CITY OF PORTLAND OFFICE OF TRANSPORTATION

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Technical Memo

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to: Bicycle Master Plan Steering Committee/Technical Advisory Committee

from: Roger Geller, Bicycle Coordinator
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re: Platinum Bicycle Master Plan –
Best Practices Bikeway Networks and Classifications

This report documents a survey of best practices for spacing, classifying and developing bicycle transportation networks as found in the most bicycle-friendly cities of North America and Europe. The intent of this effort is to compare worldwide best practices with Portland's current system to help determine whether the City of Portland should adopt a more advanced bikeway classification and spacing system than currently employed. The findings of this report describe the pros and cons of these classification and spacing systems and how these standards might be applied in Portland and related to bikeway function.

Portland's Bikeway System

Portland's Bikeway Network

One of the main elements of the 1996 Bicycle Master Plan was an adopted bikeway classification map showing citywide routes targeted as "city bikeways." Over the past decade, the development of the bikeway network has been a principal ingredient in Portland's success at increasing bicycle use. The current bikeway network as contained in the City's Transportation System Plan (TSP) was developed based on the following set of criteria:

- Connecting cyclists to desired destinations, such as employment centers, commercial districts, transit stations, institutions, and recreational destinations;
- Providing continuity with the regional system;
- Providing the most direct and convenient routes possible;
- Providing a parallel bikeway approximately every half mile; and
- Targeting locations with the potential for implementation in the next twenty years.

Portland's Bikeway Classifications

In forming a bikeway classification system, the city aims to "serve all bicycle users and all types of bicycle trips." Since 1996, the City has seen an increase in the number of existing/potential cyclists, a change in the perceptions of residents who recognize cycling as a real transportation option, and a shift in the demographics of existing/potential cyclists. In 1982, only fifteen percent of the population thought riding a bike to work was a possibility for them; in 2006, 63 percent of the population under fifty-five years old agreed that it is likely they would ride a bicycle to work at some point.[1] The growing number of residents who consider it normal to use a bicycle for errands, shopping, leisure, and commuting underscores the level of support for bicycling in Portland.

[1] Campbell Delong Resources Inc - SmartTrips Program Survey September 2006.

> Maintain a system of bikeways to serve all bicycle users and all types of bicycle trips.
>
> *Portland Comprehensive Plan*
> *Policy 6.7, Bicycle Classification*

Portland's street classifications as delineated in the City's TSP (Portland's guiding transportation policy and planning document) are intended to guide how each street should function and the appropriate types of improvements they should receive. Theoretically, the higher the level of activity on the street the higher the class designation. The TSP identifies the following three bicycle classifications and their purposes:

- City Bikeways – serve the Central City, regional and town centers, station communities, and other employment, commercial, institutional, and recreational destinations.
- Off-Street Paths – serve as transportation corridors and recreational routes for bicycling, walking, and other non-motorized modes.
- Local Service Bikeways – serve local circulation needs for bicyclists and provide access to adjacent properties.

Streets carrying the highest level designation, City Bikeway, are the primary targets for bicycle improvements. All other roadways are designated as local service bikeways.

Portland Bikeway Facility Types

The City's Bicycle Master Plan goes beyond the TSP classification to identify three separate types of facilities for designated "City Bikeways": Bicycle Lanes, Bicycle Boulevards, and Signed Connections. Off-Street Paths are a fourth facility type developed outside of the roadway. These facilities reflect different criteria and treatments for their development, different locations in the private and public realm, and different functions. Both bicycle lanes and bicycle boulevards are on-street facilities; bikeways with higher traffic volumes and speeds are typically treated with Bicycle Lanes. Bicycle Boulevards are developed on City Bikeways that carry fewer than 3,000 daily motor vehicle trips. City Bikeways carrying more than 3,000 ADT are developed with bicycle lanes. The exception to this are the "signed connections," which are recommended for no treatment greater than a sign indicating the point of interest to which they lead and for which they were classified. Of the four types of facilities that can be developed along Portland's bikeways, it is only the "signed connection" that entails no consideration of the operator's comfort.

Best Practices – Network Spacing: Creating Cohesion and Opportunities for Route Selection

The Dutch *Design Manual for Bicycle Traffic* published by CROW (the "CROW manual") is the preeminent international reference on designing for bicycle traffic. It advises that bikeway networks should be "as extensive and finely meshed as possible." The manual emphasizes *cohesion*, *directness* and *safety* as key factors for developing a bikeway network, along with *attractiveness* and *comfort*.

