Technical Memo: issues and considerations associated with developing protected bicycle lanes in Portland, OR

Introduction

Portland is not alone in desiring to construct protected bikeways as part of improvements on roadways where separation is appropriate. In 2015 the Director of the Portland Bureau of Transportation (PBOT) issued a directive telling staff "to make protected bicycle lanes the preferred design on roadways where separation is called for…. [this includes] retrofits of existing roadways as well as to new construction".

As PBOT technical staff began to address this directive we found that neither our experience nor guidance from NACTO or FHWA, among others, provided clear solutions to design challenges we encountered. We found it difficult to achieve the standard of protection we want to have for bicycle lanes while also meeting our requirements for stormwater retention, allowing for efficient responses and clean set up for our emergency services providers, meeting ADA requirements and providing a comfortable and intuitive environment for all users walking and enjoying sidewalk retail including those with disabilities.

Perhaps somewhat unique to Portland are our legally-mandated and advanced requirements for stormwater management, our relatively narrow rights of way that tend to constrain many design elements and our formal adoption of classified emergency response routes. We found it difficult to address these issues in the context of often fast-moving project design efforts.

This document serves as a technical memorandum to Toole Design Group (TDG). TDG is under contract with the city to identify key design and policy challenges faced by the city and to work with city staff to develop design and policy solutions and to then train appropriate city staff on the identified solutions.

This memo is broadly organized into 3 parts:

1. **Stakeholder Interviews**, with key city staff knowledgeable about the above-identified issues
2. Additional information about **Stormwater** and the cities policies and approach to stormwater management
3. **Example Roadways** that provide clear examples of the types of challenges faced by the city.

Stakeholder Interviews

Stormwater

Meeting with Dave Nunamaker (12/22/15)
Dave is a Civil Engineer with our Bureau of Environmental Services. He is also BES' principal liaison to the Portland Bureau of Transportation (PBOT).

BES' stormwater requirements and treatments vary based on the nature of the project and the system that will ultimately receive the roadway run-off.

Policies and Goals
BES' policies and goals are fully described within the first chapter of the city's Stormwater Management Manual (SWMM). This is a living document, the most recent version of which was adopted on January 2, 2014. The manual is overseen by BES program manager Amber Clayton.

BES has policies to provide more flexibility in stormwater requirements for safety projects. An example of their increased flexibility is found with projects that are solely developing facilities for people walking. Development of sidewalks have more flexible stormwater management requirements for two principal reasons:

1. The required facilities would be relatively small, and
2. Such a requirement would place an undue burden on what is principally considered a safety project for people walking.

This is also the case with safety projects that provide crossing treatments for people walking. Though the square feet of new impervious construction (as at curb extensions associated with rapid flash beacons) would trigger stormwater requirements, BES is not requiring them in all cases.

Other agencies also consider the idea that facilities outside the normal travelled way of motor vehicles are not contributing to pollution loading of waterways. BES does not consider that.

BES also recognizes "special circumstances" that allow applicants to apply for relief from requirements.

BES has two goals for street run-off:
Flow control and pollution reduction. The goal of flow control is to minimize the peak storm run-off so as to not be harmful to the receiving system. The goal of pollution reduction is to minimize the amount of pollution that enters the receiving system. The designs for both are similar, though considerations for flow control could include larger size facilities, deeper facilities and strategic use of check dams.

Underground injection control (UIC) facilities do not require flow control but do make use of pollution reduction.

Facility Design

Nearly all of BES' stormwater management facilities are either planters, curb extensions or swales. They also have available non-vegetated treatments using underground filters (for pollution reduction, only) and a new treatment technology called "Filtera". A principal consideration for BES staff is the cost of implementation and the ongoing cost for maintenance of facilities.

Examples:
One consideration discussed with raised bikeways adjacent to the roadway is using a channel and grate system to convey water under the bikeway to planters or swales. Due to the width of bikeways, the channel and grate would be much longer than typically allowed by BES. This raises maintenance concerns as any significant accumulation of sediment and debris would lead to runoff bypassing the stormwater facility inlet.

Another solution discussed is collecting runoff in a shallow concrete inlet and piping it under the bikeway to the stormwater facilities. Because of grades, this can cause the stormwater facility to become deep. Whereas that could be acceptable where there is room for a wide stormwater facility, it may be considered problematic for narrower stormwater facilities. It also makes it more difficult for adjacent property owners to perform minimal maintenance (ie remove non-organic debris). It may also require a surrounding railing for pedestrian safety.

Emergency Response

<u>Meeting with Scott Batson (12/23/15)</u>
Scott Batson is a traffic engineer with PBOT who has worked closely with our Fire Bureau to address issues associated with Emergency Response.

Roadway design to accommodate emergency response has centered on providing for Fire Bureau vehicles. The principal design considerations are to minimize delay in accessing a destination and allowing for setting of outriggers once arrived.

Access
Portland Fire Bureau (PFB) requests a minimum of fourteen feet (14') clear between fixed objects. This is based on their vehicles being approximately 8' wide, having wider mirrors and other equipment hanging off the side.

It is possible that PFB vehicles can straddle a vertical element depending on its height and width. They may be able to go up and over it if designed to be mountable. Otherwise they would need to straddle it at a gap in the element.

Set up
The national standard for setting outriggers is twenty feet clear (20') between fixed objects. Outriggers are required for aerial ladders and buckets. It is the desire of PFB to be able to spray water down onto smaller structures that may be burning. It is possible that outriggers can extend over raised objects (such as continuous medians) depending on their height and width.

Meeting with Leo Krick, Deputy Fire Chief and Nate Takara, Fire Marshall (1/7/16)
The initial premise of this conversation was the idea of a 10’ travel lane that included a linear barrier to provide physical separation between the travel lane and an 8’ protected bicycle lane.

Set-up is generally the more demanding criteria for fire vehicles. If there’s enough room for set-up, then there will be enough room for access.

The Fire Code requires 26-feet for set up. That accounts for the approximately 10-foot wide vehicle, 5-feet for outriggers on both sides and enough room to maneuver around the outriggers. Fire Bureau generally sets up outriggers for any structure of three stories or more.

With the above situation we discussed the idea of a mountable barrier that would either allow:

- Fire trucks to straddle the barrier in accessing a fire
- Fire trucks to set their outriggers either on or across the barrier

We also discussed the idea that set up could be accommodated through provision of regularly-spaced bays (i.e. no parking or driveways) that would allow for outriggers. The spacing of such bays is dependent on the characteristics of the street. Often, Fire Bureau looks to set up at corners where building orientation allows. In other cases there may only need to be few such bays, though some streets could require them with great frequency. It all depends on context.

These ideas are worth pursuing in some more detail.

Context is important. An area where there is one-block of such barrier is more easily managed than such a barrier along an entire corridor.

We briefly discussed the trade-offs between having a 14’-wide travel lane that was open versus a 20’-wide roadway that had a median barrier. There are pros and cons of each that deserve further consideration.

There have been situations where staff doubted adequate provisions for emergency access could be made and they were. Hence, a principal take-away from this conversation is that each situation is unique and has to be evaluated based on its own merits. A key to success can often be mocking up proposed designs and having truck drivers on site to assess.

ADA

Meeting with Chon Wong (1/5/16)
Chon Wong is a Senior Engineer with PBOT working on permitting issues. He is often addressing design issues associated with ADA requirements.

There are two (2) principal ways to address detection for the sight-impaired: provide vertical separation with detectable warnings or provide a detectable surface on a flush design. PBOT’s preferred option is providing vertical separation. That separation should be a minimum of two inches. That preference is based on observations during a test that found many sight-impaired people were unable to detect warnings on a flush surface.

For addressing people in mobility devices PBOT desires a minimum three-foot (3’) step out adjacent to on-street parking. This is what PBOT requests of Bureau of Environmental Services adjacent to stormwater planters/swales adjacent to on-street parking.

Policy
The Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROAG) provides minimum guidance according to Federal Highway Administration. Local jurisdictions may exceed these minimums. For example, both of the above-mentioned treatments (vertical separation and detectable flush separation) are allowed under PROAG. Similarly, PROAG does not require a step-out other than adjacent to parking spaces designated for disabled parking. In that situation a three-foot passage is required that provides an accessible connection to the sidewalk.

Design Considerations
A protected intersection design could be problematic because of how it places the crosswalk further from the intersection. PBOT’s experience at the east end of the Hawthorne Bridge with the north crosswalk found that near-misses with pedestrians were occurring when the crosswalk was pushed away from the intersection. Bringing the crosswalk back closer to the intersection seemed to result in safer operations for people walking.

The detectability of a rolled or beveled curb is unknown. That may be something to test with those who are sight-impaired.

Stormwater

Stormwater Management Manual

This section provides more detailed information about the city's efforts related to stormwater.

Portland's Stormwater Management Manual was last updated in 2014. It describes the city's policy and technical details of the city's stormwater requirements. The principal focus of the city's efforts are to protect Portland's water resources and the city's sanitary and stormwater infrastructure. The plan is available here: https://www.portlandoregon.gov/bes/64040

Potential harm arises from:
Impervious surfaces result in increased amounts of stormwater runoff that erodes stream channels and prevent groundwater recharge. Such impervious surfaces also allow pollutants from many sources to find their way to surface and ground waters. Thus, the main strategies of stormwater management are to reduce pollution, reduce runoff volumes and recharge groundwater. In addition to having a beneficial effect on natural water these efforts also protect and conserve the existing and future conveyance capacity of storm and combined sewers.

The requirements of the Stormwater Manual come into effect for "Projects that develop or redevelop over 500 square feet of impervious surface..."

Note BES' policies to provide flexibility to these requirements as described in the section of Stakeholder Interviews.

Policy Response to Total Maximum Daily Load (TMDL) management strategies

Portland has an implementation plan to reduce TMDL pollutants from nonpoint sources in order to restore and protect water quality in the Willamette River and tributaries. This implementation plan was updated in February, 2014. The plan can be found here: https://www.portlandoregon.gov/bes/37485 (look at TMDL Implementation Page: https://www.portlandoregon.gov/bes/article/556993).

Among the citywide management strategies to address TDML parameters are several to address Toxics (DDT, Polycyclic Aromatic Hydrocarbons [PAH] and PCB). PAHs are ubiquitous in the environment due in part to the combustion of fossil fuels. These strategies include “promote carpooling, use of public transportation, walking and biking”, which is included under the “Public Involvement” key strategies. They are also addressed under “Operations and Maintenance” key strategies by “operate and maintain public streets and roads in a manner that reduces the discharge of pollutants in stormwater” and to “incorporate electric vehicles into the transportation fleet”.

To the right is Table 3, Citywide Management Strategies from the TMDL, which show promotion of biking, among other modes as a key public involvement strategy. Another key strategy, under “operations and maintenance” is to “incorporate electric vehicles into the transportation fleet”.

Table 3
Citywide Management Strategies

	KEY STRATEGIES	**TMDL Parameters Addressed**					
		Bacteria (E. coli)	**Dissolved Oxygen**	**Mercury**	**Toxics (DDT, PAH, PCB)**	**Phosphorus & Chlorophyll**	**Temperature**
Public Involvement (PI)							
1	Provide water quality education and curriculum resources for K-12 students.	×	×	×	×	×	
2	Educate the public about stormwater and surface water quality protection/pollution prevention and riparian and wetland protection via websites, workshops, fact sheets, and other outreach materials.	×	×	×	×	×	
3	Involve citizens in water quality improvement activities through community events, stewardship projects, and restoration projects.	×	×	×	×	×	×
4	Implement Multnomah County's pet waste pick-up ordinance in City parks.	×	×			×	
5	Promote carpooling, use of public transportation, walking and biking.				×		
6	Coordinate and implement education and outreach programs and strategies with other jurisdictions.	×	×	×	×	×	×
7	Post the TMDL Implementation Plan and annual reports on the City website.	×	×	×	×	×	×

Example Roadways

The following pages include examples of roadways in Portland. Designs for bikeways on these roadways faced issues associated with either stormwater, parking, emergency response, and/or limited right of way space.

These are the types of roadways we want to retrofit with/design for protected bike lanes.

There are 5 specific roadway examples:

SE 17th Avenue
SE Foster Rd
SW Bond Avenue
N Williams Avenue
NE 47th Avenue

Also included are cross-sections of typical Portland roadways.

Each section includes either final plan sets (for roadways already constructed) or detailed conceptual designs and cross-sections for roadways funded but not yet built.

SE 17th Avenue

Stormwater, Parking and Emergency Response

SE 17th Avenue between SE Powell Boulevard and SE McLoughlin Boulevard was completely rebuilt in conjunction with our regional transit authority's (TriMet) construction of the region's newest light rail line (the Orange Line). The project resulted in center-running light rail, 11-foot travel lanes (not including shy distance from trackway civil work), 7-foot buffered bicycle lanes, on-street parking in locations and stormwater retention areas.

Following are two sets of sheets from the final plan set that show pavement markings (to highlight roadway element widths) and civil improvements (to locate stormwater improvements.

The question is how could we have designed this roadway differently to provide physically separated bikeways?

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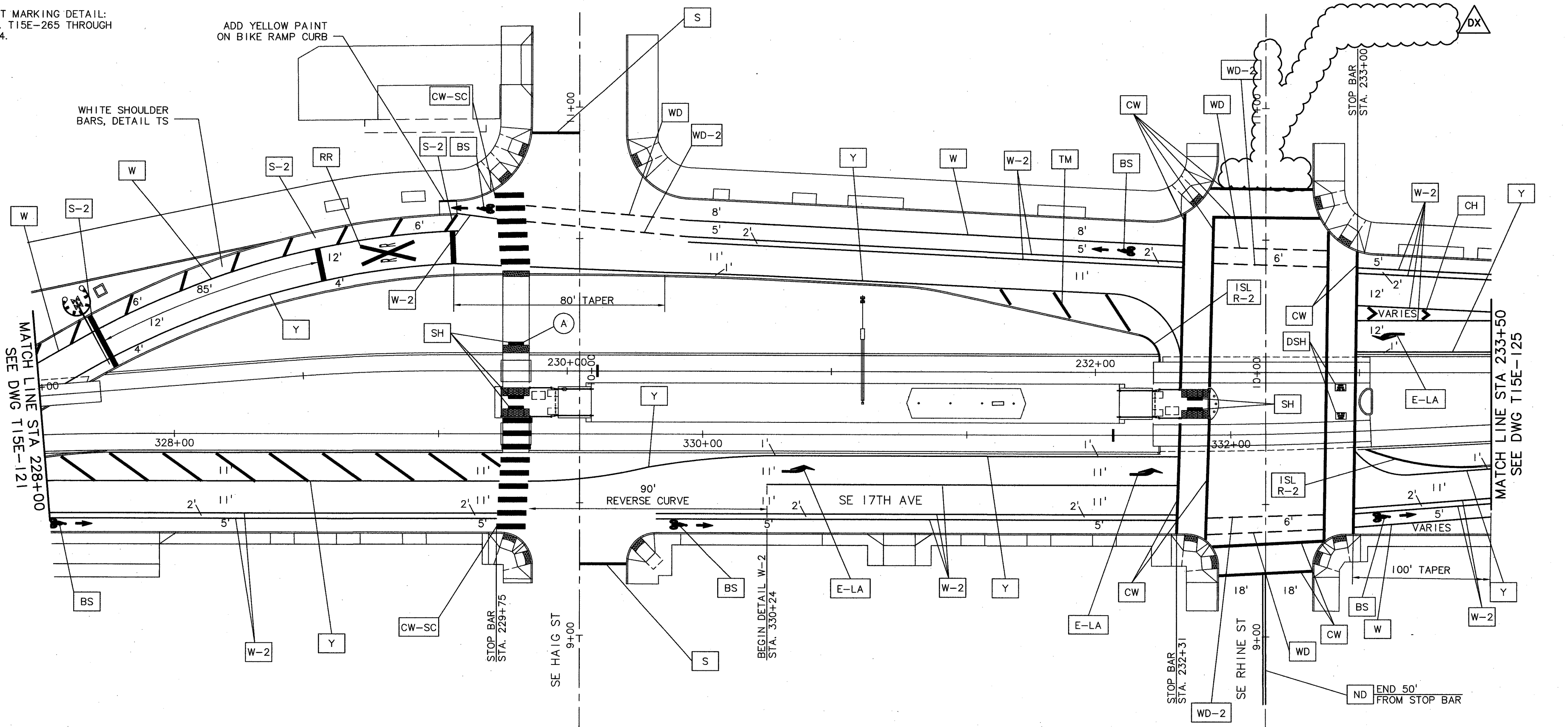

GENERAL NOTES:

1. THIS PLAN IS ACCURATE FOR PAVEMENT MARKINGS ONLY.
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SCALE: 1" = 20' (20' 10' 0' 20' 40')

NO.	DATE	BY	CHK.	APPD.	REVISIONS
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CX	10-16-14			MB	P.C. No. 351
BX	06-04-13	PLC		PLC	P.C. No. 136
A	01-21-13	PLC		PLC	PC NO. 105
	05-14-12	DMB		PLC	ISSUE FOR CONSTRUCTION

JXB (DESIGNED)	06-01-11 (DATE)
DKS CAD (DRAWN)	06-01-11 (DATE)
DMB (CHECKED)	04-25-12 (DATE)
(APPROVED)	05-14-12 (DATE)

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

DKS Associates — TRANSPORTATION SOLUTIONS

DAVID EVANS AND ASSOCIATES INC.

TRI MET — CAPITAL PROJECTS DIVISION, 1800 SW FIRST AVE., SUITE 300, PORTLAND, OREGON 97201

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APPROVED: Leah Robbins DATE:

PORTLAND TO MILWAUKIE LRT
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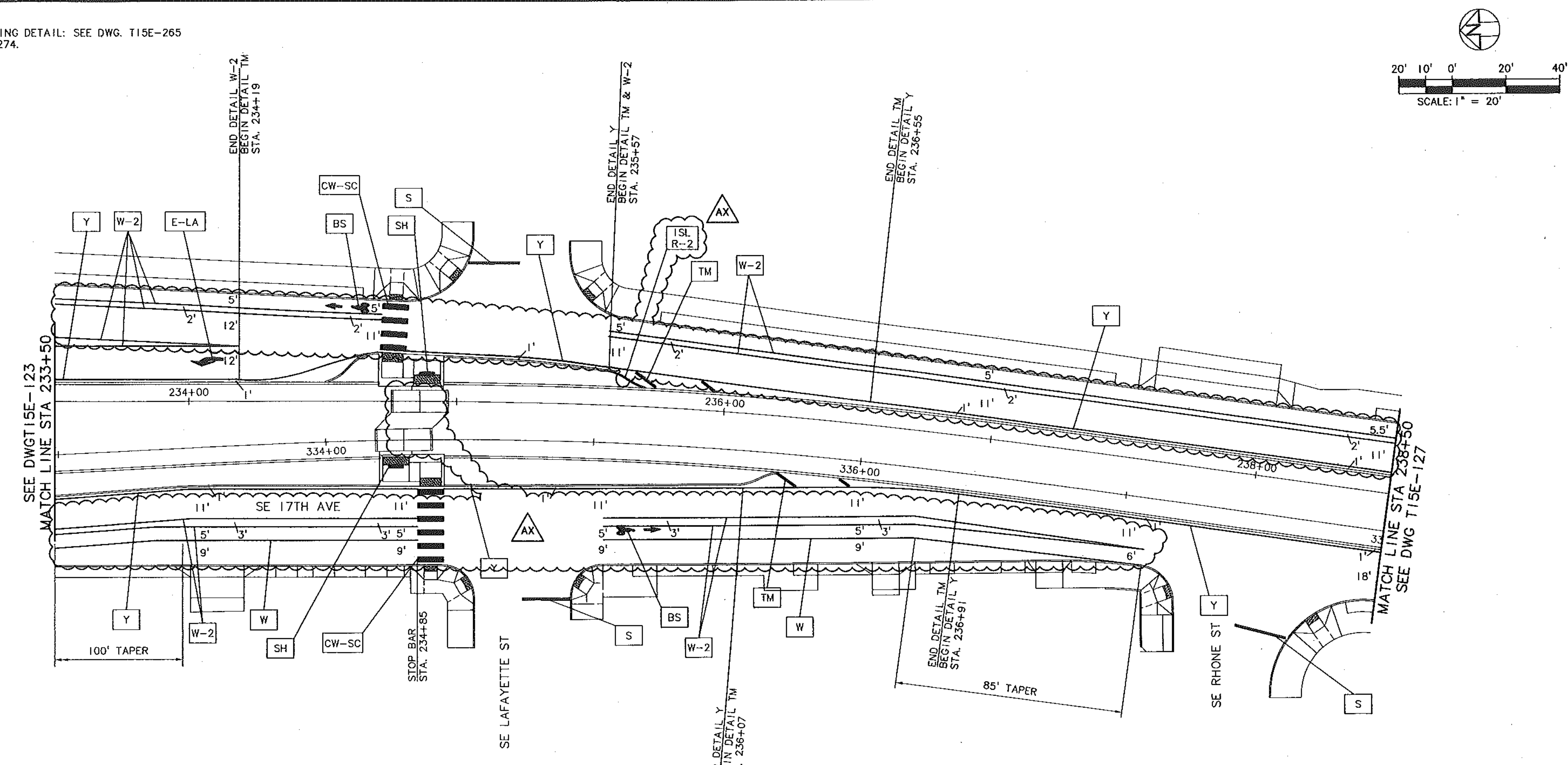

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JXB	DESIGNED	06-01-11
DKS CAD	DRAWN	06-01-11
DMB	CHECKED	04-25-12
	APPROVED	05-14-12

REGISTERED PROFESSIONAL ENGINEER OREGON OCT. 2, 1990 PETER L. COFFEY
EXPIRES: 12/31/2013

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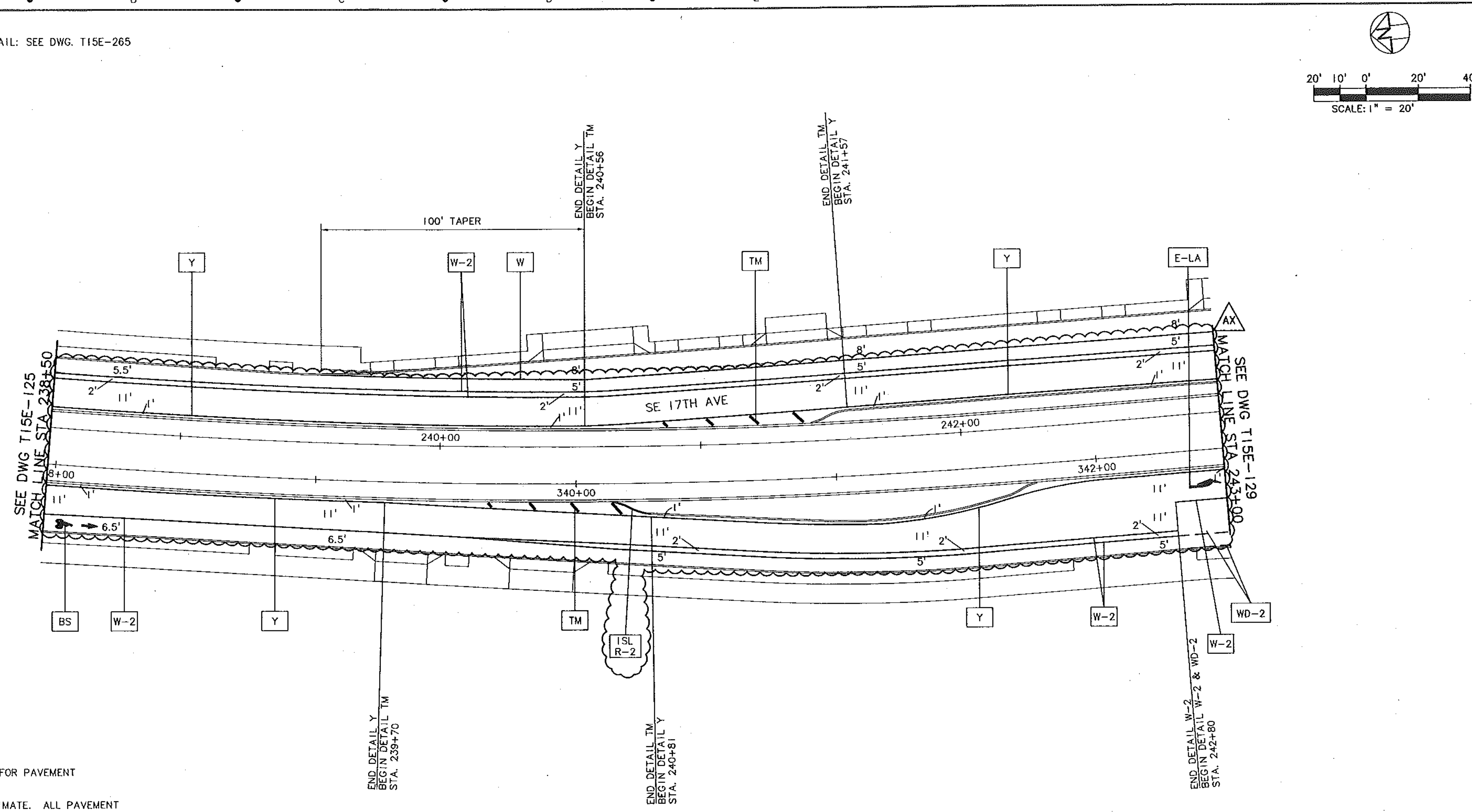

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JXB/JKW (DESIGNED)	06-01-11 (DATE)
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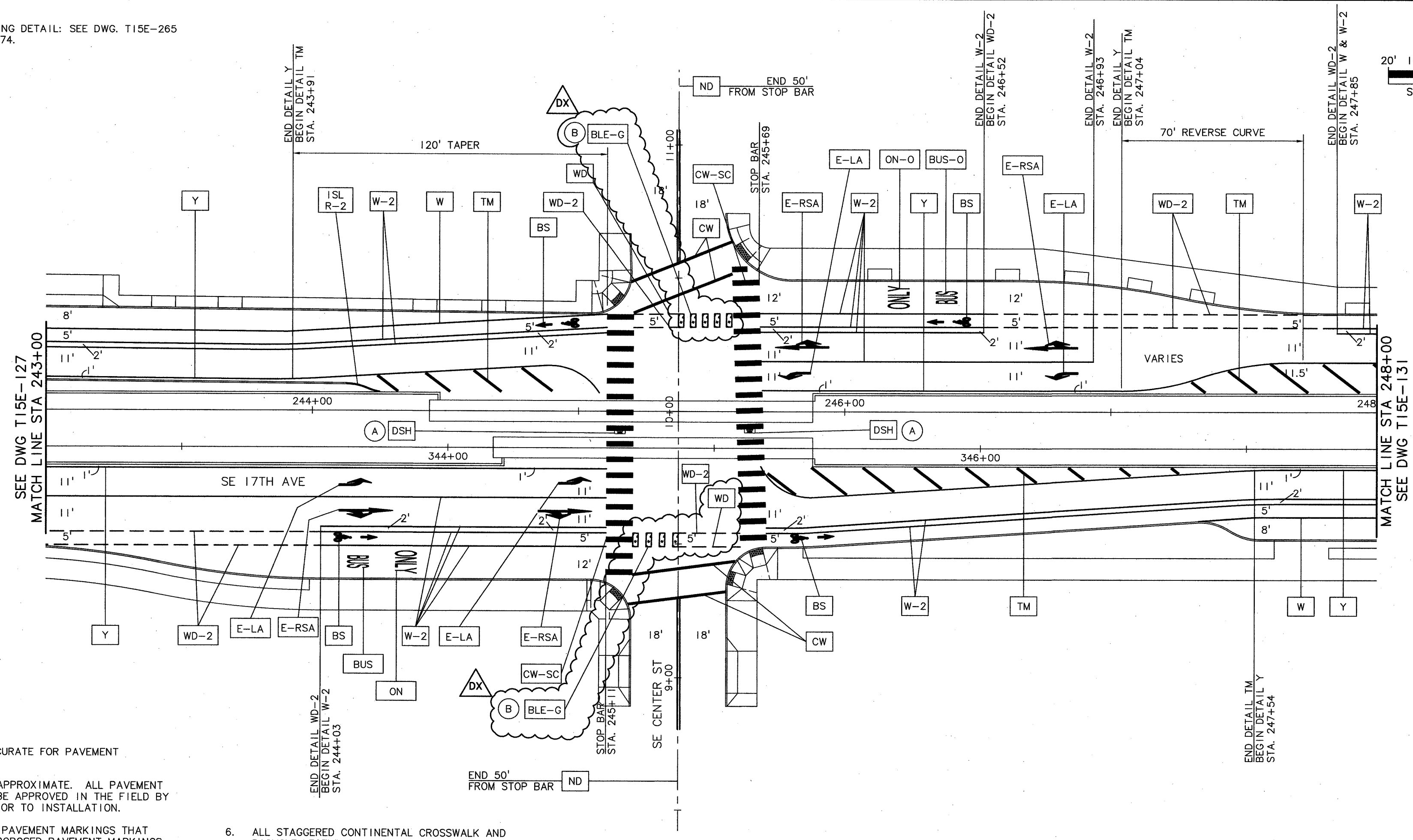

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BX	09-22-14			AF	CLARIFICATION NO. 108
AX	06-04-13	PLC		PLC	P.C. No. 136
	05-14-12	DMB		PLC	ISSUE FOR CONSTRUCTION

		DATE
DESIGNED	JXB/JKW	06-01-11
DRAWN	DKS CAD	06-01-11
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APPROVED		05-14-12

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SCALE: 1"=20' DRAWING NO.: T15E-129-DX CONTRACT NO.: RH100544JB SHEET NO.: 32

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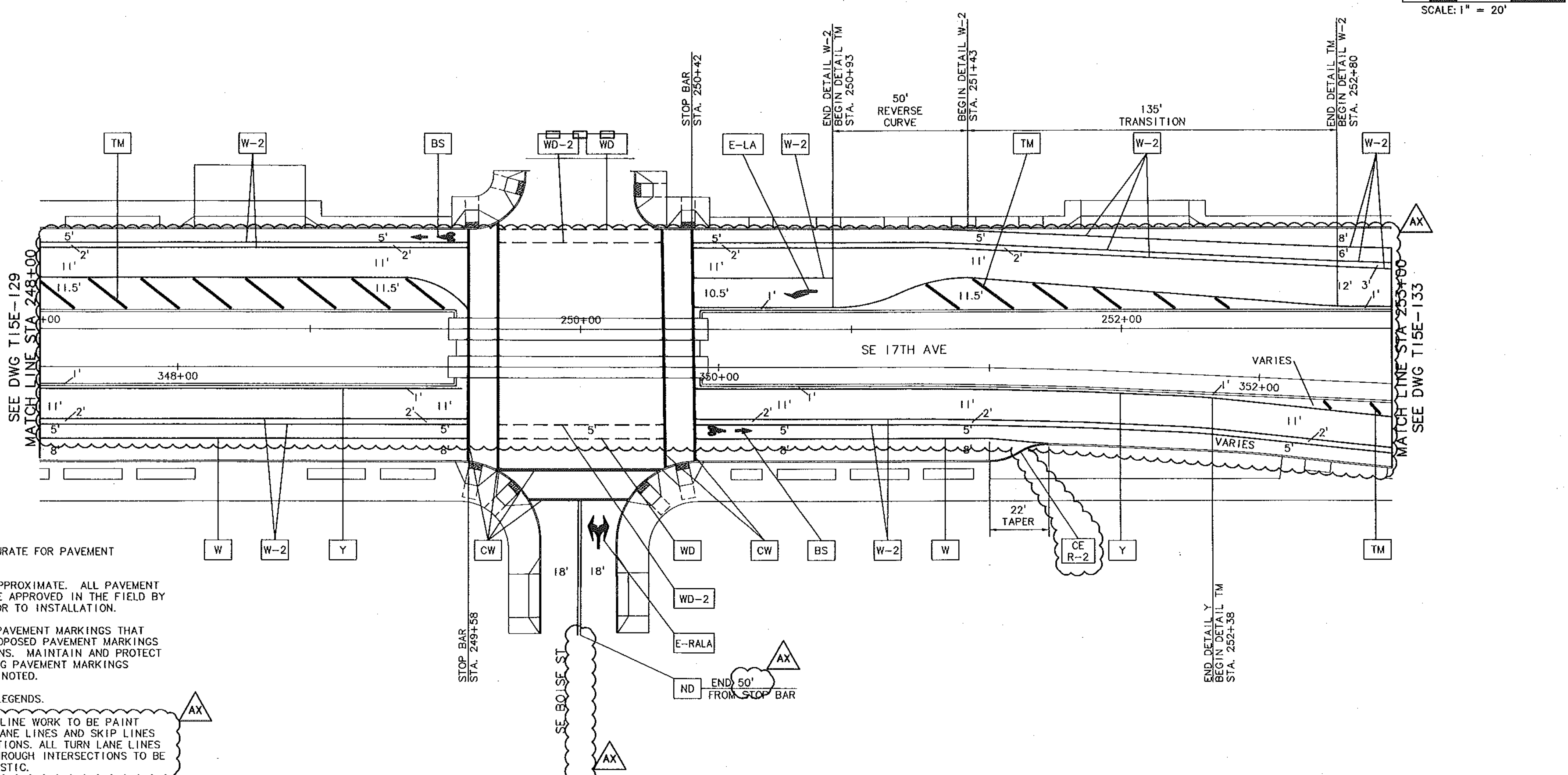

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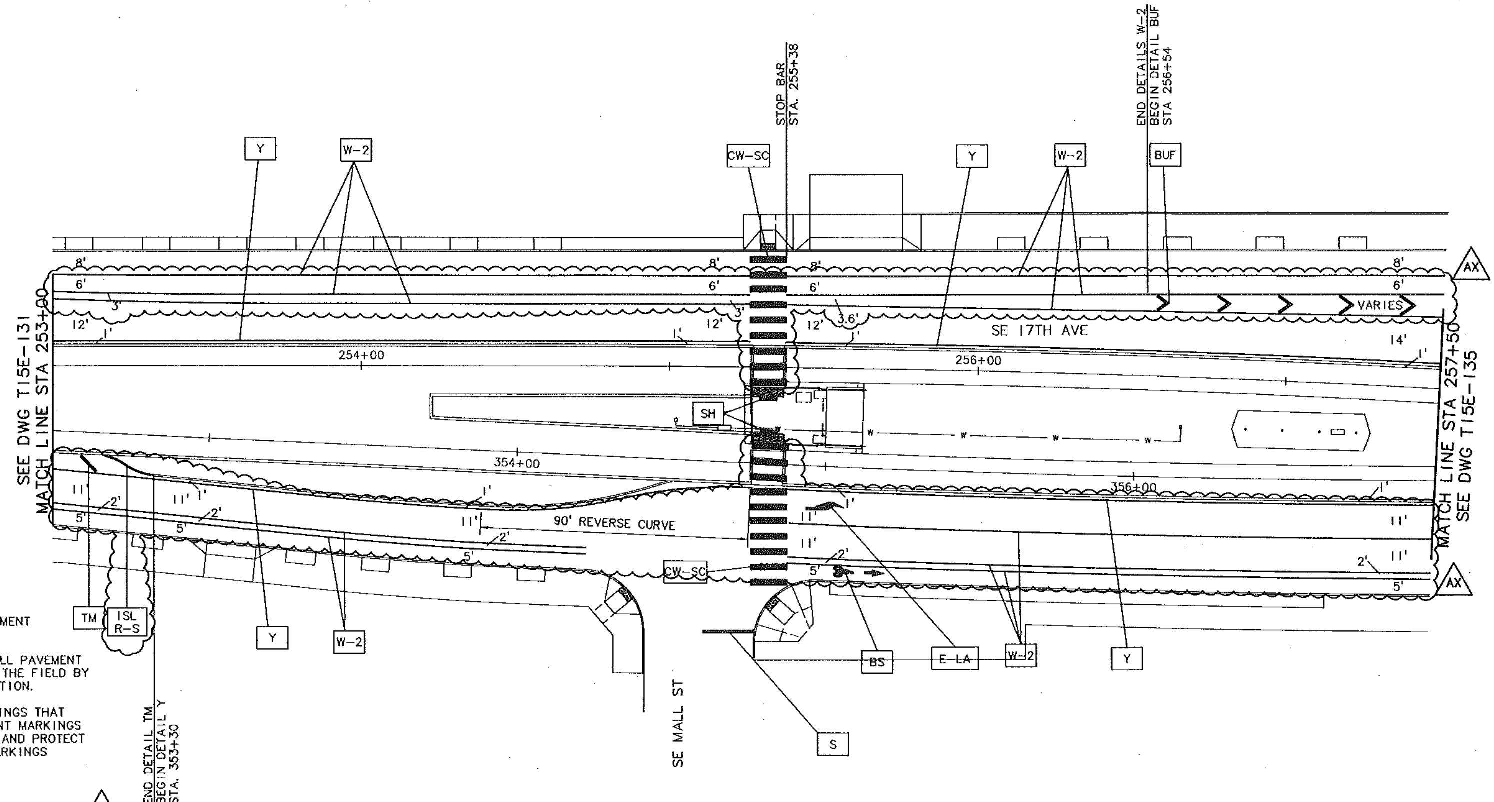

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5. ALL LONGITUDINAL LINE WORK TO BE PAINT EXCEPT FOR TURN LANE LINES. ALL TURN LANE LINES TO BE 120 MIL THERMOPLASTIC. (AX)
6. ALL STAGGERED CONTINENTAL CROSSWALK AND BICYCLE LEGEND PAVEMENT MARKINGS SHALL BE TYPE 'B-HS' THERMOPLASTIC.
7. ALL TRANSVERSE PAVEMENT MARKING BARS, EXCEPT STAGGERED CONTINENTAL CROSSWALKS, SHALL BE TYPE 'A' THERMOPLASTIC.
8. ALL TRANSVERSE PAVEMENT MARKING LEGENDS, EXCEPT BIKE LEGENDS, SHALL BE TYPE 'B-HS' THERMOPLASTIC. (AX)

NO.	DATE	BY	APPD. CHK	REVISIONS
AX	05-04-13	PLC	PLC	P.C. No. 136
	05-14-12	DMB	PLC	ISSUE FOR CONSTRUCTION

JXB (DESIGNED)	10-02-11 (DATE)
DKS CAD (DRAWN)	10-02-11 (DATE)
DMB (CHECKED)	04-25-12 (DATE)
(APPROVED)	05-14-12 (DATE)

REGISTERED PROFESSIONAL ENGINEER OREGON OCT. 2, 1990 PETER L. COFFEY
EXPIRES: 12/31/2013

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

DKS Associates TRANSPORTATION SOLUTIONS
DAVID EVANS AND ASSOCIATES INC.

