CITY OF TIGARD, OREGON
TIGARD CITY COUNCIL
ORDINANCE NO. 16-12

AN AUTHORIZATION ORDINANCE TO ALLOW SUPPORT FOR SITING OF A NEW HIGH-CAPACITY TRANSIT CORRIDOR FOR LIGHT RAIL TRANSIT SERVICE WHICH INCLUDES DOWNTOWN TIGARD, RELATED AMENDMENTS TO THE COMPREHENSIVE PLAN AND LAND USE REGULATIONS, PROVIDING REQUIRED INFORMATION AND OTHER ACTIONS.

WHEREAS, the City of Tigard City Charter, Section 53A. includes a policy that requires the City to oppose the construction of a new high-capacity transit corridor within the City boundary unless voter approval is first obtained; and

WHEREAS, an extension of light rail transit service to and within the City of Tigard is being considered and such light rail extension constitutes a new high-capacity transit corridor under Section 53A. of the Tigard City Charter; and

WHEREAS, voter approval of an authorization ordinance (under City of Tigard Charter Section 53) allowing the City to support the proposed light rail extension will substantially facilitate the development and construction of the light rail extension; and

WHEREAS, the City of Tigard City Charter Section 53C. provides that the City may not amend its comprehensive plan or land use regulations to accommodate a new high-capacity transit corridor project unless the project has first received voter approval of an authorization ordinance; and

WHEREAS, changes to City of Tigard land use regulations are required to accommodate the proposed light rail extension to the City of Tigard, including downtown Tigard; and

WHEREAS, the Tigard City Council desires to refer the authorization ordinance required under Charter Section 53C. to the voters of the City of Tigard for voter approval on November 8, 2016.

NOW, THEREFORE, THE CITY OF TIGARD ORDAINS AS FOLLOWS:

SECTION 1: A City of Tigard ordinance is hereby created as provided as follows:

NEW HIGH-CAPACITY TRANSIT CORRIDOR AUTHORIZATION ORDINANCE

SECTION A. City of Tigard support for a new high-capacity transit corridor in the City of Tigard boundary, including downtown Tigard, is allowed. The City shall send letters notifying the public officials listed in City Charter Section 53D. of this support.

SECTION B. The City of Tigard is authorized to make changes to the comprehensive plan and land use regulations to allow: (I) light rail to cross wetlands with proper mitigation protecting natural areas, habitat, and water quality; and (II) a light rail maintenance facility to be sited in specified industrial zones.

SECTION C. The following describes aspects of the new high-capacity transit corridor project, which would extend light rail service to the City of Tigard, including downtown Tigard ("Project") as required by City of Tigard City Charter, Section 53C.:

1. Road Capacity: The total change in road capacity as a result of the new high-capacity transit corridor is described in the attached Appendix A and incorporated herein by reference.

2. Housing Density: Increases in housing density are not required to site or otherwise accommodate a new high-capacity transit corridor.

3. Land Use Regulations and Comprehensive Plan: Changes anticipated to be proposed to land use regulations or the comprehensive plan to accommodate light rail are limited to: (I) allowing light rail to cross wetlands with proper mitigation protecting natural areas, habitat, and water quality; and (II) allowing a light rail maintenance facility to be sited in specified industrial zones.

4. Projected Public Cost: the current projected public cost of the entire Project is $2.4-2.8 billion. No new or increase in City of Tigard fees or taxes is proposed for the light rail project under Tigard City Charter Section 52.

SECTION D. The information in this Authorization Ordinance is based on (I) information and data available at the time the Authorization Ordinance is referred to the voters by the City of Tigard Council and (II) the light rail corridor project options sanctioned by the Southwest Corridor Steering Committee at the time the Authorization Ordinance is referred to the voters by the City of Tigard Council.

SECTION 2: The City Council of the City of Tigard finds that this Authorization Ordinance satisfies the requirements of Tigard City Charter Section 53 and Ordinance 16-11.

SECTION 3: The sections, subsections, paragraphs and clauses of this ordinance are severable. The invalidity of one section, subsection, paragraph or clause shall

not affect the validity of the remaining sections, subsections, paragraphs and clauses.

SECTION 4: This ordinance shall be effective upon certification by the County Elections official that it has received voter approval at an election conducted on November 8, 2016.

PASSED: By unanimous vote of all Council members present after being read by number and title only, this 28th day of June, 2016.

Carol A Krager

Carol A. Krager, City Recorder

APPROVED: By Tigard City Council this 28th day of June, 2016.

John L. Cook, Mayor

Approved as to form:

City Attorney

June 28, 2016

Date

APPENDIX A

Roadway Capacity Reduction Analysis
June 20, 2016

MEMORANDUM

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Portland, OR 97205
503.243.3500
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REGISTERED PROFESSIONAL ENGINEER 15148 OREGON OCT. 2, 1990 PETER L. COFFEY
EXPIRES: 12/31/17

DATE: June 20, 2016

TO: City of Tigard

FROM: Peter L. Coffey, PE

SUBJECT: Impacts on Road Capacity of Southwest Corridor Light Rail Transit Project Options

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The City of Tigard Charter requires the City to oppose any high-capacity transit project, such as the proposed options to extend light rail service to Tigard, unless the voters first approve an authorization ordinance supporting the project. The Charter also creates requirements for what must be included in the authorization ordinance. One requirement is that the ordinance must describe the total amount of road capacity or potential future road capacity that may be reduced by the project options.

The Charter requirement does <u>not</u> call for a comprehensive analysis of the impacts and benefits of the light rail options on the road network, it solely focuses on the reduction in road or potential road capacity within the five mile radius around the City of Tigard boundary. A reduction in public right-of-way that is not currently used for a roadway but that could potentially be available for new road or highway lanes in the future must be addressed, whether or not there is any plan for the additional road or highway lanes.

Thus the Charter requires road capacity to be measured on a spatial (or area) basis and to consider the capacity of unused rights-of-way on which no roadways are currently planned. To address the unique requirements of the Charter, the City enacted an ordinance that established the *"Methodology to Estimate the Total Amount of Road Capacity Reduced by a New High-Capacity Transit Corridor,"* which sets in the city's laws a definitive and transparent approach to addressing the Charter requirement regarding road capacity.

This report is prepared in accordance with city's required methodology, and uses the terms defined therein. The analysis is based on alignment options, information, and data available at the time the authorization ordinance is referred to the voters by the City Council. The analysis and findings of this analysis do not supplant the need for future traffic analysis that will be done for the Environmental Impact Statement.

The report finds that while causing a slight loss of road capacity along the overall transportation corridor between Tigard and Portland, the proposed light rail options cause substantial <u>increase</u> in the person-trip capacity of the overall transportation corridor between Tigard and Portland. No loss of existing road capacity occurs in Tigard, although light rail options use some unused right-of-way, primarily alongside

of Interstate 5 that potentially could be available for added lanes should additional lanes be planned in the future. None of the light rail options impact Pacific Highway in Tigard.

Background Traffic Analysis of Barbur Boulevard Corridor

This analysis of the capacity impacts of the Southwest Corridor light rail options on existing roadways focuses on Barbur Boulevard because it is the existing roadway (as opposed to possible future roadways, which are addressed separately later in this report) affected by the proposed light rail options between Tigard and Portland. No lanes on Interstate 5 nor on Pacific Highway in Tigard are impacted by the proposed light rail options, except to the extent that the light rail options may attract more riders and thereby reduce auto traffic on these facilities.[1]

There have been several recent traffic analyses of the Southwest Corridor and Barbur Boulevard in connection with the proposed options to extend light rail to Tigard that evaluated the corridor from downtown Portland to Tigard and Tualatin. [2] These previous traffic analyses concluded that key signalized intersections in the year 2035 will either continue to operate within mobility targets [3] or will not significantly worsen from 2035 No-build conditions with the addition of light rail along Barbur Boulevard.