Three Key Factors for Developing a Bikeway Network

Requirement	Explanation
Cohesion	A complete system of connections, providing access to all points of departure and destinations: every home, company and amenity must be accessible by bicycle.
Directness	The opportunity to cycle between points of departure and destinations via as direct a route as possible.
Safety	Conditions for cyclists are safe.

Source: CROW, Design manual for bicycle traffic (2007)

Another commonly referenced manual, *Collection of Cycle Concepts* (2000) published by the Danish Road Directorate, suggests that "more cycle routes enhance the coherence of the cycle network as cyclists have more possibilities of adapting their trips to the network," thus appealing to different

kinds of cyclists. The benefits of a cohesive bikeway network for cyclists include:

- Greater access to common destinations
- More route options between origins and destinations
- Routes for different types of cyclists
- Less need to travel out-of-direction

There are few cases in North America of cities that applied a spacing standard to their bikeway network. As part of Portland's original Bicycle Master Plan, the City aimed to provide a parallel bikeway approximately every half mile. Two cities in Colorado, i.e. Denver and Boulder, used a one-mile grid to guide their selection of bikeway routes. In Canada, Vancouver and Toronto applied a one kilometer and two kilometer grids respectively. The following table summarizes notable cases of bikeway spacing standards from cities in the Netherlands, Canada and the United States. The Netherlands provides some of the best examples of applying fixed spacing standards to develop bikeway networks since many Dutch cities, such as Delft and Veenendaal, have more than two decades of experience implementing fine-mesh bikeway grids.

Cities with Bikeway Mesh Standards

City	Country	Portland City Blocks (~250 feet)	Guiding Mesh Spacing Standard (in meters)
Delft	Netherlands	5 to 7.5 4 to 5 1 to 4	Regional: 400-600 m** (1,312-1969 ft) City: 300-400 m ** (984-1,312 ft) District: 100-300 m ** (328-984 ft)
Nijmegen*	Netherlands	5 to 7.5	400-600 m (1,312-1969 ft)
Valkenswaard*	Netherlands	6 to 7.5 2.5 to 4	Primary: 500-600 m (1,640-1969 ft) Secondary: 200-300 m (656-984 ft)
Veenendaal*	Netherlands	4	300 m (984 ft)
Vancouver, BC	Canada	12 ½	1000 m (3,281 ft)
Toronto, Ontario	Canada	25	2000 m (6,562 ft)
Boulder, CO	USA	20	1,600 m (5,280 ft)
Portland, OR	USA	10	800 m (2,640 ft)

Notes: Source is city bicycle plan unless otherwise noted. *CROW Design Manual for Bicycle Traffic/***Modified in 2005 – Delft Fietsactieplan II*

The guideline for network mesh width in the "CROW manual" is no more than approximately 250 meters (i.e. less than 1/6 of a mile or roughly 3 Portland blocks) in urban areas. In contrast, the *Collection of Concepts* report recommends a 500-800 meter mesh, except in areas with many destinations where spacing should be 250-400 meters. It is important that cyclists have more route choices in areas where destinations are concentrated. Mesh standards can be set based on the intensity of activity (or destinations), the functional hierarchy of routes, or the on-the-ground realities such as distinct characteristics and existing bicycle usage.

Netherlands Cases: Delft and Veenendaal

Two notable cities in the Netherlands with decades of experience applying mesh spacing standards are Delft (95,300 population) and Veenendaal (60,000 population). Both cities systematically applied fixed mesh standards throughout their entire bicycle networks.

In 197o, the Municipality of Delft launched a demonstration project funded by the Dutch government to develop a comprehensive fine-grained bikeway network. The network was based on a functional hierarchy comprised of three levels:

- City level (500 meter spacing) – provide for through bicycle trips (mobility) and serve heavy bicycle volumes and links to regional routes and major facilities. The most costly investments are made on these higher level routes.
- District level (200-300 meter spacing) –provide access to district facilities and city-level routes and serve less heavy bicycle volumes and shorter trips.
- Subdistrict level (100 meter spacing) – provide site access and serve neighborhood bicycle trips.

