizes bicycle movement, pedestrian movement or transit movement

Caption: Signalized intersections impact all travel modes, so well-designed intersections should incorporate safe and efficient movement for all travel modes. This intersection includes specific treatments to facilitate movement of…[fill in depending on the intersection shown]

DESIGN APPROACH

OVERALL INTERSECTION

Intersection operations should reflect signal strategies that minimize conflicts between different travelers and avoid designs that have high-volume permitted motor vehicle movements across pedestrian, bicycle or exclusive transit movements. Consider ways to separate these movements in different phases, use lead pedestrian/bicycle intervals, or prohibit certain motor vehicle turning movements.

- **Creating more compact intersections** will lower motor vehicle speeds, minimize pedestrian exposure and provide public space to be used for sidewalks, transit amenities, bicycle facilities or green streets treatments.
- **Short signal cycle lengths** should be used where possible to minimize delay for people walking and bicycling - cycle lengths of 60 to 90 seconds are appropriate in urban areas. Longer cycle lengths may provide more motor vehicle capacity and can accommodate more signal phases. However, long cycles are also more likely to lead to users disregarding the signal to avoid long delays.
- **Coordinated signal timing** can increase overall motor vehicle capacity within a corridor without leading to overly large intersections that impact pedestrian, bicycle or transit movement. Within urban areas, coordinated signals can be timed to achieve slow vehicle speeds (20 or 25 miles per hour), or can be set to 12 to 16 miles per hour to facilitate

bicycle movement. This bicycle-friendly signal timing is known as a "green wave" and is appropriate particularly in centers and along one-way streets where bicycle mobility is prioritized.

- **Visibility** improves safety and reduces crashes at intersections. Removing on-street parking at intersections, also known as daylighting improves safety for pedestrians crossing the street. However, improved sightlines can lead to drivers feeling comfortable at higher speeds. Therefore, improving visibility should be paired with other designs, such as curb extensions, to create relatively compact intersections that encourage safe, low-speed movement.
- **Exclusive pedestrian, bicycle and turning movements** through the intersection should be used at high crash intersections to separate these movements in different phases or prohibit certain motor vehicle turning movements.
- **Exclusive transit** movements should be used at intersections where there is bus delay.

CROSSINGS

Every leg of a signalized intersection should have a high visibility marked crosswalk, accessible curb ramps and pedestrian signals with countdowns. In urban areas closing a crossing is not desirable.

- **Fixed signal timing**, or pedestrian recall timing, which provides a pedestrian crossing phase on every cycle, helps maximize pedestrian mobility. However, there are places where actuation, where pedestrians push a button to call the signal phase, is more suitable. These places include transit corridors, intersections with infrequent pedestrian crossings, and intersections where there is high variability in pedestrian and vehicle volumes during the day.
- **Audible messaging** supports accessibility.
- **Leading pedestrian intervals** (between 3-7 seconds), at intersections with heavy volumes of turning vehicles, creates more visibility for pedestrians and can reduce vehicle and pedestrian crashes. Uncontrolled channelized right turn lanes should not be used in urban environments, as they can create high-speed vehicle-pedestrian conflicts.
- **Medians** should be installed on roadways with three or motor vehicle travel lanes (including turn lanes). Minimum widths for medians of at least 6 feet to improve safety and provide a place to wait for slower-moving pedestrians.
- When areas of conflict are inevitable, mitigate conflicts by ensuring direct sight lines for all users and slowing vehicle speeds at these points to decrease speed differential between users. It is preferred to design conflict points between modal users to be perpendicular to the extent possible improving sight distance for all users.

TRANSIT AT INTERSECTIONS

- Queue jumps allow buses to bypass traffic queued at a red signal. Queue jumps are most suited on streets with high peak hour volumes but low right-turning vehicle volumes. For a queue jump to be effective, buses must be able to reach the front of a travel lane at the beginning of a signal cycle to receive a green light ahead of vehicles heading in the same direction in other lanes.

- Transit signal priority modifies traffic signal timing to prioritize approaching transit vehicles. Transit signal priority is appropriate on frequent transit corridors and in places where transit is often delayed due to signals or intersections with long signal cycles. It is most effective paired with far side stops.
- Transit stops on the far side of signalized intersections are generally preferred, as they allow transit vehicles arriving on green to proceed through the intersection before stopping. However, consider specific intersection conditions and the locations of land uses and destinations in determining stop location at each intersection. The Transit Stop and Transit Priority Treatments elements provide more detailed guidance and best practices relating specifically to transit movement at intersections.

BIKE INTERSECTION TREATMENTS

Bike-specific treatments at intersections should allow bicyclists to make safe and predictable through and turning movements at intersections. Protected intersections, which can cover all three movements, are addressed below.

Photo snapshot

An intersection with bike safety treatments – protected intersection, two-stage turning boxes, etc.

- **Protected intersections** provide greater physical separation between bikes and motor vehicles and reduce the number of conflict points. Protected intersection designs include corner refuge islands, a forward bike queuing area next to the corner refuge island, and a yield zone for turning motor vehicles.
- **In locations where a protected intersection design is infeasible**, other options can support safe navigation for bicyclists:
    - Left turns: Two-stage turn queue boxes allow bicyclists to take a position at the front of traffic on the cross street while out of the travel lane of the street the bicyclist just came from. Once the cross street has a green light, the bicyclist can complete the left turn movement.
    - Right turns: Right-turn bike facilities can either have their own lane or can share with right-turning vehicles, with vehicles yielding to bikes.
    - Through movements: Bike lanes should be separated from right-turning traffic. A “keyhole” bike lane should be placed between the right turn lane and the right-most through lane, with buffers if space permits, and the bike-vehicle merge area should be clearly visible to roadway users, with green markings in the conflict zone. A combined through bike lane/right-turn vehicle lane can be combined where turning vehicle volumes are low and/or space is limited, with vehicles yielding to bikes, but this is not a preferred treatment.
- **Bike boxes**, designated areas for bicyclists to wait at a signal at the front of a vehicle queue, are designed to

make bicyclists more visible to drivers. Bike boxes are paired with bike lanes, allowing bicycles dedicated space across an intersection while also providing increased visibility in the intersection itself.

- **Bike signals** can separate bike movement from other conflicting movements at an intersection. Bike signals are appropriate at intersections with high vehicle right-turning volumes, at intersections with contra-flow bike movements, when bicycles can be served longer than the vehicle phase, and at intersections with multi-use paths or separated bike lanes.

Photo snapshot

A bike signal

MOTOR VEHICLE LANES – THROUGH AND TURN LANES

- Narrower lane widths (see Motor Vehicle Travel Lanes) help reduce speeds and make intersections more compact.
- Consider prohibiting right-turn-on-red movements for motor vehicles in places with high pedestrian or bicycle crossing volumes.
- Examine the surrounding street network and consider number of turning vehicles. In some cases, it may be beneficial to remove turn lanes and/or prohibit turning movements in places where the street network provides other ways for motor vehicle drivers to navigate. This can allow for more compact intersection design and shorter signal cycles.
- In determining whether to include turn lanes, examine overall vehicle turning volumes and analyze options that include shared lanes. This decision has a tradeoff: adding turn lanes can improve motor vehicle mobility and safety in some contexts, but it increases pedestrian exposure and takes space away from other functions.
- Reducing corner radii whenever possible will shorten pedestrian crossing distances and slow down turning vehicles. It is possible to design an intersection to accommodate turning trucks, buses and emergency vehicles while preserving small corner radii.

DESIGN RESOURCES

- Signal Timing Manual, Second Edition (National Cooperative Highway Research Program Report 812)
- National Association of City Transportation Officials (NACTO)
  - *Urban Street Design Guide* Intersections, Traffic Signals
  - *Urban Bikeway Design Guide* Intersection Treatments
  - *Transit Street Design Guide* Intersections
- Federal Highway Administration (FHWA)
  - *Manual on Uniform Traffic Control Devices (MUTCD)* Pedestrian Control

    - Features, Highway Traffic Signals
- Massachusetts Department of Transportation (MassDOT)
    - *Separated Bike Lane Planning & Design Guide* Chapter 4: Intersection Design

Roundabouts and Mini-Roundabouts

Roundabouts are an alternative to signals or stop signs for intersection control that can be applied in urban, suburban and rural settings. Roundabouts are the safest known intersection form.

Roundabouts feature a circulating roadway where motor vehicles yield upon entry to other vehicles already in the roundabout. Pedestrian crossings of each street are set back from the circulating path. Roundabouts, due to their geometry, are designed to slow motor vehicles to speeds of around 15 to 20 miles per hour. Mini-roundabouts serve a similar function to roundabouts, but their scale is considerably smaller and their central and splitter islands are mountable for larger vehicles. Mini-roundabouts can be appropriate on lower-speed streets in constrained locations. In general, roundabouts offer improved safety over other intersection types. Two-way stop-controlled intersections converted to roundabouts see an 82 percent in reduction in severe crashes, and signalized intersections converted to roundabouts have a 78 percent reduction in severe crashes, according to FHWA.

Roundabouts typically require more right-of-way than a stop-controlled or signalized intersection, but may result in narrower cross sections along the road segments. For single-lane roundabouts that are usable for large freight trucks, the inscribed circle diameter is commonly between 100-150 feet. Roundabouts with lower freight volumes can be smaller, while roundabouts with expected Interstate type tractor-trailers and oversize loads may need to be adjusted to accommodate larger trucks where needed. For two-lane roundabouts that are usable for large freight trucks, the inscribed circle diameter is commonly between 150-220 feet. The exact amount of right of way depends on the local circumstances and design details. Roundabouts may require less right-of-way for queue storage at approaches.

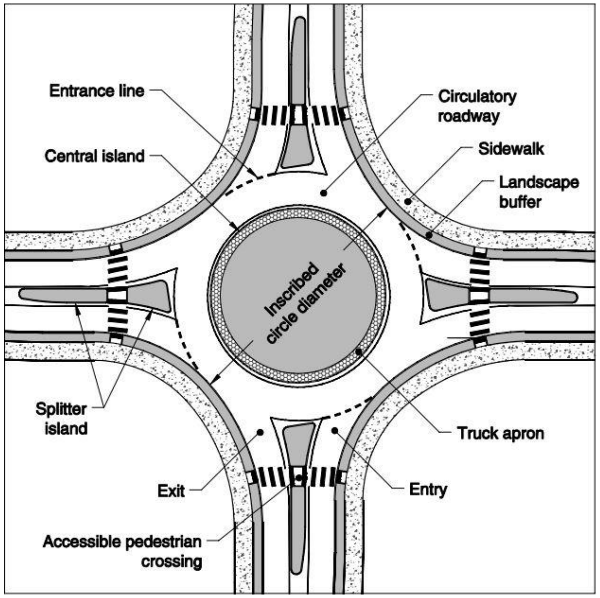
Roundabouts can be used on streets with one or two through lanes per direction. Compared with signals, roundabouts have a similar motor vehicle capacity, and can offer lower levels of average delay, depending on vehicle volumes. Typically a roundabout would operate acceptable when the sum of the conflicting volume by lane (circulatory and entering) is less than 1,100-1,300 depending on the lane configuration. Further study will be needed to determine the appropriate lane configuration.

Photo snapshot
A roundabout with good
pedestrian crossings in our
greater metro region. Would be
nice to have aerial photos

Caption: Roundabouts provide continual traffic flow through an intersection while slowing vehicle speeds, minimizing conflict points, and broadly reducing crashes.

DESIGN APPROACH

Roundabout features should be designed to ensure slow speeds for approaching vehicles. These features include horizontal deflection at the approaches, the splitter island design (which narrows the approach), the design of the central island to limit sightlines through the roundabout, and the design of the exits.



Source: NCHRP Report 672

PEDESTRIAN CROSSINGS

Roundabouts enhance pedestrian safety because pedestrians only navigate a single direction of traffic at a time.

- **Pedestrian access** through a roundabout should include separated walkways around the roundabout, well-defined walkway edges, detectable warning strips, perpendicular crossings with contrasting crosswalk markings and a splitter island where pedestrians can comfortably wait before crossing the other direction of traffic. The exit speeds are controlled by the circulatory roadway from which drivers will start accelerating – the geometry of the exit does not necessarily control the speed.
- **Additional treatments at crossings** are appropriate in some cases, particularly multilane roundabouts. Additional signage or actuated beacons can further enhance visibility of pedestrians. Rectangular rapid flashing beacons or pedestrian hybrid beacons at pedestrian crossings along roundabouts have been shown to be effective at increasing yield rates among drivers entering and exiting a roundabout.
- **Pedestrian crossings** should be set back from the roundabout by at least one full vehicle length. This shortens the crossing distance and focuses the driver's attention first on crossing pedestrians, then on vehicles in the roundabout.

SIDEWALK OR PATH SURROUNDING ROUNDABOUT

- A sidewalk or path for pedestrians should encircle the full roundabout with setback from the motor vehicle lanes. Landscape buffers will help discourage pedestrians from crossing to the central island.
- In some cases, the path can be designed to also allow bicycle use. In these cases, it should be designed with adequate width to serve people both walking and bicycling at slow speeds, typically 10 feet minimum.

CENTRAL ISLAND

- **Landscaping, stormwater treatment, public art and gateway designs** to signal entry to a place. Design of the central island is intended to obscure sightlines through the roundabout. If these sightlines are not limited, drivers may be tempted to speed through the roundabout if they see no other entering vehicles.
- The central island, while often looking like a park or natural space that people can enjoy, should not invite pedestrians to visit. Crossings at roundabouts are designated at entrance and exit points to a roundabout; crossings into the roundabout should not be pursued.

BICYCLE FACILITIES

- **Shared lanes** - Vehicles inside a roundabout are generally traveling at a similar speed to bicycles. For roundabouts, some bicyclists may feel comfortable sharing the vehicle travel lanes and navigating the roundabout in the same way that motor vehicles do.
- **Separated facilities -** Bicyclists should also have the option to be separated from motor vehicle traffic, either on a shared path with pedestrians or on a separated bicycle facility outside the roundabout, including bicycle crossings of each intersection leg.
- **Bicycle lanes** should not be striped in the circulating roadway portion of the roundabout.

MOTOR VEHICLE LANES

- Consider the anticipated volumes of motor vehicles and their turning patterns in determining the number of lanes and lane configurations for a roundabout. A high percentage of left-turning vehicles will impact roundabout capacity more quickly, since they will remain in the circulating path longer. Multi-lane roundabouts provide more vehicle capacity, but increase pedestrian and bicyclist exposure at crossings and may require further crossing design enhancements. Single-lane roundabouts are typically predicted to be safer and the most quickly accepted by roundabout skeptics.
- The size of a roundabout is greatly influenced by the choice of design vehicle. The design vehicle should be accommodated with a mountable apron on the central island. In multi-lane roundabouts, an appropriate design may require larger vehicles to use both circulating lanes to navigate the roundabout.

DESIGN RESOURCES

- Transportation Research Board (TRB)
    - *NCHRP Report 672* Roundabouts: An Informational Guide
    - *NCHRP Report 825* Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual
    - *NCHRP Research Report 834* Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities: A Guidebook
- Federal Highway Administration (FHWA)
    - Mini-Roundabouts: Technical Summary
    - Proven Safety Countermeasures

Unsignalized Intersections

Unsignalized intersections, where vehicles approaching an intersection face STOP signs, are the most common intersection type in any city in the region. A two-way stop control is generally used at intersections between a major and minor street, where the minor street approaches have a STOP sign installed. All-way stop control is generally installed at intersections where the approach streets have similar traffic or user volumes.