TRI MET
CAPITAL PROJECTS DIVISION
1800 SW FIRST AVE., SUITE 300
PORTLAND, OREGON 97201

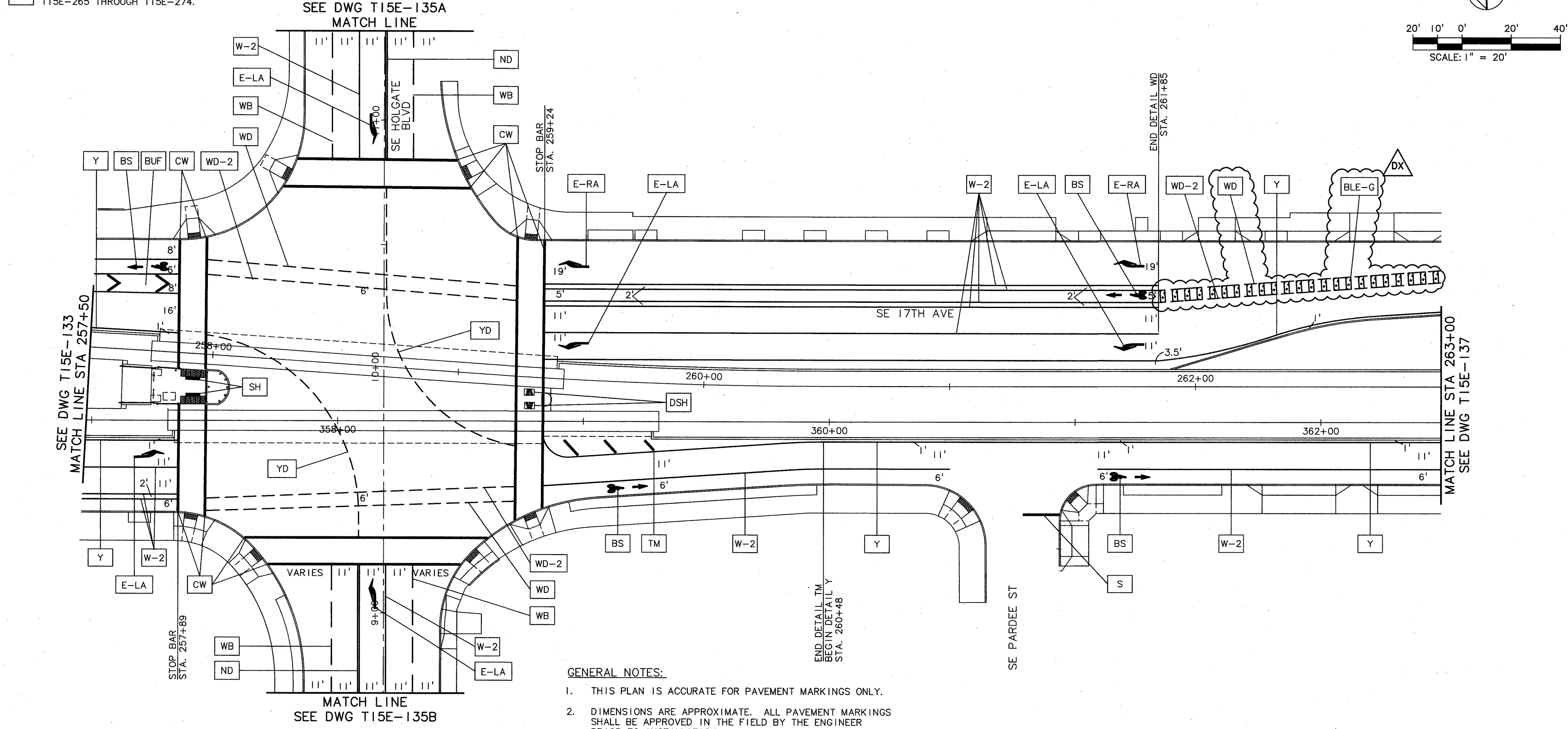
SUBMITTED: | DATE: | APPROVED: | DATE:

PORTLAND TO MILWAUKIE LRT
EAST SEGMENT
TRAFFIC
PAVEMENT MARKINGS
STA 253+00 TO STA 257+50

SCALE:	DRAWING NO.:	CONTRACT NO.:	SHEET NO.:
1"=20'	T15E-133-AX	RH100544JB	34

LEGEND:

X — PAVEMENT MARKING DETAIL: SEE DWG. T15E-265 THROUGH T15E-274.



GENERAL NOTES:

1. THIS PLAN IS ACCURATE FOR PAVEMENT MARKINGS ONLY.
2. DIMENSIONS ARE APPROXIMATE. ALL PAVEMENT MARKINGS SHALL BE APPROVED IN THE FIELD BY THE ENGINEER PRIOR TO INSTALLATION.
3. REMOVE EXISTING PAVEMENT MARKINGS THAT CONFLICT WITH PROPOSED PAVEMENT MARKINGS SHOWN ON THE PLANS. MAINTAIN AND PROTECT ALL OTHER EXISTING PAVEMENT MARKINGS UNLESS OTHERWISE NOTED.
4. CENTER PAVEMENT LEGENDS.
5. ALL LONGITUDINAL LINE WORK TO BE PAINT EXCEPT FOR TURN LANE LINES AND SKIP LINES THROUGH INTERSECTIONS. ALL TURN LANE LINES AND SKIP LINES THROUGH INTERSECTIONS TO BE 120 MIL THERMOPLASTIC.
6. ALL STAGGERED CONTINENTAL CROSSWALK AND BICYCLE LEGEND PAVEMENT MARKINGS SHALL BE TYPE 'B-HS' THERMOPLASTIC.
7. ALL TRANSVERSE PAVEMENT MARKING BARS, EXCEPT STAGGERED CONTINENTAL CROSSWALKS, SHALL BE TYPE 'A' THERMOPLASTIC.
8. ALL TRANSVERSE PAVEMENT MARKING LEGENDS, EXCEPT BIKE LEGENDS, SHALL BE TYPE 'B-HS' THERMOPLASTIC.

NO.	DATE	BY	CHK.	APPD.	REVISIONS
DX	06-15-15	AF		MT	P.C. No. 136B
CX	10-16-14			MB	P.C. No. 351
BX	06-04-13	PLC		PLC	P.C. No. 136
A	06-14-12	DMB		PLC	PC NO. 20 - "STOP HERE" PAVEMENT MARKINGS MODIFIED
	05-14-12	DMB		PLC	ISSUE FOR CONSTRUCTION

DESIGNED	JXB	10-02-11
DRAWN	DKS CAD	10-02-11
CHECKED	DMB	04-25-12
APPROVED		05-14-12

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

DKS Associates TRANSPORTATION SOLUTIONS — DAVID EVANS AND ASSOCIATES INC.

TRIMET — CAPITAL PROJECTS DIVISION, 1800 SW FIRST AVE., SUITE 300, PORTLAND, OREGON 97201

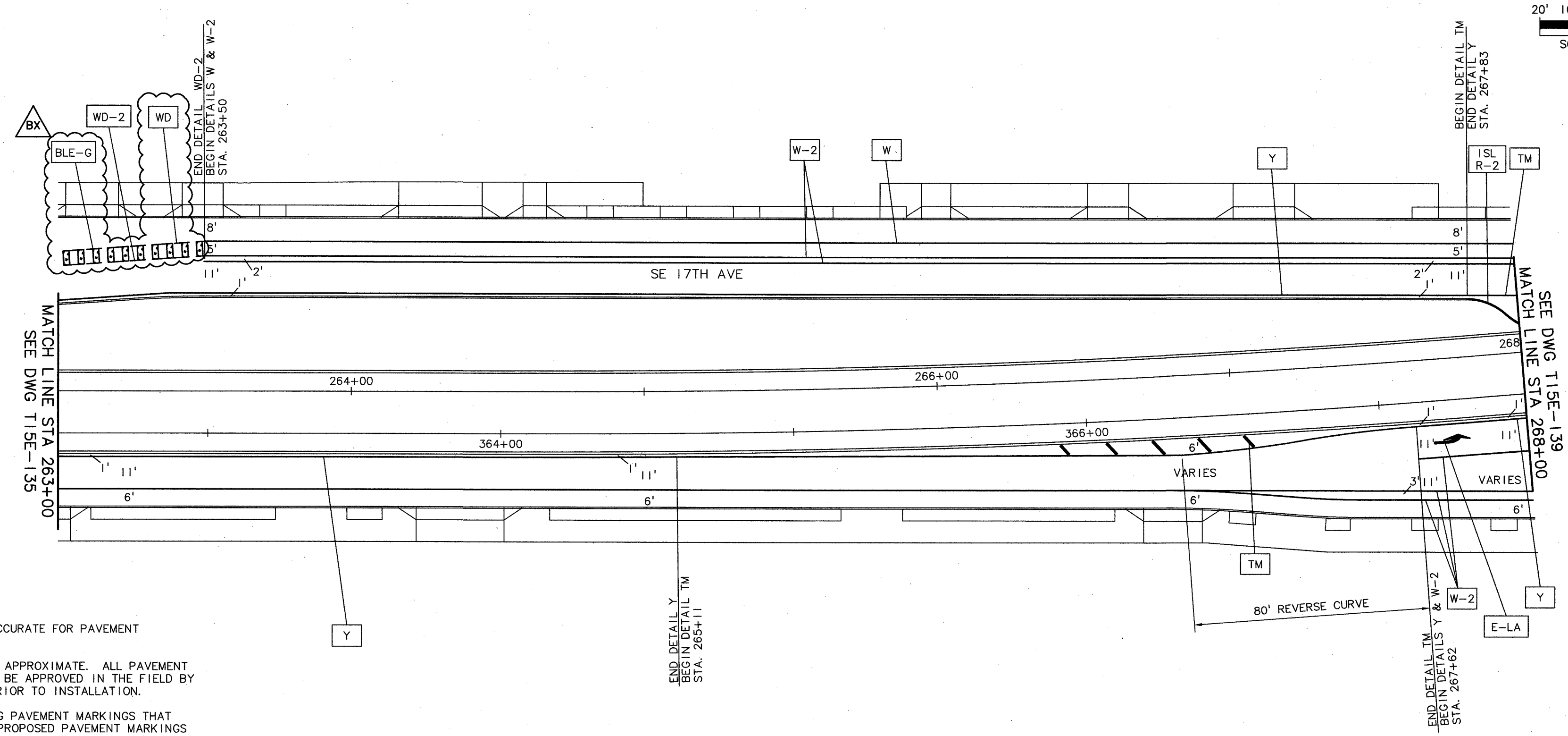
SUBMITTED: DATE: APPROVED: Leah Robbins DATE:

PORTLAND TO MILWAUKIE LRT
EAST SEGMENT
TRAFFIC
PAVEMENT MARKINGS
STA 257+50 TO STA 263+00

SCALE: 1"=20' | DRAWING NO.: T15E-135-DX | CONTRACT NO.: RH100544JB | SHEET NO.: 35

LEGEND:

[X] PAVEMENT MARKING DETAIL: SEE DWG. T15E-265 THROUGH T15E-274.



GENERAL NOTES:

1. THIS PLAN IS ACCURATE FOR PAVEMENT MARKINGS ONLY.
2. DIMENSIONS ARE APPROXIMATE. ALL PAVEMENT MARKINGS SHALL BE APPROVED IN THE FIELD BY THE ENGINEER PRIOR TO INSTALLATION.
3. REMOVE EXISTING PAVEMENT MARKINGS THAT CONFLICT WITH PROPOSED PAVEMENT MARKINGS SHOWN ON THE PLANS. MAINTAIN AND PROTECT ALL OTHER EXISTING PAVEMENT MARKINGS UNLESS OTHERWISE NOTED.
4. CENTER PAVEMENT LEGENDS.
5. ALL LONGITUDINAL LINE WORK TO BE PAINT EXCEPT FOR TURN LANE LINES. ALL TURN LANE LINES TO BE 120 MIL THERMOPLASTIC.
6. ALL STAGGERED CONTINENTAL CROSSWALK AND BICYCLE LEGEND PAVEMENT MARKINGS SHALL BE TYPE 'B-HS' THERMOPLASTIC.
7. ALL TRANSVERSE PAVEMENT MARKING BARS, EXCEPT STAGGERED CONTINENTAL CROSSWALKS, SHALL BE TYPE 'A' THERMOPLASTIC.
8. ALL TRANSVERSE PAVEMENT MARKING LEGENDS, EXCEPT BIKE LEGENDS, SHALL BE TYPE 'B-HS' THERMOPLASTIC.

NO.	DATE	BY	CHK.	APPD.	REVISIONS
BX	06-15-15	AF		MT	P.C. No. 136B
AX	06-04-13	PLC		PLC	P.C. No. 136
	05-14-12	DMB		PLC	ISSUE FOR CONSTRUCTION

DESIGNED	JXB/JKW	06-01-11
DRAWN	DKS CAD	06-01-11
CHECKED	DMB	04-25-12
APPROVED		05-14-12

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

DKS Associates TRANSPORTATION SOLUTIONS — DAVID EVANS AND ASSOCIATES INC.

TRI MET — CAPITAL PROJECTS DIVISION, 1800 SW FIRST AVE., SUITE 300, PORTLAND, OREGON 97201

SUBMITTED: DATE: APPROVED: Leah Robbins DATE:

PORTLAND TO MILWAUKIE LRT
EAST SEGMENT
TRAFFIC
PAVEMENT MARKINGS
STA 263+00 TO STA 268+00

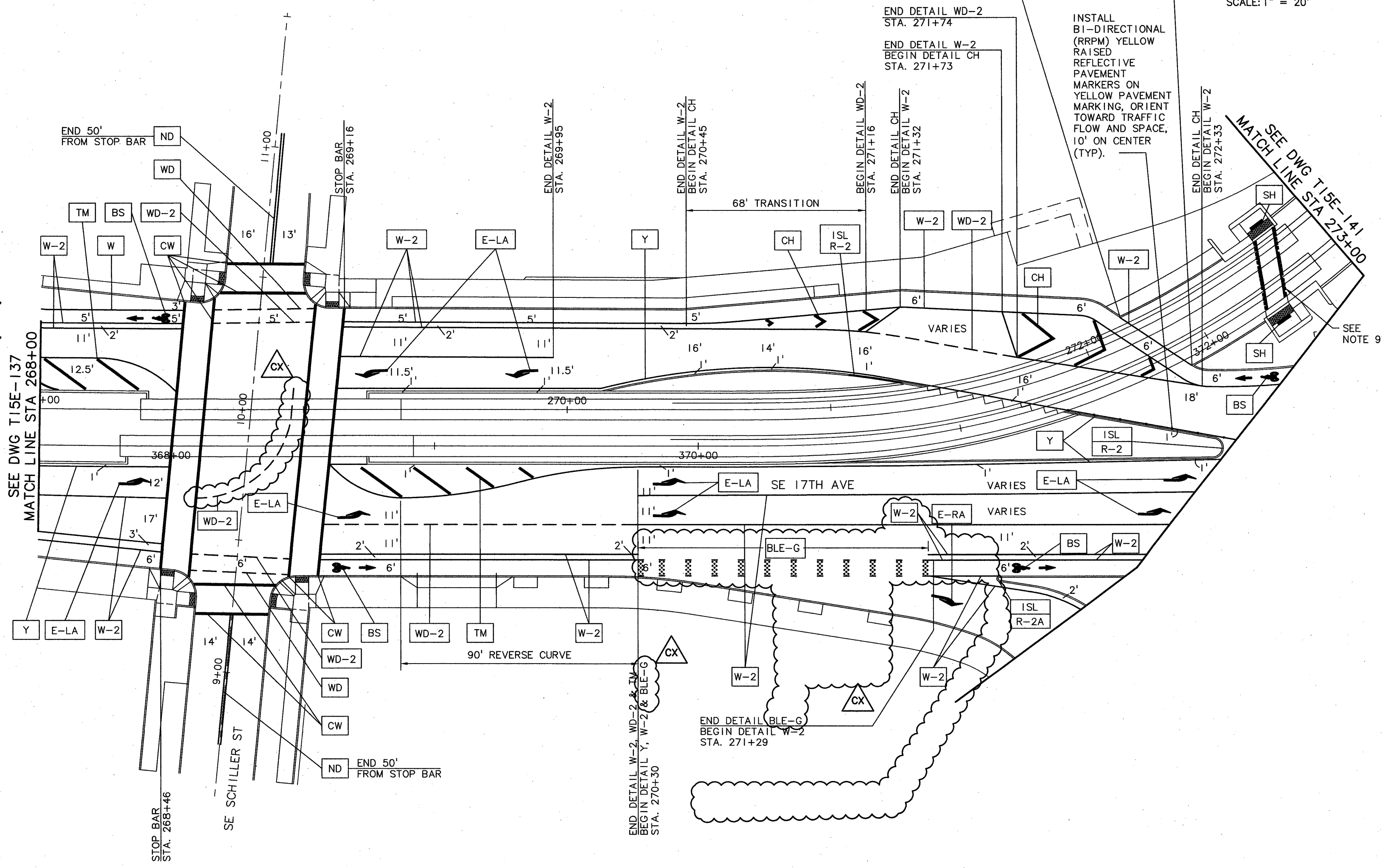
SCALE: 1"=20' — DRAWING NO.: T15E-137-BX — CONTRACT NO.: RH100544JB — SHEET NO.: 38

LEGEND:

[X] PAVEMENT MARKING DETAIL: SEE DWG. T15E-265 THROUGH T15E-274.

GENERAL NOTES:

1. THIS PLAN IS ACCURATE FOR PAVEMENT MARKINGS ONLY.
2. DIMENSIONS ARE APPROXIMATE. ALL PAVEMENT MARKINGS SHALL BE APPROVED IN THE FIELD BY THE ENGINEER PRIOR TO INSTALLATION.
3. REMOVE EXISTING PAVEMENT MARKINGS THAT CONFLICT WITH PROPOSED PAVEMENT MARKINGS SHOWN ON THE PLANS. MAINTAIN AND PROTECT ALL OTHER EXISTING PAVEMENT MARKINGS UNLESS OTHERWISE NOTED.
4. CENTER PAVEMENT LEGENDS.
5. ALL LONGITUDINAL LINE WORK TO BE PAINT EXCEPT FOR TURN LANE LINES AND SKIP LINES THROUGH INTERSECTIONS. ALL TURN LANE LINES AND SKIP LINES THROUGH INTERSECTIONS TO BE 120 MIL THERMOPLASTIC.
6. ALL STAGGERED CONTINENTAL CROSSWALK AND BICYCLE LEGEND PAVEMENT MARKINGS SHALL BE TYPE 'B-HS' THERMOPLASTIC.
7. ALL TRANSVERSE PAVEMENT MARKING BARS, EXCEPT STAGGERED CONTINENTAL CROSSWALKS, SHALL BE TYPE 'A' THERMOPLASTIC.
8. ALL TRANSVERSE PAVEMENT MARKING LEGENDS, EXCEPT BIKE LEGENDS, SHALL BE TYPE 'B-HS' THERMOPLASTIC.
9. INSTALL PEDESTRIAN BLIND GUIDE WAYFINDING BARS, ADVANTAGE ONE TACTILE SYSTEMS, 316 SS MARINE GRADE, OR APPROVED EQUAL, PER 1/CTM558 WITH 6" SOLID WHITE THERMOPLASTIC STRIPE.



CX	06-03-14	PLC	PLC	P.C. No. 136 REV 1	
BX	06-04-13	PLC	PLC	P.C. No. 292	
AX	06-04-13	PLC	PLC	P.C. No. 136	
	05-14-12	DMB	PLC	ISSUE FOR CONSTRUCTION	
NO.	DATE	BY CHK.	APPD.	REVISIONS	

JKW DESIGNED 06-01-11 DATE
DKS CAD DRAWN 06-01-11 DATE
DMB CHECKED 04-25-12 DATE
APPROVED 05-14-12 DATE

REGISTERED PROFESSIONAL ENGINEER OREGON OCT. 2, 1990 PETER L. COFFEY EXPIRES: 12/31/2015

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

DKS Associates TRANSPORTATION SOLUTIONS

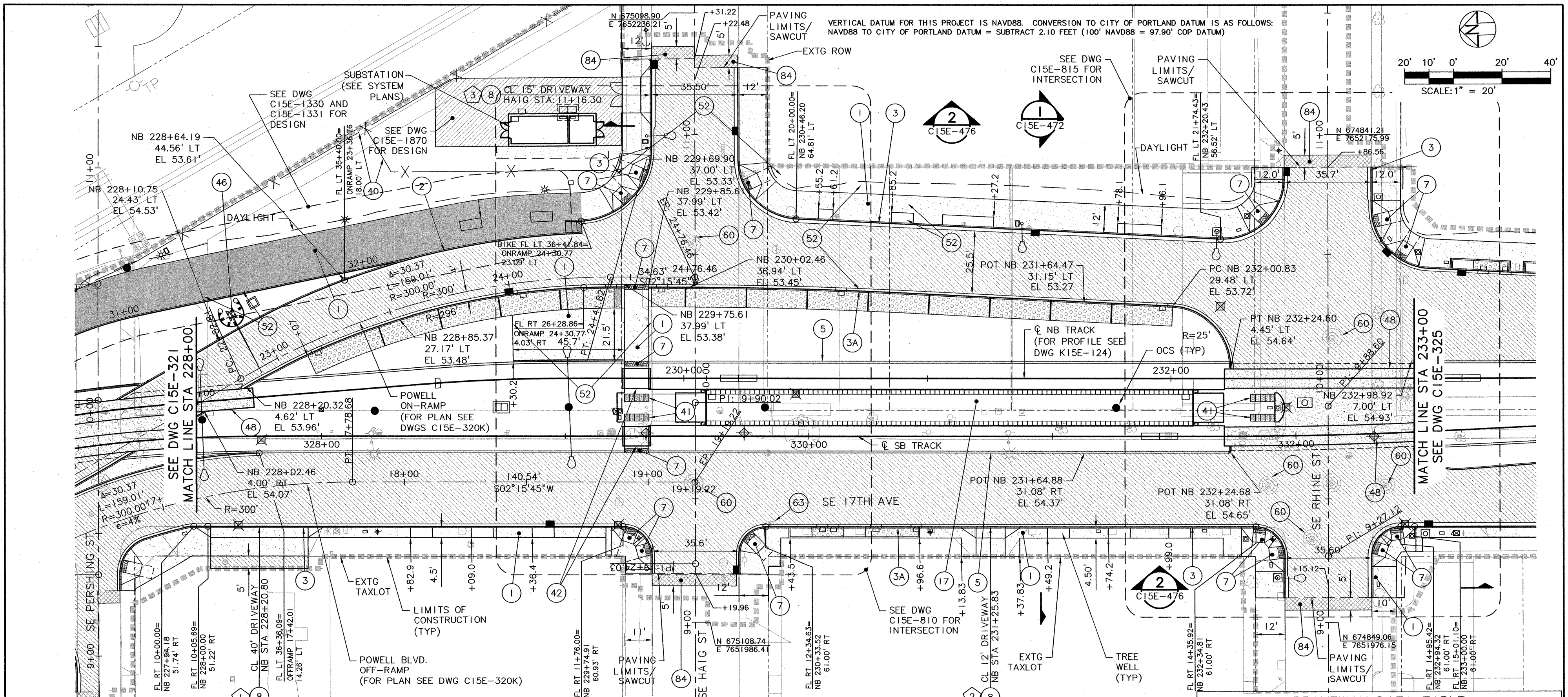
DAVID EVANS AND ASSOCIATES INC.

TRI MET CAPITAL PROJECTS DIVISION 1800 SW FIRST AVE., SUITE 300 PORTLAND, OREGON 97201

SUBMITTED: DATE: APPROVED: DATE:

PORTLAND TO MILWAUKIE LRT
EAST SEGMENT
TRAFFIC
PAVEMENT MARKINGS
STA 268+00 TO STA 271+00

SCALE: 1"=20' DRAWING NO.: T15E-139-CX CONTRACT NO.: RH100544JB SHEET NO.: 39



CONSTRUCTION NOTES:

1. CONSTRUCT PCC STANDARD SIDEWALK (SEE ODOT STD DWG RD720)
2. CONSTRUCT STANDARD CURB (SEE ODOT STD DWG RD700)
3. CONSTRUCT CONCRETE CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE ODOT STD DWG RD700)
3A. CONSTRUCT THICKENED CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE DWG C15E-495A FOR COP STD DWG P-540)
5. CONSTRUCT TYPE II BALLAST CURB (SEE TRACK DWGS FOR DETAILS-VOLUME I)
7. CONSTRUCT PCC RAMP (SEE ODOT STD DWG RD755)
8. CONSTRUCT PCC DRIVEWAY (SEE DWG C15E-495 FOR COP STD DWG P-528)
17. CONSTRUCT PLATFORM (SEE DWG C15E-1703 FOR DETAILS)
40. INSTALL FENCE/RAILING (SEE ARCHITECTURAL DWGS FOR DETAILS – VOLUME 4)
41. INSTALL TACTILE PAVERS (TRUNCATED DOMES) (SEE TRIMET DIRECTIVE DWG BTM012)
42. INSTALL CONCRETE RAIL CROSSING PANELS (SEE TRACK DWGS FOR DETAILS – VOLUME I)
46. INSTALL RAILROAD GATE (SEE SYSTEM DWGS FOR DETAILS – SEGMENT 'J')
48. INSTALL EMBEDDED TRACK (SEE TRACK DWGS FOR DETAILS – VOLUME I)
52. INSTALL IRRIGATION SLEEVE (NOT SHOWN – APPROX LOCATION) (SEE LANDSCAPE DWGS FOR DETAILS – VOLUME 4)
60. ADJUST MANHOLE TO FINISHED GRADE
63. ADJUST CATCHBASIN TO FINISHED GRADE
84. COLD PLANE/INLAY (SEE DWG C15E-491 FOR DETAILS)

GENERAL NOTES

1. BASE MAPPING USED AS A BASIS FOR THE DESIGN WAS PROVIDED BY TRIMET. EXISTING TOPOGRAPHIC FEATURES WERE DEVELOPED BY TRIMET AND CH2M HILL FROM GIS DATA, AS-BUILT DRAWINGS, FIELD VISITS, AND AERIAL PHOTOGRAMMETRY. FEW COMPONENTS INCLUDE INFORMATION FROM ON THE GROUND FIELD SURVEY. CONTRACTOR SHALL VERIFY TOPOGRAPHY PRIOR TO CONSTRUCTION. HORIZONTAL AND VERTICAL CONTROL FOR THIS PROJECT SHALL BE OBTAINED FROM TRIMET PRIOR TO STARTING CONSTRUCTION.
2. FOR PROPOSED RIGHT OF WAY SEE RIGHT OF WAY PLANS, VOLUME 6.
3. ALL CONSTRUCTION TO BE PER CITY OF PORTLAND STANDARDS UNLESS NOTED OTHERWISE ON PLANS.
4. FOR STORM WATER QUALITY FACILITIES AND DRAINAGE CONVEYANCE SYSTEMS SEE DRAWINGS C15E-500 TO C15E-699.
5. ALL TREE WELL STATIONING IS NB STATIONING. TREE WELLS ARE 4'W X 9'L UNLESS NOTED OTHERWISE ON PLANS.

DRIVEWAY DATA TABLE

LOCATION	FL	FL	BK SW	BK SW	DW	DW	1" LIP	1" LIP
PT NO	1	2	3	4	5	6	7	8
1	52.66	52.93	53.22	53.49	53.33	53.60	52.74	53.01
2	52.78	52.74	53.48	53.42	53.58	53.52	52.87	52.82
3	54.69	54.74	55.25	55.30	55.36	55.41	54.77	54.83

LEGEND

- FULL AC ROADWAY
- PCC ROADWAY/SIDEWALK/ DRIVEWAY/EMBEDDED TRACK
- WATER QUALITY FACILITY (SEE STORM PLANS)
- CONSTRUCTION LIMITS
- COLD PLANE/INLAY
- DESIGN NOT SHOWN ON THIS SHEET. (FOR DESIGN SEE SHEET REFERENCE CALLOUT)

NO.	DATE	BY	CHK.	APPD.	REVISIONS
	05-14-12	TAWH		RGA	ISSUED FOR CONSTRUCTION

RGA DESIGNED 07-07-11 DATE
RJM DRAWN 07-07-11 DATE
TAWH CHECKED 04-11-12 DATE
APPROVED 05-14-12 DATE

REGISTERED PROFESSIONAL ENGINEER 55529 OREGON JULY 15, 2003 RAFAEL GAETA
EXPIRES: 06/30/2013

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

DAVID EVANS AND ASSOCIATES INC.