Delft managed to achieve a bicycle mode share greater than 30 percent as the result of investments made to the city's bicycle network. An evaluation of the Delft Bicycle Network Plan conducted in 1987 by the Dutch Ministry of Transport and Public Works established that implementation of a dense, consistent and coherent bicycle network promotes cycling for the following reasons:[2]

- the bicycle is used for both very short and long trips;
- bicycle trips have a widely scattered pattern of origins and destinations and should be served by a fine grain network;
- cyclists do not use circuitous routes and a tighter grid of bikeways largely avoids indirect travel; and
- such a network offers better cognition and perception of travel possibilities, thus easing navigation.

The evaluation report further recommends different design features and spacing for each functional level so costs can be restricted and the maximum number of cyclists will benefit from the investments made. The Delft mesh standards were slightly adjusted with the adoption of the 2005 Bicycle Action Plan II to further incorporate the regional network. However, they preserved measures dictating the level of network density.

Concurrently, the City of Veenendaal also persistently applied dense mesh standards for its bikeway network; however, there was no distinction made based on the relative importance of different routes. All bicycle routes, regardless of functional level, are spaced 300 meters apart and are designed equally for comfort and speed. More than 30 percent of all trips made by residents are by bicycle, in part due to the density of the network that allows cyclists to:[3]

- practically always attain their ideal travel line;
- minimize diversions;
- choose between two or three route options; and
- select a route that suits their own taste.

[2] *Evaluation of the Delft Bicycle Network Plan*, Dutch Ministry of Transport and Public Works, The Hague, Netherlands, 1987.
[3] *Cycling in the Netherlands*, Ministry of Transport, Public Works and Water Management, The Hague, Netherlands, 2007.

The Portland Context

PDOT staff recently evaluated the density of bikeways (excluding undeveloped bike lanes) in different areas of Portland as part of an in-depth analysis of bicycling conditions. Not surprisingly, neighborhoods close to the Central City scored the highest for bikeway network density. East Portland, the West Hills and Southwest, where the development pattern did not follow a tight grid, scored lower. This finding suggests that any bikeway mesh standard adopted for the city may need to vary for districts with different geographic and street grid characteristics.

The Portland Comprehensive Plan policy for Bicycle Classification (Policy 6.7) aims for a "system of bikeways to serve all bicycle users and all types of bicycle trips." The City's Bicycle Master Plan called for parallel bikeways every half mile without distinguishing between the types of on-street facilities, i.e. bike lanes or boulevards, or the types of users they served. If a bikeway was developed with the appropriate treatment, it was believed that all potential users would be accommodated. Our thinking has evolved on this point. In order to attract a broader range of users, it is necessary to identify a network of bicycle routes where cyclists encounter minimal interactions with motor vehicles. The Danish *Collection of Concepts* states that "main bicycle routes can run along very busy roads with a number of junctions, which gives children a sense of perceived risk. In such cases there should be coherent alternative routes." In other words, it is necessary to consider the spacing and connectivity of non/low motorized traffic routes developed and proposed as bicycle boulevards or off-street paths.

Summary of Considerations

Should the City's Bikeway Network Be More Fine-Grained?
Based on what we've seen from some of the best cycling cities/countries around the world, the two main advantages to a dense bikeway network are: it limits out of direction travel and it provides options to people using a bicycle for transportation. A denser network of bikeways necessarily creates more bicycle-oriented crossings of roadways that—untreated—present significant barriers to crossing. More crossings, and more bicycle-optimized streets, translate to less out-of-direction travel.

In addition, a more fine-grained Portland bicycle network provides for more travel options. This will allow cyclists of different skill and comfort levels to find routes better suited to the varying transportation needs and level of comfort found among the "interested but concerned" cyclist Portland is working to attract to bicycle transportation. For example, while a collector street with a bicycle facility on it may emphasize speed of travel, potentially at the expense of comfort, a nearby parallel bicycle boulevard route would emphasize comfort. While the former will well serve the person needing to arrive at their destination soon, the latter will likely be a preferred choice for both a less-skilled cyclist as well as a family riding together.

Should the Bikeway Network Density Vary by District?
That the density of the bikeway network will vary by district is almost a foregone conclusion. Portland's Bureau of Planning identifies three distinct planning areas for Portland: the historic streetcar neighborhoods, Portland's Outer East neighborhoods, which developed in a post-World War II suburban pattern and those areas of Portland's westside whose defining characteristic is its topography. As the streetcar neighborhoods are generally defined by a well-connected street grid and relatively high roadway density, they lend themselves well to a bikeway grid that can achieve the spacing herein identified for some of Europe's most bicycle-friendly cities.