There are several types of unsignalized intersections – two-way stop control, all-way stop control and uncontrolled intersections. Each of these types is distinct and likely to be found in different settings. Two-way stop-controlled intersections are most common. They are found on local streets in residential neighborhoods and at many side-street intersections with higher classification streets. All-way stop-controlled intersections stop all approaching vehicles and are typically used for intersections of streets with similar volumes of vehicle travel. They also may be used to prioritize pedestrian crossings. Uncontrolled intersections are typically used only on very low volume local streets and require approaching drivers to yield to other approaching traffic to their right. As unsignalized intersections grow busier with motor vehicles or crossing pedestrians, a roundabout or signal may be warranted.

Photo snapshot

Potentially show an all-way or two-way stop near a school with good crosswalk markings.

Caption: Stop-controlled intersections can provide safe and comfortable spaces for all users in a variety of settings. Marked crossings can increase awareness and visibility of pedestrians.

DESIGN APPROACH

OVERALL INTERSECTION

- **Consider a variety of factors before choosing stop control**. These include motor vehicle volumes, pedestrian volumes, bicycle travel routes, approach visibility and crash history. If the intersection has had at least five crashes in the preceding 12 months, if the intersection has a high number of pedestrians, or if visibility is limited on at least one intersection approach, consider additional treatments or alternate intersection control methods.
- The most appropriate intersection control treatment should be designed to **maximize safety and manage conflicts**, allow efficient multi-modal operations, and provide appropriate accessibility.

CROSSINGS

- **It is imperative to provide increased protection and visibility for pedestrians** as vehicle speeds and volumes go up. If a street has more than 3,000 annual average daily traffic, speeds greater than 20 MPH, and at least two lanes of traffic, then marked crosswalks should be included. Even if these thresholds are not met, marked crosswalks should be considered at intersections approaching schools, parks, senior centers and other locations with significant pedestrian activity.

- **High-visibility crosswalk markings** – conventional, ladder or zebra markings – are preferable to standard or dashed crosswalk markings and produce higher yielding rates. Stop bars should be set back from the marked crosswalk to further enforce driver yielding behavior.
- **Additional design treatments**, in addition to a high-visibility marked crosswalk, may be needed to provide a safe and comfortable crossing. Additional treatments include curb extensions, median refuge islands, signing, rectangular rapid flashing beacons and pedestrian hybrid beacons (also see Midblock Crossings).
- **Median islands** are recommended when a pedestrian must cross more than two lanes of traffic. Other treatments are selected based on motor vehicle speeds, vehicle volumes, anticipated or actual pedestrian volumes, sight distance and other characteristics of the local context.
- **Visibility at intersections** is important, especially on uncontrolled intersection approaches. Removing parking near intersections (daylighting) can improve sight distance and increase driver yielding rates for crossing pedestrians.
- **Crossing spacing:** Metro's Regional Transportation Functional Plan suggests that accessible crossing points be placed no more than 330 feet apart.

TRANSIT CONSIDERATIONS

- **Sidewalks and safe crossings** at intersections are necessary for pedestrians to access transit. A general rule of thumb is to examine an approximately one-half mile walkshed around a transit stop (a 10-minute walk for the average adult). Looking within this walkshed, review unsignalized intersections and consider whether they present barriers for pedestrians trying to reach a given transit stop.
- The Transit Stop design element provides more design considerations for unsignalized intersections.

BICYCLE FACILITIES

- **Bike boxes provide a designated area for bicycles to queue** at the head of a traffic lane. While typically used at signalized intersections, bike boxes are appropriate on approach streets where vehicle queuing often forms or if a two-stage left-turn queue box may be needed to successfully navigate through an intersection.
- **Bicycle boulevards** are low motor vehicle traffic streets that run **parallel to major arterials and prioritize bicycle movement**. At unsignalized intersections, default to providing uncontrolled approaches on bicycle boulevards when intersecting with other minor streets. To be effective for moving people on bicycles efficiently, bicycle boulevards should have stretches of at least one-half mile without a stop sign.
- When a **bicycle boulevard crosses a major street** and no longer has the right of way, there are three classes of treatments for bicyclists: signs and pavement markings (including continental bicycle crossing striping), physical features (including median islands or curb extensions) and actuated crossing devices (such as beacons). Treatments should be selected based on vehicle speeds, number of lanes, and anticipated volumes of all users.

- **Some bikeways cross a major street at an offset.** Getting bicycle traffic across this major street – which has higher vehicle volumes and no STOP control – can be a challenge. In general, there are two strategies: use a median island that covers the distance between the offset minor street and allow bicycles to cross one direction of traffic at a time or use a bicycle facility on the major street to cover this offset distance and provide a single crossing location of the major street.

MOTOR VEHICLE LANES – THROUGH AND TURN LANES

- In urban areas, generally use narrower lanes, as described in the Motor Vehicle Travel Lanes element.
- A decision to include a **separate left-turn or right-turn lane is contingent upon several factors**, including crash history, turning vehicle volumes and pedestrian and bicycle activity. Turn lanes can reduce queuing and delay for motor vehicles; however, they increase crossing distance for pedestrians and should be discouraged in places with high pedestrian volumes. Right turn lanes may introduce conflicts with bicyclists traveling through the intersection.
- At two-way stop-controlled intersections, control turning vehicle speeds (particularly from uncontrolled approaches) through design. Consider including raised crossings, curb extensions and tight corner radii to slow turning vehicles while also benefiting pedestrians.
- Consider prohibiting one or more motor vehicle movements at unsignalized intersections to prioritize other functions (see Access Management).

DESIGN RESOURCES

- Metro
    - Regional Transportation Functional Plan
- National Association of City Transportation Officials (NACTO)
    - *Urban Street Design Guide* Intersections, Crosswalks and Crossings
    - *Urban Bikeway Design Guide* Intersection Treatments, Bicycle Boulevards
- Institute of Transportation Engineers (ITE)
    - Unsignalized Intersection Improvement Guide
- Federal Highway Administration (FHWA)
    - *Issue Briefs* STOP Signs
- Federal Transit Administration (FTA)
    - Manual on Pedestrian and Bicycle Connections to Transit

Midblock and Enhanced Crossings

Midblock and enhanced crossings provide direct pedestrian connections to destinations, in places where the nearest intersection crossing creates substantial out-of-direction travel.

Many local destinations, including schools, parks, libraries and restaurants are oriented to the middle of a block face or are at unsignalized intersections of major streets, away from existing signalized intersections. In places with large blocks or infrequent signals, using the nearest marked or signalized crossing may result in significant out-of-direction travel for a pedestrian. In these situations, pedestrians often cross at midblock or unmarked locations, regardless of whether a safe crossing is provided. Designing a midblock crossing (between intersections) with enhanced crossing treatments (a marked major street crossing at an unsignalized intersection) to meet this demand can improve safety and connectivity for pedestrians. A well-designed crossing should be clear and visible to all street users and mitigate potential adverse effects, such as rear-end vehicle crashes due to unexpected stops.

Design Element Sketch
A midblock crossing sketch

Photo snapshot
A street with a midblock crossing, such as Division/I-205 Multi-Use Path or Division near 129th, if possible with a bus stopped directly in front of it.

Caption: Midblock crossings, when appropriately located and designed, provide important connectivity and safety for pedestrians to access community destinations and transit. This crossing includes [list features]

DESIGN APPROACH

- In centers, where pedestrian activity is expected, enhanced crossings can be added to achieve an overall pedestrian crossing spacing of 200 to 530 feet. Placement should be carefully selected based on location of destinations, transit stops, pedestrian demand, vehicle speeds, sight distance and the ability to design a safe crossing, given the conditions of the street. Note that a pedestrian needing to travel 400 feet out-of-direction (200 feet on each side of the street) would be delayed by an additional two minutes. This amount of time is considered an unacceptable level of delay for motor vehicles at intersections, and is just as unacceptable to people walking.
- Outside centers, enhanced crossings should be provided approximately every 530 feet, when pedestrian demand is anticipated.
- On regional streets, prioritize high quality, safe crossings in alignment with the spacing guidance outlined above over numerous crossings with lesser design treatments.
- Select design treatments appropriate for the street to maximize safety and maintain priority functions. *National Cooperative Highway Research Project Report 562* provides guidance on

applying these treatments, including the following:

  - A **pedestrian signal**, which stops motor vehicle traffic during the entire pedestrian phase, can be provided to facilitate safe crossings if pedestrian volume or school crossing signal warrants are met and the location is not within 300 feet of another controlled crossing location. The *Manual on Uniform Traffic Control Devices* provides thresholds for signal warrants.
  - A **pedestrian hybrid beacon** is another treatment that provides pedestrians with a "walk" indication and stops vehicles with a red indication at the beginning of the pedestrian phase.
  - **Rectangular rapid flashing beacons** are pedestrian actuated flashing lights on the side of the street and signal to vehicles the need to yield to crossing pedestrians.
  - **Raised median refuge islands** can provide pedestrians a safe place to wait and allow them to cross one direction of traffic at a time. Provide an at-grade channel in the median and consider designing it at an angle to position pedestrians to be able to see advancing traffic.
  - **High visibility crosswalk markings and advance crosswalk warning signs** help ensure that drivers see the crossing well in advance.
  - Curb extensions narrow the crossing distance and make pedestrians more visible to drivers. Raised crosswalks require vehicles to slow down when approaching a crossing.
  - **Lighting** Midblock and enhanced crossings should be illuminated to ensure pedestrians using the crossing are visible to motorists. Pedestrian scale lighting also helps pedestrians safely navigate crossings after dark.

- In addition to regional streets, pedestrians and bicyclists also need to cross throughways. In many cases, the street network does not provide sufficient connectivity – or requires significant out-of-direction travel for pedestrians and bicyclists. Depending on the potential demand, context of the street network, and existing or planned land uses, consider providing a grade-separated crossing at these locations. A grade-separated crossing of a regional street may also be appropriate in places where motor vehicle mobility is prioritized, particularly if the crossing can be provided with minimal grades for pedestrians and bicyclists.
- When a midblock crossing is on a street with transit, the midblock crossing should be located behind transit stops. This avoids additional delay to transit vehicles and allows other motor vehicles behind the transit vehicles to see pedestrians before they enter the midblock crossing.
- Placement of enhanced or midblock crossings should also be designed in coordination with trail alignment, when trails are present. Because trails generally attract high numbers of pedestrians and bicyclists, the locations where trails cross regional streets typically need enhanced crossing treatments that result in consistent driver yielding behavior. Also see Regional Trails.

Table 14

Regional Design Classifications	Midblock and Enhanced Crossings								
	Grade separated crossing	Pedestrian Signal	Pedestian Hybrid Beacon	Rectangular Rapid Flashing Beacon	Median Refuge Island	Raised crossing	Enhanced signage	High Visibility Crosswalk	Bulb-outs
Freeways	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Highways	🟢	🟡	🔴	🔴	🟡	🔴	🟡	🟡	🔴
Regional Boulevard	🔴	🟡	🟡	🟡	🟢	🟡	🟢	🟢	🟢
Community Boulevard	🔴	🟡	🟡	🟡	🟢	🟢	🟢	🟢	🟢
Regional Street	🟡	🟡	🟡	🟡	🟢	🟡	🟢	🟢	🟢
Community Street	🔴	🟡	🟡	🟡	🟢	🟡	🟢	🟢	🟢
Industrial Street	🟡	🟡	🟡	🟡	🟡	🔴	🟢	🟢	🟡
Regional Trail	🟢	🟢	🟢	🟡	🟡	🟡	🟡	🟡	🟢

🟢	Preferred design treatment
🟡	Potential design treatment
🔴	Not a typical design treatment

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
  - *Urban Street Design Guide* Midblock Crosswalks
- Institute of Transportation Engineers (ITE)
  - Designing Walkable Urban Thoroughfares: A Context Sensitive Approach

Regional Trails

Regional trails provide walking and bicycling connections across counties, cities and neighborhoods in our region.

Metro defines regional trails as multi-use paths for non-motorized users that are physically separated from motor vehicle traffic for at least 75 percent of their length and connect multiple regional destinations such as regional centers, town centers, regional parks or natural areas, high-frequency transit or other regional trails. Bikeways and sidewalks on bridges are also included in this definition. Some segments of regional trails may exist in the right of way, as a separated multi-use path. On-street bike lanes and sidewalks that connect two regional trails) typically consist of a combination of sidewalks, separated bicycle lanes or low-stress bikeways and must provide a “trail like experience.” While all trails can serve a transportation function, not all regional trails identified on Metro’s Regional Trails and Greenways Map are included in the Regional Transportation Plan (RTP). The RTP includes regional trails that support both utilitarian and recreational functions. These trails are generally located near or in residential areas or mixed-use centers and provide access to daily needs. Trails in the RTP are defined as transportation facilities and are part of the regional transportation system. Regional trails in the RTP are eligible to receive federal transportation funds. Trails that use federal transportation funds need to be ADA accessible according to the AASHTO trail design guidelines. There are some pedestrian only trails or trails near sensitive habitat on the RTP network that most likely will not be paved. In these cases, regional bicycle connections are planned parallel to pedestrian only regional trails.

Guidance in this section is intended for these regional trails that serve a transportation function, in addition to recreation. Metro’s *Green Trails* focuses on developing soft-surface trails in natural areas; those types of trails are not covered within this guide. For the purposes of this guide, “multi-use path” is used to describe hard-surface trails outside the street right of way or parallel to the street or throughway, while “on-street connection” refers to on-street bikeways and sidewalks within the street right of way that connect regional trails .

As part of our transportation system, regional trails contribute to our systemwide outcomes in important ways. They can also serve some key design functions, including:

- Pedestrian and bicycle mobility and access
- Place-making and public space
- Places to bring nature into the urban environment
- Places to restore or enhance the natural environment
- Space for outdoor recreation
- Routes for emergency response and evacuation
- Routes for utility maintenance
- Flood storage

REGIONAL TRAIL DESIGN PRINCIPLES

There are a variety of designs that are appropriate for regional trails, depending on the context and intended use of the trail, and these principles apply to both multi-use paths and on-street connections. In addition to the street design principles at the beginning of this chapter, regional trails should be designed in alignment with the following five principles:

Serve the anticipated users. Understand what types of users and how many are likely to use the trail. Figure 1 lists some of the typical uses of trails. Different user types travel at different speeds, and trail design needs to account for potential interactions between users. People walking travel anywhere from 1 to 3 mph while moving, and may pause frequently. They may travel in wheelchairs, push strollers or have dogs on leashes. An average jogger travels about 6 mph while an average bicyclist travels at 10-12 mph, and some move more slowly. E-bikes enable people to travel faster, on average, at 20 mph or higher. Trail design must account for these users, and more. As technology developments continue to offer new travel methods, trails are likely to attract people traveling in new ways.

Provide safety and security. Designing for safety and security on trails needs to consider a variety of aspects. Safety generally refers to protecting against crashes between users and needs to be considered in measured in several ways – safety between different users traveling on the trail, especially in conditions with a high mix of user types, and through safe street crossings. Security refers to people not feeling vulnerable to personal harm from others. Design can improve security, such as landscaping that maximizes visibility, adequate lighting, frequent access points and avoiding enclosed spaces.

Integrate trails with the street system and within neighborhoods. In selecting a trail alignment, consider its context. Try to avoid trails in the floodplain; when this is not feasible, identify an alternate route for use during high water events as part of the design. Try to select direct routes that avoid excess out-of-direction travel. Select and design street crossings that are safe and convenient, and minimize street crossings where possible. Utility corridors, waterways and rail corridors may already have right of way and can simplify trail alignment. To integrate with neighborhoods, consider how the trail will interact with land uses adjacent to its alignment, and provide frequent well-defined, visible access points where possible to ensure local communities have ready access. Creating opportunities for local involvement and investment in the trail, through art, gardens, volunteering and programs can help create ownership and local stewardship of the trail. Include wayfinding to help trail users orient themselves and find their way to destinations.

