Memorandum

To: Barbara Lee, City of Seattle

From: Kristen Lohse, Bill Schultheiss, and Peter Lagerwey

Date: April 03, 2014

Re: City of Seattle Department of Transportation
Westlake Ave North Cycle Track
Phase 1: Alternatives Evaluation
Project No. 13-16

Existing Conditions and Design Criteria

Toole Design Group (TDG) prepared this memorandum to document existing conditions along the Westlake Avenue North right-of-way and present design criteria and documentation that will guide the design and development of the preliminary plans for the Westlake Avenue North Cycle Track and provide the basis for final design and construction documents.

In conjunction with this effort, TDG has also prepared two additional memos for the Traffic Circulation Study and the Parking Utilization Study. These studies provide more in-depth documentation of existing conditions and analysis about vehicle, bicycle and pedestrian circulation and parking patterns that will influence the design of the cycle track.

Project Description

The Seattle Department of Transportation (SDOT) is developing a protected bike lane for two-way bicycle traffic along Westlake Avenue North from Lake Union Park at Aloha Street to the start of the Ship Canal Trail, just north of Halladay Street, a section of approximately 1.2 miles in length.

The cycle track is intended to:

- Improve safety by providing distinct pathways for bicyclists, pedestrians and motorists.
- Reduce bicycle, vehicle and pedestrian collisions along the roadway and in the parking lot (referred to as Westlake East Roadway Avenue North).
- Increase pedestrian safety by separating bicyclists from pedestrians using the east sidewalk.
- Provide parking for and safe access to businesses.

- Serve more bicyclists by providing a flat, separated, low-stress facility.
- Improve a high use connector, meeting the City's goal to build a network that puts all residents within a quarter mile of a bike facility, as proposed in the 2013 Recommended Bicycle Master Plan.

Project Limits

The project limits are Westlake Avenue North from Lake Union Park at Aloha Street to the start of the Ship Canal Trail, 1000 feet north of Halladay Street, a section approximately 1.2 miles in length. The alternatives analysis will study several possible routes within the right-of-way. The primary focus of the analysis will be within the parking lot (Westlake East Roadway Avenue North).

PART 1: Existing Conditions

This existing conditions analysis provides a big picture analysis of the elements that will influence the design using existing and new data sources. The issues of parking supply and utilization, and bicycle, pedestrian and motor vehicle circulation are covered in more depth in separate studies.

Figure 1: Project Location.

Right-of-Way

The Westlake Avenue North right-of-way is 150 feet wide. From west to east, the cross section features a sidewalk on the west side, a 4-lane roadway, typically 46-feet wide, a landscaped planting strip on the east side of the road with trees planted approximately 35 feet on center, a parking lot (Westlake East Roadway Avenue North), and a sidewalk on the east side of the parking lot. An access road, varying in width, runs along some segments of the parking lot on the east side. Westlake Avenue North carries an Average Annual Daily Traffic (AADT) of 23,900 (per 2011 counts) vehicles and has a speed limit of 35 miles per hour (MPH). The cross section of the parking lot varies primarily due to the presence or absence of the service drive to the east of the parking lot, the location of the east sidewalk, and the

amount of landscaping. In some segments, the east sidewalk is located along the west side of the service drive. **Table 1** shows the range of width of each element within the roadway, along with the typical dimensions.

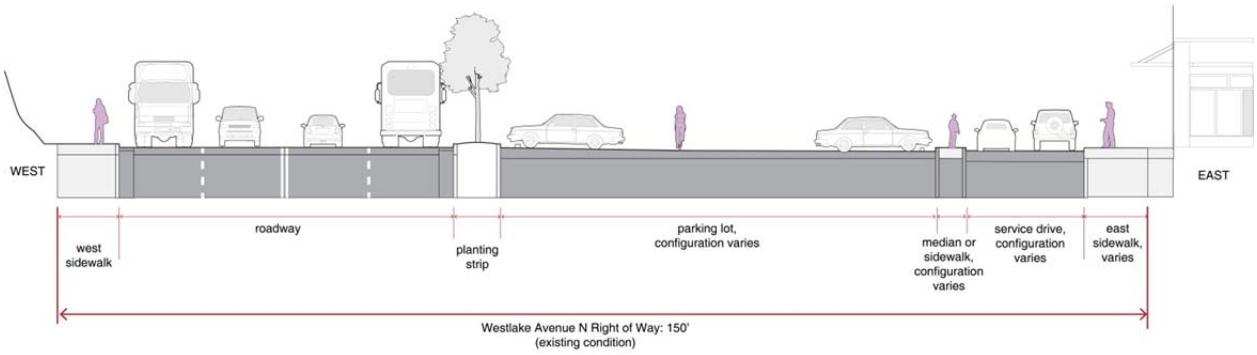

Figure 2: Cross-section Depicting Typical Existing Conditions.

Table 1. Typical Dimensions

WEST SIDEWALK	**ROADWAY** (Westlake Avenue North)	**LANDSCAPED ROADWAY BUFFER**	**PARKING LOT** (Westlake East Roadway North)	**SERVICE LANE** (where present)	**EAST SIDEWALK**
6’ – 12’ 6’ Typical	46’ – 60’ 46’ Typical	6’ – 9’ 6’ Typical	30’ – 60’ 55’ Typical	10’ – 20’ 15’ Typical	4’ – 20’ 10’ typical

Figure 3: Planting strip between roadway and parking lot; parking lot; east sidewalk/building frontage.

Figure 4: Corridor Views.

Parking Lot and Access

The parking lot (Westlake East Roadway Avenue North) has 1,271 spaces, 62% of which are unrestricted (in terms of time limits). The remaining spaces are either metered (9 a.m.-4 p.m.) or unmetered with a 2 hour time limit. Spaces are designated for disabled access, loading zones, and motorcycle spaces. Dumpsters servicing both business and residential are located in some of the unrestricted parking spots.