While we can attempt to replicate that spacing in other areas of the city, the reality of a disconnected roadway network and severe topographical constraints, both of which dramatically skew the grid, likely means that a "world-class" spacing of classified bikeways will not be achievable in all areas of Portland.

What Spacing Standard Might be Used in Areas Where Destinations are Concentrated yet Scattered, such as along Commercial Corridors and Main Streets?
The Dutch cities considered in this memo provide a range of spacing guidelines Portland can apply in providing access to commercial destination nodes along Commercial Corridors and Main Streets. However, rather than blindly applying a blanket standard for accessing commercial destinations, it should be the goal of Portland's bikeway network to identify those destinations and ensure they are well-served by the bikeway network. In identifying bikeways, planners will need to take into account many other features of the route in addition to how they intersect with Commercial Corridors (assuming the Commercial Corridor itself is not designed to include a bikeway). These include the continuity of the route, other destinations it may serve, and the feasibility of converting that route into a bikeway that will meet our soon to be updated design guidelines.

Best Practices – Network Classification

Routes identified on bicycle transportation networks are often distinguished based on their relative function. This is the case in many cities including Portland with its two-tier bicycle classifications of on-street bikeways, i.e. City Bikeways and Local Service Bikeways. In Portland, the roadways carrying the higher classification of City Bikeway are those typically prioritized for investments in bicycle infrastructure.

Portland's classification system is identical to the network system adopted in London, England. The London Cycling Action Plan (2004) identified 900 km of local bikeways, referred to as London Cycle Network Plus (LCN+) routes, to be targeted for investment and completion by 2009/2010. LCN+ routes carry higher volumes of bicycle traffic and once built will offer a high standard of service for bicycles, in terms of journey time, safety and comfort.

The Dutch CROW design manual outlines the functional classification system used at the local level in the Netherlands and suggests a three tiered hierarchy. Two criteria are suggested for designating main cycle routes: the role of the route within the network, and the volume of cyclists on the route. A study of main cycle routes by the Dutch Bicycle Council resulted in the following indicators for each functional level:

- Main cycle routes: (>2,000 cyclists/day) routes used by many cyclists and offering the highest level of quality. Three criteria must be met by these routes; length (minimum 1 km), directness, passage of barriers and/or attractiveness result in use by a large proportion of cyclists, and total ridership (used by a large number of cyclists).
- Cycle routes: (500-2,500 cyclists/day) provides "district" level connections linking a neighborhood to other neighborhoods within a district.
- Basic network: (<750 cyclists/day) provides "neighborhood" level connection on every street that can be used by cyclists.

The following table comprises a survey of bikeway classifications utilized in notable cities throughout North America. Some cities do not make a policy distinction between the classification of a route and the facility assigned to that route. Many cities group bicycle route into three basic categories: bike lane, shared roadway, or off-street path. Only one of the cities listed below – Boulder – employs a hierarchical system as part of the network classification. In the Boulder Transportation Master Plan, the bikeway network is further classified into

"primary" or "secondary" corridors. Primary Corridors are generally defined as bikeways on streets classified as arterials. As stated in the Plan, Primary Corridors are given some priority in terms of funding allocation and in facility maintenance.

BIKEWAY CLASSIFICATIONS IN NOTABLE NORTH AMERICAN CITIES

CITY	POLICY CLASSIFICATIONS
Portland, OR	City Bikeway, Off-street Path, Local Service Bikeway
New York, NY	On Street Bike Lanes, Signed Bicycle Routes, Seasonal Bicycle Paths/Lanes, Multi Use Paths
San Francisco, CA	Bicycle Lane, Wide Curb-lane, Bicycle Route (mixed traffic), Bicycle Path
Davis, CA	Bike Lanes, Bike Paths
Denver, CO	Grid Routes: on-street/off-street, Neighborhood Bike Routes
Boulder, CO	Primary (arterial) vs. Secondary (residential) Corridors: Primary has some priority in funding/maintenance
	Streets with Bike Lanes, Designated Bike Routes, Multi-Use Paths
Madison, WI	Bike Lane/Paved Shoulder, Bike Path/Trail
Seattle, WA	On-road Bicycle Routes, Off-road Bicycle Routes
Vancouver, BC, Canada	Bike lanes on arterial streets, Local street bikeways, Dedicated off-street paths

The advantages and disadvantages of potential bicycle classification schemes are summarized in the following table. The right-hand column, titled "applicability", contains brief comments for consideration in the application of each classification scheme.