The City of Portland recently adopted the Barbur Concept Plan for the six-mile Barbur Boulevard corridor from Portland's Central City to the Tigard city limit. Key provisions of this plan are to *"establish safe and comfortable conditions for active transportation"* in the corridor, *"complete pedestrian and bicycle connections and access to transit throughout the corridor,"* and *"prioritize active transportation improvements on Barbur."* [4] To make Barbur Boulevard more pedestrian- and bicycle-friendly, the traffic signals on Barbur Boulevard will need to devote more "green time" for cross-streets to make it easier for pedestrians and bicyclists to cross Barbur Boulevard. Consequently there will be less "green time" for the north-south motor vehicle traffic on mainline Barbur Boulevard. This change in signal timing along Barbur Boulevard results in decreases in *Motor Vehicle Capacity*, and is anticipated whether or not light rail is extended to Tigard.

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[1] Along Interstate 5, all existing lanes remain in each direction and along Barbur Boulevard, south of the Naito Parkway confluence, two through lanes remain in each direction.

[2] *SW Corridor Supplemental Refinement Traffic Impact Analysis Executive Summary Traffic Report*, DKS Associates, March 16, 2016 and *Final SW Corridor Traffic Analysis and Operations Memorandum*, DKS Associates, July 29, 2014.

[3] Mobility targets measured through a volume to capacity ratio (v/c ratio).

[4] *Barbur Concept Plan*, City of Portland, April 2013 (page 48); Resolution No. 37014, adopted by City Council April 24, 2013.

Motor Vehicle Capacity Impacts on Existing Roadways

The *Vehicle Lane Impact Map*, provided as Figure 1, shows the general location of vehicular lanes on *Existing Roadways* that will be displaced or that will be added for general public traffic by an *Alignment Option*. As shown, while there are no impacts along Interstate 5 or on Pacific Highway in Tigard, some use of existing lanes occur in locations along Barbur Boulevard in Portland. However, the changes in the configuration of lanes on Barbur Boulevard may not directly translate into a material change in the Motor Vehicle Capacity of Barbur Boulevard, as the operations of the intersections along Barbur Boulevard must also be taken into consideration.

The design of intersections (including traffic signals) along arterial roadways and interchanges along freeway segments (where weaving and merging conditions exist) are major considerations in determining the *Motor Vehicle Capacity* of these facilities. Intersections and interchanges are typically the controlling bottlenecks of traffic flow and the ability of a roadway system to efficiently carry traffic is generally diminished in these areas. The main consequence of a bottleneck is an immediate reduction in capacity of the roadway. For arterial roadways such as Barbur Boulevard, the controlling bottlenecks are signalized intersections, and the most congested of these intersections are referred to as *Critical Intersections*.

Net Motor Vehicle Capacity Reduction on Existing Roadways

Using the recent traffic analyses for the SW Corridor, [5] the Barbur Boulevard corridor was assessed to identify *Critical Intersections* associated with the proposed *Alignment Options*. Since Interstate 5, Pacific Highway in Tigard, and other corridor routes are not impacted by any *Alignment Option*, there was no need to assess *Critical Intersections* on those facilities.

Intersections on Barbur Boulevard were identified as *Critical Intersections* if the overall intersection *Volume to Capacity Ratio* (V/C Ratio) forecasted for the year 2035 was greater than 0.90. The following intersections met this criterion:

- Barbur Boulevard and 60th Avenue (AM peak)
- Barbur Boulevard and Capitol Highway (AM and PM peak)
- Barbur Boulevard and 24th Avenue/I-5 SB Off-Ramp (AM peak)

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[5] *SW Corridor Supplemental Refinement Traffic Impact Analysis Executive Summary Traffic Report*, DKS Associates, March 16, 2016 and *Final SW Corridor Traffic Analysis and Operations Memorandum*, DKS Associates, July 29, 2014.[6] The 4th Avenue/Caruthers Street/Broadway intersection in downtown Portland is controlled by downstream congestion at the 6th Avenue/Broadway intersection, the on-ramp to I-405 and other downstream congestion locations. The reconfiguration of this intersection does not impact the *Motor Vehicle Capacity* of the roadway system in this area of closely spaced traffic signals. The downstream constraint (6th/Broadway) is not changed by this project. Therefore, the 4th Avenue/Caruthers Street/Broadway intersection was not considered a *Critical Intersection* for this analysis.

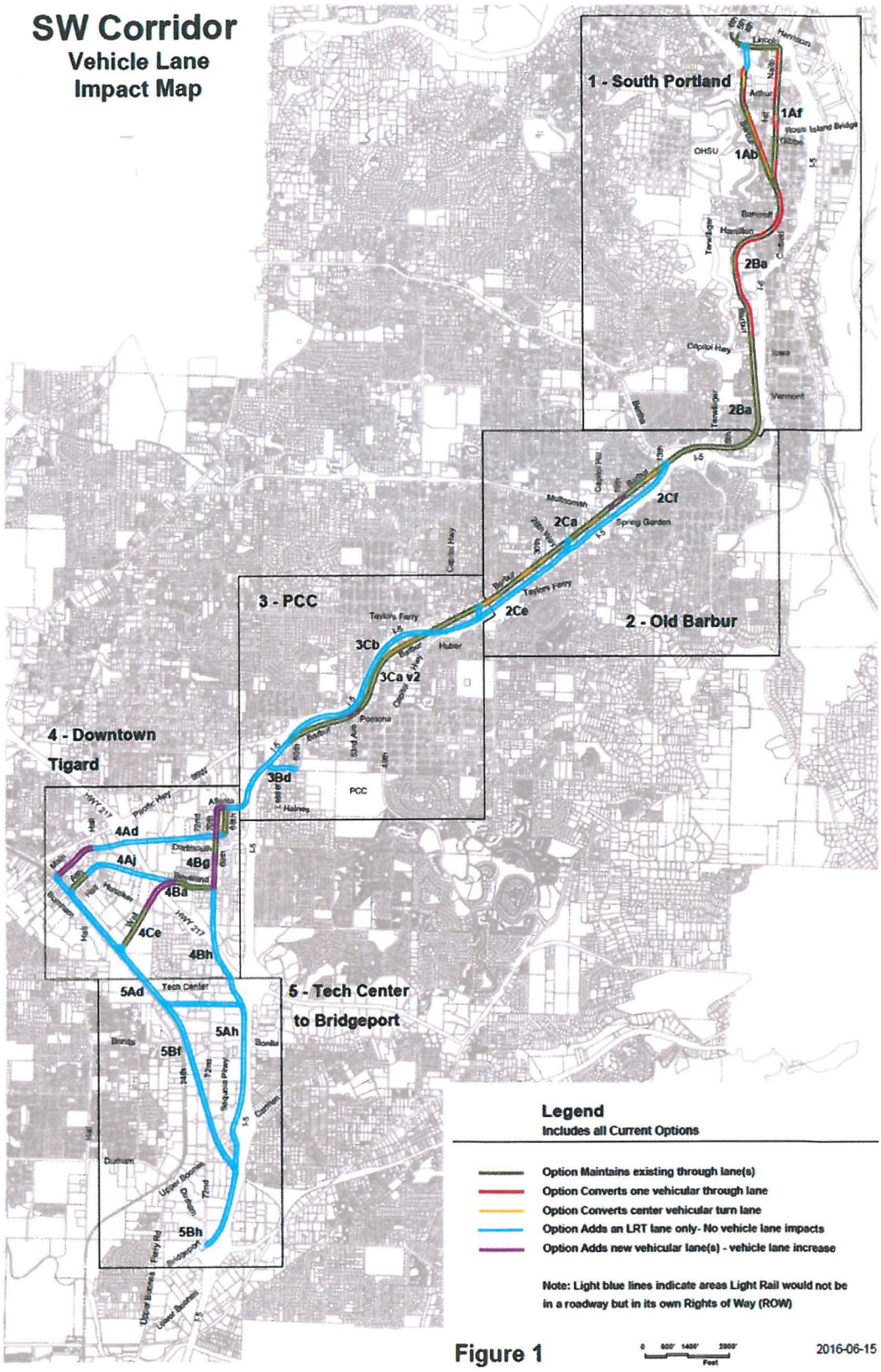
SW Corridor
Vehicle Lane
Impact Map
1 - South Portland
1Af
1Ab
2Ba
2Ba
2Cf
2Ca
2Ce
2 - Old Barbur
3 - PCC
3Cb
3Ca v2
3Bd
4 - Downtown
Tigard
4Ad
4Aj
4Bg
4Ba
4Ce
4Bh
5 - Tech Center
to Bridgeport
5Ad
5Ah
5Bf
5Bh
Legend
Includes all Current Options
Option Maintains existing through lane(s)
Option Converts one vehicular through lane
Option Converts center vehicular turn lane
Option Adds an LRT lane only- No vehicle lane impacts
Option Adds new vehicular lane(s) - vehicle lane increase
Note: Light blue lines indicate areas Light Rail would not be in a roadway but in its own Rights of Way (ROW)
0 800' 1400' 2800'
Feet
2016-06-15

