

Cost Analysis of Bicycle Facilities:
Cases from cities in the Portland, OR region

FINAL DRAFT

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CONTENTS

EXECUTIVE SUMMARY

Overview

As communities nationwide are faced with declining transportation revenues and increased demand, bicycle facilities can offer a way to increase the capacity of the existing infrastructure at a lower cost than traditional road projects. Bicycling instead of driving for shorter distances can help reduce traffic congestion by getting cars off the roadway, while promoting physical activity and better health for the individual. However, this potential can be overlooked as local officials are often unaware of the need to enhance the bicycle network to increase ridership, along with the relatively low cost to improve and expand the network. This study was undertaken to provide policy-makers with objective information on the true costs of bicycle facilities; to give transportation planners and engineers cost data to develop realistic plans and cost estimates; and, to help active transportation advocates make the case to the public and to elected officials for the economic benefits of bicycle facilities and cost savings over other infrastructure. We worked with staff at the Portland regional government (Metro) and ten cities in the metropolitan region to identify and document costs for a range of recently-completed bicycle infrastructure projects.

Key Findings

This study documented the costs associated with installing various bicycle facilities on existing streets, along with descriptions and photos of each facility type. For each type of bicycle facility there are a range of possible costs, determined in part on whether the change is a simple intervention or more complex redesign, and what level of planning or engineering the physical and political context require. In general, we found that costs associated with design and construct of bicycle infrastructure improvements are relatively low when compared to similar lengths of roadway projects. For example, the City of Portland calculated that the city's entire bicycle network, consisting of over 300 miles of bikeways would cost $60 million to replace (2008 dollars), whereas the same investment would yield just one mile of a four-lane urban freeway.[1] In addition, bicycle facilities can often be combined with other roadway improvements to take advantage of economies of scale. For example, bicycle lanes can often be added to streets as part of planned maintenance or re-striping projects at a cost of $1 -5 per foot (excluding right of way acquisition and engineering costs). Bicycle boulevards, which are through-routes on streets with low traffic volumes and speeds, typically include a range of improvements to calm traffic and improve conditions for cycling. Depending on the context and magnitude of the project, bicycle boulevards generally cost between $9.50 and $27.20 per foot. Table 1 provides an overview of our cost findings for a variety of bicycle infrastructure.

Implications

This study provides objective information on the true costs of bicycle facilities that can be used by local policy makers, transportation planners and engineers, and advocates to support the cost effectiveness of this mode of transportation, and to develop realistic plans to increase the amount of local bicycle infrastructure.

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1 City of Portland Bureau of Transportation, "How Portland Benefits from Bicycle Transportation." Accessed online 11/15/2011 at http://www.portlandonline.com/transportation/index.cfm?c=34816&a=371038.

However, we also found that there is a need for improved cost tracking. Costs for bicycle facilities are not easy to capture for several reasons: they often occur as part of a larger multi-modal roadway projects, and bicycle-related costs are not tracked separately; in addition, the facility costs may reside in several departments or agencies, commonly planning and engineering, and not always aggregated at the end of the project.

Table 1 Cost Overview

Category	Facility Type	Cost
Bike Lanes	Line/stripe removal	$0.62/ft
	Bike Lanes	$0.83-$6.35/ft
	Buffered Bike Lane	$2-$9.33/ft
	Bike Lane Stencil	$250-$270/stencil
Signs and Markings	Remove existing sign	$129/sign
	Remove and Reinstall existing signs	$140/sign
	New stop sign	$150/sign
	Wayfinding sign	$200-$440/sign
	Sharrow	$250-339/sharrow
Flow, Volume, Speed Management	Bike-Thru Median	$721/ft
	Speed Hump	$2,500-$2,800/hump
	Chicanes	$5,000/chicane
	Traffic Circles	$20,000/circle
Intersections and Crossings	Pedestrian and Bicycle crossing signs	$200/sign
	Crosswalk	$1,000/crosswalk
	Raised Crosswalk	$3,500/crosswalk
	Two-stage turn queue box	$1,000/box
	Bike Box	$5,000/box
	Standard Curb Extension	$15,600/extension
	Green Curb Extension	$28,397/extension
	Refuge Island	$1,700-$21,580/island
	Rectangular Rapid Flash Beacon	$7,500-$20,250/RRFB
	Bicycle Signal Head	$5,000/signal
	Bicycle Loop Detection	$6,630-$7,730/lane
	Bicycle Signal Push Button Actuation	$3,000/pole
	Complete Bicycle Signal Retrofit	$52,201/signal
	HAWK Signal	$150,000/intersection
	Full Signal	$140,000-$250,000/intersection
Bicycle Boulevards	Bicycle Boulevard	$9.49-$27.20/ft
Cycle Tracks	At Grade Cycle Track	$24.79/ft
	One Way Raised Cycle Track	$68.16/ft
	Two Way Raised Cycle Track	$188-$698/ft
End of Trip Facilities	Bike Racks	$200/rack
	Bicycle Corral	$3,000/corral

INTRODUCTION

Background

Bicycling is rapidly growing in popularity as a transportation choice for many shorter trips because of its environmental, economic and health benefits. Studies have found that safe and convenient cycling infrastructure is an important element to increase the mode share of trips taken by bicycle[2]. However, many American cities have been built to facilitate automobile travel, and are not conducive to bicycling. Even as local government officials often recognize the importance of providing bicycle facilities, the perception is often that bicycle facilities are expensive and serve only a small minority. In Portland, as bikeway miles increased almost four-fold from 79 miles in 1991 to 307 in 2011, counts of cyclists crossing major bridges into downtown increased over six-fold to 18,257 (accounting for over 16% of daily traffic over those bridges).[3] According to the U.S. Census Bureau, over 6% of workers regularly commuted by bicycle in the city in 2011, compared to about 1% in 1990.[4] Investing in bicycle facilities can be a very good value for cities. Research shows that constructing bicycle facilities has the potential to increase the number of bicycle trips, which over time can reduce the need for more costly road expansion projects. The City of Portland had made substantial efforts to document the value of its investment in bicycle transportation, calculating the Portland's entire bicycle network, consisting of over 300 miles of bikeways would cost $60 million to replace (2008 dollars), whereas the same investment would yield just one mile of a four-lane urban freeway[5].

Portland also notes that increases in economic activity and population between 1991 and 2008 would have overwhelmed the capacity of the city's existing bridges had the related increase in mobility needs been borne solely by auto traffic. Instead, much of the increase in traffic has been borne by bicyclists, allowing the bridges to continue to meet the needs of automobiles on the bridges at the same level of service as the early 1990s.

Study Intent and Development

Bicycle facilities vary between regions, cities, and even between locations within the same city. There is a range of potential facilities that are appropriate for a variety of contexts, from older urban streets, to new, suburban-style development, and

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[2] Pucher et al. "Infrastructure, programs, and policies to increase bicycling: An international review", Preventative Medacine 50 (2010), S106-S125.

[3] City of Portland Bureau of Transportation, "2011 Bicycle Counts Report" Accessed online 3/29/2013 at http://www.portlandoregon.gov/transportation/article/386265. and 2012 motor vehicle bridge counts accessed at http://www.portlandmaps.com/.

[4] 2011 data from American Community Survey. 1990 data from Decennial Census.

5 City of Portland Bureau of Transportation, "How Portland Benefits from Bicycle Transportation." Accessed online 11/15/2011 at http://www.portlandonline.com/transportation/index.cfm?c=34816&a=371038.

everything in between. The viable options will depend on a number of factors, including the community's safety needs, transportation and health goals, and availability of funding. Understanding the costs associated with building new bicycle facilities is essential to effectively plan how, when and where to develop and/or improve a facility network. The Portland region is an appropriate location for this study because multiple jurisdictions in that region have a long history and experience with a wide range of facility types in a variety of settings.