PROS, CONS AND APPLICABILITY OF BICYCLE CLASSIFICATION SCHEMES

SCHEME	PROS	CONS	APPLICABILITY
Binary (On/Off)	• Offers flexibility to assign appropriate facility/ improvements upon implementation • All routes eligible for the highest quality treatment	• Provides little guidance for modal conflicts, facility selection and design	Current bicycle classification scheme adopted in the City of Portland TSP. No distinction is made between routes on the bicycle network.
Functional	• Informs network prioritization to meet capacity requirements • Provides a framework for network design • Higher level streets targeted for the highest quality treatment	• May restrict the tools or funding available for treating lower-level routes • Requires significant data collection and forecasting • Relies on model forecasting	The Dutch model for forming a network. A hierarchy of class levels is defined based on the character of the traffic served on the route. The volume of bike trips is a common measure use to classify routes. This becomes relevant when a critical mass of cyclists exists.
Implementation Priority	• Elevates implementation priorities to the policy level • Allows for development of a clear work plan	• Could restrict the implementation of lower level routes • Changes may require a policy amendment • No comparable framework exists in current city policy	Class levels are defined based on the priority of a route for improvement. Boulder, CO, uses a second overlay to designate routes of primary or secondary importance. Portland currently addresses project priorities in the implementation strategy.
Facility Type	• Provides specific/clear design intent. Classification is clearly translated to what is applied on the ground • Eases communication with public	• Lack of flexibility for site specific design • Requires a plan amendment if conditions change	The classification directly reflects the desired facility type on the route. This is the system utilized in most of the North American cities profiled above.

<u>The Portland Context</u>

The rationale behind assigning a single classification of "City Bikeway" to all primary on-street bicycle routes is that it enables investment prioritization while preserving the flexibility to assign an appropriate bikeway facility based on conditions at the time of implementation. Boulder's focus on arterial streets is similar to the bicycle networks adopted in Portland's original Bicycle Master Plan, in which arterials with bike lanes represent 67% of the proposed network, and in Metro's Regional Transportation Plan, where "regional streets" with bike lanes are considered to "provide the primary network for bicycle travel in the region."

<u>Summary of Considerations</u>

Should the City Expand the On-Street Bikeway Classifications Beyond the Current Two-Tier System?

We are certainly leaning toward expanding our classification system from the simple binary system we have now to at least a three-tiered functional hierarchy classification. At the top of this hierarchy would be "Major City Bikeways," or something to that effect. This classification would identify those bikeways that either a) are a direct link to the City Center and/or Regional Centers b) carry high volumes of cyclists or are expected to carry high volumes of cyclists c) natural funnels to which cyclists must necessarily gravitate as they traverse barriers (esp. bridges and flat routes in otherwise hilly terrain).

The next tier would be "City Bikeways," which would be all other mobility routes not identified as "major." The lowest tier would be "Local Service Bikeways," which provide a local access function.

We would no longer classify off-street paths as a separate designation and would instead provide them with a functional classification.

In addition to these corridor classifications, we may identify a "Bicycle District". Our current thinking is that a Bicycle District defines a destination area of town that is characterized by multiple commercial, institutional or other common destinations on almost every street within the area. Such areas could include the Downtown, River District, Lloyd District, Gateway, Hollywood, and other areas with multiple roadways with multiple destinations. While these areas would also have City Bikeways (and/or Major City Bikeways) running through them, classification as a "Bicycle District" would indicate intent to make all streets within the district be welcoming for bicycle traffic. As these areas will typically coincide with the Regional and Town Centers, which are intended to attract much commercial and employment activity, the streets defining such centers should work well for bicycle transportation.

In addition to these three classifications, we are likely to recommend additional overlay classifications that may fit more appropriately with the city's Street Design classifications. These include something currently loosely described as a "Commercial Access Corridor," and a "Green Connector." A Commercial Access Corridor is an area of focused commercial activity that is on a street that does not form part of the City's mobility bikeway network but that must still be welcoming to bicycle traffic. The idea of Green Connectors is one that is gaining traction within the Portland Bureau of Transportation, Bureau of Parks and Recreation, Bureau of Planning, and Bureau of Environmental Services. These would be both off-street and on-street. The on-street facilities may be more like a "Super Bicycle Boulevard" that offers supremely comfortable conditions for bicycling. These routes could carry certain design characteristics (street trees, exceptionally low volumes, water retention facilities) that primarily provide access to parks and other natural features in the city.