TRIMET — CAPITAL PROJECTS DIVISION, 710 NE HOLLADAY STREET, PORTLAND, OREGON 97232

SUBMITTED: DATE: 05-14-12
APPROVED: DATE: 05-14-12

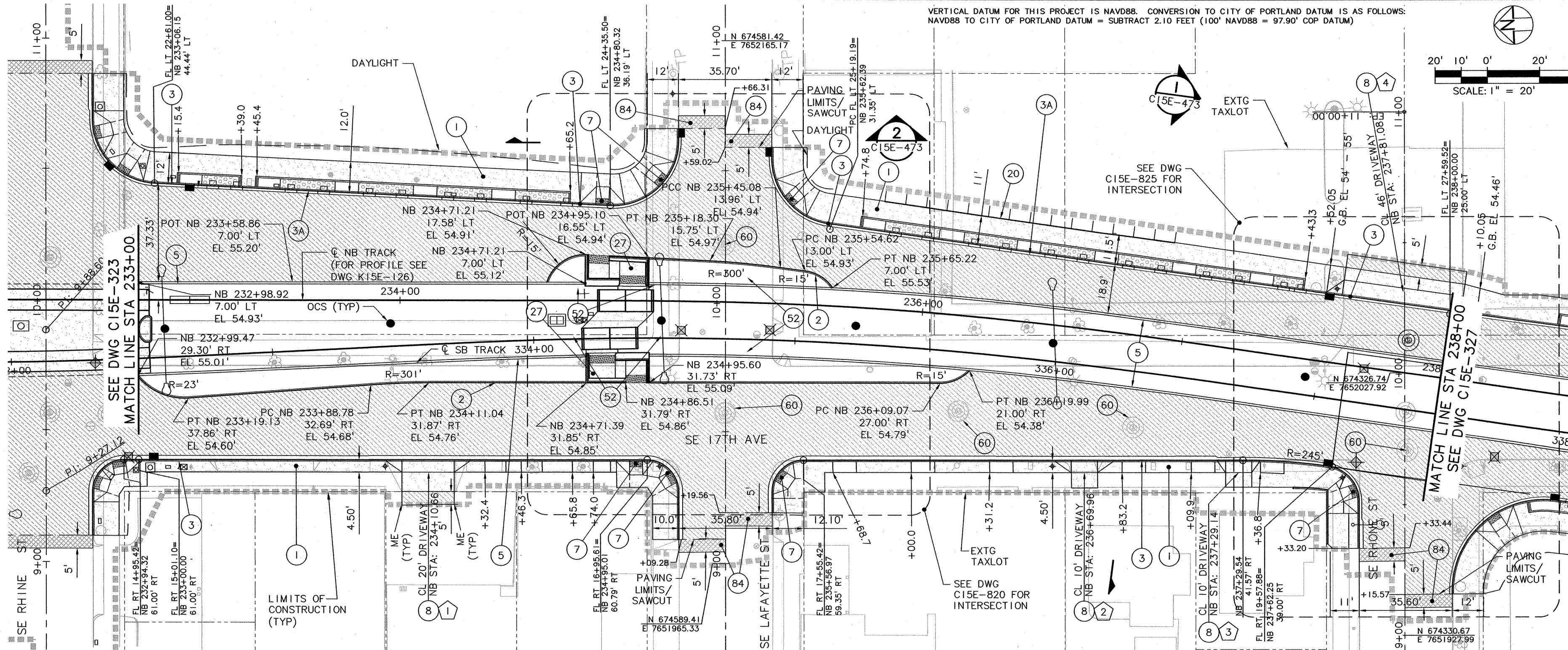
PORTLAND TO MILWAUKIE LRT

EAST SEGMENT

CIVIL
ROADWAY PLAN (SE 17TH AVE)
STA 228+00 TO STA 233+00

SCALE: 1"=20' | DRAWING NO.: C15E-323 | CONTRACT NO.: RH100544JB | SHEET NO.: 157

VERTICAL DATUM FOR THIS PROJECT IS NAVD88. CONVERSION TO CITY OF PORTLAND DATUM IS AS FOLLOWS: NAVD88 TO CITY OF PORTLAND DATUM = SUBTRACT 2.10 FEET (100' NAVD88 = 97.90' COP DATUM)



CONSTRUCTION NOTES:

1. CONSTRUCT PCC STANDARD SIDEWALK (SEE ODOT STD DWG RD720)
2. CONSTRUCT STANDARD CURB (SEE ODOT STD DWG RD700)
3. CONSTRUCT CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE ODOT STD DWG RD700)
3A. CONSTRUCT THICKENED CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE DWG C15E-495A FOR COP STD DWG P-540)
5. CONSTRUCT TYPE II BALLAST CURB (SEE TRACK DWGS FOR DETAILS–VOLUME 1)
7. CONSTRUCT PCC RAMP (SEE ODOT STD DWG RD755)
8. CONSTRUCT PCC DRIVEWAY (SEE DWG C15E-495 FOR COP STD DWG P-528)
20. CONSTRUCT RETAINING WALL (SEE STRUCTURAL DWGS FOR DETAILS – VOLUME 5)
27. CONSTRUCT Z-CROSSING (SEE TRIMET DIRECTIVE DWGS CTM 556 AND CTM 557)
52. INSTALL IRRIGATION SLEEVE (NOT SHOWN – APPROX LOCATION) (SEE LANDSCAPE DWGS FOR DETAILS – VOLUME 4)
60. ADJUST MANHOLE TO FINISHED GRADE
84. COLD PLANE/INLAY (SEE DWG C15E-491 FOR DETAILS)

DRIVEWAY DATA TABLE

LOCATION	FL	FL	BK SW	BK SW	DW	DW	1" LIP	1" LIP
POINT	1	2	3	4	5	6	7	8
1	53.91	53.85	54.47	54.41	54.59	54.53	54.00	53.94
2	53.93	53.96	54.43	54.37	54.52	54.44	54.01	54.04
3	53.75	53.78	54.31	54.37	54.33	54.48	53.83	53.86
4	53.97	53.83	54.77	54.41	54.87	54.48	54.05	53.92

GENERAL NOTES

1. BASE MAPPING USED AS A BASIS FOR THE DESIGN WAS PROVIDED BY TRIMET. EXISTING TOPOGRAPHIC FEATURES WERE DEVELOPED BY TRIMET AND CH2M HILL FROM GIS DATA, AS-BUILT DRAWINGS, FIELD VISITS, AND AERIAL PHOTOGRAMMETRY. FEW COMPONENTS INCLUDE INFORMATION FROM ON THE GROUND FIELD SURVEY. CONTRACTOR SHALL VERIFY TOPOGRAPHY PRIOR TO CONSTRUCTION. HORIZONTAL AND VERTICAL CONTROL FOR THIS PROJECT SHALL BE OBTAINED FROM TRIMET PRIOR TO STARTING CONSTRUCTION.
2. FOR PROPOSED RIGHT OF WAY SEE RIGHT OF WAY PLANS, VOLUME 6.
3. ALL CONSTRUCTION TO BE PER CITY OF PORTLAND STANDARDS UNLESS NOTED OTHERWISE ON PLANS.
4. FOR STORM WATER QUALITY FACILITIES AND DRAINAGE CONVEYANCE SYSTEMS SEE DRAWINGS C15E-500 TO C15E-699.
5. ALL TREE WELL STATIONING IS NB STATIONING. TREE WELLS ARE 4'W X 9'L UNLESS NOTED OTHERWISE ON PLANS.

LEGEND

- FULL AC ROADWAY
- PCC ROADWAY/SIDEWALK/ DRIVEWAY/EMBEDDED TRACK
- WATER QUALITY FACILITY (SEE STORM PLANS)
- CONSTRUCTION LIMITS
- COLD PLANE/INLAY

NO.	DATE	BY	CHK.	APPD.	REVISIONS
	05-14-12	TAWH		RGA	ISSUED FOR CONSTRUCTION

DESIGNED RGA 07-07-11
DRAWN RJM 07-07-11
CHECKED TAWH 04-11-12
APPROVED 05-14-12

REGISTERED PROFESSIONAL ENGINEER 55529 OREGON JULY 15, 2003 RAFAEL GAETA 5-2-12
EXPIRES: 06/30/2013

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

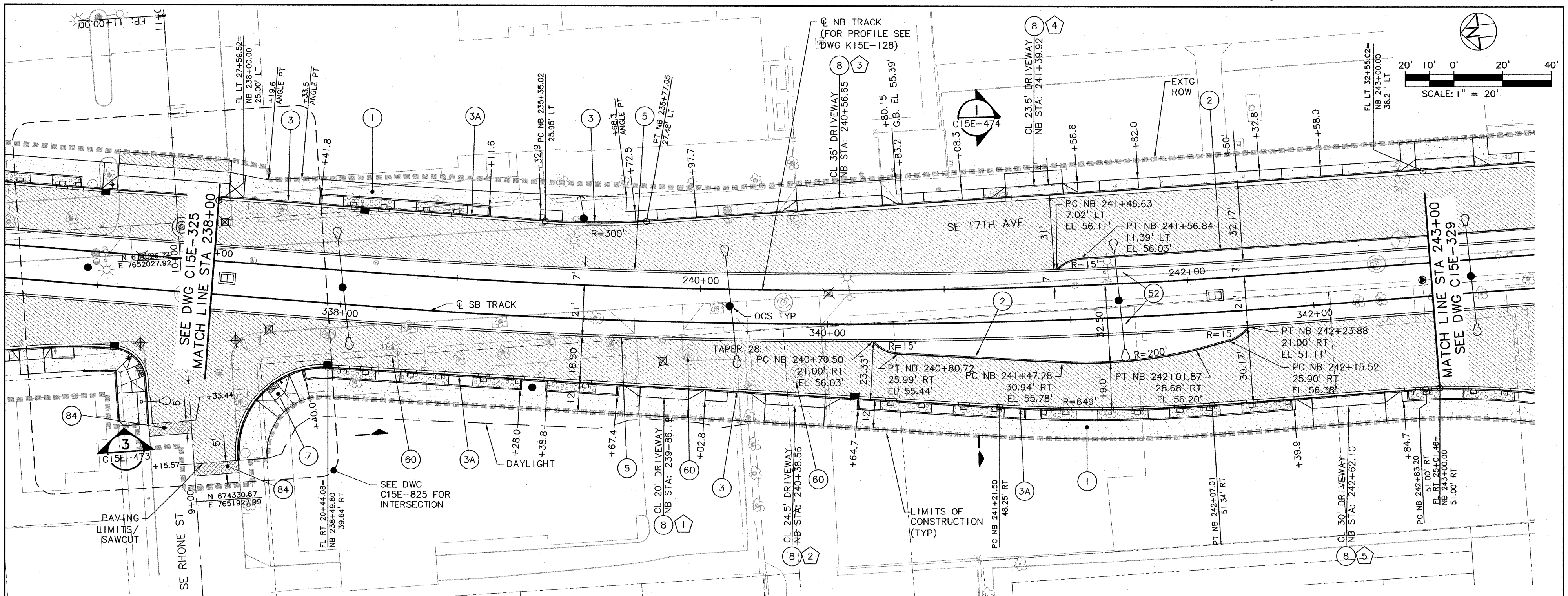
DAVID EVANS AND ASSOCIATES INC.

TRIMET CAPITAL PROJECTS DIVISION
710 NE HOLLADAY STREET
PORTLAND, OREGON 97232

SUBMITTED: DATE: 05-14-12
APPROVED: Leah Robbins DATE: 05-14-12

PORTLAND TO MILWAUKIE LRT
EAST SEGMENT
CIVIL
ROADWAY PLAN (SE 17TH AVE)
STA 233+00 TO STA 238+00

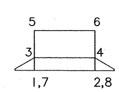
SCALE: 1"=20' | DRAWING NO.: C15E-325 | CONTRACT NO.: RH100544JB | SHEET NO.: 159



CONSTRUCTION NOTES:

- (1) CONSTRUCT PCC STANDARD SIDEWALK (SEE ODOT STD DWG RD720)
- (2) CONSTRUCT STANDARD CURB (SEE ODOT STD DWG RD700)
- (3) CONSTRUCT CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE ODOT STD DWG RD700)
- (3A) CONSTRUCT THICKENED CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE DWG C15E-495A FOR COP STD DWG P-540)
- (5) CONSTRUCT TYPE II BALLAST CURB (SEE TRACK DWGS FOR DETAILS-VOLUME I)
- (7) CONSTRUCT PCC RAMP (SEE ODOT STD DWG RD755)
- (8) CONSTRUCT PCC DRIVEWAY (SEE DWG C15E-495 FOR COP STD DWG P-528)
- (52) INSTALL IRRIGATION SLEEVE (NOT SHOWN – APPROX LOCATION) (SEE LANDSCAPE DWGS FOR DETAILS – VOLUME 4
- (60) ADJUST MANHOLE TO FINISHED GRADE
- (84) COLD PLANE/INLAY (SEE DWG C15E-491 FOR DETAILS)

VERTICAL DATUM FOR THIS PROJECT IS NAVD88. CONVERSION TO CITY OF PORTLAND DATUM IS AS FOLLOWS: NAVD88 TO CITY OF PORTLAND DATUM = SUBTRACT 2.10 FEET (100' NAVD88 = 97.90' COP DATUM)



DRIVEWAY DATA TABLE

LOCATION	FL	FL	BK SW	BK SW	DW	DW	1" LIP	1" LIP
PT NO	1	2	3	4	5	6	7	8
1	54.46	54.36	55.02	54.92	55.13	55.03	54.54	54.44
2	54.74	54.62	55.30	55.18	55.41	55.29	54.82	54.70
3	54.40	54.80	54.93	55.22	55.07	55.33	54.48	54.88
4	55.08	55.28	55.68	55.89	55.72	56.00	55.16	55.36
5	54.74	54.62	55.30	55.18	55.41	55.29	54.82	54.70

GENERAL NOTES

1. BASE MAPPING USED AS A BASIS FOR THE DESIGN WAS PROVIDED BY TRIMET. EXISTING TOPOGRAPHIC FEATURES WERE DEVELOPED BY TRIMET AND CH2M HILL FROM GIS DATA, AS-BUILT DRAWINGS, FIELD VISITS, AND AERIAL PHOTOGRAMMETRY. FEW COMPONENTS INCLUDE INFORMATION FROM ON THE GROUND FIELD SURVEY. CONTRACTOR SHALL VERIFY TOPOGRAPHY PRIOR TO CONSTRUCTION. HORIZONTAL AND VERTICAL CONTROL FOR THIS PROJECT SHALL BE OBTAINED FROM TRIMET PRIOR TO STARTING CONSTRUCTION.
2. FOR PROPOSED RIGHT OF WAY SEE RIGHT OF WAY PLANS, VOLUME 6.
3. ALL CONSTRUCTION TO BE PER CITY OF PORTLAND STANDARDS UNLESS NOTED OTHERWISE ON PLANS.
4. FOR STORM WATER QUALITY FACILITIES AND DRAINAGE CONVEYANCE SYSTEMS SEE DRAWINGS C15E-500 TO C15E-699.
5. ALL TREE WELL STATIONING IS NB STATIONING. TREE WELLS ARE 4'W X 9'L UNLESS NOTED OTHERWISE ON PLANS.

LEGEND

- FULL AC ROADWAY
- PCC ROADWAY/SIDEWALK/ DRIVEWAY
- WATER QUALITY FACILITY (SEE STORM PLANS)
- CONSTRUCTION LIMITS
- COLD PLANE/INLAY

NO.	DATE	BY	CHK.	APPD.	REVISIONS
	05-14-12	TAWH		RGA	ISSUED FOR CONSTRUCTION

DESIGNED: RGA 07-07-11
DRAWN: RJM 07-07-11
CHECKED: TAWH 04-11-12
APPROVED: RGA 05-14-12

REGISTERED PROFESSIONAL ENGINEER 55529 OREGON JULY 15, 2003 RAFAEL GAETA 5-2-12
EXPIRES: 06/30/2013

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

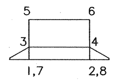
DAVID EVANS AND ASSOCIATES INC.

TRI MET CAPITAL PROJECTS DIVISION 710 NE HOLLADAY STREET PORTLAND, OREGON 97232

SUBMITTED: DATE: 05-14-12
APPROVED: Leah Robbins DATE: 05-14-12

PORTLAND TO MILWAUKIE LRT
EAST SEGMENT
CIVIL
ROADWAY PLAN (SE 17TH AVE)
STA 238+00 TO STA 243+00

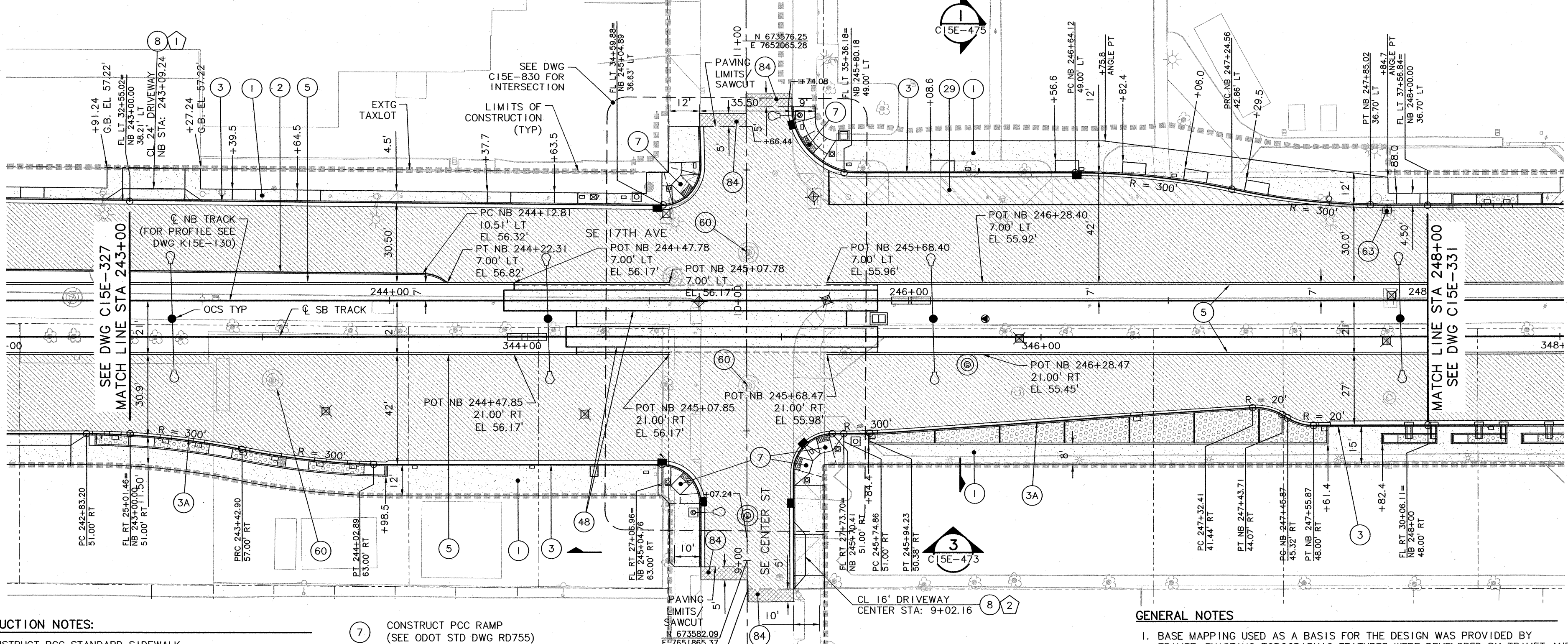
SCALE: 1"=20' | DRAWING NO.: C15E-327 | CONTRACT NO.: RH100544JB | SHEET NO.: 161



DRIVEWAY DATA TABLE								
LOCATION	EL	EL	BK SW	BK SW	DW	DW	1" LIP	1" LIP
PT NO	1	2	3	4	5	6	7	8
(1)	56.62	56.60	57.18	57.16	57.28	57.30	56.70	56.68
(2)	55.12	55.57	55.68	56.13	55.80	56.24	55.21	55.65
(3)	55.89	55.75	56.35	56.31	56.49	56.43	55.98	55.84

VERTICAL DATUM FOR THIS PROJECT IS NAVD88. CONVERSION TO CITY OF PORTLAND DATUM IS AS FOLLOWS: NAVD88 TO CITY OF PORTLAND DATUM = SUBTRACT 2.10 FEET (100' NAVD88 = 97.90' COP DATUM)

20' 10' 0' 20' 40'
SCALE: 1" = 20'



CONSTRUCTION NOTES:

1. CONSTRUCT PCC STANDARD SIDEWALK (SEE ODOT STD DWG RD720)
2. CONSTRUCT STANDARD CURB (SEE ODOT STD DWG RD700)
3. CONSTRUCT CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE ODOT STD DWG RD700)
3A. CONSTRUCT THICKENED CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE DWG C15E-495A FOR COP STD DWG P-540)
5. CONSTRUCT TYPE II BALLAST CURB (SEE TRACK DWGS FOR DETAILS-VOLUME 1)
7. CONSTRUCT PCC RAMP (SEE ODOT STD DWG RD755)
8. CONSTRUCT PCC DRIVEWAY (SEE DWG C15E-495 FOR COP STD DWG P-528)
29. CONSTRUCT BUS TURNOUT (SEE DWG C15E-495B FOR COP STD DWG 3-111)
48. INSTALL EMBEDDED TRACK (SEE TRACK DWGS FOR DETAILS - VOLUME 1)
60. ADJUST MANHOLE TO FINISHED GRADE
63. ADJUST CATCHBASIN TO FINISHED GRADE
84. COLD PLANE/INLAY (SEE DWG C15E-491 FOR DETAILS)

LEGEND

- FULL AC ROADWAY
- PCC ROADWAY/SIDEWALK/ DRIVEWAY/EMBEDDED TRACK
- WATER QUALITY FACILITY (SEE STORM PLANS)
- CONSTRUCTION LIMITS
- COLD PLANE/INLAY
- BUS STOP

GENERAL NOTES

1. BASE MAPPING USED AS A BASIS FOR THE DESIGN WAS PROVIDED BY TRIMET. EXISTING TOPOGRAPHIC FEATURES WERE DEVELOPED BY TRIMET AND CH2M HILL FROM GIS DATA, AS-BUILT DRAWINGS, FIELD VISITS, AND AERIAL PHOTOGRAMMETRY. FEW COMPONENTS INCLUDE INFORMATION FROM ON THE GROUND FIELD SURVEY. CONTRACTOR SHALL VERIFY TOPOGRAPHY PRIOR TO CONSTRUCTION. HORIZONTAL AND VERTICAL CONTROL FOR THIS PROJECT SHALL BE OBTAINED FROM TRIMET PRIOR TO STARTING CONSTRUCTION.
2. FOR PROPOSED RIGHT OF WAY SEE RIGHT OF WAY PLANS, VOLUME 6.
3. ALL CONSTRUCTION TO BE PER CITY OF PORTLAND STANDARDS UNLESS NOTED OTHERWISE ON PLANS.
4. FOR STORM WATER QUALITY FACILITIES AND DRAINAGE CONVEYANCE SYSTEMS SEE DRAWINGS C15E-500 TO C15E-699.
5. ALL TREE WELL STATIONING IS NB STATIONING. TREE WELLS ARE 4'W X 9'L UNLESS NOTED OTHERWISE ON PLANS.

NO.	DATE	BY	CHK.	APPD.	REVISIONS
	05-14-12	TAWH		RGA	ISSUED FOR CONSTRUCTION

RGA (DESIGNED)	07-07-11 (DATE)
RJM (DRAWN)	07-07-11 (DATE)
TAWH (CHECKED)	04-11-12 (DATE)
RGA (APPROVED)	05-14-12 (DATE)

REGISTERED PROFESSIONAL ENGINEER 55529 OREGON JULY 15, 2003 RAFAEL GAETA 5-2-12
EXPIRES: 06/30/2013

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

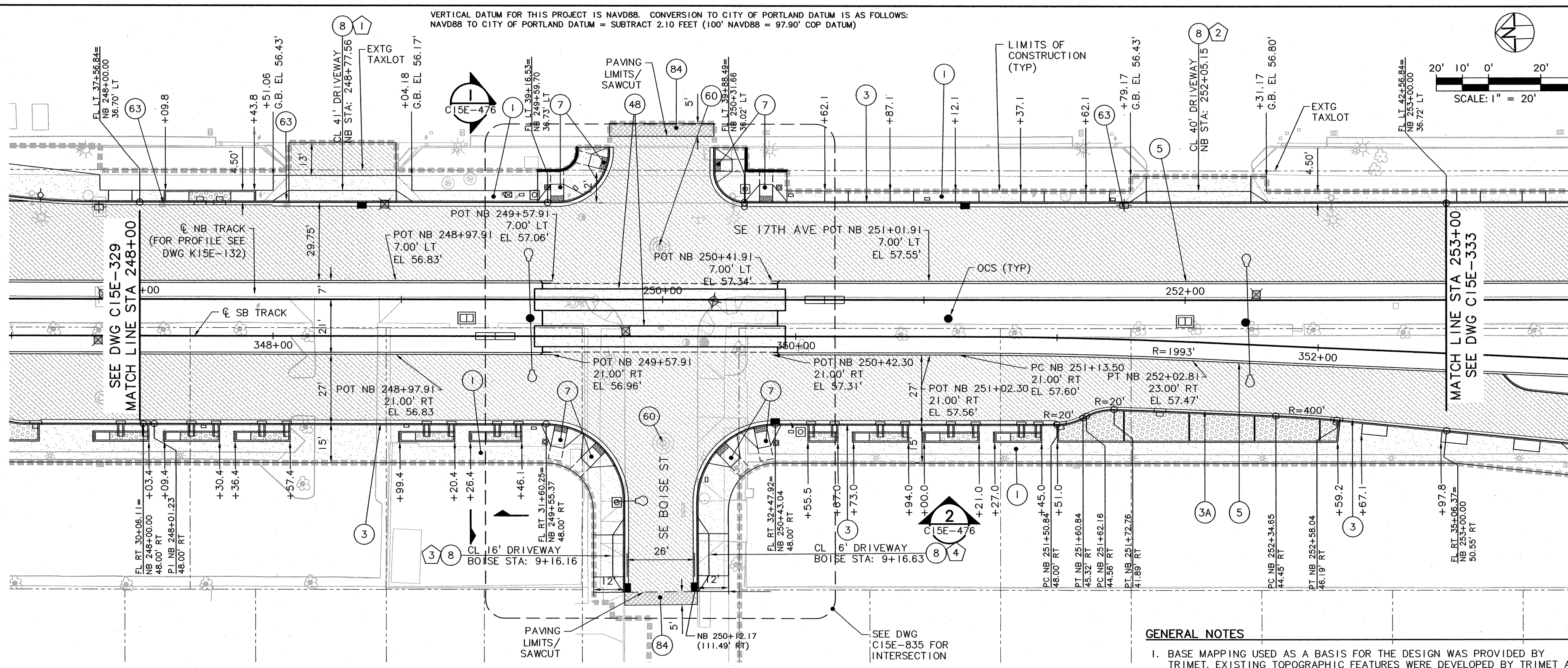
DAVID EVANS AND ASSOCIATES INC.

TRIMET
CAPITAL PROJECTS DIVISION
710 NE HOLLADAY STREET
PORTLAND, OREGON 97232

SUBMITTED: [signature] DATE: 05-14-12
APPROVED: Leah Robbins DATE: 05-14-12

PORTLAND TO MILWAUKIE LRT
EAST SEGMENT
CIVIL
ROADWAY PLAN (SE 17TH AVE)
STA 243+00 TO STA 248+00

SCALE: 1"=20' | DRAWING NO.: C15E-329 | CONTRACT NO.: RH100544JB | SHEET NO.: 163



CONSTRUCTION NOTES:

(1) CONSTRUCT PCC STANDARD SIDEWALK (SEE ODOT STD DWG RD720)

(3) CONSTRUCT CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE ODOT STD DWG RD700)

(3A) CONSTRUCT THICKENED CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE DWG C15E-495A FOR COP STD DWG P-540)

(5) CONSTRUCT TYPE II BALLAST CURB (SEE TRACK DWGS FOR DETAILS-VOLUME I)

(7) CONSTRUCT PCC RAMP (SEE ODOT STD DWG RD755)

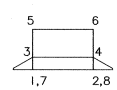
(8) CONSTRUCT PCC DRIVEWAY (SEE DWG C15E-495 FOR COP STD DWG P-528)

(48) INSTALL EMBEDDED TRACK (SEE TRACK DWGS FOR DETAILS – VOLUME I)

(60) ADJUST MANHOLE TO FINISHED GRADE

(63) ADJUST CATCHBASIN TO FINISHED GRADE

(84) COLD PLANE/INLAY (SEE DWG C15E-491 FOR DETAILS)



DRIVEWAY DATA TABLE

LOCATION	FL	FL	BK SW	BK SW	DW	DW	1" LIP	1" LIP
PT NO	1	2	3	4	5	6	7	8
1	55.61	55.43	55.91	55.78	56.02	55.90	55.69	55.52
2	55.92	56.09	56.45	56.56	56.56	56.67	56.00	56.17
3	55.96	56.01	56.52	56.57	56.63	56.68	56.04	56.10
4	56.14	56.10	56.70	56.66	56.81	56.77	56.23	56.18

GENERAL NOTES

1. BASE MAPPING USED AS A BASIS FOR THE DESIGN WAS PROVIDED BY TRIMET. EXISTING TOPOGRAPHIC FEATURES WERE DEVELOPED BY TRIMET AND CH2M HILL FROM GIS DATA, AS-BUILT DRAWINGS, FIELD VISITS, AND AERIAL PHOTOGRAMMETRY. FEW COMPONENTS INCLUDE INFORMATION FROM ON THE GROUND FIELD SURVEY. CONTRACTOR SHALL VERIFY TOPOGRAPHY PRIOR TO CONSTRUCTION. HORIZONTAL AND VERTICAL CONTROL FOR THIS PROJECT SHALL BE OBTAINED FROM TRIMET PRIOR TO STARTING CONSTRUCTION.
2. FOR PROPOSED RIGHT OF WAY SEE RIGHT OF WAY PLANS, VOLUME 6.
3. ALL CONSTRUCTION TO BE PER CITY OF PORTLAND STANDARDS UNLESS NOTED OTHERWISE ON PLANS.
4. FOR STORM WATER QUALITY FACILITIES AND DRAINAGE CONVEYANCE SYSTEMS SEE DRAWINGS C15E-500 TO C15E-699.
5. ALL TREE WELL STATIONING IS NB STATIONING. TREE WELLS ARE 4'W X 9'L UNLESS NOTED OTHERWISE ON PLANS.

LEGEND

- FULL AC ROADWAY
- PCC ROADWAY/SIDEWALK/ DRIVEWAY/EMBEDDED TRACK
- WATER QUALITY FACILITY (SEE STORM PLANS)
- CONSTRUCTION LIMITS
- COLD PLANE/INLAY

NO.	DATE	BY	CHK.	APPD.	REVISIONS
	05-14-12	TAWH		RGA	ISSUED FOR CONSTRUCTION

DESIGNED: RGA	DATE: 07-07-11
DRAWN: RJM	DATE: 07-07-11
CHECKED: TAWH	DATE: 04-11-12
APPROVED: RGA	DATE: 05-14-12

REGISTERED PROFESSIONAL ENGINEER 55529 OREGON JULY 15, 2003 RAFAEL GAETA
EXPIRES: 06/30/2013

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

DAVID EVANS AND ASSOCIATES INC.

TRI MET CAPITAL PROJECTS DIVISION
710 NE HOLLADAY STREET
PORTLAND, OREGON 97232

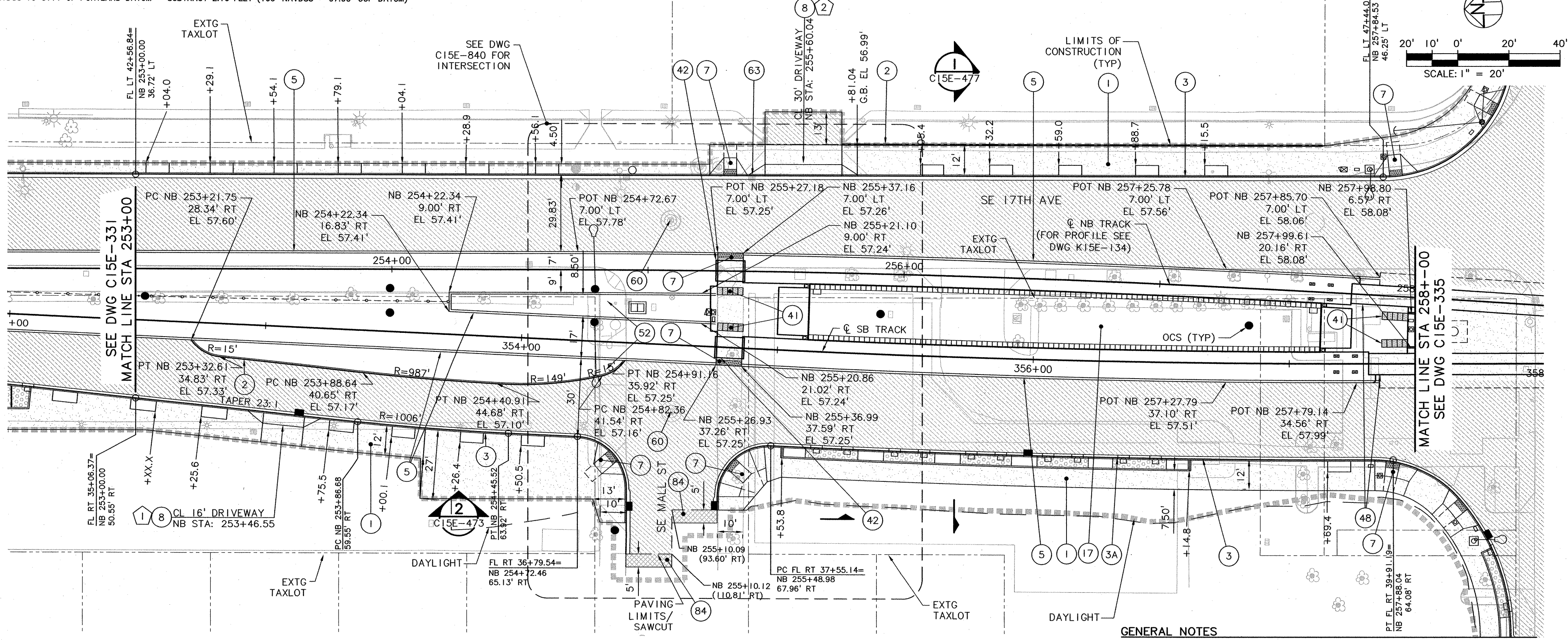
SUBMITTED: [signature] DATE: 05-14-12
APPROVED: [signature] DATE: 05-14-12

PORTLAND TO MILWAUKIE LRT
EAST SEGMENT

CIVIL
ROADWAY PLAN (SE 17TH AVE)
STA 248+00 TO STA 253+00

SCALE: 1"=20' | DRAWING NO.: C15E-331 | CONTRACT NO.: RH100544JB | SHEET NO.: 165

VERTICAL DATUM FOR THIS PROJECT IS NAVD88. CONVERSION TO CITY OF PORTLAND DATUM IS AS FOLLOWS:
NAVD88 TO CITY OF PORTLAND DATUM = SUBTRACT 2.10 FEET (100' NAVD88 = 97.90' COP DATUM)



CONSTRUCTION NOTES:

(1) CONSTRUCT PCC STANDARD SIDEWALK (SEE ODOT STD DWG RD720)

(2) CONSTRUCT STANDARD CURB (SEE ODOT STD DWG RD700)

(3) CONSTRUCT CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE ODOT STD DWG RD700)

(3A) CONSTRUCT THICKENED CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE DWG C15E-495A FOR COP STD DWG P-540)

(5) CONSTRUCT TYPE II BALLAST CURB (SEE TRACK DWGS FOR DETAILS-VOLUME 1)

(7) CONSTRUCT PCC RAMP (SEE ODOT STD DWG RD755)

(8) CONSTRUCT PCC DRIVEWAY (SEE DWG C15E-495 FOR COP STD DWG P-528)

(17) CONSTRUCT PLATFORM (SEE DWG C15E-1704 FOR DETAILS)

(41) INSTALL TACTILE PAVERS (TRUNCATED DOMES) (SEE TRIMET DIRECTIVE DWG BTM012)

(42) INSTALL CONCRETE RAIL CROSSING PANELS (SEE TRACK DWGS FOR DETAILS - VOLUME 1)

(48) INSTALL EMBEDDED TRACK (SEE TRACK DWGS FOR DETAILS - VOLUME 1)

(52) INSTALL IRRIGATION SLEEVE (NOT SHOWN - APPROX LOCATION) (SEE LANDSCAPE DWGS FOR DETAILS - VOLUME 4

(60) ADJUST MANHOLE TO FINISHED GRADE

(63) ADJUST CATCHBASIN TO FINISH GRADE

(84) COLD PLANE/INLAY (SEE DWG C15E-491 FOR DETAILS)

DRIVEWAY DATA TABLE

LOCATION	FL	FL	BK SW	BK SW	DW	DW	1" LIP	1" LIP
PT NO	1	2	3	4	5	6	7	8
1	56.43	56.44	56.99	57.00	57.10	57.11	56.51	56.52
2	56.24	56.30	56.50	56.54	56.61	56.65	56.32	56.38

GENERAL NOTES

1. BASE MAPPING USED AS A BASIS FOR THE DESIGN WAS PROVIDED BY TRIMET. EXISTING TOPOGRAPHIC FEATURES WERE DEVELOPED BY TRIMET AND CH2M HILL FROM GIS DATA, AS-BUILT DRAWINGS, FIELD VISITS, AND AERIAL PHOTOGRAMMETRY. FEW COMPONENTS INCLUDE INFORMATION FROM ON THE GROUND FIELD SURVEY. CONTRACTOR SHALL VERIFY TOPOGRAPHY PRIOR TO CONSTRUCTION. HORIZONTAL AND VERTICAL CONTROL FOR THIS PROJECT SHALL BE OBTAINED FROM TRIMET PRIOR TO STARTING CONSTRUCTION.
2. FOR PROPOSED RIGHT OF WAY SEE RIGHT OF WAY PLANS, VOLUME 6.
3. ALL CONSTRUCTION TO BE PER CITY OF PORTLAND STANDARDS UNLESS NOTED OTHERWISE ON PLANS.
4. FOR STORM WATER QUALITY FACILITIES AND DRAINAGE CONVEYANCE SYSTEMS SEE DRAWINGS C15E-500 TO C15E-699.
5. ALL TREE WELL STATIONING IS NB STATIONING. TREE WELLS ARE 4'W X 9'L UNLESS NOTED OTHERWISE ON PLANS.