This study was originally intended to simply document the costs associated with installing various types of bicycle facilities on existing streets and roadways. As we talked with transportation professionals working in cities and counties throughout the Portland metropolitan region, it quickly became clear that it's not quite that simple. First, many projects, such as installing bike lanes, often occur as part of a larger maintenance project, such as re-striping or re-paving a roadway. So while it's fairly straightforward to detail the cost to purchase and install the striping material to designate the bicycle lane, the other items are bundled into the larger project and difficult to itemize.

For other types of facilities, such as bicycle boulevards or neighborhood greenways, there is a range of improvements that can be made. These will vary depending on the physical street environment, surrounding traffic patterns, and neighborhood context. As a result, the costs associated with retrofitting a mile of roadway into a bicycle boulevard also vary widely depending on the level of improvement desired.

In addition, though agencies may document the cost of materials and labor, they do not always reflect the time and money associated with planning or community outreach efforts, or the cost of additional studies that may be needed, such as a traffic study to evaluate the impacts of changes associated with a bike boulevard.

This report documents costs where they can be itemized, but more importantly, it highlights the elements and trade-offs to consider when planning for new bicycle facilities. Brief case studies highlight the range of treatment options to consider for more complex facilities, such as bicycle boulevards. Other cases highlight the cost savings of bicycle facilities in lieu of expanding motor vehicle capacity and the avoided costs of expensive roadway treatments through increasing access to bicycle facilities.

The report offers practical tools and information for understanding the costs of various types of facilities. We hope that it will provide valuable information for communities that that do not yet have experience building these facilities and additional context and comparative information for agencies that do have experience.

Importance of Local Context

Local context plays a major role in determining what facilities can be built and how much they will cost. One of the major variables in the cost of implementing new bicycle facilities that will differ from location to location is the amount of outreach and planning needed for a particular project. Similarly, existing conditions, community needs, and related factors affect the cost of implementing a particular facility. The ability of a municipality to add bicycle facilities depends on a number of factors, including:

- *Political and staff support:*
  How much "political capital" will need to be expended to move forward?
  How urgent is the need for the facility based on safety or other data?
  How active and influential are bicycle advocacy groups?
  How significant and known are the impacts of bicycling on the local economy?
- *Amount and condition of right of way*:
  Will the municipality have to purchase additional right of way? If so, the costs of the project can increase dramatically.
  Is the right of way flat/level? If not, adding support, embankments or other features to create a flat road surface can increase costs dramatically.
  How will the facility affect drainage?
- *Current roadway/lane configuration*:
  Is there enough room in the shoulder or extra width in existing lanes to add a bike lane?
  Can a lane be dedicated to bicycles?
  Are the street's traffic speeds and volumes appropriate to be a bicycle boulevard? If not, what would need to be done to make it appropriate?
  Is the road a candidate for a road diet (e.g. converting a four lane road into a road with one travel lane in each direction with a left turn lane and bike lanes)?
  Would parking need to be removed? If so, what would the impact of that be?
- *State-specific DOT requirements where state facilities run through cities and counties:*
  How coordinated are the actions of the state and local agencies?
  What are the state DOT priorities in terms of vehicle speed, volume, and multi-modality?
  Does the state have a complete streets policy or requirement?

The examples and cases discussed in this report illustrate the need for champions at both the leadership and staff level, and the need for staff to have the knowledge and support to advocate for investments in bicycle facilities. Having information about facility costs and expected outcomes can help policymakers and community members to understand the value of investing in bicycle transportation.

Sources of Information

Facility descriptions draw from a report published by the National Association of City Transportation Officials (NACTO), the "NACTO Urban Bikeway Design Guide"; reports and other documents released by the Initiative for Bicycle and Pedestrian Innovation at Portland State University (including "Fundamentals of Bicycle Boulevard Planning & Design", by Walker et al.); and research documents from Portland State University faculty (including a final report by Monsere et al., "Evaluation of Innovative Bicycle Facilities: SW Broadway Cycle Track & SW Stark/Oak Street Buffered Bike Lanes").

The City of Portland provided the bulk of the facility and project cost and context information presented in this report. City and County planners and engineers in the Portland Metro region also contributed to the findings to round out the findings with examples from communities of various sizes and types. Without their assistance this report would not have been possible. Where necessary, this information has been supplemented with other peer-reviewed papers, published news articles, and agency reports – these sources are cited where used.

Types of Facilities & Organization of the Report

The report is organized by facility type, generally ranging from some of the most basic and least expensive bicycle system elements (such as sharrows and bike lanes) to increasingly complex and fully-developed and/or exclusive bikeway routes (such as bicycle boulevards and cycle tracks). Many of the facilities are used in combination as needs and opportunities allow, particularly in the case of the bicycle boulevards.

Challenges Encountered

Isolating bicycle-specific costs: Often bicycle facilities are built as part of a larger construction project (e.g. the redevelopment of an intersection or segment of roadway). Many costs are common to the bicycle and non-bicycle related portions of the project, and are often not broken down by element in a way that provides a firm price on a specific bicycle project. For example, in the City of Portland, a cycle track (approximately 3200' long) that was constructed on SW Moody Avenue as part of a larger road reconstruction project was estimated to cost "around $600,000" out of a project total of $66 million. However, the city acknowledged that it had not separated the costs for the bicycle facilities from the overall project costs and so could not provide exacts numbers.[6]

Cost information silos: We also encountered situations wherein some of the planners and engineers did not have the cost information for the facilities we inquired about, and had some trouble tracking it down. Sometimes cost information was kept with planners or engineers, and it was not always easily transferable between the two groups without expending a fair amount of time and effort. Further, cost information is sometimes kept in accounting or engineering files and is not always easy to track down.

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[6] Joseph Rose, Oregonian, *Portland opens new cycle track along Southwest Moody Avenue near South Waterfront District.* Accessed online 11/16/11 at http://blog.oregonlive.com/commuting/2011/11/portland_opens_new_cycle_track.html

Bike Lanes

Bike lanes have historically been one of the principal building blocks of a bicycle network. A conventional bike lane usually consists of a four to six foot lane, separated from traffic lanes by a six- to eight-inch white line. If needed, a four-inch white line provides separation from parked vehicles. Bike lanes are generally located on busier streets, collectors and arterials, where some separation between motor vehicles and bicycles is desirable.

Depending on the roadway context, system needs, and budget, there are a number of variations on conventional bike lanes. This report will focus on two types: conventional bike lanes and buffered bike lanes. Other variations, such as left-side bike lanes and contra-flow bike lanes (e.g. a bike-only lane going against traffic in an otherwise one-way street), would have similar construction and materials costs associated with them, but might have varying amounts of planning and designs costs, depending on the nature of the project.

Bike lanes can be designed into a new street design, or added after the fact, either by repurposing a wide shoulder, narrowing existing traffic lanes, repurposing existing traffic lanes (as in a road diet), or a combination of these approaches. Many municipalities add or update bike lanes during a planned re-paving or re-striping of a roadway where the bike lane is not the main/sole objective of the project. This is a low-cost way to increase the number of bike lanes in a community. However it requires that the city engineer or other staff member overseeing these projects is proactive in seeking and implementing these opportunities.