Would a System Based on Functional Hierarchy Help the City Define the Relative Importance of Individual Bikeways and/or Prioritize Investments?
Yes. The intent of a classification of "Major City Bikeway" is to have accompanying policy to support the types of designs and necessary investment needed to accommodate high volumes of cyclists. The city's experience is that the normal bikeway designs as identified in the AASHTO Guide for the Development of Bicycle Facilities are inadequate to handle the volumes of cyclists Portland is currently experiencing. As we continue to promote bicycling and build new infrastructure, this problem will only worsen with increased use.

How Would the Level of Bicycle Classification Relate to the Level of Potential Investment?
For many roadways, creating Major City Bikeways that achieve their intended function will require significant levels of investment. Setting a high bar in terms of function, and then creating benchmarks and measurable operating criteria, will likely require repeated investments in these facilities over time to ensure that they achieve their intended function. At the same time, a significant element in Portland's strategy is to develop as many "low-stress" bikeways as possible. While some of these routes are likely to be classified as Major City Bikeways, the majority will be classified as City Bikeways. Depending on the city's ultimate implementation strategy for bikeways, City Bikeways could, as a group, receive significant attention and initial investment.

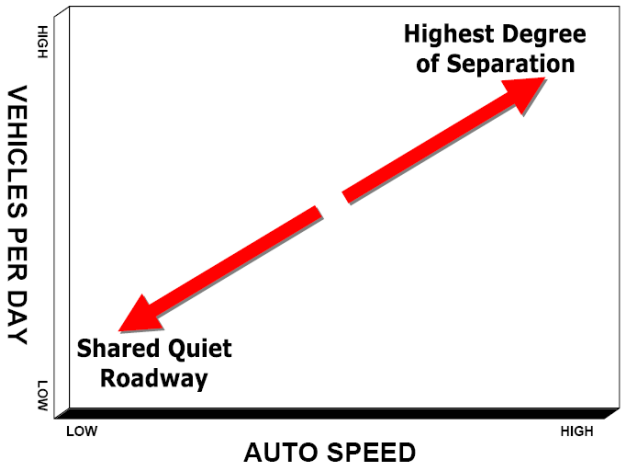
Best Practices – Facility Selection and Roadway Design

This section presents best practices for selecting appropriate bikeway facility types and discusses the implications of bikeway classifications upon bikeway design. The quality of bicycling experience on a given route is determined by the safety, comfort, directness and attractiveness it provides. On streets where cyclists interact with motor vehicles the bikeway facility type and roadway design play an important role in achieving these objectives. The CROW manual outlines general principles for road sections. If it serves a distributor function for motorized traffic, a specific bicycle facility is required. If the road section exclusively serves an "estate" (or local) access function, such facilities are not normally required due to low speed of motorized traffic.

In Portland, the guidelines for facility type selection, as defined in the original Bicycle Master Plan, are based on traffic classification and the average number of motor vehicles per day. If a street segment has motor vehicle volumes greater than 3,000 per day, bicycle lanes are the recommended facility type. On "local service" streets with 3,000 vehicles per day or less, City Bikeways are developed as bicycle boulevards. Although Portland's bikeway network is generally categorized into four facility types (i.e. bike lanes, bike boulevards, multi-use trails and signed connections), a broader palate of design treatments are employed on City Bikeways. The following table summarizes the range of bikeway treatments used in select cities across North America and Europe.

	CITY															
		Europe					Canada		USA							
BICYCLE FACILITY TYPES	Portland, OR	Amsterdam, NL	London, UK	Copenhagen, DK	Berlin, D	Muenster, D	Montreal, Quebec, CA	Vancouver, BC, CA	Berkeley, Ca	San Francisco, Ca	Palo Alto, Ca	Boulder, Co	Chicago, Il	Austin, Tx	Minneapolis, Mn	New York, Ny	Orlando, Fl
Multi-Use Path	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bicycle Boulevard/Bicycle Priority Street	✓	✓		✓	✓	✓		✓	✓		✓		✓	✓			
Bike Lane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
"Sharrow" (Shared Lane Marking)	✓						✓	✓		✓		✓	✓			✓	✓
Wide Outside/Curb Lane	✓									✓				✓			
Signed Route	✓		✓						✓				✓		✓	✓	✓
Shared Roadway		✓	✓		✓				✓	✓	✓	✓	✓	✓			
Wide Shoulder	✓						✓					✓		✓	✓		
Bike/Bus Lane		✓	✓		✓	✓	✓	✓				✓	✓				
Advisory Cycle Lane no Centerline		✓	✓		✓	✓											
Residential Speed (30 km/h) Zone		✓	✓		✓	✓											
Contraflow Bike Lane	✓	✓	✓	✓	✓	✓	✓					✓					
1-Way(cycletrack)/2-way Sidepath		✓	✓	✓	✓	✓	✓									✓	
Car Free Zone – bicycle route		✓	✓	✓	✓	✓											