LEGEND

- FULL AC ROADWAY
- PCC ROADWAY/SIDEWALK/ DRIVEWAY/EMBEDDED TRACK
- WATER QUALITY FACILITY (SEE STORM PLANS)
- CONSTRUCTION LIMITS
- COLD PLANE/INLAY
- ASPHALT DRIVEWAY/OVERLAY

NO.	DATE	BY	CHK.	APPD.	REVISIONS
	05-14-12	TAWH		RGA	ISSUED FOR CONSTRUCTION

DESIGNED: RGA 07-07-11
DRAWN: RJM 07-07-11
CHECKED: TAWH 04-11-12
APPROVED: RGA 05-14-12

REGISTERED PROFESSIONAL ENGINEER 55529 OREGON JULY 15, 2003 RAFAEL GAETA 5-2-12
EXPIRES: 06/30/2013

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

DAVID EVANS AND ASSOCIATES INC.

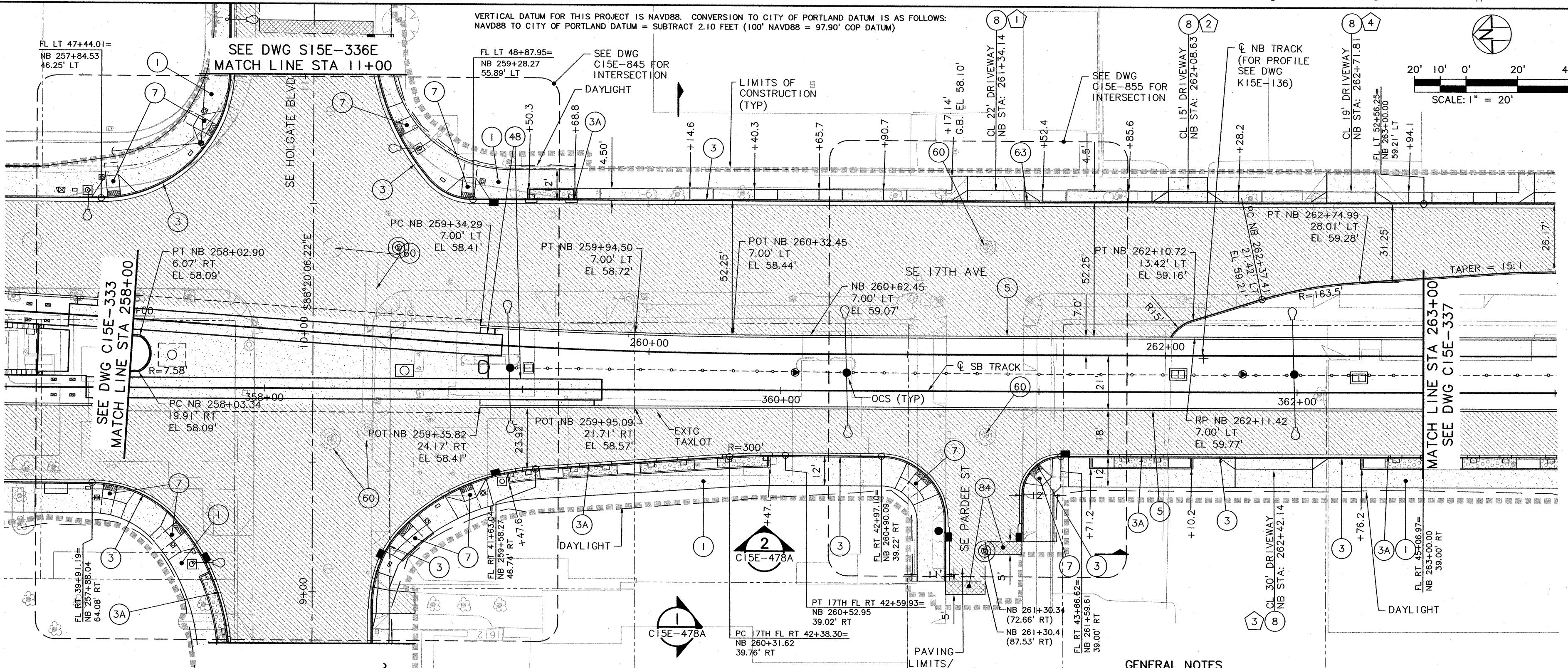
TRIMET CAPITAL PROJECTS DIVISION 710 NE HOLLADAY STREET PORTLAND, OREGON 97232

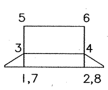
SUBMITTED: DATE: 05-14-12
APPROVED: DATE: 05-14-12

PORTLAND TO MILWAUKIE LRT
EAST SEGMENT
CIVIL
ROADWAY PLAN (SE 17TH AVE)
STA 253+00 TO STA 258+00

SCALE: 1"=20' | DRAWING NO.: C15E-333 | CONTRACT NO.: RH100544JB | SHEET NO.: 167

VERTICAL DATUM FOR THIS PROJECT IS NAVD88. CONVERSION TO CITY OF PORTLAND DATUM IS AS FOLLOWS:
NAVD88 TO CITY OF PORTLAND DATUM = SUBTRACT 2.10 FEET (100' NAVD88 = 97.90' COP DATUM)





CONSTRUCTION NOTES:

(1) CONSTRUCT PCC STANDARD SIDEWALK (SEE ODOT STD DWG RD720)

(3) CONSTRUCT CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE ODOT STD DWG RD700)

(3A) CONSTRUCT THICKENED CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE DWG C15E-495A FOR COP STD DWG P-540)

(5) CONSTRUCT TYPE II BALLAST CURB (SEE TRACK DWGS FOR DETAILS-VOLUME I)

(7) CONSTRUCT PCC RAMP (SEE ODOT STD DWG RD755)

(8) CONSTRUCT PCC DRIVEWAY (SEE DWG C15E-495 FOR COP STD DWG P-528)

(48) INSTALL EMBEDDED TRACK (SEE TRACK DWGS FOR DETAILS - VOLUME I)

(60) ADJUST MANHOLE TO FINISHED GRADE

(63) ADJUST CATCHBASIN TO FINISHED GRADE

(84) COLD PLANE/INLAY (SEE DWG C15E-491 FOR DETAILS)

DRIVEWAY DATA TABLE

LOCATION	FL	FL	BK SW	BK SW	DW	DW	1" LIP	1" LIP
PT NO	1	2	3	4	5	6	7	8
1	57.78	57.88	58.06	58.25	58.17	58.31	57.87	57.96
2	58.11	58.17	58.57	58.62	58.70	58.69	58.19	58.25
3	59.18	59.03	59.74	59.59	59.85	59.70	59.26	59.11
4	58.35	58.42	58.75	58.87	58.82	58.99	58.43	58.51

GENERAL NOTES

1. BASE MAPPING USED AS A BASIS FOR THE DESIGN WAS PROVIDED BY TRIMET. EXISTING TOPOGRAPHIC FEATURES WERE DEVELOPED BY TRIMET AND CH2M HILL FROM GIS DATA, AS-BUILT DRAWINGS, FIELD VISITS, AND AERIAL PHOTOGRAMMETRY. FEW COMPONENTS INCLUDE INFORMATION FROM ON THE GROUND FIELD SURVEY. CONTRACTOR SHALL VERIFY TOPOGRAPHY PRIOR TO CONSTRUCTION. HORIZONTAL AND VERTICAL CONTROL FOR THIS PROJECT SHALL BE OBTAINED FROM TRIMET PRIOR TO STARTING CONSTRUCTION.
2. FOR PROPOSED RIGHT OF WAY SEE RIGHT OF WAY PLANS, VOLUME 6.
3. ALL CONSTRUCTION TO BE PER CITY OF PORTLAND STANDARDS UNLESS NOTED OTHERWISE ON PLANS.
4. FOR STORM WATER QUALITY FACILITIES AND DRAINAGE CONVEYANCE SYSTEMS SEE DRAWINGS C15E-500 TO C15E-699.
5. ALL TREE WELL STATIONING IS NB STATIONING. TREE WELLS ARE 4'W X 9'L UNLESS NOTED OTHERWISE ON PLANS.

FULL AC ROADWAY
PCC ROADWAY/SIDEWALK/ DRIVEWAY/EMBEDDED TRACK
WATER QUALITY FACILITY (SEE STORM PLANS)
CONSTRUCTION LIMITS
COLD PLANE/INLAY

NO.	DATE	BY	CHK.	APPD.	REVISIONS
	05-14-12	TAWH		RGA	ISSUED FOR CONSTRUCTION

DESIGNED: RGA 07-07-11
DRAWN: RJM 07-07-11
CHECKED: TAWH 04-11-12
APPROVED: RGA 05-14-12

REGISTERED PROFESSIONAL ENGINEER 55529 OREGON JULY 15, 2003 RAFAEL GAETA 5-2-12
EXPIRES: 06/30/2013

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

DAVID EVANS AND ASSOCIATES INC.

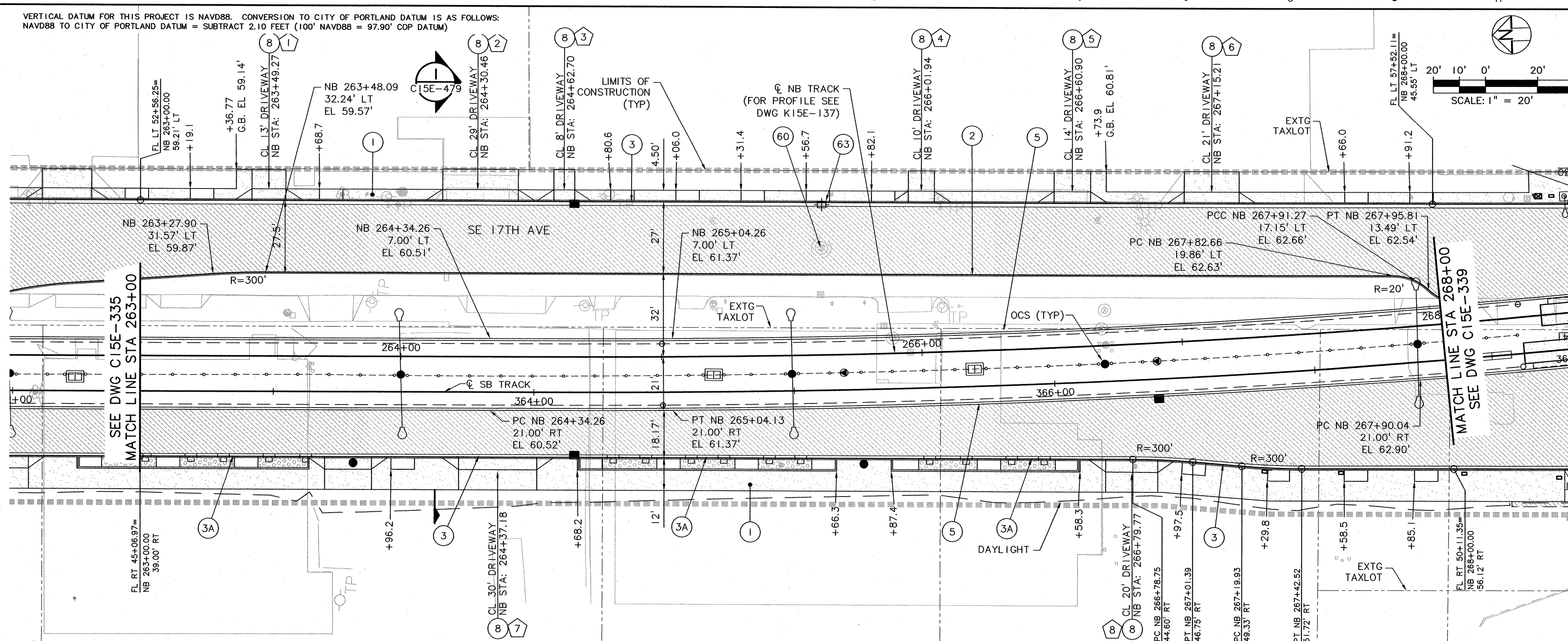
TRIMET CAPITAL PROJECTS DIVISION
710 NE HOLLADAY STREET
PORTLAND, OREGON 97232

SUBMITTED: DATE: 05-14-12
APPROVED: DATE: 05-14-12

PORTLAND TO MILWAUKIE LRT
EAST SEGMENT
CIVIL
ROADWAY PLAN (SE 17TH AVE)
STA 258+00 TO STA 263+00

SCALE: 1"=20' | DRAWING NO.: C15E-335 | CONTRACT NO.: RH100544JB | SHEET NO.: 169

VERTICAL DATUM FOR THIS PROJECT IS NAVD88. CONVERSION TO CITY OF PORTLAND DATUM IS AS FOLLOWS:
NAVD88 TO CITY OF PORTLAND DATUM = SUBTRACT 2.10 FEET (100' NAVD88 = 97.90' COP DATUM)



CONSTRUCTION NOTES:

(1) CONSTRUCT PCC STANDARD SIDEWALK (SEE ODOT STD DWG RD720)

(2) CONSTRUCT STANDARD CURB (SEE ODOT STD DWG RD700)

(3) CONSTRUCT CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE ODOT STD DWG RD700)

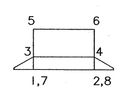
(3A) CONSTRUCT THICKENED CURB AND GUTTER WITH 18" GUTTER PAN (12" GUTTER PAN ADJACENT TO BIKE LANE) (SEE DWG C15E-495A FOR COP STD DWG P-540)

(5) CONSTRUCT TYPE II BALLAST CURB (SEE TRACK DWGS FOR DETAILS–VOLUME I)

(8) CONSTRUCT PCC DRIVEWAY (SEE DWG C15E-495 FOR COP STD DWG P-528)

(60) ADJUST MANHOLE TO FINISHED GRADE

(63) ADJUST CATCHBASIN TO FINISHED GRADE



DRIVEWAY DATA TABLE

LOCATION	FL	FL	BK SW	BK SW	DW	DW	1" LIP	1" LIP
PT NO	1	2	3	4	5	6	7	8
1	58.66	58.71	59.04	59.06	59.16	59.17	58.74	58.80
2	59.03	59.19	59.48	59.56	59.48	59.64	59.11	59.27
3	59.26	59.30	59.60	59.71	59.72	59.77	59.34	59.39
4	59.88	59.92	60.27	60.30	60.29	60.34	59.97	60.00
5	60.07	60.11	60.64	60.67	60.72	60.79	60.15	60.20
6	60.23	60.31	60.65	60.73	60.72	60.74	60.32	60.39
7	60.19	60.04	60.75	60.60	60.86	60.71	60.28	60.12
8	59.86	59.77	60.42	60.33	60.54	60.44	59.95	59.85

GENERAL NOTES

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4. FOR STORM WATER QUALITY FACILITIES AND DRAINAGE CONVEYANCE SYSTEMS SEE DRAWINGS C15E-500 TO C15E-699.
5. ALL TREE WELL STATIONING IS NB STATIONING. TREE WELLS ARE 4'W X 9'L UNLESS NOTED OTHERWISE ON PLANS.

LEGEND

- FULL AC ROADWAY
- CONSTRUCTION LIMITS
- PCC ROADWAY/SIDEWALK/ DRIVEWAY/EMBEDDED TRACK
- WATER QUALITY FACILITY (SEE STORM PLANS)

NO.	DATE	BY	CHK.	APPD.	REVISIONS
	05-14-12	TAWH		RGA	ISSUED FOR CONSTRUCTION

DESIGNED: RGA 07-07-11
DRAWN: RJM 07-07-11
CHECKED: TAWH 04-11-12
APPROVED: RGA 05-14-12

REGISTERED PROFESSIONAL ENGINEER 55529 OREGON JULY 15, 2003 RAFAEL GAETA 5-2-12
EXPIRES: 06/30/2013

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

DAVID EVANS AND ASSOCIATES INC.

TRI MET
CAPITAL PROJECTS DIVISION
710 NE HOLLADAY STREET
PORTLAND, OREGON 97232

SUBMITTED: [signature] DATE: 05-14-12
APPROVED: Leah Robbins DATE: 05-14-12

PORTLAND TO MILWAUKIE LRT
EAST SEGMENT
CIVIL
ROADWAY PLAN (SE 17TH AVE)
STA 263+00 TO STA 268+00

SCALE: 1"=20' | DRAWING NO.: C15E-337 | CONTRACT NO.: RH100544JB | SHEET NO.: 177

SE Foster Rd

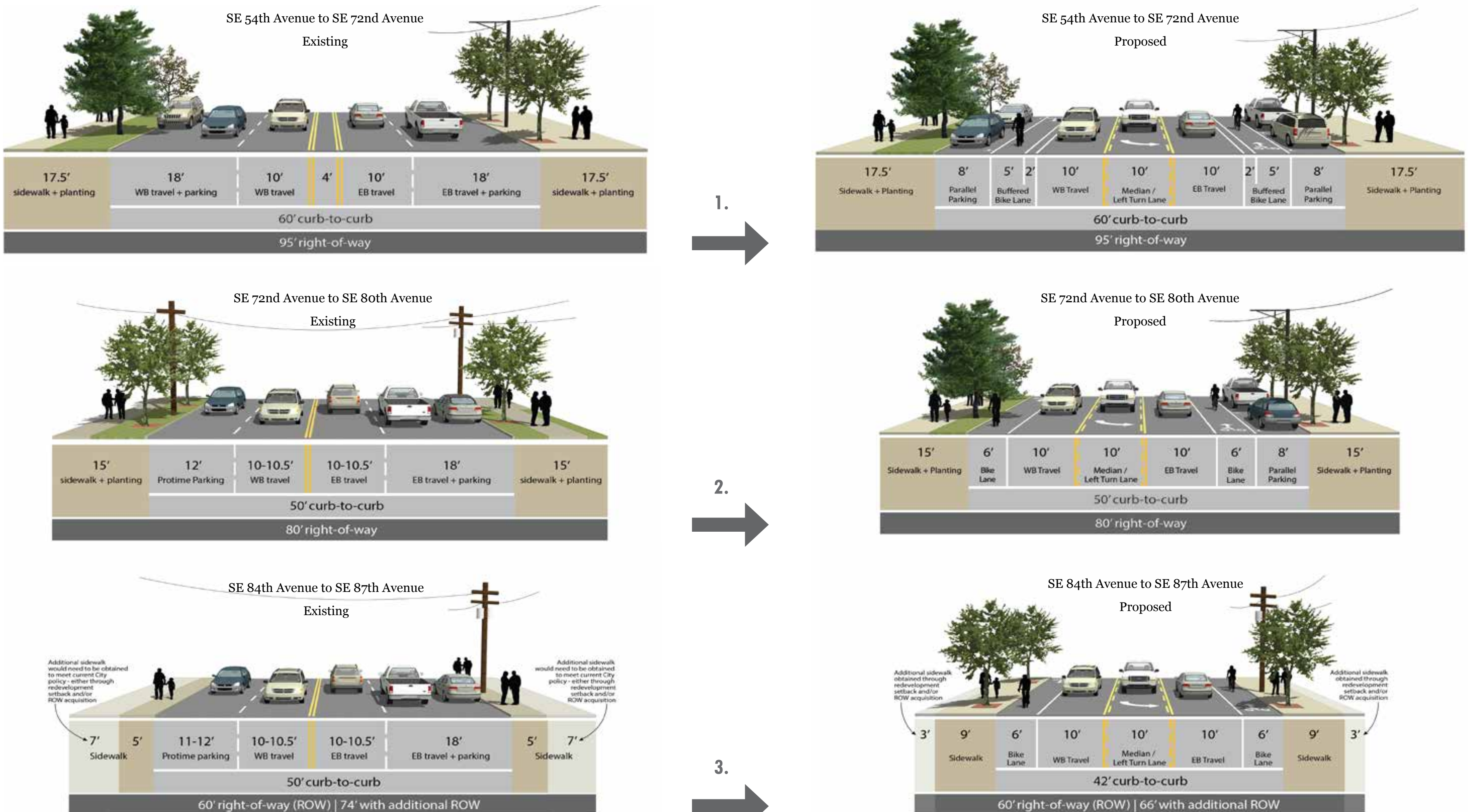
Working within limited space

SE Foster Rd is a diagonal roadway in SE Portland with varying cross-section widths. A recently-approved project—soon to go to final design and construction—will include a road diet and seven-foot buffered bicycle lanes. The question is how to provide better than the buffered lanes along the 2.25 mile corridor within the project's $5.2 million budget.

The City-Council approved plan is available here: http://www.portlandoregon.gov/transportation/article/484883

Specific relevant pages follow.

Figure 2-5 Existing and Proposed Cross Sections



Source: Nelson\Nygaard

Source: Nelson\Nygaard

Note: Actual cross sections may vary depending on the segment.

3 RECOMMENDED CORRIDOR DESIGN

3 Recommended Corridor Design

This section integrates the different elements of the plan and presents it in plan view. It highlights the location of crossings (curb extensions, median islands with rectangular rapid flash beacons, traffic signals), the cross section and transition areas, and streetscape and transit features.

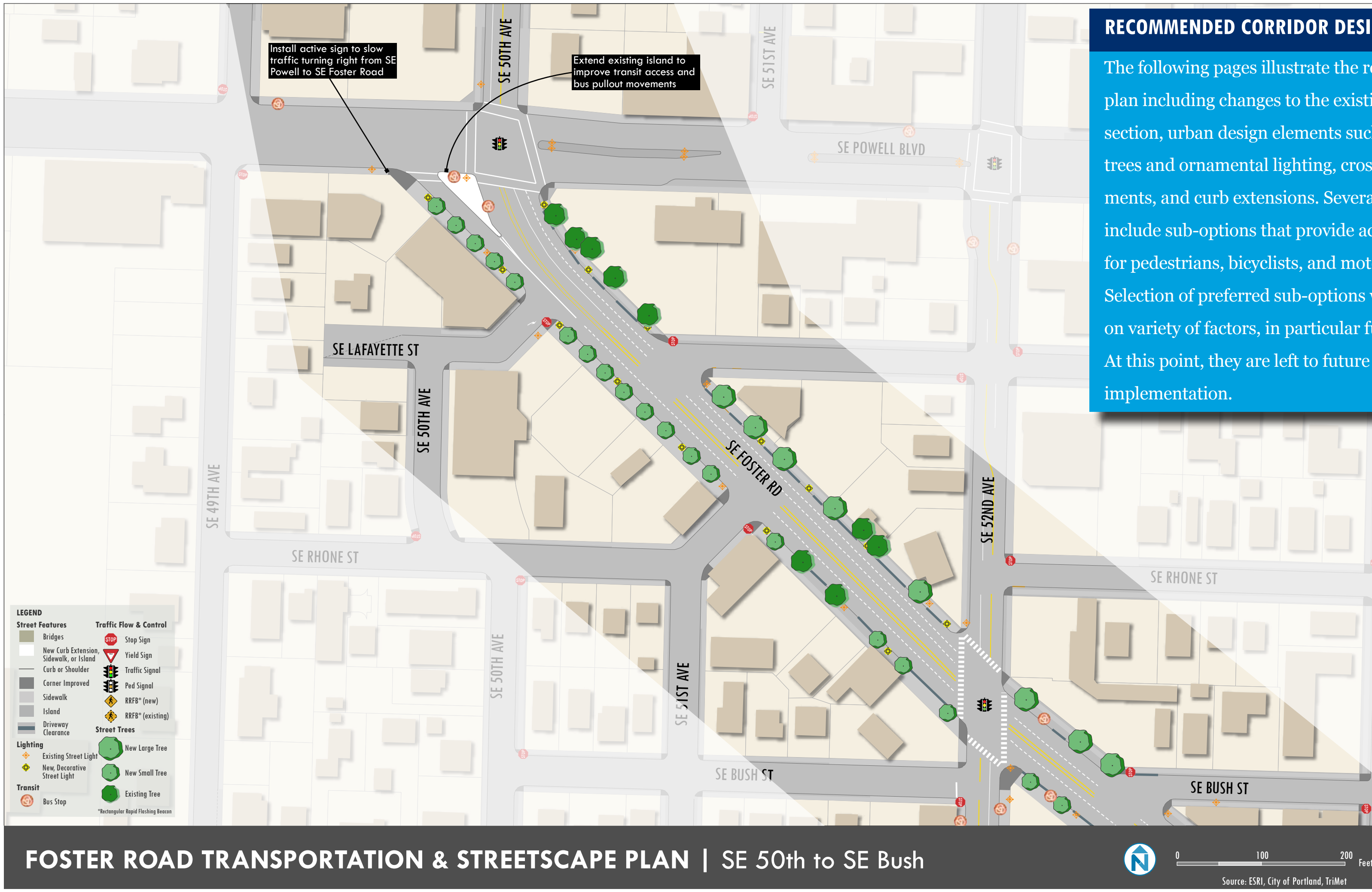
The graphics cover Foster Road from Powell Boulevard/SE 50th Avenue to Lents Town Center area around SE 90th Avenue.

The placement of street trees and street lights is mostly conceptual. While analysis has been conducted, more is needed as part of the next phase of the project to determine exact feasibility and location. Likewise, the plan identifies general location of transit stops. PBOT staff will continue to work with TriMet staff to determine the exact location of bus stops and amenities.

Equitable distribution of improvements. Fulfilling the goal of an equitable distribution of benefits and burdens of change among the area's diverse communities, the following graphics show that all areas of Foster Road benefit from transportation improvements. The safety and access improvements of the conversion of the cross section cover almost the entirety of the corridor. Crossing enhancements and streetscape and transit improvements are also distributed throughout the corridor.

The area of most investment is the eastern segment, from SE 82nd Avenue to SE 90th Avenue in the Lents neighborhood. This is the result of this area being the one with the most substandard transportation network, with very narrow, inaccessible sidewalks and no street trees or bus shelters.

Figure 3-1 SE 50th Avenue to Bush Street

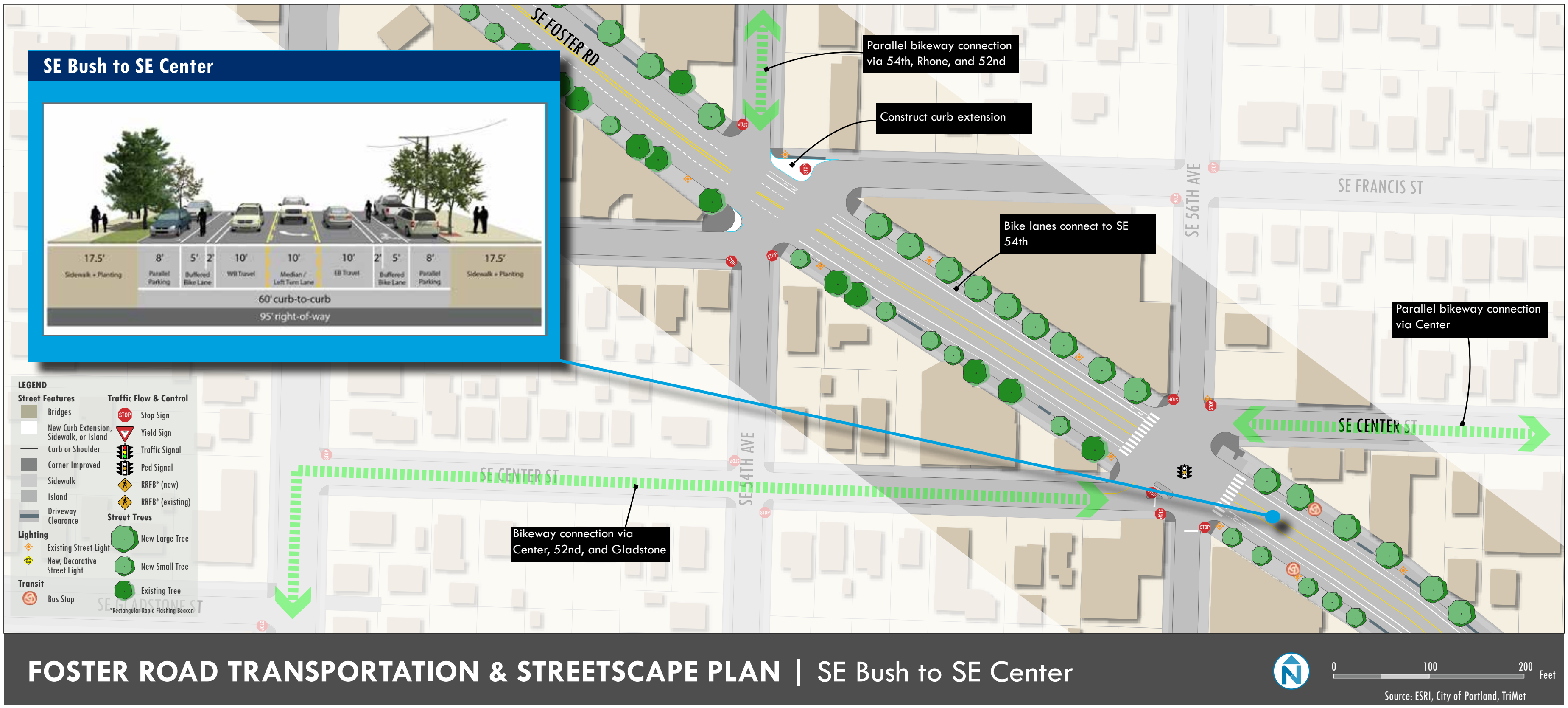


Source: Nelson\Nygaard

RECOMMENDED CORRIDOR DESIGN

The following pages illustrate the recommended plan including changes to the existing cross section, urban design elements such as street trees and ornamental lighting, crossing improvements, and curb extensions. Several segments include sub-options that provide added benefits for pedestrians, bicyclists, and motorists, alike. Selection of preferred sub-options will depend on variety of factors, in particular funding. At this point, they are left to future phases of implementation.