Figure 5: Boat and vehicle parking and access on east side of right of way.

Most of the parking stalls are in a 90 degree arrangement with a two-way drive aisle, except one section with about 100 spaces that are at a 60 degree angle served by a one-way (southbound) drive aisle. All the parking spaces are dimensioned for smaller vehicles. A number of parallel parking spaces are located along the service drive. Additional information about parking supply, utilization and off-site parking can be found in the parking utilization memo.

Land Use

The land use along the corridor is diverse and includes marine retail, boating supply, industrial marine and marine residential (i.e., floating homes and marinas that allow live-aboards). There is also a mix of both large and small restaurants, businesses, offices and multi-family housing (primarily on the west side of Westlake Avenue North). The character of the corridor changes from block to block, and is characterized in **Table 2**.

Figure 6: Service drive on east side of parking lot; pedestrian crossing at Highland Drive; parking lot use by varied vehicle sizes.

Table 2. Land Use Characterization along Westlake Avenue North

STREET SEGMENT	LAND USE	BUSINESSES/LANDMARKS
Aloha to Highland Drive 900-1200 block	Lake Union Park, tourism	Kenmore Air, Argosy Cruises, Courtyard by Marriott (west side of street)
Highland Drive to Galer Street 1200-1500 block	Restaurant and Office	AGC Bldg., Starbucks, McCormick and Schmick's
Galer Street to Newton Street 1500-2000 block	Offices (both sides of Westlake)	Marina Mart Bldg., Discovery Yachts, KCPQ (west side of street)
Newton Street to McGraw Street 2000-2400 block	Marinas, restaurants, apartments (west side of street)	Lake Union Bldg., Westlake Marina, China Harbor Restaurant, Julie's Landing
McGraw St to Halladay Street 2400-2500 block	Yacht and marine supplies, floating homes	Pacific Coast Yacht Services, Marine Service Center
Halladay Street to start of Ship Canal Trail 2500-2700 block	Marine industrial, retail	Discount Divers Supply, Scrap Metal (on west side)

Adapted from the Westlake Avenue North On-Street Parking Study, 2006, Heffron Transportation, Inc.

Parking Lot Access

There are 14 ingress/egress points from Westlake Avenue North to the parking lot, shown in **Figure 7**. Three are signalized intersections (Highland, Galer and Crockett Streets), but only the Galer Street intersection provides through connectivity to the west. The steep hillside to the west of Westlake Avenue North prevents the continuation of the street grid. However, street end names are used as points of reference. **Table 3** describes the ingress/egress points, along with PM peak hour turning volumes, used as an indication of traffic volumes into and out of the parking lot

There is a pedestrian bridge across Westlake Avenue North at Galer Street/8th Avenue North which aligns with the pedestrian bridge over SR 99/Aurora Avenue North, farther to the west.