Figure 1

Pedestrians
- Walkers
- Runners
- Wheelchair users
- People with visual impairments
- Dog-walkers

Bicyclists
- Electric bikes
- Recumbent bicyclists
- Children riding bikes
- Tandem bicyclists
- Bicyclists pulling trailers
- Pedicabs

Other users
- Inline skates
- Autonomous delivery pods
- Other electric-powered modes
- Equestrians
- Skateboarders

Caption: Trails are not just for people walking and biking, and even those who walk and bike do so in a variety of ways. This table captures just some of the variety of users on our regional trails.

Fit the land use context. Trails traverse each of the various contexts in this region – they are located in and between regional centers, as well as in natural areas. Trail design must reflect these different land use types. Trails in centers should encourage slower speeds, especially where users are mixed, and consider how "lingering" and "movement" will coexist. In centers, trails should provide easy connections to the many destinations in these areas. Trails carrying people between centers can focus more on efficient and direct movement. These are trails that may serve as commute routes for people walking or biking to work. Trails in natural areas should be designed to avoid, minimize or mitigate ecological impacts. Consider low or no lighting and maximize setbacks from sensitive areas to avoid impacts on habitat, wildlife and water quality.

Respect the natural environment. Trails can be an avenue to foster and enhance the natural environment, even within an urban context. Introducing trees and natural landscaping can enhance benefits to trail users and wildlife. Designs should be harmonious with existing wildlife habitat and avoid, minimize or mitigate wetland impacts. Incorporating nature improves local and regional air quality, reduces erosion risk and helps manage stormwater runoff.

MULTI-USE PATHS

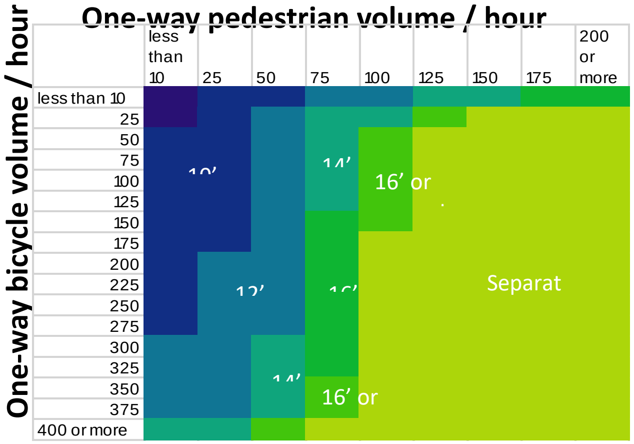
Within this guide, multi-use paths refer to the hard-surface regional trails outside the street right of way. People in the greater Portland area already enjoy a wide variety of multi-use path designs across the different communities and contexts of the region as shown here. The specific design approach for multi-use paths relies on the trail design principles above.

DESIGN APPROACH

Design Element Sketch #1

- **Trail widths** Develop estimates of anticipated users for the planning horizon, and use Figure 2 to find a starting point for the width of the multi-use path. In busier areas, the mix and volume of anticipated users may be best served with separate or delineated spaces within the trail. Figure 2 uses one-way pedestrian and bicycle volumes per hour. In considering other types of users, count slower-moving users as pedestrians and faster ones as bicyclists.

Figure 2



After selecting a starting point from Figure 2, consider increasing or decreasing the width or separation based on the following factors in Table 15:

Table 15

Increase width / separation	Decrease width / separation
In centers, where “lingering” is expected	In environmentally sensitive environments
In places where a variety of user-types are anticipated	In physically constrained settings
In places with frequent access points	To encourage slower speeds
If needed for emergency vehicle access	Where space is available (8’ widths to be applied for short distances only in constrained environments)

Design Element Sketch #2

- **Separation of users** If it is appropriate to separate pedestrians and bicyclists, evaluate the options available within the trail context. If sufficient width is available, consider providing distinct paths for pedestrians and bicyclists, separated by a buffer. New portions of the Southwest Waterfront trail in Portland are designed in this way. In places with constrained widths, consider using paint (striping or symbols) to delineate spaces, or use different surface materials without including an additional buffer.
- In practice, the **target speed and design speed should be the same**, and a roadway encourages an actual operating speed at the target speed. Target speed can be defined as the speed at which vehicles should operate on a roadway given the land use context, multimodal activity, and vehicular mobility.
- Street crossings must be designed for safe and comfortable crossings at streets. See the Midblock and Enhanced Crossing element for appropriate treatments. Trails should be aligned to cross streets in locations where a crossing can be built and the appropriate design for safety can be met as outlined in the NCHRP Report 562 methodology. Trail users should not be expected to travel out of direction to reach a crossing. On regional trails, trail users should be given priority at crossings whenever possible. NCHRP Report 562 provides a framework for examining an appropriate crossing device based on roadway speed, roadway volume and crossing distance. In some situations, grade separate crossings are more appropriate.

- **Trail intersections** should meet at 90-degrees with adequate sight distance, wherever possible, and turning radii kept away from the intersection. Signage should be placed prior to an intersection, and trails with significantly lower volumes should have a stop sign. Trails that merge – for example, two trails that meet at a narrow angle with no control signage – should be avoided.
- **Access points** should be easily visible and provide adequate sight distance for trail users to avoid collisions. Include wayfinding and signage at access points. Trails and access points should intersect at or as close to 90 degrees as possible. At locations with heavy use or higher speed trail users, consider intersection treatments to manage flows. Trail “roundabouts” can reduce conflict and tightening corner radii with physical objects can slow users.
- **Lighting** should be used on all transportation facilities. Lighting can address real and perceived safety concerns for trail users, but may not be not necessary or appropriate along all parts of a trail, however, particularly in natural areas with wildlife habitat. In these areas, lighting should be limited only to essential locations – street crossings, underpasses, or other conflict points. Important considerations include spectrum, intensity (in general, lower intensity is better), direction (never direct light upwards) and duration. Refer to the lighting design element for more information.
- **Bridges, fences, walls and other structural elements** should be designed to enhance the trail users experience and safety and minimize conflicts. Bridges can be an opportunity to enhance the identity of the trail and create an iconic landmark. Bridge decking materials should be usable when wet without becoming slippery. Bridges are often an ideal place for trail users to pause, rest and enjoy the views – design spaces to facilitate this. Trails need at least two feet of shy distance (more in high-traffic areas) from the edge of the paved trail to any walls, light fixtures, trees or other vertical elements. On curved trail sections, improve sight distance by minimizing features adjacent to the trail or by using permeable features and fencing. In locations where trails need to incorporate switchbacks in order to reach a certain level without exceeding accessible grades, also use stairs to provide a more direct route for pedestrians who wish to use it. Grades should not exceed five percent and should be kept to a minimum as much as possible.

Caption: The Trolley Trail follows the MAX Orange Line in Milwaukie. This winding section of the trail incorporates existing natural elements maintaining appropriate sight distance for trail users.

Caption: The Springwater Corridor along the Willamette River has visually permeable fencing that allows users to see what is coming around the bend. The presence of railroad tracks on one side and the Willamette River on the other side limits the shy distance for this section of the trail.

Caption: The I-205 Multi-Use Path parallels I-205 and the MAX Green Line through Multnomah and Clackamas counties. A striped yellow line delineates two-way traffic on the trail.

Caption: The Willamette River Greenway Trail in Portland's South Waterfront separates between walking and biking modes, while providing pedestrian-scale lighting and incorporating places for people to stay and linger.

DESIGN RESOURCES

- Metro
    - Intertwine trail counts and survey data
- Federal Highway Administration (FHWA)
    - *Small Town and Rural Multimodal Networks*

- American Association of State Highway Transportation Officials (AASHTO)
    - Guide for the Development of Bicycle Facilities, Fourth Edition
    - Guide for the Development of Bicycle Facilities (forthcoming)
- Transportation Research Board (TRB)
    - NCHRP Report 562: Improving Pedestrian Safety at Unsignalized Crossings
- United States Access Board
    - ADA Standards for Transportation Facilities
    - *Supplemental Notice of Proposed Rulemaking* Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way; Shared Use Paths
- Washington State Department of Transportation (WSDOT)
    - *Design Manual* Chapter 1515 Shared-Use Paths
- Colorado Department of Transportation (CDOT)
    - *Roadway Design Guide* Bicycles and Pedestrian Facilities
- Massachusetts Department of Transportation (MassDOT)
    - Shared Use Path Design Guide (forthcoming)
- City of Toronto
    - Toronto Multi-Use Trail Design Guidelines
- CROW Manual

On-Street Trail Connections

On-street connections make links between segments of multi-use paths and should be designed to provide travelers with a trail-like experience.

On-street connections use the street network to extend a trail or to make connections in the network where off-street paths are not feasible. Designs of these on-street connections cover a range of facility types, but all should continue to prioritize safety, mobility and access for trail users. Within the greater Portland area, the trail network already has many on-street connections with a variety of configurations.

DESIGN APPROACH

- The on-street trail connection must serve the anticipated needs and functions for various users. The connection must serve bicyclists of all ages and abilities, and it must provide comfortable and adequate space for walking.
- An on-street trail can be designed in a variety of configurations:
    - On streets with average annual daily traffic over 1,000 all trail users need space physically separated from motor vehicle traffic. This can take several forms:
        - Sidewalks and separated bike lanes on each side of the street – this configuration is appropriate along streets with frequent access points and where the on-street connection continues for more than a couple blocks. This configuration needs to design for transitions between the multi-use path and the bicycle lanes on each side of the street and should be examined on a case-by-case basis. These transitions may occur as part of intersections and/or midblock crossing depending on the context and locations.
        - Sidewalk and two-way separated bike lanes on one side of the street – this configuration is most appropriate when one side of the street has few or no access points, and therefore would have few motor vehicle conflicts with users. It also offers the possibility of transitioning to and from the multi-use paths without needing to cross the street.
        - A multi-use path on one or both sides of the street with a minimum 5-foot separation from the street – this configuration is also appropriate when the street has few or no access points. It also offers the possibility of transitioning to and from the trail without needing to cross the street. A multi-use path is more space efficient than separated bicycle lanes and sidewalks and can be used when trail user volumes do not warrant separation.
    - On streets with average annual daily traffic below 1,000, on-street connections where bicyclists share space with vehicles are appropriate. On streets with very low vehicle volumes with low speeds, all users, including pedestrians, can comfortably share the street. Trail

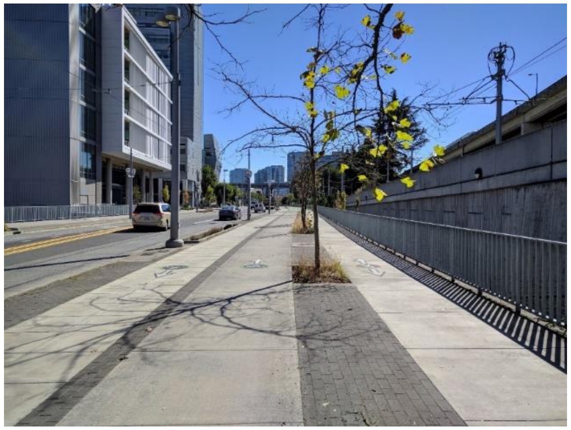
wayfinding and shared lane markings should be used to reassure trail users that sharing the travel lane is appropriate.

- Focus design attention at conflict points (such as driveways and intersections) where vehicles may conflict with trail users, designing to manage speeds and ensure awareness and visibility of trail users. A shared street design on streets with very low vehicle speeds and volumes can reduce conflicts.
- Use wayfinding to direct users to and from the on-street connection – and back to the off-street multi-use path. Wayfinding can also direct users to destinations and other amenities.

Photo snapshot

On-street trail connection – the Springwater Corridor in Sellwood, SW Miles Place

Caption: The Springwater Corridor's on-street connection on SE Umatilla Street in Portland's Sellwood neighborhood is integrated onto an existing neighborhood greenway. The result is a shared street for bicycles and vehicles, with pedestrians traveling on the sidewalk.



Caption: SW Moody Avenue provides a separated walking and biking connection to the Tilikum Crossing, the Springwater Corridor and the Willamette River Greenway.

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
    - ○ *Urban Bikeway Design Guide* Bicycle Boulevards
- American Association of State Highway Transportation Officials (AASHTO)
    - ○ Guide for the Development of Bicycle Facilities (forthcoming)
- United States Access Board
    - ○ ADA Standards for Transportation Facilities
- Washington State Department of Transportation (WSDOT)
    - ○ *Design Manual* Chapter 1515 Shared-Use Paths
- Colorado Department of Transportation (CDOT)
    - ○ *Roadway Design Guide* Bicycles and Pedestrian Facilities

PERVIOUS STREET AND TRAIL SURFACES

Street and trail surface selection, in some cases, can reduce the environmental impact of a paved surface.

Pervious surfaces are paving types that allow for water to permeate but which also support pedestrian, bicycle and sometimes motor vehicles without compromising the design. Firm pervious pavement surfaces for streets and trails include porous asphalt, porous concrete and permeable unit pavers, described below. Application of pervious pavement is evolving and should be considered in conjunction with other stormwater treatments and within the context of the street. It is especially recommended for consideration in areas that have been identified as susceptible to flooding or in areas where space constraints prohibit street trees or other green street treatments.. Pervious pavement systems should not be used where infiltration cannot be managed below the surface, such as over parking garages.

Permeable Asphalt: Similar in appearance to asphalt seen in most street roadways in the region. This pavement type is poured-in-place with fine aggregate removed from the mix, which allows water to pass through its profile.

Caption: A roadway section of pervious asphalt.

Permeable Concrete: Similar in appearance to typical concrete that is used in some roadways and many sidewalks within in the region. The pavement is poured-in-place with fine aggregate removed, which allows water to drain through its profile.

Caption: Sidewalk section of porous concrete alongside Warner-Milne Road in Oregon City.

Permeable Pavers: Interlocking, manufactured modular units are set in place with layers of sized aggregate that allows for water to pass through. The special design of the units allows for water to infiltrate between their butting joints into the aggregate layers and subsoil below. Good soil infiltration rates allow for simpler design of pavement profiles. However, if infiltration rates are low, sheet flowing to landscape areas and additional subsurface rock layers for detention and/or underdrain pipes may be necessary. Permeable pavers come in many shapes and colors and should be installed with a restraining edge. Most permeable pavers on the market meet Americans with Disabilities Act (ADA) requirements, however, evaluate their application carefully in areas with significant levels of pedestrian activity.

Caption: Permeable pavers in on-street parking adjacent to a standard asphalt paving. The pavers are held in place by raised and flush curbs. Note the drainage notches in the raised curb which can direct runoff that is not able to infiltrate during larger storm events or in circumstances in which the surface is clogged.

Caption: Eastbank Esplanade in Portland across from downtown at an overlook plaza. The contrasting use of unit pavers creates a different feel from the main concrete trail where bikers, runners, and walkers travel along. This gives users a visual and tactile indication to slow down and defines the space as more oriented to lingering.

DESIGN APPROACH:

- Minimize impermeable pavement sections that are not necessary within the street design, while still fulfilling the priority functions and providing safe, accessible movement.
- Select appropriate pavement for accessible routes. Pavement must be designed in alignment with Americans with Disabilities Act guidance to ensure that people of all abilities can navigate sidewalks, crosswalks, paths and trails and pedestrian crossings.
- Permeable asphalt, permeable concrete, and the joint spacing in permeable pavers can get clogged by roadway materials. Therefore, consider how stormwater run-off will be managed if this occurs.
- Consider the maintenance needs of different pavement types and where they are installed (street, pedestrian surface) and the capabilities of jurisdictions responsible for maintenance.
- Areas that are prone to flooding should be evaluated for potential application of permeable street treatments.

