

Transit-Supportive Densities and Land Uses

A PSRC Guidance Paper (February 2015)

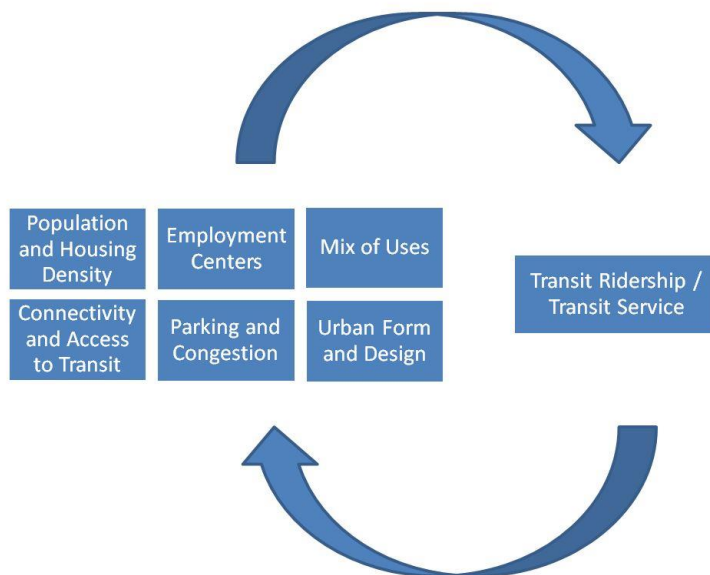
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Executive Summary

Building and sustaining a robust transit network that is financially healthy, well used, and integrated into local communities is crucial for the region to be able to achieve its vision for a sustainable future. Transit enhances mobility throughout the region, especially for transit-dependent populations. Transit also improves air quality by reducing single-occupancy vehicle travel and supports compact communities in existing urban areas. Several conditions are necessary for transit to thrive, including a critical mass of potential transit patrons, all-day travel demand, local multimodal connectivity to transit, and regional connections to major destinations. The density, mix, and pattern of land uses around transit investments can create these transit-supportive conditions.

Existing regional and local policies and programs, including those adopted by the Puget Sound Regional Council (PSRC) as well as by the region's transit agencies, address various aspects of transit-supportive land use. PSRC's VISION 2040 calls for a pattern of land use at both the regional and local scale that supports, and is supported by, a regional high-capacity transit network that links dense mixed-use and pedestrian-friendly centers.



The academic literature highlights strong evidence that transit can achieve greater ridership and cost-effectiveness by serving areas with higher densities and other complementary elements, such as mixed uses, pedestrian connectivity, and supportive parking management. The central Puget Sound region has made significant progress in planning for transit-supportive densities, particularly within designated Regional Growth Centers, and achieving a greater concentration of employment and especially housing growth near high-capacity transit corridors. However, the data also show a significant gap between existing densities and densities that regional and national

guidelines suggest are needed to support a productive and efficient transit system over the long term.

The following **guiding principles** are intended to inform planning and plan implementation by local governments, transit agencies, and PSRC itself:

Increase Densities around Transit Stations and Stops to Increase Ridership. While the scale and mix of uses may vary, all types of station areas have a role to play in boosting demand for transit trips to and from nearby land uses. Strategies include planning for compact residential and commercial development, neighborhoods with a variety of housing choices, including housing that is affordable at a range of incomes, regional and sub-regional employment centers, major institutions, and mixed-use districts.

Establish Transit-Supportive Density Goals based on Locally Relevant Data and Policies. There is no one-size-fits-all threshold for what constitutes a “transit-supportive density.” Existing PSRC guidance on density around transit is consistent with minimum thresholds cited in the literature and is an appropriate starting point for further collaboration among regional, transit, and local agencies to tailor density goals for a full range of places in the region. Tailored density goals should consider transit mode type and level of service, cost- effectiveness goals for transit, and station area type and market demand.

Maximize Land Use Potential within Transit Walksheds. Research shows that riders will typically walk up to ½ mile to access high-capacity transit and ¼ mile or more to access bus transit. Planned land use and zoning designations should allow transit-supportive densities across as much of the corresponding transit walkshed as possible and investments in connectivity should be made to expand station area walksheds where feasible.

Promote Employment Growth at Station Areas in Transit Corridors. Connecting workers to employment centers in the region is a foundation for the regional transit system. Land use strategies and place-based economic development that concentrates employment within walking distance of key transit nodes, in tandem with residential development along the transit corridor, is most effective in generating ridership demand.

Plan for and Encourage Mixed Uses and Transit-Supportive Design. In locations with dense land uses, local jurisdictions should also promote a pedestrian-friendly public realm, mixed uses at both the station area and corridor scales, and regulations to discourage uses and building types and designs that are incompatible with transit-oriented development. These approaches complement land use density in maximizing transit ridership.

Incentivize Alternatives to Automobile Travel in Station Areas. Policies and requirements that support efforts to build ridership through transit-oriented development, rather than driving and parking, should be implemented. In higher density corridors, tools such as multimodal concurrency and innovative parking management can be more compatible with supporting transit ridership.

VISION 2040: Residential densities exceeding 15 to 20 homes per acre, as well as employment areas with densities of 50 jobs per acre and higher, are preferred targets for the higher frequency and high-volume service provided by high-capacity transit.

Designation Procedures for New Regional Growth and Manufacturing/Industrial Centers: New Regional Growth Centers are expected to plan for land use that accommodates at least 45 activity units (population + jobs) per gross acre.

The findings of the literature review and resulting guiding principles presented in this issue paper are intended for use in a range of interrelated planning and plan implementation activities, including comprehensive plan updates, subarea and centers plans, and transit agency plans. PSRC can benefit from a more robust understanding of transit-supportive densities and land uses as it updates and further implements its own policies and programs, including the Growing Transit Communities Strategy and VISION 2040.

For more information on the issues addressed in this guidance paper, contact Michael Hubner, Principal Planner, Puget Sound Regional Council, by phone at (206) 971-3289 or by email at mhubner@psrc.org.

Introduction

VISION 2040 sets forth a strategy for the central Puget Sound region to achieve a more sustainable future through integrated planning and investments in land use, transportation, and economic development. Building and sustaining a robust transit network is crucial for the region to be able to achieve this vision. Transit systems that are financially healthy, well used, and integrated into local communities make possible a range of benefits, including increased transportation choices, mobility for transit-dependent populations, investment in existing communities, and reduced environmental footprint for a growing region. For these reasons, VISION 2040 and Transportation 2040, the region's transportation plan, each call for private and public land use investments and other complementary actions that help to boost transit ridership. The region's plans also call for investment in a network of transit services that link centers of population and employment and make possible the compact mixed-use centers that are envisioned for communities throughout the region.

Accordingly, this Puget Sound Regional Council (PSRC) guidance paper addresses the intersection of land use and transit planning, in particular the density of housing and employment and other elements of the land use pattern in station areas that are supportive of transit services in the central Puget Sound region. The discussion and recommendations contained in this paper are intended to benefit both local and regional planning efforts, including local comprehensive plan updates and subarea and station area plans, long-range transit agency plans, and implementation of VISION 2040 and the Growing Transit Communities (GTC) Strategy. The intended audience includes all agencies engaged in planning and implementing land use and transit plans.

This guidance paper specifically responds to a provision of the GTC Strategy, which calls on PSRC to “develop guidance for transit supportive densities...to include detailed guidance on transit supportive densities and uses, including recommended density ranges for transit communities within each high-capacity transit corridor” and “informed by regional policy, current and potential service levels for the transit modes in each location, local plans, and land use and market characteristics.”¹

The paper uses as its starting point a review of the academic literature on transit-supportive densities conducted in 2012 by the Center for Transit Oriented Development (CTOD) for the Growing Transit Communities (GTC) Partnership led by PSRC, and published as an appendix to CTOD's final report, *Implementing Equitable Transit Communities*. Another equally important starting point is direction in the adopted regional plans and policies whose outcomes include both compact development and increased transit use.

Mutually supportive benefits for land use and transportation can be realized with transit-oriented development (TOD). TOD refers to the land uses that are located within close proximity to transit stations and stops, uses that are characterized by higher densities, pedestrian-oriented design, and mix of uses that support transit ridership and successfully leverage the place-making potential of transit investments. TOD has many local and regional benefits, including improved mobility, efficiency of the transportation system, equitable development, and a significant reduction in vehicle trips, vehicle miles traveled, and travel times. Additional benefits include improved air quality and greater pedestrian mobility.²

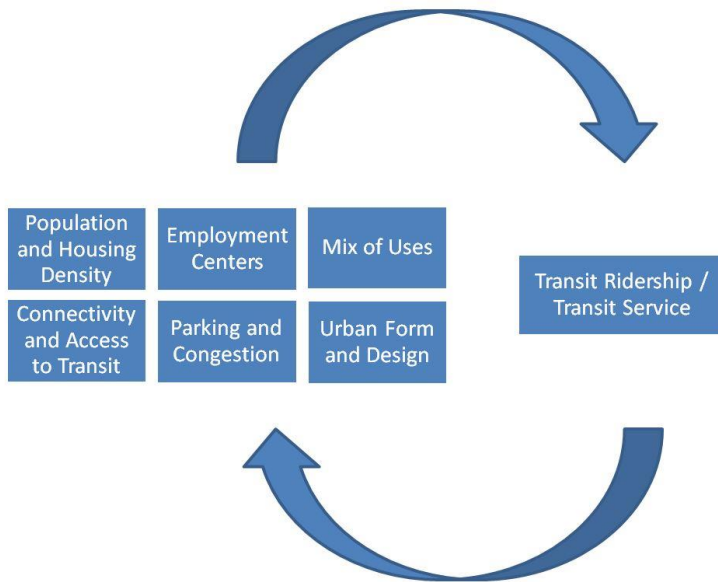
In any given corridor, both the capital investment in transit and the financial commitment to ongoing operations for service are made in response both to existing demand for transit and in anticipation of growth in transit demand over time. Much of the growth in transit demand will be the result of new development of residential, employment, commercial, and institutional uses within walking distance of transit stations and stops. As corridors

¹ See page 26 of the Growing Transit Communities Strategy (PSRC 2013), Strategy 7: Use Land Efficiently in Transit Communities.

² VISION 2040, page 81.

grow and achieve transit-oriented development over time, new and expanded transit service becomes feasible. Figure 1, below, illustrates this interdependent relationship.

Figure 1: Interdependence of Transit and Land Use



The interrelationship between factors of transit service, on the one hand, and land use and urban form, on the other, reinforces the stake that both transit agencies and local governments have in achieving transit-supportive densities and uses. For transit agencies, boosting ridership improves their fiscal bottom line and achieves agency performance goals. Serving communities where ridership demand is high builds community support and increases competitiveness for federal funding. For local governments, in addition to the development and investment in vibrant compact neighborhoods that TOD represents, making their centers and corridors more attractive for transit can lead to new and enhanced transit service.