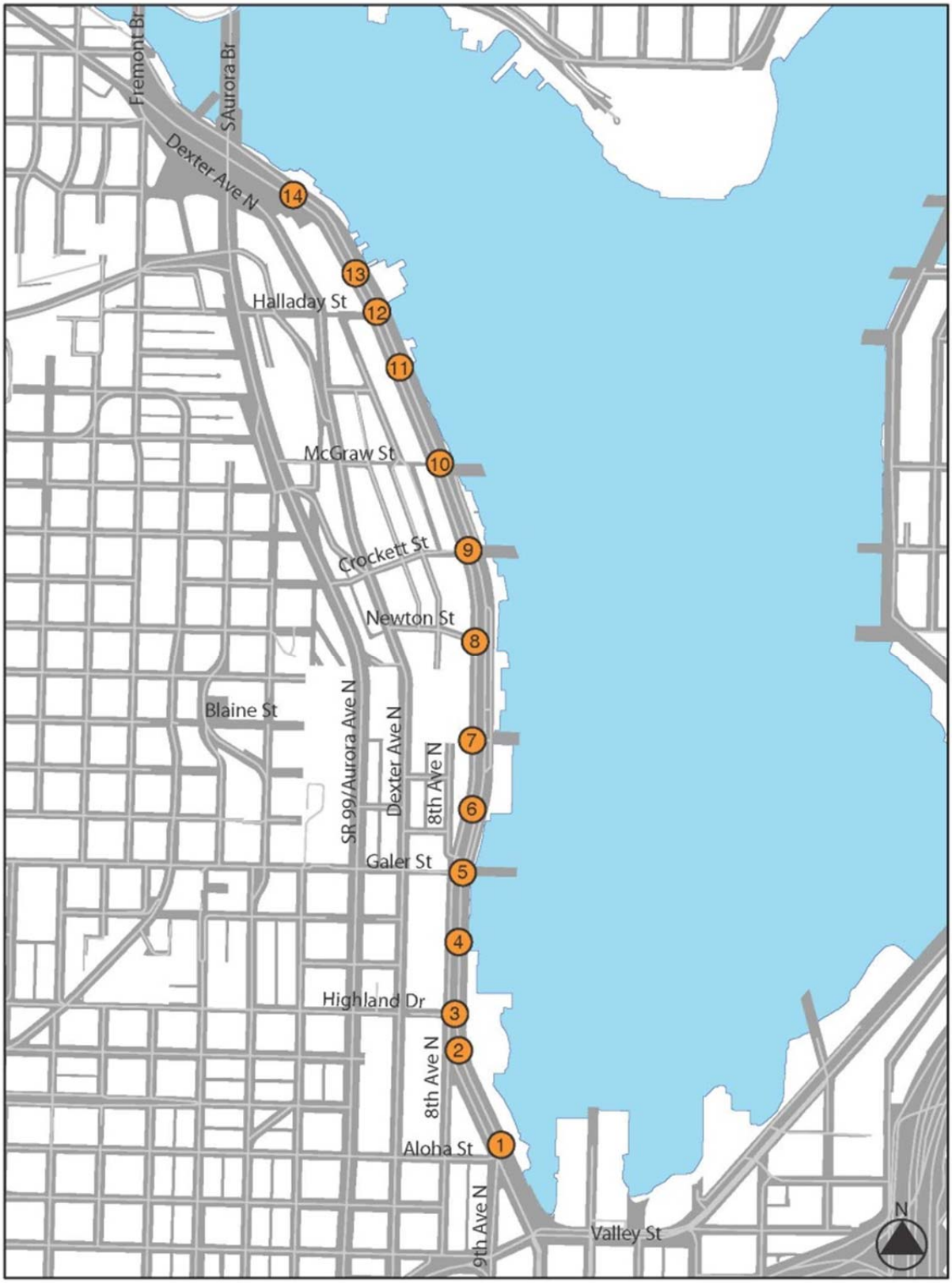

Figure 7: Driveways, Street Ends and Crossings.

Table 3 Driveways, Street Ends and Crossings

Westlake Avenue North Driveways, Street Ends & Crossings						
Cross Street or Closest Cross Street		***Nearest Landmark***	***Block or Nearest Address***	***Traffic Control***	***Type of Crossing***	***Peak Ingress and Egress Volumes****
1	9th Avenue NE & Aloha St (Driveway #1)	Lake Union Park	900	Stop	Driveway	32
2	8th Avenue North (Driveway #2)	Kenmore Air	950	Stop	Street	101
3	Highland Drive (Driveway #3)	AGC Building	1200	Signal	Street end	220
4	Driveway # 4	Rock Salt Steaks and Seafood	1234	Stop	Driveway	63
5	Galer St/ Pedestrian Overpass (Driveway #5)	Marina Mart Building	1500	Signal	Street	136
6	Driveway # 6	1530 Building	1530	Stop	Driveway	101
7	Blaine St (Driveway #7)	Lake Union Building	1700	Stop	Street end	99
8	Newton St (Driveway #8)	Newton Street Stairway	2000	Stop	Street end	102
9	Crockett St (Driveway #9)	Crockett Street Stairway	2100	Pedestrian Half Signal	Street end	106
10	McGraw St (Driveway #10)	McGraw St	2400	Stop	Driveway	43
11	Driveway # 11	Wheeler Street (to south)	2470	Stop	Driveway	41
12	Halladay St (Driveway #12)	2500 Westlake	2500	Stop	Street end	24
13	Driveway # 13	Exor Iron Works	2540	Stop	Driveway	27
14	Driveway # 14	Start of Ship Canal Trail/Sea Ray/Diamond Marina	2730	None	Driveway	57

*Peak time is 4:30-5:30 PM weekday. Turning movements are documented in more detail in the Traffic Circulation Study.

Bicycle Ridership

Local Ridership – Hourly Counts

TDG conducted bicycle and pedestrian counts in September of 2013 at three locations along the corridor:

- South of Highland Drive
- North of Galer Street
- At Driveway #14, at the project terminus.

Counts were taken during the AM, mid-day and PM peak hours. The counts indicate that bicyclists typically ride in the parking lot, rather than on Westlake Avenue North and that bicycle traffic peaks during the PM peak hour. A one-day count shows bicycling volumes (both northbound and southbound) of:

- AM peak hour bicycle volume: 133 bicyclists.
- Mid-day peak hour bicycle volume: 76 bicyclists.
- PM peak hour bicycle volume: 202 bicyclists.

Based on counts at Driveway #2, one of three locations where bicycle/pedestrian counts were taken (full results can be found in the Traffic Circulation Study), across all peak hours, more bicyclists ride on the east sidewalk at this location, but during the PM peak hour, there are nearly as many bicyclists in the parking drive. TDG also observed that bicyclists northbound tend to use the service road and/or east sidewalk, whereas southbound bicyclists tend to use the parking drive aisle.

Figure 8: People bicycling through the parking area.

Transit Volumes and Pedestrian Use

Two King County Metro bus routes run along Westlake Avenue North:

- Route 40 – Downtown to Northgate (providing frequent local service).
- Route 62 – Downtown to Ballard (providing peak hour express service).

Figure 9: Cheshiahud Lake Union Loop; pedestrian crossings through the parking lot to and from Westlake Avenue North.

Bus stops are located along the corridor at these locations; stops are paired unless otherwise indicated.

- Aloha Street (southbound only)
- Highland Drive
- Galer Street
- 8th Avenue North
- Crockett Street
- At the 2600 block, north of Halladay Street.

At each northbound bus stop, a short segment of sidewalk along the east curb of Westlake Avenue North provides a waiting area at the stop. There are also raised crosswalks across the parking lot at these stops, to provide access to and from the east sidewalk.

Below are ridership counts for 2012, provided by SDOT. At the time the counts were taken, Route 62 was new; ridership may have changed since then.

- Route 40: average daily ridership of 7,430 people (average annual ridership of 1,891,900 people), 45% inbound (toward downtown) and 53% outbound.
- Route 62: average daily ridership of 470 people (average annual ridership of 67,700 people), 41% inbound and 46% outbound.

The Traffic Circulation Study includes pedestrian and vehicle volumes and shows that pedestrian use of the corridor is higher than use by bicycles and vehicles in the AM and midday peak, but bicycle use is highest in the PM peak, above that of pedestrians and motorists. Pedestrian volumes are highest on the east sidewalk, though pedestrian volumes in the parking drive aisles are somewhat higher during the midday peak.