Figure 3-2 SE Bush Street to Center Street



Source: Nelson\Nygaard

Figure 3-3 SE 58th Avenue to 62nd Avenue

Figure 3-4 SE Holgate Street to 68th Avenue

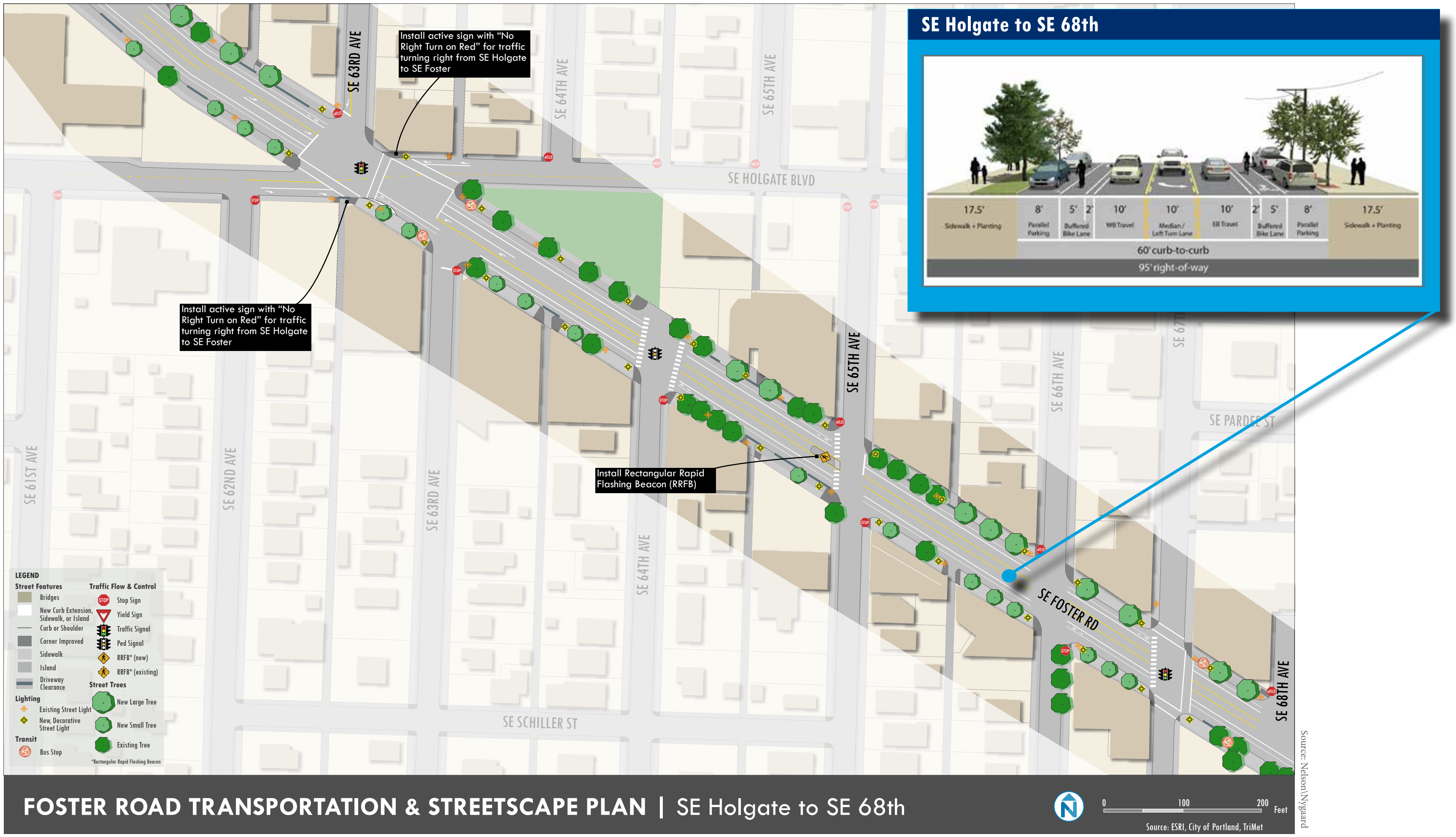
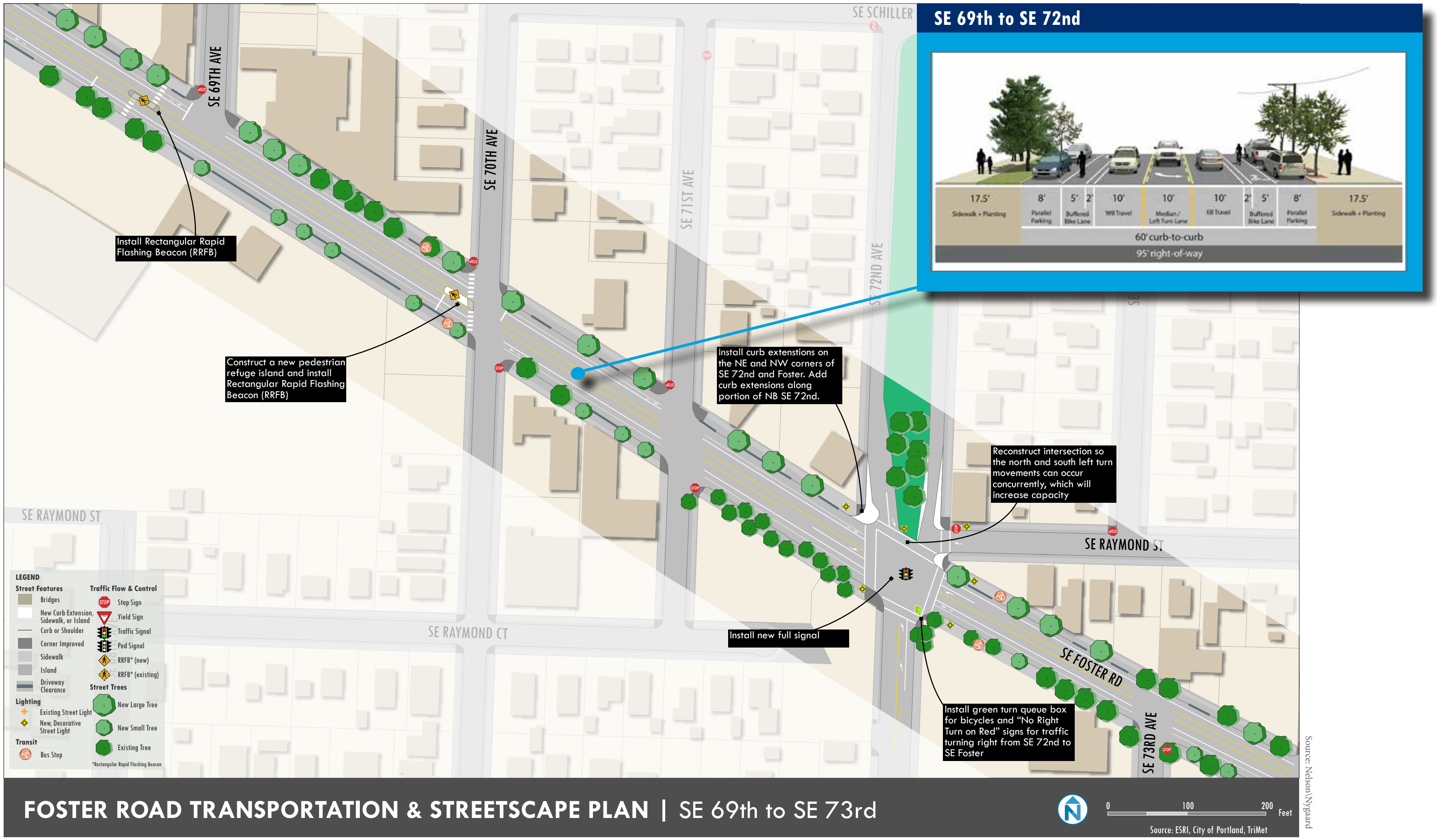


Figure 3-5 SE 69th Avenue to SE 73rd

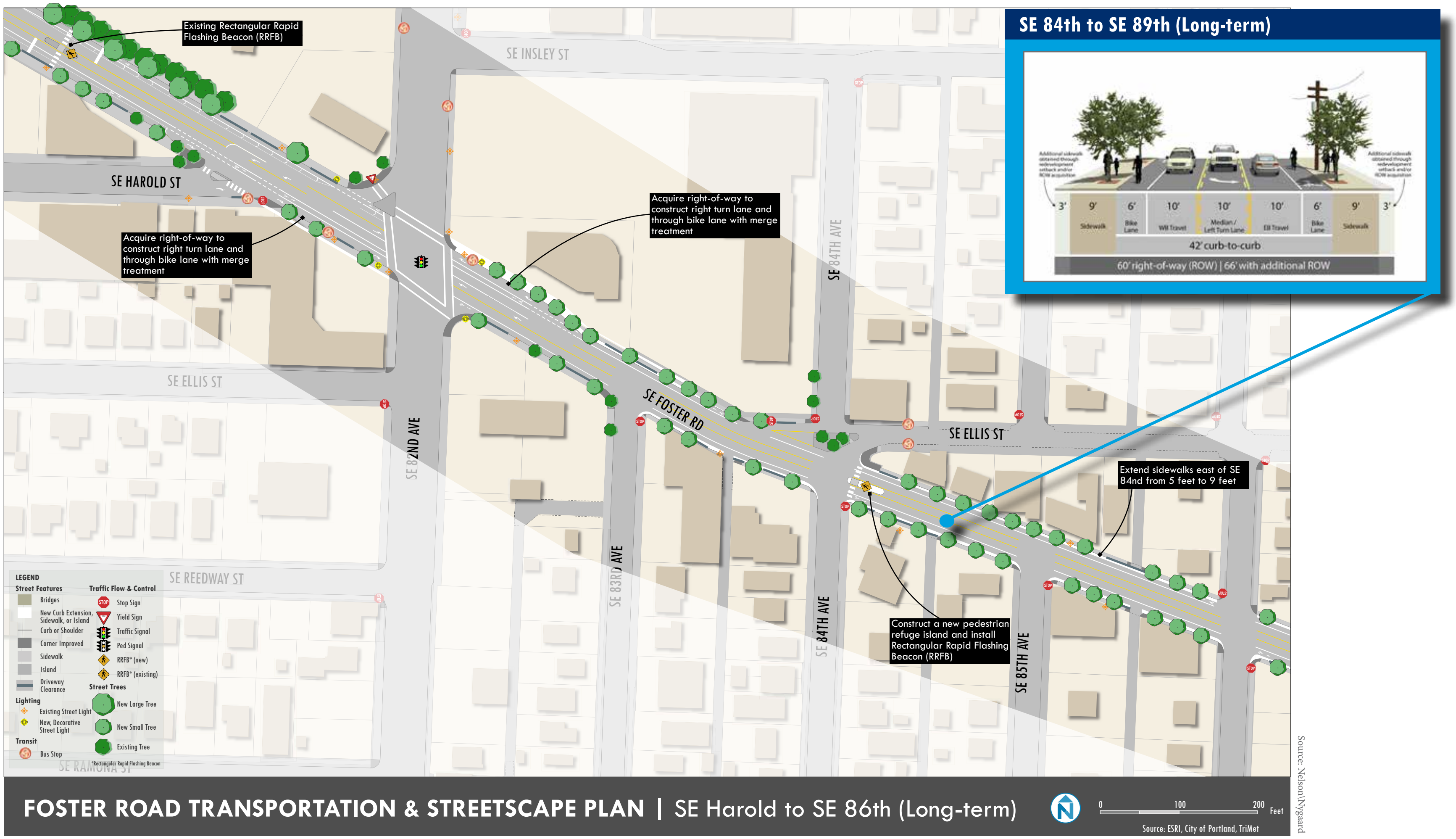


Source: Nelson\Nygaard

Figure 3-6 SE 74th Avenue to 80th Avenue

Source: Nelson\Nygaard

Figure 3-7   SE Harold Street to 86th Avenue (Long-term)



Source: Nelson\Nygaard

Figure 3-8 SE Harold Street to 86th Avenue (Short-term)

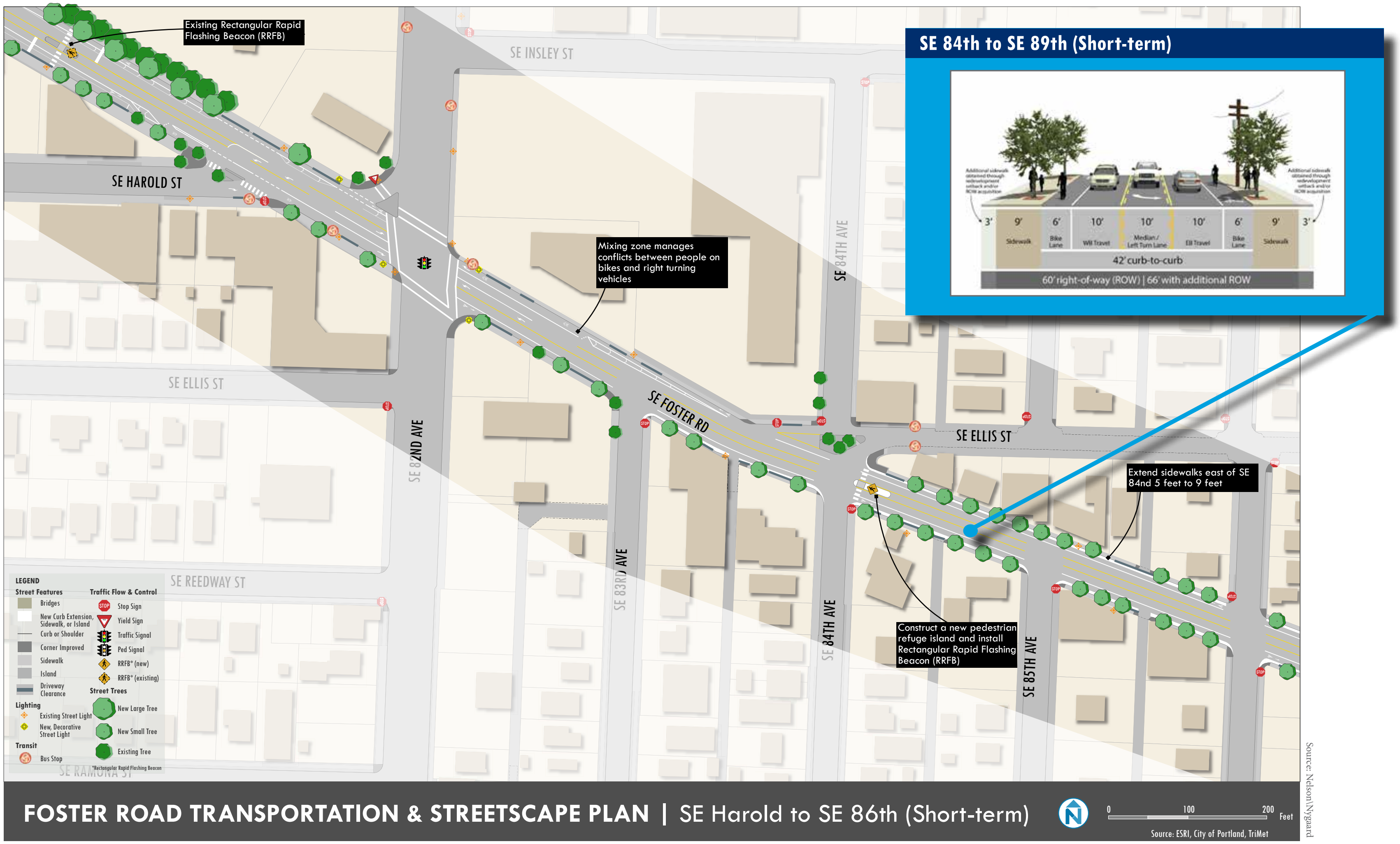
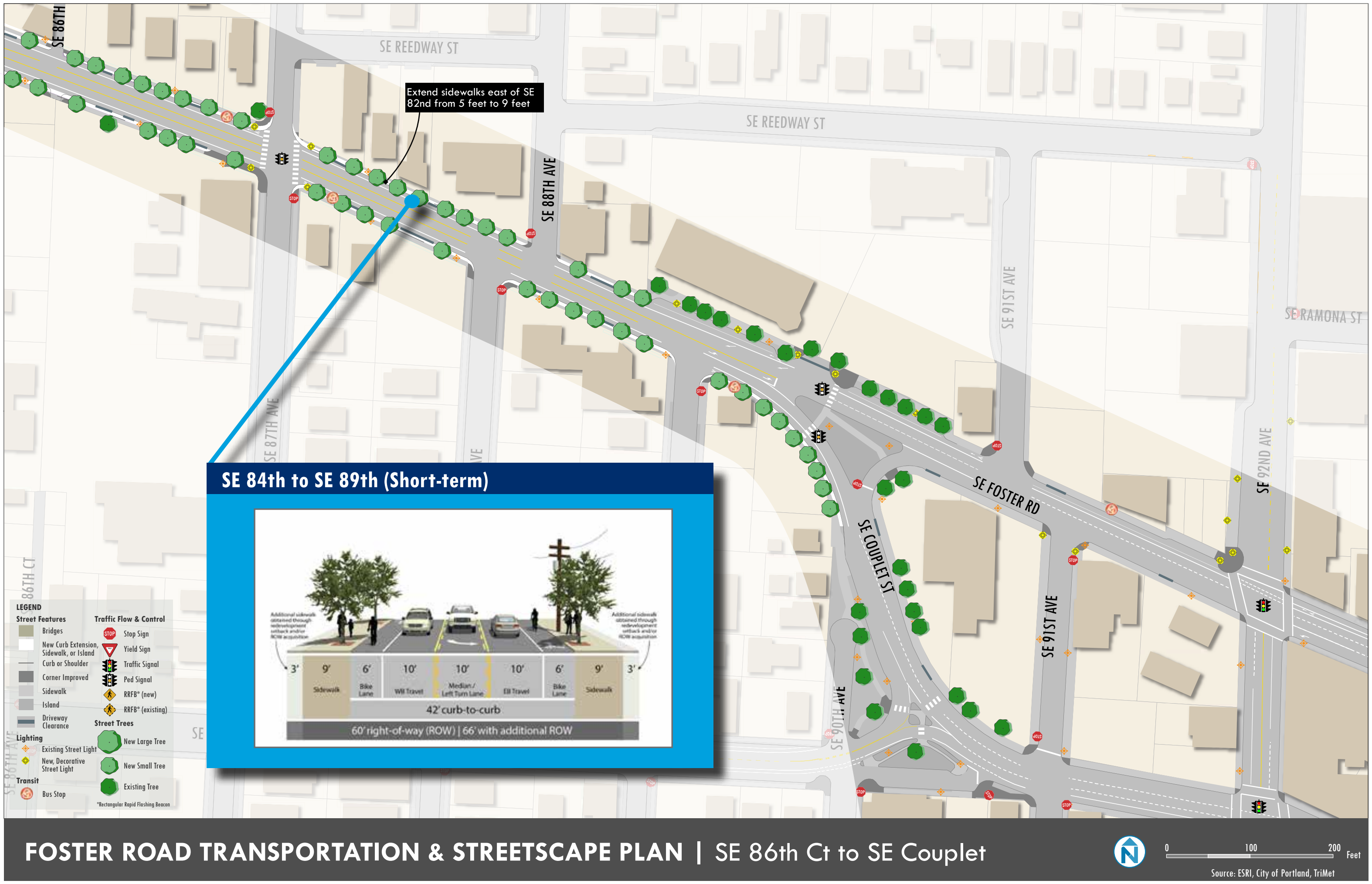


Figure 3-9   SE 86th Avenue to Couplet



Source: Nelson\Nygaard

SW Bond Avenue

Providing a good pedestrian space

The issue to consider with SW Bond Avenue is how to provide for a good pedestrian space, especially at intersections. Portland's design standards for this street (to be built on a brownfield) are intended to serve a mixed use Central City district with high employment, dense residential development and an active street life complete with sidewalk cafes.

Standards adopted a decade ago called for a 70-foot right-of-way that is in the process of begin expanded to 73-feet to allow for minimal-width parking-protected bicycle lanes. One option PBOT staff has considered is bringing the bicycle facility to sidewalk level. This raised concerns about the impact to the pedestrian environment.

The two following pages show line work for a typical intersection and the cross-section. We are likely to adopt more of a Western Avenue (Cambridge) design for a segment of Bond that is to have no building frontage. The question remains what type of design we would use in a more dense mixed-use area.

Sidewalk level separated bikeway
Western Ave, Cambridge MA

SW Bond Avenue

Right of way width is 73'.
Curb to curb distance is 47'.
Plan calls for:
2 x 11' travel lanes
2 x 8' parking.

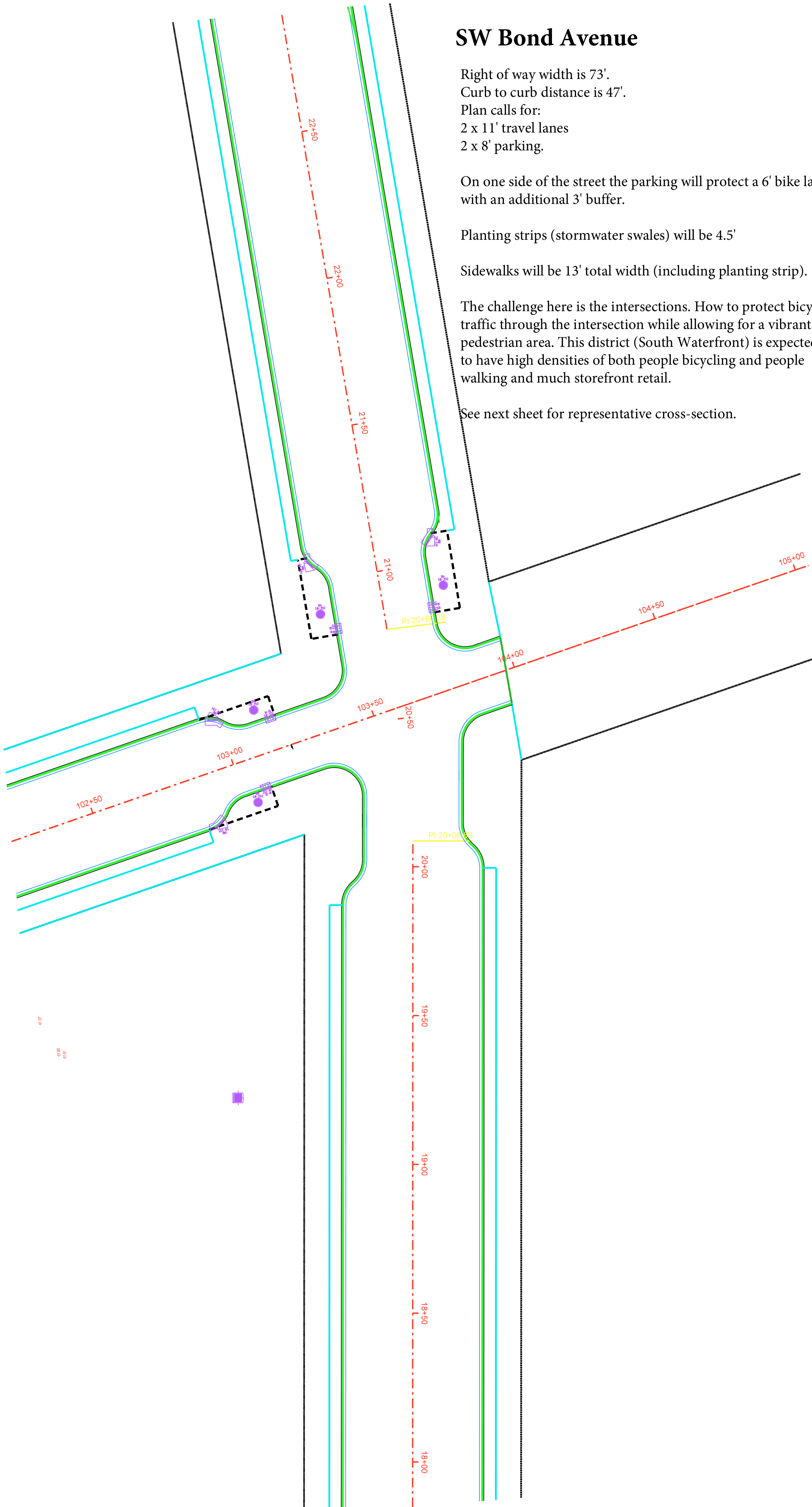
On one side of the street the parking will protect a 6' bike lane with an additional 3' buffer.

Planting strips (stormwater swales) will be 4.5'

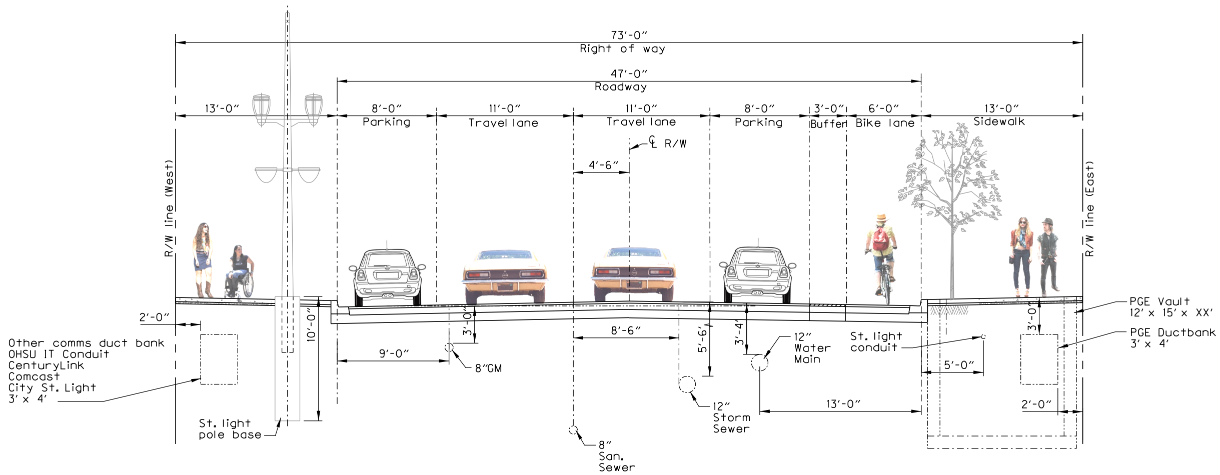
Sidewalks will be 13' total width (including planting strip).

The challenge here is the intersections. How to protect bicycle traffic through the intersection while allowing for a vibrant pedestrian area. This district (South Waterfront) is expected to have high densities of both people bicycling and people walking and much storefront retail.

See next sheet for representative cross-section.



PRELIMINARY
3/1/2016



S.W. Bond Avenue

S.W. Porter St. to S.W. River Parkway (Looking North)
Proposed Street Section

Typical Section 6 / 1C-3

Scale: 1" = 5'

WARNING
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

Plot Date: 3/1/2016 10:26:13 AM Filename: S:_II_Design\T00461- Bond,Gibbs to River Parkway SW\CAD\PRESENTATION DRAWINGS\SHT 02A-06 TYPICAL SECTIONS\PLOT_SHT_02A-06.dgn

NO.	DATE	DESCRIPTION	APPD.
		REVISION	

DESIGNED BY: L. Williams
DATE APPROVED: Feb. 2015
CAD BY: D. Ramer
DIV. ENGINEER: S. Townsen
CHECKED BY: E. Huntsinger

REGISTERED PROFESSIONAL ENGINEER 84470PE OREGON SEPTEMBER 14, 2010 EVA B. HUNTSINGER
Expires 6/30/17

APPROVALS:
SUPERVISING ENGINEER — REG. PROF. ENGR. NO. 14956PE
CITY ENGINEER — REG. PROF. ENGR. NO. 51538PE

PBOT
PORTLAND BUREAU OF TRANSPORTATION
STEVE NOVICK — COMMISSIONER
STEVE TOWNSEN, P.E. — CITY ENGINEER

CITY OF PORTLAND OREGON 1851

S.W. Bond Ave
S.W. Gibbs St. to S.W. River Parkway

Typical Section

1/4 SECTION: 3229,3230 3329,3330
PROJECT NO.: T00461.D30
SHEET NO.: 2A-6

North Williams Avenue

Providing for emergency responders

Providing for transit

One issue to consider with N Williams is how to provide for emergency response. For guidance on what emergency responders (represented by Fire Bureau) see that section of this overall memo. We went with buffered lanes in part because of the desire to maintain a minimum of 20' of clear roadway width.

Another issue is how to provide for transit. Our solution was to shift the bikeway to the left side of the roadway, though we had considered transit islands on the right side of the street; a consideration we rejected because of limited space and parking removal associated with longer bus platforms.

The following pages show the conditions that existed on N Williams Avenue before modifications and the final designs that were implemented. You can see the complete adopted plan here:
http://www.portlandoregon.gov/transportation/article/417219

EXISTING CONDITIONS

The project study area included the approximately 2-mile section of North Williams from North Winning Way in the Rose Quarter to Killingsworth Street. At present, there are 34 intersections in the study corridor. The character and function of North Williams Avenue changes along its length. Similarly, the issues and concerns identified by stakeholders varies. As a result, the project team broke the corridor into five smaller segments to better distinguish these differences and allow design solutions to be tailored to the conditions found in each segment.

The typical street existing cross-section is shown in Figure 1 and has a curb-to-curb width of 40' that includes parking on both sides of the street, two travel lanes, and a 5' - 6' wide bike lane. The existing bike lanes were added to North Williams Avenue in 1999 by narrowing the two motor vehicle travel lanes. Although the lane configuration varies at a number of intersections (where the parking lane is dropped prior to the intersection to form right- or left-turn lanes), the typical roadway width is 40' between Killingsworth Street and Hancock Street. South of Hancock Street the pavement width reduces to 36' (see Figure 2).

Existing transportation conditions along the corridor, including bicycle and motor vehicle traffic volumes, transit boardings and alightings, crash history, and parking utilization, were documented in the *North Williams Existing Conditions* memorandum prepared by Kittelson & Associates, Inc. (see Appendix B). This report relied on 2010 bike count data, but the most recent counts demonstrate a 29-percent increase in bicycle traffic between 2010 and 2011.

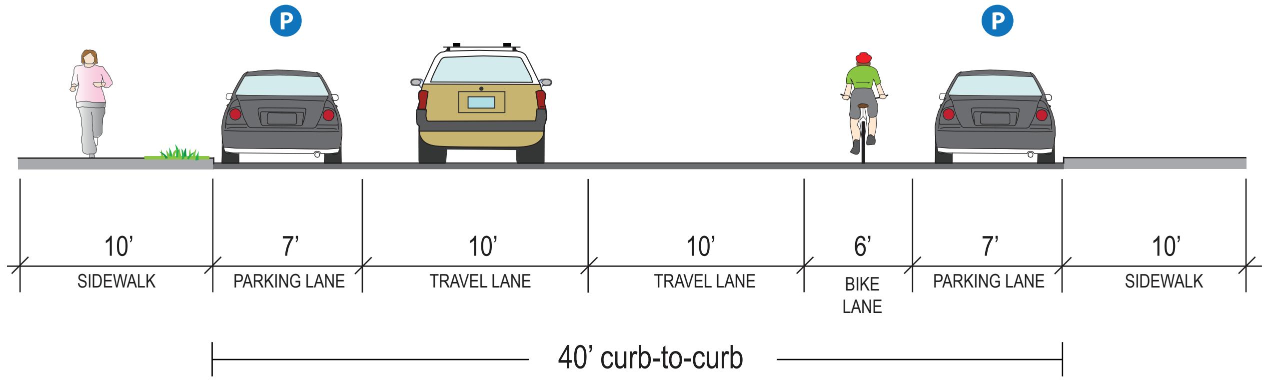


FIGURE 1: Existing street cross section between Hancock Street and Killingsworth Street

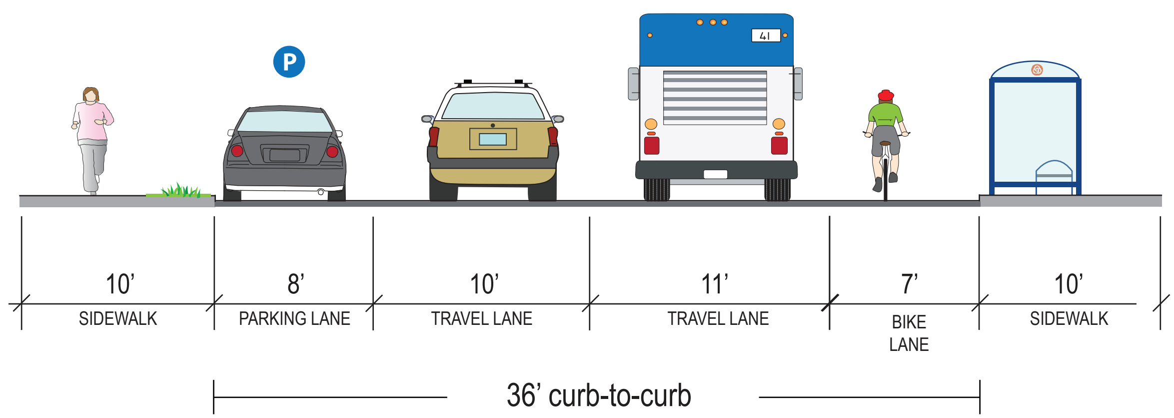


FIGURE 2: Existing street cross section south of Hancock Street

RECOMMENDED CONCEPT DEVELOPMENT

Refinement of the intial concepts for the North Williams streetscape were informed by twenty-three public meetings, four community workshops, two public open houses and a number of one-on-one conversations with community leaders and business owners. Following the first open house in April 2011, it became apparent that the North Williams Traffic Operations Safety Project may be a transportation project, but that in this community history, justice, development and transportation are all related. The initial concepts displayed at the April 2011 open house received a divided reception from the community. Long-time neighbors of North Williams and many members of the African American community were concerned about their underrepresentation in the planning process and the concepts it was producing so far.

In response to this critique, the technical planning process was placed on hold as additional community outreach was conducted. In early 2012, the new 26-person SAC began judging alternative concepts against their 10 Outcomes. The following section provides an overview of the final recommended concept—the streetscape plan that was deemed the most capable of achieving the SAC's outcomes (see Figure 4).

LEFT-SIDE BUFFERED BIKE LANE

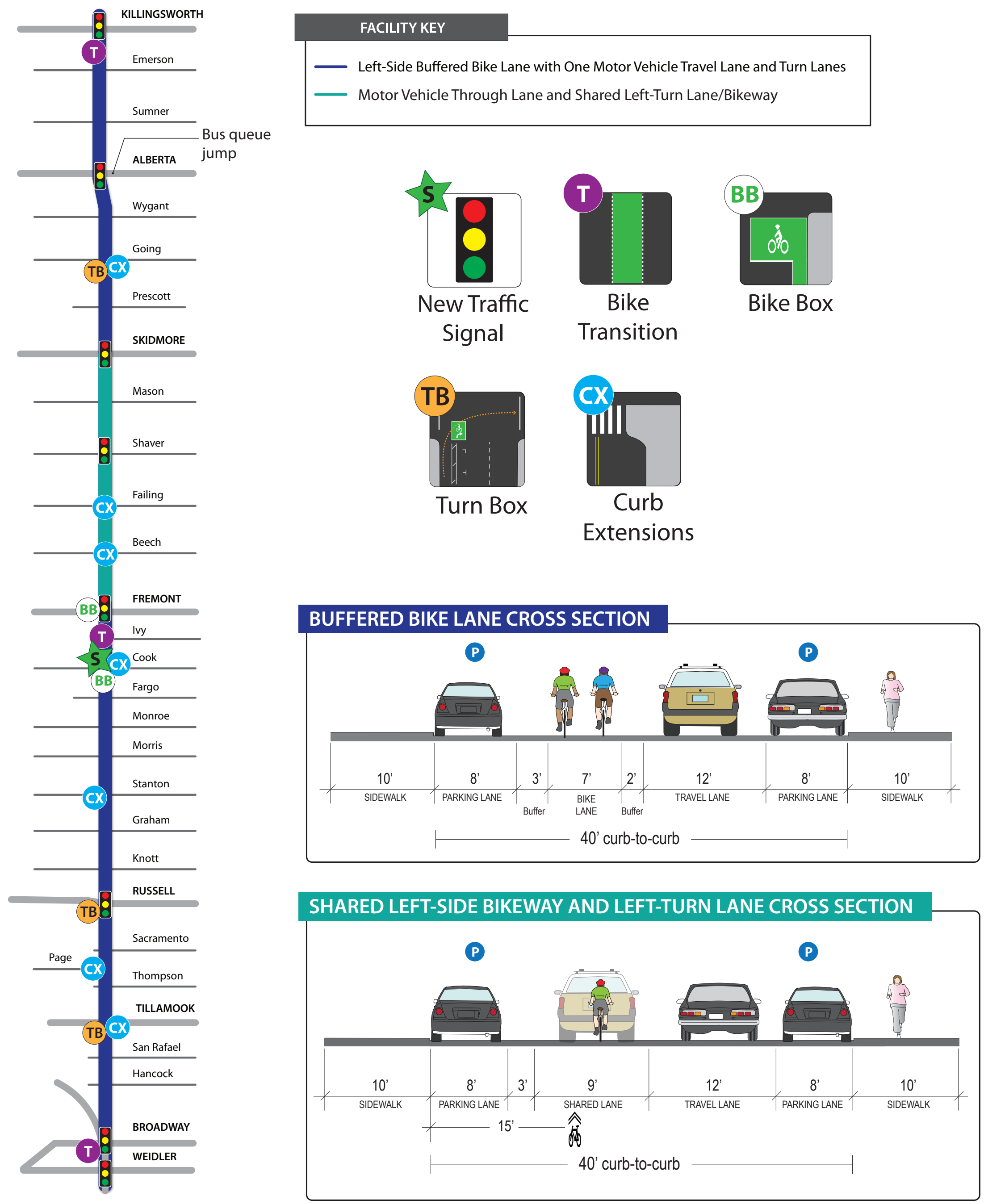
The preferred concept for the majority of the corridor is a left-side buffered bike lane with strategically placed pedestrian crossing improvements (see Figure 5). This concept involves converting the westside motor vehicle travel lane into a buffered bike lane. The advantages of this concept include:

Traffic Calming: The buffered bike lane is created by eliminating a motor vehicle travel lane. This reduction in capacity has a slowing effect on motor vehicles.