Exploring in a more in-depth manner the issues around transit-supportive land uses and densities furthers the work of PSRC both in developing regional policy and in providing technical assistance to local governments and other public agencies. While permitting and encouraging different land uses and densities are the purview of local government plans and development regulations, the role of PSRC is to promote the region's adopted vision at all levels of implementation through regional analysis, policy and plan review, strategic investments in transportation, and coordination among regional partners.

Several key questions are addressed in the sections that follow:

- What conditions are necessary for transit to become and stay productive?
- How do existing policies and programs in the region address the relationship between transit and land use?
- What guidance do peer regions provide on transit-supportive densities?
- How is density be defined and measured?
- What findings from academic research can inform planning for transit-supportive land use?

- How transit supportive are existing and planned land uses and densities in the central Puget Sound region?
- What guiding principles should inform regional, transit agency, and local planning and plan implementation going forward?

The Regional Transit System

Multiple modes of public transportation provided by state, regional, and local agencies comprise the regional transit system. Collectively, transit providers within the 4-county region that PSRC covers carry nearly 600,000 riders on an average weekday.³ Recent, ongoing, and planned investments in public transportation are enhancing and expanding the range of mobility choices for current and potential future transit users. Significant regional investments in high-capacity transit will provide primary regional services around which local transit providers are expected to be able to better coordinate around an integrated regional transit system. Currently, the following transit modes are provided in the central Puget Sound region:

- **Light rail.** Sound Transit operates the Link light rail. The first phase of Link went into service in 2009 with 13 stations between downtown Seattle and SeaTac International Airport. Future funded phases of system expansion are in various stages of development and will eventually provide service north of Seattle to Lynnwood, east to Redmond (Overlake), and south to Federal Way. Long-range plans for light rail extend to Everett in the north, downtown Redmond to the east, and Tacoma to the south.
- **Streetcar.** Three separate streetcar lines currently operate within the region. Seattle Streetcar operates the 2.6 mile South Lake Union Trolley service that links downtown Seattle with a rapidly developing close-in neighborhood. A second line in the city, the 2.5 mile First Hill Streetcar, will go into service connecting downtown with two historically high-density neighborhoods, First Hill and Capitol Hill, in 2015. Sound Transit has operated Tacoma Link, a one-mile streetcar service that connects several stations in downtown Tacoma, since 2003. An extension of the Tacoma Link is planned.
- **Commuter rail.** Sound Transit operates the Sounder commuter rail along a corridor that extends from Seattle north to Everett in Snohomish County and south to Lakewood in Pierce County. Sounder provides service to 12 stations.
- **Bus Rapid Transit (BRT).** Two transit agencies offer enhanced bus service along selected corridors in King and Snohomish counties. King County Metro Transit (Metro) has implemented six RapidRide lines in north, east, and south King County. Community Transit operates the Swift service along the SR-99 corridor in Snohomish County. Both services have features typical of many BRT systems, including specialized buses that enable expedited boarding, corridor enhancements to ensure reliable bus movement, and enhanced amenities located at selected high-demand stops.
- **Bus.** Six different transit agencies provide bus services across the region. They include Sound Transit, King County Metro, Community Transit, Everett Transit, Kitsap Transit, and Pierce Transit. Bus routes across the region vary in their intended function as part of the transit system and in level of service, particularly the frequency and span of service in each corridor. A few transit agencies from outside the four-county region provide limited inter-regional transit service.
- **Ferry.** Washington State Ferries provides auto ferry service to 14 terminals in the region and Pierce County provides ferry service to two rural islands. Ferries are a key component of the Metropolitan Transportation System, a component that accommodates large numbers of cars and other vehicles, along with foot and bicycle passengers connecting to communities on either side of Puget Sound. King County Ferry District and Kitsap Transit provide passenger-only ferry service in the region.

³ National Transit Database, August 2014 Monthly Dataset

Transportation 2040 provides a typology of transit services in the region that classifies transit routes across multiple modes in terms of common function and role within the region, as follows:

- **Core transit services** include light rail, BRT, and other high-frequency bus services. Core services are generally routed to or through areas with higher density population and/or employment and mixed uses, and are thus expected to draw higher ridership.
- **Community Connector transit services** are routed between or through areas that are not dense enough to warrant Core transit service. The operator is required or has chosen to serve these areas for policy reasons that include providing basic transit coverage to all communities and especially to serve the needs of more transit-dependent populations. Community Connector bus service typically extends throughout the day, but at a lower frequency of service and carrying fewer passengers than Core transit. Community Connector routes may evolve into Core services when transit demand and land use changes warrant it.
- **Specialized transit services** are routed to serve very specific users at specific times, such as peak period commuters. Running only at specific times of the day, Specialized service is generally high speed and express bus and commuter rail transit, and is typically designed to carry high volumes of passengers.

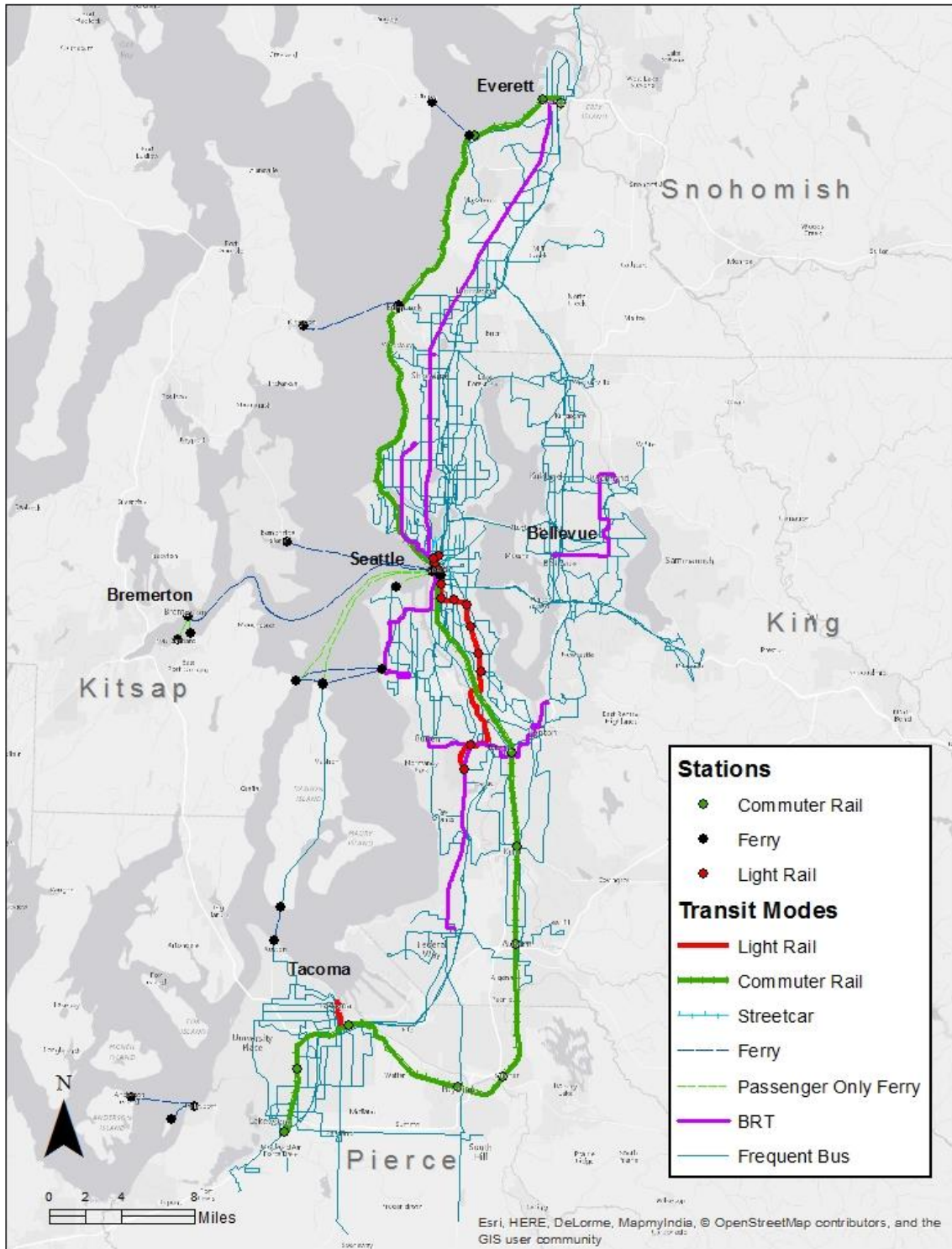
Another category of transit service that is relevant to regional land use policy is high-capacity transit (HCT). RCW 81.104.010 defines HCT as follows:

“High capacity transit system means a system of public transportation services within an urbanized region operating principally on exclusive rights-of-way, and the supporting services and facilities necessary to implement such a system, including interim express services and high occupancy vehicle lanes, which taken as a whole, provides a substantially higher level of passenger capacity, speed, and service frequency than traditional public transportation systems operating principally in general purpose roadways.”

HCT includes various transit modes, including heavy rail, commuter rail, light rail, streetcar, BRT, and express bus service. Sound Transit and King County Metro are the main providers of HCT in the region. There is a significant overlap between Core and high-capacity transit services. This issue paper addresses all transit modes and levels of service, with a focus on TOD potential around higher levels of transit service afforded by Core transit and HCT.

The map in Figure 2 shows the primary elements of the regional transit system. Highlighted are the regional high-capacity network along with bus routes that provide service, on average, every half hour or more frequently. Other bus routes that provide less frequent service, which are also part of the region’s transit network, are not shown on this map.

Figure 2: Regional Transportation Network (Existing)



What Does Transit Need to Thrive?