Garbage Collection

Dumpsters/containers are located on both sides of the parking lot (though mostly on the west side) and vary in size from 96 gallon containers to 8 cubic yard containers. Cleanscapes collects garbage two or three times a week, depending on the individual needs of businesses, so garbage collection happens nearly every day. The most intensive activity is from the 2000 block north.

Dumpsters stored semi-permanently in the right-of-way reduce parking capacity, and depending on location may also raise occasional visibility/access issues.

Figure 10: Dumpsters and garbage containers in the parking area.

PART 2: Cycle Track Design Criteria

Reference Documents and Discussion

Protected bicycle facilities like cycle tracks are a recent addition to America's bicycle-facilities toolbox, though cycle tracks have been designed and built for decades in northern Europe. The most thorough and substantial design guidance for cycle tracks comes from the Netherlands' *CROW Manual*. The National Association of City Traffic Officials (NACTO) *Urban Bikeway Design Guide* provides a summary of design considerations and treatments for cycle tracks based upon European designs and the limited available US guidance. The 2012 American Association of Highway and Transportation (AASHTO) *Guide for the Development of Bicycle Facilities*, the primary U.S. reference for the design of bicycle facilities, does not address cycle tracks. However, it provides extensive guidance for the design of multi-use paths which share many common design elements with cycle tracks.

The design criteria for this project have been developed based on the following references:

Primary:

- CROW - CROW: Record 25, Design Manual for Bicycle Traffic. The Netherlands, 2006.
- NACTO Guide - *The National Association of City Traffic Officials (NACTO) Urban Bikeway Design Guide.*
- MUTCD - *Manual of Uniform Traffic Devices.*

Secondary:

- AASHTO Bike Guide - *American Association of Highway and Transportation Officials Guide for the Development of Bicycle Facilities, 2012.*
- ROWIM - *Seattle ROW Improvement Manual.*
- London Guidelines - *London Cycling Design Standards.*

Design Criteria

The recommended design criteria are described on the following pages and summarized on page 22.

Cycle Track Cross Section

Cycle Track Width

The proposed Westlake Cycle Track will accommodate two-way bicycle traffic. Two-way cycle tracks typically consist of two adjacent lanes, one in each direction. However, they are physically separated from motor vehicle lanes and distinct from pedestrian travel ways. For example, they may be placed on either side of a planting strip, curb, trail or parking lane.

To date, the City of Seattle has constructed a number of two-way cycle tracks at 10 feet wide, the width of two bicycle lanes. Twelve feet is the desirable width per NACTO guidelines, 8 feet is the minimum in constrained conditions. Separation methods factor into the cross-section width; vertical separation

elements require shy distance and adjacent parking lanes require additional space to allow motorists to enter and exit their cars without encroaching into the cycle track.

Beyond providing enough space to allow bi-directional travel, the cross section should accommodate the projected volume of cyclists. With higher bicycle volumes, a cycle track should be wide enough to allow cyclists to overtake one another going the same direction, without interfering with cyclists traveling in the opposite direction. The CROW Manual recommends a 10-12 foot width, depending on bicycle volumes.

Design Speed

Design speed is a critical issue for the design of cycle tracks. Where cycle tracks intersect pathways of motorists and pedestrians, the speed of bicyclists will have a direct impact on visibility and reaction time for all users. The design speed for a cycle track does not have to be uniform throughout its length. Research has documented that reductions in bicyclist design speeds and motorists' turning speeds approaching intersections can improve safety for pedestrians, bicyclists and motorists.

The profile of the 'design vehicle' or typical intended user of the cycle track is a primary factor to consider. Current preference for the Westlake corridor by some bicyclists over the parallel buffered bike lanes on Dexter Avenue North indicates that many people prefer a flatter route, despite the high level of visual friction and possible delay by vehicles maneuvering the parking lot. Pedestrians, joggers, skateboarders, vehicles parking, business foot traffic, deliveries, and dumpsters create friction for bicyclists traveling through the Westlake corridor by bicycle. As a separated bicycle-only facility, the anticipated design user will continue to be those bicyclists who are seeking a trail-like facility that is lower stress.

The context of the facility also has a direct influence on the design speed. Along the Westlake corridor, other factors that may influence design speed include:

- The number of driveway crossings (14, addressed below).
- The speed of the roadway (posted at 35 MPH).
- The presence of bus stops and movement of transit users east-west across the right-of-way.
- Access to businesses by customers and employees from the parking lot.
- Access to boats, live-aboards and floating homes.
- Garbage collection spots and activity.
- Loading zones, truck movements and deliveries.
- Other users of the corridor – pedestrians, joggers, skateboarders etc.

The AASHTO guide indicates that casual/less confident bicyclists ride at speeds of 8-12 MPH, whereas experienced/confident riders travel at 15-18 mph and over 20 MPH on descents. The guide recommends a design speed of 18 MPH for urban shared use paths, based on the 85th percentile speed of bicyclists. The CROW Manual recommends a design speed of 18.5 MPH for cycle tracks, whereas the London

guidelines recommend a lower speed of 15 MPH and a design speed of 10 MPH where there is high pedestrian use.

Horizontal and vertical alignment and dimensional control

Within the U.S., cycle tracks are often sited parallel to the direction of motor vehicle travel and between the roadway and the sidewalk, using buffers of space, bollards, planters, a row of parked cars or shifts in vertical alignment to separate modes. The Westlake corridor offers a broader range of alignment opportunities than would a typical street because of the right-of-way width. The proposed alternatives will include alignments that are not strictly parallel to the roadway, so typical alignment guidelines may not be entirely applicable. The discussion below offers general guidance for the use of horizontal and vertical alignments.

