Moving Princeton Forward:
Looking at Transportation Alternatives for the Princeton Community and the Route 1 Corridor
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Introduction

As cities and regions across the United States have continued to experience growth over the last decade, transportation has become a major concern. Planners in Central New Jersey are faced with a particularly difficult challenge. Decades of piecemeal development has created a landscape strewn with disparate housing developments, office parks, and shopping centers that is now straining the region’s road infrastructure. While pressure to expand the region’s highways exists, an increasing number of residents recognize that pouring more asphalt is unlikely to solve the region’s traffic issues – and may actually exacerbate the problem. Combined with fear of high gas prices, and growing awareness of the environmental problems associated with auto emissions, planners are looking for alternatives to road expansion to solve the current transportation challenges.

Most planners argue the long-term solution is to return the state’s land use patterns to its former ways – with compact towns linked by trains (or buses) to major activity centers. These walkable, mixed-use villages are integrated with homes, apartments, shops, offices and schools – and are much more supportive of public transportation. Emphasizing this concept, planners hope to decrease the number of car trips needed to meet the necessities of daily life. However, making the type of changes to the state’s development patterns will take decades, and will not address the problems on the roads today.

As such, planners must look at how to retrofit the current suburban landscape to create suitable alternatives for the private automobile. In Princeton, planners are blessed with a 2.7 mile rail spur (“The Dinky”) that connects the community to the Northeast Corridor – and allows commuters from Princeton easy access to job centers along the line. Proposals have been made to extend the line, however, the fiscal conditions at present – combined with a reluctant operator – have put such plans on permanent hold. In addition, recent expansion plans by the University may put the line’s very existence at risk.

Should the Princeton Branch be decommissioned, the impact on traffic in the area will likely be large. Therefore, a workable alternative must be developed. The current focus of planners is a Bus Rapid Transit (BRT) line that would utilize the right-of-way occupied by the Dinky, and expand to connect major points along Route 1. While this option holds promise, several issues need to be addressed to ensure that just a investment would serve the community and commuters adequately. As an alternative to BRT, planners could analyze the feasibility of building a Personal Rapid Transit (PRT) system for the Princeton vicinity. While few working examples of such systems exist, the characteristics of the Princeton community lend themselves to a PRT network.

Whatever actions are taken to tackle the transportation challenges of the region, they should serve to provide frequent and reliable service to residents and commuters. This will ensure that the system is a realistic alternative to the private automobile – which is important if the system is to attract current drivers, and not just existing transit riders.
Existing Conditions

DEMOGRAPHICS AND EMPLOYMENT

Princeton, New Jersey consists of two municipalities – Princeton Borough and Princeton Township. The Borough of Princeton consists primarily of the downtown core area of Princeton (centered along Nassau Street) along with the majority of university buildings and the Princeton Train Station. The Borough has a population of approximately 13,500 residents¹ and an area of 1.9 square miles. The surrounding township includes the rest of the university and residential areas – entailing a population of 17,490 residents and an area of 16.62 square miles. Both the borough and the township have seen a particularly high level of growth in the past several decades, growing between 18-21% from 1990-2000. While growth has stalled in the borough recently, the township grew 8.3% from 2000 until 2007.

Princeton is a major employment center. The university itself employs approximately 5,700 people. Additionally, in the near vicinity are the offices of major corporations, foundations and research institutions, including ETS Testing Service, Bristol Myers-Squibb, Prudential Financial, Merill-Lynch, Siemens, General Electric, and others.

EXISTING PUBLIC TRANSIT OPTIONS

The Dinky
The New Jersey Transit Princeton Branch (known as the “Dinky”) provides 41 roundtrips between Princeton Borough and Princeton Junction Station in West Windsor, New Jersey. On an average weekday, there are 2,260 passengers who take the 2.8 mile journey – which costs $2.25 for a one-way trip². The Princeton Junction Station is NJ Transit’s 5th busiest station, serving approximately 7,800 commuters on an average weekday³. Parking at the station is severely oversubscribed, with a waiting period of 2-8 years, depending on its location and the residency of the driver. While operating costs for the Princeton Branch are not available, they can be estimated at approximately $2-$2.2 million per year based on NJ Transit’s reported operating cost per rail service hour of $362.10⁴ – with an operating loss of $400,000-$600,000 per year⁵.