Several key elements of transit demand and access are prerequisites for Core and high-capacity transit services to achieve and sustain high ridership and productivity. Depending on the location and type of service, these basic conditions can be provided by an appropriate mix of nearby land uses and densities, non-motorized infrastructure, feeder transit, and station parking. Specifically, transit needs the following conditions to thrive:

- **Critical mass of potential transit patrons.** Total potential ridership for transit is first and foremost a function of the amount of activity—residential, employment, commercial, institutional—within the transit service area. However, the sum of land uses and activities, even uses within close proximity of transit corridors and stations, is not necessarily sufficient. Other factors, listed below, are also necessary.
- **Travel demand throughout the day.** Where transit service is provided along a corridor with moderate to high frequency throughout the day, activities and land uses that generate all-day trip making, during both peak and non-peak hours, are highly desirable from the standpoint of transit efficiency. Bi-directional trip making throughout the day makes it possible for transit agencies to attain high ridership while accommodating a variety of mobility needs and choices.
- **Local connectivity to transit via multiple modes.** The service area for transit is defined based on proximity to the station with a distance factor that varies by mode of travel to the station. Typically, walk distance is assumed to be $\frac{1}{4}$ to $\frac{1}{2}$ mile, bike distance approximately 3 miles, and feeder bus and auto access to transit over longer distances. While a critical mass of activity may be present within those service areas, lacking sufficient infrastructure, such as sidewalks, bikeways, transit connections, and parking, the land uses present within them will generate limited ridership.
- **Regional connectivity to high-demand destinations.** At the scale of an individual transit station or stop, a critical mass of activity may be present within a well-connected service area, but it won't produce high ridership if the transit system does not provide connections to key high-demand destinations. Major employment centers are the most important anchors for the transit system, including both central business districts and secondary employment concentrations in outlying neighborhoods and suburbs. Nearly as important, especially for all-day travel, are educational institutions, hospitals, and cultural, entertainment, or civic centers.

How Do Existing Policies and Programs Address Transit-Supportive Land Uses?

VISION 2040

VISION 2040, which was adopted by PSRC in 2008, is the central Puget Sound region's long-range strategy for sustainable growth management, transportation, and economic development. The Regional Growth Strategy and a focus on accommodating growth in centers are at the core of VISION 2040. These policies call for a pattern of land use at both the regional and local scales that is intended to support, and be supported by, a regional high-capacity transit network.

Under VISION 2040, the region's population and employment growth is focused within designated urban growth areas. Development within urban growth areas is more cost-effective to provide with a wide range of infrastructure and services, including transit, than is a more sprawling development pattern. Within the urban growth areas, growth is further concentrated in regionally-designated Regional Growth Centers and Manufacturing/Industrial Centers as well as in other locally-designated centers of activity and planned growth. VISION 2040 explicitly calls for transit investments within and between regional centers and other subregional and local centers to be supported by planning and zoning for TOD on land that is located in close proximity to those services.

While VISION 2040 does not include in any of its adopted Multicounty Planning Policies any prescriptive standards for what intensity of development would be considered “transit-oriented,” the plan does provide some quantitative guidance in the supporting text. A description of “Transit Supportive Densities” provides the following background:

Extensive national research has shown that residential densities exceeding 7 or 8 homes per gross acre support efficient and reliable local transit service. Household densities should reach, at minimum, 10 to 20 dwelling units per gross acre close to transit stations. Residential densities exceeding 15 to 20 homes per acre, as well as employment areas with densities of 50 jobs per acre and higher, are preferred targets for the higher frequency and high-volume service provided by high-capacity transit. (VISION 2040, pg. 81)

VISION 2040 also recognizes the reciprocal relationship between land use and transit. MPP-T-11 specifically reinforces the regional land use vision by calling on the region to “prioritize investments in transportation facilities and services in the urban growth area that support compact, pedestrian- and transit-oriented densities and development.” (VISION 2040, pg. 83)

Transit-supportive land uses and densities are also addressed through the implementation of VISION 2040. PSRC adopted criteria for the designation of new Regional Growth Centers in 2003 and updated the criteria in 2011. The criteria call for minimum planned densities of 45 activity units (population plus jobs) per gross acre, a standard that should be reflected in the long-range plan designations and zoning for each center. One rationale for this threshold was to support the high-capacity transit network that links Regional Growth Centers. However, this criterion should not be interpreted as explicit regional guidance on transit-supportive densities in all contexts. For one, Regional Growth Centers are not the same as transit walksheds. Moreover, 45 AUs per acre is considered a floor which some centers have already exceeded and many will be planning above and beyond for their future densities.

Implementation of VISION 2040 through technical assistance has proceeded through a series of guidance and reference documents provided to local governments and other agencies. These include *Growth Targets and Mode Split Goals for Regional Centers (2014)* and the *Transit Supportive Planning Toolkit (2013)*.

Transportation 2040

Transportation 2040, the region’s federally-mandated Metropolitan Transportation Plan and state-mandated Regional Transportation Plan, which was adopted by PSRC in 2010 and updated in 2014, implements VISION 2040 through strategic investments in transit, roads, and other transportation infrastructure. Transportation 2040 supports VISION 2040 and the Regional Growth Strategy with an emphasis on transit investments, totaling approximately \$80 billion over the next 30 years, nearly half of total plan investments. The plan also addresses transit-oriented development and transit-supportive land uses as integral to its implementation.

Transportation 2040 describes the benefits of transit-oriented development as follows:

Well-designed transit-oriented communities can lead to a range of substantial social and environmental benefits. Transit-oriented communities have the potential to:

- Promote health by encouraging walking and biking, cutting air pollution, and reducing motor vehicle accidents.
- Lower household expenses for transportation.
- Reduce municipal infrastructure costs.
- Help meet the growing demand for “walkable communities.”

- Curb land consumption and thereby help conserve farms and natural ecosystems, and protect water quality.
- Cut energy consumption and greenhouse gas emissions associated with both transportation and the built environment.

(Transportation 2040, pg. 10)

The plan also provides guidance for local implementation via a set of 10 “Physical Design Guidelines” that include:

1. Encourage a mix of complementary land uses, particularly uses that generate pedestrian activity and transit ridership.
2. Encourage compact growth by addressing planned density.

(Transportation 2040, pg. 7)

The Transportation 2040 Update (adopted in 2014) carries the emphasis on transit station areas further by incorporating the goals and overall framework for “thriving and equitable transit communities” that was developed by the Growing Transit Communities Partnership. The Update highlights a commitment to capturing housing and employment growth by leveraging the region’s transit investments to the greatest degree possible in transit station areas and corridors. Specifically, the regional Growing Transit Communities Strategy sets as a goal significantly boosting the share of the region’s housing and employment growth that locates in transit station areas. Strategies include proactive station area planning and transit station design to maximize TOD potential, policies and regulations that promote efficient use of land, strategic parking management, and a broad range of infrastructure investments.

Finally, the concept of transit-supportive densities plays a role in project prioritization for regional transportation planning and funding. The project prioritization process addresses “support for centers” in its rating criteria for project in the regional plan. Specifically, “access to transit supportive land uses” is recognized by awarding projects where existing nearby densities are greater than 8 dwelling units per gross acre with one point and projects with densities over 15 dwelling units per acre with two points. VISION 2040, as cited above, provides the basis for the thresholds used in prioritization.

Transit Agency Plans and Policies

Transit agencies in the region have adopted policies and programs to work with local governments to coordinate planning activities and to encourage land uses and public facilities that are supportive of the transit services they provide. The efforts of Sound Transit, King County Metro, and Community Transit are representative of the coordination of land use with existing Core and high-capacity transit services, including both rail and BRT.

Sound Transit

The statute authorizing Sound Transit’s regional high-capacity transit planning, development, and operations (RCW 81.104) makes several important connections between transit and land use. The statute states that HCT should serve communities that have transit-supportive land use plans, including providing for transit-supportive densities. RCW 81.104.080 addresses transit-supportive land use in the regional context to be implemented through coordinated planning facilitated by the PSRC (as Regional Transportation Planning Organization) and interlocal agreements with local government, where appropriate.

Sound Transit adopted an updated Transit-Oriented Development policy in 2012. The policy defines TOD as a:

...land development pattern that integrates transit and land use by promoting transit ridership while supporting community land use and development visions. TOD typically consists of public and private development projects that create dense, pedestrian oriented environments with a mix of land uses and activities at and around transit facilities. The design, configuration, and mix of buildings and activities around the transit facility, as well as the location and design of the transit facility, should encourage people to use transit and foster a healthy, livable environment.

The TOD policy establishes a framework for Sound Transit to consider TOD early and throughout the process of planning, design, and implementation of the transit system. Under the policy, TOD has a prominent place in corridor planning and design. The TOD Strategic Plan (2014 update) reiterates the agency's focus on connecting centers and commits it to a robust evaluation of TOD potential as a key input when evaluating alternative alignments and station locations. Analysis of TOD potential looks at existing conditions and also local plans as they relate to land use density and mix, station access, and market conditions.

The TOD Strategic Plan also calls for Sound Transit to engage as a key stakeholder in station area planning and to "advocate for TOD at the local level to create the greatest opportunity for ridership and livable transit communities."

With Sound Transit's update to its Long-Range Plan as a precursor to system planning in 2015, the agency expects to further explore the relationship between land use and current and future demand for transit as a basis for selecting appropriate transit routes and modes to include in the plan. Sound Transit released a draft "Issue Paper on Regional Land Use and Transit Planning" in October 2014, for the purpose of informing the Regional Transit Long-Range Plan Update and also ongoing implementation of the agency's TOD policy.

King County Metro Transit

The 2012 King County Countywide Planning Policies (KCCP,) the 2012 King County Comprehensive Plan, and the Strategic Climate Action Plan collectively provide strong support for transit-oriented development. These policies guide Metro Transit's planning for future service levels and locations. KCCP policies U-108 and U-318 direct the County to support urban centers and to promote transit-oriented development. The Strategic Climate Action Plan (2012) places transit-oriented development as a priority action to reduce greenhouse gas emissions.

King County Metro Service Guidelines, last updated in 2013, include a methodology for setting target bus service levels for each transit corridor. "Productivity" is a key criterion that reflects the density of households and jobs in the service area that define the transit market. Specifically, two measures are used to define the potential productivity of a corridor:

1. Households within ¼ mile of all transit stops per corridor mile, and
2. Jobs and student enrollment at universities and colleges within ¼ mile of all transit stops per corridor mile.

Metro reports that the thresholds employed using this approach generally align with industry guidelines for transit-supportive densities. For example, a research-based threshold of 15 households per acre approximates a measure of 3,000 households per corridor mile, both of which correspond to transit service level frequencies of every 15 minutes or less.

Metro's Strategic Plan addresses transit-supportive land use in Strategy 3.3.1, which calls for Metro to "encourage land uses, policies, and development that lead to communities that transit can serve effectively and efficiently."

Community Transit (Snohomish County)

Community Transit adopted Service Guidelines in 2010 as an appendix to the Long Range Transit Plan. The Guidelines set minimum density thresholds for each service type. These density thresholds are similar to those used by King County Metro. For example, frequent all day bus service requires at least 15 households / acre or, when considering population and employment together, 30 “activity units” (population plus jobs) per gross acre. Bus rapid transit warrants a similar intensity of use under these guidelines.