Figure 1

- Barbur Boulevard and 19th Avenue/Capitol Hill Road (AM and PM peak)
- Barbur Boulevard and Terwilliger Boulevard (AM and PM peak)
- Barbur Boulevard and Hamilton Street (AM peak)
- 4th Avenue and Caruthers Street/Broadway (AM peak) [6]

Motor Vehicle Capacity and *Volume to Capacity (V/C) Ratios* for each of the *Critical Intersections* were estimated, using the practices described in the Highway Capacity Manual,[7] for the 2035 No-Build (without an *Alignment Option)* and the 2035 system with *Alignment Options* (with light rail transit). During the AM *Peak-Hour* (future year conditions) traffic volumes are very directional on Barbur Boulevard with northbound volumes approximately two-to-four times greater than southbound traffic volumes and *V/C Ratios* for the northbound through movements are also significantly higher than for the southbound movements (see Table 1A and Table 1B). Therefore, *Motor Vehicle Capacity* reductions for the AM Peak Hour were evaluated in the northbound (critical) direction. During the PM peak hour (future year conditions) traffic volumes were relatively balanced in both directions and therefore *Motor Vehicle Capacity* reductions were evaluated in both directions on Barbur Boulevard.

Tables 1A and 1B show the estimated reduction in the *Motor Vehicle Capacity* of each *Critical Intersection* along Barbur Boulevard caused by the *Alignment Options*. *Reduced Motor Vehicle Capacity* is calculated as the difference of the *Motor Vehicle Capacity* of the *Critical Intersection* without the *Alignment Option* minus the *Motor Vehicle Capacity* of the *Critical Intersection* with the *Alignment Option*. To illustrate the range of potential impacts of the *Alignment Options,* Table 1A shows results for the *Alignment Option* having the greatest impact on *Motor Vehicle Capacity* on Barbur Boulevard and Table 1B shows results for the *Alignment Option* with the least impact.

The *Motor Vehicle Capacity* impacts of *Alignment Options* on the *Critical Intersections* are used to determine the overall Motor Vehicle Capacity impact on the Barbur Boulevard corridor. *Alignment Options* impact the overall Motor Vehicle Capacity of a roadway in two distinct ways: (i) changes in the physical configuration and traffic signalization of *Critical Intersections*, as described above, and (ii) changes in the volume of on-street buses on Barbur Boulevard. With the introduction of light rail, some buses currently operating on Barbur Boulevard are no longer required because they are replaced by light rail vehicles operating on a dedicated right-of-way. This makes additional *Motor Vehicle Capacity*

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[6] The 4th Avenue/Caruthers Street/Broadway intersection in downtown Portland is controlled by downstream congestion at the 6th Avenue/Broadway intersection, the on-ramp to I-405 and other downstream congestion locations. The reconfiguration of this intersection does not impact the *Motor Vehicle Capacity* of the roadway system in this area of closely spaced traffic signals. The downstream constraint (6th/Broadway) is not changed by this project. Therefore, the 4th Avenue/Caruthers Street/Broadway intersection was not considered a *Critical Intersection* for this analysis.

[7] 2000 Highway Capacity Manual, Transportation Research Board, Special Report 209, 2000, Chapter 16, Washington DC, 2000.

Table 1A - Motor Vehicle Capacity and Net Motor Vehicle Capacity Reduction on Existing Roadways (Barbur Boulevard)
(Alignment Option with *Greatest Impact* on Motor Vehicle Capacity)

	Motor Vehicle Capacity								Net Motor Vehicle Capacity Reduction					
	Northbound Direction				Southbound Direction				Northbound Direction			Southbound Direction		
Critical Intersections[1,2]	No-Build[3] Capacity[4]	No-Build[3] v/c Ratio[4]	Alignment Option[3] Capacity[4]	Alignment Option[3] v/c Ratio[4]	No-Build[3] Capacity[4]	No-Build[3] v/c Ratio[4]	Alignment Option[3] Capacity[4]	Alignment Option[3] v/c Ratio[4]	Reduced Motor Vehicle Capacity of Intersection[8]	Capacity Freed-Up By Relocation of Buses[6]	Net Motor Vehicle Capacity Reduction[7]	Reduced Motor Vehicle Capacity of Intersection[8]	Capacity Freed Up By Relocation of Buses[6]	Net Motor Vehicle Capacity Reduction[7]
PM Peak Hour (Year 2035)														
SW Barbur Blvd (Hwy 99W) & SW Capitol Hwy	1638	0.61	1866	0.49	2692	0.64	2605	0.81	(228)	24	(252)	87	24	63
SW Barbur Blvd (Hwy 99W) & Capitol Hill Rd/19th	1886	0.86	1694	0.97	1825	0.83	1642	0.93	192	24	168	183	24	159
SW Barbur Blvd (Hwy 99W) & SW Terwilliger Blvd	1334	1.07	1140	1.13	1604	0.76	1424	0.82	194	24	170	180	24	156
AM Peak Hour (Year 2035)														
SW Barbur Blvd (Hwy 99W) & 60th	1534	0.91	1504	0.92	5	0.38	5	0.36	30	24	6	5	5	5
SW Barbur Blvd (Hwy 99W) & SW Capitol Hwy	1521	0.89	1504	0.90	5	0.70	5	0.70	17	24	(7)	5	5	5
SW Barbur Blvd (Hwy 99W) & 24th/I-5 Off-Ramp	2397	0.90	2410	0.90	5	0.43	5	0.41	(13)	24	(37)	5	5	5
SW Barbur Blvd (Hwy 99W) & Capitol Hill Rd/19th	1866	0.95	1656	1.05	5	0.45	5	0.48	210	24	186	5	5	5
SW Barbur Blvd (Hwy 99W) & SW Terwilliger Blvd	1657	1.00	1592	0.86	5	0.30	5	0.32	65	24	41	5	5	5
SW Barbur Blvd (Hwy 99W) & SW Hamilton Sreet	2616	1.22	2492	1.02	5	0.25	5	0.34	124	24	100	5	5	5

Note 1: Listing of "Critical Intersections" obtained from: 1) SW Corridor Supplemental Refinement Traffic Impact Analysis Executive Summary Traffic Report, DKS Associates, March 16, 2016 and 2) Final SW Corridor Traffic Analysis and Operations Memorandum, DKS Associates, July 29, 2014.

Note 2: The 4th Avenue/Caruthers Street/Broadway intersection in downtown Portland is controlled by downstream congestion at the 6th Avenue/Broadway intersection, the on ramp to I-405 and other downstream congestion locations. The reconfiguration of this intersection does not impact the motor vehicle capacity of the roadway system in this area of closely spaced traffic signals and therefore was not considered a critical intersection.

Note 3: Definitions. "No-Build" is the Same as "without an Alignment Option", "Alignment Option" is the option with Light Rail considered to have Greatest Impact on Motor Vehicle Capacity which is Option 2Ca/3Ca V2

Note 4: Definitions: "Capacity" (or Motor Vehicle Capacity) and "V/C Ratio" (Volume to Capacity Ratio) obtained from Highway Capacity Manual analysis determination of Lane Group Capacity (see Note 1). Capacity is in vehicles/hour.