Tiger Transit
Princeton University offers several bus/shuttle lines to help students, staff and visitors move around the campus and to remote parking, housing and facilities. While figures detailing precise ridership and costs are not publicly available, estimates for annual ridership of the entire Tiger Transit system are approximately 723,000 passengers per year. Using cost estimates from other bus/shuttle lines, the annual budget for the Tiger Transit system is likely in the range of $800,000-$1 million a year.

¹ Census data for Princeton Borough, 2007, US Census Bureau
² NJ Transit Ridership Statistics, Fiscal Year 2007-2008, Office of Public Information
⁴ NJ Transit Performance Measures, FY 2007
⁵ Reported operating loss in 1989 was $335,000. “Commuter Rail Lines and Competition”, NY Times, July 16, 1989
Princeton Borough Jitney
Princeton Borough, Princeton University and NJ Transit have partnered to provide a free jitney service during the morning and evening rush hours. Called the “Free-B”, the jitney connects Princeton Station with the downtown core. Riders can flag down the shuttle at any point along its 20-minute route. Ridership on the recently launched service is approximately 500 passengers on an average weekday. The cost for the service is approximately $60,000 a year, which is subsidized by the university and NJ Transit⁶.

NJ Transit Bus
NJ Transit operates 2 bus lines (605,606) that connect the downtown core of Princeton borough with Montgomery Township and destinations along the Route 1 corridor in Lawrence and Hamilton Townships. These lines receive a combined total of approximately 800 average weekday riders. In addition, NJ Transit operates a bus line from Trenton to Princeton Junction and the Princeton Forrestal Campus which has a ridership of approximately 1,034 on an average weekday. While figures for the operating costs of these services are not available, it is estimated that they cost approximately $1.4-$1.6 million per year based on NJ Transit’s reported operating cost per bus service hour of $138.47⁷ - with an operating loss of approximately $600,000-$800,000.

⁷ NJ Transit Performance Measures, FY 2007
Challenges and Opportunities

UNIVERSITY EXPANSION PLANS

In 2006, Princeton Alumnus Peter B. Lewis ’55 made a $101 million gift to the University to help build a new performing arts center on campus. To make this a reality, the university has proposed a new “arts and transit” neighborhood as part of the university’s overall campus plan. The plans call for a new annex of the Princeton Art Museum and an Experimental Media Studio, in addition to the new Lewis Performing Arts Center. In 2008, Princeton announced the hiring of world-renowned architectural firm Steven Holl Architects to design the new arts buildings, signaling the university’s intention to make a dramatic mark on the campus.

To make room for the new buildings and improve traffic/pedestrian flow and provide access to an existing parking facility, the university has proposed moving the Dinky station at least 500 feet south from its current location. In addition, commuter parking would be relocated further south.

The proposed relocation of the Dinky station has been met with community opposition, who feel that the station will become more inconvenient for commuters – decreasing ridership and threatening its existence.

ROUTE 1 BUS RAPID TRANSIT

In early 2004, NJ Transit in cooperation with the Delaware Valley Regional Planning Commission (DVRPC), the North Jersey Transportation Planning Authority (NJTPA) and the New Jersey Department of Transportation (NJDOT), began to study transportation alternatives that could provide
congestion relief to U.S. Route 1 between Trenton and South Brunswick, New Jersey.

Acknowledging the low-density development patterns in the region and statewide and local taxpayers’ reluctance to finance large rail expansion projects, planners focused on creating a bus rapid transit (BRT) system to link the communities along the Route 1 corridor to each other and the existing Northeast Corridor.

As part of the plan, planners hope to utilize the Princeton Branch right-of-way to run buses between Princeton and Princeton Junction along dedicated bus lanes. This lane would interchange with a similar lane along Route 1 that links Princeton with Plainsboro and South Brunswick to the north, and Lawrence Township and and the suburbs along I-95 in New Jersey and Pennsylvania.

The BRT plan provides an opportunity for Princeton to be tightly integrated into a regional transit system. NJ Transit has had a great deal of success using buses to move commuters into New York via the XBL Bus Lane in the Lincoln Tunnel. However, many of the details regarding the BRT are still under formation, and the success of such a system is unknown, particularly if the system does not provide frequent and reliable service and dedicated rights-of-way so that buses aren’t stuck in traffic.