Community Transit has worked with local governments in its service area to identify “transit emphasis corridors” that are intended to be a focus for future transit service expansion. In preparation of the Long Range Transit Plan, the agency conducted an evaluation of each of these corridors as a means of prioritizing planned service levels. Factors considered in this evaluation include existing population and employment densities, current and forecasted ridership and productivity, and corridor features, such as bike/pedestrian infrastructure. Service guidelines provide key benchmarks for future productivity quantified as boardings per revenue hour expected for each service type (e.g., BRT, local, commuter routes).

Peer Regional Guidance on Transit-Supportive Densities

As a complement to the review of the academic literature on this topic, the Center for Transit Oriented Development also reported on examples of transit-supportive density guidance used by several other metropolitan planning organizations (MPOs), peer agencies to PSRC, and made available to their member jurisdictions. Figure 3, below, summarizes the results of that research. The functional type of station areas, reflected in the table, was an additional variable these MPOs used to tailor guidance for local areas.

Figure 3: Sample of Gross Residential Densities from Station Area Planning Guidelines

	Urban Core (Downtown)	City Center	Suburban Center
Metropolitan Transportation Commission (Bay Area) Station Area Planning Manual	16-60 du/acre	10-30 du/acre	5-20 du/acre
City of San Diego TOD Guidelines		17-30 du/acre (avg) 12 du/acre (min)	13-20 du/acre (avg) 8 du /acre min)
Sacramento Regional Transit Guide to TOD	36 du / acre (min)	¼ mile: 20 du / acre (min) ½ mile: 15 du / acre (min)	¼ mile: 15 du / acre (min) ½ mile: 10 du / acre (min)
City of Charlotte (standards for light rail)		25 (min)	25 (min)
Note: San Diego’s TOD Design Guidelines provide net densities; they have been converted to gross densities using an average gross-to-net ratio of 0.67.			
Source: Strategic Economics and Sound Transit			

How Should Density Be Defined?

There many ways that land use densities may be defined and quantified. In order to ensure effectiveness and consistency, regional guidance on minimum or desired densities for transit station areas should be clear about that definition. There are several dimensions to this question, including geography, gross vs. net density, quantification of land uses, and the relationship between transit usage and different categories of land use.

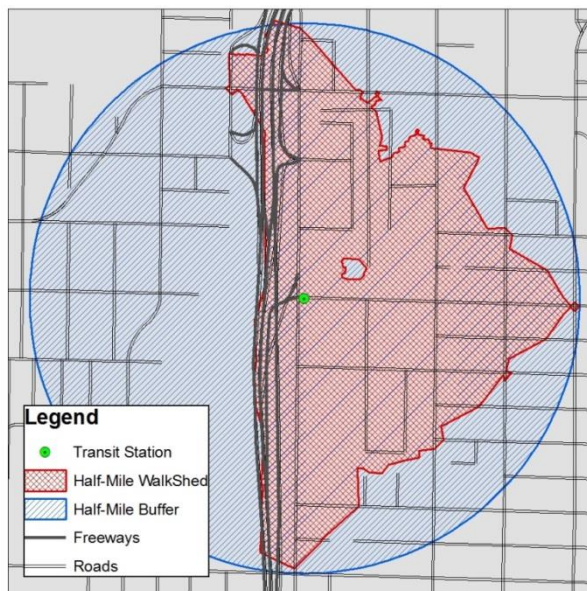
Geography

Research shows that many people are willing to walk 10 minutes, or up to a half mile, to access high-capacity transit, such as light rail or commuter rail. For this reason, the half-mile walk distance (or walkshed) around transit stations is the preferred area for measuring and planning for transit-supportive densities for these modes (Guerra et al., 2011). Geographic information system tools can be used to map the transit walkshed, accounting for the existing grid of streets and paths, topography, and barriers to walking.

For bus or streetcar transit modes, with closely spaced stops, a quarter-mile buffer, approximating a five minute walk, on either side of the corridor would be appropriate to capture a reasonable walkshed for this type of service. Where wider spacing between stops is present, a common feature of BRT corridors, a quarter-mile buffer around each stop is preferred. With a high-quality walking environment and high level of reliable transit service, the walkshed around bus transit may extend well beyond the ¼ mile distance. Research also suggests as well that ¼ mile may be an appropriate radius for measuring proximity of employment to transit. (Guerra et al., 2011)

The half-mile as-the-crow-flies radius approach is the simplest method for delineating a walkshed and covers approximately 500 acres (a quarter-mile radius encompasses about 125 acres). However, in a pedestrian landscape where street grids and physical barriers may restrict walking options, the radius encompasses more land than a pedestrian can actually reach in 10 minutes (or five minutes respectively). The half-mile network buffer is a more accurate estimation of a 10-minute walkshed, and will encompass somewhat less than 500 acres. The map in Figure 4 illustrates the walkshed concept, specifically showing the Northgate station area in Seattle, with a walkshed that is currently constrained by a loose grid of streets and a physical barrier (I-5 freeway).

Figure 4: Half-Mile (10-Minute) Walkshed



Gross vs. Net Density

The second dimension addresses the distinction between **gross** and **net** density. Net density refers to the level of activity or development on a single parcel of land. Land use plans and zoning regulations typically address net densities to describe the desired intensity of land use on a parcel. Gross density refers to the sum of all development and activity across a larger area, including private land parcels, as well as areas not available for development, such as waterways, streets, and public facilities.

Transit ridership is primarily a function of gross density. What matters to the functioning of the transit system is the total number of residents, jobs, and other sources of transit demand that are located within walking distance of the station. Holding constant the net density allowed by zoning, gross density of a station area can vary considerably, due to a range of other factors, such as the amount of land taken up by streets, other public uses that do not contribute to gross density, and water bodies.

Appendix A shows maps and data for several example transit station areas that help to illustrate the distinction between net and gross density. In urban locations, a third or more of the land may be taken up by rights-of-way. As seen in the case of the Ballard BRT station area, a gross residential density of 15 units per acre may necessitate an average net residential density that is much higher, in this case 65 units per acre.

Quantifying Land Uses

Another dimension in defining density relates to the **unit of development or activity** that is used to quantify land use in the station area. Residential land uses can be quantified in terms of housing units, households, population, or other related measures. Employment uses can be quantified in terms of employees, square feet of commercial or office floor area, or other related measures.

Looking at either residential or employment density in isolation may miss the entire picture on transit-supportive densities. A more composite measure of activity would look at the sum of population and jobs, a measure which is referred to as “activity units” by PSRC. Because Core and high-capacity transit serve various centers throughout the region where existing and/or long-range planned land uses include a rich mixture of residential and employment, activity units can be a more appropriate measure of density in most cases, especially where a significant share of both residential and employment-based land uses are present.

How Different Types of Land Use Relate to Transit Ridership

Not all land use is created equal with respect to its impact on transit. Each major category of use—residential, employment, commercial, institutional—has distinct patterns of trip generation and physical development that shape the metrics used to quantify “density.”

Residential land uses are generally points where transit trips originate for multiple purposes, including trips to place of employment, school, shopping, services, and recreation. The number and mix of trip types made each day is influenced by household characteristics, such as number of persons, demographic factors such as age, and economic conditions such as income and auto ownership. Generally, households that have low incomes or limited access to automobiles will use transit more frequently.

Employment uses generate significant transit ridership demand when they are located in close proximity to transit stations and stops. Office-based employment typically has the highest number of jobs per acre among major employment uses. Central business districts, with high numbers and high density of office and other workers are typically the primary anchor for regional transit systems. As such, the overall size of the CBD is a key measure of potential transit demand. Among job categories, government, knowledge-based, and entertainment industries are most likely to locate in transit-oriented development and are most likely to benefit from proximity to transit. (Strategic Economics, 2012) Major employment centers with a more dispersed employment base, such as the Boeing plant in Everett, can also contribute to transit ridership with effective “last mile” solutions to connect employment sites to a regional transit access point.

Commercial uses generate transit trips both by employees and by customers. Commercial uses that create a high volume of foot traffic are most transit-supportive, such as restaurants, small retailers, and personal services. Commercial buildings that are oriented to the sidewalk are the preferred commercial form.

Institutional uses fall into several main categories. Educational institutions, in particularly colleges, universities, and other post-secondary institutions generate significant demand for transit on the part of students and staff. Large research and region-serving hospitals can also benefit locations near transit, generating trips throughout the day by staff and patients. Finally, civic and cultural institutions, such as libraries, community centers, museums, and city halls attract significant travel by a variety of modes, including transit.

Findings from the Research Literature

Numerous academic studies have examined the relationship between land use and travel behavior, particularly transit use. Much of this literature focuses on factors related to density, but other factors are cited as well, including land use mix, urban form, design, supportive infrastructure, and incentives for auto use. Building on the contributions of the Center for Transit Oriented Development to Growing Transit Communities, an expanded review of that literature highlights the following major findings.

Finding: A Strong Relationship Exists between Density and Transit Ridership

How do land use densities around transit affect ridership? As summarized by CTOD, the relationship between land use and transit ridership is multifaceted:

There are several mechanisms by which increased density can shape demand for transit. Firstly, higher density development intensifies the origins and destinations served by the transit system, thus increasing the number of people living near transit who could potentially travel to transit-served destinations and expanding the number of jobs in those locations. Secondly, higher density development tends to increase congestion and reduce parking availability, thus increasing the cost of driving relative to taking transit. (CTOD, 2012)

The positive relationship between density and transit ridership has been widely supported in the academic literature for several decades. In both theory and in practice, there are two primary linkages between density and transit use. First, residents of high density neighborhoods are more likely to use transit. Second, higher densities bring more origins and destinations within easy access of transit, especially by walking from within a half-mile of the transit station.

Multiple studies have found an elastic relationship between density and transit ridership. With varying degrees of magnitude, as densities increase, so does ridership. CTOD cites several studies that show that doubling residential density increases transit boardings in a station area by between 15% and 59%. In another study, Cervero (2006) found that doubling residential density within ½ mile of a rail station increases ridership by 15% to 25%. Kuby et al. (2004) found that each 100 additional jobs located in a light rail station area leads to 2.3 additional boardings, each 100 additional residents leads to 9.3 boardings.

Data suggest that not all density increases have the same impact. In a study conducted in the Puget Sound region (Pivo and Frank, 1994), researchers found that single-occupancy vehicle use drops and transit use increases most rapidly when densities surpass key thresholds. Significant transit ridership gains begin to occur when density surpasses 30 activity units (residents plus employees) per gross acre and the most significant gains in ridership occur when densities exceed 45-50 activity units per gross acre.