Sometimes is it advantageous to shift the horizontal alignment of a cycle track away from vehicle lanes or sidewalk, and the context will dictate the alignment. Some examples include:

- To provide adequate separation from travel lanes, parked cars and other elements.
- To transition bicyclists from the cycle track into or out of an intersection or 'mixing zone' where sight distance is enhanced and awareness is increased, to facilitate turning movements.
- To control the design speed of the cycle track by introducing deflection to slow bicyclists on approaches to conflict points with turning motorists.

Similarly, vertical alignment can be used to differentiate the travel way of bicycles from pedestrians on the sidewalk or motorists on the roadway, or can be used to accentuate crosswalks or other mixing zones where different modes come into contact. Typical vertical separations are either 6" above the roadway (at sidewalk height) or 3" above the roadway, below sidewalk height.

Separation Methods

There are a variety of separation methods for cycle track designs. The overall goal is to provide a physical or spatial barrier to reinforce separation between the cycle track and the adjacent parking or travel lane and the pedestrian realm. Depending on the context and constraints within a project site, separation can be achieved through any of the following:

- Parking placement, with painted buffers and/or flexible bollards or flex posts.
- Curbs of various types.
- Concrete barriers or concrete median islands.
- Planters, trees, stormwater management features.
- Differentiating materials.
- Grade changes.
- Street furniture.
- Horizontal buffers are recommended adjacent to parallel parked cars to allow loading and unloading and to prevent 'dooring' - 3' minimum per NACTO guidelines if there is no raised curb or median between the cycle track and vehicle travel lanes.

- Vertical barriers, such as flex posts, must be a 42" minimum height (AASHTO).

Vertical or grade changes require the least amount of width, but may have implications for drainage, the relationship to sidewalks and pedestrian facilities, and other features. Horizontal separation requires a wider footprint.

Depending on the placement and design of a cycle track, motorists and pedestrians may attempt to enter and use the cycle track. Additional signage and pavement markings may be required to define the space as bicycle-only; elements such as street trees, plantings, street furnishings or other furnishings can be used to further reinforce the separation of modes.

Horizontal and Vertical Clearances

Per the AASHTO Bike Guide for shared-use paths, minimum clearances are:

- 2 feet minimum to horizontal obstructions and 4 feet minimum to signs placed 2 feet from the edge of the travelled way.
- 8 feet minimum to vertical obstructions, such as an overhead sign.

When sited adjacent to a parallel parking lane, NACTO recommends a parking buffer of 3 feet to allow passenger loading/unloading and to prevent 'dooring'.

Similarly, NACTO recommends that a painted buffer of 3 feet in which bollards, planters or other forms of physical protection can be sited where a raised median or curbs are not provided.

A shy distance of at least 1 foot is recommended next to any vertical element, such as a planter, fence or bollard.

Intersection Design

Intersection Design Considerations

As with roadways, cycle track intersections are the highest potential conflict areas for bicyclists, and the fewer conflict points, the safer and more comfortable the cycle track for bicyclists and other users crossing the cycle track. The Westlake Avenue North corridor is approximately 1.2 miles with 14 entry/exit points to the parking lot (approximately every 500 feet).

The Traffic Circulation Study examined driveway ingress and egress volumes at each of the 14 driveways to determine if there are opportunities for driveway consolidation to reduce the number of conflict points along the cycle track. The volume counts show that the southern driveways are typically busier. Further research is needed to determine if access management should be employed at the lower volume driveways. The volume, type, and turning radius of delivery vehicles, especially for marine-related businesses will be a factor in any driveway consolidation decisions.

In general, where roadways and driveways intersect and cross cycle tracks, the safety of bicyclists, pedestrians and motorists must all be considered. The treatment of intersections will depend greatly on each alignment's proximity and relationship to Westlake Avenue North, so design treatments will vary and be engineered to the specifics of each crossing. Some key geometric and operational strategies by intersection control type are listed below:

Unsignalized Intersections

- Use geometry to slow motorist turning speeds through reduced curb radii.
- Maximize sight lines through horizontal alignment (bringing bicycles closer to vehicle), adjust the placement or limit parking near intersections.
- Delineate the conflict area, make right of way clear.
- Turn restrictions may be employed, such as for left turns which are associated with higher crash rates as compared to right turns.
- Provide queuing space and appropriate traffic control for motorists approaching cycle track crossings.

Signalized Intersections

- Use geometry to slow motorist turning speeds.
- Maximize sight lines through horizontal alignment (bringing bicycles closer to vehicle), placement/limitation of parking.
- Operationally, bicyclists and motorists may be operating in the same space at the same time depending on signal phasing. Where appropriate, provide a separate or leading bicycle phase with bike signals to separate bicyclists and motorist movements.
- Turn restrictions may be employed, such as restricted left turns along Westlake Avenue North into the parking when bicycles are detected.
- Use accessible pushbuttons or bicycle detection where appropriate.
- Provide queuing space and appropriate traffic control for motorists approaching cycle track crossings.

Signs, pavement markings, colored pavement, and changes in surfacing can and should be used where appropriate.

Opportunities for Bicycle Turning Movements

- Provide opportunities for bicyclists to make convenient and comfortable turns into and out of the cycle track onto Westlake Avenue North, or into the parking lot though the use of two-stage queuing boxes where appropriate.
- Use bike boxes, where appropriate, to create a highly visible queuing space for bicyclists at intersections.

Sight Triangles

NACTO recommends minimum sight distance triangles of 10-20 feet from minor street crossings (see **Figure 11**). Major street crossings may require more. The location of parked cars (addressed below), the placement of street trees and landscaping, dumpsters and utility structures must be considered in regards to their effect on sight distance at crossings and intersections.