In addition, as NJ Transit is known to be a reluctant operator of the Dinky (due to its operating loss), some residents worry that the BRT plan will lead to the decommissioning of the Dinky, without an adequate replacement in service.

CONCEPT 4c: ROUTE 1 BUS RAPID TRANSIT
Central New Jersey BRT Alternatives Analysis Study
Providing Transit Service to Suburban Communities

While growing number residents of traffic congested communities are aware of the need for alternative means of transportation, the reality is that because of current land use patterns, many of these areas are unfit for conventional public transit service. These areas feature separated land uses that isolate housing from employment and retail centers, and do not encourage concentrations of activity that would support transit service. Furthermore, distances between homes and stores are such that even walking is not often feasible. Thus, residents are generally left to rely on their car for mobility.

While Borough of Princeton seems relatively dense in the downtown core, and could demonstrate promise as a transit village, a look at the population density figures show that it is less than ideal. The current population of Princeton Borough, which includes a significant number of university students, is estimated to be approximately 13,517\(^8\). This equals about 11.1 persons per acre, just slightly above the conventional threshold of 10 persons per acre needed to begin supporting transit service. The township and surrounding areas have even lower densities.

Therefore, any transit service proposed for Princeton and its surrounding communities will likely not attract enough ridership to be self-sufficient. While this is often the case for public transportation operators, it often produces service that is vulnerable to cuts, leading to infrequent and unreliable service. This makes transit unattractive to all but those with no other alternatives. Since the Princeton area has a high percentage of upper-income residents and jobs, it will be necessary to design a system that can provide frequent and convenient service at the lowest cost.

Moving forward, changes should be encouraged in the development patterns of the region to focus growth near transit infrastructure, and to create street networks that allow walking, bicycling, and cost-effective transit service.

\(^8\) U.S. Census Bureau 2007 Estimate
Alternative 1:
Extending the Dinky

The New Jersey Princeton Branch, or “Dinky”, is a 2.8 mile branch of the original Pennsylvania Railroad that dates from 1865, when the company’s new mainline track connecting New York and Philadelphia was shifted east from its original location along the Delaware & Raritan Canal. The Princeton Branch originally stretched 3.2 miles, just south of the current location of Blair Hall (indeed, Blair Hall’s notable archway and its long flight of stairs were constructed to serve as the entrance to the university from the station).

In its heyday, the Princeton branch welcomed scores of eager Princeton football fans on special trains from New York, Philadelphia, Washington D.C. – along with Yale and Harvard Fans from New Haven and Cambridge. Three yards with over 30 sidings were built to accommodate the traffic (the university’s tennis courts and athletic fields now occupy the space). In 1905, the branch was double-tracked and a new swing bridge over the canal was constructed. In 1920, as university buildings pressed up against the Dinky’s tracks and students complained about the soot from locomotives, the station was moved to its current location, shortening the branch by several tenths of a mile. The line was electrified in 1936.

While the survival of the Princeton Branch has been threatened several times over the past decades, it has managed to remain in operation. As the nearby region experienced growth of the late 1990s, NJ Transit has considered expansion of the Princeton Branch deeper into Princeton and to towns further north such as Rocky Hill and Montgomery. However, with the current economic climate, these plans have not been discussed any further. In addition, the university has announced plans to move the current station at least 500 feet south to accommodate a new performing arts center. In combination with a potential bus rapid transit line that is being studied by the New Jersey Department of Transportation to connect Princeton with the Route 1 corridor (NJ Transit is said to be a reluctant operator of the Dinky), the future of the Dinky may be in doubt.

EXTENSION TO NASSAU STREET

To counter the effect of the university’s plan to relocate the Dinky station further away from campus and the downtown core, a new .7 mile underground extension could restore the line’s original terminus near Nassau Street. The likely location of a new station would be at Palmer Square. The costs of such an extension are estimated at $45-$65 million, depending on the tunneling technology used (this is likely to be a combination of cut-and-cover and bored
Additionally, the entire Princeton Branch could be automated to allow for more frequent and cost-effective service.