Evidence also suggests that the strength of the relationship between density and ridership varies by transit mode, frequency of service, and by type of land use. Light rail ridership has a strong relationship to residential densities. Ridership on other modes may be less responsive to increases in residential density. For example, ridership on

commuter rail is much more highly correlated with the size and density of a region's central business district than with residential density along the corridor. (Parsons et al., 1996)

TOD that includes affordable housing that accommodates low-income households will have a more substantial impact on transit ridership. Low-income households are more likely to use transit for work and other trips and are more likely to report limited access to an automobile. In a recent study, low-income households living within ¼ mile of high frequency transit drove 50% fewer miles than high-income residents of transit station areas, and 50% fewer miles than low-income households living outside of transit-served areas. (California Housing Partnership Corporation and Transfrom, 2014)

Finding: Employment Concentrations Drive Regional Transit Use

High residential densities alone cannot support transit if the network does not connect residents to major destinations. Large, dense concentrations of employment are critical in driving transit ridership, especially for fixed-guideway systems such as light rail and commuter rail (CTOD, 2012).

Widely cited research by Pushkarev and Zupan (1977) examined the relationship between land use, ridership, and transit viability relative to transit system cost. The research found that, generally, "light rail transit requires a central business district of at least 35 to 50 million square feet....equivalent to CBD employment of 140,000 to 200,000." As a point of comparison, Seattle Downtown Regional Growth Center contains approximately 150,000 jobs, with more than 50,000 additional jobs in portions of adjacent centers that are accessible via transit serving the CBD, putting our region well within the prescribed range.

The interdependence between population and job densities and the performance of a transit system underscores the importance of coordinated planning along transit corridors. Cervero and Guerra (2012) address this challenge:

In terms of density, increasing the number of jobs around stations appears to have a stronger impact on ridership than increasing the number of residents. Since jobs tend to be concentrated around existing downtown stations, however, few system expansions are likely to capture significant job concentrations. This means that rail expansions in residential areas need to be coordinated with proactive policies to facilitate job growth in other areas.

Employment concentrations in suburban locations can also drive ridership, but the impact is less pronounced. However, according to CTOD (2012), "as subregional job centers increasingly resemble CBDs in terms of density, employment size, land use mix and urban design, they may drive more transit demand."

When connected to a central business district by convenient high-capacity transit options, major secondary centers can greatly benefit the transit system by generating bi-directional flows of riders. This is precisely the strategy that underlies VISION 2040 and Sound Transit's long-range plan: encouraging the development of mixed-use centers with better jobs-housing balance, and linking them and other important regional trip generators together with high-capacity transit. In this region, the East Link light rail currently under construction to connect downtown Seattle, downtown Bellevue, and Overlake is one such corridor. As other high-capacity transit corridors are implemented to the north and south of Seattle, corridor planning to link existing secondary job centers and economic development to grow the job base along the transit lines are thus crucial to long-term transit supportiveness of the region's land uses.

Finding: Other Factors in Station Areas Complement Density in Supporting Transit

Transit ridership is influenced by other aspects of the built environment that are closely inter-related with density. These factors include land use mix, connectivity, urban form and design, and capacity for the circulation and

parking of automobiles. As a whole, station areas that incorporate transit-supportive elements in all or most of these areas can be more successful in achieving desired travel outcomes.

It is hard to separate out the effects of land use mix and urban design from the effects of density on transit ridership because these factors are strongly inter-correlated. Research literature suggests that while factors other than density have a smaller effect on ridership than does density, they work very well to support high transit ridership in combination with dense land uses (Parsons et al., 1996).

Mix of Uses

Although less influential than density, land use mix will have an impact on travel behavior at a range of scales within a transit corridor. As has already been noted in the previous section, the presence of major destinations, such as employment centers or large institutions such as hospitals or universities, can function as anchors to the transit corridor that play a significant role in generating ridership. A more dispersed mix of uses across multiple stations along a transit corridor can generate travel demand, including for many non-peak trips to access goods, services, and recreation. In its report for the Transit Cooperative Research Program, Parsons, et al. (1996) observed that “transit service in corridors that contain a variety of residential and non-residential activities will prove especially attractive and competitive.”

Finally, within a single station area, a rich mix of uses—residential, employment, retail, public services, recreation—can foster higher rates of walking and biking within the station area. In addition, a mixed-use station area can be a more attractive transit trip destination by accommodating multiple trip purposes at a single transit stop. A wide variety of retail and service uses, including shops, pharmacies, grocery and convenience stores, restaurants, banks and public services, child care facilities, medical services, and recreation, is associated with all-day trip making. Colocation of office and other employment uses with retail and services also creates opportunities for workers to make secondary trips during the workday without the need for a car. As a high-level measure of use mix, jobs-housing balance has also been found to correlate with transit usage (Parsons, et al., 1996).

A literature review conducted for a “High Capacity Transit Corridor Assessment” (PSRC 2004) concluded that “increased mixed land use development patterns in activity centers have been found to have a positive relationship with decreases in vehicle miles traveled, lower automobile ownership rates, and increases in walking, biking, and transit use.” As a whole, the findings on mix of use suggest that the biggest impact of TOD on travel behavior overall, above and beyond transit use, may be increased walking trips for the 80% of household travel that does not involve commuting to work.

Connectivity and Urban Form and Design

Density, the mere proximity of concentrated housing or employment to transit, does not guarantee that the residents and workers within walking distance of transit will choose that mode of travel. Research has shown that there are a number of elements of the urban form and design within a transit station area that will influence mode choice and increase the likelihood that travelers will choose transit. Improving the built environment for pedestrians will enhance ridership because in a dense urban context many riders will access transit by walking. Increasing connectivity and attractiveness of those pedestrian connections will make it more likely they will choose transit.

Key design elements include:

- A dense grid of formalized streets and pedestrian paths
- Sidewalks that are safe, comfortable, and attractive

- Complete streets that are designed to accommodate multiple modes, including bicycles and pedestrians
- Building orientation to the street that creates an active and welcoming human scaled environment for walking
- Street trees and other enhancements to the public realm

Pre-1950 development is more likely to include the urban form described above as is more recent “new urbanist” development that incorporates many traditional design elements. Parsons, et al. (1996) cited data that shows that “residents of ‘traditional’ neighborhoods (i.e., pre-1950) are more likely to use non-automotive modes for non-work trips than residents of ‘suburban’ neighborhoods (i.e., post-1950).”

Roadway and Parking Capacity

Dense urban environments with robust transit patronage are often characterized by higher levels of roadway congestion and limited parking supply, especially free or low-cost parking. Factors such as the intensity of activity, volume of trips, and increased land value can naturally lead to these conditions in urban places. Public policy and regulations, such as concurrency measures that emphasize roadway level of service or parking requirements for new development, also play a role in determining the resulting capacity of roads and parking.

In particular, large facilities for automobile travel and parking (such as wide streets and large parking lots) can discourage pedestrians and bicyclists from accessing transit. The cost of parking is a major factor that will incentivize modes other than single-occupancy automobiles. Research shows that policies and investments that favor auto travel can undermine support for transit. According to Guerra and Cervero (2010), “an increase in density, with a corresponding increase in road capacity, will have little impact on VMT, and thus presumably on transit ridership as well.”

Density without appropriate transit infrastructure cannot be well served by transit. In most instances, transit vehicles themselves use roadways to serve dense urban areas. Local jurisdictions can take important steps to facilitate the circulation of transit vehicles, such as signal prioritization, in lane bus stops, and dedicated traffic lanes. These enhancements will increase transit speed and reliability, key ingredients to building and maintaining transit patronage.

Finding: Minimum Density Thresholds that are Transit Supportive

There is no universally accepted set of standards for what constitute transit-supportive densities. There are several reasons for this. First, given the variation in land use and market conditions across regions and station locations, there is no single threshold that is appropriate for all areas. Second, and more important, neither the academic literature in theory nor local and regional governments in practice have reached consensus on a minimum density that is necessary to support a given mode, level of service, or cost level of transit. The real question at hand is: What is the relationship between density, transit ridership, transit agency goals, and the cost at which transit can be provided? The answer to this question can vary significantly from region to region and corridor to corridor based on a range of factors that include:

- Mode and service level of transit
- Capital and operating costs of transit
- Cost-effectiveness/cost-recovery objectives and targets
- Local development and market characteristics
- Location within the service area
- Local and regional policy objectives

The subject of a normative density standard for transit station areas was first explored comprehensively in the book *Public Transportation and Land Use Policy* (Pushkarev and Zupan, 1977). The findings and recommendations contained in this decades-old study have been widely cited and continue to influence TOD policy today. The authors recommend an off-the-shelf set of planning benchmarks, “minimum residential densities required to make different transit modes cost effective.” For example, considering a light rail system serving a central business district (CBD) of at least 35 million square feet of commercial space, the authors recommend a density of 16 persons per gross acre.

In a more recent analysis, Cervero and Guerra (2011) revisited the questions addressed in the 1977 study in light of more recent data on ridership and transit system capital costs and a more nuanced analysis of the relationship between land use and transit system performance across different regions and transit systems.

The author found that:

Light-rail systems need around 30 people per gross acre around stations and heavy rail systems need 50 percent higher densities than this to place them in the top one-quarter of cost-effective rail investments in the U.S. The ridership gains from such increases, our research showed, would be substantial, especially when jobs are concentrated within ¼ mile of a station and housing within a half mile.

Because these findings are based on transit systems with average capital costs per mile, any specific quantitative guidance derived from them should be taken with a grain of salt. Even within a single mode, transit system development costs vary considerably. Further, performance in the top 25% of systems is a relative measure that was chosen by the authors as a proxy for more prescriptive benchmarks. Ultimately, the question of appropriate or desired cost recovery levels is going to be specific to each transit system.

Guerra and Cervero (2011) provide detailed guidance on the relationship between transit service, capital costs, and ridership across a range of different transit systems. The paper analyzed data from 59 separate transit investments including heavy rail, light rail, and bus rapid transit in 22 different cities. The authors found both population and job density to be positively correlated with transit ridership. Higher density areas also tended to have higher capital costs for transit infrastructure cost per mile. However, the research shows that higher densities do tend to improve transit’s overall cost effectiveness, despite higher costs.

Using a cost-per-rider model, the authors estimated that an average light rail system in an average city requires approximately 30 residents per gross acre in order to achieve strong cost-per-rider performance with an average capital cost of \$50 million per mile. Strong cost-per-rider performance was defined as projects that cost less than \$0.58 per passenger mile, thus falling within the top 25 percentile for cost-effectiveness of systems studied nationally. In an earlier (2010) version of this paper, the authors used the same model to quantify transit-supportive density at 56 residents *and* jobs combined per gross acre for an average cost system.