DESIGN RESOURCES

- Interlocking Concrete Pavement Institute
    - *https://www.icpi.org/*
- National Association of City Transportation Officials (NACTO)
    - *Urban Street Stormwater Guide* Stormwater Elements: Permeable Pavement

Lighting

Street lighting, designed specifically for various users, helps foster safe and livable streets, even after the sun goes down.

Street lighting must be designed appropriately for the users anticipated on the street – and lighting needs for pedestrians using the sidewalks are different from the needs of drivers in the center travelway. While street lighting is appropriate and needed on most regional streets, lower levels of lighting may be appropriate in other areas. In centers and at key landmarks, such as bridges, lighting can be designed creatively to contribute to the identity of the place. Lighting designs should also consider wildlife sensitivity and light pollution, particularly in environmentally sensitive areas. Nighttime light can impact wildlife habitat, migratory patterns and plant growth. Downward-pointing fixtures and reduced brightness can be used to minimize light pollution.

Photo snapshot

An evening photo along a street with lots of outdoor seating, people walking, and pedestrian-scale lighting

Caption: Pedestrian-scale lighting effectively extends business hours and creates a more pleasant street environment at night, both of which help create more livable communities across the region.

DESIGN APPROACH

- **Select lighting based on the following lighting design framework** to provide safety and security while also mitigating potential adverse effects of light pollution.
    1. Determine if lighting is needed for safety – especially for visibility of people walking and bicycling at intersections and crossings.
    2. Choose the lighting spectrum, avoiding use of ultraviolet or blue light. Consider the impacts of the light on habitat. Consider lighting that minimizes glare and reduces light pollution.
    3. Reduce the intensity of lighting where possible. Using an appropriate intensity can also reduce shadows, creating a great sense of security.
    4. Direct light only where it is needed, and shield it from locations where it is not. Lighting should never be directed upwards.
    5. Use motion detectors and timers to limit the duration of lighting only to times when its needed, reducing light pollution and saving energy.
- Lighting should not be placed directly over a crosswalk, since this does not adequately illuminate a pedestrian. Lighting should be located before a vehicle reaches the crosswalk to better illuminate crossing pedestrians.
- Roadway lighting, intended to provide visibility for drivers, should meet uniformity standards and required illumination levels. At intersections and crossings, ensure that all approaches are illuminated to cast light on approaching vehicles or pedestrians.

- To serve pedestrians, and particularly in centers, use pedestrian scale lighting along sidewalks and walkways and particularly at transit stops. Pedestrian scale lighting can increase security and create places where people feel comfortable traveling after dark. Warm yellow lighting creates a more welcoming environment, and dimmer lights reduce glare. Lighting angles should be set to minimize glare for people walking on the street.
- In selecting lighting fixtures, also consider the following: energy requirements, adaptability to new technology, maintenance needs, aesthetics and availability.
- Poles should be placed in the street furniture zone of the sidewalk or other location that does not impede pedestrian travel. When possible, space poles away from street trees.

DESIGN RESOURCES

- National Association of City Transportation Officials (NACTO)
  - *Urban Street Design Guide* Sidewalks, Commercial Shared Street, Visibility/Sight Distance
- Federal Highway Administration (FHWA)
  - Informational Report on Lighting Design for Midblock Crosswalks
- U.S. Department of Energy
  - *Solid-State Lighting Program* Pedestrian-Friendly Outdoor Lighting
- U.S. Department of the Interior
  - Artificial Night Lighting and Protected Lands
- City of Seattle
  - *Seattle Department of Transportation* Pedestrian Lighting Citywide Plan
- International Dark-Sky Association
  - Fixture Seal of Approval

Wayfinding

Wayfinding refers to information, signs, maps and intuitive spatial design that helps people move through a space. Pedestrians and bicyclists may have the time to linger and consider a more detailed map of destinations and routes, particularly in centers. In other cases, system users are on the move and often need wayfinding to be easy to understand and provide clear, concise direction. Above all, wayfinding should be welcoming and simple to facilitate seamless use of our streets and trails for all users.

For more information on wayfinding on regional trails, reference Metro's *Intertwine Regional Trail Wayfinding Sign Guidelines*.

Caption: Effective wayfinding is simple to understand, regardless of how much information may be presented. Strong branding will help people recognize upcoming wayfinding signage. The decorative bicycle element along Clinton Avenue celebrates bicycling and identifies the route as a bicycle boulevard.

Caption: Intertwine Trail signage cohesive identity of the region's network of trails.

Caption: Pedestrian wayfinding in Forest Grove points the way to major destinations. Photo: Directional street sign to freeway or highway

Caption: Street signs help all users navigate their way around the region.

DESIGN APPROACH

- **Use intuitive and different designs and placement of wayfinding messages** depending on the intended user. Pavement markings for bicyclists provide continuous, easy-to-understand guidance. Wayfinding signage on poles should be legible while in motion and placed near eye level for pedestrians and bicyclists. Avoid placement of signs that protrude into the pedestrian through zone or area of bicycle travel. Wayfinding can also be supplemented by pavement color, design or material. Wayfinding for motor vehicle drivers should always follow the Manual on Uniform Traffic Control Devices (MUTCD) and should be in locations that do not obstruct sightlines between other modes of transport.

- **Use consistent branding** on all types of wayfinding. A consistent brand allows users to immediately identify a wayfinding sign and communicates relevant information quickly. This applies to mode-specific wayfinding and neighborhood-level signage, among other scenarios. While the MUTCD mandates much of motor vehicle wayfinding, transit stop and station branding is a good model for all other types of wayfinding.
- **Bicycle wayfinding signage is most important at intersections**. There are generally three types of wayfinding messages that are used on bicycle routes: a decision sign, a turn sign, and a confirmation sign. A decision sign provides information on upcoming destinations and distances, where riders need to make a route choice. A turn sign directs bicyclists to turn at a specific intersection in order to follow a particular route. A confirmation sign simply confirms that the bicyclist is on a particular route.
- **Sightlines** should allow people to see and recognize upcoming destinations, when possible.
- **Users should not need to speak English to understand a wayfinding sign**. Signage should minimize language and use pictures and maps that are easy to understand across cultures.
- **Universal design principles** will help all users understand wayfinding signage. Text sizes should be large enough for people of all ages to see, and straight-forward, sans serif fonts are preferred.
- **Sense of place, identify** wayfinding and signs can help create a sense of identity.

DESIGN RESOURCES

- Metro
    - The Intertwine Regional Trails Signage Guidelines
- National Association of City Transportation Officials (NACTO)
    - *Urban Bikeway Design Guide* Bike Route Wayfinding Signage and Markings System
    - *Transit Street Design Guide* Passenger Information & Wayfinding, System Wayfinding and Brand
- Federal Highway Administration (FHWA)
    - Manual on Uniform Traffic Control Devices (MUTCD): 2D. Guide Signs – Conventional Roads
- Massachusetts Institute of Technology (MIT)
    - *Designing Navigable Information Spaces* Design Principles for Wayfinding

Place-making Amenities

Designing for the local context brings focus onto our neighborhoods, block faces and street corners. These are the places where people spend their time. They are the places people remember. Creating places for the community starts at this scale, and local people must drive this place-making process. Streets and trails can be designed to provide the canvas for places – places that provide social opportunities and create a comfortable environment. Incorporating room for art, vegetation and flexible public space can provide an avenue for local residents to build the identity of their community. Table 16 provides guidance on when specific place-making elements are appropriate to implement.

Photo snapshot

A street or intersection featuring place-making amenities – painted intersections, Orenco Station area, people on benches along a street

Caption: Place-making - provides an opportunity to remake city streetscapes and orient them around human experiences. Specific information on photo location to come.

DESIGN APPROACH

- The most successful place-making projects are bottom-up processes with community input and buy-in. Consider partnering with local artists to develop designs, incorporate local preferences and support the local economy. Working with the community will shape the street design process in ways that they want.
- Create places for people to linger at key points along the street – either standing or sitting. Select places where people may want to stay to observe or participate in activities around them. Providing seating – either through benches or with low walls, steps or other surfaces that can serve as a place to pause.
- Fountains, trees, landscaping, murals, sculptures and other visual features invite people to sit, linger and enjoy their surroundings. In some cases, portions of the street right or way or space from adjacent parcels can be allocated to parklets or public plazas.
- Some of the best place-making projects are used in ways that go beyond the original vision and develop organically over time. When developing street designs, create flexible public space that can evolve or be programmed for different uses, depending on the time of year and local community desires.
- Consider ongoing costs and maintenance when developing public spaces and amenities.

Table 16

Regional Design Classifications	Place-making Elements									
	Seating	Street Furniture	Street trees	Planters / landscaping	Community art /murals	Sidewalk Cafes	Parklets, plazas, and fountains	Wayfinding	Ornamental / Pedestrian Lighting	Community Programming
Freeways	🔴	🔴	🔴	🟡	🟡	🔴	🔴	🔴	🔴	🔴
Highways	🔴	🔴	🔴	🟡	🟡	🔴	🔴	🔴	🔴	🔴
Regional Boulevard	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢
Community Boulevard	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢
Regional Street	🟡	🟡	🟢	🟢	🟢	🟡	🟡	🟢	🟢	🟡
Community Street	🟡	🟡	🟢	🟢	🟢	🟡	🟡	🟢	🟢	🟡
Industrial Street	🔴	🔴	🟡	🔴	🟡	🔴	🔴	🟡	🔴	🔴
Regional Trail	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🟢	🟢	🟡

🟢	Preferred place-making element
🟡	Potential place-making element
🔴	Not a typical place-making element

DESIGN RESOURCES

- Project for Public Spaces
    - *Public Space Resources* What is Placemaking?
    - *Placemaking* What if We Built Our Cities Around Places?
- National Endowment for the Arts
    - *The Mayor's Institute on City Design* Creative Placemaking
- Urban Land Institute

    - *UrbanLand* 10 Best Practices for Creative Placemaking
- National Association of City Transportation Officials (NACTO)
    - *NACTO Designing Cities* Chicago's Placemaking Programs

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Chapter 5: Visualizing Livable Streets and Trails

VISUALIZING LIVABLE STREETS AND TRAILS

No two streets or trails will be designed exactly the same. Street and trail design, whether it occurs in one major project or over time through phasing and incremental changes, depends on many different factors, from the surrounding and planned land uses to the various functions that the street or trail serves. This chapter provides a few illustrative examples of the street design types and trails described in Chapter 3 in a variety of contexts. Context - where the street or trail is located – has a huge influence in how the street or trail will function and feel. Depending on the context there may be more or less right of way. This too will influence the design and the design elements that can be used to support the various functions the street or trail serves. Design elements can be combined in endless variations to serve the unique needs of different communities.

[*This chapter will include between 10 and 15 renderings of regional streets and trails to illustrate the various ways in which regional streets and trails will "look" and function depending on the context]*

Chapter 6: Performance-Based Design Decision Making Framework

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PERFORMANCE-Based Design Decision Making Framework 3

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PERFORMANCE-BASED DESIGN DECISION MAKING FRAMEWORK

Photo:
Possibly Portland – Moody
multi-use path– South
Waterfront – emphasize
economic development/nature
(river) – maybe shot from the
tram or high up

[Caption: A performance-based design process continuously focuses on system wide outcomes and ensuring that the final design stays true to transportation and land use system plans, adopted policies, stakeholder engagement and decisions made during the funding process.]

6.1 Policy Guides Decision-Making

This chapter ties together the guidance from prior chapters in a performance-based design decision-making framework. Our region has agreed on outcomes we are seeking to achieve, as described in Chapter 2. Achieving these outcomes means adhering to the design principles described in Chapter 4 and serving specific functions on our transportation corridors; these functions are described in Chapter 3. Supporting these functions relies on selecting the design elements, described in Chapter 4, and designing them to maximize key functions and systemwide outcomes.

This chapter describes a decision-making process that allows practitioners the flexibility to develop solutions that will serve the key functions and lead greater Portland to these system wide outcomes while balancing project costs and other constraints.

What types of project does this guidance apply to?

The performance-based design decision-making framework is most focused on projects addressing established street corridors, intersections and regional trails. As written, the framework is geared towards reconstruction, modernization or new construction projects. These are major investments in our system and it is critical that their designs contribute to our systemwide outcomes. The decision-making framework is typically initiated after a project has been identified as a priority in a system plan, at the point when resources are identified to move forward into concept planning and design. In some cases, funding for final design and construction is identified early in the process prior to initiating the decision-making process. However, in other cases, funding is secured incrementally through competitive funding sources as the design progresses.

The framework acknowledges and considers that the majority of transportation investments occur within our existing system, one in which there are a variety of real constraints, including funding, competing objectives, existing infrastructure, physical constraints and traditional standards.

The decision-making framework can also be applied to preservation or pavement maintenance projects. Preservation projects typically focus on the pavement surface between curbs. Even within this more limited scope, however, there can be opportunities to re-examine the street design. Practitioners can use an abbreviated version of the decision-making framework to review the street's existing functions and determine if a different allocation of the street surface would better support the desired functions. Repaving projects can be used to add bikeways, buffers, transit treatments and enhanced street crossings.

While the details included in this chapter primarily address streets, trails and intersections, the overarching process and framework should also be applied to new roadway alignments, interchanges, bridges or other transportation projects under consideration within greater Portland. More detail on applying performance-based design can be found in *NCHRP Report 785: Performance-Based Analysis of Geometric Design of Highways and Streets.*

Design elements support functions to achieve outcomes.

Frontage zone
Pedestrian through zone
Street furniture zone
Street corners
Planters, swales, & basins for stormwater
Flex zone: On-street parking & other uses
Surface stormwater conveyance & detention
Other buffer elements
Motor-vehicle travel lanes
Medians
Traffic calming
Access management/driveways
Shared streets & spaces
Dedicated bicycle facilities

Pedestrian Access & Mobility
Bicycle Access & Mobility
Transit Access & Mobility
Truck Freight Access & Mobility
Auto Access & Mobility
Place-Making & Public Space
Corridors for Nature & Stormwater
Utility Corridors
Physical Activity
Emergency Response

Safety
Healthy People
Healthy Environment
Social Equity
Reduced Green House Gas Emissions
Vibrant Communities
Transportation Choices
Sustainable Economic Prosperity
Efficient & Reliable Travel
Resiliency
Security
Fiscal Stewardship

6.2 Performance-Based Design Decision-Making

Performance-based design can be described as an evolution away from a traditional standards-based design approach to an approach that expands design parameters to be more flexible and context sensitive.

Performance-based design starts with a well-defined project need, goals and related objectives, and then works to align design decisions with achieving the project objectives and furthering systemwide outcomes.

This approach relies on development and comparison of design alternatives, employing performance measures and analysis to assess progress towards objectives, and using engineering judgement informed by a multi-disciplinary team to reach a preferred design.

Other key features and benefits of a performance-based design decision-making approach include:

- Promotes responsible use of public resources to get to the outcomes that are most important and avoid the unnecessary expense of a "one-size-fits-all" approach.
- Meaningfully engages communities in project decision-making
- Provides transparency in decisions through data-driven performance measurement and documenting community needs and design decisions, especially as trade-offs are considered.
- Holistically considers implications for systemwide outcomes to work towards the lowest cost action that will adequately address the project need.
- Supports developing connected networks of streets and trails that serve all types of travel and support other community functions.

With performance-based design, each investment in the regional transportation system is carefully planned and designed to ensure projects support systemwide outcomes described in Chapter 2.

Decision-making Framework

From the outset, a performance-based design approach clearly articulates and documents the following:

- ☐ What is the "catalyst" for an investment, that is, the highest need or the "problem" we are trying to solve? In National Environmental Policy Act documentation, this is referred to as the "purpose and need." (See sidebar in Step 4)
- ☐ Who will the project serve and who will be impacted by the project?
- ☐ What are the more detailed goals or objectives of this specific project? Some of these objectives relate directly to the project functions described in Chapter 3.
- ☐ Finally, there's a vision of what the project can do for the whole region. How will this project address the "problem" and also contribute to systemwide outcomes described in Chapter 2?