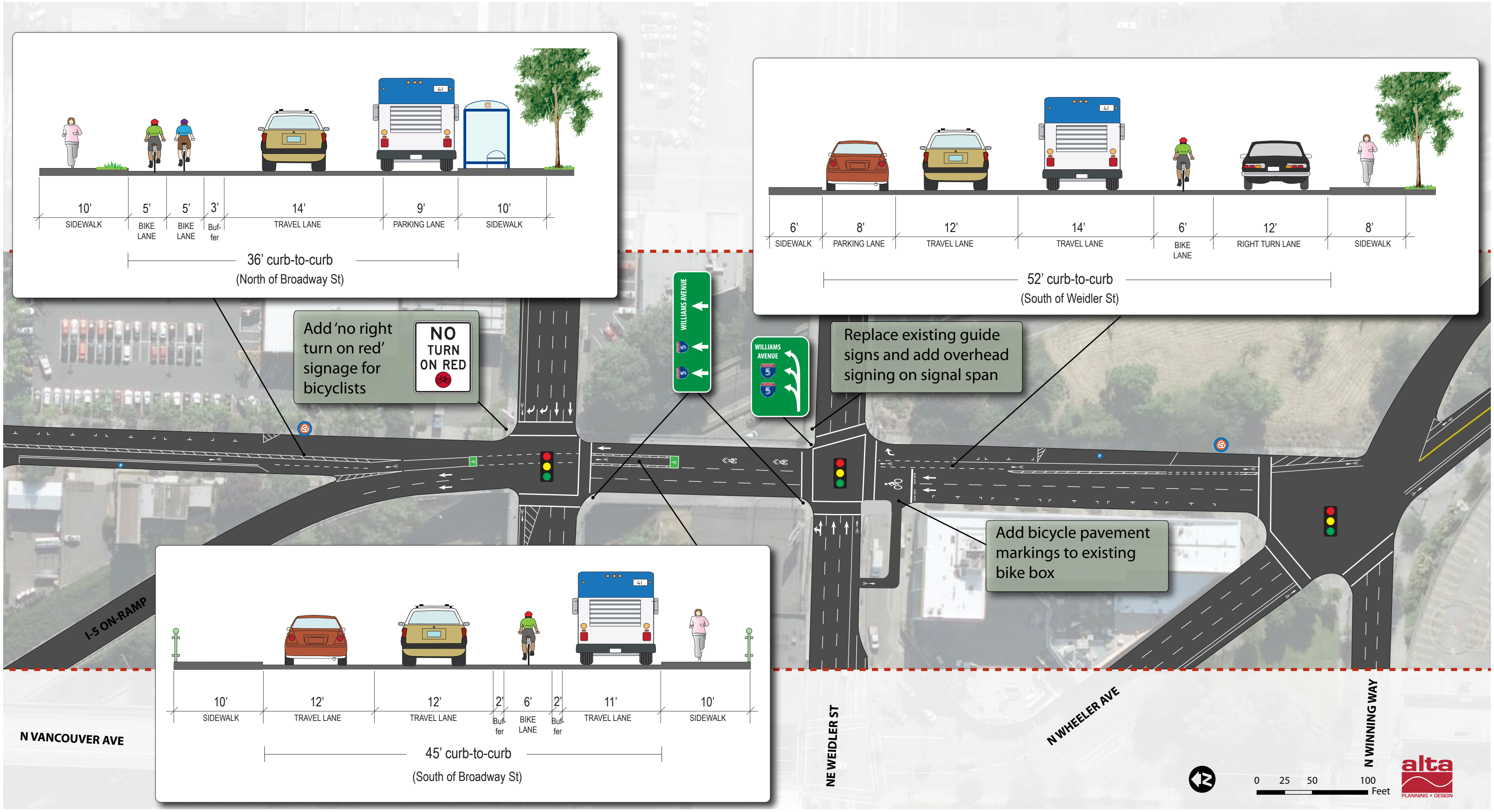
Eliminates bus/bike conflict: Under this concept bicyclists and transit operators will only be required to navigate the same roadway space at Fremont Street, where the #4 bus turns left.

Safe passing: The left-side buffered bike lane provides space for bicyclists to safely pass one another without needing to enter the adjacent motor vehicle lane.

FIGURE 4: Overview of the recommended concept for North Williams



Winning Way to I-5 On-Ramp

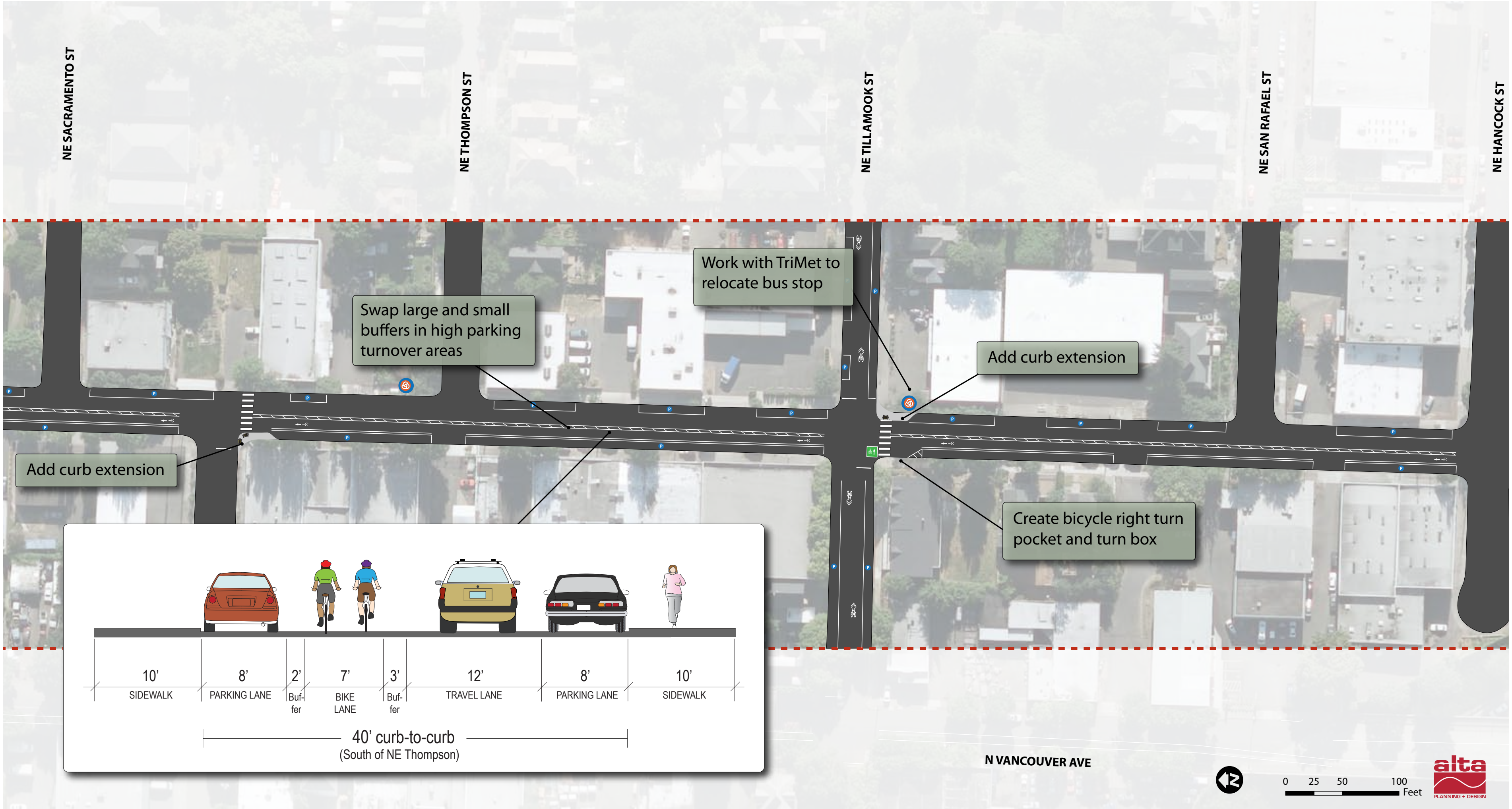


KEY FEATURES

One of the challenges of developing a left-side bikeway on North Williams is safely and intuitively transitioning bicyclists from the right side to the left. This design demonstrates how such a transition might operate. Instead of separating modes with signal phases, the design relies on sorting bicyclists and motorists in advance of the intersection at Broadway. Motor vehicle through traffic continuing on North Williams is required to stay in the far right lane and bicyclists are placed between motor vehicles entering I-5 and the right travel lane. Prominent pavement markings and signage are used to inform motorists and bicyclists about proper placement on the roadway. At the Broadway signalized intersection, a green phase allows all modes to travel forward at the same time and for bicyclists to transition comfortably to a left-side buffered bike lane.

RECOMMENDED CONCEPT DETAILS

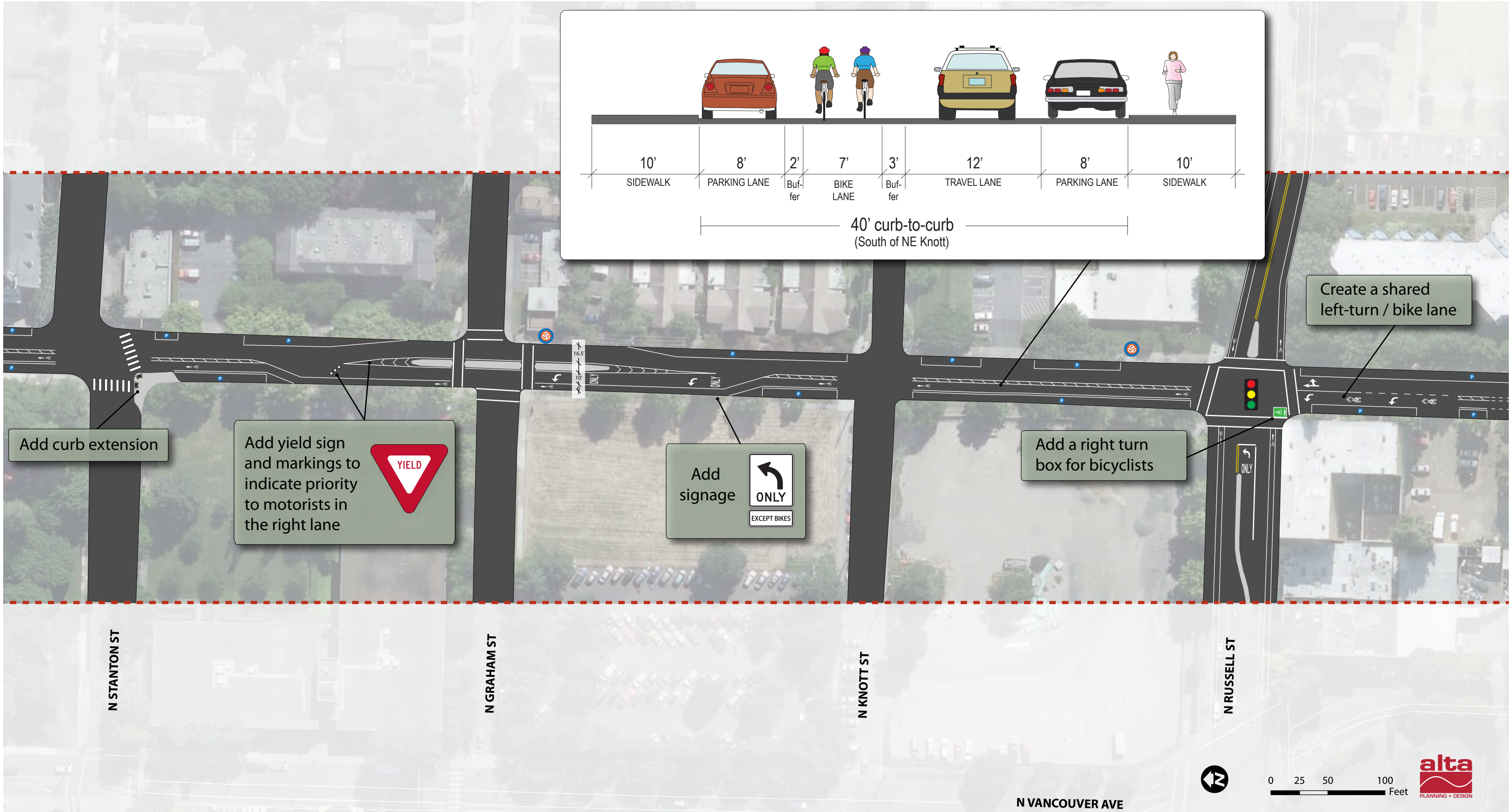
Hancock Street to Sacramento Street



KEY FEATURES

The left-side buffered bike lane is continued in this section, between Hancock Street and Sacramento Street. Special considerations are taken at the intersection with an existing Neighborhood Greenway on Tillamook Street. The increased design emphasis at this intersection anticipates high volumes of bicycle cross traffic, as well as northbound bicyclists on Williams making frequent turn movements onto Tillamook. To better facilitate right turns from North Williams onto Tillamook Street a parking space was removed in advance of the intersection to make room for a turn box. Bicyclists making right turns are able to wait in the green box for an acceptable gap in traffic prior to crossing the street. Removing parking and placing a curb extension and high visibility crosswalk at the southeast corner of the Tillamook Street intersection also helps to improve the pedestrian experience by reducing the crossing distance at this high pedestrian volume intersection.

Russell Street to Stanton Street

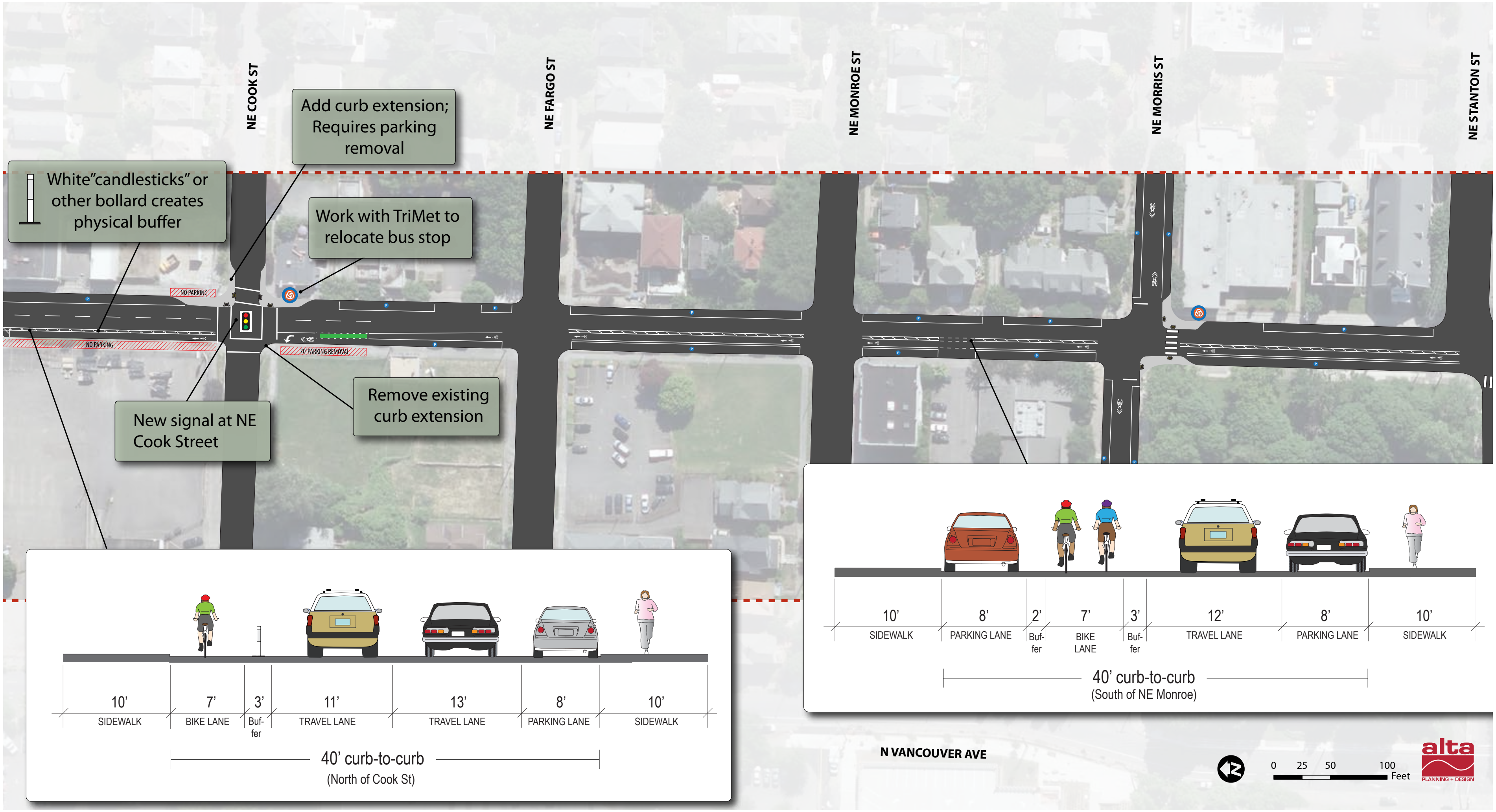


KEY FEATURES

Motor vehicle left turn volumes are significant at Russell Street, which requires maintaining a dedicated left turn only lane. To accommodate both motorists and bicyclists at this intersection a marked shared lane has been developed. Russell Street is also a popular east/west city bikeway with existing on-street bike lanes. Northbound bicyclists traveling on Williams that plan to turn eastbound on Russell Street may not be comfortable navigating across the motor vehicle travel path in advance of the intersection so a turn box has been established just in front of the existing crosswalk.

The existing concrete diverter at Graham Street proves a challenge for this design. Care was taken to separate modes through this section, however, additional steps may be required to safely accommodate all roadway users. Historically, the intersection of Williams and Stanton St has been an area of concern for the community, and there have been numerous requests for a sginal at this intersection. The recommended concept for this intersection would help to increase pedestrian comfort and safety at this intersection by adding a curb extension to reduce crossing distance. In addition, pedestrians would only need to cross a single lane of traffic, as opposed to multiple lanes.

Stanton Street to Cook Street

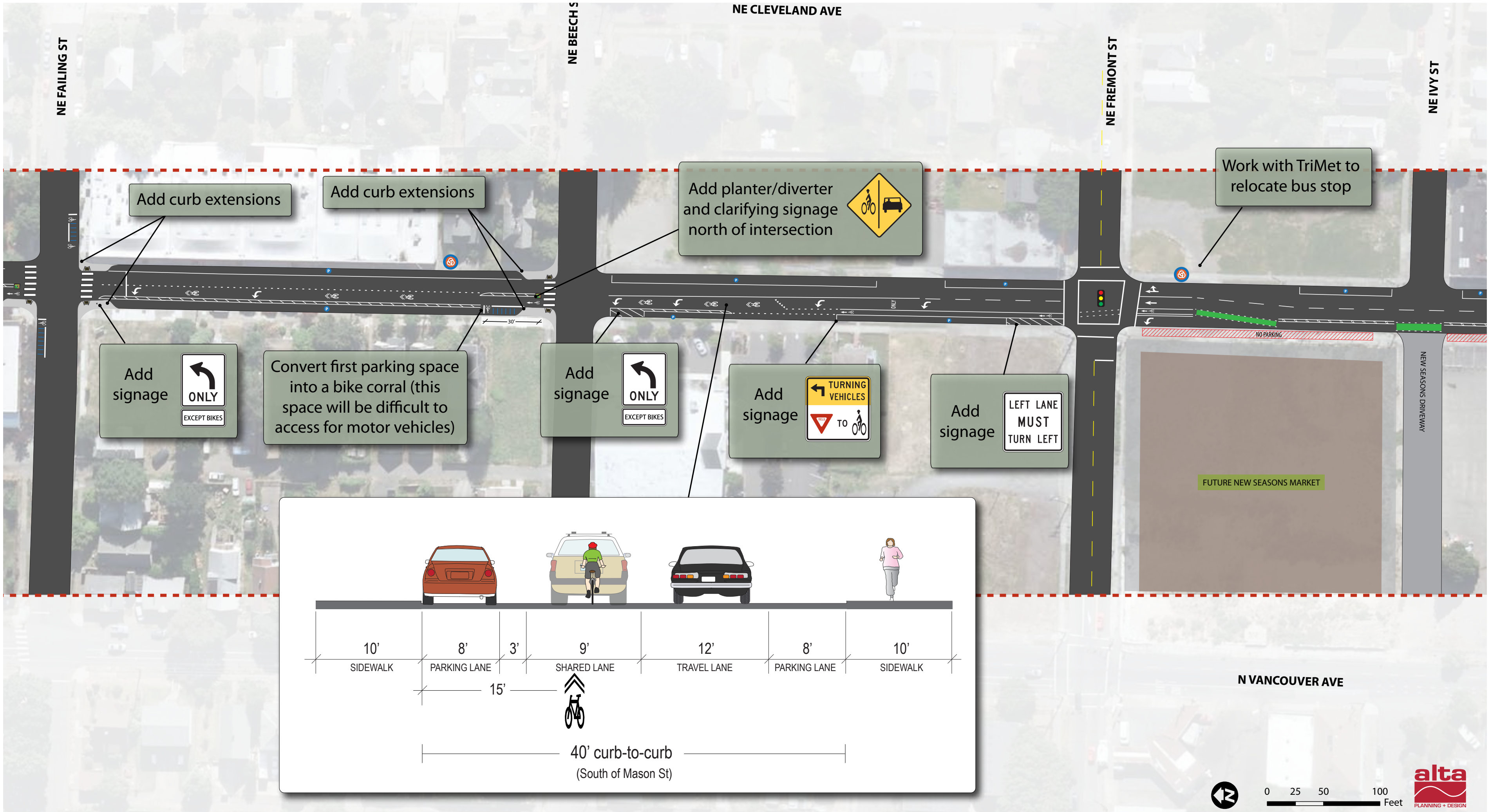


KEY FEATURES

One of the most popular strategies for managing the impact of motor vehicle traffic leaving the nearby Fremont Bridge is to add a signal at the Cook Street intersection. This will help to increase predictable behavior at a problematic intersection for pedestrians, bicyclists and motorists. The left-side buffered bikeway transitions into a barrier-protected buffered bike lane after Cook Street. Two motor vehicle through lanes are maintained, beginning at Cook Street, to help manage higher motor vehicle volumes in this section. The westside parking lane has been removed to continue the buffered bike lane. White "candlesticks" or another barrier device is recommended to prevent motorists from entering the bikeway in advance of the planned New Seasons Market driveway.

RECOMMENDED CONCEPT DETAILS

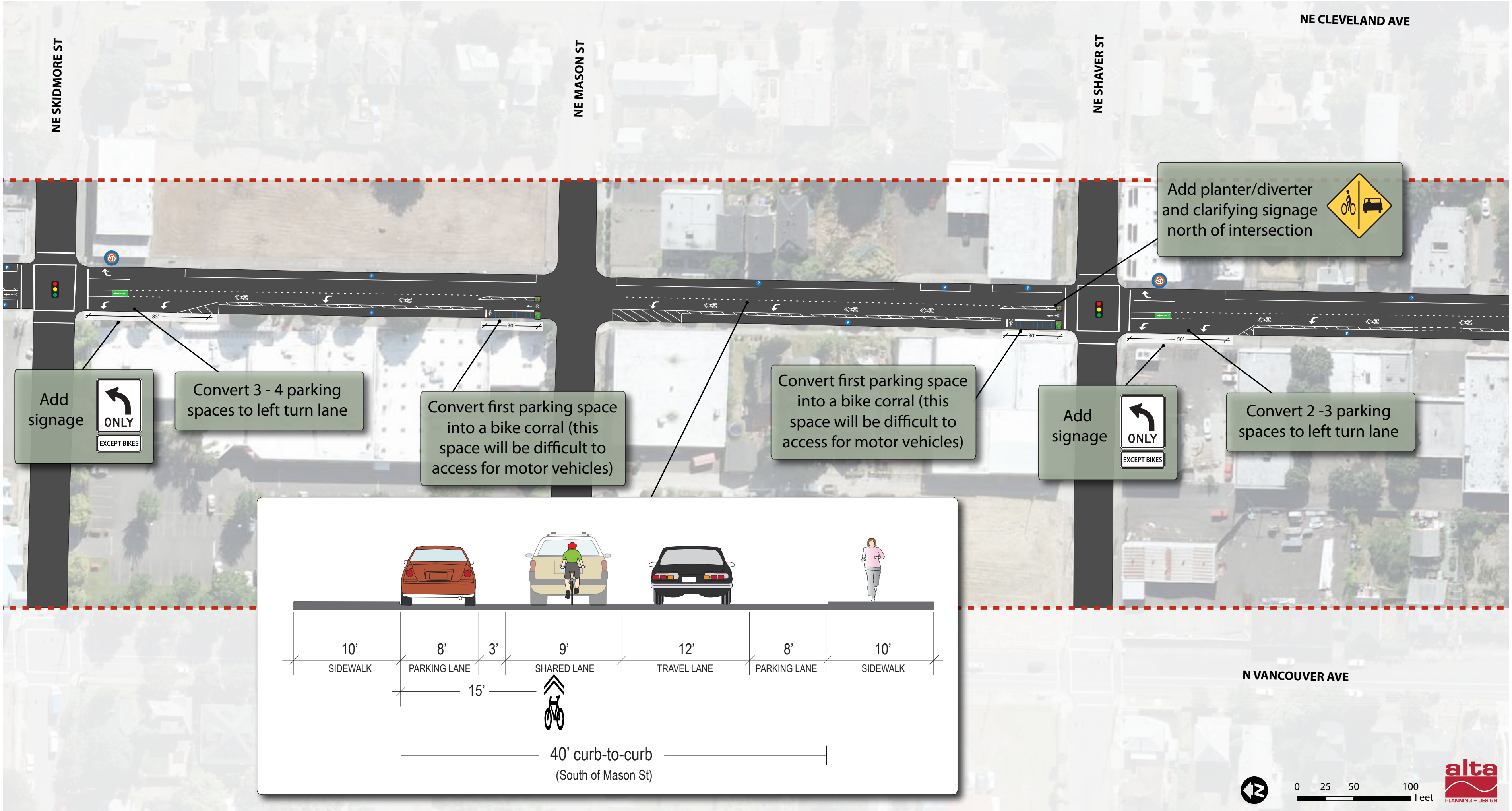
Cook Street to Failing Street



KEY FEATURES

It is expected that there will be high levels of activity at the driveway to the planned New Seasons Market. Green thermoplastic and dashed lane markings are proposed to help mitigate conflicts. The Fremont Street intersection experiences some of the highest turn volumes on the corridor and a series of alternate intersection concepts were developed to demonstrate how motor vehicle operations can be maintained while also meeting the needs of bicycle through traffic. The left-side shared bikeway and left-turn lane facility begins mid-block north of Fremont Street. Pavement yield markings and signage alert motorists to yield to bicyclists in the mid-block transistion area. At the end of each block, beginning with Beech Street, a planter flanking the bike lane requires motorists traveling in the shared lane to turn left at the intersection. Bicyclists are able to continue traveling through.

Failing Street to Skidmore Street



KEY FEATURES

The shared left-side bikeway and left-turn lane continues through the commercial area to Skidmore Street. Left-turn volumes at Shaver Street and Skidmore warrant dedicated turn lanes, so through bicyclists are directed to a bike lane pocket between the turn and through movement motor vehicle travel lanes.

RECOMMENDED CONCEPT DETAILS

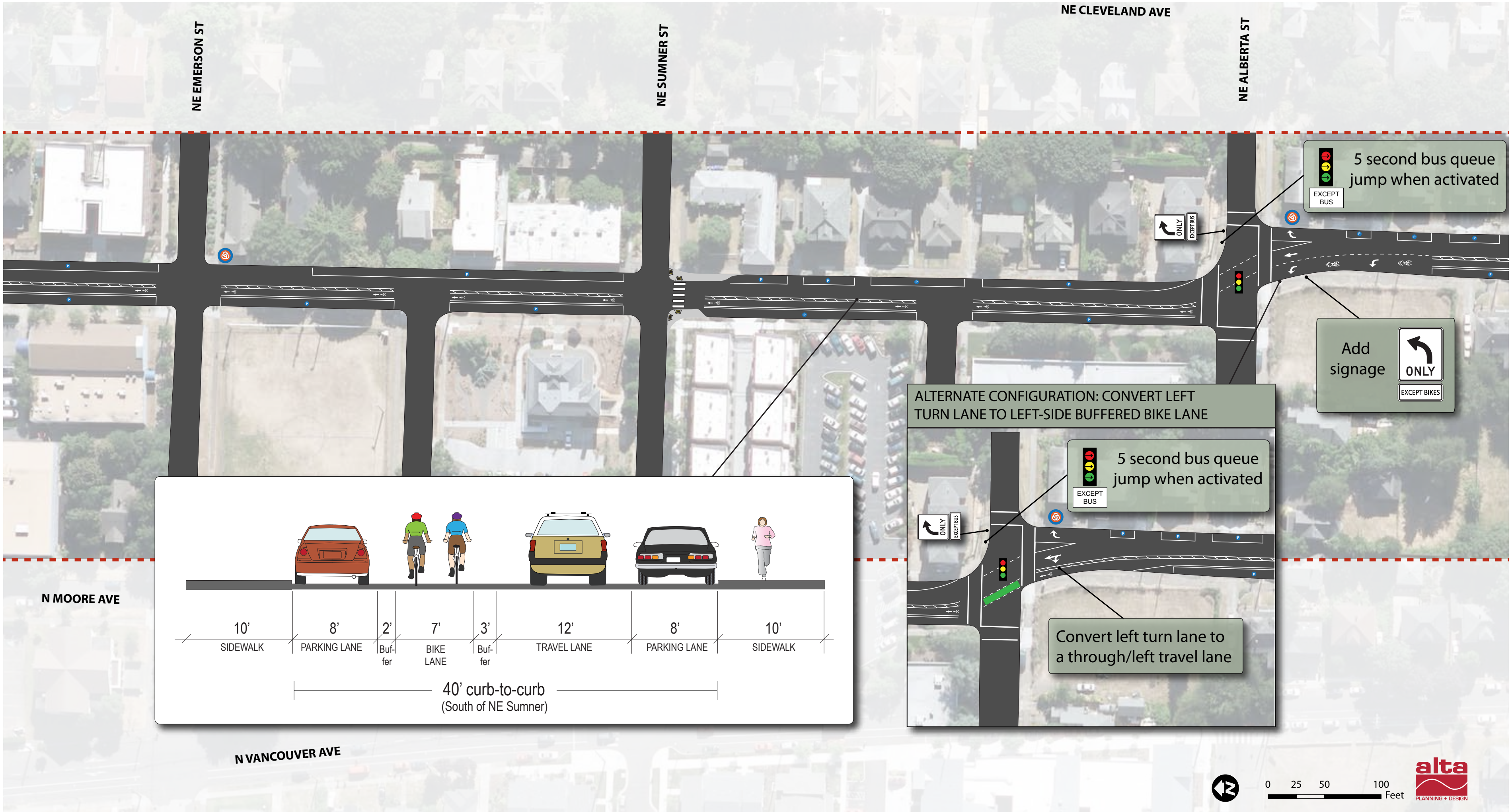
Skidmore Street to Wygant Street

KEY FEATURES

The left-side buffered bike lane begins again after Skidmore Street and continues through to the project's terminus at Killingsworth Street. Going Street is a designated Neighborhood Greenway, so an increased design emphasis for bicyclists and pedestrians has been developed here. The curb extension helps to improve the visibility of pedestrians and reduce the crossing distance, while the green turn box helps right-turning bicyclists do so comfortably.

RECOMMENDED CONCEPT DETAILS

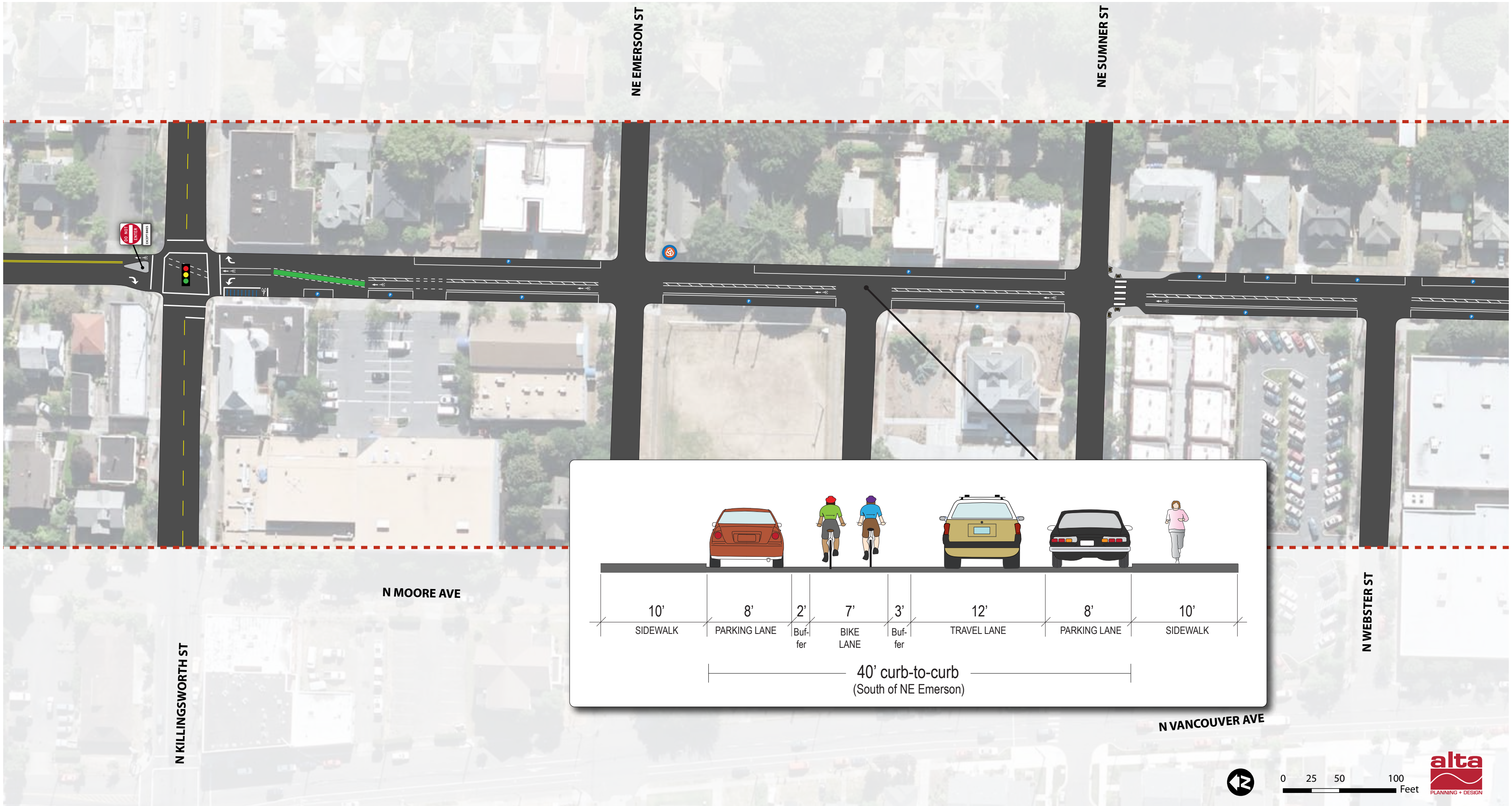
Alberta Street to Emerson Street



KEY FEATURES

The off-set intersection with Alberta Street and the existing bus stop in the right turn only lane were challenges in this section. To better facilitate movement of bus traffic a bus queue jump is proposed, similar the one at Southeast Belmont Street and Southeast Cesar Chavez Blvd. In addition, two separate intersection designs are under consideration for accommodating through bicycle traffic and left-turning motorists.