With higher capital costs, the densities needed to attain that level of performance also rise. For example, at \$75 million per mile, this analysis finds that a density of 50 residents (116 residents and jobs combined) per gross acre would be required, and at \$100 million per mile, a density of 67 residents per gross acre would be needed, in order to perform in the top 25% of light rail systems.

Guerra and Cervero predict a somewhat different relationship between density and ridership on bus rapid transit. BRT has a much lower capital cost than rail, requiring fewer riders for viability. Because BRT typically offers a less “permanent” transit investment, however, with a lower level of service, it is a weaker catalyst for TOD than rail transit. For this reason, the cost-per-rider model produces a different gradient for transit-supportive densities.

According to Guerra and Cervero (2010), a BRT system developed at a cost of \$10 million per mile would require a density of 17 jobs and persons per gross acre to be highly cost effective (top 25% of systems studied). At a cost of \$25 million per mile, the density needed to make the system cost effective goes up to 88 jobs and persons per gross acre. Figure 5, below, summarizes the major findings of these several studies.

Figure 5: Major Findings on Recommended Densities by Transit Mode

Light Rail	Bus Rapid Transit	Commuter Rail	Other Transit
<p>Pushkarev and Zupan (1977) 16 <i>residents</i> per gross acre</p> <p>Guerra and Cervero (2011) Optimal: 30 <i>residents</i> per gross acre for average cost system (\$50M per mile)</p> <p>Optimal: 67 <i>residents</i> per gross acre for system cost of \$100M per mile</p> <p>Guerra and Cervero (2010) Optimal: 56 <i>residents and jobs</i> per gross acre for average cost system</p>	<p>Guerra and Cervero (2010) Optimal: +/- 17 <i>residents and jobs</i> per gross acre depending on system cost</p>	<p>Various Ridership linked primarily to employment in CBD.</p> <p>Residential densities in station areas can boost ridership, but focus of transit service on peak travel may not support TOD to the degree of all-day frequent service.</p>	<p>Pushkarev and Zupan (1977) For local bus: 4-15 <i>dwelling units</i> per <i>net</i> acre, depending on level of service</p>

How do Existing Densities in the Region Compare with Recommended Thresholds?

Recent studies for the central Puget Sound region provide data on existing land uses and densities around transit nodes and stations that can be compared with regional and nationally recommended benchmarks. Overall, these data are encouraging in illustrating significant progress in planning for transit-supportive densities, particularly within Regional Growth Centers, and achieving a greater concentration of employment and especially housing growth near high-capacity transit corridors. However, the data also show a significant gap between existing densities in many areas and densities that regional and national guidelines suggest are needed to support a robust transit system over the long term.

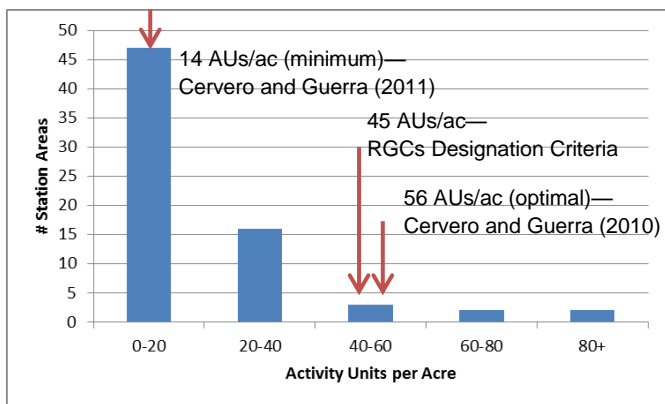
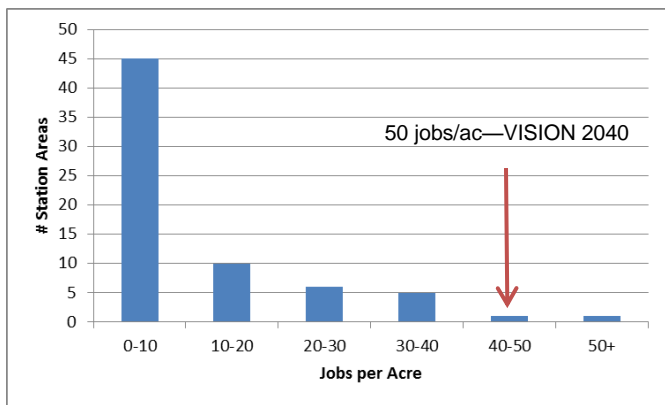
The *Regional Centers Monitoring Report—2013 Edition* (PSRC 2013) catalogues comparative data on current conditions and recent trends in the region’s designated centers. Eight out of 27 designated Regional Growth Centers had, as of 2010, attained a density of 45 activity units per gross acre, the standard established in PSRC’s designation criteria for long-term transit supportiveness. The high-performing centers included locations in Seattle along with downtown Bellevue and Overlake in Redmond. Among the remaining Regional Growth Centers, downtown Tacoma and downtown Everett were the only ones to attain more than 30 activity units per acre. Nearly all of the Regional Growth Centers, however, have densities higher than the 14 activity units per gross acre estimated by Guerra and Cervero as a “bare minimum” to support high-capacity transit. The centers are also becoming denser, with over half of the regionally designated centers increasing their activity unit density between 2000 and 2010, despite the job losses that occurred as a result of the “Great Recession” from 2007-2009.

While not included in the *Regional Centers* monitoring work, cities that are planning for one or more Regional Growth Centers have reported to the Growth Management Policy Board on their long range plans for their centers and the capacity for growth and increased density created by those plans, and implemented through zoning and capital facilities investments. These reports have made clear that potential dwelling units, employment, and activity units overall planned for in the RGCs greatly exceeds existing development densities. With the GMA-mandated comprehensive plan updates due in 2015, those cities are refreshing their targets, policies, and zoning for centers to accommodate even more growth in the new planning period.

PSRC also documented conditions along three major high-capacity transit corridors in the central Puget Sound region as part of the Growing Transit Communities effort (PSRC, 2012). The corridors, which over the long term are planned to be served by a regional light rail system or other high-capacity transit, are currently served by a variety of transit modes, including light rail, BRT, core and specialized bus, and streetcar.

As shown below in Figure 6, most of the 74 transit community study areas covered in GTC existing conditions analysis currently have levels of use and activity that are below the thresholds and guidelines for what constitutes transit-supportive densities cited previously in this paper. The one exception is the “bare minimum” 14 activity units per acre for light rail feasibility (Cervero and Guerra, 2011), a relatively low threshold which most areas do exceed.

Figure 6: Existing Densities in GTC Study Areas



With GTC’s emphasis on corridors, the region’s hub transit station areas in downtown Seattle are not included in the analysis. Based on data reported in the *Regional Centers Monitoring Report—2013 Edition*, downtown Seattle reaches densities of nearly 200 AUs per acre, well above what would be considered transit supportive.

Appendix A highlights conditions in several high performing station areas outside of downtown Seattle to illustrate the types of conditions that can and do exist to support transit investments. Capitol Hill and Downtown Bellevue will be served by light rail. Ballard and 112th St. SW will be served by BRT. In both urban and suburban contexts, these station areas approach or exceed recommended density thresholds that would support high performing transit systems.

The observed gap between actual and recommended densities for transit station areas is not unique to the central Puget Sound region. National research shows that existing densities in transit station areas in many urban regions fall short of standards in the academic literature and regional guidelines. For example Guerra and Cervero (2011) compared transit station areas in a large national sample with thresholds recommended by the most common industry standard (Pushkarev and Zarpan 1977), concluding that “the average rail investment of the past four decades has fewer households around stations than the recommended minimum. Just 26% of heavy rail and 19% of light rail station areas surpass the recommended minimum.”

Why does this gap exist? One reason is a history of auto-oriented development in many locations, coupled with the fact that recent high-capacity transit investments have had little opportunity to date to influence development. It is important to note that the density data reflect a snapshot of conditions in a changing landscape, both national and regionally, of transit and land use. Most of the study areas in the central Puget Sound region HCT corridors do not yet have light rail service, and for most locations, the local governments have only recently initiated station area planning, if at all. The data indicate that significant work on the part of the public sector along with investment from the private sector will be necessary to approach densities that are likely to provide the ridership for a highly cost-effective high-capacity transit network.

Policies and development regulations are another set of factors that may contribute to sub-optimal levels of activity in the walksheds around transit stations. The GTC existing conditions research revealed both opportunities and barriers for achieving transit-supportive densities. In many locations, existing development and zoning limit the opportunities for TOD to relatively small areas within the transit station walkshed. In a third of the GTC study areas, single-family zoning covers over half of the land within walking distance of transit nodes. Multifamily net densities range considerably, from very high densities (greater than 200 units per net acre) in downtown Seattle and Tacoma and others to under 100 units per net acre in major suburban activity centers to 50 units per net acre or less in secondary nodes along transit corridors.

Finally, factors related to sub-regional real estate markets and the economics of development are barriers to achieving private investment in TOD. The *Puget Sound Region Transit-Oriented Development Market Study* (Strategic Economics, 2012) assessed the prospects for TOD in the three long-term planned light rail corridors in the region. The study found uneven market support in the north corridor through Snohomish County to Everett and generally weak market support for TOD in the short to medium term south of Seattle to Tacoma. As regional transit connections bring these areas a much higher level of accessibility to regional job markets and institutions, cities in those corridors have an opportunity to overcome soft real estate markets to attract new investment in TOD.

Guiding Principles to Achieve Transit-Supportive Land Uses

Several key guiding principles stand out for the region and its constituent jurisdictions to follow as they plan for transit and transit-supportive communities. These principles are grounded in the research on the relationship between land use, density, and transit, and also reflect best practices among regional governments and transit agencies.

Guiding Principle: Increase Densities around Transit Stations and Stops to Increase Ridership

As research has consistently shown, a strong positive relationship exists between density of land use and transit ridership. Steps to increase the number of residents, jobs, or both, within walking distance of transit stations and stops will pay off in increased numbers of people using transit for a variety of trip purposes, increased pedestrian travel, and decreased per capita vehicle trips and vehicle miles traveled. All types of station areas have a role to play in supporting transit with land use, though the scale and mix of uses will vary among station areas.

The region’s HCT network is designed to connect regionally designated centers of population and employment. Designation criteria for new Regional Growth Centers set minimum targets for future planned densities that reinforce land uses that support transit ridership. However, there are other HCT station areas that are not regionally designated or not covered by these criteria, and non-HCT routes as well, where planning for and achieving transit-supportive densities is equally important.

Transit-supportive densities can be achieved through multiple means. Density is not necessarily the same as height, though increasing building height is an important aspect of boosting densities in many cases. Dense mixed-use development can achieve a critical mass for transit use through means such as joint development over and around transit stations, infill on underutilized sites such as surface parking lots, and horizontal mixed uses with housing, office, and retail.