Note 5: During the AM peak hour (year 2035) traffic volumes are very directional on Barbur Boulevard with northbound volumes approximately two to four times greater than southbound traffic volumes. *Volume to Capacity Ratios* for the northbound direction are also significantly higher than the southbound direction. Therefore, during the AM peak hour, capacity reductions were evaluated in the northbound or *Critical Direction* only. During the PM peak hour (year 2035) traffic volumes are relatively balanced in both directions and therefore capacity reductions were considered in both directions on Barbur Boulevard.

Note 6: The year 2035 Peak Hour Motor Vehicle Capacity freed up on the Existing Roadway by relocating on-street transit vehicles (buses) to the separated guideway in the Alignment Option. Assumes with Alignment Option, there will be a reduction of 12 buses in each direction along Barbur Boulevard in the year 2035 peak hour. A bus motor vehicle capacity equivalence factor of 1 bus equals approximately 2 motor vehicles from a capacity perspective is assumed.

Note 7: The Net Motor Vehicle Capacity is the highest reduction at the Critical Intersections. The yellow highlighted cells indicate a Net Motor Vehicle Capacity Reduction of: 170 vehicles per hour in the PM peak hour northbound direction; 160 (rounded) vehicles per hour in the PM peak hour southbound direction; 190 (rounded) vehicles per hour in the AM peak hour northbound direction. Capacity reductions from multiple intersections are not additive.

Note 8: Reduced Motor Vehicle Capacity at intersection equals No-Build Capacity minus Alignment Option Capacity.

Table 1B - Motor Vehicle Capacity and Net Motor Vehicle Capacity Reduction on Existing Roadways (Barbur Boulevard)
(Alignment Option with *Least Impact* on Motor Vehicle Capacity)

	Motor Vehicle Capacity								Net Motor Vehicle Capacity Reduction					
	Northbound Direction				Southbound Direction				Northbound Direction			Southbound Direction		
Critical Intersections[1,2]	No-Build[3] Capacity[4]	No-Build[3] v/c Ratio[4]	Alignment Option[3] Capacity[4]	Alignment Option[3] v/c Ratio[4]	No-Build[3] Capacity[4]	No-Build[3] v/c Ratio[4]	Alignment Option[3] Capacity[4]	Alignment Option[3] v/c Ratio[4]	Reduced Motor Vehicle Capacity of Intersection[8]	Capacity Freed-Up By Relocation of Buses[6]	Net Motor Vehicle Capacity Reduction[7]	Reduced Motor Vehicle Capacity of Intersection[8]	Capacity Freed Up By Relocation of Buses[6]	Net Motor Vehicle Capacity Reduction[7]
PM Peak Hour (Year 2035)														
SW Barbur Blvd (Hwy 99W) & SW Terwilliger Blvd	1334	1.07	1140	1.13	1604	0.76	1424	0.82	194	24	170	180	24	156
AM Peak Hour (Year 2035)														
SW Barbur Blvd (Hwy 99W) & SW Terwilliger Blvd	1657	1.00	1592	0.86	5	0.30	5	0.32	65	24	41	5	5	5
SW Barbur Blvd (Hwy 99W) & SW Hamilton Sreet	2616	1.22	2492	1.02	5	0.25	5	0.34	124	24	100	5	5	5

Note 1: Listing of "Critical Intersections" obtained from: 1) SW Corridor Supplemental Refinement Traffic Impact Analysis Executive Summary Traffic Report, DKS Associates, March 16, 2016 and 2) Final SW Corridor Traffic Analysis and Operations Memorandum, DKS Associates, July 29, 2014.

Note 2: The 4th Avenue/Caruthers Street/Broadway intersection in downtown Portland is controlled by downstream congestion at the 6th Avenue/Broadway intersection, the on-ramp to I-405 and other downstream congestion locations. The reconfiguration of this intersection does not impact the motor vehicle capacity of the roadway system in this area of closely spaced traffic signals and therefore was not considered a critical intersection.

Note 3: Definitions: "No Build" is the Same as "without an Alignment Option"; "Alignment Option" is the option with Light Rail considered to have Least Impact on Motor Vehicle Capacity which is Option 2Cf/2Ce/3Cb

Note 4: Definitions: "Capacity" (or Motor Vehicle Capacity) and "V/C Ratio" (Volume to Capacity Ratio) obtained from Highway Capacity Manual analysis determination of Lane Group Capacity (see Note 1) Capacity is in vehicles/hour.

Note 5: During the AM peak hour (year 2035) traffic volumes are very directional on Barbur Boulevard with northbound volumes approximately two to four times greater than southbound traffic volumes. *Volume to Capacity Ratios* for the northbound direction are also significantly higher than the southbound direction. Therefore, during the AM peak hour, capacity reductions were evaluated in the northbound or *Critical Direction* only. During the PM peak hour (year 2035) traffic volumes are relatively balanced in both directions and therefore capacity reductions were considered in both directions on Barbur Boulevard.

Note 6: The year 2035 Peak Hour Motor Vehicle Capacity freed up on the Existing Roadway by relocating on-street transit vehicles (buses) to the separated guideway in the Alignment Option. Assumes with Alignment Option, there will be a reduction of 12 buses in each direction along Barbur Boulevard in the year 2035 peak hour. A bus-motor vehicle capacity equivalence factor of 1 bus equals approximately 2 motor vehicles from a capacity perspective is assumed.

Note 7: The Net Motor Vehicle Capacity is the highest reduction at the Critical Intersections. The yellow highlighted cells indicate a Net Motor Vehicle Capacity Reduction of: 170 vehicles per hour in the PM peak hour northbound direction; 160 (rounded) vehicles per hour in the PM peak hour southbound direction; 100 (rounded) vehicles per hour in the AM peak hour northbound direction. Capacity reductions from multiple intersections are not additive.

Note 8: Reduced Motor Vehicle Capacity of Intersection equals No Build Capacity minus Alignment Option Capacity.

available on Barbur Boulevard for auto and truck traffic. The composite effect of these impacts is referred to in this analysis as the *Net Motor Vehicle Capacity Reduction.*

In calculating the *Net Motor Vehicle Capacity Reduction* caused by an *Alignment Option*, the reduction in the overall corridor capacity of Barbur Boulevard is estimated as the highest *Reduced Motor Vehicle Capacity* among all of the evaluated *Critical Intersections* for the *Alignment Option*. The capacity made available to truck and auto traffic by reducing the volume of on-street buses is estimated by multiplying the reduction in the forecasted 2035 *Peak Hour, Peak Direction* on-street bus volume caused by the *Alignment Option* by the bus-auto capacity equivalence factor (1 bus uses capacity of 2 autos). These factors yield the following estimated *Net Motor Vehicle Capacity Reduction* on Barbur Boulevard in year 2035:

- Northbound PM Peak Hour: 170 vehicles per hour[8]
- Southbound PM Peak Hour: 160 vehicles per hour[9]
- Northbound AM Peak Hour: 100 vehicles per hour[10] to 190 vehicles per hour[11]

As mentioned earlier, the *Alignment Options* do not impact motor vehicle capacity on Interstate 5 or Pacific Highway in Tigard.