Emerson Street to Killingsworth Street



KEY FEATURES

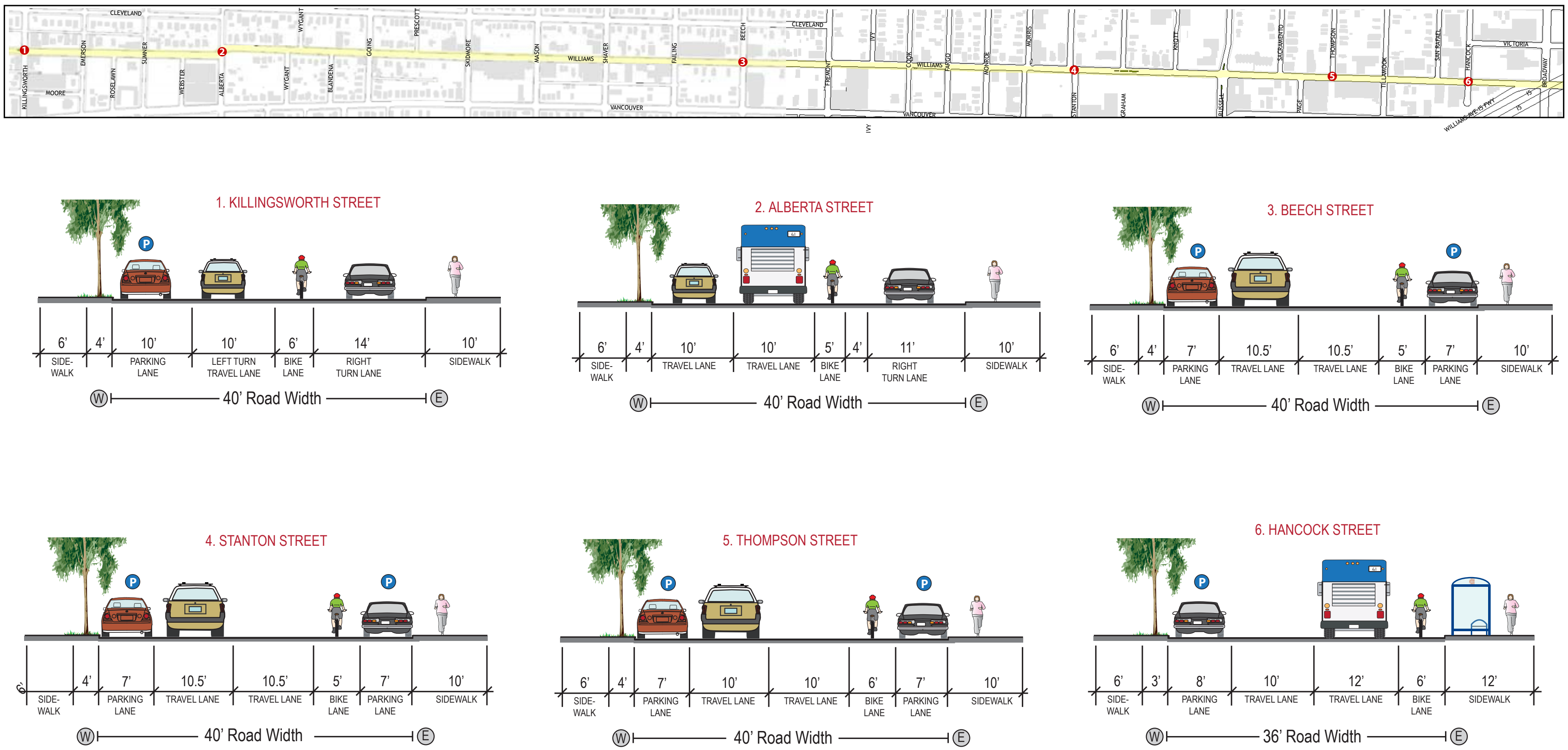
The treatment in advance of the intersection with Killingsworth Street involves the use of green thermoplastic to highlight the conflict area between merging motorists and through bicyclists. The bike lane pocket positions bicyclists for good access to the existing Neighborhood Greenway north of the intersection.

EXISTING CONDITIONS

To provide information on opportunities and constraints on potential pedestrian and bicycle design treatments, the existing conditions analysis identifies traffic volumes and operations, parking supply and demand, public transportation supply and demand, and bicycle/pedestrian safety issues along the North Williams corridor. Figure 1 shows existing cross sections on the North Williams corridor.

North Williams Traffic Operations Safety Project

January 2011



Measurements taken using GIS from 2009 Orthro Imagery provided by the City of Portland

EXISTING CROSS SECTIONS - NORTH WILLIAMS AVENUE

FIGURE 1

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING / PLANNING

alta

NE 47th Avenue

Stormwater, Pedestrian Environment, Freight Movement

NE 47th Avenue is a freight street. It is currently an approximately 24-foot center strip asphalt street that is funded to be rebuilt within its 60-foot right of way between NE Columbia Boulevard and NE Cornfoot Road.

The issues considered for this roadway have been how to provide a separated bicycle facility on a roadway with high freight traffic, high posted speed (40 mph) and how to provide a good sidewalk environment. There is an attractor park along accessed from the roadway that is a significant destination for school field trips.

In limited right of way the first consideration was to provide a raised bikeway. This created issues for getting stormwater to the planter strip, which also includes bioswales. There was also concern that the raised bikeway would destabilize goods carried in the trailers of interstate vehicles (AASHTO references issues with freight vehicles unevenly mounting raised roadway elements during a turning movement, as when entering a driveway).

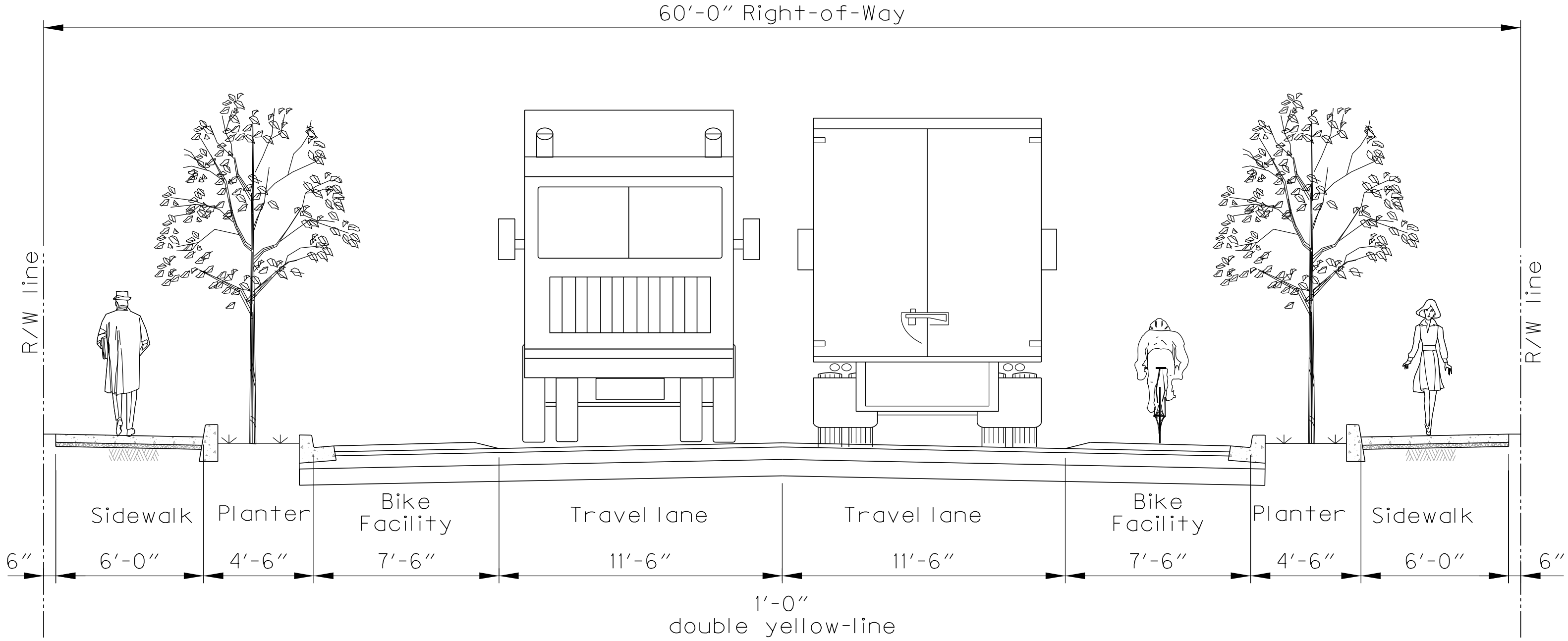
Following are cross-sections showing the range of options considered (A through F). Option C shows a narrow (6") curb between the travel lane and bikelane. We rejected this option because we believe the curb will

a) be difficult to see (concrete on concrete)
b) is sufficiently narrow so as to catch errant tires and direct vehicles into the bike lane rather than keep them out of it

PBOT recently decided to implement Option F as this is expected to be a relatively low volume route for pedestrians.

NE 47th Avenue

OPTION A
Raised Cycle Track



PROS:

- Raised cycle track most comfortable for cyclists

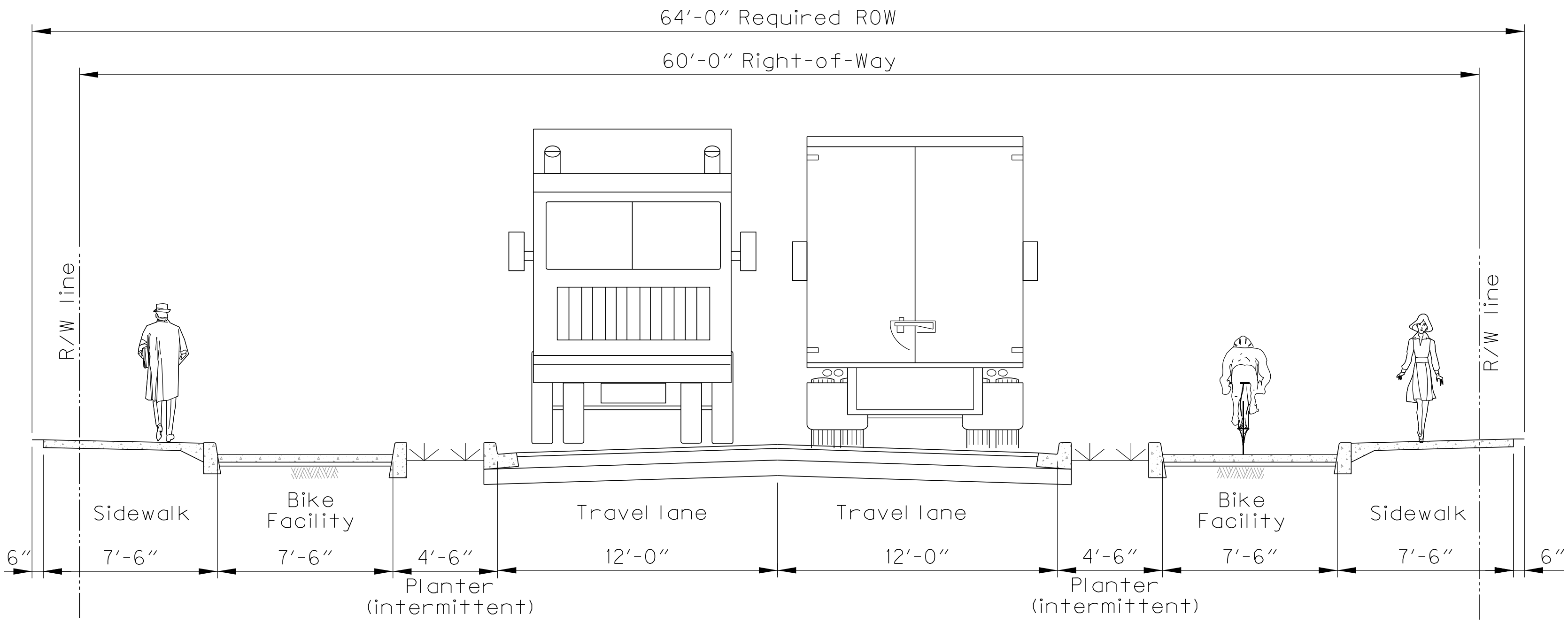
CONS:

- Have to pipe water from travel lane - deep planters = handrail, tall walls.
- Alternative (stormfilters) won't work because storm sewer too shallow.

NE 47th Avenue

OPTION B

Bike Lane Buffered by Storm Planters



PROS:

- Protected bike facility
- 12' travel lanes
- Easily drain roadway to stormwater facilities

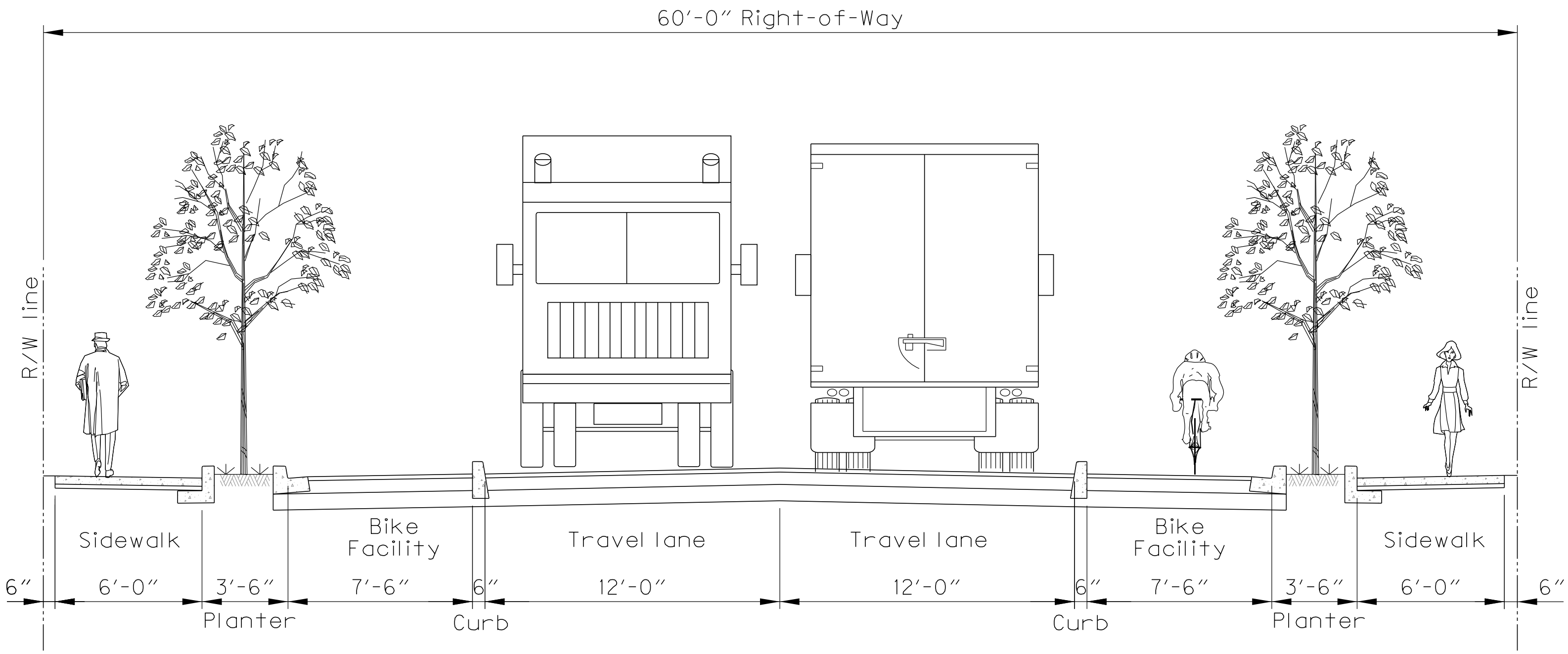
CONS:

- Need additional ROW
- No street trees/buffer for pedestrian zone

NE 47th Avenue

OPTION C

Bike Lane Buffered by Intermittent Curb



PROS:

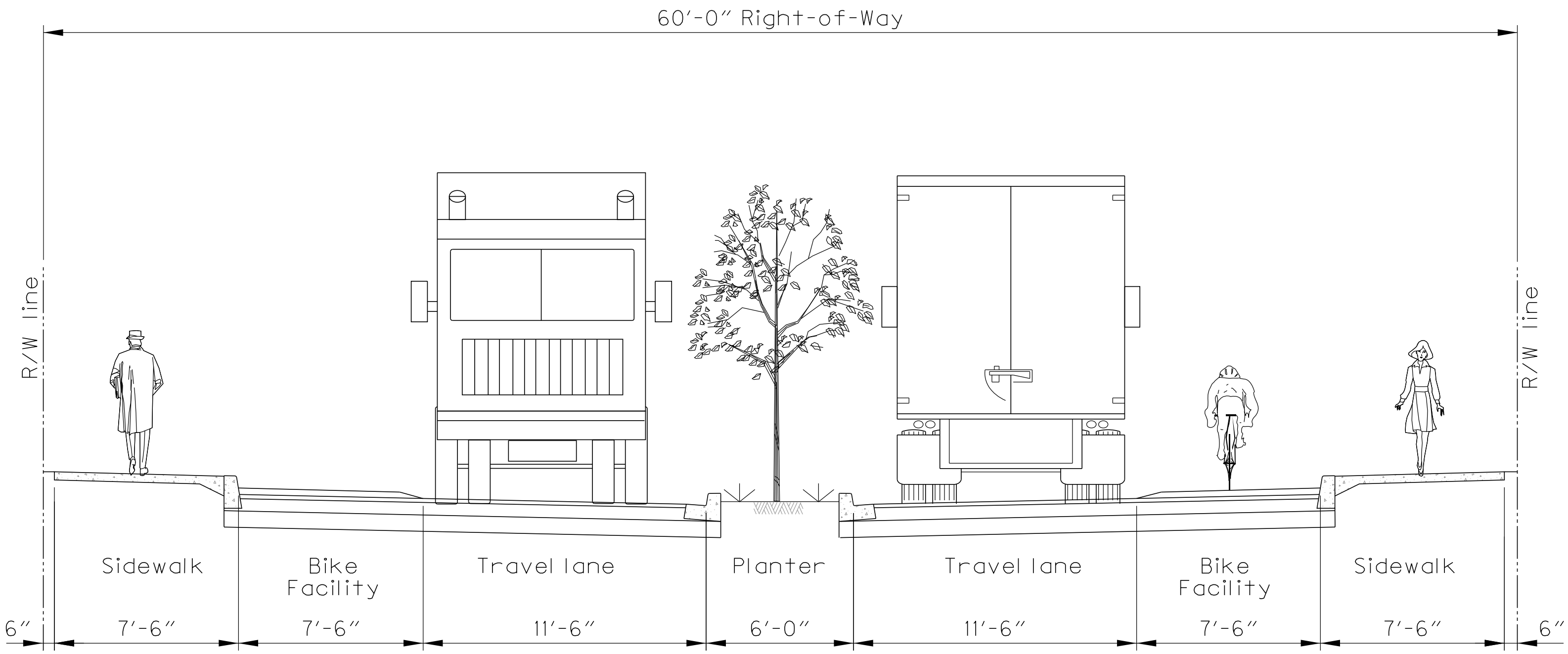
- Protected bike facility
- 12' travel lanes
- Easily drain roadway to stormwater planters
- Enough room to include planting strip with trees
- MEETS EVERYONE NEEDS

CONS:

NE 47th Avenue

OPTION D

Raised Cycle Track with Center Median



PROS:

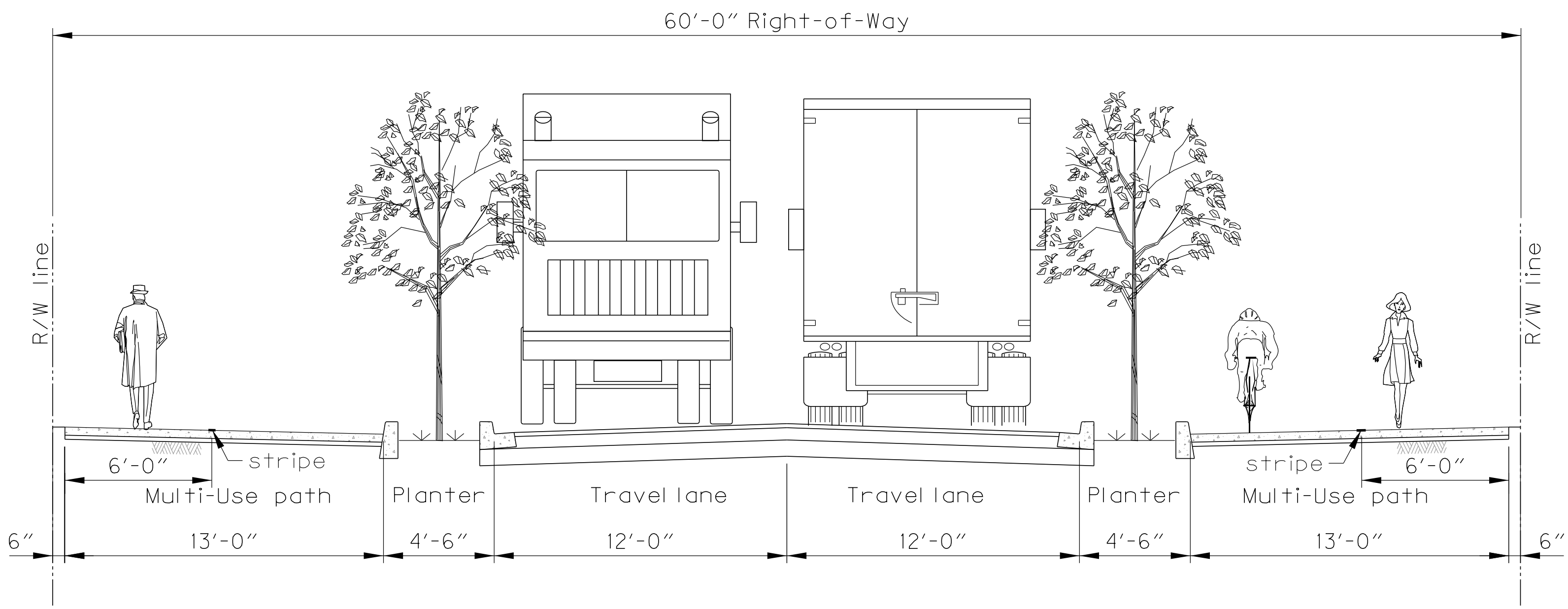
- Raised cycle track most comfortable for cyclists
- Valley gutter solves stormwater drainage issue

CONS:

- No street trees/buffer for pedestrian zone

NE 47th Avenue

OPTION E
Multi-Use Path



PROS:

- 12' travel lanes
- Easily drain roadway to stormwater facilities
- Planting strip w/ street trees for buffer from traffic

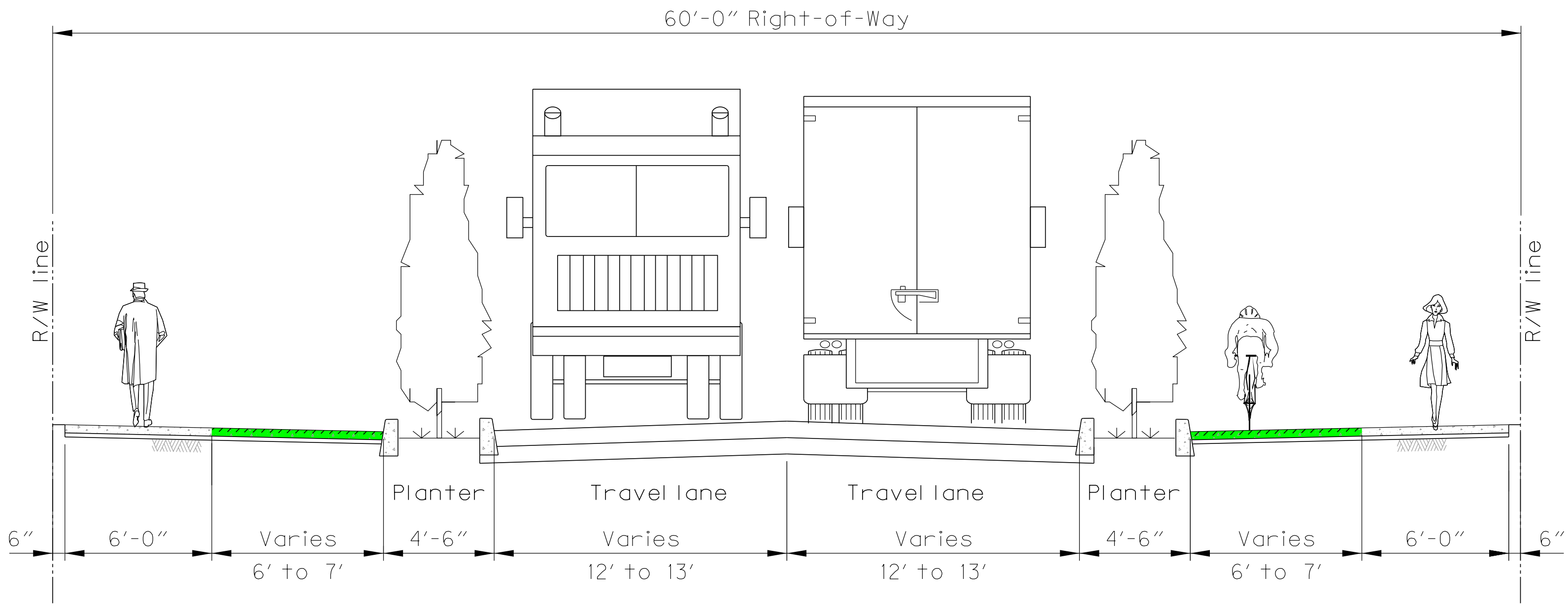
CONS:

- Less separation between bikes and pedestrians

NE 47th Avenue

OPTION F

Separated Split Mode

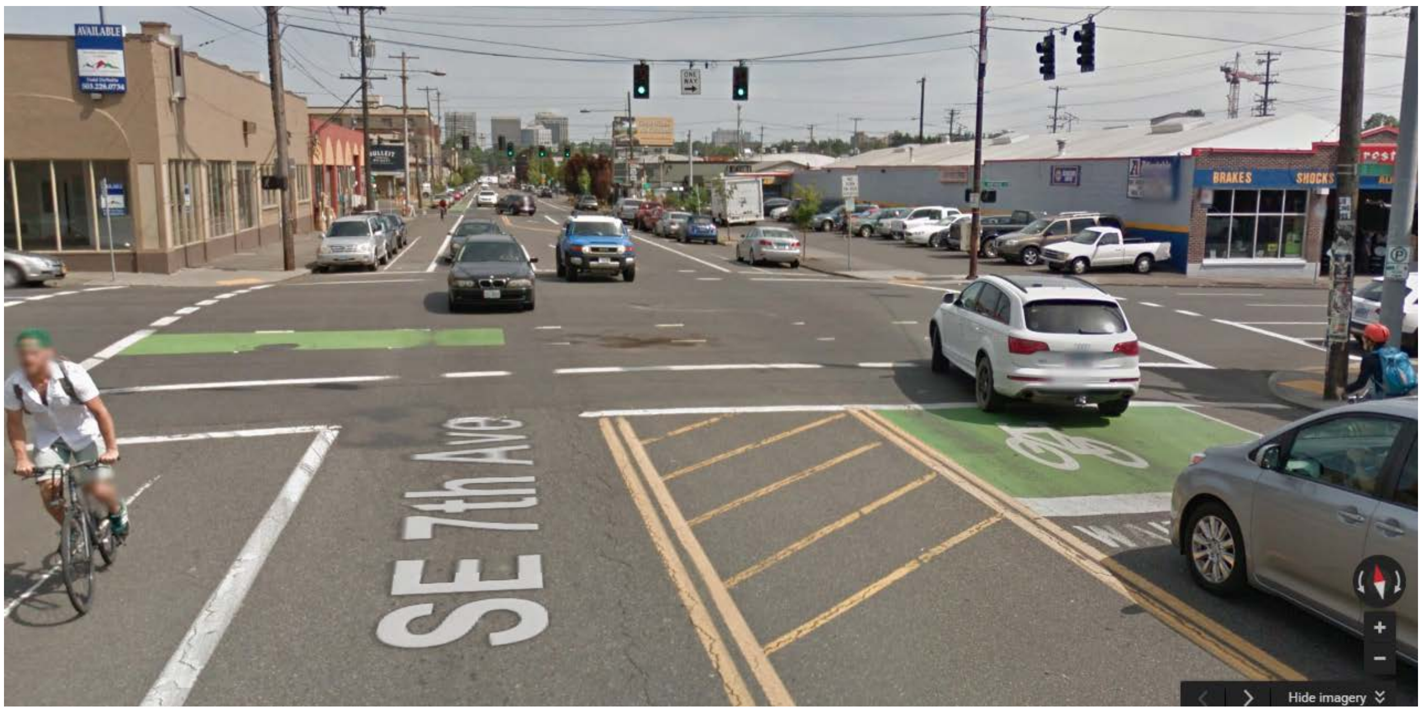


Typical Cross-Sections

Working within limited space

The following cross-sections show typical curb-to-curb widths in Portland and suggested designs for better bicycle facilities. How can these designs best be altered to allow for separated bicycle lanes? Generally, these roadways have two 12-foot sidewalk corridors. See typical designs for sidewalk corridors—from Portland's Pedestrian Design Guide—at the end of this section. The entire Pedestrian Design Guide can be found here: https://www.portlandoregon.gov/article/437808

Of especial interest is are designs for the 56-foot curb-to-curb section. An screenshot of such a roadway is shown below. How would this roadway best be transformed to provide protected bikeways, stormwater, etc?

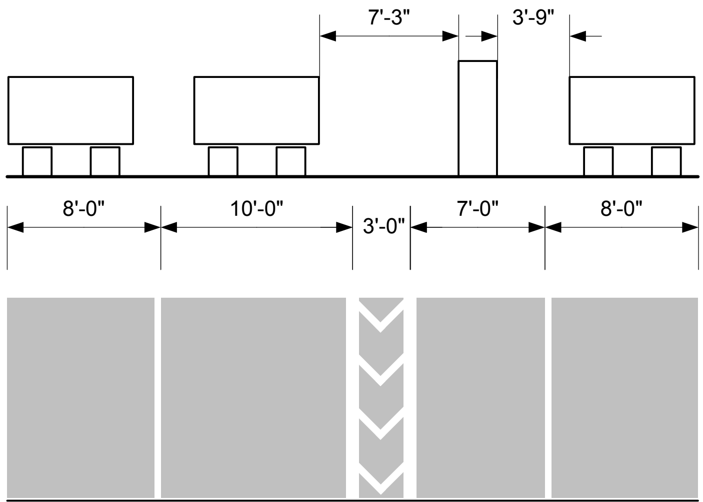


SE 7th Avenue in Portland, looking north.

56-foot curb-to-curb cross-section.

36-foot one-way roadway

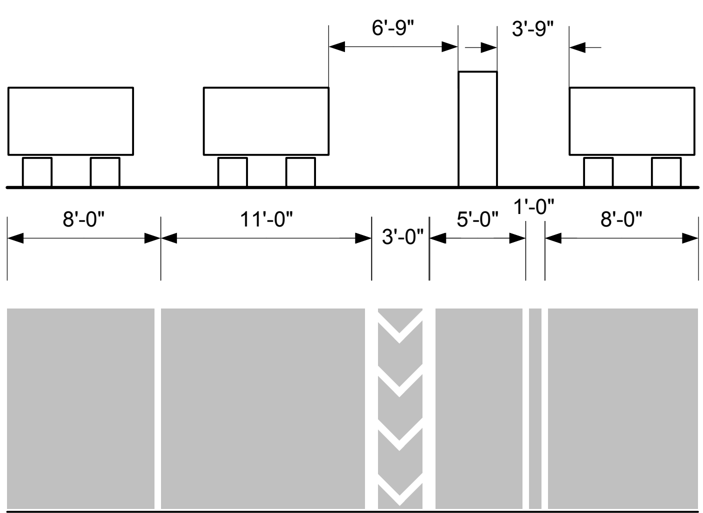
Buffered lane option A



This is appropriate for relatively low-volume 36-foot wide couplet streets, as on NW 18th & 19th Avenues.

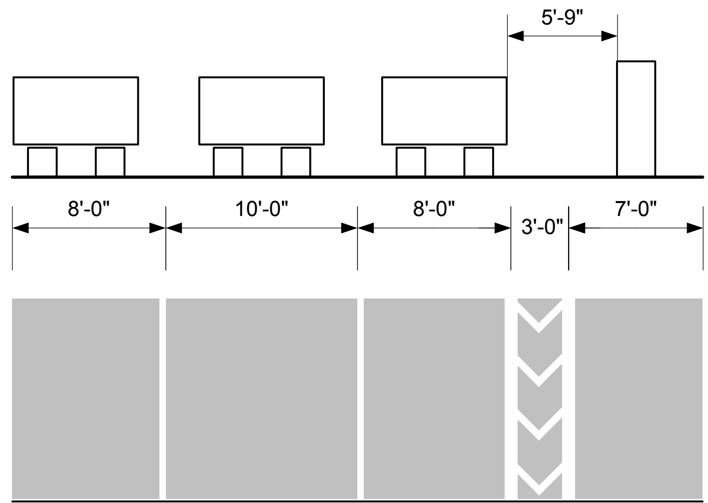
In this design the buffer can be narrowed to 2' in order to provide for an 11' travel lane. An additional buffer could also be placed between the on-street parking and bicycle area.

Buffered lane option B



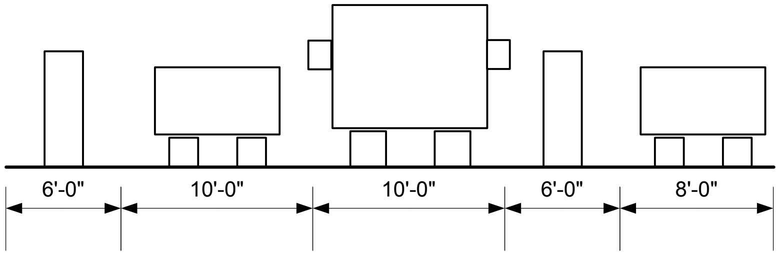
This option reconfigures the buffers to widen the travel lane and provide a delineated buffer adjacent to parking.