**Potential ridership gains**

It is difficult to what effect an extension to Palmer Square would have on ridership. However, it would likely lead to fewer car trips to the commuter parking lots, as more residents would be within walking distance to the station. Compared to the university’s plans to relocate the station southward – which is likely to decrease ridership somewhat – a new Palmer Square station would serve to retain existing ridership on the Dinky – if not grow it. Should the train’s schedule be lengthened and the frequency of departures increased, the line could also attract additional riders.

**Cost Benefit Analysis**

Assuming a total cost of $55 million for construction of a new underground tunnel, station and automated vehicles and control equipment, the Princeton Branch could serve 2,500-2,800 passengers per average weekday. Compared to the possible reduction of ridership to 1,800-2,000 from the current level of 2,260, the capital costs per passenger would equal approximately $68,000-$80,000. This figure makes it unlikely that such an expansion would be funded. Similar rail construction projects have a much more cost-effective per rider outlay of $13,500-$16,000 (St. Louis, Houston).

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<th>DINKY EXTENSION OVERVIEW</th>
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<td><strong>Capital costs/new rider</strong></td>
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<td><strong>Costs per passenger/mile</strong></td>
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<td><strong>Travel time from Palmer Square to Princeton Junction</strong></td>
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Alternative 2: Bringing Bus Rapid Transit (BRT) to Princeton

Bus rapid transit (BRT) is a more recent transportation technology that uses bus vehicles to provide service similar to rail transit. Using a combination of fewer stops, frequent service, larger vehicles, off-vehicle fare collection, synchronized signaling, and dedicated rights-of-way, BRT has approached the speed, capacity and reliability of light-rail trains in some cities. Los Angeles, Pittsburgh, Boston, Cleveland and New York currently operate BRT lines or have plans to do so. While controversies do exist about the effectiveness of BRT, this analysis will only focus on the current proposal for BRT service for Princeton, and make recommendations for its improvement.

THE PLAN

The current proposal involves building an exclusive bus right-of-way along the Route 1 corridor and alongside the Princeton Branch right-of-way between Princeton Borough and Princeton Junction in West Windsor. These dedicated rights of way would become the backbone of an eight line BRT system that would connect a new rail station and park-n-ride facility in South Brunswick in the north to new park-n-ride stations along I-95 as far south as Bucks County, Pennsylvania. The system would total about 36 miles of dedicated busways, 22 stations, and 7 park-n-ride facilities. The construction cost estimates have ranged from $600-$800 million for the entire system. NJ DOT planners estimate that the system could serve 43,500 weekday riders by 2025 (in contrast to the 26,600 riders that NJ DOT estimates will attract with existing bus service).

RECOMMENDATIONS

Ensure that the dedicated right-of-way is continuous for all segments of the network. While the majority of the proposed BRT network will travel on exclusive BRT guideway, the current plan still has several segments where buses would flow on lanes with mixed traffic. In order for the Route 1 BRT lines to be attractive to commuters, it’s critical that they remain separate from congested traffic on Route 1. This recommendation also applies to the BRT proposed route through Princeton Borough. While exclusive lanes may be difficult to identity in the downtown core, they are essential for the success of the line. One option might be the removal of street parking during rush hour to create a bus lane.

Provide adequate pedestrian infrastructure at stations. Much of the existing development along Route 1 is often unfriendly or inaccessible to pedestrians. Care
must be taken to upgrade the environment and connections to destinations around BRT stations in order to make the system most useful. For example, stations at the retail centers should incorporate pleasant and protected pathways through the parking lots. Also, heated shelters, real-time “next bus” signs, and restrooms should be encouraged. At park-n-ride stations, planners should ensure that parking does not overwhelm the station.

**Encourage transit-supportive development around stations.** While the BRT will help to provide frequent and reliable transit service to the Route 1 corridor, it will be most cost-effective if the local municipalities focus new growth around the new stations, ensuring that new housing and jobs in the region are transit accessible, helping to reduce traffic and leveraging the public investment in the new system.