A multi-discipline project team improves decision-making to develop design based solutions

Agencies should strive to create multi-disciplinary project teams that collaborate throughout the planning and design process. Including multi-disciplinary technical staff and teams helps ensure that the needs of the community are met, that projects are feasible and that desired outcomes are met.

Involving individuals with an array of relevant technical skills – such as civil engineering, landscape architecture, natural resource preservation and geotechnical – early in the project, particularly in developing and evaluating alternatives, allow teams to identify and address feasibility or implementation challenges early on.

Involving individuals with policy and community engagement skills throughout the development of the final design can help ensure that later design decisions continue to align with policy goals and community needs and priorities.

The following page illustrates an overarching performance-based design decision-making framework. Each of the eight steps in this decision-making framework is then expanded in the following sections, with the following elements also included:

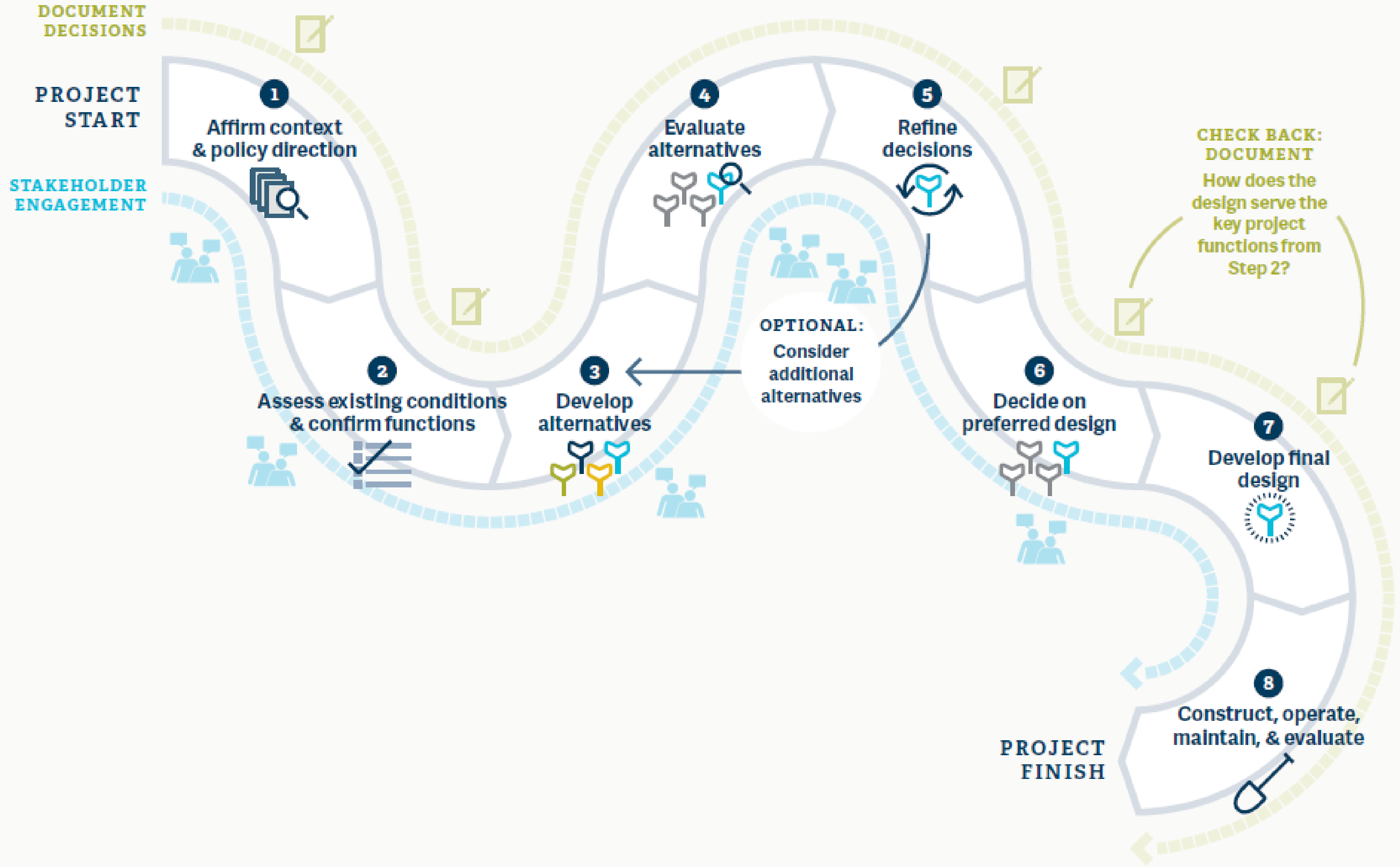
Stakeholder Engagement Key to transparent performance-based decision-making is engaging diverse, multi-disciplinary viewpoints and impacted communities to make sure the design represents community goals. Best practices for stakeholder engagment opportunities are included in each step, where applicable. These best practices on stakeholder engagement are intended to align with and support, not replace, local processes already in place.

Document Documenting planning and design decisions, along with the reasoning behind the decision, will tell the story to stakeholders and the public and will also reduce legal risk for the implementing agency. Suggested documentation is included in each step, where applicable.

Existing Tools or Examples Various agencies have already developed tools or practices to accomplish each of these steps. These tools can provide useful insights or a potential starting point for agencies within the Portland metropolitan area. Existing tools and examples are included in each step, where applicable.

A performance-based design decision-making framework contributes to systemwide networks and regional outcomes.

It starts with a well-defined project need and clear objectives.



STEP 1 AFFIRM CONTEXT AND POLICY DIRECTION

Step 1 begins when a priority project from a system plan is identified to move forward. Sometimes, a funding source or sources for the project has been identified, though securing funding may not be complete. Typically, the project has been identified and prioritized in local and regional transportation system plans through robust stakeholder engagement. Ideally this selection has occurred in recognition of the project's potential to contribute to regional, state and local outcomes. Following the identification of the need for the project, the performance-based design process is initiated by affirming the project context and the applicable policy direction.

This step lays the framework to ensure the ultimate design stays true to transportation and land use system plans, adopted policies, stakeholder engagement and decisions made during the funding process.

In this step, practitioners should review and affirm:

☐ Project need and objectives and how it will contribute to systemwide outcomes.
☐ Land use context(s) within the study area, including regional land use types as well as any additional guidance from a local jurisdiction code or plan that is likely to shape future land use.
☐ Regional and local design classification of the streets within the study area.
☐ Local and regional modal network maps adopted in the Regional Transportation Plan, local transportation system plans or area plans to determine the envisioned mobility role of the streets or trails within each modal network.
☐ Relevant local, regional and state policies and guidance related to the study area to affirm which policies create definitive requirements and which provide more general direction.
☐ Environmental constraints and benefits, including wildlife corridors, wetlands and other sensitive habitats. Depending on the project and the surrounding environment, determine whether and what type of National Environmental Policy Act documentation is needed for the project. Understanding of current applicable stormwater regulations and standards.
☐ Who the project is serving and who may be impacted by the project.
☐ Past stakeholder engagement around the project

Stakeholder Engagement Develop a plan for engaging project stakeholders. For each, determine whether their final approval is needed to move design forward.

- Members of the public
- Local jurisdiction(s) elected officials and staff
- Community representatives from project area, especially including representatives from historically marginalized communities
- Business representatives from project area
- Managing agency of the street right of way
- Owners of adjacent properties
- Operators (e.g., transit, mobility services, emergency services, utility services, freight carriers)
- Others

Document Prepare documentation that affirms the context and policy direction. Documentation at this step is often in the form of an Intergovernmental Agreement, a project agreement of charter or a project scope. Having project decision-makers sign on to these documents can increase accountability and commitment to project outcomes.

Existing Tools or Examples The cities of Portland and Seattle use project development check-lists to ensure that all agency partners and all key policies have been identified at the start of the project. They also support coordination, such as with utility providers.

STEP 2 ASSESS EXISTING CONDITIONS AND CONFIRM FUNCTIONS

Step 2 prepares practitioners for the development and evaluation of project alternatives in Steps 3 and 4. Step 2 is focused on:

- collecting information related to the existing conditions,
- identifying which functions of the street or trail are currently served,
- determining which functions should be served with completion of the project, and
- selecting performance measures.

Stakeholder Engagement Discuss stakeholder priorities, building on previous engagement if any, to influence the prioritization of functions on the street. Local stakeholder knowledge can also inform the existing conditions assessment.

ASSESS EXISTING CONDITIONS AND CONSTRAINTS

Collecting data about existing conditions and constraints prior to a new investment provides an important benchmark – the "before" data. After a project is completed, additional data is collected to provide a "before and after" study, which contributes to industry best practices. This data can also be used in the evaluation of the design alternatives. The level of data collection and documentation will vary depending on the scale and complexity of the project and the specific needs of each project.

The following questions should be considered when documenting existing conditions:

General

☐ What is the history, socio-economic demographics, land-use patterns and cultural context of the project area? Has the surrounding community been disproportionately impacted in the past?
☐ What are the ownership patterns of nearby properties (including rental vs home ownership for displacement analysis)?
☐ Are there traffic safety concerns in the project area?
☐ What is the willingness of sellers if right of way is needed?
☐ Are there historic and cultural resources in the project area?
☐ Are there environmental resources and/or constraints including sensitive habitat and wildlife corridors in the project area?
☐ What wildlife uses this area and what impacts might occur? Is there a need for wildlife crossings?
☐ Are there other physical constraints, such as bridges, over- or underpasses, railroads or other major utilities?
☐ Are there air quality concerns in the study area? What is the baseline air quality in the project area?

Pedestrian Realm

☐ What are the existing pedestrian facilities (sidewalk width, condition, street trees, street furniture, other amenities, crossings)?
☐ What is the existing level of tree canopy?
☐ Is there access for people with disabilities along the sidewalk and at crossings?
☐ What level of pedestrian activity is occurring today? Is there a desire or potential for higher pedestrian activity?
☐ What is the location, spacing and design of enhanced pedestrian crossings? Do they serve "desired" crossing locations?

Bikeways

☐ What is the existing bicycle facility?
☐ What type of bicyclist is currently served?
☐ What are current and forecast bicycle volumes?
☐ Is there a parallel route that is equally direct/accessible and/or that has been identified in a local jurisdiction plan?

Transit Facilities

☐ What type and frequency of transit is there now and in future plans?
☐ What types of transit facilities exist on the street (stops, lanes, other priority treatments)?
☐ Is transit currently experiencing high levels of delay during peak hours?
☐ Low levels of reliability (poor on-time performance)?

Stormwater and Green Streets

- ☐ If any, what type of stormwater system currently exists in this location?
- ☐ What is the size of the catchment area?
- ☐ Is there a flex zone wide enough to accommodate curb extensions?
- ☐ Is the street or trail identified in a stormwater management plan?
- ☐ What right of way constraints exist in this location that could influence green streets infrastructure (overall width, presence of driveways, overhead or underground utilities)?
- ☐ What are the key physical characteristics in this location, such as slopes, soil infiltration rates or existing waterways? In some cases, a topographical survey may be needed to adequately identify conditions.
- ☐ Is it included in an urban forestry plan?
- ☐ What are the types, age, size and health of existing trees in the project area?

Flex Zone

- ☐ Collect information on what types of “flex zone uses” are occurring now, and where are they occurring?
    - ○ Loading/unloading
    - ○ Parking utilization
    - ○ Mail delivery
    - ○ Garbage and recycling collection
    - ○ Pick-up/drop-off
    - ○ Bicycle/scooter/motorcycle parking
    - ○ Green streets treatments
    - ○ Bicycle mobility
    - ○ Transit lanes and stops
    - ○ Parklets / expanded sidewalk
- ☐ To what extent are these uses occurring (e.g. what is the parking utilization, how often is the loading zone in use)?
- ☐ What is the availability of off-street parking in the vicinity? What about parking availability on side-streets?

Center Travelway

- ☐ What is the existing configuration and lane widths?
- ☐ What are the volumes of motor vehicles, transit and freight vehicles using the street?
- ☐ What portion of existing vehicular capacity is used during the peak hour or study period?
- ☐ If applicable, how many hours of the day experience near, at or over-capacity vehicle demand?
- ☐ What are the crash patterns on this street, in terms of severity, cause, modes involved, location and other factors?

Intersections

- ☐ What is the existing intersection configuration?
- ☐ What are the volumes of people traversing the intersection by each of the various modes?
- ☐ What are the crash patterns at each intersection and what movements are they associated with?
- ☐ How well is the intersection serving the current and forecast users traveling through it, considering all modes?
    - ○ In developing future volumes, travel demand model forecast volumes should be considered only the starting point, since travel patterns are likely to be impacted by factors not accounted for within travel demand models.

- ☐ What vehicle turning movements are accommodated/allowed at each intersection?
- ☐ How many crossings are marked? In Oregon, if it is not marked otherwise, every intersection is a legal pedestrian crossing. Are any crossings closed?
- ☐ Does the intersection currently have any specific treatments designed to better serve bicyclists, pedestrians, transit, or freight?

Trails

- ☐ If the trail currently exists, what is the width, striping and surface type?
- ☐ What destinations are served by the trail?
- ☐ How many and what types of streets does the trail need to cross?
- ☐ Are there environmental or other physical constraints?
- ☐ What types of users currently use or are anticipated on the trail?
- ☐ What are current and/or forecast trail user volumes?

CONFIRM FUNCTIONS

Next, assess which functions and the level at which the functions are being currently served, if an existing street or trail. Then, confirm which functions should be served on the reconstructed or new street or trail.

Existing Tools or Examples

- Existing conditions documentation will vary depending on the complexity of the project. Many new and developing data sources are available to support understanding of the existing system. Portal contains a variety of transportation data for greater Portland. A variety of companies are offering data related to travel patterns based on mobile location or app-based data collection.

Error! Reference source not found. provides guidance on the typical functions for each regional design classification. Regional trails are also included to provide guidance on the typical functions that these facilities provide.

For each function, determine whether it should be:

- Prioritized – function is typically prioritized in the design classification and should be served to the highest level of quality possible on the street.
- Accommodated – function is typically accommodated in the design classification at a basic level. Accommodated functions are typically prioritized at a higher level on a parallel facility or elsewhere on the network.
- Served on parallel facility – function is typically is served on a parallel facility or elsewhere on the network in adherence with regional and local modal plans and polices.

Table 1 is an example of how to document existing and desired functions.

SELECT PERFORMANCE MEASURES

In conjunction with the confirmation of functions, select performance measures to evaluate each alternative in Step 4. In selecting performance measures, consider:

- Measures that evaluate how well a project supports systemwide outcomes, including safety, access, mobility, reliability, efficiency, affordability, equity, environmental and public health).
- Measures that evaluate whether and to what extent prioritized and accommodated functions are served.
- Measures to align with any additional project objectives. For example, if a project has an objective to minimize impacts on local properties, a measure could be “right of way acquisition required.”
- Measures specifically related to intersections, if applicable (further described in Step 4, Evaluate Alternatives).