Percentage Reduction in Total Radial Corridor Motor Vehicle Capacity

The estimated *Net Motor Vehicle Capacity Reduction* on Barbur Boulevard can best be understood in the context of the overall transportation corridor serving travel between Tigard and Portland. While there are many routes that may be used to travel between Tigard and Portland, this analysis uses the three major routes included in Metro's Mobility Corridor #2[12] as the overall Portland Central City to Tigard/Tualatin motor vehicle corridor. As shown in Figure 2, Metro's Mobility Corridor #2 includes:

- Interstate 5 (shown in blue in Figure 2)
- SW Barbur Boulevard (99W), then along Pacific Highway and 72nd Avenue (shown in red in Figure 2)
- SW Macadam Avenue/OR 43/A Avenue/Boones Ferry Road (shown in yellow in Figure 2)

Using the *Metro Transportation Model* and more detailed estimates for some segments of Barbur Boulevard, the aggregate *Motor Vehicle Capacity* for each of four segments of each of the three routes

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[8] 170 vehicles per hour for both the most and least impactful Alignment Options.
[9] 160 vehicles per hour is rounded up from 156 or 159 vehicles per hour, and is the same for the Alignment Options with the least and greatest impact on Motor Vehicle Capacity.
[10] 100 vehicles per hour for the Alignment Option with the least impact on Motor Vehicle Capacity.
[11] 190 vehicles per hour is rounded up from 186 vehicles per hour for the Alignment Option with the greatest impact on Motor Vehicles Capacity.
[12] http://www.oregonmetro.gov/mobility-corridors-atlas

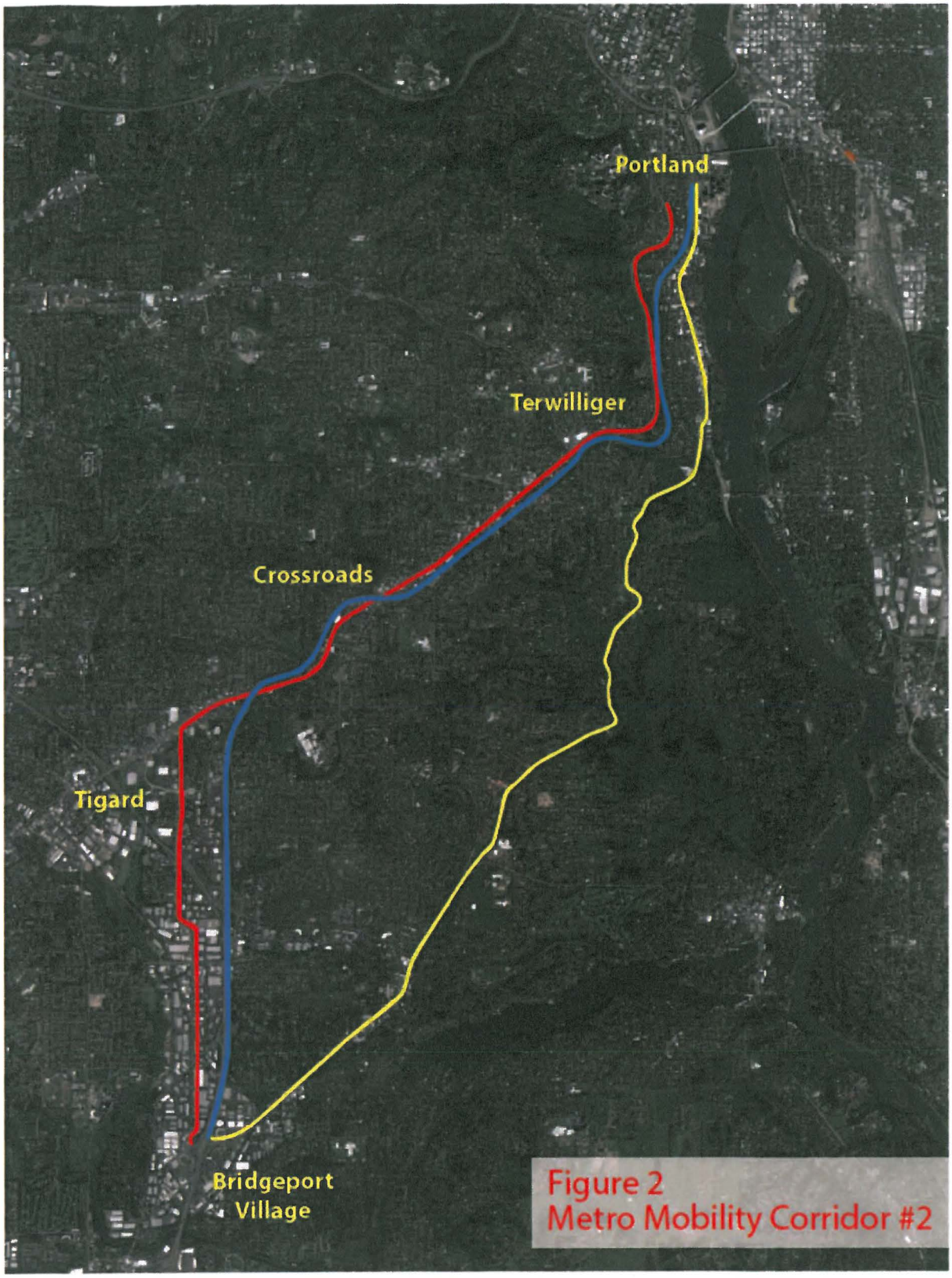

Figure 2
Metro Mobility Corridor #2

Table 2 - Percentage Reduction in Total Radial Corridor Motor Vehicle Capacity

Metro's Mobility Corridor #2[2]		Motor Vehicle Capacity (Peak Hour)[1] North Segment: Portland-Terwilliger	Mid-Barbur Segment: Terwilliger-Crossroads	Tigard Segment: Crossroads-OR217/Kruse	South Segment: OR217/Kruse-Bridgeport Village
Red Route -	Barbur Blvd - Pacific Hwy - 72nd	1600[3]	1,700[3]	900	900
Blue Route -	Interstate 5	6,300	6,300	6,300	7,200
Yellow Route -	Macadam/OR 43-A Avenue - Boones Ferry	1,200	700	1,400	1,400
Total Radial Corridor Motor Vehicle Capacity		**9,100**	**8,700**	**8,600[4]**	**9,500**

	Total Radial Corridor Motor Vehicle Capacity[6]	Net Motor Vehicle Capacity Reduction[5]	Net Total Radial Corridor Motor Vehicle Capacity[7]	**Percentage Reduction in Total Radial Corridor Motor Vehicle Capacity**
Alignment Option with Greatest Impact on Motor Vehicle	8,600	186	8,414	2.2%
Alignment Option with Least Impact on Motor Vehicle	8,600	170	8,430	2.0%

Note 1:	Motor Vehicle Capacity based on Metro's Transportation Model measured in vehicles per hour in Critical Direction (unless as noted)
Note 2:	Metro has defined a series of Mobility Corridors (http://www.oregonmetro.gov/mobility-corridors-atlas) for the region and for the Portland Central City to Tigard/Tualatin corridor (Mobility Corridor 2) three parallel routes (including Barbur Boulevard) have been considered part of the Mobility Corridor. The three routes are shown in Figure 2 and listed in the above Table.
Note 3:	Capacity based on Highway Capacity Manual analysis of corridor signalized intersections
Note 4:	Total Radial Corridor Motor Vehicle Capacity for the segment having the lowest total capacity. The yellow highlighted cell shows the lowest segment capacity and hence the Total Radial Corridor Motor Vehicle Capacity which is 8,600 vehicles per hour.
Note 5:	Net Motor Vehicle Capacity Reduction values obtained from Table 1A (largest "Net Motor Vehicle Capacity Reduction" value) and Table 1B (largest "Net Motor Vehicle Capacity Reduction" value).
Note 6:	Without Alignment Option
Note 7:	Net Total Radial Corridor Motor Vehicle Capacity is the Total Radial Corridor Motor Vehicle Capacity minus the Net Motor Vehicle Capacity Reduction.

comprising Metro Mobility Corridor #2 was estimated (see Table 2). The aggregate *Motor Vehicle Capacity* of each segment was estimated by summing the *Motor Vehicle Capacity* of the three routes in each segment (see Table 2). The controlling *Total Radial Corridor Motor Vehicle Capacity* is estimated as the capacity of the segment with the lowest aggregate *Motor Vehicle Capacity*, which in this case is the Tigard Segment between Crossroads (Capitol Highway) and OR 217 with an aggregate *Motor Vehicle Capacity* of 8,600 vehicles per hour per direction.