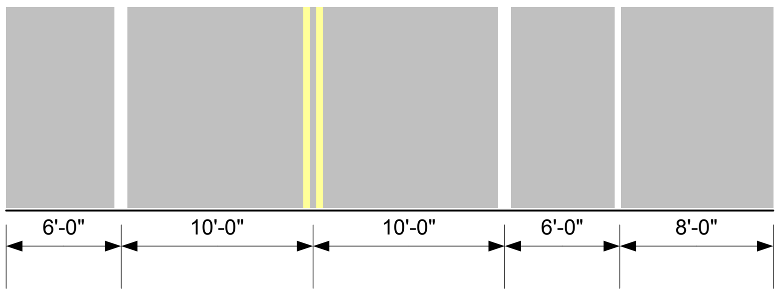
Cycle track option



A second option is to reverse the position of parking and bikeway to create a parking-protected cycle track, at the cost of more on-street parking at intersections and driveways.

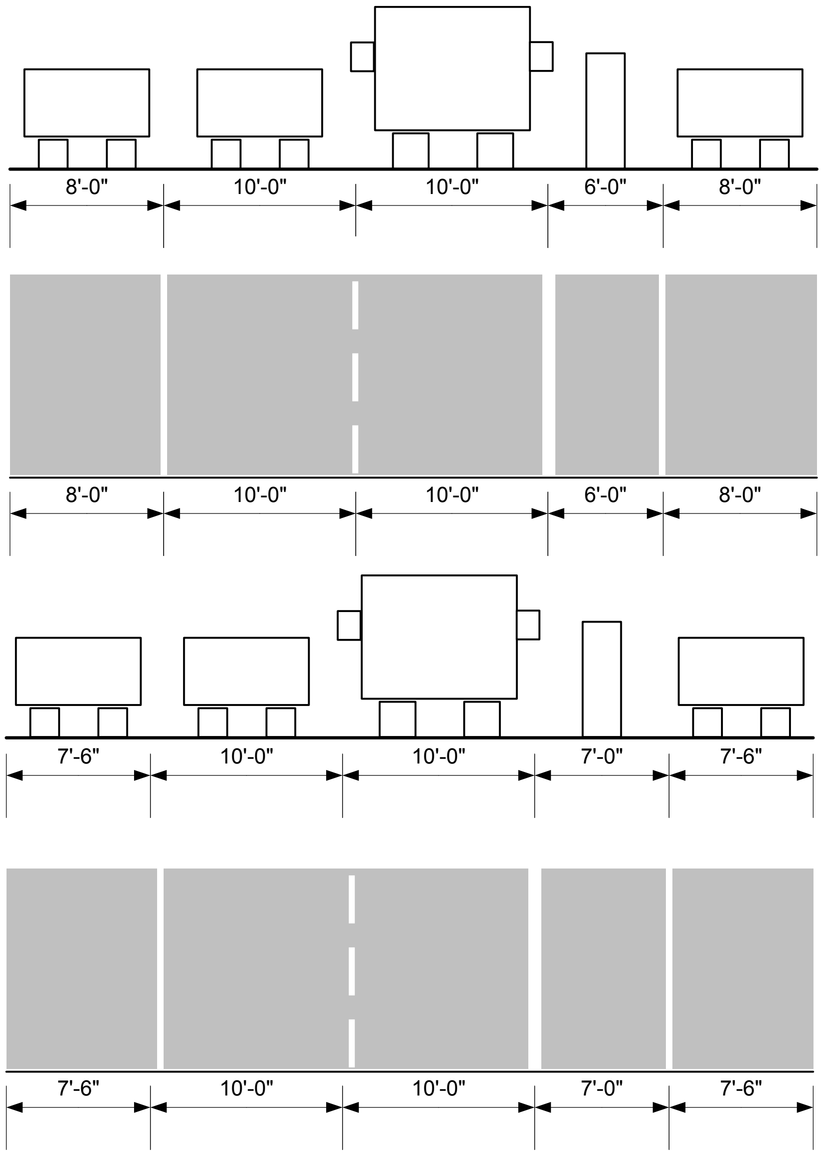
40-foot two-way roadway





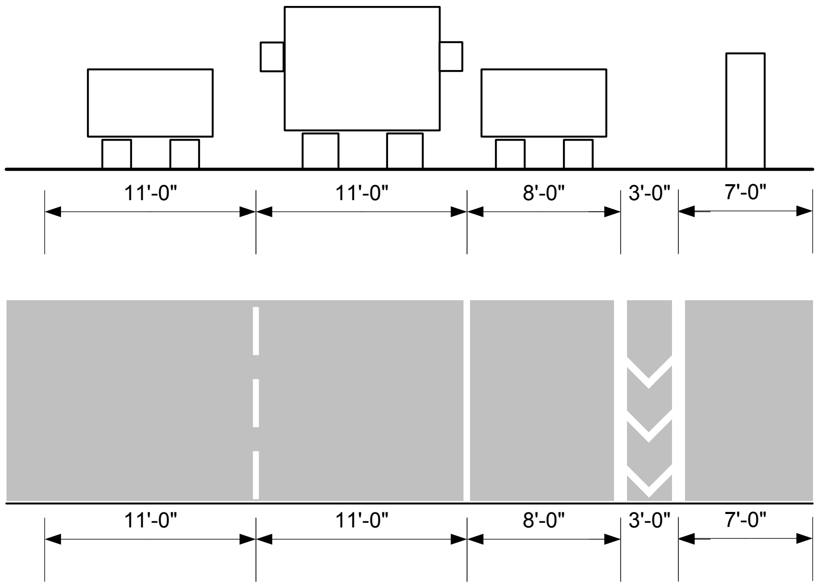
This is the approved typical design for SE 52nd Avenue between Woodstock and Division. To provide minimum six-foot bicycle lanes travel lanes are kept to ten feet.

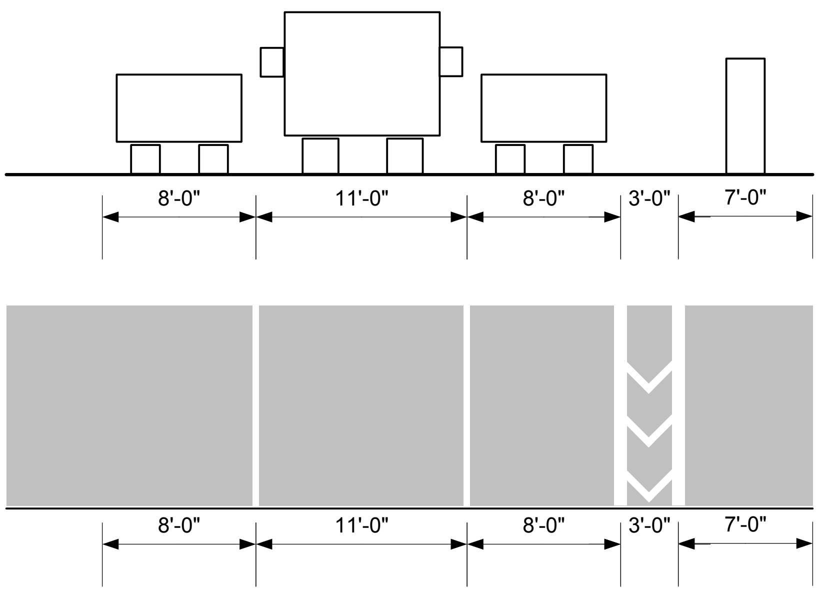
42-foot one-way roadway



These are designs that could work on NE Halsey/Weidler

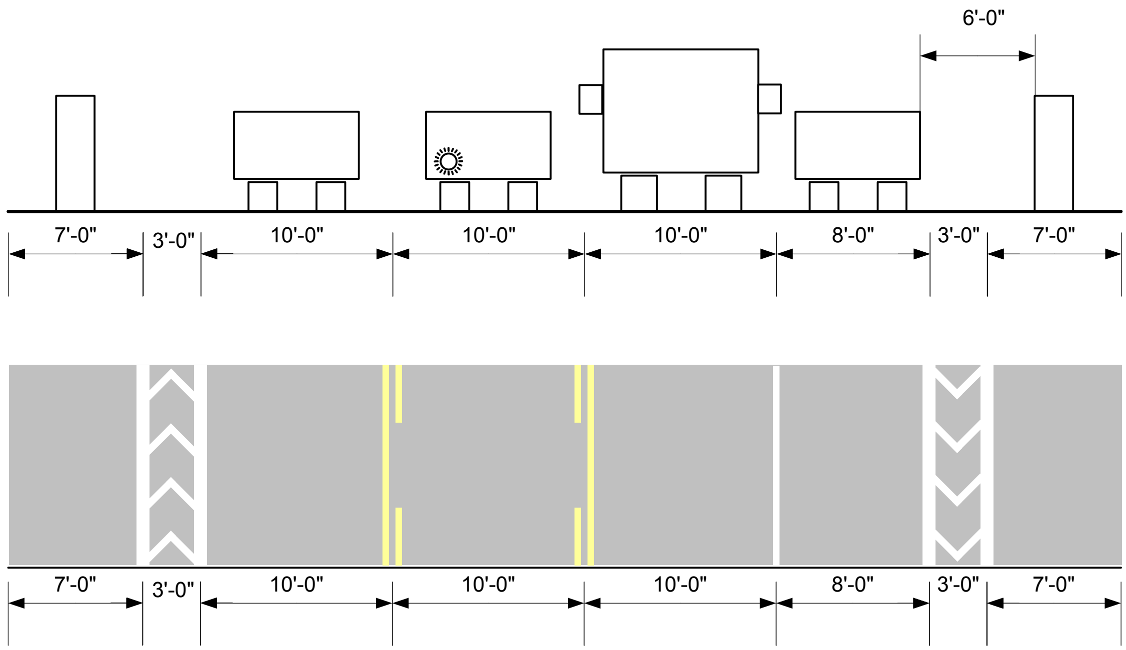
42-foot one-way roadway





These designs leave extra roadway width: two feet with parking removed on one side and five feet with a travel lane removed.

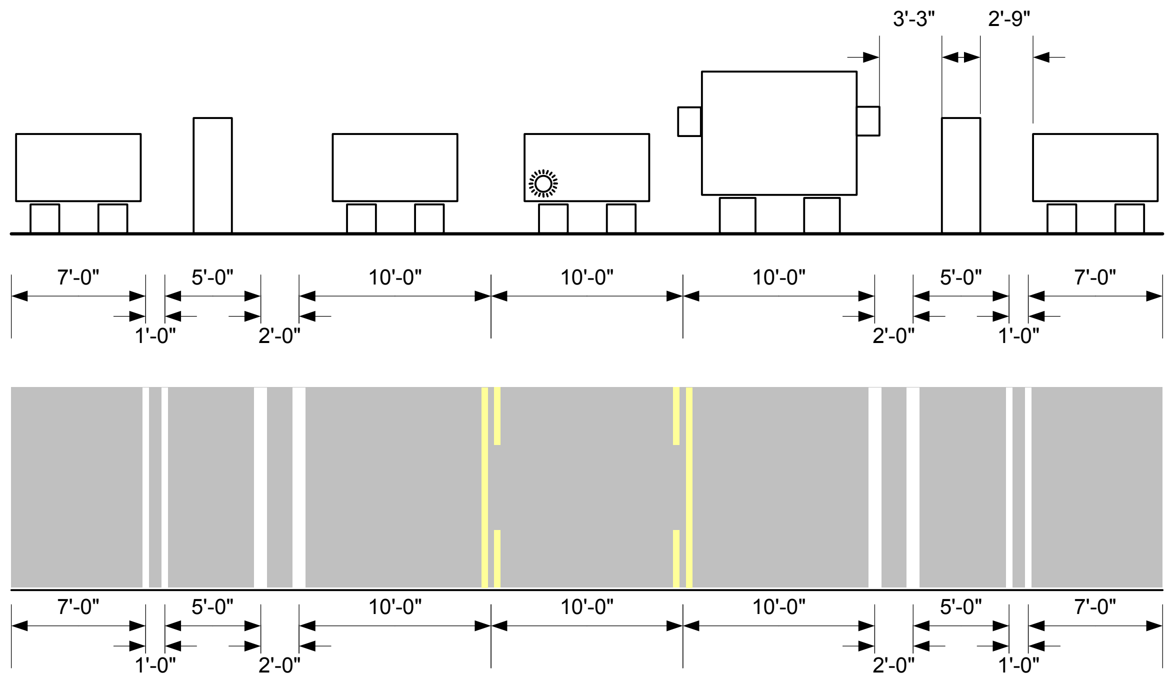
58-foot two-way roadway



This is a the width and desired cross-section for NE Multnomah Boulevard.

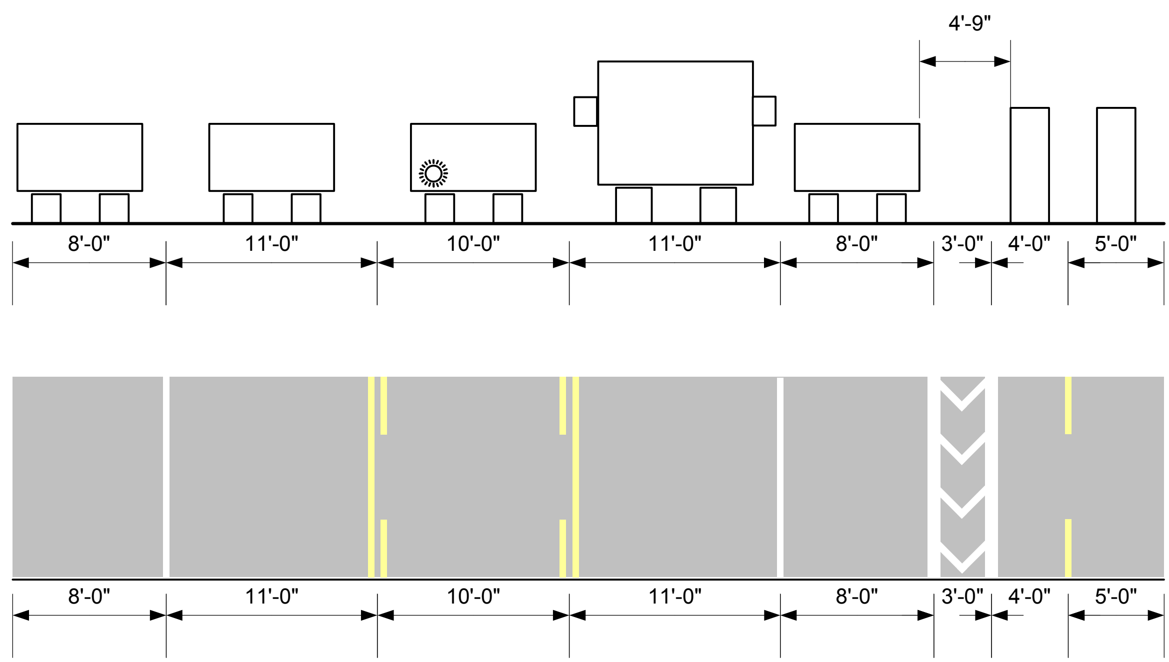
Ten foot travel lanes will work well in this section—regardless of vehicle size, because of the ample buffer on either side of the travel lanes.

60-foot two-way roadway



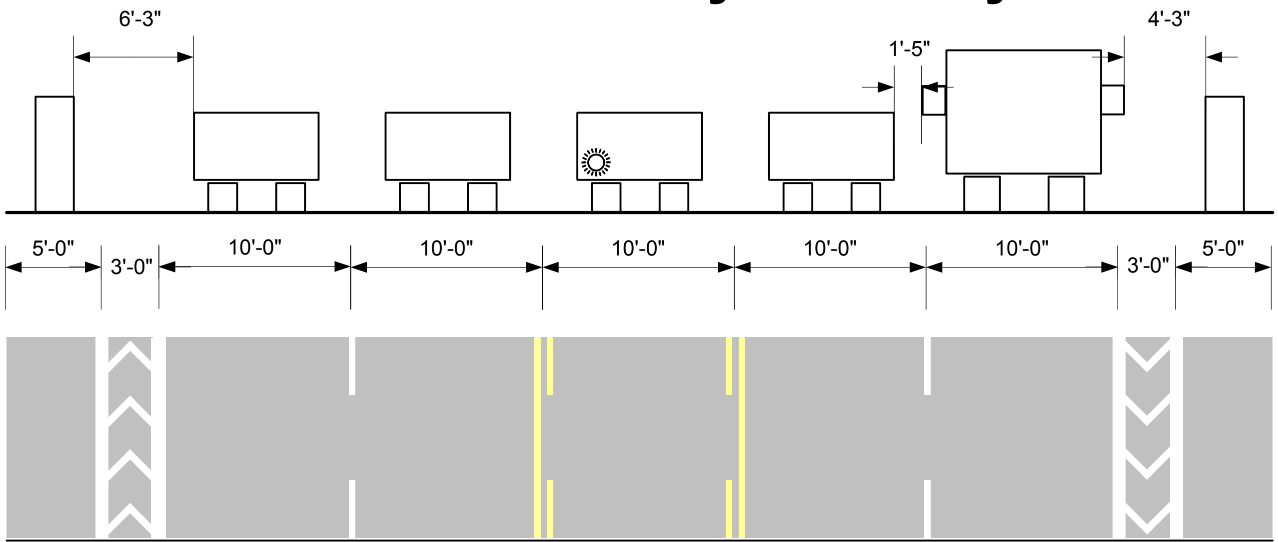
This is a suggested design for SE Foster Rd. Features include:
Buffered parking, which creates greater separation between parked cars and people bicycling. This has the benefit of creating more comfortable riding conditions, but it comes at a cost of providing side-by-side riding. The same is true for the buffered bicycle lane.

Ten-foot travel lanes work especially well in this configuration because of the center turn lane and their adjacency to buffered bicycle lanes.



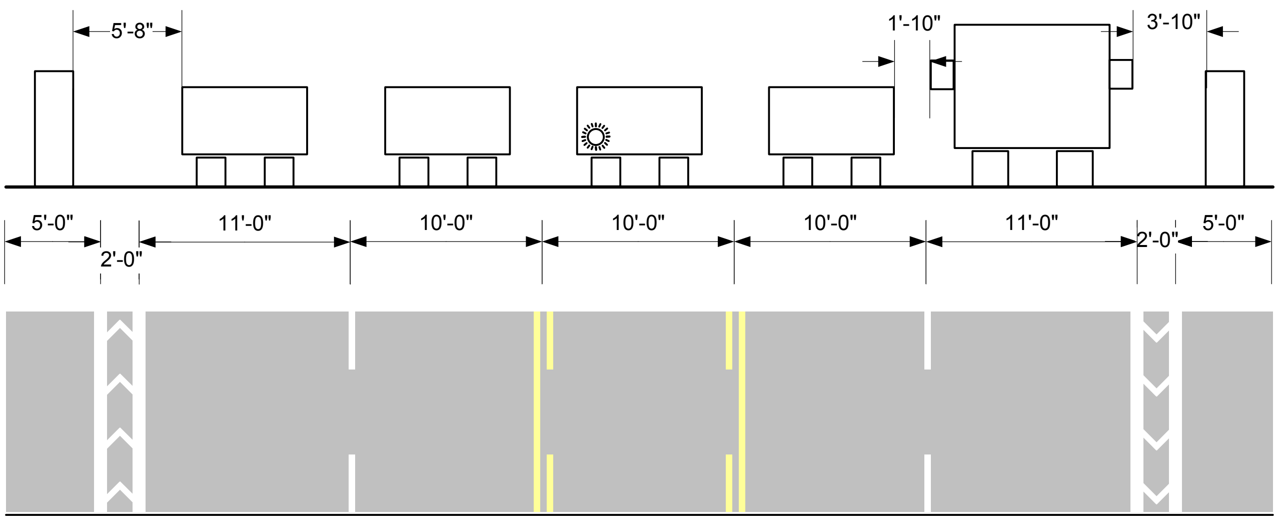
Al alternative design would allow for a two-way cycle track on one side of the roadway, protected by on-street parking. If roadway is heavily used by transit and/or freight consider widening the travel lanes to 11' (as shown here) to account for closer adjacency to on-street parking.

66-foot two-way roadway

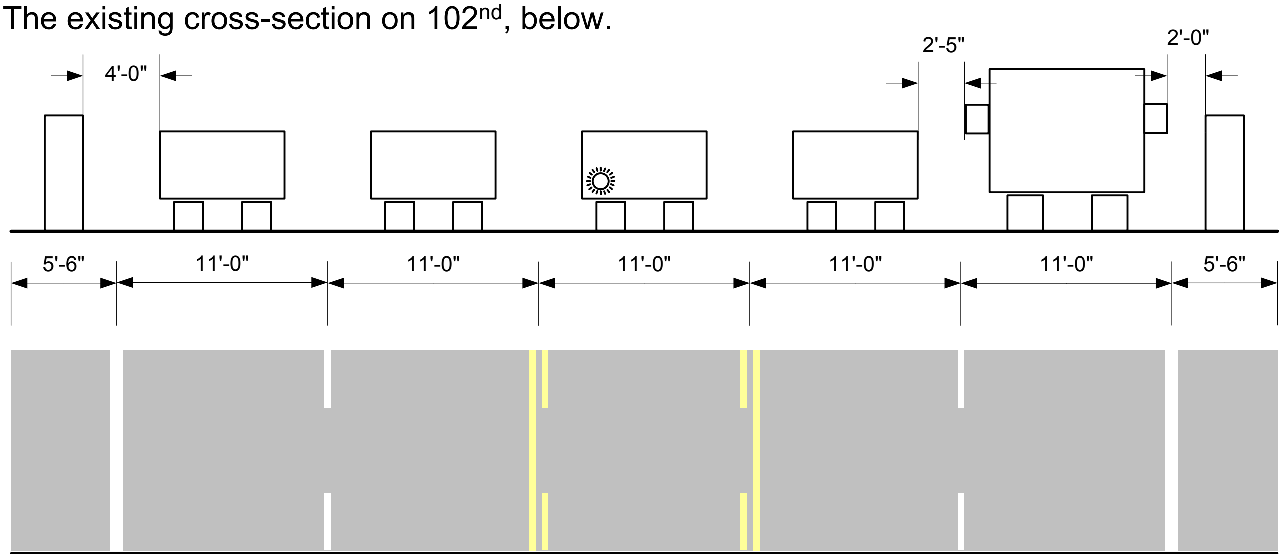


This is a suggested design for 102nd Avenue. The buffers provide significant separation between moving vehicles and people bicycling.

Ten-foot travel lanes work especially well in this configuration because of the center turn lane and their adjacency to buffered bicycle lanes.



An alternate cross-section is shown above with 11-foot outside lanes and 2-foot buffers. The existing cross-section on 102nd, below.



Cornfoot Road Improvements:
a model for active transportation in freight districts

Trammel Crow will be making improvements to Cornfoot Road as part of their development of the site at the northwest corner of the Alderwood-Cornfoot intersection. Standard improvements would include two six-foot bicycle lanes, stormwater swales and a sidewalk. An improved alternative would be a shared pathway separated from the travel lanes by the swale. This general design type has been employed along North Lombard between Marine Drive and Rivergate Boulevard. This design types works well in areas with low relatively low pedestrian use in areas with high truck use and high speeds.

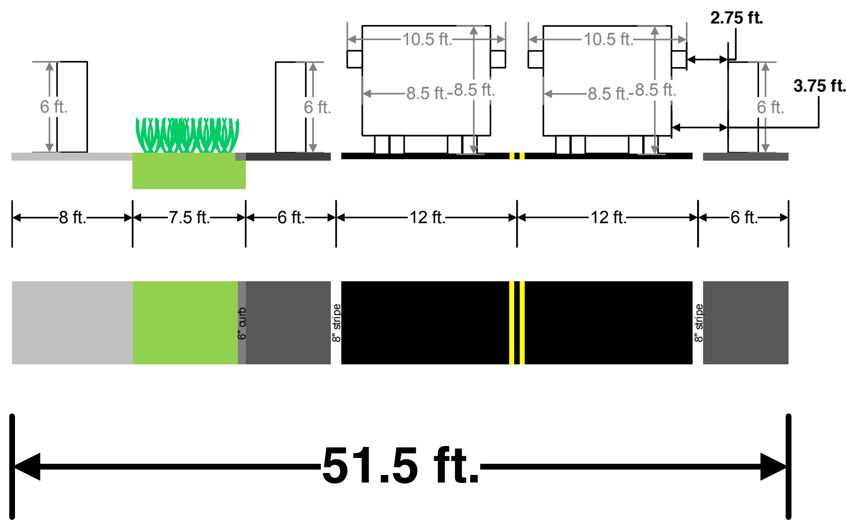
Advantages of the standard design

Bike lanes serve as roadway shoulders

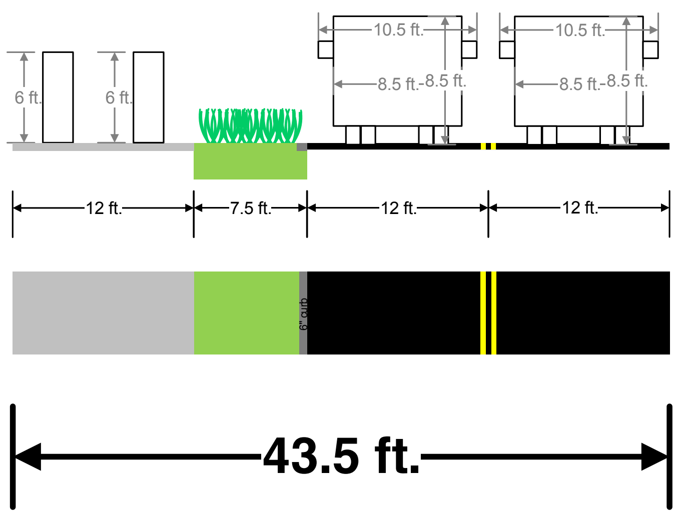
Disadvantages of the standard design

Most people are uncomfortable bicycling on roadway in standard bicycle lanes in this position

Standard design



Improved design



Advantages of the improved design

Creates comfortable cycling conditions for users of all ages and abilities
Creates more comfortable operating conditions for vehicles on roadway
Requires less overall width
Minimizes impermeable surface
Less cost

Disadvantages of the improved design

Creates shared pedestrian-bicycle environment
Delay for people bicycling at intersections

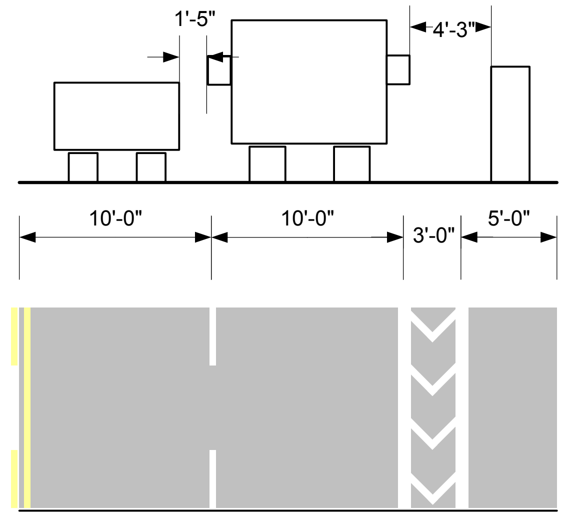
While there is strong support for this design in principal, in this particular case its implementation may require relocation of water mains and deconstruction of roadway and sidewalk already constructed west of the Alderwood intersection. This all will have to happen in a short time frame as the applicant is seeking permits to begin construction immediately.

Configuring protected and buffered lanes

Different facility types can provide similar levels of separation, and thus comfort for people bicycling, in different configurations, depending on materials and treatments used.

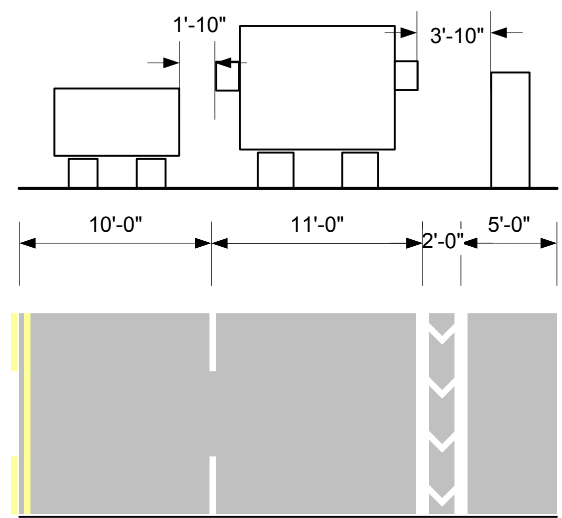
8-foot buffered bicycle lane

This standard buffered bicycle lane uses 8' of width to provide five feet of riding area and a three foot buffer. This creates more than 4 feet of separation between people bicycling and adjacent large vehicles.



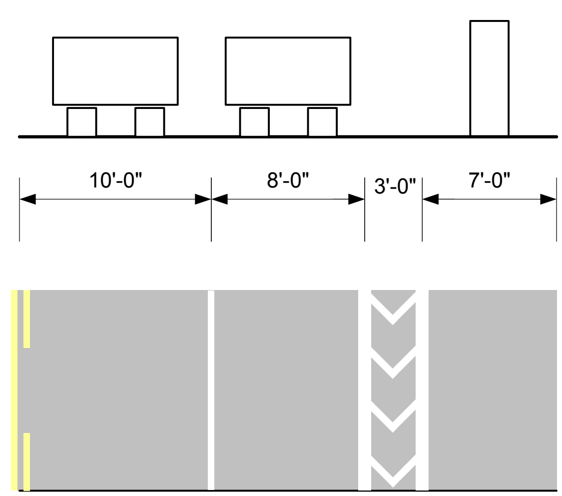
7-foot buffered bicycle lane

This slightly narrower buffered bicycle lane uses 7' of width to provide five feet of riding area and a two foot buffer. Relative to the 8-foot buffered bicycle lane it has decreased separation between large vehicles and people bicycling and slightly greater separation between adjacent motor vehicles.



Parking protected cycle track

With a parking-protected cycle track a minimum 3-foot buffer needs to be maintained for a pedestrian refuge zone. The riding area could go to a minimum 5-feet, which would still allow a sweeper to comfortably maintain the area.



Portland Pedestrian Design Guide

City of Portland
Office of Transportation
Engineering and Development
Pedestrian Transportation Program

Table A-1 Recommended Widths for Sidewalk Corridor Zones

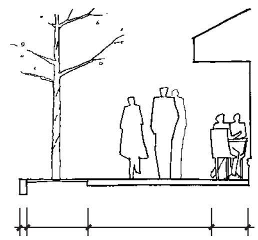
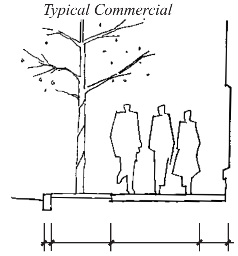
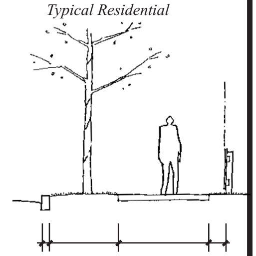
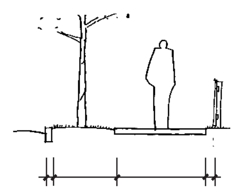
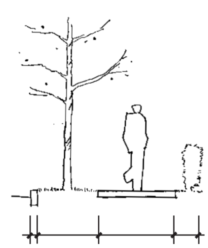
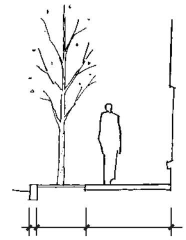
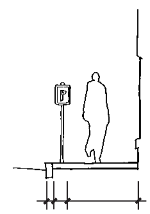
Sidewalk Corridor	Application	Recommended Configuration
4.6 m (15' - 0")	**Recommended** in Pedestrian Districts, especially for arterial streets or where ROW width is 24.5 m (80'-0").	 Curb Zone: 150 mm (0' - 6") Furnishings Zone: 1.2 m (4' - 0") Through Pedestrian Zone: 2.5 m (8' - 0") Frontage Zone: 750 mm (2' - 6")
3.7 m 12' - 0"	**Recommended** for City Walkways, for local streets in Pedestrian Districts, and for streets where ROW width is 18.2 m (60'-0").	*Typical Commercial*  *Typical Residential*  Curb Zone: 150 mm (0' - 6") Furnishings Zone: 1.2 m (4' - 0") Through Pedestrian Zone: 1.9 m (6' - 0") Frontage Zone: 450 mm (1' - 6")
3.4 m 11' - 0"	**Recommended** for Local Service Walkways where ROW width is 15.2 m (50'-0"). **Accepted** for City Walkways where ROW width is 15.2 m (50'-0") provided Through Pedestrian Zone is 1.9 m (6'-0").	 Curb Zone: 150 mm (0' - 6") Furnishings Zone: 1.2 m (4' - 0") Through Pedestrian Zone: 1.9 m (6' - 0") Frontage Zone: 150 mm (0' - 6")
3.0 m (10' - 0")	**Recommended** for Local Service Walkways in residential zones of R-7 or less dense where ROW width is less than 15.25 m (50'-0").	 Curb Zone: 150 mm (0' - 6") Furnishings Zone: 1.2 m (4' - 0") Through Pedestrian Zone: 1.5 m (5' - 0") Frontage Zone: 150 mm (0' - 6")

Table A-1 Recommended Widths for Sidewalk Corridor Zones, continued

<table>
<tr><th>Sidewalk Corridor</th><th>Application</th><th colspan="4">Recommended Configuration</th></tr>
<tr><td rowspan="3">2.7 m
(9' - 0")</td><td rowspan="3">NOT RECOMMENDED for new construction or reconstruction.
Accepted in existing constrained conditions when increasing the Sidewalk Corridor is not practicable.
Note: Minimum Sidewalk Corridor for placement of street trees. Street trees not allowed in Furnishing Zone less than 900 mm (3'-0").</td><td colspan="4"></td></tr>
<tr><td>Curb Zone</td><td>Furnishings Zone</td><td>Through Pedestrian Zone</td><td>Frontage Zone</td></tr>
<tr><td>150 mm
(0' - 6")</td><td>900 mm
(3' - 0")</td><td>1650 mm
(5' - 6")</td><td>0 m
(0' - 0")</td></tr>
<tr><td>less than
2.7 m
(9' - 0")</td><td rowspan="6">NOT RECOMMENDED.
Accepted in existing constrained conditions when increasing the Sidewalk Corridor width is not practicable.</td><td colspan="4">
</td></tr>
<tr><td></td><td>Curb Zone</td><td>Furnishings Zone</td><td>Through Pedestrian Zone</td><td>Frontage Zone</td></tr>
<tr><td>2.4 m (8' - 0")</td><td rowspan="4">150 mm
(0' - 6")</td><td>600mm
(2' - 0")</td><td>1650 mm
(5' - 6")</td><td rowspan="4">0 m
(0' - 0")</td></tr>
<tr><td>2.1 m (7' - 0")</td><td>450mm
(1' - 6")</td><td>1500 mm
(5' - 0")</td></tr>
<tr><td>1.8 m (6' - 0")</td><td>300 mm
(1' - 0")</td><td>1350 mm
(4' - 6")</td></tr>
<tr><td>1.5 m (5' - 0")</td><td>0 m</td><td>1350 mm
(4' - 6")</td></tr>
</table>

Note: Metric and English units are not equivalent. Use metric units for metric projects and English units for English projects.