Table 2 Bike Lane Cost Overview

Type	Example or Estimate	Description	Length or Number	Cost per unit
Bike Lanes (Range of $0.83-$6.35/ft)	Example	Bike lane striping, with minimal design and engineering costs, and no widening	1 ft.	$0.83/ft
	Example	One mile, two-way bike lane on residential, collector road. Retrofit, parking removal.	10,560 ft.	$1.30/ft
	Estimate	Bike Lanes - engineering estimate per foot of bike lane. Varies based on length and existing road right of way, use, width, etc.	1 ft.	$3.00/ft
	Example	Add bike lanes on bridge, part of larger bridge project, including widening of sidewalks	425 ft.	$6.35/ft
Buffered Bike Lanes (Range $2-$9.33/ft)	Example	Buffered bike lane with diagnonal line striping (accounting for $0.69 per lane foot)	1 ft.	$2/ft
	Estimate	A marked separation between a bike lane and a travel lane or parked cars.	1 ft.	$5/ft
	Example	Removing standard bike lane, install 6' bike lane with 2' shy zone, 6' square green box and bike stencil on each block, right turn lane crossover.	6,262 ft.	$9.33/ft
Hybrid Conventional/ Buffered bike lane	Example	Full roadway redesign to accommodate two bike lanes, remove parking. Buffer bike lane over bridge.	1,421 ft.	$31.92/ft
Bike Lane Stencil (Range of $250-$270)	Estimate	Bike Lane Stencil	1	$250/ stencil
	Example	Multiple projects	25	$270/ stencil
Line/stripe removal	Estimate	Removing existing pavement lines.	1 ft.	$0.62/ft

Conventional Bike Lanes

Bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signage, and are usually located adjacent to motor vehicle travel lanes. Bike lanes enable bicyclists to ride at their preferred speed without interference from prevailing traffic conditions. Bike lanes also facilitate predictable behavior and movements between bicyclists and motorists. Bicyclists may leave the bike lane to pass other bicyclists, make left turns, avoid obstacles or debris, and avoid other conflicts with other users of the street.

-NACTO Urban Bikeway Design Guide, p. 4.

Figure 1 Conventional Bike Lane, Portland, Oregon.

Conventional bike lane costs are affected by a number of factors, including the length of the project (e.g. longer segments will usually be less expensive on a per-foot basis), existing right-of-way use and width, use of bicycle stencil and arrow, design and engineering required, etc. Many agencies that we spoke to indicated that it is difficult to put a precise cost on the cost of adding a bike lane to a facility because often the bike lane is part of a larger reconstruction, repaving, update, or other change to a roadway.

- As a general guide, the City of Portland estimates that a standard bike lane costs around $3 per foot, once all costs are included, and are a function of the length of the project, existing right of way use and width, and use of signage and markings.
- The City of Beaverton, Oregon, installed bike lanes on a one-mile stretch (two miles of bike lanes total) of a residential, collector road. The retrofit required restricting parking on both sides of the street in one section, and on one side of the street in another section. The project cost $5,000 for design and engineering, $2400 for labor, $6,000 for materials, and $250 for equipment, for a total of $13,750, or $1.30 per foot ($0.83/foot for construction costs).
- The City of Gresham, Oregon, estimated that one recent project for striping of conventional bicycle lanes cost $0.86 per lane foot, but notes that this figure assumes no right of way acquisition or road widening. The sample project had minimal design and engineering costs, and was contracted out.

Buffered Bike Lanes

Buffered bike lanes are conventional bicycle lanes paired with a designated buffer space separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane. They encourage bicyclists to ride outside of the door zone when the buffer is between parked cars and bike lane. It also provides a greater space for bicycling without making the bike lane appear so wide that it might be mistaken for a travel lane or a parking lane.

-NACTO Urban Bikeway Design Guide, pp. 18-19.

The buffer may come from repurposing a standard traffic lane, using parking lane, or utilizing a wide shoulder.

Figure 2 Buffered Bike Lanes, Portland, Oregon.

Buffered bike lane costs will vary depending on several factors including the intensity of the buffer markings, the usage of pavement markings, including colored thermoplastic, paint, or stencils, the addition of any explanatory signage, and intersection treatments (particularly to address conflicts with turning motor vehicles). Additionally, costs will vary depending on where the additional buffer space comes from, whether standard traffic lanes or shoulders are repurposed, the road is widened, etc. The City of Portland estimates that a buffered bike lane costs about $5 per foot, once all costs are included.

- In downtown Portland, buffered bike lanes were installed on two streets (photo above). On one street the lane is 3,400 feet and one the other, 2,862 feet. The installation involved removing a standard travel lane, installing a 6’ buffered bike lane with a 2’ door zone between the bike lane and the travel lane on one side, and the parking area on the other side. The installation included a 6’ square of green thermoplastic with a bicycle stencil and arrow at the beginning of each block, and right turn lanes for motor vehicles at three intersections (which included a green thermoplastic section of bike lane at the crossover). The facility cost was initially $50,285, and required an additional $8,152 for remediation (signal adjustment at two intersections). This cost corresponds to an average cost of $9.33 per foot.
- The City of Gresham stated that buffered bicycle lanes for a project done “in-house” by operations staff on Division Street cost a total of approximately $2.00 per lane foot, which includes $0.69 per lane foot for the diagonal lines.

The “door zone” is the area next to parked cars where a bicyclist would get hit if a driver opened their car door.

Wayfinding Signs and Pavement Markings

Signage and pavement markings convey information about routes, directions, distances, and inform cyclists and other road users that cyclists should be expected on the marked roads. They are essential, yet relatively inexpensive, building blocks of a bikeway system that provide route guidance to cyclists alert motorists that they should expect to see bicycles. They can also alerts cyclists and motorists to the existence of existing or new bike facilities and therefore maximize the return on more expensive investments

Table 3 Signs and Markings Cost Overview

Type	Example or Estimate	Description	Cost per unit
Wayfinding sign (Range of $200-$440)	Estimate	Standard bike guide sign, with list of destinations, distance, and time. Cost is for installation and sign cost, and does not include planning and design	$200/ sign
	Example	Wayfinding signs, inclusive of design, development, and installation	$440/ sign
Sharrow (Range of $250-$339)	Estimate	Materials and installation, excluding planning costs	$250/ sharrow
	Example	Large scale installation of sharrows on city bikeways. Cost was $279 per sharrow, plus a total of $123,399 for installation (entire campaign)	$339/ sharrow

Wayfinding Signage

Wayfinding signage will usually consist of a combination of text describing directions and destinations, arrows directing cyclists at intersections, basic images (often a bicycle to convey that the sign and route are for cyclists), and distances in blocks, miles or minutes.

Figure 3 Left: "Turn" Sign. Right: Decision Sign. Portland, Oregon.

Much in the way that signs are essential to helping travelers navigate airports and motorists navigate highways, signage to help cyclists to know where they are headed is an important basic bicycle facility. Wayfinding signs are important to cyclists travelling in bike lanes on major arterials, but are even more essential for lower traffic bikeway routes that do not run along major arterials. While lower traffic residential routes, such as bicycle boulevards, may provide a lower stress environment by virtue of having fewer and slower motor vehicle traffic, they are also less likely to feature prominent in people's mental maps of a city or region. This increases the need for signs to guide the rider along the designated route.

The NACTO Urban Bikeway Design Guide separates out three distinct types of wayfinding signs[7]:

- Confirmation Signs, which "indicate to bicyclists that they are on a designated bikeway" and "make motorists aware of the bicycle route," and are recommended every two to three blocks along bicycle facilities;
- Turn Signs, which "indicate where a bikeway turns from one street onto another street"; and,
- Decision Signs, which "mark the junction of two or more bikeways" and "inform bicyclists of the designated bike route to access key destinations.

Wayfinding signage costs will vary depending on the design of the sign itself (including the size, materials, design and manufacturing costs) and the number of signs erected.