The *Percentage Reduction in Total Radial Corridor Motor Vehicle Capacity* is the *Net Motor Vehicle Capacity Reduction* of an *Alignment Option (*from Table 1A and Table 1B*)* divided by the *Total Radial Corridor Motor Vehicle Capacity* (8,600 vehicles per hour). To estimate the range *Net Motor Vehicle Capacity Reduction* of the Alignment Options, the largest value from Table 1A (190 vehicles per hour-rounded) and the largest value from Table 1B (170 vehicles per hour) were used.

As shown in Table 2, the combination of the changes in traffic signalization (which are planned with our without light rail) and the lane displacements and additional changes in traffic signalization caused by the *Alignment Options* reduce the motor vehicle capacity on the main facilities serving Tigard-Portland traffic by about a **two percent (2%)** (the high and low estimates round to about same percent).

Percentage Reduction in Tigard Subarea Motor Vehicle Capacity

Section 53 of the City of Tigard Charter focuses on an area that extends five miles from the boundary of the City of Tigard. To consider Motor Vehicle Capacity impacts in this context, a *Tigard Subarea* was created as an area with a boundary that is five miles in all directions from the boundary of the City of Tigard.

While the capacity of each (non-local) roadway link in the Tigard Subarea is available from the *Metro Transportation Model*, a methodology is required to determine the composite capacity within the *Tigard Subarea*. The *Total Tigard Subarea Vehicle Capacity* was estimated as the aggregate sum of the weighted capacity of each link coded in the Metro Transportation Model within the subarea. The weight for a link was calculated as the length of the link. The length and bi-directional capacity of each link was derived from the *Metro Transportation Model*. The length-weighted capacity of the Tigard Subarea was calculated for the No Build scenario (without any Alignment Option) and a scenario with an Alignment Option and the *Percentage Reduction in Tigard Subarea Motor Vehicle Capacity* was estimated as the percentage difference in these scenarios.

As shown in Table 3, the Alignment Options are estimated to decrease the length-weighted *Motor Vehicle Capacity* of the *Tigard Subarea* by about **0.03 percent (3/100th of 1%)**. This value will be similar for any of the Alignment Options.

Table 3 - Percentage Reduction in Tigard Subarea Motor Vehicle Capacity

	Total Tigard Subarea {Length-Weighted} Capacity [1]	*Percentage Reduction in Tigard Subarea Motor Vehicle Capacity*
No *Alignment Option* (No Build)	1,600,864	Not Applicable
Alignment Option	1,600,399	0.03%

Note 1: The *Total Tigard Subarea Capacity* is calculated by using the length and bi-directional capacity of each link coded in the *Metro Transportation Model* located within five miles of the City of Tigard. The *Total Tigard Subarea Capacity* is calculated as the aggregate sum of the weighted capacity of each link within the subarea, where the weight for a link is calculated as the length of the link.

Person Trip Capacity Impacts

The *Motor Vehicle Capacity* measures evaluated above describe only part of the overall transportation capacity impact of the proposed light rail options to Tigard and Tualatin. While *Motor Vehicle Capacity* is slightly impacted in limited locations on Barbur Boulevard, these impacts are mitigated by the added Person Trip Capacity from introducing light rail into the corridor. The impacts on travel (whether by motor vehicle or transit) can be measured as *Person Trip Capacity*, which estimates the maximum number of persons that can pass through a *Critical Intersection* in the *Critical Direction* in motor vehicles or on transit.

The *Person Trip Capacity* of the *Radial Corridor* was determined for *Alignment Options* with the greatest impact on *Motor Vehicle Capacity* and the least impact on *Motor Vehicle Capacity*, as well as for a scenario without an *Alignment Option* (No-Build). Table 4 shows the steps utilized to determine the *Percentage Increase in Person Trip Capacity*. The *Increased Person Trip Capacity* on transit resulting from the introduction of the light rail options was determined by multiplying the estimated maximum number of light rail trains that can be operated in the *Peak Hour* by the person capacity of a light rail train, and then subtracting the person capacity of the on-street buses that were removed from Barbur Boulevard due to light rail. The *Person Trip Capacity* in motor vehicles was estimated by multiplying the *Net Total Radial Corridor Motor Vehicle Capacity* from Table 2 by an assumed vehicle occupancy rate of 1.4. The *Increased Person Trip Capacity* of the *Radial Corridor* is the sum in the *Radial Corridor* of the increased person trip capacity on transit and the decreased person trip capacity in motor vehicles.

The *Percentage Increase in Person Trip Capacity* is estimated to be 36 to 37 percent for all Alignment Options (the high and low estimate round to about the same percentage). Thus, while the introduction of light rail reduces the Motor Vehicle Capacity of the *Radial Corridor* by about 2%, it increases the Person Trip Capacity of the *Radial Corridor* by about 36 to 37 percent.

Table 4 - Person Trip Capacity Impacts

Person Trip Capacity of High Capacity Transit Per Direction

Alignment Options	# of Light Rail Transit Trains Per Hour[1]	Person Capacity Per Light Rail Transit Train [2]	Transit Person Capacity Per Hour	Number of Buses Removed Per Hour[3]	Number of Persons Per Bus[4]	Person Capacity Reduction (from Buses) Per Hour	Increase in Transit Person Trip Capacity Per Hour Due to High Capacity Transit[5]
Alignment Option with Greatest Impact on Motor Vehicle Capacity	20	266	5,320	12	56	672	4,648
Alignment Option with Least Impact on Motor Vehicle Capacity	20	266	5,320	12	56	672	4,648

Person Trip Capacity Impacts for Alignment Options

	Net Total Radial Corridor Motor Vehicle Capacity[6]	Assumed Vehicle Occupancy Rate[7]	Person Trip Capacity of Radial Corridor Per Hour[8]	Increase in Person Trip Capacity of Alignment Options Per Hour[9]	Percentage Increase in Person Trip Capacity[10]
No Alignment Option (No Build)	8,600	1.4	12,040	-	0%
Alignment Option with Greatest Impact on Motor Vehicle Capacity	8,414	1.4	16,428	4,388	36%
Alignment Option with Least Impact on Motor Vehicle Capacity	8,430	1.4	16,450	4,410	37%

Note 1:	Assumed headway of 3 minutes per light rail train per direction resulting in 20 light rail trains per hour per direction for the Alignment Option
Note 2:	Assumed two-consist light rail trains which can accommodate 266 persons (seating and standing)
Note 3:	The forecasted reduction in the 2035 volume of on-street buses eliminated by high-capacity transit is 12 buses per hour per direction
Note 4:	Assumed 40 foot standard bus which can accommodate 56 persons (seating and standing)
Note 5:	Increase in Transit Person Trip Capacity Per Hour Due to High Capacity Transit equals Transit Person Capacity Per Hour minus Person Capacity Reduction (from Buses) Per Hour
Note 6:	See Table 2 for "Net Total Radial Corridor Motor Vehicle Capacity" for different Alignment Option.
Note 7:	An average Peak Hour auto occupancy rate for the corridor is 1.4 persons per vehicle which is consistent with the Metro Transportation Model.
Note 8:	Person Trip Capacity of Radial Corridor Per Hour equals Net Total Radial Corridor Motor Vehicle Capacity times Assumed Vehicle Occupancy Rate plus Increase in Person Trip Capacity Per Hour Due to High Capacity Transit
Note 9:	Increased Person Trip Capacity of an Alignment Option shall be calculated as the numeric difference of the Person Trip Capacity of the Radial Corridor with the Alignment Option minus the Person Trip Capacity of the Radial Corridor without the Alignment Option
Note 10:	The Percentage Increase in Person Trip Capacity of an Alignment Option is the fraction, expressed as a percentage, calculated as (I) the Increased Person Trip Capacity of the Alignment Option, divided by (II) the Person Trip Capacity of the Radial Corridor without the Alignment Option.