The overall positive impact of land use strategies to support a transit corridor can be fostered through steps to utilize existing lower density residential areas more efficiently. This may include upzones to encourage denser housing types, to include accessory dwelling units, cottage housing, townhomes, and apartment buildings that are carefully designed to complement existing single-family residential neighborhoods.

Ridership can be enhanced even further through residential density when new housing development includes an ample supply of units that are affordable to low income households and when existing affordable housing is preserved ahead of redevelopment that occurs in anticipation of and following transit investments (CTOD, 2009).

Guiding Principle: Establish Transit-Supportive Density Goals based on Locally Relevant Data and Policies

The studies, policies, and comparative regional standards highlighted in this issue paper provide a strong starting point for context-specific analysis and goal-setting to match transit service to appropriate land uses. Figure 7 summarizes the range of benchmarks reviewed.

Figure 7: Density Benchmarks by Transit Mode

	Light Rail	Commuter Rail / Ferry / Express Bus	Bus Rapid Transit / All-day Frequent Bus
Walk distance	½ mile	½ mile	¼ mile
Residential density	16 – 67+ residents per gross acre	n/a*	7 – 8+ housing units per gross acre
Employment	100,000 – 150,000+ jobs in CBD	CBD employment key	n/a*
Activity Units	56 – 116+ residents and jobs per gross acre	n/a*	17 +/- residents and jobs per gross acre

*"na" indicates that these metrics were not addressed in the literature reviewed

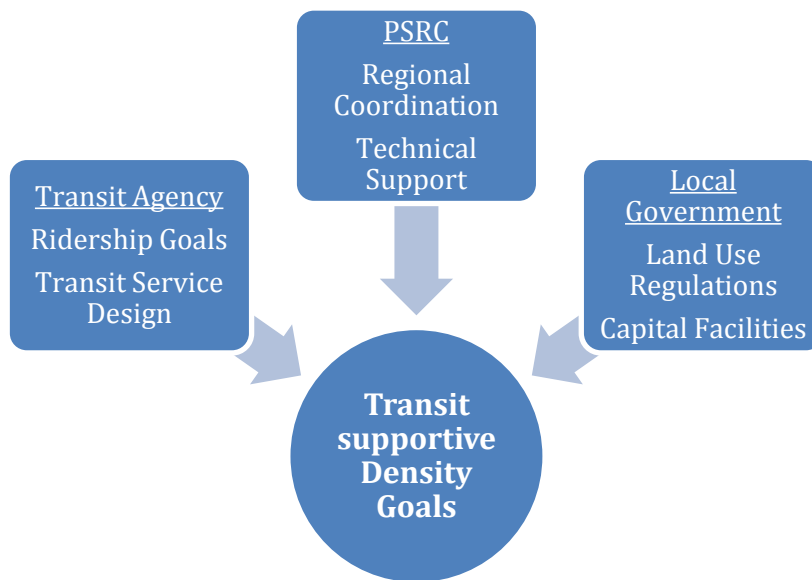
None of the density thresholds summarized here offers an off-the-shelf standard for use in this region. However, the following can be recommended, based on the research findings:

- Existing regional standards for density that supports TOD—15 to 20 units per gross acre cited in VISION 2040 and 45 activity units per gross acre required of Regional Growth Centers plans—are roughly consistent with the range of densities for light rail in Figure 7 and can reasonably be applied as a floor for average transit supportive densities in light rail corridors. However, with capital costs for light rail development in the region higher than national averages, long-term goals for station areas could reasonably promote development in key station areas that achieves densities at the high end of the ranges cited above, or even higher in some cases.

- While commuter rail ridership is not as dependent on station area densities as other transit modes, opportunities to enhance ridership and build compact communities through TOD exist in commuter rail station areas and should be promoted, especially in locations where other complementary transit options provide all-day mobility options for residents.
- TOD potential around bus transit is enhanced with higher frequency of service, reliability, and convenience, with a potential to achieve densities that greatly exceed the minimal threshold of 17 activity units per gross acre cited in the research literature.

As an alternative to one-size-fits-all density goals, a collaborative process is recommended involving major public sector stakeholders and drawing upon appropriate data and policy guidance. As shown in Figure 8, regional, transit, and local agencies each have a role to play.

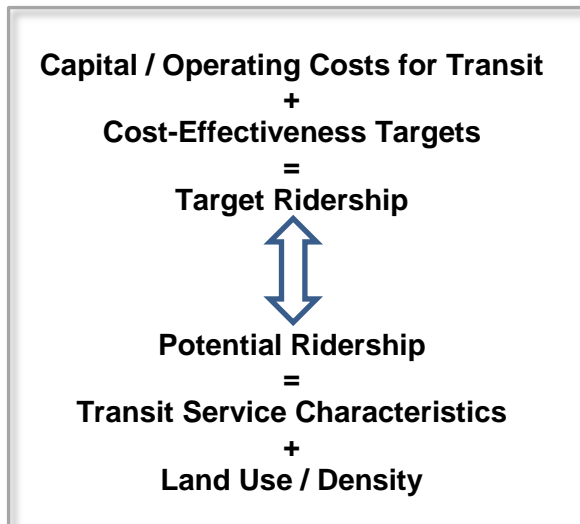
Figure 8: Model for Collaboration on Transit-Supportive Density Goals



The Puget Sound Regional Council is well suited to provide coordination among transit agencies and jurisdictions that have jurisdiction and service delivery in a corridor. With robust data and modeling capabilities, the PSRC also is a resource for the high level of technical support that may be necessary. Transit agencies make the capital investments and transit service commitments that are the anchor for TOD. Transit providers can contribute guidance in the form of ridership goals, cost-effectiveness policies, and fare box recovery targets. Increasing transit ridership is a goal of both regional and local governments, that may further be quantified, such as with mode-split goals. Finally, local governments govern land use decisions and many of the capital facilities investments that contribute to a transit-supportive development pattern.

Successful collaboration among these players is facilitated with agreement on minimal and/or optimal densities that are based on national research, but also reflect local data on the costs of providing transit, explicit targets for transit productivity (riders), and land use—both existing conditions and the long-range role of the transit station. Figure 9 illustrates a logic model for considering these factors.

Figure 9: Logic Model for Setting Transit-Supportive Density Goals



Step one in this process is to identify **relevant cost data**. For fixed-guideway HCT, such as light rail, capital cost is most relevant. For example, cost per mile of Sound Transit’s Link light rail varies by corridor and segment, but may average more than \$200 million per mile, higher than many other comparable systems. Cost per mile for BRT, as it has been implemented in this region, averages well under \$10 million per mile, lower than many other BRT systems. Because operations is a much higher percentage of the cost of any bus mode than it is for rail transit, it may also be useful to include an estimate of operating costs for BRT.

Step two is to define a **target for cost-effectiveness**. Mode- or corridor-specific targets or goals may address cost-effectiveness in terms of the number of riders per dollar of transit investment or desired levels of fare box revenue. The specified level of performance or cost-effectiveness is largely a matter of policy. Key questions may include: How much public benefit per public subsidy is desirable? What other public policy objectives might providing transit in this corridor serve? What level of fare box revenue is necessary for financial viability of the transit service? Whether adopted formally by a transit or other public agency, or merely agreed upon as a planning assumption, arriving at a goal for cost-effectiveness is best achieved by the transit agency in consultation with other public agencies making investments in the corridor.⁴

Step three involves estimating the **land uses and densities** around transit stations that would be necessary to generate the ridership that meets adopted goals. The model developed by Guerra and Cervero is one resource that provides high level estimates of threshold densities. In addition, PSRC maintains several tools that can assist with this work. The region’s current zone-based 4-step travel model has been used as a tool for estimating transit mode share broadly within corridors in the region. A new activity-based travel model, SoundCast, available in 2015, will be capable of much more detailed analysis and estimates of the interaction of density and use mix for small areas and the resulting travel behavior of residents and workers. Data from the latest regional household travel survey, completed in 2014, are a resource for advancing and updating regional modeling capabilities.

⁴ Lacking comparable cost-effectiveness goals for the 56 transit systems they analyzed, Guerra and Cervero (2010/11) used as a proxy performing in the top quartile of all transit systems on cost-per-rider. This standard is a good starting point for considering how the potential cost-effectiveness of transit in the central Puget Sound region might compare with other regions.

A final step may consider a range of **additional factors** that feed into setting density goals for local areas. These could include the role and capacity of different station area types, market strength and growth projections, and timing of transit investments.

Not all station areas will accommodate housing and employment growth at the same level of intensity and mix of uses. Generally, there is a hierarchy of places that ramp down in size, from CBD to suburban areas, along with differentiated roles for existing nodes of activity in the region. These place types will persist as part of the land use pattern that supports transit. For example, the GTC Station Area Profiles used 7 categories to characterize existing conditions in nodes along the light rail corridors: Metropolitan Core, Destination, Employment Center, Regional Center, Commuter, Neighborhood Center, and Residential Neighborhood. Place type likely will continue to shape regional guidance on transit-supportive densities and land uses.

The emphasis, however, of this kind of framework is not to limit possibilities for TOD, which will evolve and expand as real estate markets shift and as transit investments come on line over time. Place types should be used to highlight the variety of opportunities and contexts for development that supports transit along a given corridor. Places may also evolve from one type or role within a corridor to another as they grow and change.

Guiding Principle: Maximize Land Use Potential within Transit Walksheds

As summarized in this paper, research supports several widely applied standards for estimating the practical walking distance to various modes of transit. Typically, fixed-rail high-capacity transit will draw riders from within a 10-minute (1/2 mile) walk distance. Bus transit typically draws riders from a 5-minute walk distance (1/4 mile). In planning for transit-supportive land uses, local governments should address steps to take full advantage of the existing walkshed as well as steps to expand the walkshed. Doing so will not only contribute to the value of transit investments, but also address local goals, such as connecting more of a community's jobs and housing to transit, providing travel choices, and reducing travel costs.

Generally, every acre of land within 10-minute's walk of a high-capacity transit facility, or within a 5-minute walk of a frequent bus route, is an opportunity to make transit accessible to more potential transit users through development of more intensive land uses. Planned land use and zoning designations should allow transit-supportive densities across as much of the walkshed as possible. As part of the land use planning process, existing zoning or station area boundaries can be compared with the walkshed boundary using GIS to identify areas that have the potential to accommodate transit riders, but are currently planned for low-density uses.

The walkshed can be expanded to ensure that more nearby land can access transit through public and private investments that increase connectivity for pedestrians. Such efforts could include breaking up large blocks with new streets and/or pathways, expanding the sidewalk network, and new facilities to address geographic barriers. Planned pedestrian bridges at Northgate and Overlake are good examples of infrastructure investments that would greatly expand the existing walkshed.