- The City of Portland estimates that a standard guide sign costs $200, inclusive of installation. Planning and design for signage is not included in this cost estimate.
- The City of Gresham estimates that the average cost of design, development, and installation for signs put in place through a recent wayfinding project was $440 per sign. No right away was required to be purchased. Volunteers donated 235 hours for work including helping to determine the locations of signs.
- A report on "Best Practices in Bicycle and Pedestrian Wayfinding in the Washington [DC] Region" produced by the Metropolitan Washington Council of Governments stated that bicycle wayfinding signs in D.C. cost between $70 and $200, inclusive of installation.[8]
- In a forthcoming project, the Oregon Department of Transportation will be installing 29 wayfinding signs, for an estimated $14,000 (an average of $483 per sign) to guide bicyclists and pedestrians to and over the I-5 bridge.

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[7] NACTO Urban Bikeway Design Guide, National Association of City Transportation Officials, April 2011, pp 240-242.

8 Metropolitan Washington Council of Governments, "Best Practices in Bicycle and Pedestrian Wayfinding in the Washington Region", Draft, May 15, 2007.

Sharrows and other Pavement Markings

Sharrows are a shared lane marking consisting of the combination of a bicycle stencil and chevron. They serve a similar purpose to wayfinding signage by providing confirmation and direction to cyclists and making motorists aware that they should expect cyclists on the roadway. "Sharrow" is a compound of "share" and "arrow", and traditionally sharrows have been used to indicate that motorists and bicycles should share a lane or road. Sharrows are placed on the roadway to indicate where a cyclist should position themselves.

Figure 4 Sharrow. Portland, Oregon.

In 2010, the City of Portland embarked on a campaign to place sharrows on each block of all bicycle boulevards in the city to make clear that the streets were bike routes, to mark the roads as a shared facility – essentially branding the streets as bicycle boulevards. Additionally, the sharrows were intended to be close enough to one another to provide wayfinding guidance and route confirmation to cyclists. At some intersections where the route turns or shifts, the chevrons on the sharrows were positioned to direct cyclists toward the continuing route.

Similar to signage, the costs to construct and install sharrows and other pavement markings are generally a fixed amount. However, design costs generally vary less with sharrows than with wayfinding signage. The City of Portland estimates that a standard sharrow costs $250 for materials and installation, excluding costs for planning.

For the 2010 sharrow campaign, which included the installation of 2,099 sharrows, the sharrow unit cost was $279, for a total of $585,621. Installation cost an additional $126,398.86, or $60.21 per sharrow, bringing the total cost for materials and installation of the sharrows to $339.22.

Flow, Volume, and Speed Management

Some bicycle facilities are designed to improve the experience of a bikeway by managing both the bicycle and motor vehicle traffic on the route. On the cyclist side, managing the flow of cyclists so that they can maintain a steady rhythm and pace is one important factor. On the motor vehicle side, managing traffic volume and speed is important to create a safe and comfortable environment. Flow, volume and speed management facilities and techniques are usually integral components of bicycle boulevards.

Table 4 Flow, Volume, and Speed Management Cost Overview

Type	Example or Estimate	Description	Length or Number	Cost per unit
Signage - remove existing sign	Estimate	Remove existing sign	1	$129/ Sign
Signage - remove and reinstall existing signs	Estimate	Remove and reinstall existing sign (e.g. flipping stop signs)	1	$140/ sign
Signage - new stop sign	Estimate	Install new stop sign (Estimates between $150 and $200)	1	$150/ sign
Bike-Thru Median	Estimate	Bike thru median, cost is per foot of length of median	1	$721/ft
Speed Hump (Range of $2,500-$2,800)	Estimate	14 foot width	1	$2,500/ hump
	Example	Numerous humps along half mile of roadway. Costs ranged from $2800 to $5000 for the project, plus $5000 in design costs for the whole project.	1	$2,800/ hump
Chicanes	Estimate	Generally in pairs or more ($10,000 to $20,000 per pair)	1	$5,000/ chicane
Traffic Circles	Estimate		1	$20,000/ traffic circle

Add or rotate stop signs

Stop signs can be added to a route to require cross traffic to stop at a previously uncontrolled intersection or be turned to favor a bikeway route. Because bicycles are so dependent upon momentum for speed and efficiency, frequent stops create a choppy and slow cycling experience. Turning stop signs to favor the bike route can make a route faster, more enjoyable, and more comfortable for cyclists.

Figure 5 Stop Sign. Portland, Oregon.

The City of Portland estimates that a standard stop sign costs $150-$200 for the sign and installation.

Bike-Thru Median and traffic diverter

A **bike-thru median and traffic diverter** provides an opening that allows cyclists to pass through an intersection, but prevents cars and trucks from crossing the road in the direction of the bikeway (and prevents left turn movements by motorists at those locations). These facilities serve to limit traffic on bikeways.

Figure 6 Bike Thru Median. San Luis Obispo, California (PedBikeImages/Adam Fukushima)

The City of Portland estimates that a bike-thru median costs approximately $721 per foot of length (consisting of $308 for construction, $77 for project management, $77 for engineering, $105 for overhead, and $154 for contingency).

Speed bumps/humps

Speed bumps or humps require motor vehicle traffic to slow down in order to safely pass over them, thereby reducing motor vehicle speeds. Speed bumps can be installed following neighborhood requests to slow down traffic and after looking at traffic speeds (in particular, 85th percentile speeds). Typically a gap is left at the curb for drainage, however too large a gap can encourage cars to drive around the bump (with one wheel) allowing them to drive faster. The bumps cannot be used on a street with a slope greater than 8%..

Figure 7 Speed bump. Portland, Oregon.

The City of Portland estimates that a standard speed hump (14 foot width) costs $2,500. This is standard treatment and the $2,500 is for materials and construction.

A suburban city (Beaverton) completed the installation of speed humps along half a mile of roadway in September 2010. Design of the improvements was done in-house and estimated at $5,000. The speed humps ranged from $2,800 to $5,000 each.

A suburban city (Tigard, Oregon) stated that speed bumps cost them between $3,000 and $5,000. This price does not include studies, evaluation, or neighborhood outreach.

Traffic Circles

Traffic circles slow traffic down by requiring traffic to maneuver around them.

Figure 8 Traffic Circle. Portland, Oregon.

The City of Portland estimates that a standard traffic circle costs $20,000.

Chicanes

Chicanes are usually presented in groups of two or more, and are generally curb extensions to islands that require traffic to travel in a serpentine pattern to navigate them, thereby slowing down traffic.

Figure 9 Chicanes. (Flickr/Richard Drdul)

The City of Portland estimates that a standard chicane costs $10,000-20,000 per pair.

Intersections and Crossings: Signage and Pavement Markings

Adequate intersection and crossing treatments are essential to having a safe, connected, and comfortable bikeway network. Crossing treatment needs are usually determined based on the traffic volume and speed of the road being crossed, along with roadway width and other factors.

Table 5 Intersection and Crossings: Signage and Markings Cost Overview

Type	Example or Estimate	Description	Cost per unit
Pedestrian and Bicycle crossing signs	Estimate	Generally in pairs	$200/ sign
Crosswalk	Estimate	Crosswalk bars included. Addition of any stencils or color will add cost	$1,000/ crosswalk
Raised Crosswalk	Estimate	Assumes 22 foot width	$3,500/ crosswalk
Two-stage turn queue box	Estimate	"Copenhagen Left Box" with green color, bike stencil and turn arrow.	$1,000/ box
Bike Box	Estimate	Green color, bike stencil, stop bar	$5,000/ box

Pedestrian and bicycle crossing signs

Pedestrian and bicycle crossing signs alert motorists to the presence of a crossing area and the possibility of encountering people walking or bicycling through the intersection. Generally, a minimum of one sign is required in each direction. Signs can be place on posts at the side of the road or strung over the traffic lanes.