Reduced Motor Vehicle Capacity of Unused Public ROW

Section 53 of the City of Tigard Charter includes a requirement to describe the reduction in road capacity caused by the displacement (by the light rail options) of *"public rights-of-way that could otherwise provide additional road capacity at a future date."* These are not lanes or roads that currently exist and, in the affected parts of the Southwest Corridor, there are not any planned lanes or roads to serve as a basis for estimating such impacts.

As a practical matter, there are many constraints to adding *Motor Vehicle Capacity* to either Interstate 5 or Barbur Boulevard. The most significant constraint may be a lack of right-of-way in the necessary (bottleneck) locations. Adding a travel lane along Interstate 5 will require widening the roadway for an additional travel lane or lanes and widening the shoulders on both sides of the roadway to bring them up to ODOT/US DOT standards. It also likely requires reconstruction of all interchanges, reconstruction of many bridges and overpasses which connect surface streets over I-5, substantial new walls and most likely an adjustment to the roadway alignment to straighten out some of the curved sections to provide adequate sight distance meeting current standards. In addition to the reconstruction challenges, this will require ODOT to obtain additional right-of-way that they do not currently own. Along Barbur Boulevard, expanding capacity from today's conditions requires not only additional travel lanes at bottleneck locations, but the addition of standard-width sidewalks, bicycle facilities, ADA treatments, water quality facilities, and other improvements to bring the roadway up to applicable standards.

Reduced Motor Vehicle Capacity of Unused Public ROW

To address this Charter requirement, the *Reduced Motor Vehicle Capacity of the Unused Public ROW* was estimated for the *Alignment Options* with the greatest and least impact on Unused Public ROW that *"could otherwise provide additional motor vehicle capacity at a future date."* This does not include all public right-of-way in the corridor currently not being used for a transportation facility (*Unused Public ROW*), as much of the *Unused Public ROW* is too small to accommodate a new lane or road and/or is located where a new lane or road cannot efficiently function. The *Reduced Motor Vehicle Capacity of the Unused Public ROW* only considers *Unused Public ROW* that *"could otherwise provide additional motor vehicle capacity at a future date,"* which is referred to as *Useful Unused Public ROW* in this analysis.

For each applicable *Alignment Option*, *Useful Unused Public ROW* was identified as follows:

- The roadway design standards or criteria (including cross-section specifications) applicable to expanding the number of lanes on the roadway was identified; cross-sections include the width of all bicycle facilities, sidewalks, shoulders, medians, or other features needed to comply with the design standard or criteria.
- Based on the cross-section required to comply with applicable design standards or criteria, the width (i.e.; distance from the centerline of the roadway) of *Unused Public ROW* needed to added one or more lanes was determined.

- *Useful Unused Public ROW* was identified as the area of *Unused Public ROW* displaced by an *Alignment Option* [13] where:
  - The width of the Unused Public ROW is sufficient to accommodate one or more additional lanes in compliance with applicable design standards and criteria; and
  - If the roadway to be expanded is a freeway or throughway (i.e.; I-5), the location of the Unused Public ROW either (I) extends along the roadway for a distance of at least one-half of one mile or (II) addresses a system bottleneck; or
  - If the roadway to be expanded is an arterial (i.e., Barbur Boulevard), the location of the Unused Public ROW addresses a system bottleneck.

The location of *Useful Unused Public ROW* and *Unused Public ROW* impacted by the *Alignment Options* was identified, based on the criteria described above. Figure 3 shows the *Unused Public ROW* for the highest impact scenario while Figure 4 shows the *Unused Public ROW* for the lowest impact scenario. Table 5 shows the *Reduced Motor Vehicle Capacity of Unused Public ROW*, which is measured by the area (in acres) of *Useful Unused Public ROW* displaced by the *Alignment Option*.

Table 5 - Reduced Motor Vehicle Capacity of Unused Public ROW [1] (Measured in Acres)

	Low [2]	High [3]
Unused Public ROW underlying Alignment Option [4]	28.3	33.9
Reduced Motor Vehicle Capacity of Unused Public ROW due to *Alignment Option* [5]	1.3	5.0
Unused Public ROW Impacted by *Alignment Option* that does not Reduce the Potential Future Motor Vehicle Capacity of the ROW	27.0	28.9

Note 1 *Unused Public Right-of-Way (ROW)* is right-of-way underlying an *Alignment Option* that is currently in public ownership and is not improved for general public use as a transportation facility. *Useful Unused Public ROW* is *Unused Public ROW* potentially available for future Motor Vehicle Capacity.

Note 2 Low estimates are for *Alignment Options* that have the least impact on *Useful Unused Public ROW* (*Alignment Options* Nos. 1Ab/2Ba, 2Ca, 3Ca v2, 4Bg/4Ce/4Bh, 4Bh/5Ah/5Bh)

Note 3 High estimates are for *Alignment Options* that have the greatest impact on *Useful Unused Public ROW* (*Alignment Options* Nos. 1Af/2Ba, 2Cf/2Ce, 3Cb, 4Bg/4Aj 5Ad/5Ah/5Bh)

[13] This analysis only identified *Useful Unused Public ROW* that would be used by an *Alignment Option*; it did not estimate the total amount of *Useful Unused Public ROW* in the *Radial Corridor* or the *Tigard Subarea*.

Note 4 **The amount of *Unused Public ROW* that is impacted by an *Alignment Option*, whether or not the amount of potential future *Motor Vehicle Capacity* on such ROW is impacted.**

Note 5 **Reduced *Motor Vehicle Capacity* of *Unused Public ROW* estimates the amount that potential future road capacity is reduced, measured in acre, by constructing an *Alignment Option* on *Unused Public ROW*.**

Thus, the *Alignment Options* are estimated to displace 1.3- 5.0 acres of public ROW could potentially provide additional motor vehicle capacity at a future date. Keep in mind that this estimate does not consider all of the practical limitations of providing additional lanes.