Each of the facilities identified in the table above provide distinct conditions for bicycling and varying degrees of separation from motor vehicles. Bicycles can be separated from motor vehicles using paint, physical barriers or parallel low-traffic streets. The higher the degree of separation the greater the level of comfort and the fewer the number of conflict points between users.



Many bicycle design manuals, including the Dutch *CROW* guide and Danish *Collection of Concepts*, follow the principle that a higher degree of separation is needed when motor vehicle speeds and volumes are higher. The facility types and speed/volume thresholds for assigning each type differ from case to case. The aim of this principle is to select an appropriate treatment that maximizes the safety, comfort and attractiveness of the route. Another consideration in designing on-street facilities is the volume of bicycle traffic and the profile of the roadway. The CROW manual chapter on "road sections" outlines measurements for the intensity of bicycle traffic, the number of motor vehicles encounters, and the width of the roadway profile to assist in identifying appropriate roadway designs.

In addition to the principle of separation, "proximity" (or directness) is another critical consideration in selecting an appropriate bikeway facility type. If cyclists are separated from motor vehicles by distance, such as on a bike boulevard paralleling an arterial street, it is important to evaluate access by bike to destinations on the arterial street and minimize detours and network gaps. Emphasizing "proximity" to commercial areas along main streets balances the desire for separation with the need for cyclists to safely reach popular destinations. The table below illustrates how different facility types offer different degrees of separation and proximity.

Facility Type	Separation	Proximity
Signed Route		☆ ☆ ☆
Shared Lane Markings		☆ ☆ ☆
Bike Lane	☆	☆ ☆ ☆
Bicycle Boulevard	☆ ☆	☆ ☆
Off-Street Path	☆ ☆ ☆	
Cycle Track	☆ ☆ ☆	☆ ☆ ☆

Note: Other facility types not shown here, but listed earlier in the report, offer similar conditions to those included in this table.

The Portland Context

The facility types listed in the tables above outline the potential toolbox of treatments that might be utilized in a given situation. For Portland to join the ranks of the world's premier cycling cities, it is necessary to expand the range of facilities at our disposal. Before deciding how to develop a future bikeway corridor, the specific conditions must be factored, including cost, feasibility, and operating characteristics.

Summary of Considerations

How Should a Street's Function (or TSP Classification) Determine the Appropriate Treatment on the Bikeway?
In general, the existing traffic conditions on a roadway will determine the approximate treatment on a street and whether cyclists will share the roadway with automobiles (as in a bicycle boulevard) or whether they will be separated from automotive traffic (with bicycle lanes, cycletracks, buffered bicycle lanes, etc.).

What Facility Types Should be Included in a Portland Bikeway Toolbox?
While this is a question more appropriately addressed in a bikeway design guideline, we are currently looking at the following facilities for development within the city of Portland: bicycle boulevards, advisory bicycle lanes, conventional bicycle lanes, buffered bicycle lanes, cycletracks, enhanced shared roadways, and off-street paths.

How Should the City Balance the Need for "Proximity" to Commercial Uses with the Desire for Greater Separation from Automotive Traffic?
Ideally, we will develop facilities such that people on bicycles, should they desire, can be separated from high volumes of traffic on streets that serve commercial functions. The world's most bicycle-friendly western cities accomplish this through a combination of wide bicycle lanes and cycletracks. This is the idea behind designating stretches of Commercial Main Streets as "Commercial Access Corridors". Their intent will be to accomplish separation from traffic through facility design while providing proximate access.

In other cases, bicycle boulevards will provide the separation from high volumes of traffic. Because Bicycle Boulevards do not generally have high concentrations of commercial uses and will not provide the desired proximity to them—we have endeavored to site boulevard routes so that they intersect Commercial Main Streets either at or close to commercial nodes.