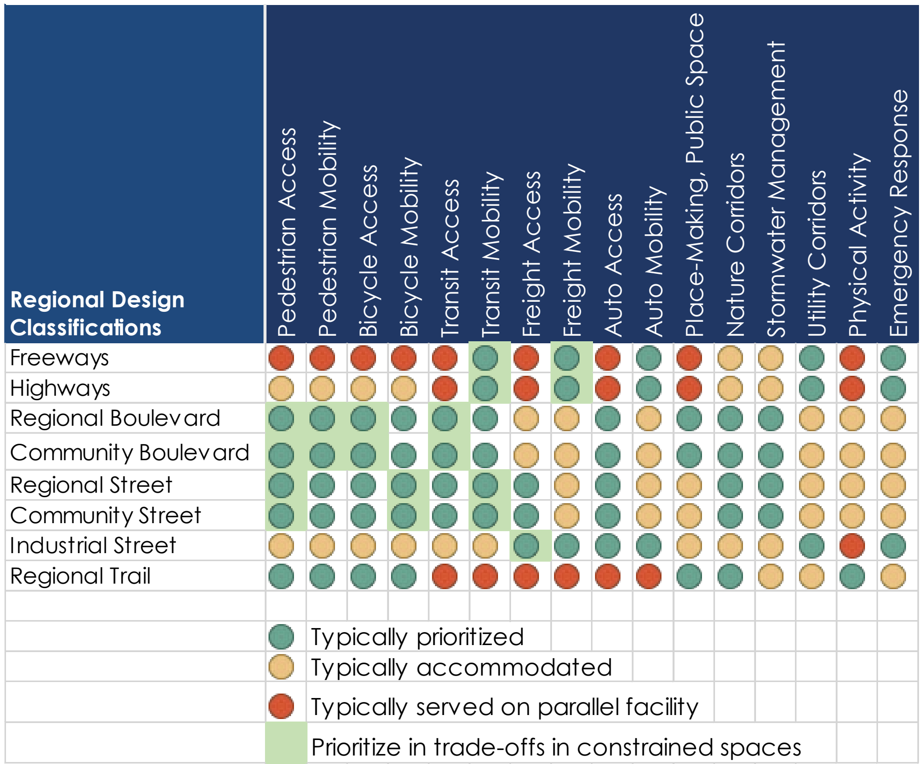
The set of performance measures should:

- Reflect the project need and objectives, system outcomes and desired functions.
- Be understandable and communicable.
- Be consistently, objectively measurable.
- Differentiate between alternatives.
- Be specific to the study area in question.
- Be at a level of detail proportionate to the project size and capacity.

Also consider whether to weight particular performance measures more heavily than others within the evaluation. Weighting can be adjusted based on public input and should also take into account whether there is more than one measure capturing the same benefit of a design.

- **Document** Document previous or current engagement that helped shape prioritization of functions
- Document existing conditions, existing functions and desired functions.
- Document the reasons for the desired functions where they differ from existing functions.
- Document the performance measures that will be used to evaluate project alternatives.

Table1: Regional Design Classifications and Functions



Regional Design Classifications	Pedestrian Access	Pedestrian Mobility	Bicycle Access	Bicycle Mobility	Transit Access	Transit Mobility	Freight Access	Freight Mobility	Auto Access	Auto Mobility	Place-Making, Public Space	Nature Corridors	Stormwater Management	Utility Corridors	Physical Activity	Emergency Response
Freeways	🔴	🔴	🔴	🔴	🔴	🟩🟢	🔴	🟩🟢	🔴	🟢	🔴	🟡	🟡	🟢	🔴	🟢
Highways	🟡	🟡	🟡	🟡	🔴	🟩🟢	🔴	🟩🟢	🔴	🟢	🔴	🟡	🟡	🟢	🔴	🟢
Regional Boulevard	🟩🟢	🟩🟢	🟩🟢	🟢	🟩🟢	🟢	🟡	🟡	🟢	🟡	🟢	🟢	🟢	🟡	🟡	🟡
Community Boulevard	🟩🟢	🟩🟢	🟩🟢	🟢	🟩🟢	🟢	🟡	🟡	🟢	🟡	🟢	🟢	🟢	🟡	🟡	🟡
Regional Street	🟩🟢	🟢	🟢	🟩🟢	🟢	🟩🟢	🟢	🟡	🟢	🟡	🟡	🟢	🟢	🟡	🟡	🟡
Community Street	🟩🟢	🟢	🟢	🟩🟢	🟢	🟩🟢	🟢	🟡	🟢	🟡	🟡	🟢	🟢	🟡	🟡	🟡
Industrial Street	🟡	🟡	🟡	🟡	🟡	🟡	🟩🟢	🟢	🟢	🟢	🟡	🟡	🟡	🟢	🔴	🟢
Regional Trail	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🟢	🟢	🟡	🟡	🟢	🟡

🟢 Typically prioritized

🟡 Typically accommodated

🔴 Typically served on parallel facility

🟩 Prioritize in trade-offs in constrained spaces

Table 1: Existing and Future Functions Documentation

Street Functions	Existing			Desired		
	Priority	Accommodated	Served on parallel facility	Priority	Accommodated	Served on parallel facility
Pedestrian Access						
Pedestrian Mobility						
Bicycle Access						
Bicycle Mobility						
Transit Access						
Transit Mobility						
Freight Access						
Freight Mobility						
Auto Access						
Auto Mobility						
Place-Making and Public Space						
Nature Corridors						
Stormwater Management						
Utility Corridors						
Physical Activity						
Emergency Response						
Other _________________________						

STEP 3 DEVELOP ALTERNATIVES

In Step 3, practitioners initiate the development of two or more design alternatives that address the project need, contribute to systemwide outcomes and serve the prioritized functions in different ways. Design alternatives are potential designs for a project, described at a high level, that can be compared and evaluated.

Development of alternatives should be guided by a safe systems approach and following the other design principles described in Chapter 4. Alternatives may range significantly in the level of investment required and may include low-cost, interim solutions and programmatic aspects.

> **Stakeholder Engagement** Seek input from stakeholders on the development of alternatives. Provide opportunities that allow stakeholders to generate cross section ideas and provide input on their priorities to help stakeholders understand the challenges, opportunities and trade-offs of creating multimodal streets.

DEVELOP ALTERNATIVES FOR STREET SEGMENTS, CORRIDORS AND TRAILS

To develop design alternatives, start by selecting design elements to serve the prioritized and accommodated functions.

The initial development of alternatives does not need to include specific design details, such as signal pole location or pavement slope, but should consider the cross-sectional elements to be included and their widths. Elements serving “priority” functions should be prioritized over elements serving “accommodated” functions.

Some alternatives are likely to exceed the available right of way. Depending on the likelihood and impacts of right of way expansion (see sidebar), practitioners may determine that one or more alternatives should be developed to stay within the existing right of way or existing curb location.

For streets, each alternative should define the following, consistent with the design classification and functions:

☐ Number and width of motor vehicle travel lanes
☐ Presence and width of exclusive transit right of way, if applicable.
☐ Stormwater management approach
☐ Width / use of flex zone, if applicable
☐ Width / type of median
☐ Width / type of bicycle facility
☐ Width of sidewalk / pedestrian realm
☐ Width of any other cross-sectional elements, if applicable
☐ Street trees
☐ Intersection control type (see next section)

For trails, each alternative should define the following:

What about right of way?

Most of the roadway corridors and some of the trail corridors within greater Portland have established rights of way, and in many cases are surrounded by developed land uses. Whether or not to consider alternatives beyond the existing right of way is a project-specific decision. In determining whether to think beyond the existing right of way, consider:

- What are the existing building footprints and setbacks along the corridor?
- How would existing land uses be impacted?
- How many property owners would be impacted if right of way is acquired?
- Are property owners willing sellers?
- Is the corridor likely to undergo significant redevelopment?
- What is the anticipated funding source for this project?

Even if right of way acquisition is deemed to be infeasible, it may be helpful to include an alternative that requires it, for purposes of comparison.

☐ Width of trail and buffers, if applicable
☐ Method of separation of users, if applicable
☐ Access points, if applicable
☐ Stormwater management approach
☐ Width of any other cross-sectional elements, if applicable
☐ Type of street crossings, including whether they are over-crossings, at grade or undercrossings.
☐ For at-grade crossings, general anticipated treatment type (e.g., at existing intersection; new signal or beacon; passive crossing treatments)

In some cases, it is helpful to include an alternative that is not fully aligned with the prioritized functions, particularly if a stakeholder group advocates for it. In this case, include the alternative alongside others and carry it forward to the evaluation in Step 4. This can contribute to learning and understanding among members of the project team and other stakeholders. It may lead to a more refined articulation of priorities.

DEVELOP ALTERNATIVES FOR INTERSECTIONS

The development of intersection alternatives should consider all potential intersection control types and designs, including:

☐ Two-way stop control
☐ All-way stop control
☐ Roundabout (mini, single-lane, and multi-lane)
☐ Signalized intersection
☐ Midblock crossing

Practitioners may also consider more than one intersection design alternative with the same control type, if applicable. In Step 5, Refine Decisions, intersection design will be refined further to include elements that serve specific needs of pedestrians, bicyclists and freight.

Other Project Types

Other unique projects, such as bridges or interchanges, should generally follow a similar approach to alternatives development: consider regional and local policy guidance, consider functions to be served, and develop alternatives in alignment with documented best practices. Resources listed at the end of Chapter 4 can be used to supplement the information provided within this guide.

QUESTIONS/CONSIDERATIONS FOR DEVELOPING ALTERNATIVES IN STEP 3

This section includes specific considerations for the various modes of travel and functions of streets and trails to help inform the development of alternatives.

Pedestrian Realm

- ☐ If the street is part of the regional pedestrian network and pedestrian access or mobility is a priority function in the design classification, include alternatives that prioritize pedestrian functions.
- ☐ Include enhanced crossing treatments as appropriate to serve pedestrian access across the street
- ☐ Determine what widths could serve anticipated activity, including both pedestrian movement, places to linger (e.g. resting, waiting for transit, sidewalk cafes), and other functions served in this realm (e.g. bicycle parking, utilities, street trees).
- ☐ People walking need to be buffered from motor vehicle movement. Determine what options can be considered for a buffer within the pedestrian realm or flex zone (e.g. street trees, landscaping, on-street parking).

Bikeways

- ☐ If the street is part of the regional bicycle network and bicycle access or mobility is a priority function in the design classification, include alternatives that prioritize serving bicycle functions.
- ☐ Identify widths and types of facilities that could serve anticipated volumes of bicyclists, and riders of all ages and abilities (given existing conditions and other components of each alternative).
- ☐ Determine if buffer widths can be minimized by providing greater physical protection in one or more alternative.
- ☐ Determine whether anticipated volumes of bicyclists and pedestrians can be served with a multi-use path on one or both sides of the street, particularly if space is constrained.

Transit Facilities

- ☐ If street is part of the regional transit network and transit access or mobility is a priority function in the design classification, include alternatives that prioritize serving transit functions.
- ☐ Determine what treatments would provide highest levels of operational benefits for transit, given the existing conditions.
- ☐ Determine if street or trail provides access to transit and include alternatives that show enhanced access.

Stormwater and Green Streets

- ☐ Identify type of green street treatments and placement options for green streets treatments within the right of way.
- ☐ If possible, identify right of way remnants (small publicly-owned parcels adjacent to the street, but not part of the street) or other locations adjacent to existing right of way that could be used to develop green streets treatments, such as rain gardens.
- ☐ Look for opportunities to reduce impermeable surface and run-off volumes. Use vegetated green streets treatments as buffers where possible.
- ☐ Identify locations to include street trees to augment tree canopy, whether in the median, flex zone, furniture zone of the sidewalk or adjacent to the right of way.

Flex Zone

- ☐ Determine what types of uses in the flex zone best serve the priority functions for this street, based on guidance from Chapter 4.
- ☐ Consider alternatives where flex zone uses are served on adjacent streets.
- ☐ Consider alternatives that allocate the flex zone in different ways. Space for bicycle parking, green streets treatments, or other flex zone uses may occur within the street furniture zone of the sidewalk, on curb extensions, or even within the adjacent properties. Adjacent properties often can accommodate bicycle parking, green streets treatments, or sidewalk cafes.
- ☐ Select flex zone designs that would mitigate predominant crash types identified in the existing conditions assessment, if applicable.

Center Travelway

- ☐ If the street is part of the regional freight network and freight access or mobility is a priority function in the design classification, include alternatives that preserve freight functions.
- ☐ If the street is part of the frequent bus network (or any rail or High Capacity Transit), include designs that prioritize transit).
- ☐ If street has two through lanes per direction and less than 25,000 vehicles per day, include an alternative that reallocates travel lane space to other functions.
- ☐ If lanes are wider than 10 feet, consider opportunities to "gain" space through narrowing lanes.
- ☐ Include an alternative with design elements to decrease operating speeds, which may reduce widths needed for buffers and/or shy distance
- ☐ If street is located within a relatively connected street grid, consider whether turning movement restrictions are feasible to minimize the need for left-turn lanes.
- ☐ If wildlife crossings are anticipated, include designs to accommodate them.

Intersections

- ☐ If there are existing buildings close to the street corners, include alternative(s) that preserve them. For other alternatives, evaluate the value (monetary, cultural and historical) of the structures in determining whether they could be redeveloped.
- ☐ If there are existing trees in the vicinity of the intersection, include alternative(s) that preserve them. For alternatives that do not, identify ways to mitigate this loss of tree canopy.
- ☐ Include an alternative with intersection designs that would mitigate predominant crash types identified in the existing conditions assessment.
- ☐ Ensure that alternatives provide opportunities for "day lighting" at intersections – a practice that removes visual barriers (such as parked cars) between pedestrian crossings and oncoming vehicles.
- ☐ If study area is on a freight route and/or has heavy volumes of freight traffic, include an alternative with design elements that enhance safety by separating trucks and other vehicles from pedestrians and bicyclists crossing the intersection.

Document Prepare documentation of the alternatives developed as part of Step 3. Ultimately, this documentation can be combined with documentation from Steps 4, 5 and 6 to describe the flow of the alternatives evaluation. Documenting alternatives visually can be helpful in communications with stakeholders.

Existing Tools or Examples

- Streetmix is an online tool for visualizing cross sections that can be helpful for developing alternatives.
- FHWA's Incorporating On-Road Bicycle Networks into Resurfacing Projects provides guidance on low-cost interim or incremental solutions associated with repaving projects.
- There are a variety of decision-making flow chart tools that can inform development of alternatives for specific elements:
    - City of Portland and City of Seattle have decision flow charts for considering a vehicle travel lane reduction.
    - Washington County's Bicycle Facility Design Toolkit and the FHWA's Bikeway Selection Guide provide guidance on how to select a low stress bicycle facility and when and whether to consider parallel networks.

STEP 4 EVALUATE ALTERNATIVES

In Step 4, practitioners use a performance-based analysis to evaluate the alternatives developed in Step 3 using the performance measures selected in Step 2.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires agencies to consider significant environmental impacts of projects and inform the public of the impacts and potential alternatives. NEPA documentation, in the form of an environmental assessment or an environmental impact statement, is required for projects receiving federal funding that do not fall under the categorical exclusion. By Step 4, practitioners should determine whether and what type of NEPA documentation is needed for the proposed alternatives. If so, the evaluation must include an assessment of a variety of environmental impacts, including aspects such as air quality, wildlife, habitat, climate and noise. The US Environmental Protection Agency and other federal transportation agencies offer more information related to NEPA.

EVALUATING STREET SEGMENT, CORRIDOR OR TRAIL ALTERNATIVES

At the outset, confirm that there is sufficient data/information to evaluate each of the alternatives for the systemwide outcomes, project objectives and functions, then determine if other measures needed.

Stakeholder Engagement Seek input from stakeholders on which alternative(s) best meet their needs.

The evaluation of alternatives may result in differing opinions from various stakeholders. In some instances it might be appropriate to increase the weight of input of different stakeholder groups, such as historically underrepresented communities. A goal of the whole process outlined in this chapter is to provide information that ensures stakeholders have a common understanding of the project and design decisions, even if they do not agree with each decision. This may require special efforts to reach stakeholders that have been excluded in the past.

Stakeholder engagement methods that offer various levels of depth and details on the analysis allow stakeholders to engage according to their level of interest and investment in the results.