**ALTERNATIVE 2A: INTEGRATE BRT WITH PRINCETON BRANCH**

While the current preferred alternative calls for replacement of the Dinky with the new BRT system, an alternative option would preserve the Dinky and create a transfer and park-n-ride station at Route 1. This would allow simple transfers between the current rail system and the proposed BRT system. To be most effective, the Dinky extension should be completed, and automation and double tracking should occur to bring headways down to 10 minutes or less.
Alternative 3: Could Personal Rapid Transit (PRT) Work for Princeton?

Personal rapid transit (PRT), also called personal automated transport (PAT), is a public transit concept that has long been the dream of a select group of transportation planners – as they could potentially offer a true alternative to the personal automobile. The system provides on-demand, non-stop point-to-point transportation, using small automated vehicles on a network of exclusive guideways. While numerous designs have been proposed, only one system in Morgantown, West Virginia has ever been built. Yet, with a new PRT project under construction at Heathrow Airport in London, interest in PRT is again rising. As PRT is billed as low-cost way to provide reliable, efficient transit service in areas without the densities traditionally required for conventional rail transit, it could provide an interesting solution for Princeton area.

The PRT system under construction at Heathrow Airport is utilizing a system developed by Advanced Transport Systems Ltd of Cardiff, Wales called ULTra (“Urban Light Transport”). This system utilizes small 4-person vehicles with rubber tires, with cost estimates of about $10 million per mile of track (single direction). The system can climb grades up to 20%, which makes it useful for application in Princeton.

A proposed network for the Princeton area would seek to incorporate current transit service (Dinky, Tiger Transit Shuttles) along with some of the proposed transit service under the Route 1 BRT corridor plan – including the retail and employment centers along US 1.

In this case, a 30 mile/41 station network of PRT guideway using the ULTra technology has been proposed. The system
would replace the Dinky service between Princeton Junction and Princeton Borough, and serve the majority of campus stops currently served by the Tiger transit shuttle.

The advantage of the ULTra system is that the guideway is only 5 feet wide, making it theoretically possible to build most of the guideways alongside existing streets at grade. Grade separations would only be required at major street/pedestrian crossings and some turns. This system would therefore seek to grade separate only 30-35% of its guideway – rather then the 90% that is typically estimated for a commercial PRT system.

**Phase I – Trunk Line**
The first phase would consist of 9.5 miles of guideway, including a 5 mile segment of double tracked between Princeton Junction and Faculty Road along the Princeton Branch right-of-way. The line would connect 19 stops on the Princeton Campus and Nassau Street with Princeton Junction station. The cost of the first phase would total approximately $95-$114 million.

This line would absorb the existing ridership of the Dinky, along with Princeton’s Tiger Transit shuttles and on-demand service – which reported an annual ridership of 723,000 boardings in 2007. Thus, we could anticipate that ridership on the first phase of the PRT system would attract approximately 4,500-6,000 in average weekday ridership. Furthermore, the opportunity exists to add stations along the Dinky right-of-way to connect a number of office parks along Alexander Road with the PRT system for the cost of one or more additional stations, which are estimated to cost $1-$1.5 million each. Finally, a park-n-ride facility could be constructed adjacent to Route 1 to encourage visitors to Princeton and other destinations to use the line.

**Phase II – Canal Pointe/PTS Winsdor Line**
This 4 mile line would connect Princeton’s planned Canal Pointe Administration Building and the Princeton Theological Seminary West Windsor Campus and Housing with the main Princeton Campus and the Princeton Junction station. In addition, it could serve the Marketfair shopping center, and the Carnegie Center Office/Hotel Complex. The cost of the phase would be $36-$44 million. Ridership for this line is difficult to calculate, but is conservatively estimated at 300-500 additional average weekday riders.

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9 Princeton Transportation & Parking, Ridership Figures 2007
PROPOSED PRT SYSTEM
Princeton/Central NJ Route 1 Corridor
Phase III – Princeton Borough/Township Line
This 3 mile extension would extend the PRT into Princeton Borough and Township along Nassau Street, Harrison Street, Walnut Lane, Franklin Avenue and Witherspoon Street. The line would serve Princeton Shopping Center, the Westminster Choir College, the Princeton Medical Center, along with providing more convenient stops for residents of the Borough and Township destined for Princeton Junction and other destinations to board the PRT. Because complicated land acquisition and grade separated turns will be involved, the cost of this phase would be $30-$36 million, with ridership estimated to be 300-500 additional average weekday riders.