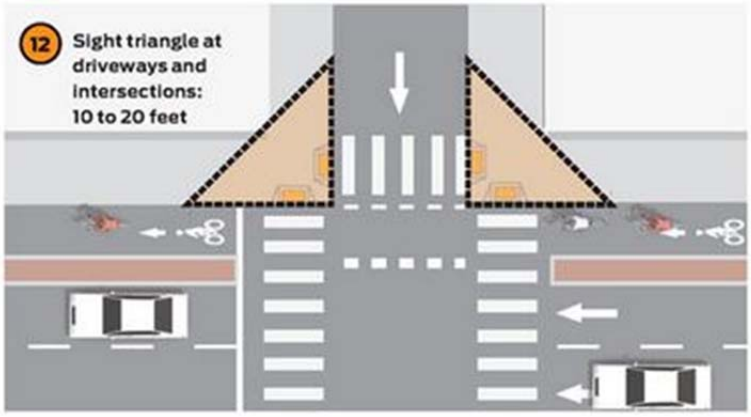

Figure 11 Sight Triangles, NACTO Guide

Stopping Sight Distance

Stopping sight distances are based on roadway and cycle track design speeds. Horizontal and vertical geometry will be designed to provide full stopping sight distances throughout the cycle track corridor.

Parking Restrictions for Sight Distance

NACTO guidelines recommend parking restrictions within 30 feet from each side of the intersection for parking-protected cycle tracks. Since the Westlake cycle track will not necessarily be aligned within the roadway, and parking lot design and relationship to the cycle track may differ from the typical parking/cycle track relationship, parking restrictions may differ from NACTO recommendations.

Pavement Marking and Signage

Pavement markings should match SDOT/City standards, which follow the NACTO guide, the latest edition of MUTCD and the AASHTO guide.

Regulatory, warning, and way-finding signage specific to cycle tracks can be used to improve overall safety and expectations for all roadway users. Particularly at intersections and driveways, where the potential for conflicts between drivers and cyclists is higher, signs and markings should be used to alert all users to be aware and look for potential conflicts. NACTO provides guidelines for pavement marking and signage, based on AASHTO and MUTCD.

Cycle track pavement markings and signage are most important at the following areas:

- **At crossings/conflict areas,** to increase awareness of bicyclists, encourage reduced bicycle speeds and proper tracking through intersections.
- **At the beginning and end of a block or cycle track segment**, to highlight the cycle track in the case that motorists or pedestrians might confuse the cycle track for travel lane or sidewalk.
- **Along the cycle track,** to promote the correct direction of travel and discourage wrong-way riding, as well as to indicate to pedestrians and vehicles the intended use of the facility.

Signage and Markings at Intersections and Crossings

REQUIRED

- Bike lane symbol & arrow (MUTCD 9C-3).

ADVISED

- Regulatory, warning and informational signage as need to improve awareness and compliance.

OPTIONAL

Below is a sample of optional treatments:

- Visual and tactile clues through intersections, such as green pavement. Green pavement should be supplemented with dashed lines.
- Bike crosswalk/shared lane markings through intersections.
- Dashed yellow line to separate two-way bicycle traffic and help cyclist tracks through the intersection/crossing.
- Continued use of the City's "Be Super Safe" educational campaign signage used on the Linden Avenue North cycle track, along Burke-Gilman Trail and other areas is recommended.

Transit Stop Accommodation

Siting a bicycle facility adjacent to transit stops creates the potential for conflicts between cyclists and pedestrians. Options for managing potential conflicts between the two modes include the use of signage and pavement markings to encourage cyclists to yield to pedestrians, or the relocation or redesign of transit stops.

The Dexter Avenue North buffered bike lanes, which include raised bus stop islands and clearly defined crossing points for pedestrians across the bike lane, are a good model for the treatment of transit stops adjacent to a bicycle facility.

Key design elements for transit stops near cycle tracks include:

- Storage/waiting space for pedestrians.
- Convenient and intuitive pedestrian access routes.
- Horizontal or vertical separation of bicyclists and pedestrians.
- Pedestrian crossings of cycle track that limit crossing exposure times.

Materials

Materials to be used in the construction of the cycle track are addressed below.

Curb and Gutter Type

Curb and gutter treatments are to be determined.

Curb options include: raised median or planted median with cast-in place concrete curbs or “C-curbs.”

Drainage

Cycle tracks can be designed to allow stormwater to drain freely from the cycle track and to the extent possible, existing drainage flow patterns will be maintained. Currently stormwater flows to the center of the parking lot and is captured in catch basins and piped to Lake Union. It is not anticipated that the cycle track will add significant impervious surface, though existing surfaces could be altered or replaced with a different type of surfacing. The project will not contain any pollution-generating impervious surfaces.

Once an alignment is selected, a stormwater memo will be developed.

Pavement Materials

Asphalt is a cost efficient material and other cycle tracks around the City have been constructed with asphalt. Depending on the final alignment, it may be possible to use the existing asphalt to provide continuity with parking lot and drainage design. New asphalt should have a depth of 3” HMA over a 6” crushed rock base, to withstand occasional vehicle loads, as specified in City of Seattle Standard Plans 401 and 402. If the cycle track is to be maintained by a street sweeper the surfacing will need to be designed to accommodate regular vehicle loads.

Concrete is also an option, and there is precedent for its use at crossings. Concrete creates a contrasting surfacing that contributes to a higher level of awareness by bicyclists and motorists. However, for use over a larger area, bicyclists may find the rhythm created by expansion and contraction joints in concrete to be disruptive. One method that has proven to minimize disruptive vibration for bicyclists is to sawcut joints and leave them untrowelled. The concrete cross section for a crossing should consist of 6” roadway cement concrete over a compacted subgrade, again per COS Standard Plans 401 and 402.