Using easy-to-understand measures and summarizing the evaluation in a table or matrix can help communicate to stakeholders with varying degrees of technical experience.

At the least, the evaluation (based on the performance measures) should answer:

- ☐ How well does this project contribute to our systemwide outcomes?
    - For example, the evaluation could use predicted safety performance to measure the anticipated crash reductions resulting from cross sectional or intersection design elements.
- ☐ What impacts does this project have on our systemwide outcomes?
    - For example, the evaluation could use "area of sensitive habitat impacted" as a measure of the impact to our environment.
- ☐ How well are the prioritized and accommodated functions served by each alternative?
    - For example, the evaluation could use sidewalk width to measure pedestrian access and mobility or level of traffic stress to measure bicycle access and mobility.
- ☐ What functions are served elsewhere?

Weighting and Trade-offs In some cases, the alternatives evaluation in Step 4 may not immediately lead to a clear answer, but will instead reveal a number of shortcomings for specific functions or outcomes – potential trade-offs in each alternative. It can be helpful, as noted in Step 2, to consider weighting some measures more heavily than others. For example, if a project is being designed on a high-crash corridor with funding specifically allocated to improve safety, the evaluation should consider weighting safety-related measures above other measures.

Weighting the various functions relative to each other depends in part on the regional design classifications. Performance of “prioritized” functions should be weighted above “accommodated” functions for the design classification (refer to **Error! Reference source not found.**).

Sometimes, the evaluation will lead to a new alternative being developed. In that case, practitioners should develop and evaluate the alternative in alignment with Steps 3 and 4.

Cost is another metric often considered in the evaluation of alternatives. All else being equal, a lower cost alternative is a better use of public funds. At this stage of the process, alternatives may not have the level of detail required to develop a cost estimate. However, identification of an “order-of-magnitude” cost can help inform a cost comparison of alternatives relative to each other. Operations and maintenance requirements can also be considered in the evaluation of the alternatives, particularly when more than one agency will be involved. If different intersection control types and configurations are considered distinctly from segment alternatives, they should also be evaluated.

EVALUATING INTERSECTION ALTERNATIVES

An intersection control evaluation may require more in-depth technical evaluation than cross-sectional alternatives to determine how well functions are being served. The intersection control evaluation should use performance measures to assess the following:

- Alignment with the prioritized and accommodated functions
- Predicted safety performance
  - Consider using safety performance functions from the Highway Safety Manual to estimate anticipated crash reductions
  - To evaluate design aspects not covered by safety performance functions, consider an assessment of potential conflict points between various users presented by each design alternative.
- Multimodal operations
  - Note: there is not currently a single metric available for assessing operations for level-of-service for all modes. Practitioners may need to select a set of measures to evaluate operations.
  - Consider operations based on existing volumes of users, as well as anticipated future volumes. In developing future volumes, travel demand model forecast volumes should be considered only the starting point, since travel patterns are likely to be impacted by factors not accounted for within travel demand models.
- Design feasibility
  - Consider available right of way, adjacent properties, existing placement of accesses, slopes, natural resources, and roadway alignments.
- Life-cycle costs, considering capital costs, maintenance, operations, cost to users (e.g., delay, crashes, fuel use) and other anticipated costs.

For intersections, the evaluation should lead to the selection of a preferred intersection control type. Further design details are then considered within Step 5 Refine Decisions.

Stakeholder Engagement All stakeholders, including staff representing agencies involved in decision-making, are involved in choosing between the design alternatives and refining design decisions. Opportunities to provide input during this step are essential to the transparency of the process. Additional stakeholders identified during the alternatives

Document Develop documentation of alternatives evaluation, including an explanation of how performance measures were evaluated. This ensures the evaluation can be verified and repeated if new alternatives are introduced. Using an evaluation matrix is helpful for visually comparing alternatives.

Existing Tools or Examples:
Transportation for London developed the Healthy Streets Checklist for Designers. The excel based tool helps stakeholders understand how changes to streets impact human health.
A new tool, the Predictive Safety Assessment Tool, was developed for converting one urban roadway facility type to another with the application of predictive methodology and principles from the Highway Safety Manual. The tool enables the safety analysts to evaluate existing and proposed facilities and covers a wide range of urban roadway segments.

A variety of agencies have introduced **intersection control evaluation** procedures into their standard practice:

- Georgia Department of Transportation has an excel-based tool to support their Intersection Control Evaluation policy – the purpose of which is to "provide traceability, transparency, consistency and accountability when identifying and selecting an intersection control solution that both meets the project purpose and reflects the overall best value in terms of specific performance-based criteria."
- CalTrans also has an intersection control evaluation policy

STEP 5 REFINE DESIGN DECISIONS

Step 5 provides guidance on how to refine design decisions for one or more alternatives to lead to selection and development of a preferred design concept. In Step 5, practitioners draw on the results of the alternatives evaluation to work through trade-offs and further refine the design of one or more alternative. In a highly complex project, or if several alternatives are still under consideration, Step 5 may include significant additional analysis and/or stakeholder outreach to inform refinements that improve the performance of the alternative. In some cases, Step 5 may be minimal.

STREET SEGMENT, CORRIDOR OR TRAIL DESIGN DECISIONS

Refinements to the design alternative(s) should consider the following:

- ☐ Sensitivity testing for increased volumes of users in the future (e.g., how long will this design serve the community in a changing future?)
- ☐ Which or whether some design elements should be (or can be) designed for relatively easy change/re-design in the future, to respond to changing demand, use patterns, and/or emerging technologies
- ☐ Project transitions at each end of the study area. Consider how each street user will transition from the project area to the existing infrastructure on each side and design for an intuitive transition.
- ☐ Opportunities for low-cost, interim improvements that only partially meet the project need, objectives, and functions – as long as they do not preclude future investments to fully serve the needs.
- ☐ Implementation strategies, including opportunities for phasing.

Sometimes, the process of refining the design alternatives will lead to the consideration of a new alternative. In that case, practitioners should develop and evaluate the alternative in alignment with Steps 3 and 4.

INTERSECTION DESIGN DECISIONS

In addition to the considerations listed for street segments, corridors or trails, refinements to intersection design alternative(s) may include the following approaches:

- ☐ If not done as part of Step 4, develop lane configurations, including presence of turn lanes, considering the trade-offs inherent in this decision (as discussed in Chapter 4 on Intersections)
- ☐ Consider the physical dimensions of the anticipated people and vehicles to inform the development of the intersection geometry, including pedestrians, bicyclists, and various vehicle types (as discussed in Chapter 4 Design Principles).
    - ○ Two-wheelchair users side-by-side at all locations.

  - Cargo bicycle or bicycle with trailer (~9 feet) for turning movements and at queuing locations
  - Standard TriMet bus where turning movements are applicable
  - Select design vehicle (for motor vehicles) depending on anticipated normal daily turning movements
  - Select a larger control vehicle, if applicable, and accommodate occasional turning movements by using opposing lanes, if needed.

CONSIDER TRADE-OFFS

In conjunction with developing refinements to the design, practitioners are likely to face trade-offs in refining the design decisions – cases where the ideal treatments to serve priority functions simply cannot be achieved within the constraints of the project. In considering these trade-offs, go through the following steps:

1. Review policy requirements, guidance and direction and consider whether policies are evolving or likely to change.
2. Consider which of the prioritized functions will most contribute to the systemwide outcomes. Refer to Table 1: *Regional Design Classifications and Priority Functions* for guidance on prioritizing within constrained spaces.
3. Determine whether any functions can be served on a parallel route that is completed as part of the project. In determining whether to serve bicycling on a parallel route, consider slopes, level of stress of the parallel route and main route, number and type of destinations on each route, amount of out of direction travel, total distance and current use patterns. If selected, the parallel route should be completed in conjunction with the project.
4. Use narrower widths for some or all design elements within the street. Confirm that motor vehicle lane widths are the narrowest appropriate for the anticipated users and street design.
5. Consider designs to slow speeds, allowing for narrower buffers and the potential to mix some modes of travel (e.g., though paved multi-use paths to serve pedestrians and bicyclists; through low-speed shared bus-bike lanes.

Document Develop documentation of the alternatives considered (including additional alternatives introduced during or after the evaluation), a summary of the evaluation and any additional analysis supporting the refinement of design decisions. This documentation can be summarized and combined with the preferred design concept (Step 6).

Existing Tools or Examples:

FHWA's Bikeway Selection Guide provides guidance on how to select a low stress bicycle facility and steps for when and whether to consider parallel networks.

"Tactical urbanism" is a flexible, often community-driven implementation strategy that uses low-cost, inexpensive materials to pilot test urban projects. A variety of guidance is available.

STEP 6 DECIDE ON PREFERRED DESIGN CONCEPT

Following the additional refinement in Step 5, practitioners and stakeholders should have adequate information to decide which design alternative to move forward. If more than one alternative was carried through Step 5, the evaluation can be updated to fully reflect these refinements.

Ultimately, the preferred design concept selected in Step 6 should reflect a performance-based approach to serving the prioritized functions and contributing to systemwide outcomes. Clear agreement on this design concept is critical before moving to Step 7.

Involvement of practitioners with multidisciplinary technical knowledge through Steps 3, 4, 5 and 6 is helpful to develop feasible alternatives and ensure identification of technical issues to address as alternatives are being refined.

In this step, practitioners develop a design concept (may be referred to as a 5 percent design or a 15 percent design) that can communicate the following information:

- Overall footprint of proposed design
- Configuration and width of proposed design elements within the design
- Areas of potential right of way impact
- Approach to stormwater management, including type of facilities and general locations.
- How prioritized functions are supported.
- How systemwide outcomes are supported.

Stakeholder Engagement Share the preferred design with the community along with a clear evaluation of how this design aligns with the prioritized functions and delivers on the envisioned outcomes.

Engage agency stakeholders to gain concurrence with the design concept.

- Whenever possible, ensure that individual agency stakeholders remain consistent through the process to build understanding and agreement leading to the design concept.
- Engage a variety of disciplines within the lead agency to further understand design implications and confirm design decisions. Include individuals involved in construction, signal operation (if applicable) and maintenance.

VETTING THE PREFERRED DESIGN CONCEPT

- ☐ Conduct additional technical evaluation and develop additional design details related to:
    - Horizontal and vertical alignment design
    - Grading
    - Environmental impacts
    - Signing and striping
    - Illumination needs and impacts
    - Stormwater management needs
    - Impacts to existing trees
    - Utilities
- ☐ Consider constructability of preferred design in how various modes will be accommodated during construction. Sometimes, it may be necessary to change the location and/or alignment to maintain access during construction.
- ☐ Identify key design details yet to be resolved and assess potential risk associated with outstanding items. For example, there may still be significant unknowns (e.g., whether utilities will need to be relocated) that can affect project cost and timeline.
- ☐ Confirm operational and maintenance needs and responsibilities. In many cases, the regionally classified streets are ones that affect and involve more than one entity in operation and maintenance. Understanding these responsibilities allows those organizations to weigh in as the design concept is developed to ensure they are able to operate and maintain the facilities as intended. For example, some separated bicycle facility designs cannot be swept with a standard street sweeper due to their width. In these cases, agencies need to consider other maintenance solutions (e.g., purchase a specialized narrow sweeper, partner with an agency that does own one or consider a different maintenance method).
- ☐ Prepare (or refine) a cost estimate for the preferred design.
    - Confirm/identify funding sources.
    - What can be designed/ constructed within the available funding sources?
    - Are there other funding sources that may contribute to specific aspects of the project?

Document In documenting the preferred design and preparing to move into final design, address each of the following steps:

- ☐ Develop a design concept drawing to clearly communicate with stakeholders and the final design project team.
- ☐ Review and verify that the preferred design concept serves the project functions identified in Step 2. If it does not, return to Step 3 of the process.
    - If, during the development of the design concept drawing, there are any refinements that result in changes to functions served or to anticipated performance of the street, this should be clearly documented with reasons justifying the change.
- ☐ Document agency concurrence on the preferred design concept, both from the lead agency and from other involved agencies. Document any design agreements with partner agencies (e.g., design exception or concurrence when applicable) and/or identify the need for future design exception documentation.

Existing Tools or Examples:

In its Design Documentation, Approval and Process Review chapter, Washington State Department of Transportation has guidance for documenting decisions throughout the timeline of project development, including prior to the full design.

STEP 7 FINALIZE DESIGN

The final design is developed based on the preferred design concept. A final design provides the detailed engineering specifications needed to initiate construction of a project. The final design and its implementation should serve the identified functions, contribute to systemwide networks and further the desired outcomes.

Often, the individuals on a project team may change between the development of the preferred design and the final design. This naturally occurs as different areas of expertise are required at each stage of the project delivery process.

However, it is critical to maintain some continuity to ensure that the project ultimately delivers what it was intended to deliver. Clear and ongoing documentation, along with frequent check-backs to earlier stages of the project can ensure this continuity. Prior to embarking on final design, project teams should:

- ☐ If the preferred design was developed more than three years prior, verify project context and need, objectives, functions, and performance measures used to arrive at the preferred design (Steps 1 & 2). If any of these have changed, revisit the alternatives developed and determine if developing and evaluating additional or new alternatives is needed.
- ☐ Review and understand the overarching project purpose and any other documented goals.
- ☐ Review and understand key project outcomes and functions identified in Steps 1 and 2.
- ☐ Review design decision documentation from Steps 3, 4, 5and 6 that led to the selection and development of the preferred design.

DEVELOP FINAL DESIGN

The development of the final design and construction bid documents typically occurs in several stages. These may vary by agency and by project but often follow a process of developing a 30-percent design, 60-percent design, 90-percent design and 100-percent final design. At the conclusion of this step, the project team will release “plans, specifications, and estimates,” which are the basis for collecting bids from contractors for construction.

As the final design progresses, the project team will need to:

- ☐ Seek permits from various agencies, as required.
- ☐ Acquire right of way, if needed.
- ☐ Continue to confirm and evaluate funding sources and opportunities.
- ☐ Outline future operations and maintenance activities and estimate costs.
- ☐ Document whether the final design contributes to desired outcomes, serves identified functions and aligns with the preferred design.
    - ○ If not, is the final design a low-cost incremental improvement that does not preclude serving those functions in the future?
- ☐ Collect “before” data as a basis for comparison.
- ☐ Develop a process for monitoring the project after construction and measuring how well it is serving the priority functions.

Stakeholder Engagement: If faced with design challenges during the final design stage, project teams should involve stakeholders from earlier project stages to further understand key priorities and preferred design decisions. Agencies who will be involved with future maintenance or operation should also have opportunities to provide input on final design decisions.

Document Any deviations from the preferred design concepts and provide justification.

- Review and verify that the design with deviations will still serve the key project functions identified in Step 2.
- If it does not, consult stakeholders and community members to determine next steps:
  - Agreement (documented) on deviations in order to move the project forward, or,
  - If consensus cannot be reached, it may be necessary, and ultimately less costly, to stop the development of the final design and return to Step 2 or 3 of the process.

STEP 8 CONSTRUCT, OPERATE, MAINTAIN AND EVALUATE

In Step 8, the project is constructed and becomes part of the transportation system. Operations and maintenance are key aspects of ensuring that the street serves the intended functions. A performance evaluation and ongoing monitoring following construction can help contribute to best practices for future projects.

CONSTRUCTION

Construction of the final design should maintain alignment with achieving systemwide outcomes and priority functions. Prior to construction, especially if there is a significant time between final design and construction, the project team should:

- Review and understand the systemwide outcomes and priority project functions documented in Steps 1 and 2.
- Review design decision documentation that led to the development of the final design.