Phase IV-IVa – Research Line
This 6 mile extension of the PRT network would serve the Princeton Forrestal Campus, along with the future location of the Princeton Medical Center. The cost would range from $48-$60 million and serve an additional 300-500 average weekday riders (once the medical center was completed). An additional 2.5 mile extension of this line could serve the string of major corporate offices and research facilities along College Road East, including Bristol Myers Squibb, Merrill Lynch, and Siemens – who employ over 2,500 workers in the area. The additional cost for this extension would be $20-$25 million, and attract an additional 300-500 average weekday riders.

Phase V – Route 1 Shopping Line
This 5 mile extension of the PRT network would serve the regional shopping core along Route 1 and Quakerbridge Road – including Windsor Green Shopping Center, Nassau Pavilion, Mercer Mall and Quakerbridge Mall. The line would largely be grade separated, and likely cost $50-$60 million and serve an estimated 300-500 additional weekday riders.

ADDITIONAL ISSUES

Managing peak travel. As Princeton Junction station is already the 5th busiest station, with 7,800 average weekday boardings\(^{10}\), the PRT system must be able to accommodate a peak load of 60-80 passengers destined for Princeton Borough at one time. This might be accommodated by designating a minimum number of vehicles to be waiting at Princeton Junction at all times. Furthermore, larger vehicles (8-12 passengers) may be expressly designed for this purpose.

Operating costs. As there are not yet commercially operating examples of the ULTra system, it is difficult to estimate the ongoing operating costs for the system. However, the operating costs for the 22 automated guided systems in the U.S. averages 27 cents per passenger-mile\(^{11}\). The developers of the ULTra system state that they believe the system can be operated for a similar amount. Thus, given an estimated annual ridership of 1.7-2.4 million riders at an average ride of 6 miles – the entire system would cost $2.3-$3.3 million per year to operate. For just the trunk line, the system would average $1.7-$2.3 million per year.

Fares. The PRT system would charge a fare for trips that originated or terminated at Princeton Junction. In addition, fares could be charged for trips between Princeton Borough and the retail centers along Route 1. Using the $2.50 fare currently charged by NJ

\(^{10}\) NJ Transit Facts at a Glance FY 2007

\(^{11}\) Comparison of Costs between Bus, PRT, LRT and Metro/rail, Göran Tegnér, TRANSEK Consultants
transit and the estimated ridership to Princeton Junction, the PRT system would generate approximately $2.2-$2.6 million per year. The additional revenue could be generated from contributions from Princeton University (as a replacement for its shuttle services), and revenue from the Route 1 park-n-ride.

COULD PRT WORK?

Looking at the rough estimates, PRT is not particularly competitive with BRT when it comes to capital costs per new rider. However, the costs per passenger/mile are significantly lower, and PRT will has the potential to provide higher quality service. Thus, an analysis should be taken to determine how to boost new ridership of the new system. As the per mile cost of guideway is still less than of BRT, an expansion of the system to additional commuter park-n-ride lots in suburban locations might help boost ridership.

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The three alternatives presented in this report are by no means a comprehensive list of options for improving mobility in and around Princeton. However, these alternatives provide useful information about how best to proceed with plans for new service in the region.

As existing transit service in the Princeton vicinity is already being utilized fully by those who can, any new transit service should seek to connect new destinations that lack adequate service. Special detail must be placed on creating a convenient, reliable and cost-effective alternative to automobiles if planners expect to attract new riders.

While the existing service between Princeton and Princeton Junction is threatened, an extension of the line to Palmer Square – while increasing convenience – is likely to generate few new riders. Thus, such an extension is likely to be deemed not cost-effective, unless combined with modifications to increase the service hours and frequency of the Dinky.

The proposed BRT network for the Route 1 Corridor looks promising, so long if planners can secure exclusive rights-of-way and ensure frequent service. Alternatively, a PRT system might be appropriate for the Princeton area, if adequate ridership can be generated from a well-planned network.

Regardless of what solutions are chosen by planners and the community, it will be crucial important to link future land use with these transportation plans to fully leverage the public and private investment in this infrastructure. If the region continues to spread and build housing separate from jobs and stores, no amount of transit could hope to relieve traffic congestion or reduce auto emissions.