An additional option would be pervious pavement-- porous asphalt or porous cement concrete. This type of surfacing is currently in use along Valley Street/Lake Union Park. Permeable paving options all require a base of rock or gravel to hold rainwater until it infiltrates into the soil, and require a minimum excavation of least 3 inches below the paving, backfilled with tamped rock or gravel. Pervious pavements also require an overflow route for runoff from big storms to flow to street drains, landscape, or a rain garden. Pervious pavement qualifies as Green Stormwater Infrastructure.

Landscape and Hardscape Materials

Seattle ROWIM specifies the following minimums for landscape elements in the right of way: Tree pit: 5’ min. width and 2”-2 ½” caliper trees.

Other landscape standards would be used in conjunction with stormwater requirements and could provide opportunities to implement green infrastructure.

Lighting

Lighting may be beneficial to the operation of the cycle track, depending on its location and proximity to other existing light sources. Additional lighting could also benefit pedestrian traffic and enhance community safety and the businesses. Lighting needs will be considered and evaluated once an alternative has been selected.

Other Factors Influencing Design

The following factors will influence the design of the cycle track within the corridor.

Parking Stall Size and Distribution Ratios

There are a number of references that address parking stall size and layouts, including *Dimensions of Parking,* Urban Land Institute, Fifth Edition, 2011, and the *Traffic Engineering Handbook*, ITE, Sixth Edition, 2009. Table 4 shows suggested design values for parking at several different angles. The table also provides a reference as to overall width of a double-loaded parking aisle depending on the angle as well as an approximate guideline as to how many spaces are provided per block. See the Attachment A for a comparison of the ITE, ULI and COS standards and TDG recommendations.

Table 4: Parking Layout Dimensions

Recommended Parking Layout Dimensions					
Space Angle	**Stall Width**	**Stall Depth to Face of Curb**	**One-way Drive Aisle Width**	**Module Width**	**Spaces per 500' Block (Two-side)**
90 degrees	8.5 feet	17 feet	22-24 feet	56 feet	118
60 degrees	8.5 feet	17 feet	14 feet	48 feet	102
45 degrees	8.5 feet	15.5 feet	12 feet	43 feet	84
30 Degrees	8.5 feet	13.5 feet	12 feet	39 feet	58
0 Degree (Parallel)	8 feet	20 feet (length)	12 feet	28 feet	50

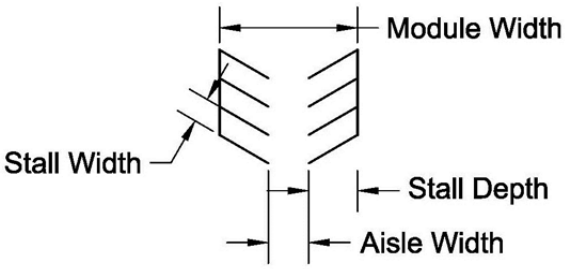

Figure 12. Diagram of Parking Layout Terminology

Figure 13 shows how circulation (one-way vs. two-way) and parking stall angles could be changed to accommodate the cycle track within the corridor.

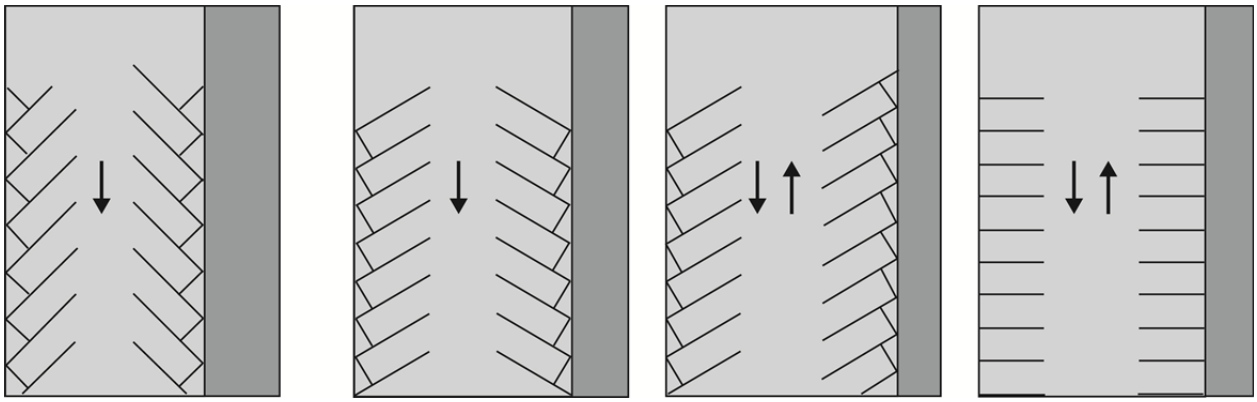

Figure 13. Comparison of Space Requirements for Varied Circulation and Parking Stall Angles.

Design Vehicles for Marine Businesses, Circulation Routes for Boats and Trailers

Delivery access is important for all businesses; marina and marine-related businesses have specialized needs to accommodate access and delivery for boats and large equipment. Further research to determine the location and specifics of these needs will be undertaken.

Dumpster Sizes – Requirements for Storage/Size, Pick-up Frequency Ratios

Cleanscapes reports that containers over 8 cubic yards use front loading trucks, which require maneuvering and backing up to mechanically unload the contents into the truck. Smaller containers are serviced by rear loading trucks; these containers are on wheels and can be maneuvered by hand to the rear of the truck.

Depending on parking configuration and alignment, trash container locations and sizes may need adjustment. Consolidation and organization of these collection areas may help maximize the use of space.

Maintenance

Ideally a cycle track should be wide enough to accommodate a street sweeper, especially where leaf or other regular debris is anticipated. A two-way cycle track with a 10 foot minimum width should be wide enough to accommodate a street sweeper. The extra space provided by a painted buffer or a line of parked cars can provide adequate space for sweepers to operate.