Crossing signs are commonly used for a pedestrian crossing, while adding bicycle specific markings or text on signage is less common.

Figure 10 Bicycle and Pedestrian Crossing Sign. Portland, Oregon.

The City of Portland estimates that a crossing sign costs $200, or a minimum of $400 per intersection (exclusive of pavement markings or any other features).

Intersection crossing markings

Intersection crossings make the bike lane visible through the intersection by the use of pavement markings. They help guide the cyclists and also make the area more visible for automobiles. This should raise awareness for both of the potential conflict area.

Crossings can be standard pedestrian crosswalks (generally a zebra crosswalk at unsignalized intersections), or a bicycle specific crossing, such as a striped bike lane, bicycle stencils and/or chevrons, use of colored thermoplastic or paint, or a combination of these features crossing the roadway.

Figure 11 Raised Crosswalk. Portland, Oregon.

Figure 12 Bicycle Crossing Marking, Vancouver, British Columbia.

The City of Portland estimates that marked crosswalks cost $1,000-$1,500 for a 22' two-lane road, with costs rising for wider streets. The addition of bicycle stencils, color and other features will increase the cost.

Raised crosswalks serve a dual purpose – that of a crosswalk and that of a speed bump or speed table. The City of Portland estimates that a standard raised crosswalk (22 foot width) costs $3,500.

Two-stage turn queue boxes

A **two-stage turn queue box** allows a two-stage turn, also known as a hook turn, box turn, or Copenhagen left. Here the cyclist moves to the right before realigning to go straight across the intersection safely making a left hand turn. Turn boxes may have a higher than average signal delay, but can reduce turning conflicts

NACTO Urban Bikeway Design Guide, p. 141.

Figure 13 Two-stage turn queue box. Portland, Oregon.

The City of Portland estimates the cost of the green left turn box to be $1,000, including materials and construction.

Bike Box

Bike boxes move cyclists to the front of traffic at signalized intersections, which allows for higher visibility of the cyclists. This visibility helps prevent conflicts between cyclists and motor vehicles turning right at the intersection. Bike boxes also group bicyclists together to clear an intersection quickly, minimizing impediment to transit or other traffic and reducing the signal delay for cyclists

Figure 14 Bike Box. Portland, Oregon.

The City of Portland has installed a number of bike boxes, usually consisting of a 14-foot deep box across the right traffic lane and bike lane. The boxes are usually green (thermoplastic). The facility includes adding green thermoplastic to a portion of the approaching bike lane (approximately 50 feet before the box), and a continuation of the bike lane through the intersection (partially colored green).

According to the City of Portland, the cost of a bike box is approximately $5,000. This cost includes the green thermoplastic, other pavement markings, related signage ("Stop Here on Red" and "No Turn on Red") and installation.

Intersections and Crossings: Curbs and Medians

Extending curbs and providing medians can help slow motor vehicle traffic improve crossing conditions for both pedestrians and bicyclists.

Table 6 Curbs and Medians Cost Overview

Type	Example or Estimate	Description	Number	Cost per unit
Refuge Island (Range of $1700-$21,580)	Example	Island done in conjunction with larger project	1	$1,700/ island
	Example	Retrofit of existing roadway, which included 5 (pedestrian) refuge islands. Neighborhood committee provided landscaping	5	$4,000/ island
	Estimate	Range listed at $14,000-$60,000. "Typical" installation provided here.	1	$21,580/ island
Standard Curb Extension	Example	Typical implementation	2	$15,600/ curb extension
Green Curb Extension	Example	With storm water features - "bio-swale"	2	$28,397/ curb extension

Curb Extensions

Curb extensions narrow the roadway, presumably slowing down cross-traffic, and reduce the crossing distance, allowing cyclists and pedestrians to get across the road more quickly. In addition to these benefits, curb extensions place cyclists and pedestrians in front of parked cars, trees, or other potential visual barriers between them and passing cars, resulting in both parties having better visibility of one another.

Figure 15 "Green" Curb Extension with storm water capture. Portland, Oregon

The City of Portland estimates that a standard curb extension costs between $13,000 and $40,000 depending on the island location and type. A typical installation (and the standard City of Portland estimate) costs $6,700 for construction, $1,600 for project management, $1,700 for engineering, $2,250 for overhead, and $3,350 for contingency, for a total of $15,600.

A “green” installation incorporating storm water capture has an estimated cost of $12,197 for construction, $3,000 for project management, $3,000 for engineering, $4,100 for overhead, and $6,100 for contingency, for a total of $28,397.

Full Medians and Pedestrian Islands

Full medians and islands create a protected space in the center of the street. These treatments reduce the length of a crossing and exposure to vehicles for pedestrians and bicyclists.

NACTO Urban Bikeway Design Guide, p. 154.

Figure 16 Full Median and Pedestrian Island. Portland, Oregon.

The City of Portland estimates that a standard refuge island costs between $14,000 and $60,000 depending on the island location and type. A typical installation (and the standard City of Portland estimate) costs $9,220 for construction, $2,300 for project management, $2,300 for engineering, $3,130 for overhead, and $4,630 for contingency, for a total of $21,580.

A suburban county (Washington County) completed a major retrofit of an existing roadway (Oleson Road) in 2009 that included 5 pedestrian crossing refuge islands (as well as adding left turn lanes at selected intersections, bike lanes, sidewalks, street lights, a new traffic signal, new water quality and storm drainage facilities, improved road geometry (safer curves and sight distances), and extensive utility upgrades). The entire project improved 2.6 miles of roadway at a total cost of $17.8 million. The refuge islands cost approximately $4,000 per refuge island, with no landscaping or irrigation included. However, a local neighborhood committee (neighborhood volunteers) landscaped and maintains landscaping on refuges according to planting plans approved by the County.

The City of Gresham installed a median refuge island on SE Stark – the contracted price was $1,760. This work was done in conjunction with a larger contracted project.

Intersections and Crossings: Signals and Beacons

Signals and beacons are two facility types that provide increased information to users indicating that there is a crossing and that cars must stop for crossing cyclists.

Table 7 Intersections and Crossing: Signals and Beacons Cost Overview

Type	Example or Estimate	Description	Number	Cost per unit
Bicycle Signal Head	Estimate	Signal mounted on existing pole	1	$5,000/ signal head
Bicycle Loop Detection (Range of $6,630-$7,730)	Example	Installation of loop detection, signal modification, and pavement marking.	1	$6,630/ installation
	Example	Installation of loop detection, signal modification, and pavement marking.	1	$7,730/ installation
Rectangular Rapid Flash Beacon (RRFB) (Range $7500-$20,250)	Example	Five lane arterial, with refuge island, 3 RRFB, and curb ramps	3	$7,500/ RRFB
	Estimate	Two per location (one pair) are needed minimum. Suggestion is for 3 beacons on 4 lane road. Does not include cost of crosswalk	2	$12,000/ RRFB
	Example	Five lane arterial, with refuge island, 2 RRFB in each direction, sidewalk segments, and curb ramps	4	$16,650/ RRFB
	Example	Five lane road, with refuge island, 2 RRFBs in each direction (4 total)	4	$20,250/ RRFB
Bicycle Signal Push Button Actuation	Example	Bicycle push button post	1	$3,000/ post
Complete Bicycle Signal Retrofit	Example	Two bicycle signal heads, loop detection, signal modification, curb ramps, where popular bike trail crosses diagonally crosses busy intersection	1	$52,201/ intersection
HAWK Signal	Example	Four lane urban arterial, four MV signal heads, 2 cyclist signal heads, two pedestrian signal heads, cyclist push button activation.	1	$150,000/ intersection
Full Signal (Range of $140,000-$250,000)	Estimate	Bids for variety of ODOT signal installations ranged from $100,000 to $180,000	1	$140,000/ intersection
	Estimate	5 lane roadway. Actual amount can vary widely, depending on lanes, width, etc	1	$250,000/ intersection

Rapid Flash Beacon

A **rapid flash beacon** (or rectangular rapid flash beacon, RRFB) is a type of active warning beacons, which are user-actuated amber flashing lights that supplement warning signs at unsignalized intersections or mid-block crosswalks. Beacons can be actuated either manually by a push-button or passively through detection. Rapid flash beacons provide high visibility as a supplement to signage.