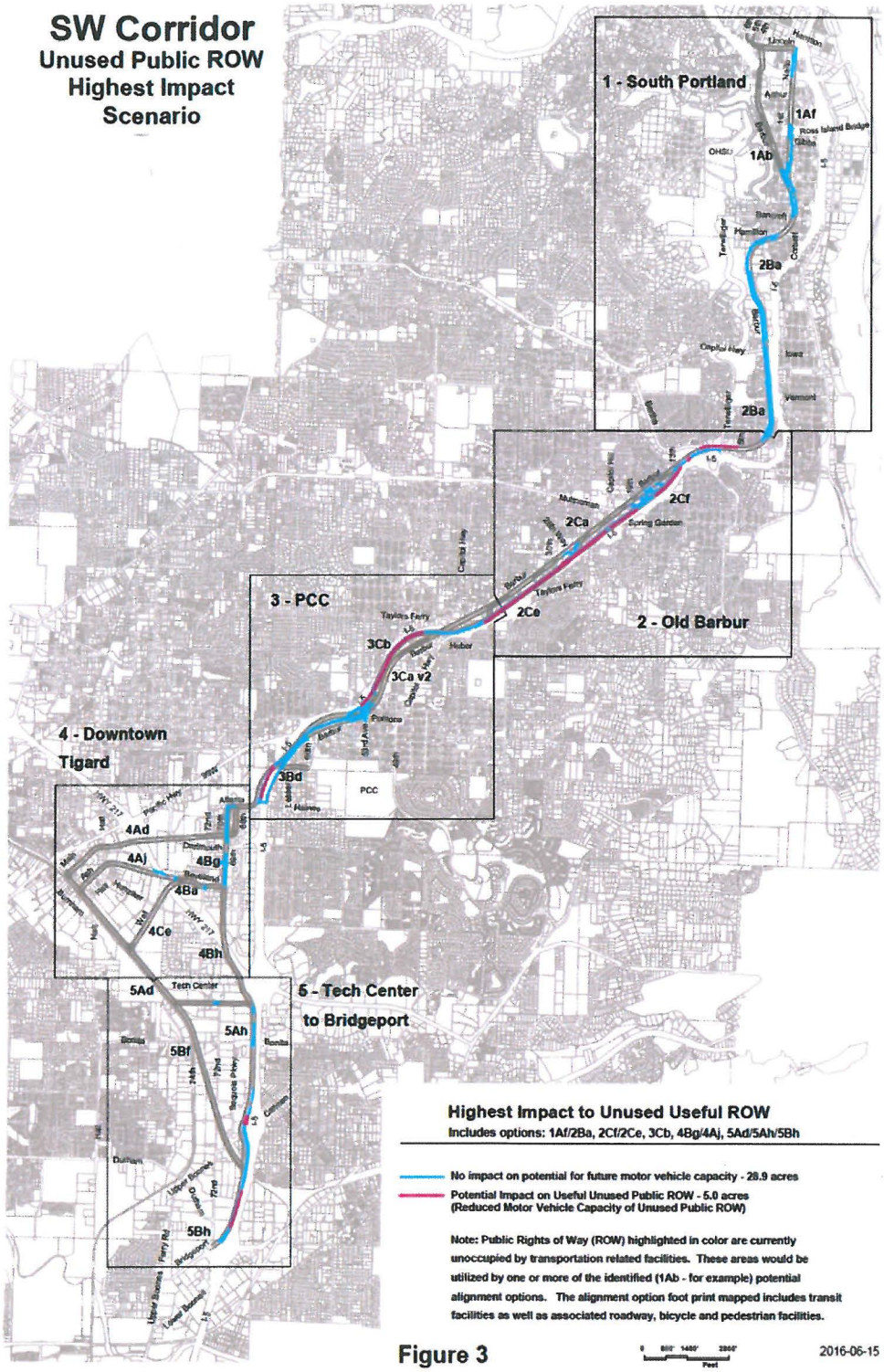
SW Corridor
Unused Public ROW
Highest Impact
Scenario
1 - South Portland
1Af
1Ab
2Ba
2Ba
2Cf
2Ca
2Ce
2 - Old Barbur
3 - PCC
3Cb
3Ca v2
3Bd
4 - Downtown
Tigard
4Ad
4Aj
4Bg
4Ba
4Ce
4Bh
5 - Tech Center
to Bridgeport
5Ad
5Ah
5Bf
5Bh
Highest Impact to Unused Useful ROW
Includes options: 1Af/2Ba, 2Cf/2Ce, 3Cb, 4Bg/4Aj, 5Ad/5Ah/5Bh
No impact on potential for future motor vehicle capacity - 28.9 acres
Potential Impact on Useful Unused Public ROW - 5.0 acres
(Reduced Motor Vehicle Capacity of Unused Public ROW)
Note: Public Rights of Way (ROW) highlighted in color are currently unoccupied by transportation related facilities. These areas would be utilized by one or more of the identified (1Ab - for example) potential alignment options. The alignment option foot print mapped includes transit facilities as well as associated roadway, bicycle and pedestrian facilities.
2016-06-15

Figure 3

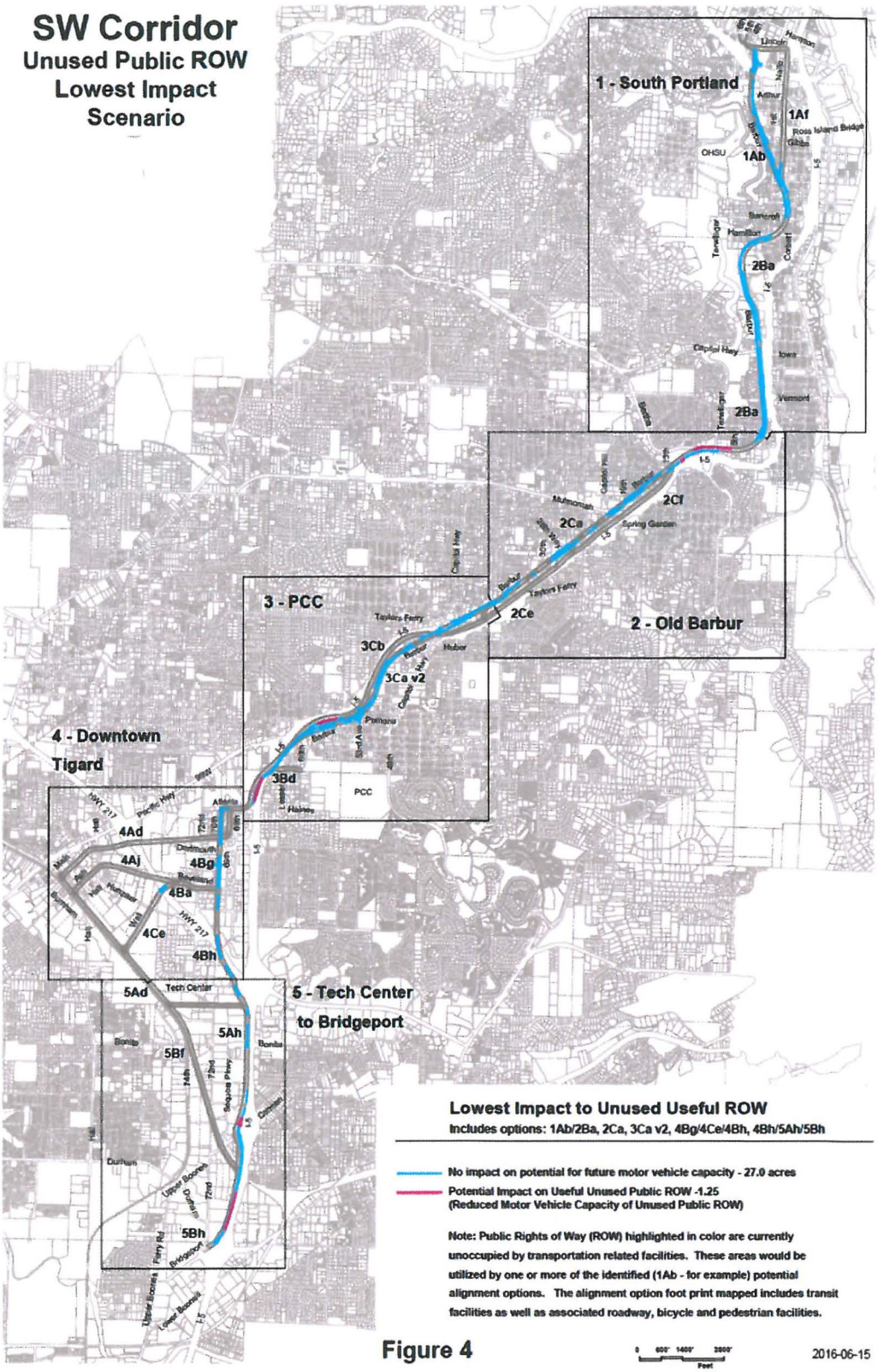
SW Corridor
Unused Public ROW
Lowest Impact
Scenario
1 - South Portland
1Af
1Ab
2Ba
2Ba
2Cf
2Ca
2Ce
2 - Old Barbur
3 - PCC
3Cb
3Ca v2
3Bd
4 - Downtown
Tigard
4Ad
4Aj
4Bg
4Ba
4Ce
4Bh
5 - Tech Center
to Bridgeport
5Ad
5Ah
5Bf
5Bh
Lowest Impact to Unused Useful ROW
Includes options: 1Ab/2Ba, 2Ca, 3Ca v2, 4Bg/4Ce/4Bh, 4Bh/5Ah/5Bh
No impact on potential for future motor vehicle capacity - 27.0 acres
Potential Impact on Useful Unused Public ROW -1.25
(Reduced Motor Vehicle Capacity of Unused Public ROW)
Note: Public Rights of Way (ROW) highlighted in color are currently unoccupied by transportation related facilities. These areas would be utilized by one or more of the identified (1Ab - for example) potential alignment options. The alignment option foot print mapped includes transit facilities as well as associated roadway, bicycle and pedestrian facilities.
2016-06-15

Figure 4