A basic premise of transit-oriented development is that land use in the station area should be more intense than it is in surrounding neighborhoods. However, it is not recommended that station areas be uniform in density throughout. A step-down approach is more appropriate in order both to maximize the parcels closest to the station with the highest densities and to ensure that, to the extent possible, the transit-supportive densities within the walkshed blend in with adjacent uses, especially single-family residential neighborhoods.

The larger the planned station area, the more flexibility there is for including both "core" and "frame" uses and densities that together provide a level of activity that supports transit. For example, where the station is anticipated to accommodate substantial employment uses, such as office, those more intensive uses should be

clustered within the ¼ mile distance. Mid- and high-rise housing is best suited for the core of the station area, with townhomes and other lower profile attached dwelling unit types interfacing with adjacent single-family neighborhoods.

Guiding Principle: Promote Employment Growth at Station Areas in Transit Corridors

Transit-supportive residential and mixed-use neighborhoods are important, but not sufficient to provide the high ridership for the transit system. Riders have to have a place to go, major destinations for daily travel along the transit corridor, especially for work. Employment centers and large institutions, such as universities and hospitals, are the anchors for a transit corridor.

Taking steps to focus more employment within walking distance of key transit nodes, in tandem with residential development along the transit corridor, is most effective in generate ridership demand.

First and foremost, economic development efforts should focus on place based employment growth in transit station areas. The work starts with actions to build on the vitality of the central business district. A healthy CBD will benefit all of the other transit communities within the system by creating demand for housing and services, and ultimately investment in these neighborhoods. Emerging employment centers in outlying neighborhoods and in suburban centers are also prime for public actions to help attract employers. Public policy should identify transit station areas as the preferred location for major public facilities that generate demand for transportation by students and the public at large.

Any of the region's long-range high-capacity transit corridors could accommodate one to several major secondary employment centers, while maintaining a balance of jobs and housing along the corridor that produces healthy ridership. Potential locations within the region include Regional Growth Centers, particularly in Metro Cities of Bellevue, Everett, Bremerton, and Tacoma, and mid-corridor nodes, such as SeaTac and Northgate. The importance of employment centers to transit ridership should be a consideration for future transit alignments that have the potential to connect major regional employers, such as Boeing, or Regional Growth Centers that are not currently served through ST2 funded light rail.

Guiding Principle: Plan for and Encourage Mixed Uses and Transit-Supportive Design

While the research literature clearly points to the density of compact development around transit investments as the primary land use driver of transit ridership, density alone cannot ensure that land uses in station areas will be truly transit supportive. As summarized by the Center for Transit Oriented Development (2012), "Given the interdependence of built environment characteristics, policies that encourage a breadth of transit-supportive strategies may be more likely to be successful than policies that focus on one dimension."

These strategies include:

- Pedestrian-friendly design
- High connectivity to the transit facility and more broadly across the station area
- Investments in infrastructure that supports non-motorized travel
- A rich mix of uses within the transit corridor, including jobs-housing balance
- Zoning to discourage or disallow uses and building designs that are incompatible with TOD, such as strip commercial, commercial parking, and low-density residential

The PSRC has produced several guidance documents that address a wide range of recommendations for the uses, design, and public amenities that are appropriate for both Regional Growth Centers and many other transit station areas in the region. *Creating Transit Station Communities*, a workbook for local implementation published in 1999,

remains a useful resource for station area planning. The recently updated *Center Plans Manual* and plan review checklist provides specific prescriptive guidance on uses and urban design elements that are relevant not only for the regionally-designated centers but other sub-regional centers that are served by high-capacity transit.

Guiding Principle: Incentivize Alternatives to Automobile Travel in Station Areas

Travel choices made by both the residents and employees in high-capacity transit station areas are influenced by the relative costs associated with different modes of travel. Policies and requirements that reduce the costs of automobile travel at the expense of other travel modes will undercut efforts to build ridership through transit-oriented development. As an alternative, innovative approaches to managing the capacity to accommodate cars in the station area can be employed in the areas of congestion impacts of new development and in parking supply.

Concurrency programs adopted by local governments have traditionally emphasized automobile travel using level-of-service standards that result in linking new development, even in areas with high levels of transit service, to actions such as widening streets and other roadway and intersection improvements that prioritize auto movement over other modes. Multimodal concurrency encompasses a toolbox of approaches to measuring mobility impacts of development across multiple modes of travel and implementing measures to enhance mobility across all modes, including through demand management, transit, and bicycle and pedestrian improvements. Resources for addressing multimodal concurrency in transit station areas are available from PSRC at <http://www.psrc.org/growth/vision2040/implementation/concurrency/>.

Parking management is another area where public policy can greatly influence the costs of driving to a station area vs. taking transit or other alternative mode. Policies and practices that undercut transit-supportive planning include free on-street parking, minimum parking requirements for new development, and land dedicated for transit station parking that may conflict with potential for residential or commercial TOD in close proximity to the station.

The Growing Transit Communities Strategy calls for broad adoption of innovative parking tools that would result in a supply of appropriately-priced parking that meets the multimodal travel needs of transit communities. The innovations include:

- Reducing or eliminating requirements for off-street parking where transit service level is high
- Encouraging market-based approaches, such as “uncoupling” the price of housing units and parking
- Shared parking, particularly in mixed-use districts
- Variable on-street parking pricing to maximize supply and access across periods of variable demand

Resources and guidance on parking management are available from a number of sources. The Right Size Parking project undertaken by King County Metro is one notable resource for best practices and data on parking utilization in multifamily housing, including in transit-rich locations. More information is available at <http://metro.kingcounty.gov/up/projects/right-size-parking/>.

Implementation and Next Steps

The findings of the literature review and resulting guiding principles presented in this issue paper are intended for use in a range of interrelated planning and plan implementation activities. Local governments are currently working toward state-mandated periodic updates to their comprehensive plans. Implementation of those plans will entail follow-up planning in the form of subarea plans, station area plans and plans for designated regional and sub-regional centers, including areas that are provided with current or future high-capacity and core transit

service. Transit agencies are preparing long-range transit plans, including guidance on system design and policies that incentivize and support TOD.

Finally, for the PSRC, implementation of VISION 2040, Transportation 2040, and the Growing Transit Communities Strategy through agency investments and programs will benefit from a more robust understanding of transit-supportive land uses. Additional guidance papers may complement this work, for example focusing on transit-supportive infrastructure, complete street design, and access. Looking forward, as well, the regional council, in consultation with transit agencies and local governments, may want to develop explicit density goals for TOD in regional and subregional centers and the corridors that connect them as part of a VISION 2040 update.

For more information on the issues addressed in this issue paper, contact Michael Hubner, Principal Planner, Puget Sound Regional Council, by phone at (206) 971-3289 or by email at mhubner@psrc.org.

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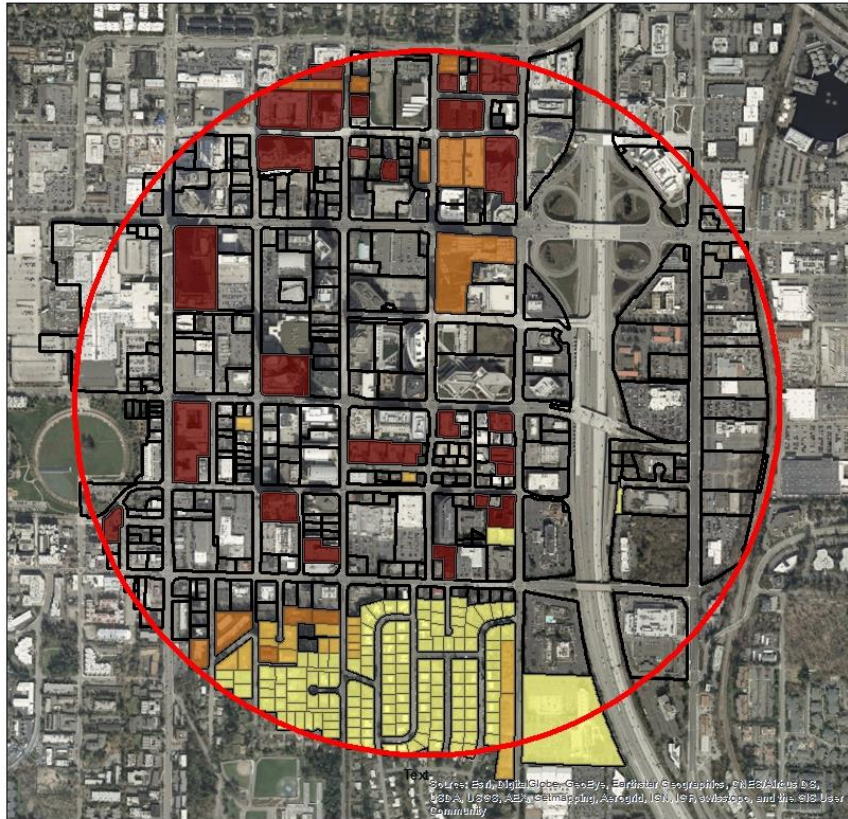
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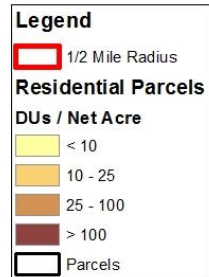
Appendix A: Transit-Supportive Densities Example Station Areas



Transit-Supportive Density Example

Downtown Bellevue Light Rail Station

Half-Mile Radius	500 acres
Area in Parcels	360 acres
Residential Parcels	90 acres
Housing Units	6,253
Jobs	40,000
Persons per Gross Acre	13
Housing Units per Gross Acre	12
Housing Units per Net Acre	17
Housing Units per Net Residential Acre	70
Activity Units per Gross Acre	92

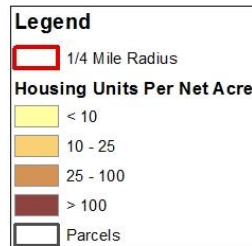




Transit-Supportive Density Example

Ballard BRT Stop

Quarter-Mile Radius	125 acres
Area in Parcels	80 acres
Residential Parcels	28 acres
Housing Units	1,840
Persons per Gross Acre	35
Housing Units per Gross Acre	15
Housing Units per Net Acre	23
Housing Units per Net Residential Acre	65





Transit-Supportive Density Example

112th St. SW BRT Stop

Quarter-Mile Radius	125 acres
Area in Parcels	100 acres
Residential Parcels	50 acres
Housing Units	1,175
Persons per Gross Acre	23
Housing Units per Gross Acre	9
Housing Units per Net Acre	12
Housing Units per Net Residential Acre	24