NACTO Urban Bikeway Design Guide, p. 221.

Figure 17 Rectangular Rapid Flash Beacon, Portland, Oregon

The cost of installing a rapid flash beacon will depend on the accompanying features, the width of the road, the inclusion of any median features, curb rebuilds, and other factors. The City of Portland estimates that rapid flash beacons cost $12,000 each to install at a crossing, and with a minimum or two per crossing, are $24,000 per location.

- A City of Portland installation of the Rectangular Rapid Flash Beacons on a five lane suburban high volume arterial (SE 82nd Ave. at SE Francis) cost a total of $81,000. The project used existing sidewalks, but added curb ramps, a refuge island, a marked crosswalk, advanced stop bars, and signage. A street tree also had to be removed to improve visibility of the pedestrians waiting to cross.
- The Oregon Department of Transportation installed a rectangular rapid flash beacon on a five lane suburban high volume arterial at a location without alternative safe crossing locations for 4 blocks in either direction (the intersection of the Tualatin Valley Highway and SW 178th) in 2010. Construction and materials on the project cost $36,790, which included the rapid flash beacon, partial added sidewalk, curb ramps, a crossing island, striping and signage. Engineering for the project cost an additional $14,810, and design was approximately 30%, or $15,000. The total combined project cost was about $66,602. This project had to be coordinated with Tri-Met because of the location of a bus stop at the site, and with a railroad because of the presence of an adjacent rail line.
- The City of Gresham installed a rapid flash beacon in 2010 (Stark/179) that cost $22,500. This project included 3 solar units, poles, pedestrian push buttons and flashers. Equipment costs were $15,000, installation costs were $5,000, and engineering and inspection costs were approximately $2,500. This work was done in conjunction with a larger project on Stark Street.

Bicycle Signal Head

Bicycle signals help cyclists to cross busy roadways by restricting cross traffic and providing (sometimes exclusive) crossing opportunities without conflicting traffic. A bicycle signal head can be used at signalized intersections to assist the traffic flow and give guidance to bicycle signal phases. They are used at intersections where a stand-alone bike path or multi-use path crosses a street, especially where the needed bicycle clearance time differs substantially from the needed pedestrian clearance time or at intersections with contra-flow pathways.

NACTO Urban Bikeway Design Guide, pp. 204-205.

Figure 18 Bicycle Signal Head, Portland, Oregon.

The city of Portland estimates that a bicycle signal would cost $5,000 to mount on an existing pole. This cost includes the signal and installation.

Bicycle Exclusive Signal

A **bicycle exclusive signal** combines a bicycle signal head and usually some type of detection to provide an exclusive crossing opportunity for cyclists.

Figure 19 Exclusive Bicycle Signal, Portland, Oregon.

Clackamas County, Oregon, is putting a bicycle signal at the intersection of the Johnson Creek Boulevard and Bell Avenue, two busy suburban roads. A popular multi-use trail (the Springwater Corridor) crosses the intersection from the SW corner to the NE corner, necessitating a two phases crossing at the current time. The signal will provide bicycles with their own phase, allowing them to cross diagonally in one phase. The bicycle exclusive signal will have loop detection on either corner where the trail hits the intersection. Markings will include a bicycle stencil and arrow pointing diagonally across the intersection. The engineer's estimate is that the change will cost $53,951, which includes $19,500 for the traffic signal modification, including two bicycle signal heads, $15,915 for the curb ramp concrete and bases, and $16,786 for related costs (survey, mobilization, clearing, etc). This does not include costs for any additional signal engineering.

Bicycle Detection & Signal Actuation

Signal detection and actuation by bicycle at traffic signals alerts the signal of a bicycle needing to cross. This can be done by push button or with in-pavement detection loops, calibrated to detect a bicycle. Proper detection will need to both accurately detect the cyclist and provide guidance to the biker on how to activate the detection. MUTCD Figure 9C-7, shown below, is a pavement marking used to indicate to bicyclists where the in-pavement detection loops are located.

NACTO Urban Bikeway Design Guide, p. 215.

Figure 20 Bicycle Loop Detection and Bicycle Push Button Detection, Portland, Oregon

The addition of bicycle detection would likely cost up to an additional $3,000-$8,000 depending on the location and situation.

- A 2011 Oregon Department of Transportation project included the award the bid for the installation of loop detection at two street crossings. Both projects also required traffic signal modification. The bid cost for one installation was $7,500, and $6,400 for the second. The addition of the bicycle detector pavement legend marking was an additional $230 in each case.
- Another 2011 Oregon Department of Transportation project included the award the bid for the installation of a bicycle push button post, at a bid cost of $3,000.

HAWK Signal

HAWK (High-intensity Activated crossWalK) Signals were developed to enhance pedestrian crossings of major streets where side-street volumes do not support installation of a conventional traffic signal (or where there are concerns that a conventional signal will encourage additional motor vehicle traffic on the minor street). Hybrid beacons may also be used at mid-block crossing locations (e.g., trail crossings). HAWK signals can significantly improve the operations of bicycle routes as well.

NACTO Urban Bikeway Design Guide, p. 227.

Figure 21 HAWK Signal, Portland, Oregon

A 2009 installation of a HAWK Signal at the intersection of a bicycle route and major four lane arterial cost the city of Portland $150,000, which included planning, design and implementation of the signal (four signal heads for motor-vehicles mounted over the lanes, two cyclist signal heads, and two pedestrians signal heads) and two cyclist activation push button posts.

Full signal

In certain cases, the only safe option is to fully signalize a previously unsignalized intersection. This could be the case on high-volume and high-speed crossing with few other route alternatives. Other times, an entire signal will need to be upgraded, and a percentage of the overall cost may be attributable to bicycle needs.

The cost of a full signal at an intersection can vary dramatically depending on the number of lanes, roadway width, and other factors.

- Portland estimates that a full signal on a 5-lane roadway costs about $240,000, though this costs will vary substantially depending on the number of lanes and amount of signal engineering needed.
- A scan of bids for traffic signal installation for Oregon Department of Transportation projects revealed a range between $100,000 and $180,000 for the signal installation alone, exclusive of detection, crosswalks, stencils, or other costs.

Bicycle Boulevards

> **Bicycle Boulevards** or Neighborhood Greenways (as they have been branded in Portland) are generally "low-volume and low-speed streets that have been optimized for bicycle travel through treatments such as traffic calming and traffic reduction, signage and pavement markings, and intersection crossing treatments."
>
> Bicycle Boulevard Guidebook, pg 2.

Figure 22 Bike Boulevards, Portland, Oregon

The cost of a bicycle boulevard is dependent upon its elements. Routes that require few major crossings of busy streets and have low existing traffic volume may not require much more than having some stop signs turned and the route marked through a combination of signage and pavement markings. Routes requiring major crossing improvements such as curb extensions, medians and signals are much more costly.