Westlake Cycle Track | Design Criteria Recommendations

	CROSS SECTION: Width and design	RECOMMENDED CRITERIA
1	Cycle Track Width	12 feet preferred, 10 feet acceptable
2	Design Speed	10 MPH – affects stopping sight distance, curves
3	Alignment	• Provides adequate separation; safe crossings • Connects well to other facilities • Manages user speeds
4	Separation from motor vehicles & pedestrians	Color, texture, grade changes, physical elements
5	Clearances	• 2 feet from horizontal elements • 3 feet from parallel-parked cars, 1.5 feet min. from drive aisles • 1 foot shy distance from curbs
	INTERSECTION/CROSSING DESIGN	**RECOMMENDED CRITERIA**
6	Intersection Design Considerations	Use geometry to define speed, maximize sight lines, delineate mixing zones; design for left turns (all modes), provide queuing space and traffic control as necessary
7	Sight Triangles	10-20 feet at driveways and intersections; certain intersections may require more
8	Stopping Sight Distances	Based on roadway and cycle track design speeds (35 MPH and 10 MPH, respectively)
9	Parking Restrictions for Sight Distance	30 feet from intersections, other situations TBD
10	Pavement Markings and Signage	• Required: Bike lane symbol + arrow • Advised: Green pavement, chevron markings, skip striping, warning signs regarding turns and bikes only • Optional: Visual and tactile clues, educational signs, dashed yellow lines
11	Transit Stop Accommodation	Provide accessibility, waiting space, safe crossings

Design Criteria Recommendations (continued)

ADDITIONAL DESIGN ELEMENTS

MATERIALS to be used in the construction of the project

Curb and Gutter Type
Drainage
Pavement Materials
Landscape and Hardscape Materials

OTHER FACTORS INFLUENCING DESIGN

Parking Stall Size and Distribution Ratios
Design Vehicles for Marine Businesses, Circulation Routes for Boats and Trailers
Dumpster Sizes and Distribution Ratios
Maintenance

References

American Association of Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities, 2012.*

City of Seattle *Right of Way Improvement Manual.*

City of Seattle Stormwater Manual: Vol. 3 Stormwater Flow, Control and Water Quality Treatment Technical Requirement Manual, City of Seattle - Seattle Public Utilities, Department and Planning and Development, November 2009.

CROW: Record 25, Design Manual for Bicycle Traffic. The Netherlands, 2006.

Dimensions of Parking, Urban Land Institute, Fifth Edition, 2011.

King County Metro Facility Design Guidelines, 1991.
http://www.kingcounty.gov/environment/wlr/sections-programs/science-section/library/document-list/mr4358-01.aspx

King County, Washington *Surface Water Design Manual,* King County Department of Natural Resources and Parks, January 9, 2009.

London Cycling Design Standards, Chapter 4- Links – Cycle lanes, cycle tracks and other cycle facilities.
http://www.tfl.gov.uk/assets/downloads/businessandpartners/lcds_chapter4.pdf

Manual of Uniform Traffic Devices, U.S. Department of Transportation Federal Highway Administration*. 2009.*

The National Association of City Traffic Officials (NACTO) *Urban Bikeway Design Guide.*

Shoreline Master Programs Permit and Enforcement.
http://www.ecy.wa.gov/programs/sea/sma/st_guide/administration/index.html

Seattle Municipal Code.

2011 Seattle Traffic Report, SDOT.
http://www.seattle.gov/transportation/docs/2011%20Traffic%20Report%20final.pdf

2011 Traffic Data and Maps, SDOT. http://www.seattle.gov/transportation/tfdmaps.htm

2008 and 2013 Speed Grand Totals, Westlake Avenue North, SDOT.

Traffic Engineering Handbook, ITE, Sixth Edition, 2009.

Attachment A

Comparison of ITE, ULI and COS standards and TDG recommendations for parking stall sizes.

Westlake Cycle Track

Attachment A. Comparison of ULI, ITE and CPS Parking Space Standards and Westlake Cycle Track Recommendations

		Total Proj.	Overhang	Stall Depth	Aisle Width	Stall Depth	Overhang	Curb to Curb
Parallel	**Toole**	8.0	0.0	8.0	12.0	8.0	0.0	28.0
30 degree	**ULI**	15.0	1.3	13.8	11.0	13.8	1.3	38.5
	ITE	-	-	-	-	-	-	-
	Seattle	17.0	3.9	13.1	12.0	13.1	3.9	38.2
	TDG Rec.	14.5	1.0	13.5	12.0	13.5	1.0	39.0
45 degree	**ULI**	17.5	1.8	15.8	12.0	15.8	1.8	43.5
	ITE	16.5	2.0	14.5	14.0	14.5	2.0	43.0
	Seattle	20.0	3.2	16.8	12.5	16.8	3.2	46.1
	TDG Rec.	17.0	1.5	15.5	12.0	15.5	1.5	43.0
60 degree	**ULI**	19.0	2.0	17.0	13.5	17.0	2.0	47.5
	ITE	18.0	1.5	16.5	17.0	16.5	1.5	50.0
	Seattle	21.0	2.2	18.8	17.0	18.8	2.2	54.6
	TDG Rec.	18.5	1.5	17.0	14.0	17.0	1.5	48.0
90 degree	**ULI**	18.0	2.5	15.5	23.0	15.5	2.5	54.0
	ITE	17.5	0.0	17.5	26.0	17.5	0.0	61.0
	Seattle	19.0	0.0	19.0	25.0	19.0	0.0	63.0
	TDG Rec.	18.5	1.5	17.0	22.0	17.0	1.5	56.0

SOURCES

Dimensions of Parking, Urban Land Institute, Fifth Edition, 2011.
Traffic Engineering Handbook , ITE, Sixth Edition, 2009.
Seattle Municipal Code 23.54.030 Parking Space Standards

Toole Design Group