During construction, the project team should ensure:

- Clear, safe and accessible routes for all modes of travel, including detours if necessary. In designing detours, limit out-of-direction travel as much as possible for pedestrians and bicyclists. Engage daily users of the project area in developing detour routes.
- Protection of natural resources in the project area throughout the construction phase.
- Ongoing communication with the surrounding community about construction process and timeline.
- Coordination with other construction activities in the vicinity, and consideration of other projects that would impact alternative routes travelers are likely to use.

Stakeholder Engagement Discuss construction sequencing with public, because it is sometimes preferred to have major impact over a short period compared to smaller impacts over an extended construction period. Notify adjacent property owners of the construction schedule and any anticipated impacts during the construction period. Construction and completion of the project is also a time to celebrate with stakeholders and the community. Ribbon-cuttings or public events are an opportunity to share the story of the project and its anticipated contributions.

Document Any minor design adjustments made during construction.

Existing Tools or Examples:

Example Tools: Portland Bureau of Transportation has developed the Traffic Design Manual Volume 2: Temporary Traffic Control. This manual provides guidance on methods for providing access for all modes during construction.

OPERATIONS AND MAINTENANCE

As an agency operates and maintains the roadway or trail, it may find other opportunities for smaller changes or investments that could further enhance the alignment with the key priority functions and overall outcomes.

As maintenance occurs and as repaving projects are done on a roadway, the project team should review any previously documented key priority functions before making any alterations to the streetscape.

Identify the need for specialized equipment or personnel training due to complex designs or specific design features. For example, busy urban roadways are often more difficult to maintain and operate than rural highways. Urban roadway design features are more likely to include elements like street trees, vegetated stormwater management solutions, separated bicycle facilities, complex multimodal signal operations, busy transit stops, and pedestrian crossing treatments. Agencies need to equip staff responsible for maintenance with the resources (training and ongoing funding) to properly maintain the roadway investments.

EVALUATION

After a project is constructed, agencies can use project performance measures (or variations of them) for evaluation and to inform design details of specific elements to better serve key functions in future designs.

- For example: If travel time reliability for any mode was used as a performance metric, travel times should be monitored and compared to the goal. This monitoring can help the agency evaluate whether or to what extent selected designs are helping to fulfill the project intent.

For projects that include “new” practices or design exceptions, the project should be reviewed and evaluated approximately three to five years after construction to document performance impacts and contribute to the refinement of industry best practices.

Before and after evaluations can provide quantitative data that agencies can use for future justification of design decisions and project alternative evaluations.

- Collect data before you implement a new design (much is readily available).
- Collect data afterwards and compare back to previous design.

Document: At 3-5 years after construction, conduct a thorough evaluation and report how well the project is performing, in alignment with the original project objectives and priority functions.

Existing Tools or Examples:

The San Francisco Municipal Transportation Agency has a Safe Streets Evaluation Handbook to guide practitioners in evaluating projects that are being implemented, including guidance on measures, data collection, evaluation and reporting back.

Some funding sources, including Metro’s Regional Flexible Fund Allocation, have specific requirements associated with evaluation after the project is constructed and after it has been in operation for a period of time.

Glossary

Access management - Enables access to land uses while maintaining roadway safety and mobility through controlling access location, design, spacing and operation.

Accessibility – The ability to reach desired goods, services, activities and destinations with relative ease, within a reasonable time, at a reasonable cost and with reasonable choices. Locations that can be accessed by many people using a variety of modes of transportation generally have a high degree of accessibility.

Arterial Street – A class of street. Arterials are intended to provide general mobility for travel within the region. Arterial streets link major commercial, residential, industrial and institutional areas. Major arterial streets are usually spaced about one mile apart. Minor arterials are spaced half mile apart. Arterials are designed to accommodate bicycle, pedestrian, truck and transit travel.

Autonomous Vehicle (AV) - Also known as a driverless car, self-driving car, robotic car, AVs use sensors and advanced control systems to operate independently of any input from a human driver.

Auxiliary lane - Provides a direct connection from one interchange ramp to the next.

Best Practices - For purposes of this document, a general term of preferred practices accepted and supported by experience of the applicable professional discipline. It is not prescriptive to a particular set of standards or a particular discipline.

Bikeway – A general term denoting improvements and provisions made to accommodate or encourage bicycling, including parking facilities, all bikeways and shared roadways not specifically designated for bicycle use.

Bike Share - fleets of bicycles available for short-term rental within a defined service area. Some bike share systems now offer electric bikes.

Biofiltration - The use of vegetation such as grasses and wetland plants to filter and treat stormwater runoff as it is conveyed through an open channel or swale, or collects in an infiltration basin .

Capacity – A transportation facility's ability to accommodate a moving stream of people or vehicles in a given place during a given time period. Increased capacity can come from building more streets or throughways, adding more transit service, timing traffic signals, adding turn lanes at intersections or many other sources.

Climate Change - Any change in climate over time, whether due to natural variability or as a result of human activity that persists for an extended period.

Complete Streets – A transportation policy and design approach where streets are designed, operated and maintained to enable safe, convenient and comfortable travel and access for users of all ages and abilities, regardless of their mode of transportation.

Congestion – A condition characterized by unstable traffic flows that prevents movement on a transportation facility at optimal legal speeds.

Connected vehicles (CVs) - Communicate with each other or with infrastructure like traffic signals and incident management systems.

Connectivity – The degree to which the local and regional street, pedestrian, bicycle, transit and freight systems in a given area are interconnected.

Context Sensitive Design - A model for transportation project development that requires proposed transportation projects to be planned not only for its physical aspects as a facility serving specific transportation objectives, but also for its effects on the aesthetic, social, economic and environmental values, needs, constraints and opportunities in a larger community setting.

Electric Bicycle –A bicycle that has two or three fully functional pedals equipped with a motor that does not exceed 1000W and is designed with a maximum speed of 20mph.

Electric vehicles (EVs) use electric motors for propulsion instead of or in addition to gasoline motors.

Emerging Technologies – In this document refers to new developments in transportation technology like automated vehicles or smart phones, and services that operate using these technologies, like car and bike share.

Equity – See Racial Equity and Social Equity.

Facility – The fixed physical assets (structures) enabling a transportation mode to operate (including travel, as well as the loading and unloading of passengers). This includes streets, throughways, bridges, sidewalks, bikeways, transit stations, bus stops, ports, air and marine terminals and rail lines.

Federal Highway Administration (FHWA) – The federal agency responsible for administering roadway programs and funds. The FHWA implements transportation legislation approved at the congressional level that appropriates all federal funds to states and local governments.

Functional Classification - The class or group of roads to which the road belongs, typically arterial, collector, and local. Throughways fall under arterial in the federal highway classification system.

Green Streets - A stormwater management approach that incorporates vegetation, soil, and engineered systems (e.g., permeable pavements) to slow, filter, and cleanse stormwater runoff from impervious surfaces (e.g., streets, sidewalks). Green streets are designed to capture rainwater at its source, where rain falls. Whereas, a traditional street is designed to direct stormwater runoff from impervious surfaces into storm sewer systems (gutters, drains, pipes) that discharge directly into surface waters, rivers, and streams.

Impervious surface - A surface that cannot be penetrated by water such as pavement, rock or a rooftop and thereby prevents infiltration and generates runoff.

Imperviousness -The percentage of impervious cover within a defined area.

Intermodal Connector – A road that provides connections between major rail yards, marine terminals, airports, and other freight intermodal facilities; and the freeway and highway system (the National Highway System).

Livability – In this document, livable streets and trails are described as facilities that are designed to support independence and access to a variety of travel options; provide orientation, safety and comfort; support social and racial equity and welcoming, safe spaces; encourage a sense of community yet provide sufficient privacy; foster a sense of neighborly ownership and responsibility; avoid and mitigate for light, noise, water and air pollution; and support regional and community outcomes.

Local Jurisdiction – For the purpose of this document, this term refers to a city or county within the Metro boundary.

Metropolitan Planning Organization (MPO) – A regional policy body responsible, in cooperation with the state and other transportation providers, for carrying out the metropolitan transportation planning requirements of federal highway and transit legislation.

Micro-mobility

Mobility – The ability to move people and goods to destinations efficiently and reliably.

Mobility Targets – Volume to capacity ratios for motor vehicles for different roadway classifications.

Mode – A type of transportation distinguished by means used (e.g., such as walking, bike, bus, single– or high–occupancy vehicle, bus, train, truck, air, marine).

Mode Choice – The ability to choose one or more modes of transportation.

Multimodal – The movement of people or goods by more than one mode.

Multi-use path

Municipal Separate Storm Sewer Systems (MS4s) - a conveyance or system of conveyances that is Designed or used to collect or convey stormwater (e.g., storm drains, pipes, ditches).

National Pollutant Discharge Elimination System (NPDES)- A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the EPA, a state or (where delegated) a tribal government or and Indian reservation.

Natural Buffer- A variable width area maintained with natural vegetation between a pollutant source and a water body that provides natural filtration and other forms of protection.

Network – Connected routes forming a cohesive system.

New Mobility Services - Transportation services like ride-hailing, microtransit and car and bike share, which operate using smart phones and other emerging technologies. Many of these services are privately operated by new mobility companies.

Parking Management - Efficient use of existing parking.

Pedestrian – A person traveling on foot, in a wheelchair or in another health–related mobility device.

Pedestrian Facility – A facility provided for the benefit of pedestrian travel, including walkways, protected street crossings, crosswalks, plazas, signs, signals, pedestrian scale street lighting and benches.

Performance Measures - A measure of how well something performs relative to desired outcomes. Used to support decision-making.

Polluted Runoff- Rainwater or snowmelt that picks up pollutants and sediments as it runs off roads, highways, parking lots, and other land-use activities that can generate pollutants.

Porous Pavement and Pavers - Alternatives to conventional asphalt that use a variety of porous media, often supported by a structural matrix, concrete grid or modular pavement, which allow water to percolate though to a sub-base for gradual infiltration.

Practical Design -

Project Development – A phase in the transportation planning process during which a proposed project undergoes a more detailed analysis of the project's social, economic and environmental impacts and various project alternatives. After a project has successfully passed through this phase, it may move forward to right–of–way acquisition and construction phases. Project development activities include: Environmental Assessment (EA)/Environmental Impact Statement (EIS) work, Design Options Analysis (DOA), management plans, and transit Alternatives Analysis (AA).

Racial Equity - When race can no longer be used to predict life outcomes and outcomes for all groups are improved. The removal of barriers with a specific focus on eliminating disparities faced by and improving equitable outcomes for communities of color.

Regional Streets - Regional streets accommodate both regional through trips and local trips. Regional streets connect centers and connect to places outside of the region. Providing for both regional through trips and local trips distinguishes regional streets from collectors or local residential streets which serve local access trips.

Regional Transportation Plan (RTP) – A long-range transportation plan that is developed and adopted for the greater Portland metropolitan planning area covering a planning horizon of at least 20 years.

Regional Trails - Off-street multi-use paths that connect multiple regional destinations such as regional centers, town centers, regional parks or natural areas, high-frequency transit or other regional trails. They serve as important transportation connections for people walking and bicycling, and support longer bicycle trips, often traversing two or more jurisdictions.

Regional Transportation System – The regional transportation system is identified on the regional transportation system maps in the Regional Transportation Plan. The system is limited to facilities of regional significance generally including regional arterials and throughways, high capacity transit and regional transit systems, regional multi–use trails with a transportation function, bicycle and pedestrian facilities that are located on or connect directly to other elements of the regional transportation system, air and marine terminals, as well as regional pipeline and rail systems.

Ride-hailing Services - (also known as transportation network companies, or TNCs) like Uber and Lyft use apps to connect passengers with drivers who provide rides in their personal vehicles.

Right of way - Areas within public ownership or easement to serve the purpose of providing access to other private and public property for people and goods.

Road Users - A motorist, passenger, public transportation operator or user, truck driver, bicyclist, motorcyclist, or pedestrian, including a person with disabilities. (23 USC section 148)

Runoff- Water from rainfall, snowmelt or otherwise discharged that flows across the ground surface instead of infiltrating the ground.

Safe System Approach - A data-driven, strategic approach to roadway safety that aims to eliminate fatal and severe injury crashes. The approach is based on a foundational understanding of the underlying causes of traffic fatalities and severe injuries (using data) and is based on the principle that errors are inevitable but serious crashes should not be.

Safe System Approach Speed Setting
Speed limits are set according to the likely crash types, the resulting impact forces, and the human body's ability to withstand these forces. It allows for human errors (that is, accepting humans will make mistakes) and acknowledges that humans are physically vulnerable (that is, physical tolerance to impact is limited). Therefore, in this approach, speed limits are set to minimize death and severe injury as a consequence of a crash.

Safety - Protection from death or bodily injury from a motor-vehicle crash through design, regulation, management, technology and operation of the transportation system.

Security (public and personal) - Protection from intentional criminal or antisocial acts while engaged in trip making through design, regulation, management, technology and operation of the transportation system.

Social Equity - The idea that all members of a societal organization or community should have access to the benefits associated with civil society – the pursuit of an equitable society requires the recognition that there are a number of attributes that give members of a society more or less privilege and that in order to provide equitable situations the impacts of these privileges (or lack thereof) must be addressed. For transportation, equity refers to fair treatment or equal access to transportation services and options. In the context of safety, transportation equity relates to improving the travel choices, the safety of travel and not unfairly impacting one group or mode of transportation. More specifically it means improved safety for all transportation options and lessening the risks or hazards associated with different choices of transportation.

Stakeholders – Individuals and organizations with an interest in or who are affected by the transportation planning process, including federal, state, regional and local officials and jurisdictions, institutions, community groups, transit operators, freight companies, shippers, non–governmental organizations, advocacy groups, the general public, and people who have traditionally been underrepresented.

Stormwater - Water produced by a storm event or conveyed through a storm sewer system.

Stormwater Management – The effort to reduce runoff of rainwater or melted snow into streets, lawns and other sites to reduce pollution of waterways.

Street –The term collectively refers to arterial, collector and local streets that are located in 2040 mixed–use corridors, industrial areas, employment areas and neighborhoods.

Swale- A natural or human-made open depression or wide, shallow ditch that intermittently contains or conveys runoff.

Traffic – Movement of motorized vehicles, non–motorized vehicles and pedestrians on transportation facilities. Often traffic levels are expressed as the number of units moving over or through a particular location during a specific time period.

Transportation System – Various transportation modes or facilities (aviation, bicycle and pedestrian, throughway, street, pipeline, transit, rail, water transport) serving as a single unit or system.

Trip – A one–way movement of a person or vehicle between two points.

Urban Growth Boundary – The politically defined boundary around an urban area beyond which no urban improvements may occur.

Urban Heat Island Effect- Caused by the prevalence of heat storing materials such as concrete and asphalt, and anthropogenic heat sources such as automobiles in urban areas. It is estimated that temperatures in cities are approximately seven to nine degrees higher than surrounding rural areas. Street trees in urban areas can great reduce this effect.

Vision Zero - A system and approach to public policy developed by the Swedish government which stresses safe interaction between road, vehicle and users. Highlighted elements include a moral imperative to preserve life, and that the system conditions and vehicle be adapted to match the capabilities of the people that use them. Vision Zero employs the Safe System approach.

Volume–to–Capacity (v/c) ratio – This is a measure of potential roadway capacity. A ratio expressing the relationship between the existing or anticipated volume of traffic on a roadway and the designed capacity of the facility. V/C standards set ratios as a minimum operating standard.

Vulnerable Users - In this document, refers to groups of people that are more vulnerable to being killed or severely injured in traffic crashes. Vulnerable users are people that are more vulnerable to being killed or seriously injured in crashes. Vulnerable users are pedestrians, bicyclists, motorcycle operators, children, older adults, road construction workers, people with disabilities, people of color and people with low income.

Watershed -The land area, or catchment, that contributes water to a specific water body. All the rain or snow that falls within this area flows to the water bodies as surface runoff, in tributary streams, or as groundwater.