Bicycle boulevards are usually placed on streets that already have many of the qualities you want in the facility – low traffic, quiet, adjacent to major roads, etc. They generally do not require significant policy changes or trade-offs, and most questions that arise concern diverting traffic and/or removing parking.

Table 8 Bicycle Boulevard Cost Overview

Type	Example or Estimate	Description	Length (ft)	Cost per unit
Bicycle Boulevard / Greenway	Example	1.2 mile bicycle boulevard with one major crossing, speed bumps, stop sign additions, etc. Retrofit, stand alone.	6,336	$9.49/ft
	Example	2.7 mile bicycle boulevard with 2 major crossings, speed bumps, stop sign changes, etc. Retrofit, stand alone.	14,256	$12.94/ft
	Example	4 mile bicycle boulevard with three major crossings (1 with short two-way cycle track), speed bumps and stop signs, etc. Retrofit, stand alone.	21,120	$14.06/ft
	Example	2.1 mile bicycle boulevard with two major crossings, and minimal speed bumps/stop signs. Retrofit, stand alone.	11,088	$27.20/ft

Because bicycle boulevards are much more subject to the cost of the sum of their parts than other facilities discussed here, various parts will be broken down below. Bicycle boulevards often incorporate many of the facilities discussed earlier in the report, including adding wayfinding signage and pavement markings, managing cyclist flow and motor vehicle volume and speed, and improving crossings. Major crossings requiring signalization changes or other interventions often account for a large percentage of the costs of a bike boulevard. Given the range of improvements that can be included in bicycle boulevards, there is a significant range in the cost per distance depending on the facilities to be included.

Table 9 Bicycle Boulevard Elements

Bicycle Boulevard Elements	Report Section	Page Number
Wayfinding **Sharrows**	Wayfinding Signs and Pavement Markings	11 13
Add or rotate stop signs **Bike-Thru Median and traffic diverter.** **Speed bumps/humps** **Traffic Circles** **Chicanes**	Flow, Volume and Speed Management	15 15 16 16 17
Pedestrian and bicycle crossing signs **Crossing Markings** **Bike Box**	Intersections and Crossings: Signage and Pavement Markings	18 19 20
Curb extension (standard or green) **Full median**	Intersections and Crossings: Curbs and Medians	21 22
Rapid flash beacon **Bicycle signal.** **HAWK Signal** **Full signal**	Intersections and Crossings: Signals and Beacons	24 25 26 27

The scenarios below provide some examples of the array of improvements and associated costs for bicycle boulevards ranging from small- to larger-scale changes.

- The 2.7 mile North Concord Neighborhood Greenway included crossing improvements at North Killingsworth (a refuge island for cyclists) and North Rosa Parks (a median barrier preventing cars from going straight on North Concord across North Rosa Parks, along with median refuge islands). 17 Speed bumps were added, stop signs were turned at 7 intersections, removed at 2 intersections, and added at 17 intersections to facilitate cyclist movement and discourage the use of the route as a cut-through for motor vehicles. The facility cost $184,543, or an average of $68,349 per mile or $12.95 per foot.
- The 1.2 mile SE Mill Neighborhood Greenway included a crossing improvement at SE 92nd Avenue (two crosswalks and refuge islands), 18 speed bumps, and the addition of 9 stop signs at previously uncontrolled intersections. The facility cost $60,104, or an average $50,087 per mile or $9.49 per foot.
- The 2.1 mile SE Center-Gladstone Neighborhood Greenway included substantial crossing improvements at SE Foster, consisting of a major sidewalk and curb reconstruction with green storm water features, and bicycle push buttons, and at SE 42st, consisting of a large diverter with green storm water features. Speed bumps already existing between 43rd and 50th, but two additional speed bumps were added. Stop signs were turned at one minor intersection. The facility cost $301,615, or an average of $143,626 per mile or $27.20 per foot.
- The 4 mile N/NE Going Neighborhood Greenway included crossing improvements at MLK Boulevard and Northeast 33rd Avenue, consisting of green diverters and a one block two-way cycle track. Speed Bumps and stop sign changes were made all along the corridor. The project cost an initial $282,000, while additional work at NE 15th brought the total to $297,000, which comes out to $74,250 per mile or $14.06 per foot.

Taken this range of costs, from around $9.50 per foot on the low end to around $27.20 per foot on the high end, bicycle boulevards compare favorably to bike lanes. Our earlier costs for standard bike lanes (at between $1-5 per foot) and buffered bike lanes (at about $2-9 per foot) generally did not require additional right of way acquisitions (which could add substantially to the cost of a bike lane. Further, the bike boulevard costs are for complete routes, including crossings and flow management.

CYCLE TRACKS

One-Way or Two-way At-Grade Cycle Track

At-grade cycle tracks are on the street level and use different methods to distinguish them as exclusive use for bikes and protect them from traffic. They could have pavement markings to separate them from parked cars, bollards and other design elements for further separation. Since the lane is protected, there is a decreased risk of having a motor vehicle passenger open a door into a cyclists' path ("dooring") or interfering with motor vehicles. The increase in comfort for cyclists and the increased safety makes a cycle track a more attractive route option for many levels of cyclists.

Two-way cycle tracks allow bicycle movement in both directions on one side of the road. They can either be raised or on the street level, and would be an option for a street where there is not enough room for a one-way track on either side of the road.

NACTO Urban Bikeway Design Guide, p. 59 & 91.

Figure 23 One-Way At-Grade Cycle Track, Portland, Oregon.

Figure 24 Two-Way At-Grade Cycle Track, Washington, D.C.

Table 10 Cycle Track Cost Overview

Type	Example or Estimate	Description	Length (ft)	Cost per unit
At Grade Cycle Track	Example	1800 foot one way cycle track with MV parking and painted buffer as separation - no curb or new pavement/concrete. Green left turn boxes. Retrofit, stand alone.	1,800	$24.79/ft
One Way Raised Cycle Track	Example	One mile grade separated bicycle exclusive cycle track, 6" concrete. Portion of total streetscape project	5,280	$68.16/ft
Two Way Raised Cycle Track (Range of $188-$698)	Example	3,200 foot two-way separated concrete cycle track, with adjacent sidewalk and additional buffers between cycle track directions and motor vehicle lanes. Complete rebuild, part of total street rebuild.	3,200	$188/ft
	Estimate	Estimate for two way raised concrete cycle track	1	$698/ft

The cost of a one-way at-grade cycle track will depend on a number of factors – one of the main determinants will be the type of separation between the cycle track and motor vehicle traffic lanes. A raised curb between motor vehicles lanes (including parking strips) and the cycle track would increase the cost of a track significantly. A simple painted buffer would result in substantially lower construction costs. Bollards, depending on the size and material, would fall somewhere in between curbed and painted buffers. Intersection treatments, especially where motor vehicles are making turns across the cycle track, are another area where facilities (for example, the addition of bicycle-specific signalization to a cycle track intersection), and therefore costs, may vary substantially.

The cost of a two-way at-grade cycle track will have many of the same cost factors as a one-way at-grade cycle track, including the type of separation and intersection treatments.

On the low end of the cost spectrum, the City of Portland built a one-way 1,800 foot cycle track on SW Broadway. The cycle track involved restriping the entire segment and placing a wide bike lane between parked cars and the sidewalk, separated by a painted buffer. The treatment also involved bicycle stencils and 7' by 7' left-turn boxes at each intersection (green thermoplastic boxes with a bicycle stencil). The cycle track cost $44,623 to build, or $25 per foot.

As a basis of comparison, Washington D.C.'s Department of Transportation built a three-mile two-way at-grade cycle track on NW 15th Street. Separation was achieved through a combination of paint and plastic "flex-posts", and cyclists follow existing pedestrian signals. The cost of the three-mile cycle track, was estimated at $340,000, or $21.50 per foot.[9]

In contrast, Vancouver recently built several at-grade two-way cycle tracks in its downtown core, which included concrete curb separation, with a design that allowed for the addition of planters in some areas (to provide greenery and some added separation), green thermoplastic bike crossings, and signage. [10]

- The half-mile Dunsmuir Street cycle track cost 810,000 CAD ($769,500 US), or 306 CAD ($291 US) per foot.[11] A longer cycle track (1.1 miles) on Hornby Street also included signalization at four intersections with high turn volume. Those intersections consist of right turn arrows for motor vehicles and bicycle specific signals.
- The Hornby cycle track cost 3.2m CAD ($3.04 m US), including 1.1m CAD ($1.05m US) for the signalization and 400,000 CAD ($380,000 US) for planters. This comes out to a total or about $575 (USD) per foot.

Figure 25 Hornby Cycle Track. Vancouver, British Columbia

[9] DC Department of Transportation. "15th Street Separated Bike Lane Pilot Project: Interim Results and Next Steps", August 2010. Accessed online 12/8/11 at http://www.dc.gov/DC/DDOT/Publication%20Files/On%20Your%20Street/Bicycles%20and%20Pedestrians/Bicycles/Bike%20Lanes/15thStreetNW_Pilot_Phase2.pdf

[10] Vancouver cost information: http://www.canada.com/vancouversun/news/westcoastnews/story.html?id=a75c68b6-2c60-4d94-baa5-622418f69aa0
Facility details: http://vancouver.ca/engsvcs/transport/cycling/separated/effect.htm

[11] Using 1 CAD = $0.95 US Dollar exchange rate

Raised Cycle Track

A **raised cycle track** incorporates a grade separation between cyclists and motor vehicles. At intersections they go to the street or sidewalk level and will often have a mountable curb for bikes. This might be a good option for a street with higher speeds and fewer cross streets or driveways.

NACTO Urban Bikeway Design Guide, p. 75.

Figure 26 Raised Cycle Track, NE Cully Blvd., Portland, OR.

Raised cycle tracks may have many of the same cost factors as at-grade cycle tracks, including buffer type (although a raised curb is implied, the presence and type of planting strip may vary) and intersection treatments. Additional considerations are the cycle track surface type (concrete or asphalt), potentially increased need to acquire right of way, and in some cases, separation between cyclists and pedestrians. The City of Portland estimates the cost of a raised cycle track to be $275/foot ($93 for construction, $23 for project management, $23 for engineering, $78 for overhead, and $58 for contingency) for a raised one-way cycle track. The scenarios below illustrate costs for two different types of cycle track facilities, including a one-way and two-way cycle track with raised and non-raised surfaces.

Portland's Cully Cycle Track: In 2010, Portland completed a cycle track on NE Cully Boulevard. The cycle track, which is half a mile in each direction (one mile total), was built as part of a complete overhaul of Cully Boulevard and so many of the costs are impossible to pull from the project as a whole. The cycle track is a grade separated track (from both the roadway and sidewalk) composed of 6" thick concrete – thicker than a standard sidewalk to accommodate maintenance equipment being driven over it. Construction occurred July 2010 to July 2011, with funding coming from Federal and City sources. An estimate of the facility cost, including construction, materials and design comes to approximately $360,000, or just about $68 per foot.

- For the entire Cully cycle track project, project development and ROW purchasing/leasing cost $375,000, and included public involvement, open houses, newsletters, translation costs (Somali and Spanish), planning staff time, alternative development, preliminary design including cross-sections, etc.

Design and engineering cost $624,045. Construction and materials cost $3,800,000. Construction and materials went to the low bidder.

- The costs **directly associated with the cycle track** totaled $118,083.70 and include $79,603.35 for the concrete, and $38,480.35 for the cycle track curbs. The project manager estimates that another $11,391.26 is attributable to the cycle track, consisting of a portion of costs for pavement markings, arrows, etc. Finally, the project manager estimates that a approximately 10% of some general costs of the projects (e.g. flaggers, temporary signage, etc) totaling $74,409.63 is attributable to the cycle track. Thus, construction and materials for this project total approximately $203,884.59.
- The project manager estimated that between 15%-35% of the design costs can be attributed to the cycle track (or $93,606.75 to $218,415.75). The middle of that range (25% or $156,011.25) is assumed in the estimate above. The reason for the large range is that this is the first time the City of Portland has incorporated a full cycle track into a roadway design and doing so was complicated.

Moody Cycle Track: In 2011, Portland completed a 3,200 foot two-way separated cycle track on SW Moody Avenue as part of a major $66m roadway reconstruction incorporating dual streetcar tracks, an elevated roadway, and three lanes of traffic. The cycle track is on the west side of SW Moody. The total area provide for pedestrians and bicycles is about 24 feet wide throughout the corridor, with the space dedicated to cyclists varying from 6-7 feet per direction (with a planted strip in between) to a shared 11 foot lane. The cycle track component of the project was estimated by the 2030 bike plan to cost $600,000[12], or $188 per foot of length.

Figure 27 SW Moody Cycle Track. Portland, Oregon

The City of Portland estimates that a raised concrete 2-way cycle track costs $698 per foot ($282 for construction, $71 for project management, $28 for engineering, $168 for overhead, and $149 for contingency).

[12] "Portland opens new cycle track along Southwest Moody Avenue near South Waterfront District," The Oregonian, November 3, 2011. Accessed online 12/8/11 at http://blog.oregonlive.com/commuting/2011/11/portland_opens_new_cycle_track.html

Bicycle Parking Facilities

Having a secure and convenient place to park and lock a bicycle is important to making a bicycle network function.

Table 11 Bicycle Parking Cost Overview

Type	Example or Estimate	Description	Cost per unit
Bike Racks	Estimate	Standard staple rack	$200/rack
Bicycle Corral	Estimate	Depends on number of racks and buffer, etc	$3,000/ corral

Bike Racks

Bike racks come in a variety of formats. A simple staple rack is perhaps the most common type of bike rack, although racks also come in various other shapes and sizes. Sometimes racks are designed to bring an artistic and unique flare to a streetscape. Other times they are simply utilitarian.

Figure 28 Staple Bike Rack, Portland, OR.

Bicycle racks cost about $200 per rack, including site marking and installation labor in the City of Portland. Artistic racks will cost more.

Figure 27 Artistic Bike Rack, Portland, OR.

Bicycle Corrals

Bicycle corrals are a collection of bike racks (generally 6 to 12) placed parallel to one another, usually on-street. Corrals allow for up to 20 bicycles to be parked in the space that would previously have been used by one or two cars.

Figure 29 Bicycle Corral. Portland, Oregon.

Since 2008, the City of Portland has installed over 70 bicycle corrals, often at the request of an adjacent business. The City of Portland works with local businesses on bicycle corrals under an agreement wherein the City installs the corral, and the sponsoring business agrees to maintain the facility. A typical corral costs $3,000 in materials and labor for the installation.

Conclusions

As stated at the outset, this project was initiated to document the costs associated with associated with installing various types of bicycle facilities on existing streets and roadways. By providing a range of examples from recent projects, it provides objective cost information that can be used as a starting point by other communities considering similar facilities. Obviously, actual costs will vary according to the circumstances of each individual project. The local context, community needs, community outreach, and other factors will affect the cost of each facility. However, these costs can provide planners and decision-makers with data that can be used to compare the costs of bicycle facilities with other roadway improvements and draw their own conclusions about the relative value of bicycle facilities. When combined with research on how bicycle facilities can increase rates of cycling, this cost information can provide a persuasive argument on the economic and health benefits of building and enhancing bicycle facilities.